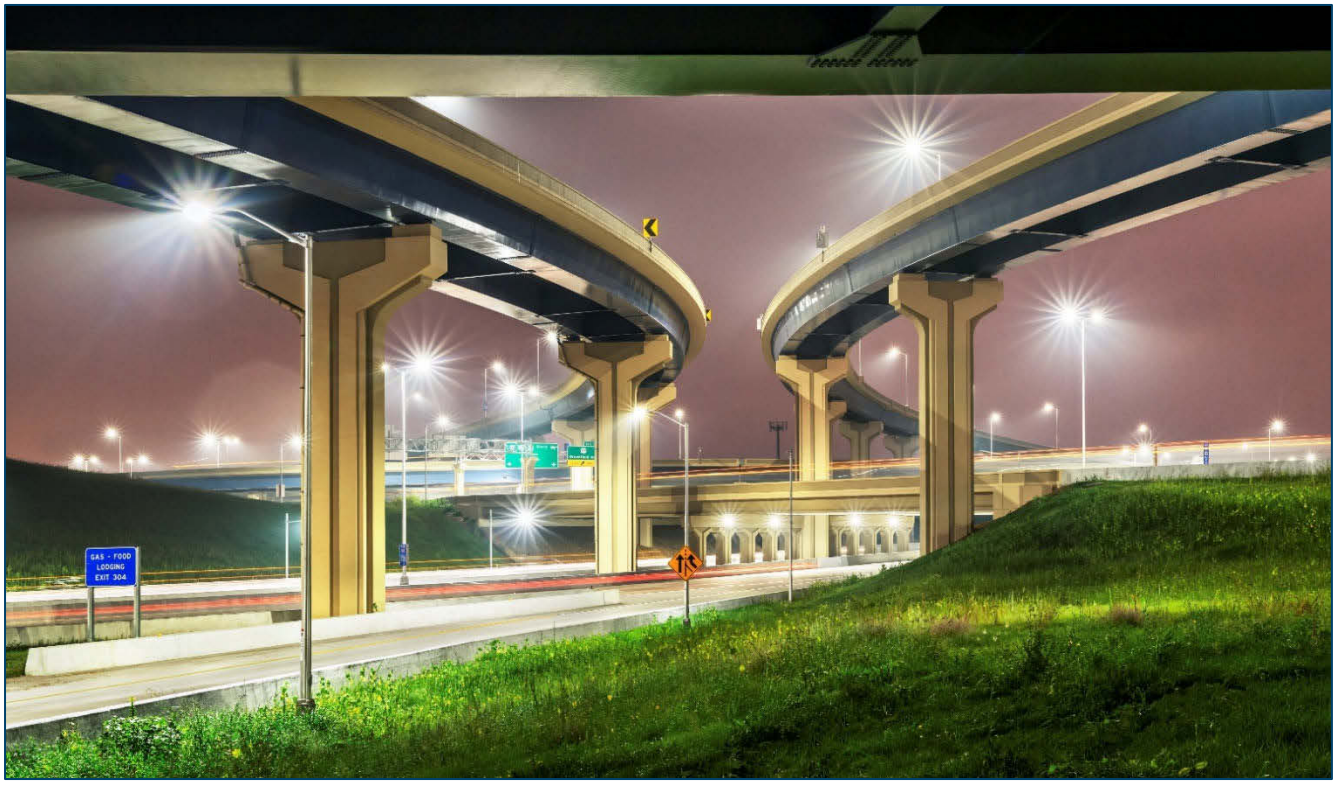
Construction and Materials Manual

Wisconsin Department of Transportation
Bureau of Project Development

April 2026 Edition



Annotations, shown in boxed text on the table of contents with updates, in this edition of the Construction and Materials Manual identify the substantive revisions made since the last edition. A brief explanation of each provision revised is provided both in the table of contents with updates and again adjacent to each revision within the chapter.

Foreword

WisDOT provides the Construction and Materials Manual (CMM) to help staff administer and inspect construction projects. The goal is uniform application and enforcement of contract requirements.

The CMM clarifies the contract and may reference contract requirements but does not supersede the contract. The CMM also communicates department policies, practices, and expectations to consultants, contractors, and other construction industry partners.

CMM guidance is based on common industry practice for transportation construction work. Situations not covered require experience, engineering judgment, and advice from experienced engineers, supervisors or subject matter technical experts.

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Most CMM content is not part of the contract. However, some of the CMM is mobilized into the contract by specific reference from within the contract. CMM sections referenced in the standard specifications have an orange-highlighted entry pointing to contractual language within that section. For example:

Standard spec references to concrete testing and sampling methods contained in this chapter:
Standard spec 701.3 ..... concrete testing
CMM provisions mobilized by the contract:
CMM 870.4.8 ..... strength/maturity relationship development

Within the section, above the heading of the referenced content, there will be an orange-highlighted entry identifying standard specification references. For example:

Requirements for developing a strength/maturity relationship are mobilized into the contract by standard spec 502.3.10.1.3.

CMM sections explicitly referenced in the standard specifications are tabulated below.

CMM Sections Mobilized into the Contract

CMM Section	Contractual Reference
CMM 145	Quality standards for temporary concrete barrier
CMM 424	Assignment of cost for crack repairs
CMM 525	Evaporation nomograph
CMM 645	Erosion Control Implementation Plan (ECIP)
CMM 710	Construction data packet
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CMM 836	HMA QMP requirements
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SECTION 110 Project Management

110.1 Introductions and Definitions

For additional information (on Project Management in Design/Planning) see FDM 2-1.

110.1.1 Originator

The Bureau of Project Development (BPD) is the originator of this section. Any questions or recommendations concerning this chapter should be directed to the BPD Proposal Management Section, DOT DTSD BPD Project Management mailbox. Terms and acronyms used in this section are defined in FDM 2-1 Attachment 1.1 and FDM 2-1 Attachment 1.2.

110.1.2 Overview

FDM Chapter 2 includes policies, standards, procedural requirements and guidelines used to deliver highway improvement projects. Project management is using skills, knowledge, and resources to deliver the right project that meets the division's and public's expectations for schedule, costs and serviceability.

DTSD's project management begins at program development and carries through facility construction project closure. Project management methodology is applied throughout the following major phases: Project Initiation, Design, and Construction are discussed in FDM 2-15. Each of these phases includes one or more processes to complete one or more products, services, or projects.

110.1.3 Project Management Support

The DTSD provides support for project management through the Transportation Project Management System (TPMS) which is developed, implemented and maintained by the Division's Project Management Unit. The TPMS includes the applications, reports, training, processes, documentation, support, etc. that are needed to manage WisDOT improvement projects. DTSD's project management methodology is applying processes and procedures to advance projects through sequential phases that result in completing one or more products or services. This methodology includes application of knowledge and skills in managing the project plan, scope, schedule, costs, quality, team, communications, performance, risks and contracted services.

The Project Management Steering Committee (PMSC) is modal in representation and the sounding board for important project management strategic directions and implementation efforts. The Project Management Unit supports the PMSC by developing, implementing, maintaining and evaluating the TPMS.

110.2 Program vs. Project Management

For additional information (on Project Management in Design/Planning) see FDM 2-5.

Program management is the process of managing a group of related projects in a coordinated way. Program management provides well defined system goals that are met through the completion of a group of projects. Through oversight of the related projects, program management ensures the overall program goals are met.

Project management is the discipline of planning, organizing, securing, and managing resources to bring about the successful completion of specific project goals and objectives. A project is a well-defined sequence of activities that, when completed, result in a tangible product - a highway safety improvement, for example.

The goals of Program Management and Project Management are the same. The primary difference between program management and project management is in the number of projects considered in measuring success of each of the goals.

110.3 Program vs. Performance Management

For additional information (on Project Management in Design/Planning) see FDM 2-10.

Performance management is a continuous process of asking what is important to the organization, how those activities can be monitored and identifying opportunities for improvement. All DTSD staff and management are involved in performance management. Each of us has a role to play in either direct project delivery or the management of a program. Likewise, each of us is responsible to ensure that we deliver a quality product as efficiently as possible.

As DTSD takes a new look at performance management, the division is emphasizing the structure needed to not only successfully identify potential improvement areas but to build this process of continuous improvement into the organization in a more structured manner. WisDOT staff can review performance measure information on the MyDOT site at:

https://wigov.sharepoint.com/sites/dot/Pages/NewsAndLearning/mapss.aspx

Project management plans are a key component to the performance management system. Accurate scope, schedule and budget information allows project teams to track progress, compare progress to benchmarks and inform the department of the project's progress. Monitoring and controlling these elements will lead to stable project delivery, a project that meets the intended needs and is delivered on time and at or below budget.

Performance measures and indicators are essential for a continuously improving organization. Process improvements that result from the feedback loop allow the division to increase quality, exhibit good stewardship and potentially reduce resource demand in some areas so they can be shifted to new tasks.

Questions about individual performance measures should be directed to your business area representative. Questions about project specific results should be directed to your management team.

110.4 Project Integration Management

For additional information (on Project Management in Design/Planning) see FDM 2-15.

110.4.1 Overview

Project Integration Management is the practice of making certain every part of the project is coordinated. Project management is an integrative undertaking requiring each project process to be appropriately aligned and connected with the other processes to facilitate coordination. The project manager is responsible for this coordination. Corporate supported project management tools must be used to prepare the project plan, record, manage, and report project information.

The Project Management Plan includes documents of decisions regarding project scope, schedule, budget, quality, resources, communication, stakeholders, risks, and procurements. Once compiled the plan is placed under control and forms the basis for monitoring project work.

The PDS project manager must prioritize work to resolve competition for time and resources and keep the team focused on completing the project work. Project work must be monitored to verify the planned work is progressing in accordance with the approved project plan. Corrective action is implemented as needed to meet the project requirements.

Current accepted practice considers project management as a five-step process which has a logical sense of flow. The five steps are:

1. Initiating
2. Planning
3. Executing
4. Monitoring and Controlling
5. Closing

Interwoven into these five steps are a number of knowledge areas. Each knowledge area is an identified part of project management defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools, and techniques. The current knowledge areas are:

- Change
- Scope
- Schedule
- Budget
- Quality
- Resources
- Procurement
- Communication
- Stakeholders
- Risk

The five-step process and the knowledge areas are united and coordinated by applying project integration management knowledge and skills. The interrelationship between the five steps and the knowledge areas is shown on the Five Step Process and Knowledge Area Matrix in FDM 2-15 Attachment 1.1. The interrelationship is discussed extensively in FDM 2-20.

The department is responsible for a wide variety of improvement project types, from a simple resurfacing project to an extremely complex "mega" project. The project management efforts needed to complete a particular project successfully also vary widely. The information in the following sections will focus on activities needed for a standard project. The activities would become more and more involved as the complexity of a project increases.

110.4.2 Processes in Project Integration Management

Following are the steps in the broad concept that PMBOK® calls the Project Integration Management Process.

110.4.2.1 Develop Project Overview

At WisDOT, the project overview:

- Formally authorizes the existence of a project
- Provides the project manager with authority to apply organizational resources to project activities
- Provides well-defined project start and project boundaries
- Creates a formal record of the project
- Validates alignment of the project to the strategy and ongoing work of the organization

110.4.2.2 Develop Project Management Plan

The project management plan is a summary of the various knowledge area plans discussed in CMM 110.5 and includes Change Management discussed below in CMM 110.4.2.5.

110.4.2.3 Direct and Manage Project Work

"The process of leading and performing the work defined in the project management plan."[1]

110.4.2.4 Monitor and Control Project Work

"The process of tracking, reviewing, and reporting project progress against the performance objectives defined in the project management plan." [1]

110.4.2.5 Change Management

"Change Management is the process of reviewing change requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating their disposition. IT reviews requests for changes or modifications to project documents, deliverables, baselines, or the project management plan and approves or rejects the changes." [1]

The primary changes during this Construction Process that are considered are changes to the scope, schedule, or budget baselines, although changes to communication, resources, procurement, quality, or risk management plans may also need discussion.

During construction, the changes being managed are usually change orders (CMM 242), cost reduction incentives (CMM 244), contract claims (CMM 254), incentive/disincentives (CMM 234.1), liquidated damages (CMM 234.2), and force account work (CMM 246). There may also be changes to the project schedule and budget, as well as the staff/consultant budget. It is possible that other change requests may also be considered. Approved changes are processed through the Contract Modification Process (CMM 242).

Project managers should follow the change management process in place in their Region.

110.4.2.6 Close Project

At WisDOT, closing a project consists of finalizing all activities across all processes to formally close the project or phase.

110.5 Project Management in Construction

For additional information (on Project Management in Design/Planning) see FDM 2-20.

110.5.1 Scope Management

"Scope Management includes the processes required to ensure that the project includes the work required, and only the work required, to complete the project successfully. Managing the project scope is primarily concerned with defining and controlling what is and is not included in the project."[1] For expanded definitions of the Scope Management process, see FDM 2-20 Attachment 5.1.

Scope Management, Schedule Management (CMM 110.5.2), and Budget Management (CMM 110.5.3) are closely aligned, and their respective plans are usually developed at the same time.

Inputs used by WisDOT to manage the scope are the plans, special provisions, and the executed contract. Another input is the contractor's progress schedule (standard spec 108.4). The contractor may also notify the engineer of possible revisions to the contract (standard spec 104.2) or propose Cost Reduction Incentives (CMM 244).

The scope management plan includes six processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Scope Management	Planning	FDM 2-20
Collect Requirements	Planning	FDM 2-20
Define Scope	Planning	FDM 2-20
Use WisDOT's WBS	Planning	FDM 2-20
Validate Scope	Monitoring and Controlling	FDM 2-20
Control Scope	Monitoring and Controlling	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.1.1 Plan Scope Management

"Plan Scope Management is the process of creating a scope management plan that documents how the project scope will be defined, validated, and controlled."[1]

At WisDOT, the scope of the construction project is detailed in the plans, special provisions, and the executed contract. The plan for managing the scope is to ensure the plans, special provisions, and contracts are followed.

110.5.1.2 Collect Requirements

"Collect Requirements is the process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives."[1]

At WisDOT, the scope of the construction project is detailed in the plans, special provisions, and the executed contract. That information comprises the requirements.

110.5.1.3 Use WisDOT's Work Breakdown Structure

The process of subdividing project deliverables and project work into smaller, more manageable components is simplified since the department already has a work breakdown structure (WBS)."[1]

At WisDOT, most of the standard projects do not need to use this process. This process will usually only be used on the high profile or mega projects, as they may have more unusual construction activities.

110.5.1.4 Validate Scope

"Validate Scope is the process of formalizing acceptance of the completed project deliverables."[1]

At WisDOT, the scope of the construction project is detailed in the plans, special provisions, and the executed contract. The objective of validating the scope is to reach a common understanding between the contractor and WisDOT on the extent of the work.

110.5.1.5 Control Scope

"Control Scope is the process of monitoring the status of the project scope and managing changes to the scope baseline."[1]

Project progress meetings are discussed in CMM 218.3.1. The Progress Schedule, CMM 165.2, the Project Tracking System CMM 165.3, and Field Manager CMM 165.8 provide valuable input at the progress meetings.

As part of the Control Scope process, the Region has a role in monitoring the status of all projects in the Program (See Program Monitoring discussions in Chapter 3 of the Program Management Manual.) For individual projects, changes in the scope need to be discussed in context of the impacts on a Program.

110.5.2 Schedule Management

"Schedule Management includes the processes required to manage the timely completion of the project."[1] For expanded definitions of the Schedule Management process, see FDM 2-20 Attachment 5.2.

Scope Management (CMM 110.5.1), Schedule Management, and Budget Management (CMM 110.5.3) are closely aligned, and their respective plans are usually developed at the same time.

The schedule management plan includes seven processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Schedule Management	Planning	FDM 2-20

Define Activities	Planning	FDM 2-20
Sequence Activities	Planning	FDM 2-20
Estimate Activity Resources	Planning	FDM 2-20
Estimate Activity Durations	Planning	FDM 2-20
Develop Schedule	Planning	FDM 2-20
Control Schedule	Monitoring and Controlling	FDM 2-20-15.4.1

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.2.1 Plan Schedule Management

"Plan Schedule Management is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule."*[1]*

At WisDOT, the schedule of the construction project is detailed in the plans, special provisions, and the executed contract. The plan for managing the schedule is to ensure the plans, special provisions, and executed contract are followed.

110.5.2.2 Select Activities

"Select Activities is the process of identifying and documenting the specific actions to be performed to produce the project deliverables."*[1]*

At WisDOT, most of the standard projects will not use this process. This process will usually only be used on the high profile or mega projects, as they may have more unusual construction activities.

110.5.2.3 Sequence Activities

"Sequence Activities is the process of identifying and documenting relationships among the project activities."*[1]*

At WisDOT, most of the standard projects will not use this process. This process will usually only be used on the high profile or mega projects, as they may have more unusual construction activities.

110.5.2.4 Estimate Activity Resources

"Estimate Activity Resources is the process of estimating the type and quantities of material, resources, equipment, or supplies required to perform each activity."*[1]*

At WisDOT, most of the standard projects will not use this process. This process will usually only be used on the high profile or mega projects, as they may have more unusual construction activities.

110.5.2.5 Estimate Activity Durations

"Estimate Activity Durations is the process of estimating the number of work periods needed to complete individual activities with estimated resources."*[1]*

At WisDOT, most of the standard projects will not use this process. This process will usually only be used on the high profile or mega projects, as they may have more unusual construction activities.

110.5.2.6 Develop Schedule

"Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model."*[1]*

At WisDOT, the Region PDS Project Manager (Design) created the preliminary construction schedule showing the estimated contract time (See FDM 19-10-30 for a discussion of Contract Time for Completion). This estimated time was included in the bidding documents and the successful contractor must comply with that time requirement. The Develop Schedule process involves reviewing the contractor's schedule of operations for compliance with the contract documents. When the contractor's schedule is approved, the PDS Project Manager (Construction) can prepare a schedule for contract administration by WisDOT staff and/or consultant staff.

110.5.2.7 Control Schedule

"Control Schedule is the process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan."*[1]*

The Control Schedule sub-process involves reviewing the contractor's approved schedule of operations against the actual progress. When the contractor's progress is not in line with the approved schedule, the contractor should initiate corrective action. The PDS Project Manager (Construction) also acts to bring the progress back in line with the schedule or require a revised schedule. Changes to the approved schedule may result in changes to the WisDOT schedule for contract administration.

110.5.3 Budget Management

"Budget Management includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so that the project can be completed within the approved budget."[1] For expanded definitions of the Budget Management process, see FDM 2-20 Attachment 5.3.

Scope Management (CMM 110.5.1), Schedule Management (CMM 110.5.2), and Budget Management are closely aligned, and their respective plans are usually developed at the same time.

The budget management plan includes four processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Budget Management	Planning	FDM 2-20
Estimate Costs	Planning	FDM 2-20
Determine Budget	Planning	FDM 2-20
Control Costs	Monitoring and Controlling	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.3.1 Plan Budget Management

"Plan Budget Management is the process that establishes the policies, procedures, and documentation for planning, managing, expending, and controlling project costs."[1]

At WisDOT, budget management is more concerned with the monitoring the cost to construct the improvement project. This is done by watching for potential changes to the scope or schedule. The other component costs of the project (delivery and non-delivery) are also managed, just not to the extent as the construction cost. The delivery cost (cost of in-house and/or consultant staff to administer the construction contract) is dependent on the time the contractor takes to complete the work under the contract.

110.5.3.2 Estimate Costs

"Estimate Costs is the process of developing an approximation of the monetary resources needed to complete project activities."[1]

At WisDOT, the cost of in-house and/or consultant staff to administer the construction contract is estimated based on previous similar construction contracts.

110.5.3.3 Determine Budget

"Determine Budget is the process of aggregating the estimated costs of individual activities or work packages to establish an authorized Budget baseline."[1]

As noted above, budget management at WisDOT is more concerned with monitoring the cost to construct the improvement project. The other component costs of the project (delivery and non-delivery) are also managed, just not to the extent as the construction cost. The overall project budget is the sum of the money expected to be paid to the contractor under the contract, the delivery costs, and non-delivery costs.

110.5.3.4 Control Costs

"Control Costs is the process of monitoring the status of the project to update the project costs and managing changes to the budget baseline."[1]

The Control Costs process involves monitoring the two main items: contract costs and delivery costs. The contract costs are monitored by reviewing the contractor's status of work complete against the time elapsed (See discussion of Field Manager in CMM 165.8 for this information). When the contractor's work complete is not in line with the time elapsed, the PDS Project Manager (Construction) needs to advise the contractor of the discrepancy and ask for an explanation of the difference. Cost can also be reviewed with over runs/under runs on items performed and change orders. The delivery costs are monitored by reviewing in-house and/or consultant hours against the earlier estimates.

The construction cost estimate is updated at least twice during the construction process:

- Life cycle 40 - After the project is awarded.
- Life cycle 50 - When the construction is complete.

110.5.4 Communication Management

"Communication Management includes the processes that are required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the

ultimate disposition of project information."[1] For expanded definitions of the Communication Management process, see FDM 2-20 Attachment 5.6.

Communication Management and Stakeholder Management (CMM 110.5.5) are closely aligned.

The communication management plan includes three processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Communication Management	Planning	FDM 2-20
Manage Communication	Executing	FDM 2-20
Control Communication	Monitoring and Controlling	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.4.1 Plan Communication Management

"Plan Communications Management is the process of developing an appropriate approach and plan for project communications based on stakeholder's information needs and requirements, and available organizational assets."[1]

At WisDOT, the Plan Communication Management process started as part of the Design function is continued into this Construction function. An important part of the process is considering the information in the R/W commitments to Project Manager supplied by the Technical Services Section - Real Estate.

110.5.4.2 Manage Communication

"Manage Communication is the process of creating, collecting, distributing, storing, retrieving, and the ultimate disposition of project information in accordance with the communications management plan."[1]

At WisDOT, the communication processes are discussed in CMM 218.3 - Project Communication and 2-20 - Public Relations. The project manager should work with the Region Communication Manager (RCM) to ensure that effective consistent communication is provided to internal and external stakeholders.

110.5.4.3 Control Communication

"Control Communication is the process of monitoring and controlling communication throughout the entire project life cycle to ensure the information needs of the project stakeholders are met."[1]

As noted above, the communication processes are discussed in CMM 218.3 - Project Communication and 2-20 - Public Relations. The project manager should work with the Region Communication Manager (RCM) to ensure that effective consistent communication is provided to internal and external stakeholders.

110.5.5 Stakeholder Management

"Stakeholder Management includes the processes required to identify the people, groups, or organizations that could impact or be impacted by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution."[1] For expanded definitions of the Scope Management process, see FDM 2-20 Attachment 5.1.

Stakeholder Management and Communication Management (CMM 110.5.4) are closely aligned.

The stakeholder management plan includes four processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Identify Stakeholders	Initiating	FDM 2-20
Plan Stakeholder Management	Planning	FDM 2-20
Manage Stakeholder Engagement	Executing	FDM 2-20
Control Stakeholder Engagement	Monitoring and Controlling	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.5.1 Identify Stakeholders

"Identify Stakeholders is the process of identifying the people, groups, or organizations that could impact or be impacted by a decision, activity, or outcome of the project, analyzing and documenting relevant

information regarding their interests, involvement, interdependencies, influence, and potential impact on project success."[1]

At WisDOT, the initial interaction with stakeholders is done as part of the programming process and continues in the Design function. An important document used to track those interested in the project is the Stakeholder Register. When the project responsibility shifts to BPD - Construction the register should be reviewed to see if additional entries are needed. One primary source of potential new stakeholder is the R/W commitments to Project Manager supplied by the Technical Services Section - Real Estate.

110.5.5.2 Plan Stakeholder Management

"Plan Stakeholder Management is the process of developing appropriate management strategies to effectively engage stakeholders throughout the project life cycle, based on the analysis of their needs, interests, and potential impact on project success."[1]

At WisDOT, the Plan Stakeholder Management process started as part of the Design function is continued into this Construction function. An important part of the process is considering the information in the R/W commitments to Project Manager supplied by the Technical Services Section - Real Estate.

110.5.5.3 Manage Stakeholder Engagement

"Manage Stakeholder Engagement is the process of communicating and working with stakeholders to meet their needs/expectations, address issues as they occur, and foster appropriate stakeholder engagement in project activities throughout the project life."[1]

At WisDOT, the communication processes are discussed in CMM 218.3 - Project Communication and 2-20 - Public Relations. The project manager should work with the Region Communication Manager (RCM) to ensure that effective consistent communication is provided to internal and external stakeholders.

110.5.5.4 Control Stakeholder Engagement

"Control Stakeholder Engagement is the process of monitoring overall project stakeholder relationships and adjusting strategies and plans for engaging stakeholders."[1]

As noted above, the communication processes are discussed in CMM 218.3 - Project Communication and 2-20 - Public Relations. The project manager should work with the Region Communication Manager (RCM) to ensure that effective consistent communication is provided to internal and external stakeholders.

110.5.6 Resource Management

"Resource Management includes the processes that organize, manage, and lead the project team."[1] For expanded definitions of the Resource Management process, see FDM 2-20 Attachment 5.5.

The resource management plan includes four processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Resource Management	Planning	FDM 2-20
Acquire Project Team	Executing	FDM 2-20
Develop Project Team	Executing	FDM 2-20
Manage Project Team	Executing	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.6.1 Plan Resource Management

"Plan Resource Management is the process of identifying and documenting project roles, responsibilities, required skills, reporting relationships, and creating a *resource* management plan."[1]

At WisDOT, for most improvement projects, the resources are assigned based on the staffs that were needed to complete similar projects in the past. If there are not enough in-house resources available, consultant staff are obtained as discussed in the Procurement Management Plan (CMM 110.5.7).

110.5.6.2 Acquire Project Team

"Acquire Project Team is the process of confirming human resource availability and obtaining the team necessary to complete project activities."[1]

At WisDOT, the project team is generally assigned, with the number and skills of the team members determined based on previous similar projects.

110.5.6.3 Develop Project Team

"Develop Project Team is the process of improving competencies, team member interaction, and overall team environment to enhance project performance."[1]

At WisDOT, the project team usually has the needed competencies and there is minimal development needed.

110.5.6.4 Manage Project Team

"Manage Project Team is the process of tracking team member performance, providing feedback, resolving issues, and managing team changes to optimize project performance."[1]

At WisDOT, the project manager monitors performance and then provides information about each team member's performance to his/her supervisor.

110.5.7 Procurement Management

Broadly defined, Procurement Management includes the processes necessary to purchase or acquire goods or services needed from outside the project team. At WisDOT, procuring engineering services is allowed under Chapter 84 of the Wisconsin Statutes. WisDOT's procurement policies and procedures are described in FDM Chapter 8.

Note: Sometimes services are supplied by municipal staffs. Those can be design engineering services and/or construction inspection services. However, the process to procure those services is discussed in FDM 3-20 Attachment 11.1 - A Policy on Construction of State and Federal-Aid Highway Projects by Forces and Equipment of Counties or Other Local Governmental Units. The process to procure services by consulting firms is discussed below.

The procurement management plan includes four processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Procurement Management	Planning	FDM 2-20
Conduct Procurements	Executing	FDM 2-20
Control Procurements	Monitoring and Controlling	FDM 2-20
Close Procurements	Closing	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.7.1 Plan Procurement Management

"Plan Procurement Management is the process of documenting project procurement decisions, specifying the approach, and identifying potential *consultants*."[1]

At WisDOT, the plan procurement management process is briefly discussed as part of the consultant contract process overview (in FDM 8-1-1) and consists of two steps:

A project is identified as requiring consultant staff (Item 1).

Funding is approved for the consultant portion of the project (Item 2).

The process is further discussed in PMM 06-05-10 - Managing Consultants.

At the conclusion of this process, the procurement management plan is in place. For most of the projects that require consultant services during construction, FDM Chapter 8 details that plan.

110.5.7.2 Conduct Procurements

"Conduct Procurements is the process of obtaining *consultant* responses, selecting a *consultant*, and awarding a contract."[1]

At WisDOT, the conduct procurements process is discussed in the following FDM sections:

- FDM 8-1 - Introduction
- FDM 8-5 - Securing Consultant Services
- FDM 8-10 - Contract Negotiation
- FDM 8-15 - Contracts
- FDM 8-20 - Contract Procedures

At the conclusion of this process, the consultant contract to provide an engineering and/or inspection service is in place.

110.5.7.3 Control Procurements

"Control Procurements is the process of managing procurement relationships, monitoring contract performance, and making changes and corrections to contracts as appropriate."[1]

At WisDOT, the process is discussed in CMM 216 - Consultant Contracts for Construction Services

The control procurement process is also discussed in the following FDM section:

- FDM 8-25 - Contract Management

During this process, possible changes to the procurement management plan may come up. This could be in response to a potential contract amendment (FDM 8-25-15), resolving a conflict (FDM 8-25-20), or responding to a claim or dispute (FDM 8-25-25). Any possible changes should be discussed as part of the Change Management process (CMM 110.4.2.5, above). Results of that process should be documented.

110.5.7.4 Close Procurements

"Close Procurements is the process of completing each executed consultant contract."[1]

At WisDOT, the close procurement sub-process is briefly discussed as part of the consultant contract process overview (in FDM 8-1-1, paragraph 1.2) and consists of two steps:

1. The WisDOT Project Manager evaluates the performance of the consultant upon completion of the contract (Item 10 (see FDM 8-25-5)).
2. Final contract costs are audited if the contract meets the necessary criteria (Item 11 (see FDM 8-25-30))

110.5.8 Risk Management

"Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project."[1] For expanded definitions of the Risk Management process, see FDM 2-20 Attachment 5.7.

The risk management plan includes six processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Risk Management	Planning	FDM 2-20
Identify Risks	Planning	FDM 2-20
Perform Qualitative Risk Analysis	Planning	FDM 2-20
Perform Quantitative Risk Analysis	Planning	FDM 2-20
Plan Risk Responses	Planning	FDM 2-20
Control Risks	Monitoring and Controlling	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.8.1 Plan Risk Management

"Plan Risk Management is the process of defining how to conduct risk management activities for a project."[1]

At WisDOT, the Plan Risk Management process started as part of the Design function is continued into this Construction function. An important part of the process is considering the information existing risk register.

110.5.8.2 Identify Risk

"Identify Risks is the process of determining which risks may affect the project and documenting their characteristics."[1]

At WisDOT, the existing risk register prepared as part of the Design function should be reviewed to see if some of the previously identified risks may still be present. It is possible that new risks may need to be added, especially on projects that include construction on new R/W or near environmentally sensitive areas.

110.5.8.3 Perform Qualitative Risk Analysis

"Perform Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact."[1]

At WisDOT, most of the standard projects have few risks. This process and the following Perform Quantitative Risk Analysis process will usually only be used on the high profile or mega projects.

110.5.8.4 Perform Quantitative Risk Analysis

"Perform Quantitative Risk Analysis is the process of numerically analyzing the effect of identified risks on overall project objectives."[1]

At WisDOT, most of the standard projects have few risks. This process and the previous Perform Qualitative Risk Analysis process will usually only be used on the high profile or mega projects.

110.5.8.5 Plan Risk Responses

"Plan Risk Responses is the process of developing options and actions to enhance opportunities and to reduce threats to project objectives."[1]

At WisDOT, the risk register updated for the Construction function should be reviewed to develop options.

110.5.8.6 Control Risks

"Control Risks is the process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the project."[1]

At WisDOT, if an identified risk occurs, the options previously developed should be implemented.

110.5.9 Quality Management

"Quality Management includes the processes and activities that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken." For expanded definitions of the Quality Management process, see FDM 2-20 Attachment 5.4.

Note: The Quality Management Plan discussed in this section should not be confused with WisDOT's QMP during construction. The QMP (see CMM 830) provides references, procedures, and examples for inspection, sampling, testing, and documentation of various construction materials and methods. The primary goals of the QMP are to provide consistent construction quality, ensure effective use of personnel, and maintain cooperation throughout all phases of the work.

The MAPSS (Mobility, Accountability, Preservation, Safety, Service) Performance Improvement program is well established at WisDOT. The following performance measures are monitored in the construction process:

- On-Time Performance
- On-Budget Performance

Additional DTSD performance measures, although not part of the MAPSS program, are also monitored in the construction process:

- Finals Tracking
- Unprogrammed Costs
- Explanation of Variation for individual items.
- Design Quality Index (DQI) (CMM 170.3)

Several other quality efforts are discussed in the CMM:

- Contractor Performance Evaluations (CMM 170.1)
  - Rating of Prime Contractors
  - Rating of Subcontractors
- Consultant Performance Evaluations (CMM 170.2)

Reporting on the above performance measures and quality efforts is typically completed after construction operations are finished - although notes on drafts of those reports as influencing factors occur would simplify the completion later. However, there are several activities that occur while construction operations are in progress that contribute to the Quality Control sub-process.

- CMM 160 - Construction Inspection
  - "All portions of the work and materials are inspected to obtain acceptable work in accordance with the requirements of the contract. It is the duty of the inspection forces to determine that the work is performed in accordance with the specified requirements." Proper inspection assures quality construction.
- CMM 165 - Contract Records
  - CMM 165.2 - The Project Schedule prepared by the contractor and approved by WisDOT is used in "…identifying…a rate of progress that will not result in completion within the contract time" (figure 165-2). Problems with meeting the contract time can be addressed early in the project.
  - CMM 165.3 - Project Tracking System which allows the project engineer to "…report project specific, contract specific and performance measure information.
  - CMM 165.5 - Field Information Tracking System where "structures, field office, staff, acceptance dates, performance measures and various field reports are required and entered…."

- CMM 226 - Preconstruction Meeting
  - "The preconstruction meeting is a vitally important meeting in which department personnel, consultants, and contractor's staff have the opportunity to become acquainted and begin the process of creating the team that will build the project. Some of the primary goals of the preconstruction meeting include:
    - Establish lines of authority and communication
    - Clarify responsibilities of contractor's personnel, department personnel, consultants, subcontractors, and suppliers
    - Identify potential issues and the process for resolution
    - Resolve potential sources of misunderstanding
    - Plan and discuss detailed arrangements necessary for a successful project."
  - The Model Preconstruction Meeting Agenda (figure 226-2) includes a discussion of scheduling regular progress meetings that will be held during construction.
  - The importance of holding progress meetings is emphasized in the Timely Decision Making Manual where it suggests weekly progress meetings to "…review construction progress and future work activities, identify potential delays as early as possible for mitigation planning, raise issues and bring them to resolution, and make subsequent action assignments when appropriate". These discussion topics allow the project engineer to control the quality of the construction project.
  - CMM 236 - Intermediate/Tentative/Final Estimates

The quality management plan includes three processes:

Knowledge Area Processes (per PMBOK®)	Process Group (per PMBOK®)	FDM Reference
Plan Quality Management	Planning	FDM 2-20
Perform Quality Assurance	Executing	FDM 2-20
Control Quality	Monitoring and Controlling	FDM 2-20

The information resulting from this management plan during construction may be stored in Project Tracking or Field Manager.

110.5.9.1 Plan Quality Management

"Plan Quality Management is the process of identifying quality requirements and/or standards for the project and its deliverables and documenting how the project will demonstrate compliance with relevant quality requirements and/or standards."[1]

At WisDOT, the Plan Quality Management process started as part of the Design function is continued into this Construction function. The information above is part of the plan.

110.5.9.2 Perform Quality Assurance

"Perform Quality Assurance is the process of auditing the quality requirements and the results from quality control measurements to ensure that appropriate quality standards and operational definitions are used."[1]

The information provided above is part of the Perform Quality Assurance process.

110.5.9.3 Control Quality

"Control Quality is the process of monitoring and recording results of executing the quality activities to assess performance and recommend necessary changes."[1]

The information provided above is part of the Control Quality process.

[1] Project Management Institute. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* - Fifth Edition. (2013). Copyright and all rights reserved. Material from this publication has been reproduced with the permission of PMI.

SECTION 115 Glossary

115.1 References and Acronyms

Note that links provided for the Advancing Standards Transforming Markets (ASTM International), formerly known as the American Society for Testing and Materials, and the American Association of State Highway and Transportation Officials (AASHTO) require a subscription to ASTM Compass® (https://www.astm.org/products-services/enterprise-solutions/astm-compass.html). ASTM Compass® is a web site that allows online access to ASTM and ASSHTO standards along with additional technical information.

Interpret acronyms used throughout the CMM as follows:

AASHTO American Association of State Highway and Transportation Officials

AC Asphalt cement

APL Department's approved products list available at:
https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/appr-prod/default.aspx

ASTM American Society for Testing and Materials

BOS The department's Bureau of Structures

BTS The department's Bureau of Technical Services

CMM The department's Construction and Materials Manual

EBS Excavation below subgrade

ECIP Erosion Control Implementation Plan

FHWA Federal Highway Administration

HTCP The department's Highway Technician Certification Program

- **ACT** An HTCP assistant certified technician

MASH Manual for Assessing Safety Hardware

NCHRP National Cooperative Highway Research Program

NTPEP AASHTO's National Transportation Product Evaluation Program

OSHA Occupational Safety and Health Administration

PAL Department's erosion control product acceptability list available at:
https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/pal/default.aspx

QMP Quality management program

- **QC** Quality control
- **QV** Quality verification
- **IA** Independent assurance

QPL Department's electrical qualified product list available at:
https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/prods/qpl.aspx

WisDOT Wisconsin Department of Transportation

WTM WisDOT Test Modified

WTP WisDOT Test Procedure

Other commonly used WisDOT acronyms are defined at:
https://webapp.dot.state.wi.us/acronyms/

115.2 Definitions

The department defines terms used I here in 115.2. Interpret these terms, used throughout the CMM, as follows:

Absorption The process of a solid taking up liquid into its interior by capillary action.

Abutment The structural element supporting the ends of a bridge.

Addendum A revision to the plans or the proposal form developed before opening of proposals.

Admixture Any material other than Portland cement, aggregates, and water added to a concrete batch just before or during mixing.

Aggregate Inert mineral material such as sand, gravel, crushed gravel, crushed stone, or combinations thereof.

Air-entraining agent A material added to concrete to increase the amount of trapped air in the mixture. Entrained air is present in the form of minute bubbles.

Air-entraining cement	Cement into which air-entraining agents have been inter-ground at the mill.
Angle of repose	Acute angle measured between a horizontal plane and the maximum unsupported slope a material will lie at without sliding.
Anti-desiccant	A chemical emulsion applied to needles of newly planted evergreens to reduce loss of moisture.
As-built plan	An exact reproduction of the original contract plan upon which is drawn or written, in red ink, including all additions, deletions, and modifications to the original plan that have actually been constructed.
Asphalt cement	Asphalt refined to meet specifications for paving purposes.
Asphaltic binder course	A plant mix of coarse graded aggregate and asphaltic material, which constitutes the lower layer of the asphaltic pavement.
Asphaltic binder mixture	A coarse graded asphaltic mixture normally having less asphaltic material than a surface mixture and used for construction of the binder course upon which the asphaltic surface course is placed.
Asphaltic concrete	A designed combination of mineral aggregate filler and asphaltic cement mixed in a plant, laid, and compacted while hot.
Asphaltic emulsion	A mixture in which minute globules of bitumen are suspended in water. When the emulsion is applied to a surface, the water evaporates or runs off quickly, leaving a thin coating of bitumen.
Auxiliary lane	The portion of the roadway adjoining the traveled way for parking, change of speed, or for other purposes supplementary to through traffic movement.
Award	The department's acceptance of a bid.
Back sight	A survey sight taken along a previously established survey alignment in order to extend the line; a survey sight taken on a point of previously established elevation in order to establish the elevations of other points.
Back slope	A surface pitched downward and toward the traveled way; normally, lying between the construction limit and the ditch.
Balance points	Points on the centerline of the roadway between which the amount of cut (excavation) equals the amount of fill (embankment) after the quantities have been adjusted for swell or shrinkage.
Base	The layer or layers of specified or selected material of designed thickness placed on a subbase or subgrade to support a surface course.
Batch plant	An assembly consisting of a mixer and its feeder components by which aggregates are proportioned with either cement or asphalt, in order to produce a batch.
Bench mark	A permanent point of known or assumed elevation.
Bent	The term is used in connection with bridges supported by timber trestles. A framed bent is a structural unit consisting of posts that rest upon a sill and support a cap. A pile bent consists of piles that support a cap. The cap supports the stringers and deck.
Bidder	An individual, partnership, joint venture, corporation, limited liability company, limited liability partnership, or a combination of any or all jointly, submitting a proposal (bid) for the work advertised in the invitation for bids, acting directly or through a duly authorized representative.
Bitumen	A group of hydrocarbons, including asphalt, tar, and coal tar pitch.
Blended cements	Blended cements are combinations of Portland cement and slag cement, fly ash or silica fume, used in making Portland cement concrete. Blended cements come from the cement manufacturer in the blended state, rather than a concrete producer proportioning the individual materials at the batch plant.
Blue tops	Wooden hubs or stakes driven into the subgrade to indicate the finished subgrade elevation.
Borrow	Suitable material from sources outside the right-of-way limits of the project, used primarily for embankments.

Breakdown rolling	The initial compaction effort applied to a freshly placed asphaltic mixture by a roller operating immediately behind the paver.
Breaker run	Aggregate composed of very large particles resulting from mechanical crushing of stone in a primary crusher which has not been separated by screens into standardized sizes.
Bridge	A structure having a span of more than 20 feet from face to face of abutments or end bents, measured along the centerline of the roadway, spanning a water course or other opening or obstruction, such as a highway or railroad, including the substructure, superstructure, and trestle work approaches.
Butt joint	A transverse interface between existing and new paved surfaces, formed by cutting or sawing a vertical notch into the existing surface and then paving into the notch.
Business day	Every day the calendar shows, except Saturdays, Sundays, and department-specified holidays.
Calendar day	Every day the calendar shows, including Saturdays, Sundays, and department-specified holidays.
Camber	A slight convex upward curvature built into a structure or a structural member that allows for the downward deflection of the structure under load, in order to match finished grade line.
Cap	A heavy, horizontal member placed on top of the piles or posts of a trestle bent.
Cement	The substance used for binding particles of aggregate together to form a pavement. Examples include Portland cement and asphalt cement.
Cement paste	A mixture of Portland cement and water.
Central mix	Concrete that has been completely mixed in a stationary plant. Further mixing in the transporting vehicle is not needed.
Certificate of materials (DT1310)	Report for each let contract documenting all material deviations from contract specifications and Buy America Exception use.
Certificate of compliance	A document, provided by a manufacturer, producer, or supplier of a product, stating that the product as furnished to the contractor complies with the pertinent specifications and contract requirements.
Certified report of test or analysis	A certified test report, provided by a manufacturer, producer, or supplier of a product, indicating that actual results of tests or analyses comply with the elements of the specification requirements.
Change order	A written order to the contractor detailing changes to the specified work quantities or modifications within the scope of the original contract.
Chip seal	An asphaltic surface treatment consisting of a high rate spray application of asphalt emulsion, followed immediately by an overlay of aggregate chips.
Coarse aggregate	Aggregate predominantly retained on the No. 4 sieve.
Cofferdam	A watertight enclosure from which water is pumped to expose a stream bed or lake bed so construction may proceed under dry conditions.
Completion date	The calendar date shown in the proposal on or before which the work contemplated under the contract must be completed.
Composite pipe	Pipe having a wall cross-section of ABS (Acrylonitrile-Butadiene-Styrene) material for the inner and outer surfaces, which are separated by a lightweight (perlite) concrete mixture.
Concrete; Portland cement concrete	The product resulting from mixing aggregates such as sand, crushed stone, and gravel with Portland cement and water to produce Portland cement concrete.
Concrete mobile mixer	A self-propelled mixer having internal storage bins and tanks for cement, aggregates, and water, and an internal batch mixing capability. It is used for production at job sites where demand may be small or delivery time may be critical.
Construction joint	A vertical joint made necessary by a prolonged interruption in the placing of the surfacing material.

Construction limits	The limits of grading or other work generally defined by slope stakes offset from the actual slope intercepts or limits of the work.
Contract	The written agreement between the department and the contractor setting forth the obligations of the parties to the contract, including, but not limited to, performance of the work, furnishing of labor and materials, and basis of payment. The contract includes the notice to contractors, proposal, contract form, contract bond, standard specifications, special provisions, addenda, general plans, detailed plans, notice to proceed, and change orders and agreements required to complete the construction of the work in an acceptable manner, including authorized extensions, all of which constitute one instrument.
Contract bid item	An item of work whose quantity and unit of payment are specified in the contract.
Contract bond	The department-approved form of security, executed by the contractor and the contractor's surety or sureties, guaranteeing the performance of the contract work, completion of the contract requirements, and the payment of claims as provided in 779.14 of the Wisconsin statutes.
Contract period	The period from the specified date of commencing work to the date that the specified number of calendar or working days has elapsed, both dates inclusive, or from the specified date of commencing work to the specified completion date, both dates inclusive; as specified in the contract.
Contract time	The number of calendar or working days shown in the proposal representing the time allowed for the completion of the work contemplated in the contract.
Contract time extension	An allowance of calendar or working days given to the contractor for unavoidable delays to the prosecution of the work or because of increased value of the contract, resulting in an overrun of contract time.
Contraction joint	A transverse vertical joint sawn in a concrete pavement slab to control the location of transverse cracks.
Contractor	The individual, partnership, joint venture, corporation, limited liability company, limited liability partnership, or agency undertaking the performance of the work under the terms of the contract and acting directly or through a duly authorized representative.
Control strip	A short section of pavement layer or course compacted to the maximum density attainable with the equipment to be used for the rest of the layer or course. The attained maximum density is used as a reference when determining density of the rest of the course or layer.
Controlled access	A situation where the public authority, WisDOT, or a local government establishes, through purchase or legal action, whether or not private driveways or public streets will be allowed to intersect the major highway or street, and if so, the number and nature of those connections.
Cost reduction incentive	A financial reward resulting from acceptance and implementation of a formal suggestion for reducing the cost of a construction contract.
Crown	The highest point on a nonsuperelevated cross-section of a road.
Crushed aggregate	Aggregate resulting from the mechanical breaking of rock, boulders, large cobbles, or gravel.
Culvert	Any structure not classified as a bridge that provides an opening under a roadway.
Daylighting	As applied to column forms: The providing of openings in the forms for the purpose of inspecting and working the concrete. As applied to highways in cuts: Cutting back the slope on the inside of a curve or at an intersection for the purpose of increasing sight distance. Daylighting ditches.
Dense graded aggregate	A well-graded aggregate proportioned to contain a relatively small percentage of voids.

Department	The Wisconsin Department of Transportation.
Diamond interchange	A 4-leg interchange with a single one-way ramp in each quadrant.
Directional interchange	An interchange generally having more than one highway grade separation, with direct connections for the major left-turning movements.
Divided highway	A highway with separate roadways for traffic in opposite directions.
Dowel	A load transfer element usually consisting of a plain round steel bar embedded in a concrete pavement and extending across a transverse joint.
Drift pin	A metal pin tapered at both ends, used to draw members of a steel structure into position by being driven through the corresponding rivet or bolt holes.
Emulsified asphalt	An emulsion of asphalt cement, water, and a small amount of an emulsifying agent. Emulsified asphalts may be of either the anionic or cationic type, depending upon the type of emulsifying agent.
End-result specification	A written requirement that places the entire responsibility on the contractor or producer for supplying an item of specified construction or a material of specified quality.
Engineer	The secretary of the department of transportation or the secretary's authorized representative limited by the particular duties assigned to the representative.
Equipment	Machinery and articles necessary for the proper construction and acceptable completion of the work. This includes the supplies, tools, and apparatus for upkeep and maintenance of the equipment.
Expansion joint	A joint located to provide for expansion of a rigid slab without damage to itself, adjacent slabs, or structures.
Expressway	A divided arterial highway for through traffic with full or partial control of access and either at-grade or grade-separated intersections.
Extra work	All work performed by the contractor, with approval of the engineer, that does not appear in the proposal or contract as a specific bid item accompanied by a unit price, and that is not included under the price bid for other bid items in the contract. Extra work may also consist of additions to, or changes in, design of contract bid items or portions of contract bid items, if additions are wholly disassociated from or outside the scope of work in the contract, and if the work caused by these additions or changes must be performed under conditions or in a manner materially different from the conditions and manner existent for contract bid items under the original scope of work.
Fabricator	Company that performs fabricated metal processes such as forging, stamping, bending, forming, and machining used to shape individual pieces of metal; and other processes, such as welding and assembling, used to join separate parts together.
Fine aggregate	Those aggregates that entirely pass the 3/8" sieve, almost entirely pass the No. 4 sieve, and are predominantly retained on the No. 200 sieve.
Fineness modulus	A numerical value obtained by adding the total percentages of a sample of the aggregate retained on each of a specified series of sieves and then dividing the sum by 100.
Flash point	The lowest temperature at which an asphaltic material subjected to increasing heat will ignite when exposed to open flame.
Flexible pavement	A pavement structure that maintains intimate contact with and distributes loads to the subgrade and depends upon aggregate interlock, particle friction, and cohesion for stability.
Floor	The structural component of a bridge in which vehicular and pedestrian traffic is directly applied, including bridge decks and slab spans.
Flushing	The loss of uncombined (free) asphalt from an asphaltic mixture.
Fly ash	A finely divided residue resulting from the burning of coal.
Follower	A short piece of a pile that rests on the pile being driven and transmits the blow of the hammer to it. It is used when the top of the driven pile is below the leads of the pile driver.

Force account work	Prescribed work paid for on the basis of actual costs of labor, equipment, and materials. Also called "service and supply work."
Foresight	A survey sight taken to a point to determine elevation of that point, or a survey sight taken to a point to extend a previously established alignment.
Freeway	An expressway with access allowed only at interchanges.
Geogrid	A grid-pattern plastic sheet used to enhance the strength of earth construction.
Geotextile	Any water-permeable thin sheet of textile material used with foundation, soil, rock, earth, or any other geotechnical managing-related material, as an integral part of a man-made project, structure or system.
Girders	The longitudinal fabricated bridge members supporting the deck of a bridge, either directly or through floor beams.
Gradation	A general term used to describe the composition by size of the aggregate particles in a mixture. It is usually expressed as the proportion (percent) of the aggregate that will pass a series of designated standardized sieves.
Grading limits	The lateral lines beyond which no material is excavated in cuts and no material is deposited in fills.
Grout	A mortar of liquid consistency used to consolidate a mass of loose material or to fill seams, cracks, joints, or holes and consisting chiefly of sand and cement.
Gusset plate	A plate of metal used at some joints of a steel-framed structure.
Gutter	Area between the face of the curb and the edge of the pavement.
High-early strength cement	A type of Portland cement that differs from regular cement in chemical composition and finer particle size. Concrete made with high-early strength cement gains strength faster than that made with regular cement.
Hot roller	The unit of compaction equipment performing the initial or breakdown compaction of a freshly laid asphaltic surface.
Hot screen	The wire mesh in the aggregate feeder component of an asphaltic mixing plant. It is used to separate the various sizes of heated aggregate before incorporation in a mix.
Hub	A short, wooden stake of square-end section used for survey reference points.
Inslope	A side slope between the shoulder and the ditch.
Interlock	A "fail-safe" mechanism in a mixing plant that denies further progression through the sequence of operations until preset requirements are met.
Invitation for bids	The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate the character, quantity, and location of the work to be done, or the character and quantity of the equipment and material to be furnished, and the time and place of submitting the proposals.
Island	A defined area between traffic lanes for control of vehicle movements or for pedestrian refuge. Within an intersection, a median or an outer separation is considered an island.
Laboratory	The materials testing laboratory of the department or other testing laboratory designated by the engineer.
Laitance	A weak mortar that may collect at the surface of freshly placed concrete, usually caused by an excess of mixing water or by over finishing.
Leads	The two vertical members of a pile driver that steady the hammer and the pile during the driving.
Leveling course	The layer of material placed on an existing surface to eliminate irregularities before placing an overlying course. Also called wedging course.
Liquid asphalt	An asphaltic material having a soft or fluid consistency that is beyond the range of measurement by the standard penetration test.

	Liquid asphalts include the three following normally designated types:
Liquid limit	The moisture content that is the boundary between the liquid and plastic states for the minus No. 40 fraction of soil.
Liquidated damages	A credit payment to the state by a contractor for non-justified exceeding of the contract time.
Local road or street	A street or road used primarily for access to residences, businesses, or other abutting property.
Locke shot	A survey sight using a hand-held level, when cross-sectioning and out of range of the leveling instrument.
Longitudinal joint	A joint normally placed between traffic lanes to control longitudinal cracking in concrete pavement.
Lute	A hand-held tool that resembles a rake in general form but has a smooth, straight bottom edge in place of teeth. It is used to smooth and shape asphaltic surfaces.
Major item	A bid item whose total cost, determined by multiplying the bidding schedule quantity and the contract unit price, is equal to or greater than 5 percent of the total amount of the original contract.
Materials archive	Material documentation retained in long-term storage for future reference.
Materials project records	Material documentation to be retained with the construction project records.
Median	The portion of a divided highway separating the traveled ways for traffic in opposite directions.
Median lane	A speed change lane within the median to accommodate left-turning vehicles.
Mineral filler	Limestone dust, Portland cement or other similar material incorporated into asphaltic and concrete mixes to fill voids.
Minor item	Any contract bid item whose total cost is less than 5% of the original contract amount.
Moisture content	The proportion of moisture present in a material, expressed as a percentage of the oven-dry weight of the material.
Moisture-density relationship	The effect of moisture content on the density of a soil compacted according to specified conditions.
Mud sill	A platform, usually timber, laid on earth as a bed for the sill of a framed trestle bent, or one of the timbers in such a platform.
Notice to proceed	A written notice from the engineer to the contractor of the time period within which the prosecution of the work must begin.
Open graded aggregate	A well graded aggregate containing little or no fine aggregate, with a relatively large percentage of voids.
Optimum moisture content	The moisture content at which a particular soil will be brought to the greatest density obtainable with a specified compactive effort.
Ordinary compaction	Compactive effort applied to an asphaltic layer or course to achieve a state of visual non-deflection under the compaction vehicle load.
Overbreak	The material in rock cuts that is removed outside the staked backslope limit.
Overburden	The soil mantle found over a deposit of rock, sand, or gravel. It is normally stripped off and stockpiled for later use.
Pavement structure	The combination of subbase, base, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.
Penetration	The consistency of an asphalt cement, expressed as the distance that a standard needle penetrates a sample of the material under standard conditions of loading, time, and temperature.
Permeable voids	Those voids in the individual particles of a dry material that become filled with water when the material is soaked.
Pier	The vertical structural element built to support a bridge at the junction of connecting spans.
Plans	The department-approved plans, profiles, typical cross-sections, working drawings, and supplemental drawings that show the location, character, dimensions, and details of the work to be done.

Plastic limit	The moisture content that is the boundary between the moldable and semi-solid states of consistency of a soil. It is defined as the moisture content at which a soil will just begin to crumble when rolled into a thread approximately 1/8-inch in diameter.
Plasticity	The property of a soil that allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.
Plasticity index	The numerical difference between the liquid limit and the plastic limit.
Portland cement	The product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates to which no addition, other than water and/or untreated calcium sulfate, has been made subsequent to calcination.
Portland cement concrete	The product resulting from mixing Portland cement, aggregate, and water.
Prime coat	An application of a low viscosity liquid asphaltic material to coat and bind aggregate particles preparatory to placing a surface course.
Profile grade	A line denoting elevation on the top of the pavement surface course, as taken along a longitudinal centerline or reference line.
Profiler	Equipment capable of measuring variations from a true plane on a pavement surface.
Project	The designated physical area together with improvements to be constructed under the contract.
Proposal	The written offer of the bidder, submitted on the prescribed proposal form, to perform the work at the prices quoted by the bidder; also, commonly known as the "bid."
Proposal form	The approved form on which the department requires bids to be prepared and submitted.
Proposal guaranty	The security furnished with a bid to guarantee that the bidder will enter into the contract if the bid is accepted.
PS&E	Plans, specifications, and estimates, included as part of the contract proposal package, which define the scope and detail of work to be done under the contract.
Pugmill	A type of mixer having paddles on a rotating horizontal shaft.
Pumping	The ejection of foundation material, either wet or dry, through joints or cracks, or along edges of concrete slabs, due to vertical movements of the slab under traffic.
Quarry	A deposit of ledge rock from which the rock is excavated by cutting or blasting.
Quartering	A method of reducing the size of a sample without segregation.
Ramp	A connecting roadway between two intersecting highways at a highway separation; also, may include other access connections.
Recycled asphaltic surface	A pavement produced by combining salvaged asphaltic pavement, new aggregate, and new asphalt cement.
Recycling	Reuse of previously used paving materials.
Refinery	A plant for producing petroleum products from crude oil.
Reflection crack	A crack appearing in a resurface or overlay that is caused by movement at joints or cracks in underlying base or pavement.
Resurfacing	The placing of one or more new courses or layers on an existing pavement surface.
Right of access	The right to enter a highway from abutting land and exit a highway to abutting land.
Right of entry	The right of department personnel to enter private property temporarily to survey and investigate for transportation-related purposes.
Right-of-way	Land, property, or interest in land or property acquired for or devoted to transportation purposes.
Rigid pavement	A pavement structure having a Portland cement concrete slab as the surface course.
Riprap	An unbound collection of broken stones placed in or near water to protect a slope from erosion by lake or stream water action.

Roadbed The graded portion of a highway, within top slopes and side slopes, prepared as a foundation for the pavement structure and shoulders.

Roadbed material The material below the subgrade in cuts and fills (embankments) and in embankment foundations extending to such depth as affects the support of the pavement structure.

Roadside The area adjoining the outer edge of the roadway. Areas between the roadways of a divided highway may also be considered roadside.

Roadside control The public regulation of the roadside to improve highway safety, expedite the free-flow of traffic, conserve abutting property values, safeguard highway investment and preserve the attractiveness of the landscape.

Roadway The portion of a highway within the limits of construction. A divided highway has 2 or more roadways.

Rubble Irregular pieces of rock produced by natural or man-made forces and used in masonry.

Sand Granular material almost entirely passing the No. 4 sieve and predominantly retained on the No. 200 sieve.

Scalper screen A wire mesh placed in a stream of aggregate to remove material of excessive size.

Screed A bar, plate, or pan used to strike off fresh paving mixture to an established elevation and plane.

Seal coat A thin surface treatment consisting of asphaltic material and cover aggregate.

Segregation Non-uniform distribution of the various particle sizes within an aggregate.

Semi-automatic mixing plant A plant which, after an initial input by the operator for each weighing, proportioning, and mixing sequence, will automatically complete the sequence.

Semi-final estimate A tentative final estimate indicating the engineer has measured and reported all quantities. The department prepares and submits a semi-final estimate for the contractor's review before issuing a final estimate.

Shoulders The portions of the roadway contiguous with the traveled way for accommodation of stopped vehicles, emergency use, and lateral support of base and surface courses.

Shrink mix Concrete which has been partially mixed in a stationary plant, dumped into a truck mixer, and then has the mixing completed while in the truck.

Side slope A surface pitched downward and away from the traveled way; an inslope.

Sieve In materials testing work, a screen or series of screens having standardized square openings and used for subdividing a material into separate successive sizes.

Silica fume A pozzolan used in Portland Cement Concrete to reduce the permeability of the concrete and increase compressive strengths. It can be used separately in bags, or by using a blended cement that contains the appropriate amount of silica fume. It is a co-product of the ferro-silicone industry.

Silt screen A geotextile erected and anchored as a floating vertical barrier in a body of water in order to trap and retain residue resulting from construction operations, while allowing clear water to pass.

Slag cement Formerly known as ground granulated blast furnace slag(GGBFS), slag cements are glassy, non-metallic, silicates and aluminosilicates of calcium, a co-product of the processing of iron ore in a blast furnace. The resulting molten material is quenched, or granulated, dried and then ground into a powder that is used as a partial replacement for Portland cement in Portland cement concrete.

Slope stake A stake set at right angles to the centerline to mark the point at which the proposed finished highway backslope or side slope will intersect the existing ground surface.

Slump	Subsidence in height of a freshly mixed concrete sample, following its molding in a standard slump cone and immediate release from the cone.
Slurry seal	A seal coat consisting of a semi-fluid mixture of asphaltic emulsion and fine aggregate.
Soundness	The resistance of an aggregate to breakdown by expansion forces of freezing water or a crystallizing chemical.
Special compaction	The comp active effort applied to an earth embankment or base course in order to achieve a measured specific density.
Special provisions	Written directions and requirements applicable to a specific project and not otherwise prescribed in the standard specifications.
Specifications	Written directions, provisions, and requirements contained in the standard specifications or special provisions, together with written agreements and documents referenced in the contract, pertaining to the method or manner of performing the work, the quantities of work, and the quality of materials to be furnished under the contract; as made part of the contract and contained in or referenced in the proposal.
Splitting	Reduction in the size of a material sample preparatory to testing by means of a standardized method.
Stabilization	Modification of soils or aggregates by incorporating materials that will increase load bearing capacity, firmness, and resistance to weathering or displacement.
Standard compaction	Compactive effort applied to an earth embankment or base course to achieve a state of visual non-deflection under the compaction equipment load.
Standard specifications	Written directions and requirements approved for general application and repetitive use for highway and structures construction and for administration of the contract.
Static roller	Compaction equipment achieving compactive effort by application of gravity only.
Statistically random sampling	Sampling at times or at locations determined in advance by using a table or numbers so arranged that every digit has an equal chance of occurring.
Storage hopper, silo	A closed, heated, and insulated container capable of storing asphaltic mixture up to 16 hours without significant heat loss.
Stringers	The longitudinal members supporting the flooring of a bridge.
Subbase	The layer or layers of specified or selected material of designed thickness placed on a subgrade to support base.
Subcontractor	The individual, partnership, corporation, limited liability company, or joint venture to which the contractor, with the department's written consent, sublets part of the contract.
Subfoundation course	An aggregate backfill placed below footings, or the bottom of box culvert slabs, in soft, muddy, or wet locations to provide support to the footing or slab.
Subgrade	The top surface of a roadbed upon which the pavement structure and shoulders are constructed.
Subletting	Agreement by the contractor with a third party for the third party to perform part of the work under the contract.
Substructure	All of the bridge below the bridge seats or below the tops of the caps of piling or framed trestles, including the wing walls, backwalls, and parapets of abutments.
Superelevation	Banking of a curve.
Superintendent	The contractor's authorized representative in responsible charge of the work.
Superstructure	All of the bridge above the bridge seats or above the tops of caps of piling or framed trestles, including flooring, but excluding wing walls, backwalls, and parapets of abutments.
Surety	The company executing a contract bond with the contractor.

Surface course	One or more layers of a pavement structure, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate.
Surface moisture	That part of the moisture content of aggregate that has not been absorbed into the particles.
Surface treatment	One or more applications of asphaltic material and cover aggregate, or a thin layer of asphaltic plant mix, over an old pavement or any element of a new pavement structure.
Surge bin	An open, unheated, and uninsulated container capable of storing asphaltic mixture without significant heat loss for no more than two hours.
Tack coat	An application of asphaltic material to an existing pavement surface to provide bond with an asphaltic overlay.
Tie bar	A deformed (ridged) steel bar embedded in the concrete pavement and extending across a joint to prevent separation of abutting slabs.
Tiller	A machine having round, dull-edged discs with notched edges, used to anchor mulch by pressing it into the seed bed.
Time chart	A graph prepared by the project designer and submitted with the PS&E to identify controlling work items, and the time and sequencing needed for their completion.
Tining	Grooving of an unhardened concrete surface by means of a steel "comb." A macrotexture is produced that promotes surface water runoff, reduces hydroplaning, and improves friction.
Traffic lane	The portion of a traveled way provided for the movement of a single line of vehicles.
Transit mix	Concrete which has been produced by introducing uncombined mixture ingredients into a mixer truck and then subsequently combining and mixing entirely in the truck.
Traveled way	The portion of the roadway provided for the movement of vehicles, exclusive of shoulders and auxiliary lanes.
Tremie	An assembly of an intake hopper, tube, and discharge spout used for placing concrete under water.
Value engineering	An organized effort directed at analyzing the function of a highway-related component for the purpose of achieving the function at the lowest possible cost.
Vibratory roller	Construction compaction equipment capable of transmitting both a static and a dynamic load to the underlying surface.
Wale	A heavy, horizontal beam used as a guard or as a brace. In a cofferdam, wales brace the vertical sheet piles against lateral pressures.
Water-cementitious material ratio	The ratio of net water, total water in the mixture minus the water absorbed by the aggregates, to total cementitious materials in concrete by weight.
Wear	The abrasion of aggregates. The wear test measures the resistance of an aggregate to abrasion.
Web	The element of a "T", "H", "WF" or "I" shape structural steel beam that connects the flanges and provides stability to the beam section.
Well graded aggregate	An aggregate possessing proportionate distribution of successive particle sizes.
Work	The furnishing of all labor, materials, equipment, and incidentals and the performing of all tasks needed to complete the project or a specific part of the project as specified in the contract, together with fulfillment of all associated obligations and duties required by the contract.
Working day	A calendar day, except Saturdays, Sundays, department-specified holidays, and the period from November 16 to March 31, both dates inclusive, on which weather or other conditions not under the control of the contractor will allow construction operations to proceed for at least 8 hours of the day with the normal working force engaged in performing the controlling item of work which would be in progress at this time.

Working drawings Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans, computations or similar data which the contractor is or may be required to submit to the engineer for review.

Yield The coverage or spread of a mixture.

SECTION 130 Hazardous Materials

130.1 Hazardous Chemicals

130.1.1 Background

OSHA and the Department of Safety and Professional Services (DSPS) have developed guidelines that WisDOT follows to protect its employees from hazardous chemicals. These guidelines are called the Hazard Communications Standard or the "Right to Know" Law. WisDOT recognizes it is the employee's right to know about hazardous chemicals used in the workplace and believes that knowledge of these chemicals is the best protection for the employee.

From its office workers to road crews, WisDOT personnel handle a variety of hazardous chemicals that, if used or handled improperly, could result in injury. To inform employees, the department has developed a hazard communication program, consisting of written material and training. The Hazardous Materials and Waste Management Program Manual is available at:

https://wigov.sharepoint.com/sites/dot/Shared Documents/Facilities/WisDOTSafetyManual.pdf

Overall responsibility for the program rests with the Risk and Safety Unit, Bureau of Business Services, in the Division of Business Management.

Ultimately, however, each employee must take responsibility for keeping a safe work area. This is done by knowing where to get information, knowing how to read product labels and Safety Data Sheets (SDS), and knowing when and how to warn others about hazards.

130.1.2 Information Sources

Employees can get inventory information on the hazardous chemicals currently used by the department from the hazardous materials manager. The inventory information contains the following items:

1. Product name.
2. Product manufacturer.
3. Date the product was introduced into the work area.
4. Name of the work area.
5. Hazard information as outlined on the SDS.
6. Name of the hazardous materials manager.

Inventory information for hazardous chemicals not currently used by WisDOT is available for 30 years following stoppage of use.

A second source of information is the SDS supplied by the manufacturer for each chemical. Copies of the SDS are on file at every level of the department. They contain the following information:

1. **Identification:** This section identifies the chemical on the SDS as well as the recommended uses. It also provides the essential contact information of the supplier.
2. **Hazards Identification:** This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards.
3. **Composition/Information on Ingredients:** This section identifies the ingredients contained in the product indicated on the SDS including impurities and stabilizing additives. This section also includes information on substances, mixtures, and chemicals where a trade secret is claimed.
4. **First-Aid Measures:** This section describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical.
5. **Fire-Fighting Measures:** This section provides recommendations for fighting a fire caused by the chemical.
6. **Accidental Release Measures:** This section provides recommendations on the appropriate response to spills, leaks or releases, including containment and cleanup practices to prevent or minimize the exposure to people, properties or the environment. It may also include recommendations distinguishing between responses for large and small spills where spill volume has a significant impact on the hazard.
7. **Handling and Storage:** This section provides guidance on the safe handling practices and conditions for safe storage of chemicals.
8. **Exposure Controls/Personal Protection:** This section indicates the exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure.
9. **Physical and Chemical properties:** This section identifies the physical and chemical properties associated with the substance or mixture.
10. **Stability and Reactivity:** This section describes the reactivity hazards of the chemical and the chemical stability information.
11. **Toxicological Information:** This section identifies toxicological and health effects information or indicates that such data are not available.

12. **Ecological Information (non-mandatory):** This section provides information to evaluate the environmental impact of the chemical(s) if it were released to the environment.
13. **Disposal Considerations (non-mandatory):** This section provides guidance on proper disposal practices, recycling or reclamation of the chemical(s) or its container, and safe handling practices. To minimize exposure, this section should also refer the reader to Section 8 (Exposure Controls/Personal Protection) of the SDS.
14. **Transport Information (non-mandatory):** This section provides guidance on classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea.
15. **Regulatory Information (non-mandatory):** This section identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS.
16. **Other Information:** This section indicates when the SDS was prepared or when the last known revision was made. The SDS may also state where the changes have been made to the previous version. You may wish to contact the supplier for an explanation of the changes.

A third source of information is the label on the chemical container. Label information includes the following items:

1. Product identity (chemical name or brand name).
2. Specific hazard warning.
3. Manufacturer's name and address.

A label must appear on every container. To cover frequent situations when a label is damaged or when a chemical is transferred to another container, WisDOT has created its own labeling system. The label must contain the following information:

1. Product identity (chemical name or brand name).
2. Specific hazard warning.

This information should be exactly as it appears on the label of the original container. The employee transferring a chemical into a new container is responsible for filling out and applying the label.

130.1.3 Working with Hazardous Chemicals

Hazardous chemicals are classified into two categories, those that present physical hazards and those that present health hazards. Physical hazards include fire, explosions, and chemical reactions. Health hazards may damage the employee's body by exposure, causing disorders ranging from skin irritations to cancers.

130.1.4 Safe Work Practices

WisDOT provides the necessary information about hazardous chemicals used in the workplace and training to those employees exposed to hazards, but the final responsibility for the safety and health of the employee must rest with each employee. Employees should do the following:

1. Read the product label when storing and before opening and using.
2. Read the SDS if more information is needed.
3. Follow safe work practices.
4. Know how and where protective equipment is stored and how to use it.
5. Know what to do in case of an accident.

130.1.5 Physical Hazards

The employee should learn the fire, explosive, and other physical hazards of chemicals used in the work. Physical hazards include:

Flammable and combustible liquids - examples are paint, solvents, oil, and hydraulic fluids.

- Compressed gases - examples are acetylene gas and liquid propane gas.
- Flammable solids - an example is a road flare.
- Water reactive chemicals - an example is calcium carbide used in soils moisture testing.
- Oxidizers - examples are nitrates, chromates, dichromates, and permanganates used in photo development.

Currently, the WisDOT hazardous chemical inventory does not include any compounds that are explosives, pyrophorics, organic peroxides, or unstable reactives. If any of these are added, the appropriate inventory, storage, handling, and training procedures will be developed.

130.1.6 Health Hazards

Hazardous chemicals and the effect on the health of the employee can be classed as follows:

- Carcinogens can cause cancer.
- Corrosives can cause destruction or alteration of living tissue.

- Irritants can cause nonpermanent inflammation of living tissue.
- Sensitizers can cause persons to develop allergic reactions.

An employee should learn to recognize the signs and symptoms of overexposure to certain chemicals. Each SDS discloses the effects of overexposure and classifies a chemical according to the human organ or system it affects.

130.1.7 Requirements for Contractors and Subcontractors

The OSHA/DWD guidelines on hazardous chemicals apply also to prime contractors and their subcontractors. Refer to CMM 135 for direction on how to proceed if you observe a hazardous situation. Contractors and subcontractors should follow these guidelines on construction sites:

1. Collect liquid waste in either UN Approved 5-gallon lidded pails or 30 or 55-gallon drums.
2. Collect solid waste in appropriate containers.
3. Segregate chemically incompatible wastes.
4. Dispose of hazardous waste promptly following the WisDOT procedures, so that only small quantities are on the job site at any one time.
5. Locate combustible piles away from buildings, roadways, and ignition sources.
6. Collect flammable and corrosive liquid wastes in appropriate covered containers.
7. Inspect hazardous waste containers continuously to ensure they are not leaking, uncovered, or spilled.
8. Identify the hazardous waste and hazard associated with each waste by properly labeling the exterior of each container, storage tank, transport vehicle, or building.

130.2 Hazardous Substance Found During Construction

Standard spec 107.24 requires that whenever the construction operations encounter or expose any abnormal conditions that may indicate the presence of a hazardous substance; operations must be discontinued immediately in the vicinity of the abnormal condition and the engineer must be notified. Abnormal conditions include the following:

- Underground storage tanks.
- Smoke.
- Obnoxious odor.
- Visible fumes.
- Sheen on groundwater.
- Suspected asbestos.

When a tank or asbestos containing material (ACM) is discovered during construction, the engineer should immediately contact the following people:

- Project manager.
- Region hazardous materials coordinator.

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/environment/regenvhazardmatcoords.pdf

- BTS, Environmental Services Section at (608) 266-1476.
- For leaks or spills contact the DNR area Spill Coordinator (click spill response tab) at:

  https://dnr.wi.gov/topic/Brownfields/Contact.html
- For underground storage tanks, the DNR Remediation and Redevelopment program at:

  https://dnr.wisconsin.gov/sites/default/files/topic/Brownfields/rrphone_8-6.pdf

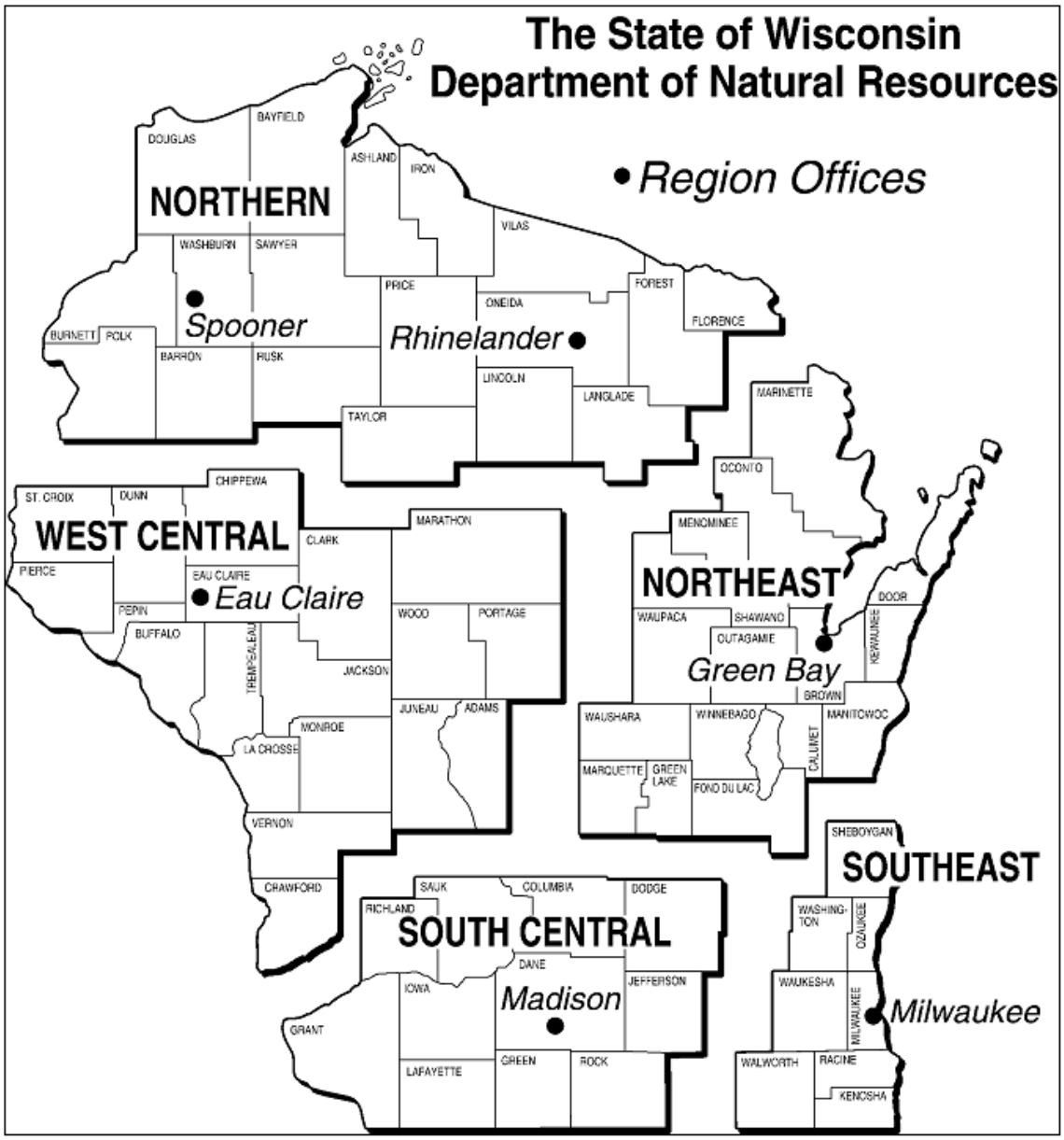
  For asbestos contact the DNR asbestos inspector.

  https://dnr.wisconsin.gov/sites/default/files/topic/AirQuality/AsbestosInspectorMap.pdf

Section 292.11, Wisconsin Statutes, requires any person who possesses or controls a hazardous substance that is discharged, or who causes the discharge of a hazardous substance to immediately notify the Wisconsin Department of Natural Resources (DNR) at:

https://dnr.wi.gov/topic/Spills/report.html

FIGURE 130-1 Map of the DNR Regions.



The engineer should document as much information as possible about the hazardous substance using the checklist in figure 130-2 as a guideline.

FIGURE 130-2 Construction Emergency Checklist

CONSTRUCTION EMERGENCY CHECKLIST

Date:_____Time:_____ Your Initials:_____

CONTACTS:

person who took call: _____ Phone ( ) _____

Consultant contacted:_____

Who will be the consultant representative? _____

When will they be able to get on-site? _____

DESCRIPTION OF THE PROJECT

ID: _____ REGION:_____COUNTY:_____

HIGHWAY NO/STREET NAME: _____

LOCATION OF PROBLEM:_____

SITE CHARACTERISTICS

Appearance, odor of soils in area
Appearance, odor of liquids in area
Tanks (UST's) or pipes present
Approximate size and dimension of UST
Location of UST or contamination relative to centerline and station
Obvious liquid or product in the tank
Are utilities marked?
Any previous land use knowledge that would be useful
Soil types, depth to groundwater

STATUS OF CONSTRUCTION PROJECT

Status of highway construction near site (type of job, are you just starting, or at the end of the job?)
How soon does work in the impacted area need to be completed?
Can work continue in an area away from contamination? For how long?
Can the impacted are be avoided?
Could design in the contaminated area be changed? (easier to tell once consultant has defined nature and extend of contamination).

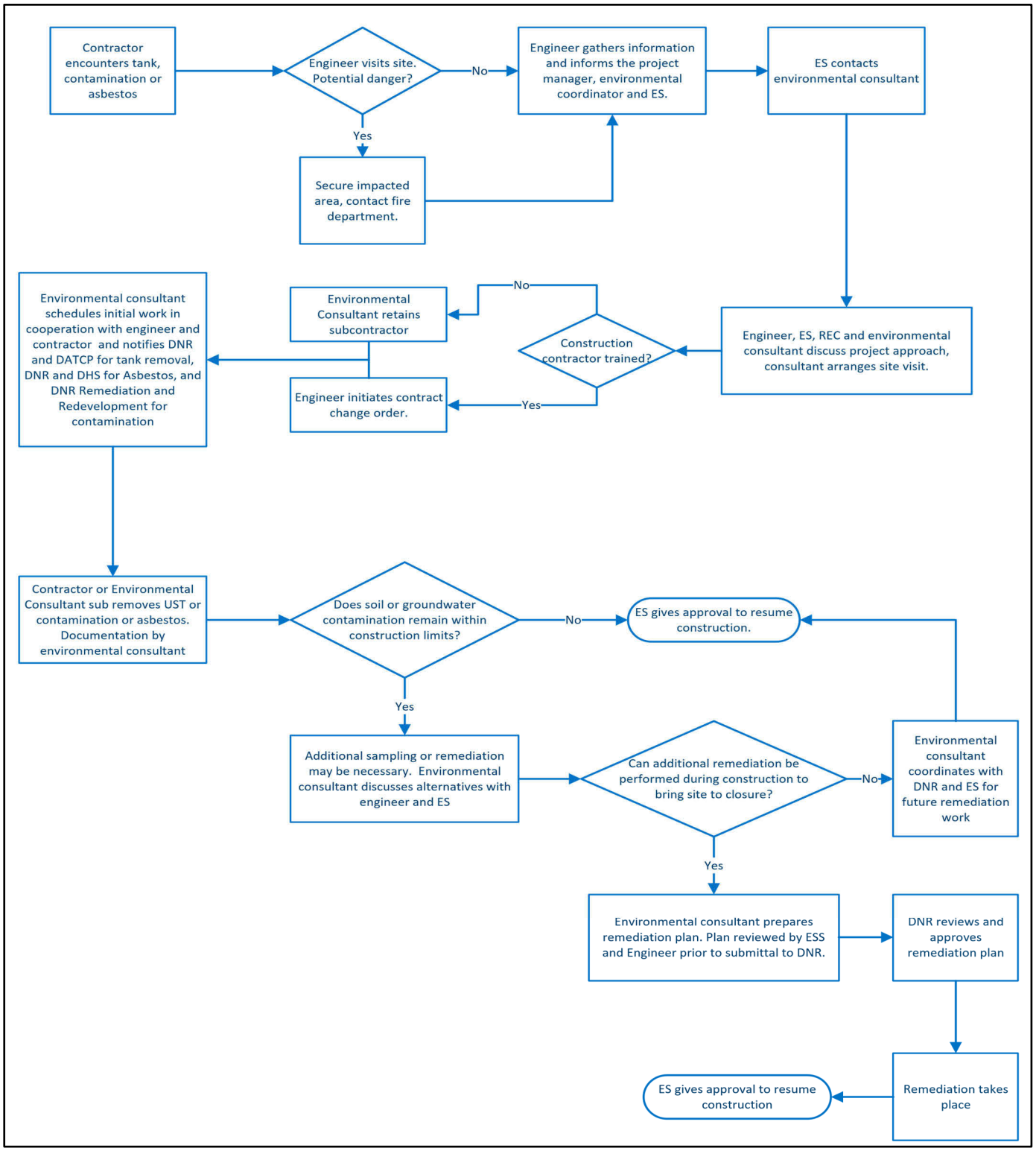
NOTIFICATION OF AUTHORITIES and SITE SAFETY CHECKLIST

Have you:

Stopped work in the area?	YES / NO
Secured the area?	YES / NO
Contacted the local fire department?	YES / NO
Contacted the area DNR representative?	YES / NO
Located an area where contaminated soil could be stockpiled if necessary?	YES / NO

Figure 130-3 shows procedures to follow if contamination is encountered during construction operations.

FIGURE 130-3 Contamination Procedures Flow Chart



PM - Project Manager

ES - BTS Environmental Services Section

UST - Underground Storage Tank

130.2.1 Suspected Asbestos Contamination

Suspected asbestos-containing material should be immediately wetted and kept wet until it is either abated or determined to be non-asbestos. Work may continue in other areas of the project where health and safety are not at risk. The engineer should gather the following information immediately upon discovery of a potential asbestos hazard:

1. What the potential hazard is: pipe, insulation, etc.
2. Location of the material, appearance, and approximate size.
3. Whether the material is being kept wet.
4. Whether utilities in the area of concern are marked.
5. Owner of the material found: utility, private, state.
6. How long the area can be avoided.
7. Project ID.

130.2.2 Underground Storage Tanks and Suspected Groundwater Contamination

If there is any evidence of underground contamination, the engineer should immediately gather the following information:

1. Appearance, odor of soils in the area.
2. Appearance, odor of liquids in the area. If you can't identify the substance assume it is dangerous and potentially flammable.
3. Tanks (USTs) or filler pipe present.
4. Approximate size and/or dimensions of UST.
5. Location of UST or contamination relative to centerline and station.
6. Obvious liquid or product in the tank.
7. Whether utilities in the area of concern are marked.
8. Any previous land use knowledge, which may help determine nature of hazardous material.
9. Soil types, depth to ground water.
10. Status of highway construction near the site.
11. Project ID.

130.2.3 Coordination With BTS, Environmental Services Section

The engineer must cautiously inspect the impacted area to gather site-specific information. If there is any question as to where potential danger exists, the engineer should contact the local fire department and follow directions given. In extreme situations, posting security personnel to prevent trespassing may be necessary until the fire department or other proper authorities arrive. Security may include fencing, signing, and/or blocking off the area.

The BTS, Environmental Services Section (ES) is responsible for hiring an environmental consultant to perform any remediation or abatement work. ES acts as a liaison between the DNR, DATCP, and the WisDOT regions. It is critical that the engineer provides ES with as much site-specific information as early as possible, so that they can retain an environmental consultant that will best meet the project schedule and assist the project manager in preventing violations of health, safety, and environmental regulations.

To avoid mobilization delays, if the prime or one of the subcontractors already on site is trained, licensed, and willing to perform a tank removal or excavation they will be considered the first choice for conducting the tank removal or excavation. The consultant chosen by ES will verify contractor qualifications. This evaluation includes consideration of relevant experience, expertise, HAZWOPER 40-hour health and safety training, and license verification. If the prime contractor or their subcontractors are not qualified, the ES environmental consultant will hire a qualified subcontractor. The ES environmental consultant will supervise the work.

The engineer and project manager should work closely with ES to determine the approach to be taken at the site. It may be decided that the tank pull or asbestos testing can be scheduled promptly, and all interested parties will be present, in which case, no site visit would be required in advance. If contaminated soil or water is discovered rather than (or in addition to) tanks, a site visit may be necessary to gather information to plan for remediation.

Tanks or asbestos-containing materials (ACM) must not be moved or removed before ES investigation. Parties that must be present include an environmental consultant representing ES, the designated contractor for remediation, and preferably, the engineer.

Suspended work should not be resumed until the conditions of an ordered remedy are fully satisfied, or until ES has a determined no further study or remediation is needed and the engineer has given authorization.

130.2.4 Remediation Costs

Costs related to the tank removal or site cleanup will be charged to the project. Any change orders should be initiated by the engineer when the on-site contractor is used. The environmental consultant retained by ES will be responsible for preparing payment requests to be processed by ES if the environmental consultant obtains a different contractor for asbestos inspection or abatement, tank removal, or site cleanup.

130.2.5 Coordination of Removal

ES will coordinate the schedule of the tank and/or contamination removal or asbestos testing and abatement with the environmental consultant and the engineer. The goal is to minimize disruption of construction while ensuring proper inspection and remediation or abatement. The ES' environmental consultant must supervise all necessary tank removal or site remediation work conducted by a contractor.

130.2.6 Additional Remediation

If contamination is widespread or the extent of contamination is unknown, a thorough site investigation including soil borings may become necessary. Typically, this determination is made after pulling a tank and/or excavating a minor amount (100 cubic yards or less) of contaminated soil, and possibly excavating test pits. The environmental consultant will recommend a site investigation, including soil borings, to determine the nature and extent of the contamination, or immediate remediation through excavation.

It is important at this time for the engineer to coordinate with ES to determine the best approach. The environmental consultant must be available for consultation regarding alternative options. It is possible the costs of the investigation and remediation may be greater than the cost of the project; therefore, at minimum the following criteria must be considered:

1. Schedule
    - How soon does work in the impacted area need to be completed?
    - Can work continue in an area away from contamination: For how long?
    - Can impacted area be avoided?
    - Could design in contaminated area be changed (i.e., resurface rather than reconstruct, or temporary pavement, or modifications of ditching or slope)?
2. Cost
    - Compare cost of highway project to cost of remediation.
    - Cost of delays for construction contractor and any subcontractor.
    - Cost of delays for road closures affecting local businesses.
3. Responsibility
    - Is there an obvious responsible party (RP), (e.g. are UST's partly on private property)?
    - If WisDOT is not the RP, should WisDOT remediate only the impacted WisDOT right of way to avoid project delay?
    - WisDOT should always remove UST's when located within the project's limits.
    - If WisDOT is the RP, (or more likely, WisDOT decides that the project schedule cannot be held up to wait for the RP to act), WisDOT should remediate and/or monitor the impacted area as needed to complete the highway project.

If it is determined the next step is investigation or remediation, the environmental consultant must prepare and present a work plan for ES approval. Under circumstances of significant contamination (free product on or in the groundwater, extensive soil contamination), DNR must approve the work plan and ES must make the determination. ES will then present the work plan and schedule to the region (project manager or engineer) for discussion and/or approval.

Once all parties agree on the proposed work, the work will be scheduled by ES in conjunction with the environmental consultant, region, and the contractor.

130.2.7 Assessment of Contamination Beneath UST's

Before the first site investigation or tank removal, it is generally unknown if soil and ground water contamination are present. During this initial procedure the existence of contamination is confirmed or denied. The environmental consultant is responsible for making this determination.

If tanks are removed, and soil and/or ground water are found to be free of contamination, further environmental work generally will not be necessary. If tanks have been removed, the environmental consultant is responsible for the safe disposal of the tanks. Materials that they contained must be

disposed of through the State's Mandatory Hazardous Waste Contract administered by the ES. Follow the procedure in FDM 21-35-35.

Once the site is cleared of contamination by ES, the engineer will be responsible for further instructions to the consultant and/or contractors regarding site restoration to properly accommodate road construction. The environmental consultant or abatement contractor is responsible for the proper disposal of the asbestos-containing material in a landfill licensed for asbestos disposal.

130.2.8 Location for Stockpile Material

If soil contamination is found and the area is small (100 cubic yards or less) remediation may take place the same day as the tank removal. Before soil can be removed, the engineer must secure an area to store the contaminated soil. DNR regulations require the contaminated soil must be stockpiled on plastic and covered with plastic in an area that will not be disturbed for a time period of up to six months. The environmental consultant must supervise this procedure.

130.3 Lead Paint Wastes from Bridge Projects

130.3.1 General

The guidelines for management of lead paint waste from bridge projects are broken down into two categories:

1. Projects generating greater than one 55-gallon drum of lead paint waste. These are typically recyclable abrasive projects.
2. Projects generating less than one 55-gallon drum of lead paint waste. These are typically power-tool projects.

130.3.2 Bridge Projects Generating More Than One 55-Gallon Drum of Lead Paint Waste

130.3.2.1 EPA Identification Number

WisDOT has made a waste determination for its bridge paint systems. Sampling and testing of the residue is not necessary.

Contact BTS-ES to obtain an EPA Generator Notification Number (EPA ID) for the bridge site. EPA ID numbers are required for transportation and disposal of DOT lead paint waste for projects generating quantities over one 55-gallon drum. One EPA ID number is acceptable for sister-bridges. The hazardous materials specialist (Shar Te Beest 608-266-1476, sharlene.tebeest@dot.wi.gov) in BTS, requests the EPA ID numbers from USEPA. The EPA sends the EPA number to the hazardous materials specialist, who forwards it to the requestor and the region hazardous materials coordinator. It may take up to 30 days to receive a number, and no transportation of waste can occur without it, therefore, the hazardous materials coordinator should request numbers at least a month before the PS&E submittal date.

The following information is necessary to obtain an EPA ID number:

- Project identification number.
- Bridge number(s) and site location/address from HSIS - example "B10-240 and B10-241, STH 34 over Fox River, North and South bound."
- City/town or nearest city/town, zip code, and county.
- Bridge inspector or person responsible for project - please specify if this person is in construction or maintenance.
- Type of project: steel grit or power-tool.
- Project schedule - estimated start and finish of paint removal.
- Preconstruction meeting date and contractor, if known.

130.3.2.2 Service Arrangement

The DOA hazardous waste contractor provides services for container drop-off, pick-up, and disposal. Contact information is available at:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/environment/hazwaste-contacts.pdf

Use the Disposal Request (DT1231) and follow the procedure in FDM 21-35-35. The contract requires a minimum of ten days notification for container drop-off and pickup; please plan accordingly. A representative from this contractor will attend preconstruction meetings whenever possible. Invitation to the preconstruction meeting is strongly recommended. If attendance is not possible, service arrangements must be made directly with this contractor before the start of the project.

The following items should be addressed with the hazardous waste contractor:

- Confirm EPA ID number.
- Project schedule for drop-off of equipment and pick-up of waste.
- Project type: steel grit or power tool.

- Container needs: drums 30- or 55-gallon, roll off, or lugger boxes. 30-gallon drums are recommended when possible.
- Project location and accessibility.
- Identification of a level, stable, and secure location for drum delivery, storage, and pickup.

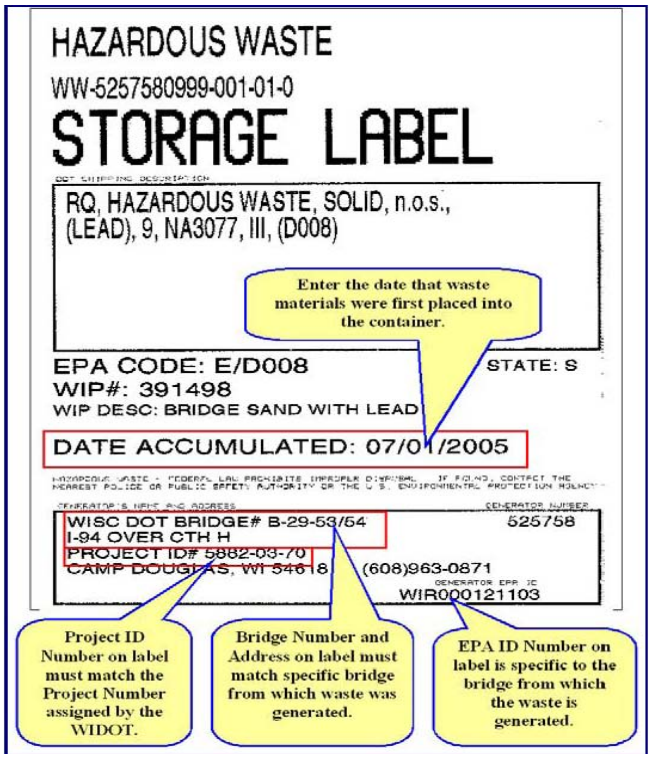
130.3.2.3 Waste Collection

All paint resulting from structure repainting, rehabilitation, or removal must be properly captured, contained, and disposed of in compliance with the hazardous waste management laws of Wisconsin. Structure repainting, rehabilitation, or removal contracts will include appropriate special provisions covering the steps to be taken by the contractor to satisfy those waste management requirements. The contractor is responsible for performing the work and completing the contract in accordance with the special provision.

130.3.2.4 Labeling

Hazardous waste contractors supply labels at the time of container drop-off. Labels are pre-printed and bridge-specific and must be affixed to the containers as they are being filled. The person filling the container must complete the "Date Accumulated" line on the label when the material is first put in the container. Do not put regular garbage into the lead paint waste drums. Disposable PPE is acceptable.

FIGURE 130-4 Sample Hazardous Waste Storage Tag



130.3.2.5 Staging

Filled drums must be stored on an easily accessible level surface, outside the clear zone, and not in a wetland, ditch, or other inaccessible location. Whenever possible, drums should be placed on pavement or a compacted surface so that they do not sink in. A full 55-gallon drum may weigh up to 600 pounds. Take this into consideration when determining the staging location for the drums.

130.3.2.6 Waste Transportation

The DOA waste disposal contract requires a **minimum of ten days** lead time for pickup. This enables the hazardous waste contractor to coordinate pickups with other projects, which reduces the disposal costs charged to the project.

To schedule a waste pickup, the engineer will send an e-mail to the applicable hazardous waste contractor contact listed in the following PDF document:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/environment/hazwaste-contacts.pdf

CC the ES hazardous materials specialist: dothazmatunit@dot.wi.gov

CC the hazardous materials coordinator listed at:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/environment/regenvhazardmatcoords.pdf

Include the following information in the email:

- Project identification number.
- Bridge number(s) and location, for example:

  "B10-240 and B10-241, STH 34 over Fox River, North and South bound, 5 miles north of junction with USH41."
- EPA ID number for each bridge
- Number of containers to be picked up.
- Number of new containers to be delivered (if applicable)
- Storage location for the containers (map with location marked on it is preferred)
- Name and telephone number of on-site contact person.
- Pickup and delivery will occur between 8 am and 4:30 pm Central time unless other arrangements are made with the disposal contractor in advance.
- Last possible date for pickup.

The disposal contractor will sign the manifests on behalf of WisDOT unless the bridge inspector has had the appropriate hazardous materials shipping training under USDOT PHMSA's 49 CFR 171-180 Hazardous Materials Regulations (HMR). The Bridge Inspector is responsible for verifying and documenting the number of drums being picked up.

130.3.2.7 Cost

Project identification numbers are required on bridge projects generating lead paint waste. Costs for transportation and disposal will be charged back to each project.

130.4 Bridge Projects Generating Less Than One 55-Gallon Drum of Lead Paint Waste

WisDOT does not need to obtain project-specific EPA IDs for projects generating less than one 55-gallon drum of waste. The DNR must be notified when the agreement is used, as described below. After paint removal, it is the responsibility of the bridge inspector and/or person responsible for the project to transport waste to the region facility for storage and final pick-up by the contractor.

130.4.1 DNR Approval

To comply with the DNR guidelines, the following procedures must be followed before the project begins. Contact your hazardous materials coordinator and the appropriate DNR region hazardous waste management specialists with the following information:

- Bridge number and location.
- Bridge inspector and/or person responsible.
- Anticipated amount of waste to be generated.
- Mode of transportation (field vehicle).
- Expected data that waste will be transported.

A contact list for the respective DNR contacts is available at:

https://dnr.wisconsin.gov/topic/Waste/EPAs.html

130.4.2 Supplies

UN-approved 5-gallon plastic containers with lids should be used for these projects. It is strongly recommended that these be purchased locally to avoid mobilization charges from the statewide hazardous waste contractor. Typically, the container costs $15 and transportation costs exceed $200. If you need hazardous waste labels, they can be mailed in advance by contacting one of the following:

Your hazardous materials coordinator listed at:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/environment/regenvhazardmatcoords.pdf

Your hazardous materials specialist: dothazmatunit@dot.wi.gov

Your statewide hazardous waste contractor contact listed in the following PDF document:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/environment/hazwaste-contacts.pdf

130.4.3 Transportation

Upon completion of the paint removal, it is the responsibility of the bridge inspector and/or person responsible for the project to transport the waste to the region facility for storage and final pick-up by the statewide hazardous waste contractor. Use of a field vehicle is acceptable. A manifest is not required. The containers should be tightly sealed and labeled.

The transporting party must consult with the hazardous materials coordinator to determine where the waste should be stored at the region facility.

SECTION 135 Safety

135.1 Construction Safety Rules and Regulations

135.1.1 Legal Background

Standard spec 107 requires the contractor to comply with all federal, state, and local laws governing safety, health, and sanitation, and to provide necessary safety devices, protective equipment, and safeguards. The contractor must also take action reasonably needed to protect the life and health of employees on the job and the safety of the public.

Wisconsin statute 101.11 requires every employer to furnish safe employment and provide a safe place of employment for employees and frequenters. The employer must furnish and require safety devices, protective devices, and safeguards; must adopt and use methods and processes reasonably adequate to render the employment and the place of employment safe; and must do everything reasonably necessary to protect the life, health, safety, and welfare of employees and frequenters. A frequenter is anyone who is not an employee of the contractor or not a trespasser.

OSHA is empowered to adopt rules or orders, having the full force of law, necessary for the safety and welfare of employees in the private sector. Thus, employees of the contractor and subcontractors are protected by the OSHA rules. OSHA administers and enforces its own rules.

The Wisconsin Department of Workforce Development (DWD) is empowered under Wisconsin statute 101.055 to adopt safety rules or orders, having the full force of law, necessary for the safety and welfare of public employees. Thus, employees of the state, county, town, city, and other political subdivisions of government are protected by the rules of DWD. DWD administers and enforces its own rules.

Under the Worker's Compensation Act, which is administered by DWD, a death benefit or compensation for an injury must be increased if the employer failed to comply with adopted rules or orders of DWD or OSHA. The death benefit or compensation for an injury must be reduced if the employee failed to use safety devices required by DWD or OSHA and provided by the employer, or if injury results from the employee's failure to obey any reasonable safety rule adopted and enforced by the employer (Wisconsin statutes 102.57 and 102.58).

135.1.2 Implementation

On department construction projects, WisDOT is primarily responsible for the safety and welfare of its employees, while the contractor is primarily responsible for the safety and welfare of the contractor's employees and frequenters. WisDOT personnel assigned to the project can be construed to be frequenters and, therefore, some degree of responsibility for their safety also rests upon the contractor.

WisDOT project personnel are expected to be aware of, and to follow the safety plan established by the contractor for the project. The contractor is required to have a site-specific safety plan based on the Job Hazard Assessment / Analyst (JHA) of the work to be performed. Examples of written programs include retrieval procedures in case of a fall, emergency procedures in case of trench collapse, and emergency rescue procedures for working over water.

WisDOT does not have the authority or responsibility for the direct enforcement of the OSHA safety codes on contract work under its jurisdiction. However, under the language of the standard specifications, it is considered to be within the authority of the engineer or safety representative to obtain correction of a condition that is obviously hazardous, whether or not the hazard is a violation of a safety code. Furthermore, the department's Risk and Safety Management section advises that the engineer or safety representative assumes additional risk if he/she observes a violation or hazard and nothing is done to alert the contractor and, subsequently, injury or death occurs.

Therefore, when hazardous conditions or a violation of a safety code are observed on a construction project, the engineer or inspector will promptly call the contractor's attention to it and request it be corrected. If the condition is not promptly corrected, the circumstances involved will be referred to the region office. The region office may notify the contractor in writing of the violation and demand immediate correction and notify OSHA to investigate the reported violation. Where the violation is flagrant, or a substantial hazard exists, work under the contract may be suspended.

Project safety specifications may provide for increased requirements beyond the scope of this document and will take precedence.

135.1.3 Summary of Safety Provisions

The following provisions have been extracted from the safety provisions of OSHA and DWD that particularly apply to highway and bridge construction. They have been condensed for the sake of brevity. The specific reference is shown in parenthesis following the text. This summary should be viewed as a good starting guide for project personnel assessing construction safety, not as a complete listing.

135.1.3.1 Selected OSHA Rules and Regulations for Contractor's and Subcontractor's Personnel

1. Accident Prevention Responsibility.

   It is the responsibility of the employer to initiate and maintain a written safety program, including documented frequent and regular inspections of job sites, materials, and equipment by competent persons. The employer must instruct employees in the recognition and avoidance of unsafe conditions. The employer must allow only trained or experienced employees to operate equipment and machinery. Use of equipment, tools, and materials that do not comply with OSHA requirements are prohibited (OSHA 1926.20, 1926.21).

2. First Aid and Medical Attention.

   The employer must make first aid services and provisions for medical care available. Provisions must be made before the start of the project for prompt medical attention in case of injury. A first aid kit containing at a minimum: latex or nitrile gloves; CPR masks; adhesive, pressure, and cling bandages; antiseptic wipes; bite/sting swabs; cold packs; and safety glasses. The first aid kit must be accessible and must be checked at least weekly to ensure that expended items are replaced. Where the eyes or body of a worker may be exposed to corrosive or potentially harmful materials, facilities for quick drenching or flushing the eyes and body must be provided and maintained in the work area for emergency use. In the absence of an infirmary, clinic, or hospital in proximity to the work site, a person having a valid certification must be available to render first aid. Proper equipment for prompt transportation of injured persons, or a communications system for contacting ambulance service, must be provided. Telephone numbers of doctors, hospitals, and ambulances must be conspicuously posted. (OSHA 1926.23, 1926.50)

3. Housekeeping.

   Form lumber, scrap lumber with protruding nails, and other debris must be kept cleared from work areas, passageways, and stairs. Trash, waste, and refuse must be collected, separated, and stored in containers. Containers of garbage and oily, hazardous, and flammable substances must be covered. Safe means must be provided for the regular removal of combustible scrap and debris during construction. Garbage and waste must be removed at frequent and regular intervals (OSHA 1926.25).

4. Sanitation.

   An adequate supply of potable water must be provided. Drinking water containers must be clearly marked, capable of being tightly closed and equipped with a tap. Water must not be dipped from the container. The common drinking cup is prohibited. A minimum of one toilet must be provided for every 20 workers. Washing facilities must be provided for employees applying paints or coatings or other work operations producing harmful contaminants. Washing facilities must be close to the job site and equipped to remove harmful substances (OSHA 1926.51).

5. Personal Protective Equipment.

   The employer is responsible for the wearing of appropriate personal protective equipment by employees in operations that expose the employees to hazardous conditions (OSHA 1926.28).

6. Noise Exposure.

   Feasible administrative and engineering controls must be used to reduce the noise levels to permissible levels. Failing that, personal protective equipment must be provided to employees and must be used. Devices to be inserted in the ear must be fitted by competent persons. Plain cotton is not an acceptable protective device (OSHA 1926.52, 1926.101).

TABLE 135-1 Permissible Noise Exposures

DURATION per DAY (hr.)	SOUND LEVEL (dBA)[1]
8	90
6	92
4	95
3	97
2	100
1 - 1 1/2	102
1	105
1/4 or less	115
[1] Maximum must not exceed 140 dB from impact or impulsive noise.	

7. Gases, Vapors, Fumes, Dusts, and Mists.

   After using feasible administrative and engineering controls and finding they are not adequate or fail, employees exposed to harmful air contaminants must be provided with personal protective equipment and must use it. Respirators must be of an approved design appropriate for the purpose, inspected regularly

and maintained in good condition. Employees required to wear respirators must be instructed in proper use and equipment limitations (OSHA 1926.55, 1926.103).

8. Head Protection.

   Employees working in areas where there is a possible danger of head injury from impact, falling or flying objects, or electrical shock or burns must be protected by protective helmets. The helmets must meet the specifications for the type of anticipated hazard (OSHA 1926.100).

9. Eye and Face Protection.

   Employees must be provided with eye and face protection when exposed to potential eye or facial injury from machines or work operations producing physical, chemical or radiation agents. Protection must meet the specifications for the type of use or anticipated hazard (OSHA 1926.102).

10. Safety Nets.

    Safety nets must be provided when work places are more than 25 feet above the ground, water surface, or other surfaces where ladders, scaffolds, catch platforms, temporary floors, safety lines, or safety belts are not practical. Work operations must not begin until the net is in place and tested. The nets must be hung as close under the work area as practical, but not more than 25 feet below the work surface. The nets must extend 8 feet beyond the limits of the work area (OSHA 1926.105).

11. Working Over or Near Water.

    Employees working over or near water where the danger of drowning exists must be provided with U.S. Coast Guard approved life jackets or buoyant work vests. Before use, the life jackets and vests must be inspected for defects. Ring buoys with at least 90 feet of line must be available at locations no more than 1200 feet apart. A lifesaving boat must be available at the work site (OSHA 1926.106).

12. Fire Protection.

    A fire protection burn permit program must be developed and followed. It must be designed to effectively meet without delay fire hazards as they occur.

    Adequate firefighting equipment, appropriate for the intended use, must be provided. The equipment must be conspicuously located, readily accessible at all times, periodically inspected and maintained in good operating condition. As warranted by the project, a fire brigade must also be provided.

    Portable fire extinguishers must be visually inspected monthly, and checked by a certified inspector at least annually. Carbon tetrachloride and other vaporizing liquid fire extinguishers are prohibited (OSHA 1926.150).

13. Flammable and Combustible Liquids.

    Only approved containers and portable tanks must be used for storing and dispensing flammable and combustible liquids. Flammable and combustible liquids must be kept in closed containers when not in use.

    Conspicuous and legible signs prohibiting smoking must be posted in service and refueling areas. Each service or refueling area must be provided with a fire extinguisher rated 20 B:C or higher located within 75 feet of dispensing equipment (OSHA 1926.152).

14. Signaling.

    Flaggers or other traffic controls must be provided when signs, signals, and barricades do not provide necessary protection on or adjacent to a highway or street. Flaggers must wear a high visibility safety vest meeting ANSI/ISEA 107 2004 standards when flagging. Signals must conform to those in the FHWA Manual on Uniform Traffic Control Devices (OSHA 1926.201).

15. Hand Tools and Power-Operated Hand Tools.

    Employers must not issue or allow the use of unsafe hand tools. Power-operated hand tools, which are designed to accommodate guards, must be equipped with the guards when in use. Electrical power-operated hand tools must either be of an approved double insulated type or suitably grounded. Fuel-operated tools must be stopped while being fueled, serviced, or maintained. High-pressure, atomizing airless paint spray guns must be equipped with a trigger safety catch (OSHA 1926.300-302).

16. Ladders and Scaffolding.

    Ladders with broken or missing rungs or steps, broken or split side rails, or other faulty or defective construction are prohibited from use. Portable ladders must be used at a pitch or incline such that the horizontal distance from the top support to the ladder foot is about one-quarter of the working length of the ladder. Side rails must extend at least 3 feet above the landing.

    Portable ladders must be placed on a substantial base and the area around the top and bottom of the ladder kept clean. Portable ladders in use must be secured to prevent being displaced. Ladders must not be placed in any location where they may be displaced, unless protected by barricades or guards. Metal ladders must be checked for corrosion in open-end hollow rungs. Portable metal ladders must not be used for electrical work or where they may contact electrical conductors (OSHA 1926.1053).

    Scaffolds must be erected on firm, sound footings. Scaffolds must be capable of supporting four times the maximum intended load without failure.

Scaffold platforms more than 10 feet above the ground must be provided with guardrail and toeboards on open sides and ends. Guardrail must have a vertical height of 42 inches from the floor or platform to the upper surface of the top rail. An intermediate rail must be provided midway between the floor or platform and the underside of the top rail. The posts of uprights must be not less than nominal 2" x 4" spaced not more than 8 feet center-to-center, the top rail not less than nominal 2" x 4", and the intermediate rail not less than 1" x 6". Toeboards must be at least 4 inches high.

Scaffold platforms from 4 - 10 feet above the ground must be provided with guardrail (OSHA 1926.451).

WisDOT employees are required to tie off when working 6 feet or more above a surface.

17. Cranes, Derricks, Hoists, and Conveyors.

    The rated load capacity, recommended operating speed, and hazard warnings or instructions should be conspicuously posted on all equipment. The employer must comply with equipment specifications and limitations. A competent person must make a thorough annual inspection of the hoisting machinery, and a record of the inspection must be kept. Before each use, the equipment and machinery must be inspected by a competent person to ensure it is in a safe operating condition and deficiencies corrected before use. It must also be inspected periodically during use. ANSI approved hand signals must be used. Pictures of the approved hand signals to crane and derrick operators must be posted at the work site. Accessible areas within the swing radius of the rear of the crane must be barricaded to prevent a person from being struck by the crane. A fire extinguisher rated 5 B:C or higher must be immediately available to the operator of the equipment.

    Minimum clearance from live electrical power lines rated 50 kV or less must be 10 feet. Minimum clearance from live electrical power lines rated above 50 kV must be 10 feet plus 0.4 inch for each kV over 50.

    Conveyor systems must be equipped with an audible warning signal to be sounded before start-up (OSHA 1926.550, 1926.555).

18. Off-Highway Motor Vehicles.

    Vehicles must be checked at the start of each work shift to ensure they are in safe operating condition. Construction equipment and vehicles must be equipped with a reverse signal alarm audible above the surrounding noise level. Vehicles with an obstructed view to the rear must not be used unless they are backed only when an observer signals that it is safe to back.

    Vehicles loaded by crane, shovel, end loader, or similar equipment must have a cab shield or canopy to protect the operator. Rubber-tire vehicles must be equipped with fenders. Mud flaps may be used instead offenders on vehicles not designed for fenders (OSHA 1926.601).

19. Earth Moving Equipment.

    These rules apply to scrapers, loaders, bulldozers, graders, off-highway trucks, crawler or wheel tractors, agricultural and industrial tractors, and similar equipment used in earth moving operations.

    Roll-over protection and brakes must be provided. Seat belts meeting industry standards must be provided and used on all equipment, except equipment designed for stand up operation and equipment without rollover protection. Brakes must be capable of stopping and holding fully loaded equipment. Rubber-tire equipment capable of speeds above 15 mph must be equipped with fenders on all wheels, unless it can be shown that the unprotected wheels present no hazard to personnel from flying objects. Equipment must not be backed unless equipped with a reverse signal alarm audible above the surrounding noise level, or is backed only when an employee signals that it is safe to back. Bi-directional machines must be equipped with an operative horn distinguishable from the surrounding noise level (OSHA 1926.602).

20. Excavation and Trenches.

    Surface encumbrances such as trees or boulders that are located as to create a hazard must be removed or supported. Uncovered utilities must be supported and protected, or removed as needed to protect employees. A stairway, ladder, ramp, or other equipment must be provided in excavations more than 4 feet deep to provide a means of exit without more than 25 feet of lateral travel. Diversion ditches, dikes, or other suitable means must be used to prevent surface water from entering an excavation. Water must not be allowed to accumulate in an excavation. Excavated or other material must not be stored nearer than 2 feet from the edge of an excavation, unless restrained by a retaining device. A competent person must make daily inspection of excavations. If evidence of possible cave-in is found, work in the excavation must cease and employees must be removed until needed precautions have been taken. Adequate barrier protection must be provided at remotely located excavations. Wells, pits, shafts, etc., must be barricaded or covered (OSHA 1926.651).

    Employees in an excavation must be protected from cave-in by an adequate protective system unless the excavation is in stable rock, or is less than 5 feet deep and inspection by a competent person indicates no danger of cave-in. For excavations deeper than 5 feet and not in stable rock, the contractor has the option of laying the sides of the excavation back to a 1 1/2:1 slope (horizontal distance to vertical distance), providing a sloping and benching system based on Appendices A and B of this OSHA section, providing a system designed by a registered professional engineer, or providing a system based upon data approved by a registered professional engineer. Information on the safe installation, use, and removal of any trench support system must be available at the job site. Trench boxes or shields may be used if designed or

approved by a registered professional engineer or selected on the basis of data approved by a registered professional engineer.

A "competent person" means one who is capable of identifying existing and predictable hazards in the surroundings, and has the authority to take prompt corrective action to eliminate the hazards (OSHA 1926.652).

21. Steel Erection.

    During the placing of solid web structural members, the load must not be released from the hoisting line until the members are secured with at least two bolts of each connection and drawn up wrench-tight. When bolts or drift pins are being knocked out, means must be provided to keep them from falling (OSHA 1926.751, 1926.752).

22. Cofferdams.

    Warning signals for evacuation of employees, in case of an emergency, must be developed and posted (OSHA 1926,802).

23. Explosives.

    Explosive material must be stored in approved facilities. Only authorized and qualified persons must handle or use explosives. Blasters must take special precautions in congested areas or in close proximity to structures and highway to control the throw of fragments. Signs must be posted on all roads within 1000 feet of blasting operations, warning against using mobile radio transmitters. Utility owners in the proximity of blasting operations must be notified, and utility facilities safeguarded from the blast.

    Before a blast is fired, the blaster in charge must make certain all employees are at a safe distance or under cover, and must sound a loud warning signal. Flaggers must be safely positioned on all highways to stop traffic passing through the blasting zone (OSHA 1926.900, 1926.909, ILHR 7 & 8).

24. Storage.

    Materials stored in tiers must be stacked, blocked, or otherwise secured to prevent sliding, falling, spreading, tilting, or collapse (OSHA 1926.250).

25. Concrete Forms and Shoring.

    Formwork and shoring must safely support all loads imposed during placing concrete. All protruding reinforcing steel onto which employees could fall should be guarded to remove hazard of impalement. No employee must place or tie reinforcing steel more than 6 feet above a working platform unless protected by a safety belt or equivalent (OSHA 1926.701).

26. Site Clearing.

    All equipment must have a rollover protection system. In addition, equipment must be protected with an overhead canopy guard of 1/8 inch steel plate, 1/4 inch woven wire mesh, or equivalent, and a rear canopy guard of 1/4 inch woven wire mesh (OSHA 1926.604).

135.1.3.2 Selected DWD Rules and Regulations for Construction Personnel of the State and Other Political Subdivisions

DWD has adopted the OSHA regulations and supplemented them with some of their own. DWD rules apply to employees of the state and other political subdivisions such as towns, cities, and counties performing construction. For construction done by the state, a town, a city, or a county, the engineer or inspector reviewing the site should be aware that OSHA and DWD rules apply.

1. General.

    No person may work on the surface of any structural member, floor or other working platform which has become slippery, unless the surface is cleaned, sprinkled with sand or made non-slippery (ILHR 32.37).

2. Scaffolding.

    Support must be provided for all workers on inclined surfaces having a slope of more than 4 inches rise in 12 inches of horizontal run (ILHR 32.38).

3. Motor Vehicles.

    Trucks with dump bodies must be equipped with positive, permanently attached dump body support, capable of being locked into position to prevent accidental lowering while being maintained, inspected or left unattended (ILHR 32.39).

4. Excavation.

    A railing, guard, or barricade must be provided at the edge of an excavation as soon as it will not interfere with the work.

    All excavations exposed to persons at night must be marked with yellow warning lights placed at un-barricaded points and along any side adjoining a public highway or sidewalk.

    No person may work in any trench, shaft, tunnel, or caisson over 5 feet in depth without another person present at the surface (ILHR 32.40).

135.2 Safety Operations for WisDOT Personnel

On construction projects, particular attention to safety is necessary. Work may be performed by WisDOT employees in or near traffic, or in close proximity to construction activities. It is essential employees keep their own personal safety in mind and recognize the hazards connected with their duties. Also, engineers must always keep in mind the safety of the employees under their direction.

Each engineer is charged with the responsibility of providing safety leadership at all times and safety enforcement when necessary. Employees should receive instruction in the safe use of tools, materials, and equipment, and the safe prosecution of work projects. Employees should also refer to their Employee Handbook and the department Safety Manual for safety rules and policies.

The employee should ensure that an area is safe before entering for the purpose of inspection. For example, a deep trench must be adequately shored and braced before entering it.

State employees working around aggregate production and processing plants must be trained in WisDOT Mine Safety and Health Act (MSHA) and be particularly careful for both themselves and others to avoid accidents. The adequacy of foundations for storage hoppers, effectiveness of stairways and railing, hazards from moving belts or gears, dangers from falling or flying materials, exposure to hot materials, and other similar features are to be reviewed by the engineer, and desirable or necessary corrective measures called to the attention of the contractor or producer. The correction must be completed before WisDOT personnel are allowed to enter or work upon the premises.

The employee must at all times watch for backing trucks and not depend upon hearing alone for warning. The noise of plants and other equipment often makes it impossible to hear trucks approaching, and the truck driver's vision area is restricted when backing a truck. Constant vigilance is a life or death matter.

Parking state vehicles too close to the path of construction equipment, behind standing equipment, or in other hazardous locations is not allowed. Construction equipment is becoming larger, heavier, and faster, which in turn increases the hazards.

Where traffic is maintained on a construction job, inspectors and others must take care to not step onto the traveled portion of the roadway into the path of cars and trucks.

Where the engineering crew is working in conflict with traffic, the work area should be marked with proper signs and traffic control devices, and the crew should be protected by a qualified flagger equipped with STOP and SLOW sign paddles. High visibility safety garments meeting ANSI/ISEA 107 2004 certification must be worn.

Employees are prohibited from operating contractor's equipment or machinery, riding upon contractor's equipment, or flagging and directing traffic for the contractor. The occasional, necessary use of contractor's equipment or portable bridges or walkways to safely cross fresh concrete or asphaltic surfaces to obtain necessary measurements, etc., is allowed.

Vehicles of employees must be legally parked well back from the edge of the travel-way and preferably off the shoulder in rural areas. They should never be left where they may be a hazard due to proximity to moving traffic, by restricting or obstructing highway sight distance, or by obstructing work operations.

When a condition requires protective equipment use, the engineer or the employee's immediate supervisor is responsible for seeing the equipment has been furnished and is being used. It is the employee's responsibility to use the equipment. Under the Worker's Compensation Act, administered by DWD, a death benefit or compensation for an injury must be reduced if the employee failed to use safety devices required by DWD and provided by the employer.

135.3 Traffic Protection for Surveyors and Inspectors

135.3.1 General Safety Practices

The engineer is responsible for ensuring correct safety procedures, as well as proper use of safety devices, and that WisDOT personnel adhere to warning signs.

Before starting work involving exposure to moving vehicles, the engineer should warn employees of the potential hazards. Employees should be instructed in the safe manner of doing the work and the proper use of warning signs and devices. During the work, the engineer should require employees to follow established safe work practices.

All employees should be constantly on the alert. They should face in the direction of approaching traffic, whenever possible, when required to stop or stand in a traffic lane. They should never enter or cross a traffic lane without first watching for oncoming vehicles and waiting until the lane is clear.

Survey work, to the extent practicable, is conducted off the traveled way. Exposure to traffic hazards can be substantially reduced by using offset lines run on the shoulders or at some greater distance from the

pavement. Workers should minimize crossing of traffic lanes by taking measurements on one side of the highway at a time.

Measurement in a traffic lane should be done as quickly as possible. Standing in or adjacent to a live traffic lane while discussing the work or recording readings is not to be done.

Traffic hazards associated with peak volumes can be avoided by adjusting working hours to perform the work during off-peak traffic conditions.

When project construction barricades cannot adequately protect survey or inspection work, warning signs, and devices, it will be necessary to provide additional safety measures. Added protection should be provided to personnel performing work such as setting up and sighting instruments, painting numbers on pavement, or taking measurements. Flaggers, barricades, cones, and warning sign arrays are some measures that might be taken.

The work should be planned and performed so traffic is not unduly delayed or subjected to accident hazards. When necessary to stop traffic, hold delays to a minimum.

135.3.2 Warning Signs, Devices, and Flaggers

135.3.2.1 Advance Warning Signs

Warning signs should be used in these cases:

1. Where traffic is heavy or fast, and it is necessary for survey personnel or others to cross or enter a traveled lane occasionally, even though the majority of the survey operations are well clear of the traveled way.
2. Except when the traffic is extremely light, if the work is being done within or immediately adjacent to traveled lanes, and survey personnel must enter or cross the lanes at frequent intervals.
3. When restricted sight distances due to a hill or a sharp curve reduce visibility of the operations to a dangerous degree.

Standard warning signs reading "Worker (Symbol)" or "Survey Crew", as appropriate, should be placed before work starts in a position where readily visible to approaching traffic and at a sufficient distance from the work area to allow the motorist to slow, or stop if necessary, after seeing the sign and before entering the work area. On rural highways, the sign should be placed on the shoulder, 2-6 feet outside the traveled lane. On urban streets the sign should be placed approximately 2 feet back of the curb or in the parking lane, whichever will give adequate visibility. For divided roadways, a supplemental sign should be placed in the median for observation by drivers of vehicles in the inner or left lane. Signs should be provided for traffic from both directions when two-way traffic is involved.

To be effective, the signs should be placed not closer to the work area than 200 feet for traffic speeds up to 25 mph, 300 feet for speeds 25 mph to 35 mph, 500 feet for speeds 35 mph to 50 mph, and 1,000 feet for speeds over 50 mph. Signs should not be placed at so great a distance from the work that their warning value is lost. Generally, on rural locations the signs should be moved ahead when the work zone moves to a site more than approximately 3,000 feet from the sign. Signs placed at the far end of the work area for approaching traffic in opposite lanes should be placed at maximum distances and moved when minimum distances occur.

When the work zone extends over 2,500 feet or more, and workers are at more than one place in the area, supplementary warning may be provided if considered to be needed, by erecting traffic cones, with or without orange flags, or another warning sign. These would be placed at the locations on the shoulder, parking lane or outside the curb as previously explained.

On highways having sufficient volume of high-speed traffic to warrant their use, two advance warning signs should be provided and spaced 500 feet or more apart. One sign should be placed at about 500 feet from the beginning of the work area, as required for speeds over 35 mph. This sign should be moved ahead as the work progresses and as the nature of the work will allow. Generally, work operations should not advance more than 3,000 feet from this sign. The second sign should be initially placed 500 feet towards the approaching traffic from the first sign. It may be left in place until the 3,000 feet maximum for the first sign is reached, or until the second sign becomes ineffective. Both signs should then be picked up and reset at the original spacing. Signs placed at the far end of a work area for approaching traffic in opposite lanes should be placed at maximum distances and moved when minimum distances occur.

Warning signs and devices left in place when work operations are not in progress tend to create disrespect in motorists for the warnings. During the noon hour, at night or during other periods when work operations are suspended, signs and warning devices should be removed or covered to indicate they are not in effect.

Refer to figures 135-1 to 135-3 for typical signs and sign placements.

FIGURE 135-1 Advance Warning Signs and Cones

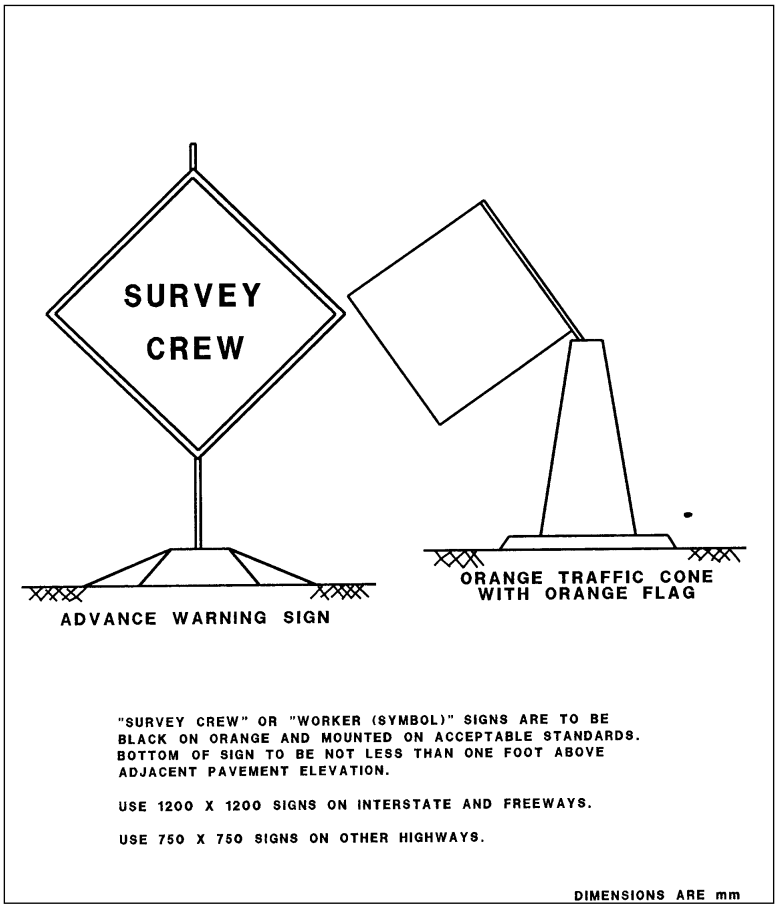
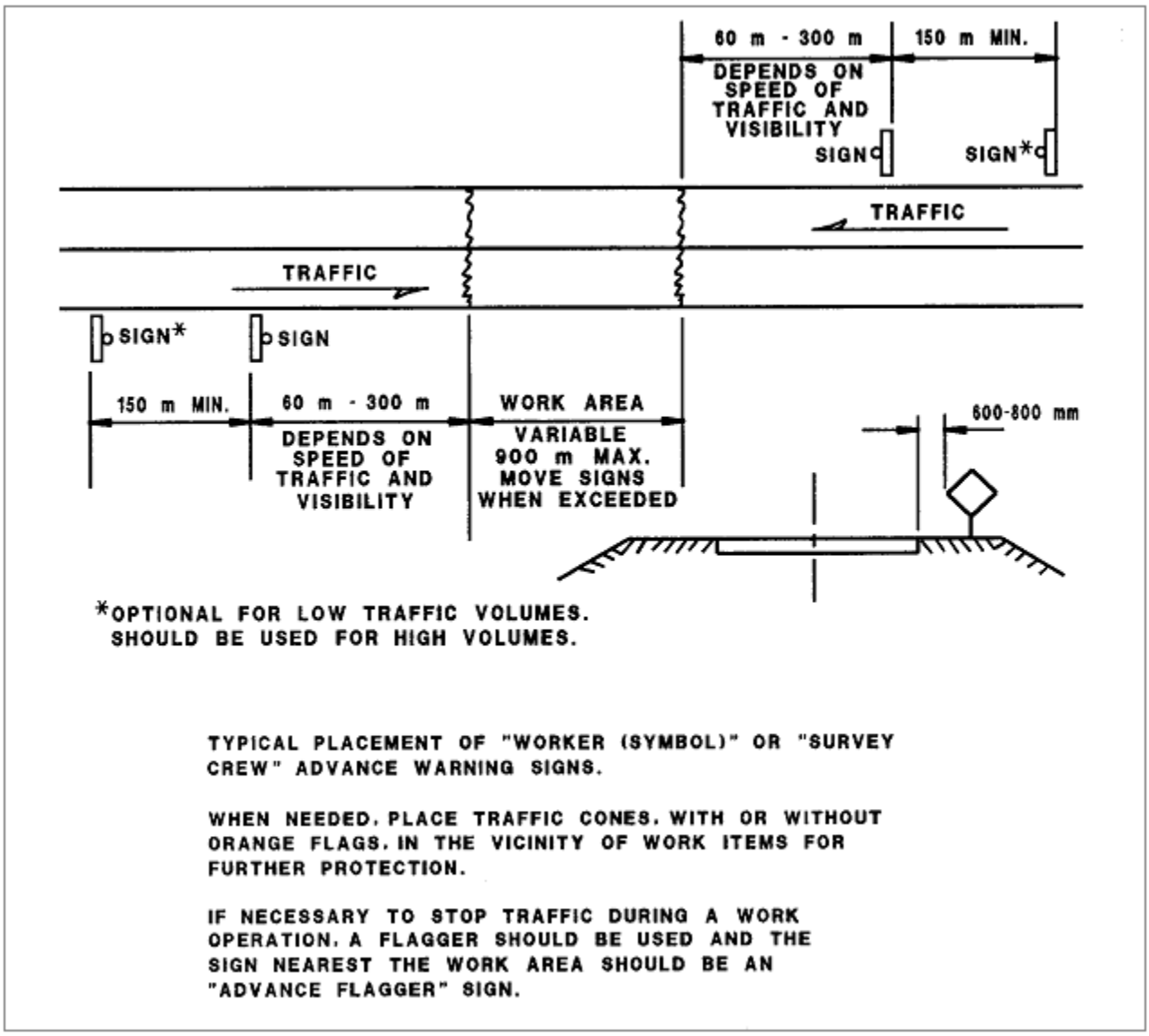


FIGURE 135-2 Typical Sign Placement for Work Area on a Single Roadway

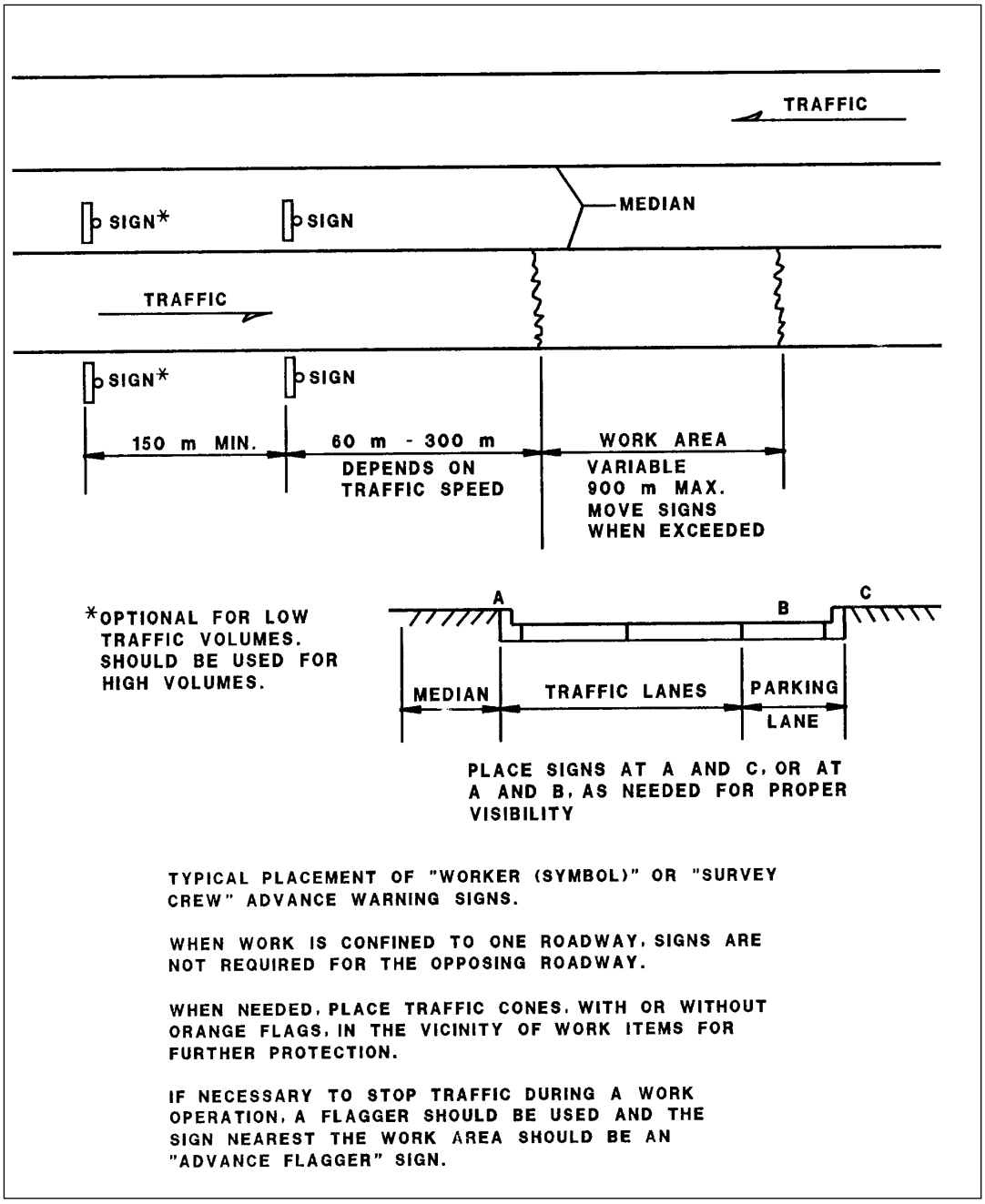


TYPICAL PLACEMENT OF "WORKER (SYMBOL)" OR "SURVEY CREW" ADVANCE WARNING SIGNS.

WHEN NEEDED, PLACE TRAFFIC CONES, WITH OR WITHOUT ORANGE FLAGS, IN THE VICINITY OF WORK ITEMS FOR FURTHER PROTECTION.

IF NECESSARY TO STOP TRAFFIC DURING A WORK OPERATION, A FLAGGER SHOULD BE USED AND THE SIGN NEAREST THE WORK AREA SHOULD BE AN "ADVANCE FLAGGER" SIGN.

FIGURE 135-3 Typical Sign Placement for Work Area on Dual Roadways



135.3.2.2 Flags and Traffic Cones

Orange traffic cones may be used, with or without orange flags, in addition to the advance warning signs for the guidance of traffic where circumstances warrant. The cones should be arranged to define the work area and guide the flow of traffic past it. Generally, a minimum of 3 cones is needed. They should be placed from 20 to 50 feet apart, depending upon traffic and roadway conditions.

135.3.2.3 Flagging

Flagging operations are described as a part of the temporary traffic control required to protect work zones in CMM 145.14.

135.4 Traffic Protection for Density Testing of Asphaltic Pavements

Ideally, this testing should be done while a lane is closed for pavement construction. Testing within the closed construction work area could be accomplished immediately behind the cold roller and a short distance, generally 50 to 200 feet, in front of the contractor's trailing flagger.

When the testing is delayed until after the lane is reopened because of manpower limitations or other reasons, those persons responsible for testing must also provide traffic control to protect the tester and the motorists. Variable field conditions will require customized traffic control planning for each project.

The inspector making the nuclear test must occupy the pavement for about 10 minutes at any one-test location. We advise that at least one flagger be used, regardless of traffic conditions, because of the vulnerability of the tester. In those situations where the lane is reopened before the tests have been made, the traffic control must conform to Part VI of the Manual of Uniform Traffic Control Devices, including revisions by the FHWA and supplements by WisDOT.

Further suggestions for protecting the asphaltic pavement tester include:

1. A "Be Prepared to Stop" sign.
2. A rotating dome-light or a flashing light on the inspector's vehicle.
3. A "Worker (symbol)" sign on the inspector's vehicle.

After the advance warning devices are in place and the flaggers are ready, the inspector's vehicle should be parked a reasonable distance upstream from the test site to warn traffic and protect the tester. The vehicle either can be centered in the closed lane, straddling the closed lane and shoulder, or completely on the shoulder.

135.5 First Aid Services

If injured, obtain medical treatment promptly and report the accident to your supervisor as soon as possible. If anyone else is injured, provide first aid within the limits of your skill and knowledge. Form DOA 6058 must be filled out by the injured employee.

Section 895.48 of the Wisconsin statutes provides immunity from civil liability for department employees rendering first aid at the scene of any emergency or accident.

135.6 Use of Liquefied Petroleum Gas Stoves

Where bottled gas stoves are used on the project for drying samples of soil, aggregates, etc., their use must conform to the safety requirements of OSHA 1926.153, Subpart F, as adopted by DWD. The following general rules will apply:

1. The bottle container and first stage regulatory device must be located outside the building that houses the stove. Container, regulator, valves, and fittings must bear the USDOT approval, or be approved by DWD or agencies recognized by them. A safety relief valve must be provided.
2. The container must be installed on a firm foundation or securely supported. The discharge from the safety relief valve on the bottle must be not less than 5 feet horizontally away from a window or opening in the building, which is below the level of the discharge.
3. A suitable length of a flexible hose designed to withstand at least 250 psi and approved by a recognized testing agency may connect the bottle to the stove. The gas must be shut off at the end of each working day's use.
4. Filled or partly filled bottles are to be stored outside. Each storage area must have at least one appropriately rated fire extinguisher.

135.7 Safety Equipment

135.7.1 General Requirements

Wisconsin statute 101.11 spells out the employer's responsibility to provide a safe work place and safe employment, and to furnish and to require using safety devices and safeguards.

Directive TAM 7 of the department elaborates further upon this responsibility of the employer. Supervisors and lead workers are responsible for the safety of all persons under their direction and all persons coming into the work area, and are responsible for:

1. Training employees in the safest manner to do their work.
2. Reviewing safety policies and procedures with employees.
3. Checking that necessary safety equipment is provided and used.
4. Taking prompt action to correct unsafe conditions and practices.
5. Investigating and reporting accidents, and recommending corrective action.

WisDOT employees are responsible for their personal safety and that of their co-workers. They are encouraged to report unsafe conditions and equipment to their supervisor. If they fail to comply with WisDOT safety rules and programs, they will be subject to discipline.

135.7.2 Safety Vests

WisDOT-approved high visibility safety vests are required for any employee working on highways, roads, streets, or their easements carrying traffic and including, but not limited to, the following specific locations and work activities (as outlined in Safety Directive 57):

- Members of pavement marking, signing, and electrical crews on field assignment. Electrical crews while working inside traffic signal controller cabinets or other electrical facilities.
- Members of field survey crews working in off-highway locations during hunting season.
- Construction personnel or other employees on field assignment while working in areas removed from normal vehicular travel where they are exposed to potential injury from construction equipment operations or other contractor or DOT vehicle operation within the area or project.
- Any employee who is a casual or infrequent visitor to any of the fore mentioned locations or work activities for purposes of review, discussion, or supervision.
- Where exposure to the specific conditions described above is intermittent, the general rule must be to opt for wearing high visibility safety vests, at all times.
- Approved safety vests and pants are required to be worn by DOT employees during the hours of darkness (1/2 hour before sunset & 1/2 hour after sunrise or during low visibility. Per ANSI/ISEA 107-2004, wearing high visibility pants in addition to the vest makes the Vest and Pant a Class 3 ensemble.

Supervisors are responsible for demonstrating safe practices and ensuring that employees are informed of the latest requirements/policies regarding safety vests and that safety vests be worn at all times in areas where the personal safety of an employee can be maximized by being highly visible. Safety vests meeting current department specifications may be obtained directly from Central Supply Services.

135.7.3 Standard Warning Devices

Advance warning signs, traffic cones, sign paddles, flags, and other safety devices are maintained in stock at Central Supply Services. Regions may requisition or replenish their supply of these items directly from Supply Services as needed.

To effectively attract the attention of motorists, warning devices must be legible. Signs should be handled carefully and transported so the sign face is not scratched or scuffed. Signs and other devices, which are damaged, dirty or faded, should be replaced, cleaned, or renewed. Flags and signs should be inspected when in use to make sure the flags are not wrapped around their supports, or that the signs have not been upset or turned so the message is not visible.

135.7.4 Eye Protection

Employees of the department working in the following areas and performing the following activities are required to use eye protection. These requirements are contained in Safety Directive 36 of the department.

1. Shop and field personnel who wear eyeglasses (including sunglasses) on the job must wear safety glasses or safety goggles where there is a hazard to eyes.
2. Employees repairing, removing, or installing any electrical or communications equipment must wear safety glasses or safety goggles.
3. Members of the marking and signing and survey field crews must wear safety glasses or safety goggles when on the job.
4. Employees exposed to flying particles, splashing metal or injurious radiant energy must wear safety glasses or safety goggles. This includes the driving of "frost pins" by survey crewmembers.

Supervisors are responsible for ensuring eye protection is worn at all times in an area where there is a hazard to the eyes. It is the responsibility of all employees who are exposed to eye hazards, including supervisory personnel, to wear the eye protection required and provided. Non-prescription safety and safety sunglasses may be obtained directly from Central Supply Services.

135.7.5 Foot Protection

Under the department's Safety Directive 30, department employees must wear safety shoes or strap-on metal foot guards in the following locations and performing the following activities.

1. Construction projects.
2. Maintenance and materials personnel on field assignment.
3. Signing, pavement marking, and electrical personnel.
4. Survey personnel on field assignment.
5. Supervisors and review personnel visiting these locations or activities.

Foot protection must meet ANSI Standard 241.1.95/75. Table 135-2 shows the types and styles of foot protection and the locations in which they are to be worn:

TABLE 135-2 Foot Protection

Location	Min. Type *	Min. Style**
Asphalt or concrete paving sites	A	2
Bridge erection sites (bridge repair sites)	A	2
Building demolition sites	A	2
Emission Center	A	1
Location	Min. Type *	Min. Style**
Loading Docks:		
Where metal containers, equipment or parts are being loaded or unloaded.	B	2
Where wooden containers, equipment or parts are being loaded or unloaded.	B	2
All others	A	2
Materials Lab, Testing Machine Room	A	1
Pavement coring sites	A	2
Pavement Marking Shop	A	1
Portable truck weighing sites	A	2
Prestress concrete plants	B	2
Riot control sites	A	2
Sign erection sites	B	2
Sign Manufacturing Shop (exclusive of Drafting Room)	A	1
Sign Shops in the Regions	A	1
Signal installation and maintenance sites	A	2
Soil test drilling sites	A	2
Steel fabrication plants	B	2
Testing Machine Room at Materials Laboratory	A	1
Truck loading and unloading	A	2
Truck weighing scales (portable scales only)	A	2
Warehouses	A	1
All other field locations:	A	2

*Type: A - Class 75 Safety Shoe
B - Class 75 Safety Shoe with Metatarsal Guard

**Style: 1 - Oxford
2 - 5" Minimum High Shoe

Supervisors are responsible for ensuring foot protection is worn at all times in areas where there are hazards that could cause injury to the feet.

It is the responsibility of employees who are exposed to foot hazards to wear approved foot protection.

135.7.6 Protective Headgear (Hard Hats)

Employees of the department are required to wear protective hard hats in work areas where there is possible danger of head injury from impact, falling or flying objects, or electrical shock or burns. This requirement is contained in the department's Safety Directive 51.

Visitors will be furnished protective headgear for ensuring that head protection is worn at all times in areas where there are hazards that could cause injury to the head. Employees, including supervisors, who are exposed to head hazards, will be responsible for wearing the head protection provided by the department.

Supervisors, including engineers, should use good judgment in determining mandatory use of protective headgear during construction work operations. Areas where hardhat protection is required should be posted when possible.

All personnel are required to wear protective headgear in any area posted as being required by the contractor.

135.7.7 Hearing Protection

Failing to achieve feasible administrative and engineering controls to reduce the noise levels to permissible levels, personal protective equipment must be provided to WisDOT employees and must be used to reduce sound levels within the permissible levels. Plain cotton is not an acceptable protective device (OSHA 1926.52, 1926.101).

Personal Hearing Protection that conforms to the EPA Noise Reduction Rating (NRR) must be used and must provide sufficient noise reduction to lower the work environment sound levels to 85dB or less (see Safety Directive 95.

The requirements contained in the department's Safety Directives, can be found at the following link:

https://wigov.sharepoint.com/sites/dot/Pages/Facilities/Safety.aspx

135.7.8 Fall Protection

Employees of the department are required to maintain 100% tie-off in where the potential exists for a fall of 6 (six) feet or greater. Bridge projects are required to have, at minimum, two sets of serviceable fall protection equipment available: one for use and the second for recovery operations if necessary. Excavations with a fall potential of 6 feet also require fall protection while working along the top edge.

Department employees should never enter a situation where a fall potential exists without recovery assistance being immediately available.

Supervisors are responsible for ensuring fall protection is worn at all times in an area where there is a hazard. It is the responsibility of all employees who are exposed to fall hazards, including supervisory personnel, to wear the protection required and provided. Fall protection harnesses and lanyards may be obtained directly from Central Supply Services.

135.7.9 Confined Spaces

A confined space is a space with restricted means of access, not meant for continuous occupancy that by its nature may contain an atmosphere non-conducive to supporting human life. Employees of the department are not to enter a confined space without proper training in the entry procedures. Access should be only by persons trained in proper testing and entry procedures.

Typical confined spaces we encounter include manholes, utility vaults, pits, and trenches with limited ventilation or soil contamination, some types of formwork, and box beam girders.

Breaking the plane of the opening with any part of the body constitutes entry by OSHA definition.

Supervisors are responsible for ensuring conformance to confined space entry procedures and to ensure trained personnel are available when the need to enter a confined space exists. Required testing and recovery equipment is available on each region for use by the properly trained operators.

135.8 Pedestrian Safety

Standard spec 104.6 specifically provide for the accommodation of pedestrian traffic. When the work area encroaches upon a sidewalk, crosswalk, or other areas near an area utilized by pedestrians, special consideration must be given to pedestrian accommodation and safety. Pedestrians are more susceptible to personal injury in working areas than are motorists. Visibility and recognition of hazards is an important requirement for the safety of pedestrians.

Where accessible routes are currently provided in accordance with the Americans with Disabilities Act, these routes must be maintained or suitable alternatives provided.

When evaluating the need to accommodate and protect pedestrians, emphasis should be placed on not creating a new barrier to pedestrian movement.

The contractor to ensure passageways are safe and well defined should provide protective barricades, fencing, handrails and bridges, together with warning and guidance devices. If not provided for in the contract, a change order to the contract may be necessary to furnish appropriate protection.

Where walks are closed by construction or maintenance, an alternate walkway should be provided when feasible. Where it is necessary to divert pedestrians into the parking lane of a street, barricades and delineation should be provided to separate the pedestrian walkway from the adjacent traffic lane. Pedestrians should not be diverted into a portion of the street used by vehicular traffic. At locations where adjacent alternate walkways cannot be provided, appropriate signs should be posted at the limits of

construction and in advance of the closure at the nearest crosswalk or intersection to divert pedestrians across the street.

When hazardous work conditions exist overhead, it may be necessary to install a fixed fence-type or canopy-type pedestrian walkway to protect and control pedestrians. Wood and chain link fencing can be used with warning lights and illumination to warn and guide both pedestrians and motorists.

Fences around a construction area are often necessary and may be a requirement of the local jurisdiction building code. They are often constructed in conjunction with a special pedestrian walkway, when there are deep excavations, or when pedestrian access to the job site is not desirable. Installation of the fencing must take into account relocation of existing control devices and facilities such as traffic signals, pedestrian signals, traffic signs, and parking meters. Chain link fencing which can be seen through may be needed at intersections to provide adequate sight distance.

135.9 Site Health and Safety Checklist

The DTD Safety Coordinators and the DOT Safety Steering Committee have recommended that this form be posted next to the phone in all DOT field offices for safety purposes.

Staff can download form WS1071 "Site Health and Safety Check List."

SECTION 140 Field Facilities and State-Owned Equipment

140.1 Field Facilities

The field office and field laboratory, as may be required by the contract, should be located at the sites selected by the engineer and leveled and anchored before construction operations start. The field office and field laboratory are for the sole use of department employees. Contractor personnel should not use these facilities to conduct their business.

The sites should be well drained, have full access at all times, and have adequate parking. Telephone, electric power, water supply, and sanitary facilities are to be in place and functioning before work requiring a field office or field laboratory begins.

The engineer should make a thorough check that all the specifications are met. This includes ensuring that the proper field office as specified in the contract has been delivered to the site. Field offices type B, C, and D vary in dimensions and amenities provided. Particular attention should be directed toward anchorages to prevent overturning; security, including window screens and door locks; firefighting equipment; sanitary facilities; an exhaust fan if the lab is used for asphaltic mix control; and an air conditioner.

The steps leading to the field facility should have a uniform rise of not more than 8 inches and a uniform tread of not less than 9 inches. Four or more steps must be equipped with a substantial smooth handrail 29 to 35 inches high as measured from tread nose and placed on the right side descending and on the open side, if any. The railings must have an intermediate member at mid-height.

The field office should be equipped with two telephones and two exchange services. The telephones are for the sole use of department staff. The department pays for long distance telephone calls and telegrams other than estimate and progress report transmittal. Engineers should request a state telephone card from the region for this purpose. If a cellular phone is added to the contract for engineer use, cellular air-time is also paid for by the department.

The field office should also be furnished with ergonomically correct office chairs. Required features for office chairs are specified in standard spec 642.2.2.1. The intent of this specification is to have the contractor provide chairs that are typically available at office supply outlet for approximately $100 to $150 and maintained in good condition. figure 140-1 shows pictures of acceptable chairs and their catalog descriptions.

FIGURE 140-1 Example Office Chairs, A and B



A) High-Back Fabric Mesh Task Chair:

- 4" pneumatic gas height adjustment from 40" - 44".
- Contoured seat and back with lumbar support.
- Back cushion: 20" W x 26" H
- Seat cushion: 20" D x 21" W

B) Adjustable Arm Task Chair

- 4" German Suspa gas height adjustment from 35 7/8" - 40".
- Padded adjustable arms and lumbar support.
- 360 degree swivel and tilt control.
- Back cushion: 20" D x 21" W

140.2 State-Owned Equipment

Sufficient equipment and supplies should be available on the project to accomplish assignments efficiently, accurately, and without delay.

Most equipment is expensive and used under adverse conditions. It must be given the best of care to produce quality results. Dust covers should be in place when the equipment is not in use. Dust and dirt should be removed at the end of each workday. Instruction books and maintenance schedules should be stored with the equipment and followed faithfully.

Equipment must also be protected against theft. Remote, isolated field office and laboratory sites that cannot be secured should be avoided. Doors and windows of the field facilities must be equipped with adequate locks and screens. Offices, laboratories, state vehicles, and private vehicles carrying state-owned equipment must be locked when unattended, or the equipment must be stored in a secure place.

Property the state owns or has care, custody, and control of, is covered by state insurance. If department employees choose to use their own personal equipment instead of state-owned equipment, for reasons of their own that are of no advantage to the state, their property will not be covered by state insurance.

SECTION 145 Traffic Control

CMM provisions mobilized by contract:
CMM 145.12.5.....Quality Standards for Temporary Concrete Barrier

145.1 General

Standard spec 104.6 provides for three types of traffic control situations. These are road closed to traffic, road closed to through traffic, and road open to all traffic.

145.2 Road Closed To Traffic

When the contract provides that the road or portions of the road be closed to all traffic, the contractor must furnish, erect, and maintain the traffic control devices at the project termini and at intersecting roads along the project as provided in the contract or directed by the project engineer. A road closed to all traffic means that the traveling public is not allowed on that portion of the road. However, the contactor is still responsible for protecting motorists and pedestrians that may enter the work zone from possible hazards.

When closing the road or portions of the road to all traffic, the local emergency agencies, postal authorities, school bus companies, etc. should be notified by the project engineer in advance of the closing so they can determine alternate routes.

145.3 Road closed to Through Traffic

Closed to through traffic means that only those vehicles with a destination to, from, or within the work zone are allowed.

When the contract provides that the road or portions of the road be closed to through traffic, the contractor must furnish, erect, and maintain the traffic control devices at the project termini and at intersecting roads along the project as provided in the contract or required by the project engineer. The contractor must also furnish, erect, and maintain traffic control devices within the project limits as required for the safe accommodation of local traffic.

When a road is closed to through traffic, apply standard spec 104.6.1.2.3 drop-off provisions where work is occurring in spot locations while other portions of the roadway are undisturbed. In this condition drivers may not notice outside of the signs that any work is being done.

Example

Consider a culvert replacement with a mill and overlay. The culverts will get replaced individually within a closed roadway but the surface outside of the culvert work is largely untouched. The only indication of work to a driver would be the spot locations where the culverts have been replaced. In this case the full drop-off spec applies.

When a road is closed to through traffic, and the original driving surface is completely obliterated, the application of standard spec 104.6.1.2.3 may be limited. Safe accommodation must still be provided to the road users but the standard spec provisions would be difficult to follow, such as:

- Many roadways that are closed to through traffic could have speed limit signs removed.
- If the pavement surface has been removed, temporary concrete barrier could not be used because it is not crash tested for that application.
- There would also be difficulty in defining the adjacent lane if the pavement is removed.

Efforts still need to be taken to delineate hazards with drums or barricades to warn local traffic of exposed drainage structures and other possible hazards.

The contractor must at all times conduct the work in a manner to provide safe, reasonably-direct, all-weather, 24-hour pedestrian and vehicular access to abutting properties along the highway being improved.

145.4 Road Open to all Traffic

When the contract provides for the maintenance of all traffic over or along the road while undergoing improvement or reconstruction, the road must be kept open to all traffic, and the contractor must keep the portions of the road being used by public traffic in a condition that pedestrian and vehicular traffic will be safely and adequately accommodated. The project engineer should make a daily inspection of the road condition.

The contractor must furnish, erect, and maintain traffic control devices as required for the safe accommodation of the traffic.

145.5 Worker Safety

Federal regulation 23 CFR Part 634 mandates that workers within the right of way of a highway project wear high-visibility safety apparel meeting performance class 2 or 3 requirements of the ANSI/ISEA 107-2004. CMM 135 contains further safety guidance.

145.6 Traffic Control Plan

All projects require a traffic control plan (TCP) to be included as part of the PS&E. The TCP is developed to be consistent with the prosecution and progress, utility coordination, and traffic provisions of the contract.

The contractor is responsible for implementation of the TCP. The project engineer will monitor the work of the contractor in this regard, and will ensure that required traffic controls are established at the start of the project and are properly maintained and operated during the time the control situation exists. The controls are to remain in place only as long as necessary and must be immediately removed thereafter. Where operations are performed in stages, only those devices pertinent to that particular stage must be used to avoid confusing the motorist.

During the daily inspection, the project engineer should look for signage and barriers that are within the right-of-way that could cause a safety problem for the traveling public. Such things as signage or barrels that are not needed, not properly anchored or not properly stored should be removed from the right-of-way to prevent potential hazards for the public. Consult standard spec 643 for each project regarding allowable timeframes for signage and barriers use when construction is inactive.

Instead of implementing the adopted TCP elements in the contract, the contractor can choose to develop other measures if they can achieve the required results more expeditiously. Contractor-developed TCP's are subject to the same reviews and approvals as other contract changes.

All aspects of the traffic plan including signing, barricading, flagging, traffic handling, and blockading of streets should be discussed, explained, and coordinated with appropriate local officials, especially when urban projects are involved.

The project engineer should contact the region traffic section and local law enforcement officials to solicit their assistance in evaluating effectiveness of the traffic control operations, and to obtain written reports of crashes occurring in the work zone and immediate project vicinity, during the life of the project. The project engineer will notify the Bureau of Traffic Operations by sending an email to DOTWorkZoneCrashes@dot.wi.gov with details of the crash.

In addition to implementing any necessary corrective actions, the project engineer should provide any crash reports to the project manager on a weekly basis. If necessary, the project's crash situation will be reviewed by representatives of the region, as appropriate, in cooperation with the traffic engineering section.

This review will be done for the purpose of evaluating the crash frequency and severity occurring on the project and determining appropriate action necessary to remedy the contributing deficiency. Findings will be documented by the region, with copies furnished to appropriate statewide bureaus, enabling necessary corrective actions to be implemented on future projects and ensuring the overall effectiveness of the TCP program.

Further information on traffic control plans can be found in FDM 11-50-20 and on Traffic Special provision in FDM 19-15-20. Federal regulation 23 CFR 630 Subpart K mandates that traffic control be administered in the same manner as any other contract item. The contractor is expected to be aware of specific contract requirements and any revisions necessary to meet the terms of the contract.

145.7 Detours

145.7.1 For State Trunk Highway Projects

During construction or improvement of state trunk highways, when the contract requires closing the road to through traffic, the contractor is responsible for providing detours to route traffic. Selection of the detour route is generally determined before award of contract, and whenever practicable, routing of the detour will be over state trunk highways. The project engineer will decide when contract operations requiring the closing of the road will start, and when applicable will notify the region office in sufficient time to provide for public information and any coordination needed for the detour.

When officially marked and designated detours are routed over roads that are not a part of the state trunk highway system, statute 84.20 provides the department is liable for any damage to the roads resulting from their use as detours and requires that upon ending their use as detours, they must be restored to a condition at least equal to that existing just before their use as a detour.

Local roads required for detours may first be surfaced or otherwise conditioned to the extent determined necessary to adequately provide for the detoured traffic. Construction funds will be used for the improvement work, which can be performed by service and supply contract or by private contract. Normal maintenance work on detours is provided through the department.

Before roads that are not state trunk highways are officially marked and used as detours, the project engineer needs to make a condition survey, recording the type, width, thickness, condition of the

surfacing, condition of drainage structures, and other features of the road that may be affected by the detoured traffic. The project engineer should take photographs when practicable, unless other region personnel have previously made the condition survey. When the road is finished being used as a detour, a condition survey will again be made to determine whether or not any restoration work will be required. Construction funds will be used for restoration work performed by service and supply contract. The project engineer should consider including a representative of region maintenance and of the local maintaining authority as part of the condition survey team.

During the construction of a state highway project, drivers frequently make extensive use of roads that are not officially marked detours by their own accord and preference. Use of these roads instead of the officially marked detour is not a responsibility of the department.

145.7.2 For Local Road Projects

Where the contract provides for closing county highways or local roads or streets, the need for and the selection of a detour route is generally determined before award of the contract. The contractor, when specified in the contract, or the agency in charge of the closed road, will be responsible for detour signing.

The project engineer will decide when contract operations requiring closing of the road or street will start, and will notify the maintaining agency in sufficient time for erection of the detour signing if the detour signing is not part of the work under the contract.

Detours for county highways and local roads and streets may be routed over state trunk highways with prior approval of the department. Signing for the detour must be in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) and must not interfere with signing already in place on the state trunk highway.

Correction of damage or deterioration to roads and streets used as detour routes for projects on county highways and local roads and streets will not be the responsibility of the contractor or the department, but will be the responsibility of the local unit of government.

145.7.3 Review of Detour Routes on Local Roads

Frequently, it becomes necessary for a local unit of government (municipality, town, or county) to close a road under its jurisdiction to allow the reconstruction of that road. A detour is then established to accommodate the rerouted flow of traffic.

Under Wisconsin law, a local unit of government is responsible for the detour of a route under its jurisdiction. For that reason, WisDOT traditionally has made only informal reviews of these detours as a courtesy to the local unit of government, and only after being requested to do so by the local agency. To aid WisDOT personnel performing these reviews, the following procedure has been established. It will apply only to those formal detours set up to accommodate traffic rerouted as a result of federally-funded projects that WisDOT is responsible for administering.

1. Upon being notified that a detour route is about to be placed in service, a WisDOT representative (typically, the project engineer) should arrange to drive the entire route in company with the responsible local official to ensure the detour will operate safely.
2. The field review should be made immediately before placing the detour in operation.
3. Traffic signing and pavement marking should be reviewed along the entire length of the detour. Capacity of the route to accommodate both its normal traffic demand and the detoured traffic should be considered.
4. The WisDOT representative should offer suggestions where improvement is considered necessary.
5. The WisDOT representative should enter both the results of the field review and suggestions offered into the project diary.

Follow-up review by WisDOT of the detour operation and maintenance will be appropriate if requested by the maintaining authority.

145.8 Transportation Management Plan (TMP)

145.8.1 General

In addition to implementation and monitoring of the traffic control plan, there may be public information and outreach, transportation operations, and incident management elements of the TMP to implement. The contractor is responsible to implement any requirements specified in the contract. Other elements related to public information and coordination with law enforcement, local agencies, and other projects are typically the responsibility of the project engineer or other region staff. Before the TMP is implemented, it is advisable to identify key personnel and their responsibilities and provide contact information.

The project engineer and the contractor may discuss and agree (preferably at the preconstruction meeting) on how emergency operations will be carried out. If the project stipulates that a daily log of traffic control operations be kept, document this requirement in the implementation plan and share information

with parties before beginning construction activities. Identify the line of authority for both department and contractor personnel responsible for traffic control. Also identify personnel assigned the TMP monitoring responsibility.

Use the WisTMP System to find the TMP, located here:

http://transportal.cee.wisc.edu/tmp/

145.8.2 Monitor TMP

Refer to appropriate WisDOT policies, standards, and procedures for TMP monitoring. FDM 11-50-5 and FDM 11-50-10 provide guidance on the TMP process and components. Monitoring may be as simple as a daily or weekly traffic control review log or more complex for projects requiring TMP type 4. Review changes with the contractor. Follow FDM 11-50-5.14 for certain changes that may require documentation, and an amendment to the TMP. Document the changes in the WisTMP System.

Some elements of TMP strategies such as media releases, notifications to target groups, brochures, flyers, newsletters, etc., may need early distribution. Additionally, motorist notification, installation of fixed message signs, signing of detour routes, putting changeable message signs in place, and work zone ITS require lead time.

During construction, the region should assign an individual to collect data on the TMP. The data collected may be used to prepare a report on the successes and challenges of the TMP. The data collected may include:

- Verification of work zone setup.
- Changes that were made during construction.
- Changes that were made to the original TMP (include successes or failures).
- Public/motorist reaction.
- Identification of peak hours.
- Average daily delays experienced, i.e., queues.
- Frequency of complaints and the nature of the complaints.
- Crash occurrence (type and frequency).
- Surveys/feedback.
- A track of implementation cost.
- Person(s) responsible for the implementation of TMP.

145.8.3 Post Construction Project Evaluation

TMP strategies should be linked to measures of performance to determine how effective the applied strategy was in promoting safety and mobility at a work zone. Use the data collected while monitoring the TMP during construction to assess the quality, performance, and effectiveness of the TMP in achieving project objectives.

Performance measures are typically applied to fulfill four functions:

- To continuously improve services, i.e. to understand how the strategy is performing and whether modification of its application is necessary to improve performance;
- To strengthen accountability of either the department's or the contractor's personnel to ensure the strategy is achieving the desired effect;
- To communicate the results of strategies to the public, stakeholders, and upper management, and;
- To provide better information for effective decision-making and resource allocation in the future.

Performance measures for work zones differ from one project to the next. For example, car-pooling usage would be used to measure the effectiveness of a TMP mitigation strategy such as ride share incentives. Additionally, a work zone may include new strategies, such as new technology (ITS) or innovative contracting strategies. In these instances, a unique performance measure may be developed to evaluate the effectiveness of the new strategy.

The post construction report should provide brief discussion on the following areas:

- Overall statement reflecting the usefulness of the TMP.
- The changes that were made to correct oversights in the TMP.
- Changes to the original TMP and how successful those changes were.
- Public reaction to the TMP from comments, feedback, or surveys.
- Average delay time (how often the 15 minutes criteria was exceeded and the steps taken to remedy the situation).
- Frequency of complaints made about the project, the nature of the complaints, and how they were resolved.

- Type of crashes/incidents that occurred during construction, and how they were resolved.
- Recommendations or suggestions for future projects.
- Highlight the areas of the TMP that were successfully implemented.

Attach the post construction report to the TMP in the WisTMP System.

Once the project is complete, the TMP must have its status in the WisTMP System changed to Complete. The Project Manager must perform a "Mark as Completed" action in the WisTMP System.

145.9 Traffic Control Devices

145.9.1 General Requirements

Before allowing work operations to start or to continue, the project engineer should ensure that the contractor provides effective and credible signing and properly installs warning signs, barricades, changeable message signs, arrow panels, and other traffic control devices according to project plans, the MUTCD, Work Zone Safety handbook, or other approved plans. If a flagger is required, flagging operations must be performed in accordance with the WisDOT flagger handbook. The contractor must provide adequate warning to the traveling public of any obstruction in the road or work operations that may be a hazard to traffic.

The "Quality Guidelines for Temporary Traffic Control Devices" handbook published by American Traffic Safety Services Association (ATSSA) is available at the traffic section of each region office. The handbook shows three levels of device quality: acceptable, marginal, and unacceptable. A traffic control device introduced to the work site must be in acceptable condition. It may degrade to marginal quality during the project, but once an item has been determined to be unacceptable it must be replaced with an acceptable device.

Temporary traffic control devices must be monitored and maintained throughout the course of construction, including utility and maintenance operations. The contractor is required to provide a level of inspection necessary to ensure ongoing compliance with the quality guidelines.

Where the traffic is maintained on a construction project, advance warning is required sufficiently in advance of construction operations to alert drivers in time for them to become aware of conditions ahead before entering the work area. The number of signs and their proper positions relative to the work area will be largely influenced by the type, volume, and rate of speed of the prevailing traffic. Projects carrying large volumes of traffic at relatively high speed will require more and larger signs at greater spacing than is required for those having comparatively light and slow traffic. Refer to Part VI of MUTCD produced by FHWA.

145.9.2 Responsibility for Signs

The responsibility for the maintenance of signs and other traffic warning devices varies, dependent upon whether the highway through the project is open to traffic, closed to through traffic, or closed to local and through traffic.

When the project is constructed under traffic, the contractor is responsible for furnishing, erecting, and maintaining approved warning signs informing the public of construction operations and associated traffic hazards.

When the work of detour signing is not included in the contract and the highway is closed to through traffic or to local and through traffic, and traffic is detoured, the applicable governmental unit is responsible for furnishing, erecting, and maintaining signs along the detour and on the regular route of the highway approaching the beginning and end of the detour.

The contractor is required to furnish, erect, and maintain appropriate signs at each end of the project and at each intermediate crossroad. The contractor is solely responsible for construction signs within the closed section of the highway that may be necessary to protect the work and safeguard the local traffic, and for the signs that may be necessary on intermediate crossroads where traffic is allowed to cross the project.

The state or other public body having jurisdiction over the highway involved must authorize using regulatory signs. The contract may require the contractor to provide and maintain regulatory signs.

If signing is not to be installed by the contractor, the project engineer should notify the region office or maintaining agency early of the signing requirements on the project so proper signing can be erected. In the case of a major sign change, such as moving traffic from one roadway to another, the project engineer should notify the region office or maintaining agency sufficiently in advance of the anticipated time of the change to arrange for the fulfillment of this responsibility.

The department will pay for covering signs under the Traffic Control Covering Signs bid items. The intent is to pay for sign covering required to conform to the contract traffic control and staging plans as modified

by the project engineer in the field. The department will not measure sign covering dictated by the contractor's operations.

For example, if the contractor were to install a Signal Ahead sign and the traffic signals were not yet operational, this permanent sign would be required to be covered. However, the department would not measure this sign covering because if was installed for the convenience of the contractor. Another instance where sign covering would not be measured is if the sign were a part of the detour signing. For example, if a permanent assembly had a left arrow and the detour required an ahead arrow, then the ahead arrow would only be paid for as a detour sign and not as a sign covering.

Temporary signs used for contractor operations will also not be paid for under sign covering. Throughout a project's construction stages there may be temporary lane closure warning signs or set-up and take down of traffic control. These temporary signs could be covered if used again, but this would be incidental to traffic control.

145.9.3 Responsibility for Barricades

The standard specs and plans require that the contractor must provide, erect, and maintain substantial barricades conforming to the requirements of the plans and MUTCD at intersecting roads and at each end of the closed section of highway. The plans and the MUTCD provide that the barricades normally must be Type III barricades meeting plan requirements.

Usually, the contractor will be required to place the mainline barricade at the beginning and end of the project. The contractor may also be directed to place and maintain partial barricades a nominal distance in advance of the beginning of the project at logical points such as the first intersection road or at other major intersecting roads.

145.9.4 Responsibility for Shielding Drop-offs and Other Hazards

If a change from the original contract staging and traffic control plans becomes necessary, the contractor is responsible to provide safety measures for the traveling public. Drop-offs and other hazards may need to be shielded using longitudinal temporary traffic barriers. The duration of the hazard and depth of the drop-off both factor into the justification for using longitudinal temporary traffic barriers.

According to 23 CFR 630.1108, using longitudinal temporary traffic barriers must be based on an engineering study. Also refer to MUTCD Section 6F. The temporary barrier must be designed following the guidelines in FDM 11-50-35. The department will not pay for the cost of the installation unless it is responsible for the change that caused the additional work. Refer to Temporary Concrete Barrier in this section for more details.

145.9.5 Covering Conflicting Signs

Conflicting permanent signs are to be covered and indicated on the traffic control sheets. Under some circumstances, there may be multiple cycles of covering and uncovering throughout the course of construction staging. The sign covering will be measured separately for each cover/uncover cycle. In addition, the number of cycles should be listed in the quantities and, if necessary, should indicate the stage in which the sign will be covered and uncovered. Standard spec 643.3.4.3 explains further cover installation and maintenance details.

The intent is to pay for sign covering required to conform to the contract traffic control and staging plans as modified by the project engineer in the field. The project engineer will not measure sign covering dictated by the contractor's operations. For example, if the contractor were to install a Signal Ahead sign and the traffic signals were not yet operational, this permanent sign would be required to be covered. However, the department would not measure this sign covering because it was installed for the convenience of the contractor. Another instance where sign covering would not be measured is if the sign were a part of the detour signing. For example, if a permanent assembly had a left arrow and the detour required an ahead arrow, then the ahead arrow would only be paid for as a detour sign and not as a sign covering. Standard spec 643.5.3 provides additional covering sign payment details.

Temporary signs used for contractor operations will also not be paid for under sign covering. Throughout a project's construction stages there may be temporary lane closure warning signs or set-up and take down of traffic control. These temporary signs could be covered if used again, but this would be incidental to traffic control.

145.9.6 Review of Traffic Control

Standard spec 643.3 requires the contractor to review traffic control devices immediately after each setup and as often as necessary for location, position, visibility, adequacy, and manner of use. The contractor should provide the project engineer with the name and telephone number of a representative responsible for emergency correction of the devices. The project engineer or designated WisDOT staff person should review the devices at least once every 24 hours during the workweek. The "Work Zone Traffic Control

Inspection Checklist," has been created to assist the review process. Copies of the checklist are available from the region office, or in the pantry software. A joint review with the contractor can be mutually beneficial. Both night and day review should be made and documented in the project diary.

On many sections of streets or highways open to local traffic or being constructed under traffic, other contractors, utilities, or governmental agencies will need to do work related or unrelated to the project. They must employ standard and adequate signing, barricading, and other warning devices to protect their particular work zone. The traffic control devices employed by third parties must not conflict with each other or with traffic control devices in place and provided by the contractor. The project engineer should be informed of all work planned by others and should arrange to coordinate the traffic control measures and the work, in cooperation with the contractor.

Standard spec 107.9 provides that vehicle and equipment parking, and storage of equipment and materials must be accomplished without undue distraction of motorists from traffic control devices and minimizing hazards to motorists, pedestrians, and workers. Parking and storage sites should be reviewed for potential hazards to motorists in conjunction with the regular signing review by the contactor and the project engineer.

145.9.7 Maintaining Traffic Control Devices

Maintenance of traffic control devices is incidental to the specific items as specified under standard spec 643.5.2.

145.9.8 Responsibility of Channelizing Devices

The contractor is required to use the traffic control devices that are shown in the plan. Traffic Control Drums are not to be substituted by 42-inch cones because cones use only half the spacing of drums.

145.10 Maintenance of Traffic During Suspension

During periods of suspension of work operations, standard spec 104.6.6 provides that the contractor must make passable and must open to traffic portions of the highway under improvement and temporary roadways or portions thereof as may be agreed upon between the contractor and project engineer for temporary accommodation of necessary traffic during the period of suspension.

Making the roadway passable will include such work as removing stored material or equipment or other obstacles and smoothing, shaping, and preparing the traveled way to a condition suitable for traffic.

The contractor is required to furnish and maintain lights, barricades, and warning signs required by the contract and approved by the project engineer for protection of the work and safety and convenience of the traveling public.

Upon resumption of work operations, the contractor must, at the contractor's cost, remove work or material used in the temporary maintenance, if required by the project engineer. However, the contractor must be reimbursed for additional materials and work required due to traffic use, in accordance with standard spec 104.2, Extra Work.

When the suspension is not provided for in the contract and is beyond the control and not the fault of the contractor, expenses incurred by the contractor in maintaining the required traffic control devices will be reimbursed as provided in standard spec 104.2 and standard spec 104.6.

If there is more than one contractor with a contract for improvement of the highway, the project engineer will determine the responsibility of each contractor for lights, barricades, and warning signs during periods of suspension of work operations and use by traffic.

During that time of use by traffic, the maintenance of the surface of the traveled way will be the responsibility of the governmental unit charged with maintenance of the highway.

145.11 Traffic Damage Claims

It is the policy of the department to bill contractors for damages caused by their construction operations to signs and other traffic control device installations. Any time a contractor removes signs and fails to reinstall them properly, or if a contractor incurs damages to signs or other traffic control devices as a result of operations, those costs should be billed to the contractor under a damage claim. Accordingly, the project engineer should record pertinent information relative to the damages or incurred costs as discussed in CMM 155. The project engineer should document communications with the contractor and subcontractors regarding work zone traffic control device quality, adequacy, and appropriateness. This information should be given to the region.

145.12 Temporary Concrete Barrier

145.12.1 General Considerations

The installation of temporary concrete barrier involves many project- or site-specific details that will need evaluation. If the construction staff discovers a problem, it is recommended that they discuss it with the

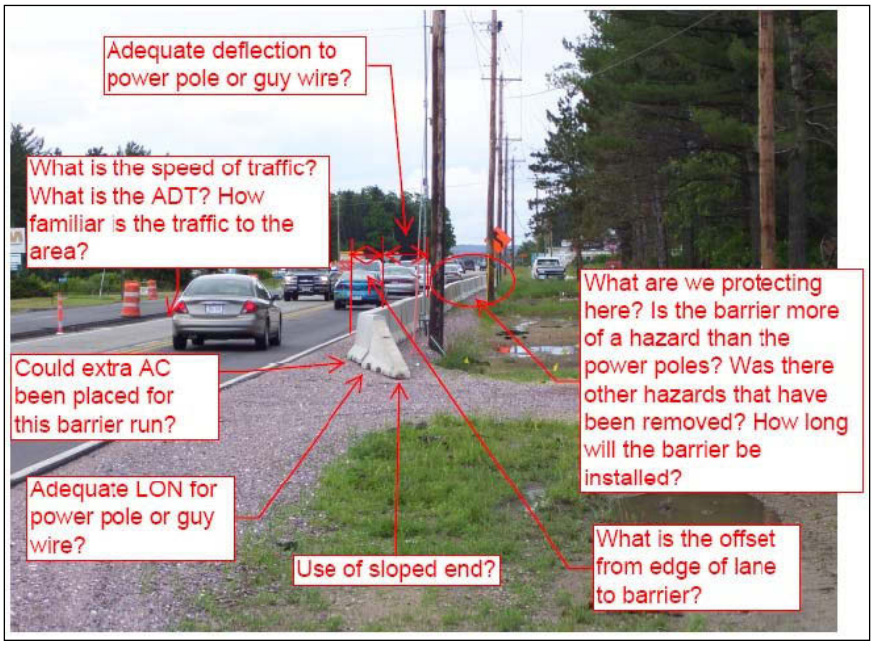
designer and region staff. Before installing temporary concrete barrier on a project, field staff should consider the following points:

1. Consider Alternatives
    - If it's not possible to install concrete barrier on pavement, but there is adequate deflection and the barrier is required for a long duration, beam guard may be a better alternative than concrete barrier. Beam guard has less chance of causing injury to vehicle occupants than concrete barrier.
    - Consider additional delineation or paint to reduce the chance of a vehicle hitting a hazard or barrier.
2. Determine the Nature of the Hazard
    - Some hazards have a higher probability of causing a fatality at any speed (cliffs, deep water, flammable liquid tanks, hazardous chemicals…) and additional protection would be warranted. The distance from the roadway to the hazard is important to determine the need for barrier. See FDM 11-50-35.
3. Reduce Duration
    - Look into the potential to reduce the duration that the barrier is needed, by accelerating work operations or using other construction techniques.
4. Reduce Speed
    - Determine if there is a potential to reduce speed in the area using regulatory signs, police enforcement, pavement markings, or delineators to reduce speed.
5. Calculate Length of Need (LON)
    - Calculate and document length of need (LON) for each barrier installation. See FDM 11-45-30.3.1.2 for LON calculation method, and FDM 11-50-35 for information on construction clear zone recommendations. If a barrier does not have appropriate LON, a vehicle could enter the work area and endanger vehicle occupants and construction staff.
    - If concrete barrier does not have adequate LON:
        - Consider beam guard and short-radius beam guard.
        - Consider additional delineation or paint to reduce the chance of a vehicle going behind the barrier.
        - Install additional barrier to get adequate LON.
        - Temporarily move access to provide room for additional barrier.
    - There may be situations where it is not possible to provide LON for a work area. Document why LON could not be provided, what alternatives or mitigation strategies were investigated, and why a particular alternative was selected.
    - The distance from the first full height barrier section to the LON point of temporary barrier is 8 sections for free standing sections, or to the LON point of the crash cushion.
6. Install on Pavement
    - Temporary barrier should be installed on asphalt or concrete. Crash tests to evaluate performance of concrete barrier were performed on asphalt and concrete. Provide 2" of asphalt for the barrier to rest on.
    - Avoid placing barrier on base course or grass. Placing concrete barrier on base course or grass will reduce the amount of contact the barrier has with the ground. This will increase deflection during impact, and it may cause the barrier to dig into the ground and tip over (i.e. increase the potential of a vehicle rolling over the top of barrier).
    - If the nature of the worksite prohibits installation of the barrier on pavement, other mitigation strategies should be investigated, including temporary guardrail marking and delineation. Document what alternatives or mitigation strategies were investigated and why a particular alternative was selected.
    - Placing the barrier on a firmly compacted, drainable base course would be preferred over placing the barrier on grass (i.e. less chance of the barrier digging into the soft soil). If placement on base course or grass is the only option, allow for more barrier deflection.
    - If possible, move the barrier to get it on asphalt or concrete. If the barrier is already installed, removing it to install asphalt, and reinstalling the barrier may not be practical, depending on how much barrier would need to be moved.

145.12.2 Example Installation

Figure 145-1 is an example to educate staff and consultants on what to look for when installing barrier. It is possible that there are project specific details that the photo does not properly show that could justify this barrier installation.

FIGURE 145-1 Example Installation



145.12.3 Connecting Barrier

Make sure that both sets of connecting loops (top and bottom) have the connection pin installed, as shown in figure 145-2. If the connection pin is not installed, the joint may fail during an impact, or the barrier may not deflect properly. If the barrier does not deflect properly during an impact, the vehicle may impact a blunt end or go over the barrier. FHWA has done a project visit and found this to be a problem. Figure 145-3 shows an improperly installed connection pin (i.e. the top plate of the connecting pin needs to be flush with the top connection loop).

FIGURE 145-2 Connecting Concrete Barrier

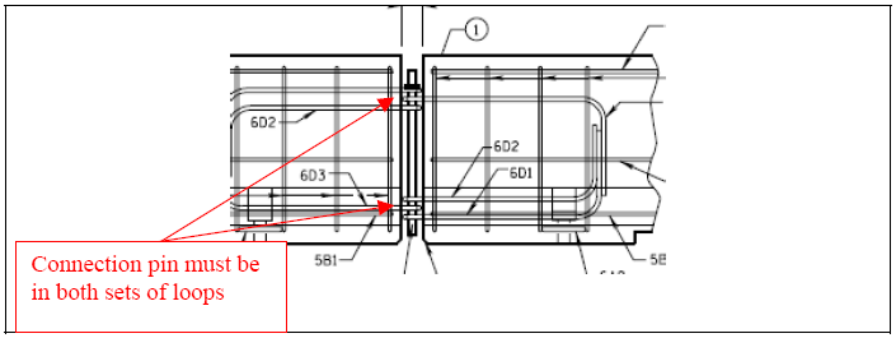
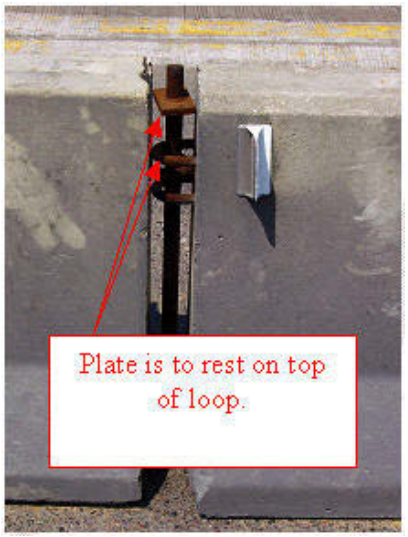


FIGURE 145-3 Improperly Connected Barrier

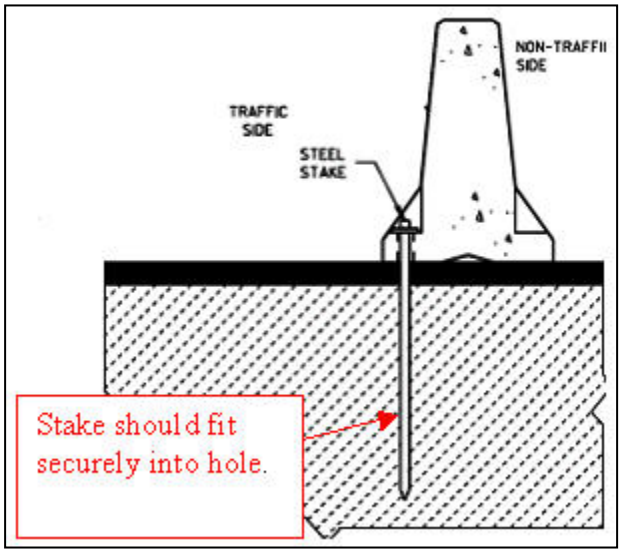


145.12.4 Anchoring Barrier

When anchoring the barrier to the pavement, make sure that the stake or anchor fits snuggly into the hole, as shown in figure 145-4. A stake or anchor that is loosely installed will not function correctly.

Only 12.5' long barrier may be anchored. 10' temporary barrier is not to be anchored even if it has anchoring holes. If no or reduced deflection is required, only 12.5' long barrier may be used and anchored in accordance with the standard detail drawing.

FIGURE 145-4 Anchoring Concrete Barrier



145.12.5 Temporary Barrier Acceptability

The quality standards for temporary barrier defined in 145.12.5 are mobilized by the contract in standard spec 603.3.2.1.

Criteria in this section describe deficiencies in temporary concrete barrier, and the effect on the quality and usability of the barrier. The guidance is based on three levels of device quality: acceptable, marginal, and unacceptable. Temporary concrete barrier introduced to the work site must be in acceptable condition. It may degrade to marginal quality during the project, but once the barrier has been determined to be unacceptable it must be replaced with acceptable barrier.

Temporary concrete barrier must be monitored and maintained throughout the course of construction. The contractor is required to provide a level of inspection necessary to ensure ongoing compliance with the quality guidelines.

145.12.5.1 Loop Damage

A loop that is out of alignment may fracture during an impact because the steel has become brittle. The barrier shown in figure 145-5 is unacceptable. If the steel loop is not firmly connected to the concrete barrier, it may break free on the next impact. The barrier section with the loop shown in figure 145-6 is unacceptable.

145.12.5.2 End Section Loss

Section loss near the joints may lead to joint failure or allow the joint to rotate too much during an impact, increasing the potential for barrier failure or injury to a vehicle occupant. Exposed steel near the end section will reduce the barrier's connection strength. figure 145-5, figure 145-6 and figure 145-7 show barriers that have excessive end section damage.

FIGURE 145-5 Loop Out of Alignment



FIGURE 145-6 Loop Not Firmly Connected to Barrier

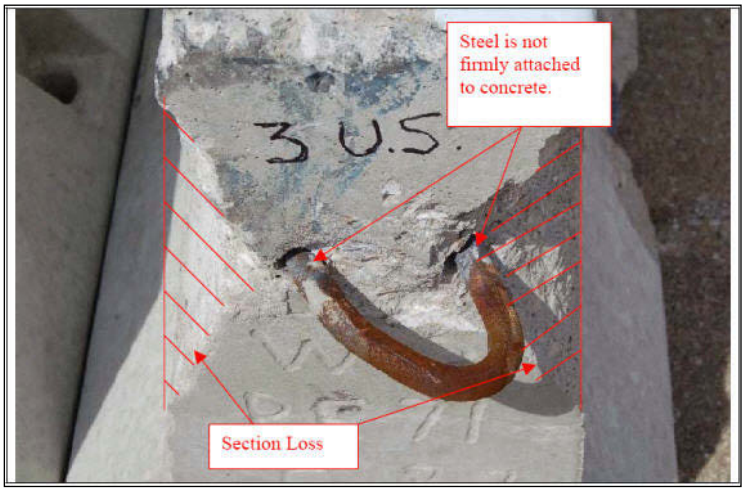


FIGURE 145-7 Exposed Steel and Section Loss Near End Section



145.12.5.3 Anchor Hole Damage

Exposed steel near the anchor hole can cause a barrier to fail during impact. Figure 145-8 shows a barrier with exposed steel and cracking of the concrete near the anchor hole. The barrier is unacceptable for a barrier requiring anchoring. If a barrier does not require anchoring and there is no other damage to the barrier, the barrier would be considered marginal.

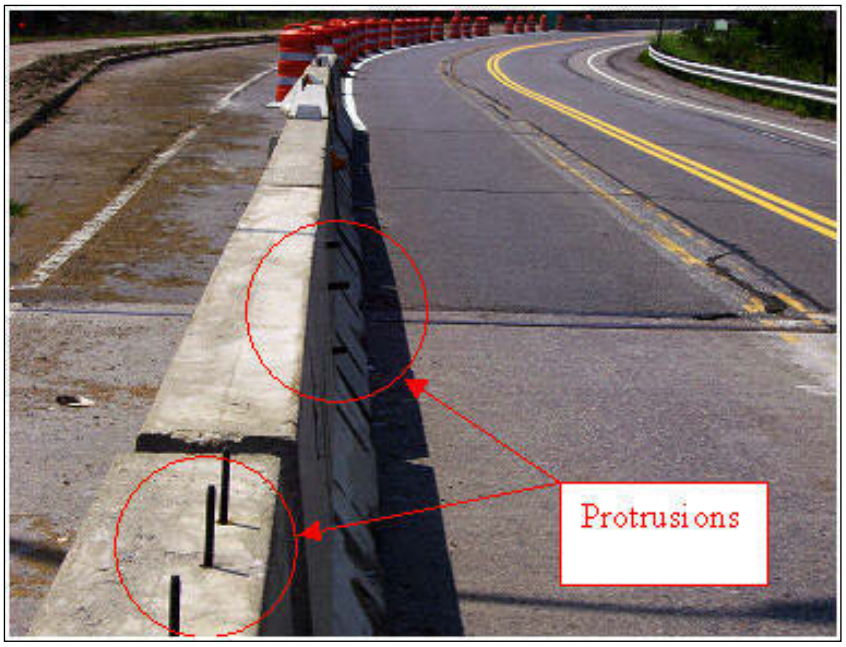
FIGURE 145-8 Anchor Hole Damage



145.12.5.4 Protrusion On Barrier

Protrusions (e.g. signs, steel bars…) are not acceptable on temporary barrier, because they are snag hazards for an impacting vehicle and can potentially expose an occupant's head to a spearing hazard. Figure 145-9 shows both vertical and horizontal protrusions on a barrier. Mounting signs on temporary barrier should be limited to areas where there are not other options. Document why it was necessary to place sign on a barrier.

FIGURE 145-9 Vertical and Horizontal Protrusions on Temporary Barrier



145.12.5.5 Exposed Steel Reinforcement

Figure 145-10 and figure 145-11 show barrier with exposed reinforcement steel. Barrier with this amount of exposed reinforcement are more likely to have insufficient strength to contain or redirect a vehicle during an impact. Barriers in this condition must not be used in areas where anchoring to a bridge deck or pavement is required. In the best-case non-anchoring scenario, this barrier would be considered marginal.

FIGURE 145-10 Exposed Steel Reinforcement



FIGURE 145-11 Exposed Steel Reinforcement



145.12.5.6 Delineation

The standard details require delineation of the temporary barrier. Have contractor provide delineation on barriers. Delineation helps to prevent impacts with the barrier.

145.12.5.7 Cracking

Cracks that are being tightly compressed by the barrier's reinforcement may be acceptable providing that the barrier does not have other damage (e.g. anchor hole damage, end section loss, loop damage...) and that the barrier does not require anchoring. Barriers that have open cracks with the cracks extending completely through the barrier should not be accepted. Barriers that have cracks that are not tightly compressed and do not extend completely through the barrier are marginal, and are not be used in areas where barrier requires anchoring.

145.12.5.8 Spalling or Chipping

The acceptability of spalling or chipping allowed on the face of temporary barrier depends on the quality (e.g. overall shape, depth, texture…), quantity, and location. Spalling or chipping that compromises the overall profile of the barrier or causes a potential snag point during an impact is unacceptable. Spalling or chipping that is greater than 4" in width and abrupt in character is unacceptable. Figures 145-12 through 145-15 show barriers with spalling or chipping issues. Note that the marginal spalling and chipping could be considered unacceptable if the deepest portion of the spalling/chipping was located closer to the anchoring to pavement hole.

FIGURE 145-12 Unacceptable Chipping and Spalling

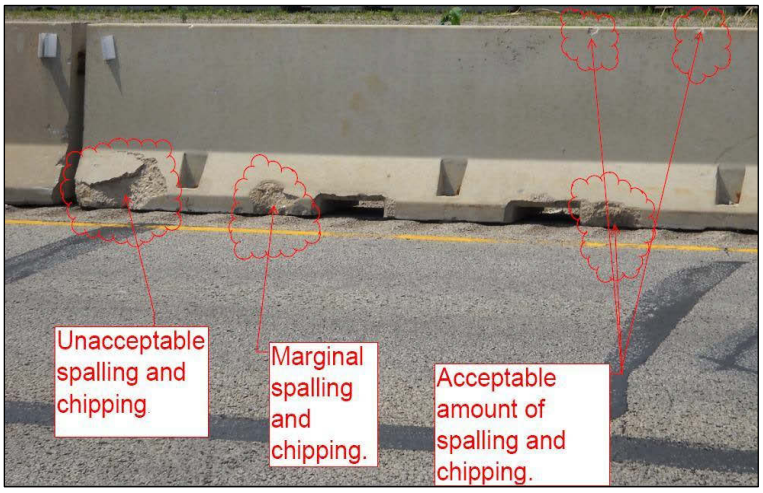


FIGURE 145-13 Top View of Barrier with Significant Chipping

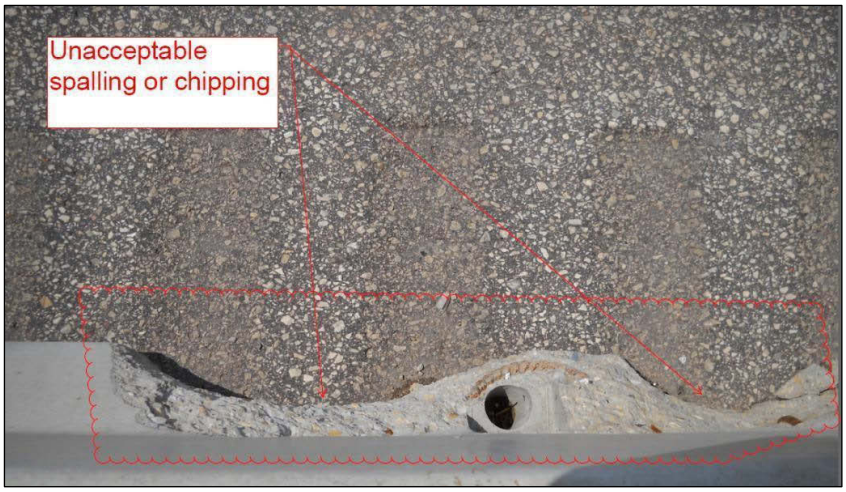


FIGURE 145-14 Spalling, Chipping, and End Section Loss

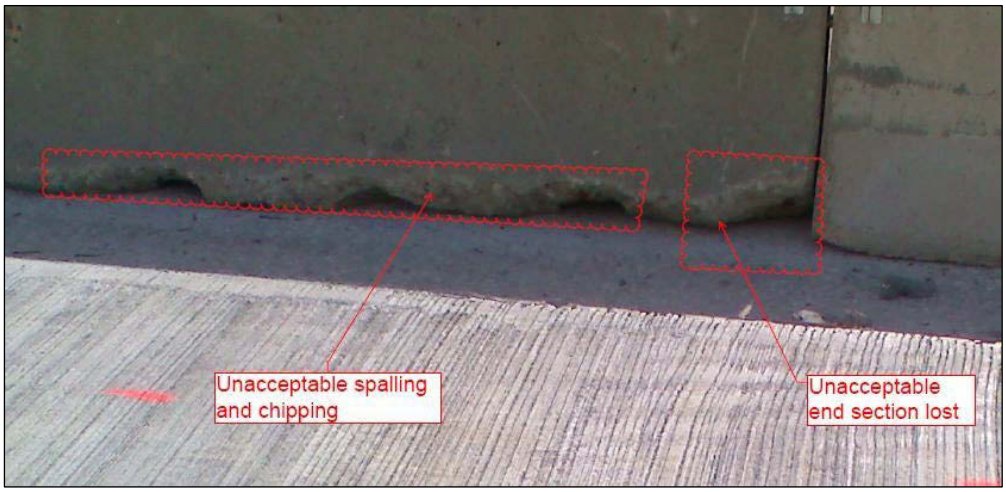
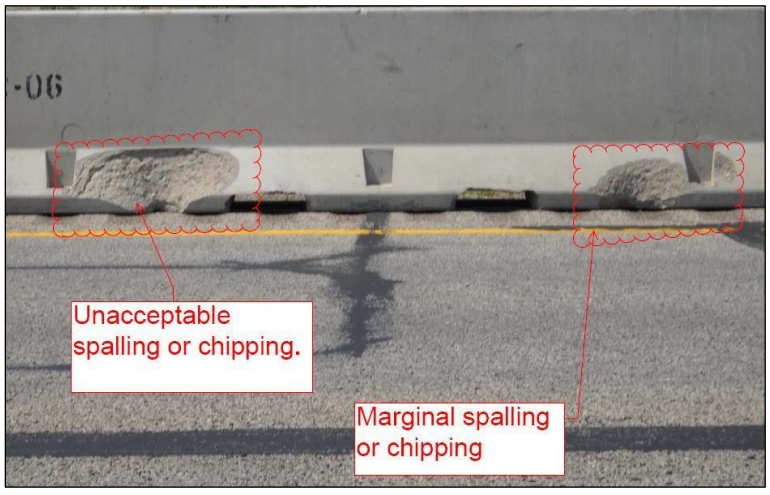


FIGURE 145-15 Chipping and Spalling



145.12.5.9 Snag Points

If a longitudinal opening is 4" or greater width it is a potential snag point and is unacceptable. Perpendicular differences in barriers of 2 inches or greater are also considered snag points that are unacceptable. Figures 145-16 through 145-18 show examples of unacceptable snag points.

FIGURE 145-16 Potential Snag Point Caused by Different Barrier Styles Not Matching Up



FIGURE 145-17 Barrier Offset Creates a Snag Point

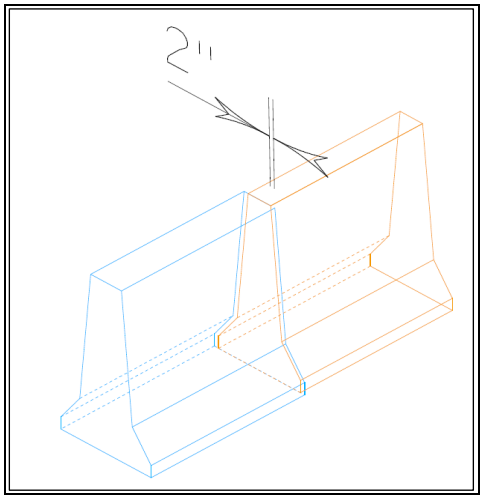
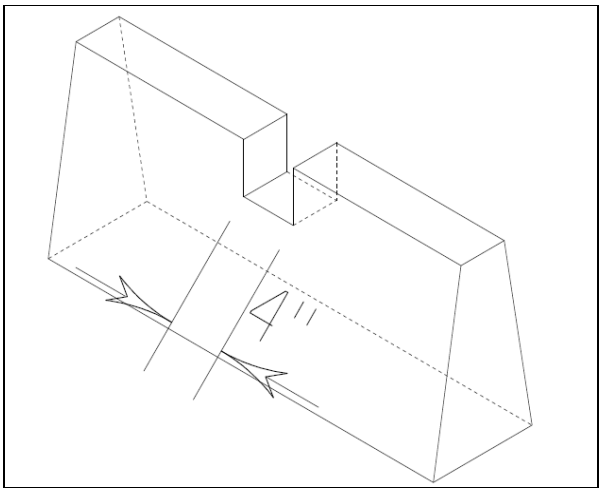


FIGURE 145-18 Opening in Barrier Causes Snag Point



145.12.6 Installation Issues

145.12.6.1 Lack of Proper End Treatment

Figure 145-19 shows two issues that deal with installation of a temporary barrier. The installation lacks proper end treatment (e.g. crash cushion required on high speed facilities, or a sloped end treatment on

low speed facilities). There is an object within the deflection distance of the barrier and the object is too close to the termination of the barrier. Length of need (LON) before hazards is discussed in this chapter in an above section and in FDM 11-45-30.3.1.2.

FIGURE 145-19 Improper Termination of Barrier and Object within Deflection Distance



145.12.6.2 Barrier Incompatibility

It's important to note that 10' temporary concrete barrier cannot be connected to 12.5' concrete barrier.

145.12.6.3 Gaps in Barrier Run

Gapping of a temporary barrier run (see figure 145-20) should not be allowed. If an errant vehicle impacted the downstream barrier run, the barrier would deflect significantly further than normal and expose the blunt end of the upstream end of the barrier run.

FIGURE 145-20 Gap in Barrier



145.12.6.4 Proper Clearance Behind Barrier

Placing materials or equipment within 2' of free standing temporary barrier (see figure 145-21) should be avoided. Material may cause the barrier to do any of the following:

- Rotate during impact (i.e. causing the errant vehicle to ramp up over the barrier).
- Have the free standing temporary barrier form a pocket during an impact (i.e. significantly increasing the probability of a severe collision).
- Expose a snag point at a barrier joint.

FIGURE 145-21 Insufficient Clearance Behind Temporary Barrier



145.12.6.5 Proper Side of Barrier Facing Traffic (12.5 foot Barrier Only)

10' temporary concrete barrier can be flipped around (i.e. what was the traffic side can become the backside of the barrier). 12.5' temporary concrete barrier cannot be flipped around. If 12.5' temporary barrier is flipped around the end section loop bars will not match up correctly (see figure 145-22). 12.5' temporary barrier may not function as intended if the separate sections of barrier are not connected properly.

FIGURE 145-22 Improper Connection of 12.5' Temporary Barrier



145.12.6.6 Barrier Not Matching Standard Detail Drawing

During the summer of 2009, FHWA and WisDOT staff saw various styles of 10' barrier that did not match the department's SDD for 10' temporary barrier (See figure 145-23).

FIGURE 145-23 Barrier Not Matching Standard Details



145.12.7 Barrier Substitution

Due to lack of compatibility in pinning WisDOT temporary barrier to Illinois temporary barrier and anchoring Illinois temporary barrier to pavement, WisDOT has decided that Illinois barrier is not allowed on WisDOT projects.

If a contractor wishes to substitute a different temporary barrier than the most current SDD it is the contractor's responsibility to provide the following before installation:

- Design drawings from manufacturer or state for the proposed barrier
- Connection details between individual barrier sections
- Anchoring to pavement or bridge deck details
- Crash test documentation, including crash testing condition and deflection information
- Location or locations where proposed design will be installed

Details provided by contractor must be continuously used in any given run of temporary barrier.

Project staff should review the substitution with region staff and BPD before accepting a different barrier design from the plan. If the barrier requires to be anchored to a pavement or bridge deck, then a passing crash test showing barrier connected to the pavement or bridge deck is required.

If the contractor is using a temporary crash cushion ask for manufacturer's installation instructions. Some manufacturers require the first temporary barrier after the crash cushion to be anchored to the pavement.

145.12.8 Barrier Removal

Bureau of Project Development is in the process of modifying the stake design to make it easier to remove the stake.

Be careful when removing anchored barrier that is state owned or being reused on a project. Avoid lifting the whole barrier vertically to loosen the stakes or anchors. This removal method stresses the anchor holes and the loop connectors.

145.13 Pedestrian Accommodation in Work Zones

The contractor should not use tape, rope, barrels, or plastic chain strung between devices; they need to provide devices to protect pedestrians against excavation or drop-offs.

The contractor should regularly inspect and maintain the pedestrian pathway to ensure the pedestrian accessibility required under the contract and as directed by the project engineer.

The project engineer should both walk the pedestrian route and drive the adjacent active roadways during inspection to review the below items to assure both the pedestrian and driving public can see each other without any obstacles.

- Check that the walkway is smooth, continuous, slip resistant, and hard throughout the entire length of the temporary pedestrian facility.
- Check that there are no obstacles on the pedestrian route. For example, verify the pedestrian route is clear of dirt/mud, poles, and construction materials. Such things as scaffolding, fencing, excavated material, broken sidewalk concrete slabs, tree stumps, parked cars, work vehicles on path, or any other miscellaneous objects, should be removed.
- Check that there are no objects protruding into the pedestrian route.(Minimum 4ft clear width)

- Check that no roadside hazard has been installed or overlooked.
- Check that no natural feature (e.g., bank rock or major tree) results in loss of visibility.
- Check that the pedestrian route, including curb ramps, is able to adequately drain.
- Check effectiveness of any treatment put in place to counter climatic conditions.
- If an alternate circulation path is being used, check that the new route includes accessible features present in the existing pedestrian route. For example, check width, slope, etc.
- Check that the curb ramps are provided when the route (either existing or alternate path) crosses a curb.
- Check that level landings are provided as needed.
- Check that crosswalks are clearly marked, especially when relocated.
- Check that drivers are aware of the potential of crossing pedestrians at an intersection.
- Check that signs and pavement markings are correctly in place.
- Check that appropriate signs have been used.
- Check that signs will remain visible at all times.
- Check that old delineation (signs, markings) has been removed or covered and is not likely to confuse pedestrians.
- Check that markings as installed have sufficient contrast with the surfacing and are clear of debris.
- Check alignment and general correctness of installation and that applicable signal heads are visible from each approach at the appropriate distances.
- Check the safe operation of signals and associated equipment.
- If a sidewalk is closed, check that the appropriate traffic control devices are present. (SDD 15D30 can aid in identifying required signs and devices.)
- Check that the sight lines for pedestrians-motorists within a pedestrian route are sufficient such that both can identify the other when turning or crossing.
- Check that all users are considered within the project area.
- Check that pedestrian routes are continuous and accessible by all pedestrians.

145.14 Flagging

Flagging is a dangerous activity and the project engineer must make sure the operation is being performed correctly. Field staff should familiarize themselves with the Wisconsin Flagging Handbook available online at:

https://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/flagger.pdf

Before the flagging operation begins, ask to see the flaggers certification. The contractor may present all the certifications at the preconstruction meeting or the flaggers may show a certification card with their name, instructor name, date of certification, and expiration date. Flaggers must be properly trained and are required to be certified. Do not allow flagging operations to begin until certified flaggers are available. The flagging techniques, proper equipment, and PPE can be found in the Wisconsin Flagging Handbook.

All flagging operations must have the proper advance warning. This can be found on SDD 15c12. Ideally this will be set up and taken down as the flaggers move, however, the signs may be taken down or set up within 1/2 hour of the work starting or stopping.

Make sure the flaggers have positioned themselves correctly to give themselves an escape route from an errant vehicle and so they can be seen by drivers. Flaggers are not allowed to sit/lean on chairs or in/on vehicles while the operation is being conducted. Make sure the flaggers are paying attention to traffic and not distracted.

Temporary Portable Rumble Strips(TPRS) are required for all flagging operations. The TPRS have a spacing requirement based on the posted speed limit. Make sure the TPRS have been installed according to the manufacturers recommendations. This also includes the strips being installed with the correct side up, and on the proper surface. Monitor the TPRS for movement and have the contractor adjust when necessary. TPRS are not required for roads with speeds limits of 35 mph or less. Do not use TPRS on loose gravel or milled surfaces because of excessive movement of the strips.

For flagging operations with two or more flaggers, radios must be used for communication.

When the flagging operation exceeds 2 miles, a pilot car must be used to better guide traffic through the work zone and control speeds. As with any longer flagging operation, the length of queues must be considered. Direct the contractor to adjust the flagging operation if queuing exceeds the advance warning.

Additional flaggers are needed at intersections. A single flagger may be sufficient at an intersection, however at higher volume side roads, an additional flagger may be needed if they cannot control all the approaches. The flaggers may use flags at intersections.

If the project will be intersecting a railroad, make sure to contact the railroad company for any further requirements. An additional flagger may be needed at the railroad tracks to stop traffic for trains and to prevent drivers from stopping on the tracks.

Flagging at night will require the flaggers to be illuminated properly as to not blind drivers.

Costs associated with flagging are incidental to the construction. This includes the signs, temporary portable rumble strips, flaggers, pilot cars and other necessary equipment. The signs shown on SDD 15c12 are incidental to the work and are not paid for as they may be frequently moved over the course of the day, unless the W20-1A Road Work Ahead is placed as part of another traffic control detail. Other signs that warn of specific road conditions such as Grooved Pavement, Loose Gravel and Bump, are paid for separately as Traffic Control Signs.

SECTION 150 Construction Equipment

150.1 Job Requirements

Standard spec 108.7.1 requires the contactor's equipment to be suitable to produce the quantity and quality of work required. The engineer should call the contractor's attention to any equipment deficiencies and, if necessary, suspend work operations until acceptable equipment is furnished.

Equipment must have a muffler system in good operating condition, without holes or leaks. Units used to haul materials subject to spilling on public roads must be equipped with sideboards, tailgates, and covers if needed to prevent spills.

150.2 Large Loadings on Highways and Structures

150.2.1 Use of Oversize Equipment During Construction

The contractor frequently may use equipment that exceeds the statutory size and mass limitations allowed upon a public highway, especially on earth-moving operations. It is interpreted from a previous court decision that even where the contract provides maintenance of traffic during construction, if the highway under construction is open to only limited public use, the contractor has a right to use the heavy road-building equipment necessary for the work. The exemption given to large equipment for transporting materials on a construction project applies only to operations within the project limits. These vehicles are not exempt from the provisions of the Wisconsin statutes relating to size and mass on other highways, even though the highway may be traversed in connection with work on the construction project, such as hauling from a borrow pit.

Occasionally, using oversize or overweight equipment may be restricted within the project limits. Standard spec 108.7.1 provides that equipment must not damage the roadway, pavement, structures, adjacent property, or other highways.

150.2.2 Loads on Structures During Construction

The contractor is not allowed to operate overweight equipment over a structure until they perform an analysis to ensure the equipment loading does not exceed the structural capacity of the structure. Under standard spec 108.7.3, if the engineer directs, a professional engineer registered in the state of Wisconsin must perform the analysis, and a stamped and signed copy of the analysis report must be submitted to WisDOT.

To minimize vibrations and movement that may jeopardize the development of strength on freshly poured concrete decks, standard spec 108.7.3 prohibits the contractor from operating heavy equipment or imposing vehicular live loads on lanes adjacent to freshly placed concrete decks until the concrete develops sufficient opening strength. Opening strength requirements are in standard spec 502.3.10.1.

150.2.3 Oversize Equipment on Completed Work

The engineer has the authority to prohibit the contractor form operating overweight equipment on portions of the existing highway intended to be retained in service upon completion of the project, and over structures or other features of the project that might be damaged by such operations.

150.3 Monitoring Construction Vehicle Masses

Standard spec 108.7.2 limits vehicle loads on subgrade, sub-base, base course, pavements, and structures to Class A highway loadings.

WisDOT personnel should not be concerned with enforcing the weight laws nor be interested in penalties for overloads as in the case with enforcement agencies, nor expect exact adherence to the letter of the law. They should realize the contractor will strive to haul the maximum allowable on each load and even under the best of controls and intentions an occasional truck may be slightly overloaded. They don't need to be overly concerned with minor infractions. The gross, repetitive, and damaging overloads are the ones to be eliminated.

When materials are weighed for payment, such as base course or asphaltic mixtures, it is a simple matter to compare the gross load against that allowed for the particular vehicle. However, there can be large overloads on individual axles or combinations of axles even when gross load is at or under the allowable, so axle loads must also be checked.

A videotape-training program has been developed to assist department personnel in identifying legal loadings and is available through region offices. By using the video and portable scales, and through some experience, an employee can visualize the proper position of the load within the truck bed and establish the pressure on the air axle needed to be legal. Portable scales are available by contacting the State Patrol.

Using the air axle renders the truck less maneuverable, so it is permissible to release the air pressure and raise the axle when turning or backing. When proceeding loaded down the highway, the air axle must be lowered with sufficient air pressure to develop the load on the axle.

If there is consistent overloading or gross overloading, the contractor should be advised and given the opportunity to correct the hauling operation and bring it within legal limits or to prove that there are not overloads. In the case of a dispute, the engineer should bring it to the attention of the region area construction supervisor for resolution. It may become necessary to bring portable scales in for weighing axles at the site.

Where the mass of a unit of equipment is in question, the contractor should be required to furnish authentic manufacturer's data on the tare and loaded masses. This will serve as a rough check.

The foregoing principles apply also to materials not normally weighed for payment, such as concrete batches.

A weight limitations summary chart can be found at the following link.

https://dot-auth-uat.wi.gov/Documents/dmv/agri-eq-veh/wght-lmts/sp4075.pdf

150.4 Use of Publicly Owned Equipment

In accordance with court decisions, it is illegal for a unit of government to engage in work for a private contractor or to rent publicly owned equipment to a private contractor, except as discussed for haul roads.

A unit of government, in performing work for a contractor or any reimbursement basis, or in renting its equipment to a contractor, would be engaging in private business and according to the court decisions would be in violation of the law, regardless of the ultimate objective of the work.

The court further held that even though the unit of government would be fully reimbursed for its costs, taxpayers money would be used and invested in the private work until such time as the unit of government had been reimbursed or paid, which in effect, would be using tax money for other than public purposes.

It if should come to the attention of the engineer that a unit of government is performing work for or renting equipment to a contractor or proposed to do such, except as discussed for haul roads, the engineer should immediately advise the unit of government or contractor or both, that such arrangement is illegal and report the circumstances to the project manager.

SECTION 155 Construction Site Crashes

155.1 General

To the extent necessary and practicable, the engineer should contact local law enforcement officials to solicit their assistance in evaluating the effectiveness of the traffic control operations, and to obtain written and verbal reports of crashes occurring in the work zone and immediate project vicinity.

In addition to implementing any necessary corrective actions consistent with the duties and responsibilities associated with the position, the engineer will provide the crash reports to the area supervisor on a weekly basis. Then, as deemed necessary, on an individual project basis, the project's crash situation will be reviewed by representatives of the region's construction, design, maintenance, and traffic sections (as appropriate), in cooperation with the statewide bureau traffic section and central office oversight engineer (as appropriate). This will be done for evaluating the crash frequency and severity occurring on the project, and for determining appropriate improvements.

Findings of the reviews will be documented by the region, with copies of the documentation furnished to appropriate statewide bureau sections, enabling implementation of improvements on future projects. The following steps identify immediate actions that should be followed by the department's field representatives to promote safety and help manage WisDOT's risk in construction work zones.

1. If emergency responders have not arrived, call 911 as soon as possible to report the crash.
2. Notify the project manager or the supervisor that a crash has occurred.
3. If the project supervisor deems necessary, notify Lori Weaver (Risk and Safety supervisor in WisDOT's Risk Management Unit, lori.weaver@dot.wi.gov) that a crash has occurred.
4. When possible, document the crash site area with photos and sketches as appropriate.
5. When available, obtain the crash report from law enforcement.

155.2 Investigation Checklist

DT2044, The Investigation Checklist, is used as a guideline only to assist the engineer in gathering potential evidence and documentation that may be requested in the defense of a claim against a state employee or contractor. Each claim is unique and may require additional information not listed on this checklist. Information gathering should begin as soon as the engineer determines that a significant event may result in the filing of a claim.

Information gathered using this checklist may be considered confidential attorney-client communication. The Risk Management unit should be contacted before releasing any information.

155.3 Traffic Damage Claims

It is the policy of the department to bill contractors for damages caused by their construction operations to signs and other traffic control device installations. Any time a contractor removes signs and fails to reinstall them properly, or any time damages to signs or other traffic control devices are incurred because of operations by a contractor, those costs should be billed to the contractor under a damage claim. Accordingly, the project manager should record pertinent information relative to such damages or incurred costs. This information should be given to the region office.

SECTION 158 Cultural Resources (Archaeology, Burial Sites, and Historic Structures)

158.1 Cultural Resource Review

WisDOT will strive to avoid impacts to cultural resources during construction. To accomplish this, the following contractor proposed disturbances require a cultural resource review:

- Borrow sites (DNR permitted sites do not apply)
- Waste sites
- Asphalt or concrete batch plants
- Temporary Stockpiles
- Other
  - Activities that may alter ground surface characteristics (i.e. material storage/staging/processing areas)

158.2 Review Process

158.2.1 Literature and Archival Search

The selected contractor completes DT1919 to initiate the literature and archival search before construction activities and/or archaeological field survey. The contractor sends completed DT1919 to BTS.

BTS will return results via email to the contractor, storm water engineer, project manager, and region environmental coordinator, within 3 working days with the appropriate recommendations. The recommendation given will be one of the following:

1. **"OK to Proceed"**: Site is cleared for cultural resources.
2. **"Avoidance Recommended"**: Contractor can either avoid site or obtain field survey by a qualified archaeologist at their expense to determine presence of cultural resources. The contractor may not proceed with work until WisDOT required coordination is completed.
3. **"Field Survey Required"**: Field surveys are required when WisDOT specifies the source of material, the site is on state-owned land (i.e. R/W, DNR land, university property, etc.) or the project has an existing Section 106 Memorandum of Agreement (MOA).
4. **"Known Burial in Area"**: Authorization from the Wisconsin Historical Society (WHS) is required, and the contractor will be responsible to coordinate with WHS if the desired location is protected by §157.70 regardless if on private or public land.

The contractor must stop construction activities and immediately notify the WHS and BTS if human remains are encountered. Contact:

Wisconsin Historical Society	BTS
(608) 264-6507 or (800) 342-7834	(608) 266-0099

158.2.2 Archaeological Field Survey

Allow two weeks for scheduling of field surveys.

1. Field surveys are funded and coordinated by WisDOT when:
   1.1. The WisDOT contract specifies the source of material.
   1.2. The contractor proposed disturbance occurs on state-owned land.
   1.3. An existing Section 106 Memorandum of Agreement (MOA) may stipulate a phase I archaeological field survey is needed for specific contractor proposals (refer to MOA language).
2. Field surveys are funded and coordinated by the contractor when the contractor chooses to use a site which BTS has communicated "avoidance recommended" or "known burial in area".

If a site is encountered during archaeological field survey, additional archaeological field testing and coordination may be needed. Costs associated with additional testing may be at the contractor's expense if the contractor chooses to use the area within the archaeological site.

SECTION 160 Construction Inspection

160.1 General

160.1.1 Construction Inspection

The department inspects work and materials to determine if it conforms to the contract before it is paid for. The department uses the Construction Critical Inspection guide to provide guidance and strengthen the application of critical inspection throughout the life of a construction project. This guidance is intended to prevent high risk consequences while providing the minimal amount of inspection to ensure a safe and successful project. The project manager is allowed the flexibility of using this guidance in its entirety, or portions of it, depending on the project conditions. The Construction Critical Inspection guide is available online at:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/con-inspect.pdf

To provide good inspection, an inspector must have a ready knowledge of the work required by the contract. Before construction, members of the inspection forces should thoroughly study the plans, specifications, and contract provisions to familiarize themselves with the requirements and be prepared to readily and correctly answer questions concerning the work that may arise during the construction operations. Inspectors should consult with the engineer before the work is started for clarification of provisions or requirements not thoroughly understood.

The inspector must make certain all materials and work comply with the contract. The contractor's operations should be closely observed, tested, measured, and documented. It is the inspector's responsibility to be in the right place at the right time.

Unacceptable work and proposed material rejections must be brought to the contractor's attention at once for prompt correction. If not promptly corrected, the situation should be brought before the engineer for resolution.

Most work inspection requires the inspector to be present during the operations where the inspector can observe details of the work. Instructions to the contractor about the work will be in the form of the results desired rather than of the method of doing it, except when specifications require a specific method be followed. Suggestions may be made when asked for by the contractor. A daily record will be kept, for future reference, of pertinent instructions and suggestions given the contractor, including the date, name of party to whom given, whether written or oral, and pertinent information.

Orders given to correct errors found in the work should be based on judgment that reflects fairness, impartiality, and knowledge of the work in question. If the contractor take's exception to an order, avoid arguments and refer the matter to the project engineer for interpretation and settlement before work progresses. To avoid complications in final settlement of a project and possible claim for extra compensation, differences arising between the engineer and the contractor over interpretation of the standard specifications or other requirements of the contract should be promptly referred to the region.

When checking equipment, the inspector will tell the contractor of any correction of adjustment necessary but will not specify any method of correction. The inspector will recheck upon completion of the adjustment. When equipment is required by the contract, an inspection of the equipment furnished will be made to determine compliance with the specification requirements.

Unsafe working conditions are to be brought to the attention of the contractor for immediate correction. The circumstances should be noted in the inspector's diary. If the unsafe conditions are not promptly corrected, the situation should be brought before the engineer for resolution.

The importance of each inspector keeping a neat, complete, up-to-date, and accurate diary and submitting reports in a timely manner cannot be overemphasized. If there are disputes, the diary records are the legal documents with which the matter may be resolved. They also serve as one basis for contractor payment.

160.1.2 Structure Inspection

Department field staff need to notify the region's bridge maintenance unit two weeks before completing each structure to arrange for an initial inspection. This inspection should take place while the contractor is still on site and before opening the structure to traffic. Include bridges, retaining walls, box culverts, and noise walls.

Contractors arrange for inspection of temporary structures as specified in standard spec 526.3.3 and overhead sign structures and other ancillary structures assigned a structure ID as specified in standard spec 532.3.8. See associated guidance in CMM 565 for temporary structures and CMM 570 for ancillary structures.

160.2 Engineer's Diary

The engineer's diary is primarily a record of the contractor's daily work performance. It is also a record of other contract-related matters. This diary is an essential record and should be written so that project activities and status on any given day will be clear to present-day or future readers.

For contracts administered in AASHTOWare Project Construction and Materials®, an engineer's diary is created with the application each day of the week for an active construction project unless time has been suspended. Required data entry includes site time, diary comments, and the associated Daily Work Reports (DWRs) created by inspection staff. The engineer's diary can be edited until it is locked and associated to a payment estimate. All the diaries or selected diaries can be printed in PDF format or hardcopy at any time within the application.

A separate diary should be kept for each contract. If there is more than one project under the contract, the activities for each project should be listed separately within the diary. For contracts administered in the AASHTOWare Project Construction and Materials® the contract number, contract description, project number, the prime contractor, and the project engineer appear on printed copies of the diary.

The following information should be recorded daily:

1. Weather conditions and temperature range.
2. Contractor's work force and equipment. Describe inefficient operations and poorly maintained equipment.
3. Description of major construction activity. Include locations and approximate quantities.
4. Controlling item of work.
5. Percent of delay. Report to the nearest 1/2 working day on the controlling item and the reason for the delay such as weather, utility conflicts, or inadequate prosecution by the contractor. See standard spec 108.9.2.2 for information on charging hours.
6. Suspensions and resumptions of contractor operations. Causes and dates should be recorded.
7. Utility operations. Report on their progress, conflicts with contractor operations and any resultant delays, and quality of workmanship as it affects the project.
8. Summary of significant conversations. Include orders to the contractor, directions and advice from supervisor, and discussions with FHWA representatives, property owners, local officials, and utility and railroad representatives.
9. Reports of meetings and conferences. Record sources of dispute and decisions made.
10. Unusual or materially different physical working conditions from those expected under the contract. Record significant information about the working conditions, progress of work, work force, equipment, and materials that would be of value should the contractor file claims for extra compensation.
11. Significant information on other work operations if not recorded in a separate field inspection diary. For instance, when a separate grade inspector's diary is not kept the information should be entered in the engineer's diary to provide a record of grading performance and compaction achievement.

    When concrete and asphaltic plant inspection or job control sampling and testing is performed only on a random basis the method of acceptance must be documented by the appropriate diary entry unless a Report of Field Inspection of Material is used. The entry should be made in a section of the diary reserved for this type of entries to allow quick access for review.
12. Major discrepancies in the plans or contract. Necessary changes and subsequent actions taken to correct the situation should be recorded.
13. Prior approvals from the region for change orders. Note the date of approval and summary of work involved. Note also any special conditions related to the approval.

The diary is available to select region office staff at any time during construction through the AASHTOWare Project Construction and Materials® application. See the AASHTOWare Project Knowledge Base (AWPKB) web site for required diary data entry fields and descriptions for each field.

160.3 Inspectors' Diaries (Daily Work Reports)

The inspector for each major work operation should keep a detailed inspection diary, also known as a daily work report, with the following information recorded each day of the work operation.

1. Weather and roadway conditions
2. Contractor forces, equipment, materials used, and hours worked.
3. Detailed description of work, including location, sizes, quantities, and methods.
4. Percent of delays, reasons for the delays, and subsequent corrections by the contractor.
5. Inspection checks, tests, and samplings.
6. Instruction from WisDOT representatives.
7. Instructions given to the contractor.
8. Requests from the contractor and disposition of those requests.

9. Contact with property owners, utilities, the public, and others.
10. Contractor compliance with specifications.
11. Initials of inspector making the entry.

For contracts administered in AASHTOWare Project Construction and Materials®, the inspectors' diaries are recorded in the Daily Work Report (DWR). Inspectors may also use Mobile Inspector®, a browser based application on a mobile device. to enter inspector diaries. Mobile Inspector® allows Project Engineers and Inspectors to collect information required for a daily work report, including item progress, contractor work force, photos, and site conditions out in the field.

The engineer also records item postings for work completed on the project on Daily Work Reports (DWRs) within AASHTOWare Project Construction and Materials®. The Daily Work Reports with item postings along with the corresponding engineer's diary with time charges are used to create payment estimates for the prime contractor.

For contracts not administered in the AASHTOWare Project Construction and Materials® software, manual entries should be made in a bound field book. The work operation that is being inspected should be printed on the cover. The project identification number, contract number, description of road, highway, and county should be recorded on the first page.

If an IDR is not used, the internal organization of the diary should be set up in conjunction with the engineer before the start of the work operation. Using standard approved formats is desirable when the diary entries are routine and repetitive daily. A standard simplified format can be entered on the margin or top of the front page. Succeeding pages can be "cut back" to reveal the line titles or column headings of the first page. This standard format provides valuable inspection control for the engineer and specific guidance for the inspector. Incorrect entries should be lined out, not erased, and after the correction is made the author should initial it.

If separate materials diaries are not kept or if pertinent materials information does not appear in the records the inspectors' diaries should contain information about materials that, when tested, failed to meet specification requirements. If the material met specifications upon retest, a simple entry such as "retest acceptable" is sufficient. The basis of acceptance of material that failed to meet tests but was used in the work should be entered. Additional information such as manufacturer, brand, model, source, lot #, batch #, or heat number should also be recorded.

The diaries need to be reviewed periodically by the engineer for completeness, clarity, and correctness. They are to be turned over to the engineer upon completion of the work operation.

160.4 Construction Inspection Checklists

The Bureau of Project Development Project Services Section has developed construction inspection checklists for select construction operations. The checklists are a good reference to prepare for field inspection, providing standard spec references that the inspector should be familiar with before inspection. They also provide many other requirements and considerations for the respective construction operations.

The Traffic Control Inspection Checklist is provided through the AASHTOware Project Knowledge Base available under Construction> Pantry> Statewide forms at:

https://awpkb.dot.wi.gov/Content/constr/PantryFiles/StatewideForms/TrafficCtrlInspectionChklst.dotm

Other checklists or job guides are provided below for the following:

- Construction Inspection Checklist for Pipe Culverts
- Construction Inspection Checklist for Piling
- Construction Inspection Checklist for Superstructures
- Job Guide for Topsoil, Fertilizer, Seeding, Mulching, and Sodding

Construction Inspector's Checklist for Pipe Culverts

This checklist has been prepared to provide the field inspector a summary of easy-to-read step-by-step requirements relative to proper installation of pipe culverts (standard spec 520). Many of these requirements apply to storm sewer (standard spec 608) as well. The following questions are based on information found in the standard specifications, and CMM.

General

Have you checked the special provisions and plans to see if any modifications have been made to the requirements listed herein?

Length Computation

Standard spec 520.3.1 specifies that, unless otherwise authorized by the engineer in writing, the contractor must not order or deliver the pipe culverts required for the project until a corrected list of sizes and lengths is furnished by the engineer. This provides WisDOT an opportunity for:

- Checking the designated plan length in the field.
- Making any necessary adjustment in length.
- Ordering the correct length of culvert pipe required at a designated location to satisfy field condition.

Are you, as a matter of routine before staking the pipe, calculating the needed length based upon shoulder and ditch elevations?

Have you accounted for skew in the computation of pipe length?

Are you checking with the contractor to see what offsets and spacings are needed?

Are you checking elevation shots for both the existing channel and the proposed grade to make sure the proposed pipe will fit field conditions? For flat sites you may need to check several hundred feet in each direction.

Are you staking the ends of the pipe or reviewing the contractor staking to determine whether the alignment shown on the plans will fit the site conditions?

Materials

Have you checked the plans to see what kind of material is specified for the installation?

Have you checked that the supplied pipe matches the class and thickness (if applicable) specified in the plans?

Is the diameter, class, and material of pipe acceptable for the anticipated depth of cover? This is especially important if the profile changed, or field conditions vary from the plans.

Are you visually inspecting each section of delivered pipe for defects?

Note:

- Each load of pipe must be accompanied by a loading document.
- The pipe must be installed only after the documentation is received.
- Pipe should be inspected as soon as possible after delivery on the job. The inspection should cover DIMENSIONS, SOUNDNESS, MARKINGS, DAMAGE incurred during shipment or unloading, or DEFECTS overlooked at plant.

Culvert Pipe Installation

Is the pipe excavation and foundation being prepared in conformance with standard spec 520.3.2.1 for roadway culverts and standard spec 520.3.2.2 for entrance and temporary culverts.

Is the pipe being laid from the downstream end toward the upstream end with the bell or groove end laid in the upstream direction and pipe spigots facing downstream?

Are sections being pushed or pulled into place to ensure tight joints?

Are joints being wrapped or sealed conforming to standard spec 520.2.6 and standard spec 520.3.3?

Are separate sections of metal pipe being joined with tightly drawn, approved connectors?

Are joints in concrete pipe being completely sealed?

Note:

- At the contractor's option, sealers meeting the requirements of standard spec 608.2 may be used. Construction methods for sealing joints with these sealers must conform to standard spec 608.3.4.

Has the need for camber been considered in areas of unanticipated or unaddressed poor soils or a profile change creating higher fills?

Note:

- Coordinate with the regional soils engineer, or BTS Geotechnical Unit on the need for camber if these conditions are encountered.

Are joint ties provided on the upstream and downstream ends of concrete culvert and concrete cattle pass installations? Ties are not required on culverts with cast in place masonry endwalls unless the plans show otherwise.

Joint ties are not required for thermoplastic pipe where a full (+/- 20 foot) pipe section is utilized from the infall and outfall to the first joint. Where a partial pipe section must be used at the infall or outfall end, it should be restrained with a manufacturer supplied external mechanical coupling, a mastic impregnated geotextile wrap with mechanical fastening bands, or a concrete collar. Apron endwalls must be secured to the pipe. No ties are required on pipes with masonry endwalls unless the plans show otherwise.

Backfilling Culvert Pipe

Foundation backfill material placed in the area under the lower half of the pipe must be thoroughly compacted especially in haunch areas under the sides of the pipe. It is also essential and required by the Specifications that the remaining foundation be thoroughly compacted in 6-inch maximum layers to an elevation of the top 12 inches above of the pipe.

The trench, starting 12 inches, above the top of the pipe shall be backfilled and compacted in layers of trench backfill material not exceeding 8 inches in depth. Unless specified differently in plan documents, the trench backfill material above the top of the pipe should be similar to adjacent materials from the typical roadway section. This is to minimize differential frost heaves due to non-uniform materials and differential compactive efforts. If the materials from the roadway section are unsuitable, standard spec 520.5.2 addresses payment for separate trench backfill materials. This only applies to the material classified as trench backfill which starts 12-inches above the top of the pipe.

Deflection Testing

Has deflection testing with a certified mandrel been performed for polyethylene and polypropylene pipe culverts and storm sewers 24-inches in diameter or larger?

For polyethylene and polypropylene culverts and storm sewers less than 24-inches in diameter, has the project engineer, not the contractor, designated at least 10 percent of the installed length of pipe for mandrel testing?

Pipe is to be tested after installation but before paving or finish grading. Waiting if practical, ideally 30 days, to mandrel test is advised to allow development of the deflection in the pipe from embankment loading.

Is the mandrel used for testing department approved? Mandrels can be supplied by the pipe manufacturer or pipe supplier and should not be field or contractor made.

Pipe that fails deflection testing needs to be relayed or replaced and retested.

Note: If deflection testing fails or if significant construction issues occur with polyethylene and polypropylene pipe, please notify the statewide drainage engineers in the Central Office Roadway Standards Development Unit.

This checklist is intended primarily to assist the WisDOT inspectors, and it is not a contract document.

Construction Inspection Checklist for Piling

This checklist has been prepared to provide the field inspector a summary of easy-to-read, step-by-step requirements for the installation of foundation piling. The following questions are based on requirements found in the plans, standard specs., special provisions, bridge manual and appropriate sections of the CMM.

Plan and Specification Review

Before starting work on an item, have you checked the contract special provisions, plans, and addendums to see if any changes or modifications have been made to the standard specifications?

Currently there are differing pile driving specifications. Become familiar with the one in your plan documents. STSP 550-010 deals with penetration resistance and ultimate values, while the remaining standard specifications deal with allowable pile bearing. Contact the geotechnical unit if you have questions.

Before the start of construction, have you checked the plan elevations of the bottom of footings, intermediate substructure components, top of pile elevations and bearing seat elevation of abutments and piers to ensure they correspond to the appropriate top of deck elevations and dimensions shown on the superstructure plans?

Has the structure been surveyed to establish the baseline of the structure, bearing lines of piers and backs of abutments?

Has an independent check of your calculations and layout been performed before the contractor starts work?

Piling

General:

The length of piling shown on the plans is considered to be approximate only and has been determined for design and estimating purposes from borings and soundings.

Piling Types:

Cast-In-Place Piling (CIP) and Steel Piling (standard spec 550***):***

Normally test piling is not used with cast-in-place or steel piling, but a full-depth driving log of the first pile should be made for informational and comparative purposes (DT1315 Piling Record). (The actual required lengths of piles are determined from the bearing information obtained from driving the test piling.)

The specified pile wall thickness (gage) for steel shell piles is the minimum gage allowed.

Electronic copies (PDFs) of DT1315 are to be submitted, with Project Manager concurrence, for all structures to the BOS by email at: DOTDTSDStructuresPiling@dot.wi.gov

and to the BTS, Geotechnical Unit at: DOTDTSDGeotechnicalPiling@dot.wi.gov

Cutting off Piles:

Is the contractor cutting off driven piles at the elevation and in according to the plan details?

Salvaged Pile Cutoffs:

If the contractor is allowed to produce pile lengths by splicing together suitable cutoffs, the cutoffs length must not be less than 5 feet to fabricate such piling.

Pile Driving Hammer:

Determination of Energy Requirements

Has it been determined what type of pile hammer will be used?

Does the hammer meet the energy requirements for the type of pile to be driven?

Has the proper pile drive system (DT3550) been submitted on projects using standard spec 550? Is the contractor-provided equipment the same as shown on this form?

During the driving of a pile, was the hammer operating at the number of blows per minute required for a given energy rating?

For single acting air or steam hammers the energy output is a product of the weight of the ram and the length of the stroke at the designated number of strokes per minute. Is the stroke being measured periodically to ensure correct hammer operation?

Bearing Value or Required Driving Resistance (standard spec 550.3.6***)***

Piles must be driven to a bearing value (or required driving resistance) not less than that shown on the plans. Use the appropriate hammer drive charts from the 'Pantry' software.

Two types of Diesel hammers

The most common type has an open upper end and an unrestricted ram that is visible above the body of the hammer on rebound. Under normal driving conditions, the height of rebound will increase as the resistance of the pile (i.e. capacity) to driving increases.

Was the length of the stroke measured? Was this done by reading on a graduated rod attached to, and extending above, the hammer body or shell, the height of the top of the ram when it rebounds?

With the other type of diesel hammer, the ram operates in a closed cylinder, and the upstroke of the ram traps and compresses air in the bounce chamber. The energy output of the hammer, within the limits of its rated energy output, will increase as the resistance of the pile being driven increases.

At the end of driving, it will be necessary for the inspector to count the blows of the hammer and measure the set (movement per blow) of the pile, to determine the equivalent energy of the hammer. The proper hammer drive chart will directly relate this information to the pile capacity.

Driving Piling:

Has the contractor submitted the proper pile material certifications and drive system information/form?

Is the piling in a correct location?

Is the piling plumb, or does it have the right batter? Was this done by checking the batter of a pile made with a spirit level attached to a board which has one edge cut to the required pile batter?

Is a proper driving helmet and pile head adapter being used? This must be done to ensure the pile head isn't damaged and the hammer is centered on the head of the pile.

Has any required preboring been completed?

Have any required pile points or end-plates been correctly installed?

Have proper welding techniques and certified welders been used when splicing piles?

Has any required concrete or granular backfill material placed after pile installation been properly tested and placed?

Pile Welding:

Has DT2320 Welding Checklist for Field Welding been completed?

Pile Driving Tips:

This operation is the most dangerous operation in bridge construction. As a general rule, when the pile is being driven, the inspector should not be in the excavated area.

- Make sure the piling size and wall thickness are correct for the location.
- Check the heat number on the piling with those listed on the certification.
- Stand upwind from the pile driving operation.
- If you use a test pile, ensure it is the same pile type and size as required in the plan and locate it such that it is representative of the whole unit (usually the center pile, not in a wingwall).
- When a test pile is not required, one pile per unit should be driven like a test pile, by counting and recording the blows for each foot and the hammer strokes.
- Look for pile damage/bending/yielding as driving is proceeding. Correct as appropriate.
- Once bearing value or penetration resistance is obtained, stop driving. Continued driving may result in pile damage.
- Check CIP piles for water-tightness by dropping a stone in each pile and listening for a splash. Advance a light down the inside of each pile to ensure the sides are not collapsed. Monitor CIP concrete volumes to ensure they match computed interior pile volumes.
- The ideal situation is when all piles are driven to approximately the same tip elevation.
- Varying pile lengths can be expected, due to differing subsurface conditions. If driven lengths vary from plan by more than about 20% during installation, contact the Geotechnical Unit.

List of items to be inspected at the construction site

Record and mark all pile lengths for possible future splicing needs.

1. Are pile points required, provided, and installed as specified?
2. Is there evidence that any pile has been damaged during shipping to the site?
3. Is the contractor lifting the piles properly?
4. Are the piles being stored properly? Piles should be stored above ground on adequate blocking, and in a manner which prevents undue bending stresses.
5. Is protective coating used on the piles?
6. Is the coating as specified and delivered undamaged?
7. Is the coating in the proper location (covering exposed areas) after the piling is installed?

This checklist is intended primarily to assist the WisDOT inspectors, and it is not a contract document.

Construction Inspection Checklist for Superstructures

This checklist has been prepared to provide for the field inspector a summary of easy-to-read step-by-step requirements relative to the proper construction of cast-in-place concrete bridge decks. The following questions are based on the requirements found in the standard specifications, special provisions, and appropriate sections of the CMM.

A. Preparation Before Superstructure Construction

1. Office Review

Are you reviewing the contract special provisions for modifications to the standard specifications?

Are you computing the volume of concrete and weight of reinforcement bars for agreement with the quantity shown in the bill of materials?

Are you determining what material must be inspected and tested before incorporation into the work?

Are you reviewing to determine what material certifications are required?

2. Field Review

Are you checking the bearing seat elevations before, during, and after each abutment or pier pour? Errors caught at this stage can often be easily corrected. Otherwise grinding or shimming may be necessary which can be costly (check bearing seats while concrete is still in fluid state).

Are you laying out bearing lines on top of abutments and piers for beam erection and checking span lengths between abutments and piers?

Are the bearing areas on supporting masonry being finished level and smooth? Improperly finished, deformed or irregular bearing area must be ground smooth, filled, or otherwise corrected to provide even bearing on the seats.

Are you inspecting material as it is delivered to the jobsite, that the material has not been damaged due to mishandling subsequent to inspection and that it is being properly stored?

B. Beam Erection

1. Structural Steel

Field Handling and Storage (standard spec 506.3.24):

Materials to be stored must be placed on skids above the ground, upright, shored, and tied or braced to preclude tipping or overturning when exposed to high wind.

Are inaccessible areas being painted before erection (bottom and top of bearings, back of beam and diaphragms, top flange in non-shear stud areas, etc.)?

Are beams and diaphragms being handled properly to keep damage to the prime coat to a minimum?

Are they providing pads, so the painted girders are not damaged by the cables or slings?

Are they using an appropriate balance beam or spreader bar for two or more pickup points with a single crane (standard spec 506.3.27)?

Minimum number of pickup points for handling girders are:

One pickup point for 0-50 feet.

Two or more pickup points for 50 feet and over.

No bent or twisted member should be put in place until its defects are corrected.

Camber may be produced or corrected by local heating (No heating will be allowed without permission). Heating above 649 degrees C (dull red) is not allowed. Water must not be used to cool metal, nor can any area be heated more than once.

Is the contractor aware that no field welding, heating, or flame cutting will be allowed on beams or girders without permission?

If a bearing area is low with respect to other areas of the structure:

- Are they using shims of the same size as the masonry plate and of the required thickness? (Avoid using number of thin shims if a single one of the required thickness can be made from standard thicknesses of plates).
- Are the shims made from the same type of steel as specified for the bearings?

2. Precast, Prestressed Concrete Girders

The maximum overhang from the point of support to the end of girder during storage, handling and transportation must not exceed the depth of the girder.

Are they handling and storing the prestressed girder in an upright position?

Upon arrival on the jobsite are you inspecting each beam for damage or cracking due to mishandling of the beam subsequent to inspection at the plant?

Beams damaged by improper handling or storing must be replaced at contractor expense.

Prestressed concrete girders must not be transported to and erected in the work until after the concrete has attained its minimum 28-day compressive strength.

If the contractor in erecting the prestressed girders elects to work with a crane on the girders of a preceding span before the concrete slab for such span has been placed and cured, the contractor must submit to the engineer for prior approval details of the proposed temporary flooring, strutting between the girders and pertinent information relating to the crane used in erecting the girders.

3. **Bearings**

   Are they only using one type of bearing pads throughout any one structure (standard spec 506.2.6)?

   Are bearings being adjusted to allow the proper clearance between units or at abutments and to provide the correct opening at expansion devices?

   If the expansion bearings are of the rocker type, are the rockers adjusted by the erector according to the prevailing temperature, so they will be vertical at the standard temperature shown on the plans?

   Are they removing excess grout or epoxy from the bolt and bearing area?

   The anchor holes should be overfilled with grout or epoxy just enough to produce a watertight fit, and excess grout or epoxy should be removed from the bolt and bearing area.

C. Placing, Finishing, and Curing Bridge Floors

The placing, finishing, and curing of concrete bridge floors is the most critical aspect of bridge construction. Not only is it critical from the standpoint of the finished surface (riding qualities), but the quality of the concrete, and thus its durability, is critical because bridge floors are probably subjected to more severe conditions conducive to scaling and deterioration than any other highway element.

One of the essential ingredients of a smooth bridge floor, after the forms and screed guides are accurately set and firmly supported, is a properly proportioned, uniform concrete mix, delivered to the bridge floor at an adequate and constant rate. Another essential element is adequate equipment and manpower to place, strike-off and finish the concrete.

D. Prepour Meeting (CMM 515.6)

Preferably the day before placement of deck concrete a meeting should be held with the contractor to review the following deck placement procedures:

1. **Falsework**

   A thorough inspection of the falsework, including footings, overhang brackets, and the forms; reinforcement; etc. (If the overhang brackets are not tight to the girders the weight of the concrete causes them to settle resulting in sags, thin deck, and shallow embedment.)

   Does the plan call for bracing of the exterior girders to the interior girders to preclude rotation of the exterior girders or does the contractor feel this should be done because of his falsework design and finishing rail location?

2. **Mix:**
   a. Have you discussed the properties of the proposed concrete mix with the region Materials Engineer and the contractor?
   b. Have you discussed with the contractor the air, slump and strength requirements for deck concrete and the location for a suitable site to run tests?

3. Delivery:
   a. Is the delivery commitment from the ready-mix supplier adequate so that the operations of placing and finishing will be continuous?
   b. Does the contractor have sufficient equipment and labor to maintain continuous concrete placement operation?

4. **Finishing Equipment & Requirements:**
   a. Is the finishing machine in a good mechanical condition and the crown checked?
   b. Has the dry run been made to check rebar clearance and depth of deck?

c. Are adequate foot bridges for finishing, and texturing provided for the concrete finishers?
d. Are there enough vibrators to adequately consolidate the concrete?

5. Manpower:

Will the contractor have supervision and enough manpower to place and finish the deck concrete and also place curing covering in a timely manner?

Has the contractor designated a person responsible for placing the curing covering?

6. Deficiency Checklist:

Have you informed the contractor of any deficiencies not previously taken care of? (Forms, reinforcement, grade, equipment, etc.)

7. Curing:

Is adequate wetted burlap, or other approved coated covering and water on the jobsite to cure the deck?

E. Concrete Placement

1. Concrete Mix:

a. Revolution requirements for truck mixers
b. Time of haul
c. Concrete temperature
d. Air Content determination
e. Slump test
f. Water cement ratio
g. Adding water or admixture to trucks at jobsite
e. Concrete delivery tickets
f. Placing concrete

Is the concrete being bucketed, conveyed, pumped, or otherwise placed in such a manner as to avoid segregation and is not being allowed to drop more than 4 ft.?

Are you checking for deflections at forms or rail supports during the deck pour?

Are you checking the anchor bolts for railing?

Are you checking drains and see that the flow line drains?

2. Consolidation & Finishing:

Is all concrete being compacted & sufficient vibration being applied?

Over vibration causes segregation and loss of entrained air.

Is the finishing machine in proper adjustment and producing an acceptable surface?

3. Depth Checks:

Are you checking the deck thickness and rebar depth at frequent intervals behind the finishing machine? (A device for stabbing the deck for cover or thickness has been made available to each Region for use in the field.)

If deck thickness or rebar depth deficiencies are found, is the contractor immediately notified so corrective action can be taken?

4. Finishing:

Is the deck surface being textured with either an artificial turf drag finish or broom finish, with no tining, in plastic state? (For design speed < 40 mph)

Is the deck surface being textured with either an artificial turf drag finish or broom finish, followed by a random tined finish? (For design speed > 40 mph)

Broom for a broomed surface should have fairly stiff, medium coarse bristles and the pressure on the broom should be regulated to prevent tearing of the surface yet produce an acceptable skid resistant surface.

Note: Decks having skew angle of 20 or greater must be finished on the skew.

- On skewed structures with skew angle of 20 or greater, tining must be perpendicular to the bridge center line and not along the skew.

- Straightedging should be done while the concrete is still in a condition that corrections can be made but delayed as much as possible to take advantage of the final slumping of the concrete.
- The inspector should closely observe the straightedging operations by the contractor or may elect to independently check the surface with a testing straightedge (straightedging should be done before brooming).

This checklist is intended primarily to assist the WisDOT inspectors, and it is not a contract document.

Job Guide for Topsoil, Fertilizer, Seeding, Mulching, and Sodding

Topsoil

Refer to standard spec 625.

Topsoils are those humus-bearing soils that can sustain plant life.

The topsoil is placed and uniformly spread over the areas to a uniform depth of min. 4 inches in rural and 6 inches in urban, unless otherwise specified.

Standard spec 625.3.3 contains special requirements for urban area where a lawn-type turf is desired. During finishing operations loose or waste stones that will not pass a 1-inch sieve must be removed.

Rocks, twigs, and clods that will not break down and other foreign material must be removed, and the entire surface must be dressed to present a uniform appearance. Rolling is not required.

Where light sandy soils are covered with heavier clay bearing loam topsoil, the two types of soils must be mixed or blended to a more homogeneous mixture by means of discs, harrows, or other appropriate equipment.

Fertilizer

Refer to standard spec 629.

Fertilizers type A and type B have been developed to ensure adequate fertilization of seed or sod located over most soil types in Wisconsin.

Type A: Fertilizer containing 32% sum total of Nitrogen, Phosphoric Acid, and Potash must be applied at 7 pounds per 1000 square foot.

Type B: Fertilizer containing 50% sum total of Nitrogen, Phosphoric Acid, and Potash must be applied at 7 pounds per 1000 square foot.

Are fertilizer nutrients being uniformly applied at Pounds/Acre rate specified in the contract?

When fertilizer is delivered in bags, is each bag or part of each bag that can NOT be duplicated, collected each day to determine the weight of fertilizer to be paid for?

Note: After entering the pay quantity in the Quantity Book, burn or otherwise destroy the bag so they cannot be used again for determining pay weight.

Do the fertilizer bags show the percent analysis, manufacturer brand, weight?

Is payment for fertilizer nutrients being determined on the basis of analysis and not on the total weight?

Note: The standard specifications allow the application of fertilizers containing percentages of components greater than the minimum specified.

For Type A fertilizer that contains a different percentage of components, determine the new application rate by multiplying the specified rate by a dimensionless factor determined as follows:

Conversion Factor = 32/New Percentage of Components.

For Type B fertilizer that contains a different percentage of components, determine the new application rate by multiplying the specified rate by a dimensionless factor determined as follows:

Conversion Factor = 50/New Percentage of Components

Seeding

Refer to standard spec 630.

Seeding consists of preparing seed beds and furnishing & sowing required seed. The project engineer must approve the seed mixture or mixtures. Seed samples may be taken by the project engineer.

Seeding rate: (standard spec 630.3.3.5)

Method A: (standard spec 630.3.3.1)

The selected seed mixture must be sown by means of equipment adapted to the purpose, or it may be scattered uniformly over the areas to be seeded, and lightly raked or dragged to cover the seed with approximately 1/4 inch of soil. After seeding the areas must be lightly rolled or compacted by means of suitable equipment, preferably of the cultipacker type. Slopes steeper than 1:3 need not be rolled.

Method B: (standard spec 630.3.3.2)

The seed must be sown or spread by means of a stream or spray of water under pressure operated from an engineer-approved machine designed for that purpose.

During the process, the contents of the tank must be kept stirred or agitated to provide uniform distribution of the seed. The tank must be emptied within one hour after seed is added.

The project engineer will reject seed that remains mixed with the water for longer than one hour. The project engineer will not require dragging or rolling.

Method C: (standard spec 630.3.3.3)

For spring seeding of seed mixtures 70 and 70A into existing ground cover.

1. Before seed bed preparation read standard spec 625.
2. Before commencing any seeding operations, has the right-of-way been shaped, trimmed, cleaned up and finished?
3. Is the disked seed bed free from debris, washes, gullies, clods and stones?
4. Your plan will specify which seeding type will be used. Is the correct type of seed being used?
5. Are the seed bag weight tickets collected to ensure that the minimum number of pounds of each type of seed is being sown?
6. Has the seeding equipment been properly adjusted and calibrated for the specified rate of application?
7. Is the ratio of seed to fertilizer appropriate?

Sodding

Refer to standard spec 631.

Sodding consists of the furnishing and laying of live sod. Watering sodded areas consists of furnishing and applying water to sodded areas.

Standard spec 631.2.1, requires that sod be indigenous to the general locality in which it is used. In other words, the sod should grow naturally under the same general climatic and soil conditions as exist at the site of the work.

For example, sods grown on peaty soils would not be acceptable for use on sandy soils. Varieties of grasses requiring a high degree of maintenance should not be planted either.

The inspector will lay out the sodded areas and determine that the bedding soil is properly prepared.

Before laying the sod, the soil surface should be loosened to a fine texture and to a depth of at least 1 inch in order to provide a condition suitable for the penetration of the grass roots. If the soil is dry, water should be applied to properly condition the bed.

During the laying of the sod, the inspector should check on the work to determine the sod is laid as tight as possible, joints are properly made, edges of the sod where water is apt to flow over it are properly imbedded in the soil, laid sod is tamped or rolled to make continuous contact with the underlying soil and the sod is properly held in place with stakes.

Attention is directed to the specified requirements for fertilizing, rolling or tamping and watering the placed sod in standard spec 631.3.

Frozen sod must not be placed, nor can sod be placed on frozen soil.

Mulching

Refer to standard spec 627.

This work consists of furnishing, placing, and anchoring a mulch cover. Mulching material consists of straw or hay in an air-dry condition, wood excelsior, wood chips or other suitable material of a similar nature, as approved by the project engineer, which is substantially free of noxious weed seeds and objectionable foreign matters.

Straw or hay must be treated with a tackifier, blown from a machine and uniformly deposited over designated areas in one operation. Tackifier must be selected from the tackifier PAL.

Straw or hay must be placed uniformly over the area to a depth of 1/2 inch to 1 inch, using 1/2 to 3 tons of mulch per acre.

Wood fiber, wood chips or similar material must be applied with approved blowing machines or other approved methods which will place a controlled amount of mulch uniformly over the area to a depth of 1/2 inch to 1-1/2 inch.

Areas to be mulched with wood chips must be treated with one pound of available nitrogen per 1000 square feet of area either before or after the application of the chip.

Has the mulch material been inspected and accepted reasonably dry (having moisture content of 10% or less) and free of noxious weed seed? Random bales may be tested to ensure they are free of noxious weed seed.

Note: An inspector must be present during initial applications to inspect the straw and hay for moisture content, state of deterioration, length of straw and to also check the equipment for suitability and operational capability.

Has a mulch storage location (when needed) been selected on the jobsite that is away from of _____? Mulching will be measured by the square yard or by the ton as provided in the contract.

Tackifier or nitrogen used for treating mulch will not be measured for payment but will be considered as subsidiary to and included as a part of the item.

This job guide is intended primarily to assist the project inspectors, and it is not a contract document.

SECTION 165 Contract Records

165.1 General

Contract documents include plans, special provisions, addenda, and standard specifications, among other documents. If there is a question about which document takes precedence over another, the governing order is provided in standard spec 105.4.

165.1.1 Forms

Standard forms are provided for reporting progress on various phases of work and for reporting other activities pertaining to the administration of the contract. Contracts that are administered in the AASHTOWare Project Construction and Materials® will not use several of these forms.

The examples of completed forms have been prepared to cover typical situations. On occasion, it may become necessary to modify a form to meet unique circumstances. Any modifications should be made with discretion and only with the approval of the agency issuing the form. The forms are to be distributed either in accordance with instructions printed on each form or, if instructions are not printed on the form, in accordance with instructions provided in the pertinent procedures of this manual.

165.1.2 Requirements for Records and Reports

The engineer and department representatives under the engineer's jurisdiction are required to maintain accurate and complete records of the work during the administration of a construction contract.

It is of prime importance that measurements and calculations of contract quantities are accurate, records of contract quantities are complete and detailed enough to sustain an audit, and records of activities pertaining to the contract contain sufficient detail and are clear enough to be read and understood by anyone unfamiliar with the contract.

Department personnel should be capable of or should be taught to compute quantities of contract items. The engineer should closely monitor qualification of personnel. A systematic method of making computations by breaking a problem into logical and simple steps, while avoiding shortcuts, should be followed. Emphasis is placed on accuracy, precision, neatness, and completeness. The computations should be made on assumption they must withstand review or analysis in future years.

165.1.3 Records Retention Policies

Construction records are to be created, filed, and maintained as specified in approved WisDOT Records Retention/Disposition Authorizations (RDA). RDAs approved by the department and the Wisconsin Public Records Board constitute required policy for records retention and disposition. Copies of RDAs are available upon request from region records coordinators, or WisDOT staff can view on MyDOT web site:

https://wigov.sharepoint.com/sites/dot/forms-docs/Pages/DTSDWisDOTApprvdRDAsbyDiv.aspx

The engineer provides direction to contract specialists, field personnel, and all involved parties to organize and maintain project records consistently throughout the project. Personnel are encouraged to file records as they are created or received into separate file folders as prescribed in current RDAs. Suggested folder labels include the following key identifiers, including RDA # and title. See examples below:

- RDA 186A: Paper "As Built" Highway Plans File
- RDA 381: Construction Project Engineer's & Inspector Diary - Paper
- RDA 410: Region Construction Contract & Project File
- RDA 350A: Hazmat Assessment Remediation Project Case Files - WisDOT Hazmat Responsible Party
- RDA 350: Hazmat Assessment Remediation Project Case Files - WisDOT Not Responsible Party

As needed, personnel may need to set up additional file folders for subcategories of records within each RDA. Include Project ID and RDA # on these folders as well. See RDA description for folder organization suggestions. For example, for the RDA 410: Region Construction Contract & Project File, create subfolders with the following headings:

- Contract Modifications
- Invoices & Payment Detail
- Erosion Control Implementation Plan (ECIP)
- Project Correspondence
- Construction Project Field & Finals Records
- Structures Project Records
- Materials Project Records
- Source Documents
- Pictures and Videos

See RDAs for complete descriptions of records contents and requirements for retention and disposition. Do not mix files and records with different RDA numbers. Do not mix files and records with different retention and dispositions.

Special circumstances that develop or become apparent after acceptance of the work may necessitate an extension of retention policies specified in the particular RDA. For example, a potential lawsuit arising from a project-related traffic accident would require extending the retention period for plans, diaries, and photographs that provide information about the traffic control status at the scene of the accident. Pending open records requests, audit proceedings, and pending RDA changes are other circumstances that require the department to place a hold on records disposition.

165.2 Progress Schedule

165.2.1 General

When required by the contract, the contractor must prepare DT1997 Progress Schedule and submit the completed form directly to the region office at least 14 days before the preconstruction conference. An example of the completed form is shown in figure 165-1. The instructions for filling out the form (page 2 of DT1997) are shown in figure 165-2.

PROGRESS SCHEDULE

DT1997 2/2006 (Replaces EC707)

Wisconsin Department of Transportation

Page _____ of _____

Project Id	Name of Road	County	Hwy. No.	Contractor
8170-04-71	Westfield - Norway	Sawburn	70	Good Roads Construction

Contract Time	or Completion Date of	Estimated Start Date	Estimated Completion Date	Prepared By	Date
60 ☑ Working Days ☐ Calendar Days		5/16/2002	8/1/2002	P.D. Cue	3/5/2002

1. The contractor shall submit a copy of the progress schedule to the Region's Project Manager prior to beginning work and 14 days prior to the preconstruction conference. At any time the work falls behind schedule, the Contractor shall submit a revised schedule, if requested by the Engineer.

2. Bar graphs shall be drawn chronologically in the sequence the work will be performed to depict the progress schedule. On working day contracts, the controlling item must be identified.

Work Items or Operations	Quantity & Units	Est. Daily Production	☐ Month ☑ Week of → 5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	
Estimated No. of Working Days per ☐ Month ☑ Week →			5	5	5	5	5	5	5	2	5	5	
			BAR GRAPH LEGEND: ■ Controlling Item; \\\\ Non-Controlling Item										
Clearing	52 Sta.	5	■	\\\\									Proposed / Actual
Excavation	31,320 CY	1,200		■	■	■	■	■					Proposed / Actual
Borrow	10,556 CY	1,000				■	■	■					Proposed / Actual
Misc. Drainage Structure				\\\\	\\\\	\\\\	\\\\	\\\					Proposed / Actual
Base Course	37,100 TON	2,500						\\\\	\\ ■	\\\\			Proposed / Actual
Asphaltic Conc. Pavement	57,860 TON	3,000									■	■	Proposed / Actual
Pavement Marking												\\\\	Proposed / Actual
Topsoil	64,500 SY	3,000							\\\\	\\\\	\\\		Proposed / Actual
Landscape Items										\\\\	\\\\	■	Proposed / Actual

FIGURE 165-1 Example Progress Schedule, DT1997

FIGURE 165-2 Instructions for Filling Out DT1997

1. General. A comprehensive progress schedule can be a valuable asset to the contractor as well as the engineer in identifying, at an early date, a rate of progress that will not result in completion within the contract time. In working day contracts, the progress schedule is also necessary to determine the controlling item for which to charge working days. Therefore, the contractor must prepare the progress schedule so that it will accurately reflect the sequence of operations and realistic production rates for the various items of work.
2. Controlling Item. The controlling item is one that must be partially or wholly completed to allow progress essential for the completion of the work within the contract time. The contractor must identify, by using the legend shown on the front of the form, which item is controlling at any time. The controlling item may be a bid item or a portion of bid items (such as at a particular location), or it may be an operation, such as painting or clean-up. An item may be controlling for a period, then be non-controlling for a time, then again become controlling.
3. Estimated Working Days Per Month. This will vary depending on the type of work and the time of the year.
4. Estimated Daily Production. The value entered in this column should be the daily rate of production proposed by the contractor during each period that the item is controlling.

See standard spec 108.4 for information on relationship bar charts (RBC) and critical path method (CPM) progress schedules.

The region will review the schedule and approve if acceptable. Schedules that lack detail, offer unrealistic rates of progress, show unacceptable coordination of interrelated operations, or other problems will be returned for revision and resubmittal.

If construction falls significantly behind schedule, the engineer should consider requesting a revised schedule from the contractor.

165.2.2 Acceptance of Progress Schedule

Answers to the following questions must be YES, before a progress schedule can be accepted.

- Was it submitted to the engineer 14 calendar days before the preconstruction meeting?
- Does it include activities that describe essential features of the work and activities that might potentially delay contract completion?
- Does it include activities that are controlling items of work?
- Does it identify the contemplated start and completion dates for each activity?
- Does it provide a duration, ranging from one to 15 working days, for each activity?
- Does it provide the sequencing of all activities?
- Does it provide the quantity and the estimated daily production rate for controlling items of work?
- Does it include a narrative that lists the work-days per week?
- Does it include number of shifts per day and hours per shift?
- Does it include department-specified holidays?
- Does it provide the estimated number of adverse weather days consistent with the monthly anticipated adverse weather days?
- Does it show completing the work within interim completion dates?
- Does it show completing the work within the specified contract time or completion date?

165.2.3 Progress Payments

Until the engineer accepts the progress schedule, the department will not make progress payments, with the exception of payments for the value of materials stockpiled on the job or specifically earmarked for the job, as specified in standard spec 109.6.3.2.

165.3 AASHTOWare Project Construction and Materials

This web based application has a unified database combining data from the design estimate stage through construction contract administration. The application provides the means to administer a construction contract including the creation of Daily Work Reports (DWRs), engineer's diaries, change orders and payment estimates plus the ability to summarize and report project specific, contract specific, and performance measure information. The system is accessible by department staff and contractor representatives. Instructions on how to use this web based application including training and support are provided by the BPD Design and Construction Technologies section on the AASHTOWare Project Knowledge Base (AWPKB) web site at:

https://awpkb.dot.wi.gov/Content/Default.htm

Additional support is provided by contacting AASHTOWare Project Administrators at:

AWPSupport@dot.wi.gov

165.4 Materials Reporting System / Materials Tracking System / Materials Information Tracking

The department's Materials Reporting System (MRS) software allows contractors to submit selected material testing data to the department electronically, estimate pay adjustments, and print reports. Qualified personnel may obtain MRS software from the department's materials system vendor web site at:

http://www.atwoodsystems.com/

The department's Materials Tracking System (MTS) and Materials Information Tracking allow project staff to administer construction materials testing, reporting, and documentation

Each region and the BTS, Materials Management section offer training and support services. Web and software support is provided at: support@atwoodsystems.com

165.5 Pantry

Personnel may use various customized statewide and region spreadsheets and forms known as "Pantry" to perform various computations for quantities, mix design, and tracking of project items. Review computations before payment. Pantry also contains a collection of statewide manuals and guides to assist personnel in the proper administration of a construction contract throughout its lifecycle. Pantry spreadsheets, forms and manuals are located on the AWPKB website at:

https://awpkb.dot.wi.gov/Content/constr/Pantry/Pantry.htm

165.6 AASHTOWare Project Construction and Materials

This system is used to electronically administer construction contracts. Contract administration includes the entry of daily work reports, engineer's diaries, item quantity usage, change orders, and pay estimates.

165.6.1 Administrators

Project Engineer

The name of the project leader for the contract. This field is required for all contracts and is selected from a list of approved AASHTOWare Project Construction and Materials® system users.

Project Engineer Office

The employer of the project engineer for the contract is selected from the vendor reference table. The selection can either be a consultant firm or WDT000 – WisDOT for department employees.

Project Manager

The name of the project manager for this contract. This field is required for all contracts and is selected from a list of approved AASHTOWare Project Construction and Materials® system users.

Supervisor

The name of the supervisor for this contract. This field is required for all contracts and is selected from a list of approved AASHTOWare Project Construction and Materials® system users.

165.6.2 Site Times

Site times are applicable to construction and maintenance work under the following conditions:

- Contracts let to bids.
- Work performed by counties or other agencies under negotiated agreements.
- Railroad or utility contracts or agreements
- Contracts involving site clearance, marking and signing, planting, or similar items.

Using site times is not applicable to contracts or agreements covering purchase of materials, preliminary or construction engineering services, soundings or material investigations, appraisal, or other similar service contracts.

A contract may have several site times associated to it. The "00" site is associated to the whole contract regardless of multiple projects in a contract. Subsequent sites are related to special provisions in the progress and prosecution of a contract that may have interim time and damages associated to them. These site damages can only be assessed in full days.

The site time is the contract completion time for a contract. The three types of contract completion time are:

- Completion date contract.
- Working day contract.
- Calendar day contract.

The time charges start date and time charges stop date must be filled in for all three types of contracts.

Time Charges Start Date and Time Charges Stop Date

Daily time charges are controlled on the contract through the AASHTOWare Project Construction and Materials® diary. For a completion date contract, the time charges start date does not influence liquidated damages at the end of a contract. The actual contract completion date is used with the time charges stop date to assess liquidated damages.

For a working day contract the time charges start and stop date are used to establish when the working day charges will begin and end on the contract.

For a calendar day contract, you need to fill in a time charges start date 10 or less days before the notice to proceed date, or the site time charges will be assessed automatically 10 days after the notice to proceed date. The time charges stop date along with the number of calendar days charged is used to assess liquidated damages. Please note time charges after the first estimate to ensure that time is starting and stopping as intended.

The time charges start date will show the date of the start of contract time. It will be the date on which work under the contract of a controlling item was started; or the date ten days after the date of notification to proceed or of final execution of the contract; or the starting date, if given, in the contract special provisions; or the notice to proceed written notification, whichever is earliest.

Contract time charges are excluded for activities occurring before and after the major operations of the contract. The time charges start date can be influenced by activities that are indirectly related to actual construction processes. The activities performed before the start, resumption of, or after the suspension or completion of actual construction are not considered controlling items to be charged as contract time, so they should not be used as a start date for contract time. These activities include:

- Construction staking, initial layout before grading work begins.
- Move-in of equipment by the contractor.
- Clearing, grubbing, stripping, and subsequent final clean-up of aggregate pits or quarries, and borrow or subbase pits.
- Delivery, installation, and removal of temporary traffic control devices.
- Exploratory digging of test holes.
- Construction, maintenance, and subsequent obliteration of access roads to pits or quarries.
- Setting up and dismantling of crushing, asphaltic, or concrete batching or mixing plants.
- Preliminary blasting or crushing for test samples.
- Watering sod, when performed after completion of all sod replacement, and all other construction work is completed. The 10-day watering requirement remains in effect, however.
- The production of aggregate stockpiles when no other work is in progress nor has been ordered to start.
- Repairs to equipment performed at the work site before the start of work, during official suspension, or after contract work is completed.
- Curing and protection of concrete after all other construction work is suspended or completed.

165.6.3 Site Events

Site events are used to document the suspension or resumption of a contract. Site events should reflect only those changes in actual job activity that are provided for under the provisions of the contract or are authorized by change order.

Suspension and resumption of work must be filled in when a change in the status is directly related to a charge of contract time. This is generally the case in connection with contracts let to bid, and only when suspension of work and contract time is permitted in the contract or authorized by a change order. If allowed, use the "Suspend Available Time Charges" and "Resume Available Time Charges" fields only on

the main contract site time records for working day contracts that must be carried over the winter months with no work activity.

165.7 Traffic Impediments

165.7.1 General

Engineers are required to enter traffic impediment information if a closure or restriction, as defined below, occur on a highway project:

1. Closure
   - Detour of all or any part of a project.
2. Restriction
   - Lane restriction: If any lane is closed.
   - Width restriction: Any highway project where the lane or shoulder width is less than what is listed in the STN log.
   - Height restriction: Any highway project where the available height along the roadway is decreased from its current clearance.
   - Weight restriction: Any highway project where the maximum weight is less than what is currently posted for the project.

165.7.2 Reporting Impediments

All closures and restrictions are required to appear on the statewide construction map found at the following link:

https://wisconsindot.gov/Pages/travel/511/511.aspx

The closures will appear in the Wisconsin Lane Closure System (LCS) used by region staff, the DMV Oversize Permits unit, State Patrol, and others throughout the DOT. In order for the closure or restriction to appear on the statewide construction map and be available for the DMV oversized/overweight permitting system in time, LCS data should be entered at least two weeks in advance by 10 am on Mondays. If you are unable to meet the two-week requirement, you must contact the DMV oversized/overweight permitting section before creating your traffic impediment record.

Access to LCS is available at:

http://transportal.cee.wisc.edu/closures/

The user manual for LCS is also available at the above site.

165.8 Daily Work Report (DWR) Item Postings

Prepare the Daily Work Report (DWR) using AASHTOWare Project Construction and Materials®. Instructions in use of the system are in the user manual available on the AWPKB site How to Administer a Construction Contract at:

https://awpkb.dot.wi.gov/Content/constr/LETContract/HowToAdminConstrContract.htm

Begin the item logging as soon as work is started. For most items, make entries daily. For certain items it may be more efficient to make entries on a weekly basis or just before preparing a construction estimate. Use inspector's diaries, plant books, survey books, and other records used as source documents to obtain the quantities. For items such as excavation, base, and surface course that normally require many days for completion, you will require several sheets for recording.

Reference DWR posting to the source documents by a brief note in the Remarks field as these examples illustrate:

- If the source document consists of measurements and computations on 8-1/2" X 11" sheets, the note in the Remarks field could be "See source document sheets _____ through _____."
- If weigh tickets are the source, the remark could simply be "See weigh tickets."
- If the DWR quantity entries are from a field book, the remark might be "See page ____ of Asphaltic Plant Book."
- For items such as Finishing Roadway, which are entered in the DWR without being transferred from another source, specify "Direct Entry."

It will be impractical to measure certain items accurately as the work progresses therefore, enter quantities based on estimates. Excavation items generally fit this category. Base the estimates on inspectors' load counts, representative cross-sections, or visual checks of completed sections. A weekly estimate of item quantities as determined by these methods will be sufficient. Record the method used for estimating in the "Remarks" column.

After completing final quantity calculations and preparing the final estimate, make the DWR part of the contract records by printing an electronic copy of the "Item History to Date Report from the Global Actions Menu within AASHTOWare Project Construction and Materials®."

165.9 Final Project Documentation

Upon completion of the contract, construction field personnel are required to turn in certain documents, forms, records, and reports developed or received during the life of the contract. For contracts administered in AASHTOWare Project Construction and Materials®, field personnel may turn in materials documents in electronic format, as specified in the RDAs covering those records "Finals" documentation requirements need to be based on current RDA descriptions and retention/disposition requirements. Finals records provide consistent contract documentation in all WisDOT regions with records retention authorization (RDA #) and title noted.

- RDA 186A - *Paper "As Built" Highway Plans File* - see procedures in CMM 165.12 AS-BUILT PLANS
- RDA # 381: *Construction Project Engineer's & Inspector Diary - Paper*
- RDA 381A: *Construction Project Diary & Inspector's Daily Report - Electronic Data*
- RDA 410: *Region Construction Contract & Project File*
  See detailed list of typical Construction Project Field & Finals Records: Structures Project Records: Materials Project Records: Source Documents:. Pictures and Videos; and Other Field Project Records such as Releases, close out records: construction permits; temporary limited easements (TLE); etc.
- RDA 148: *FieldManager™ Construction Contract Detail - Electronic Data*
- RDA 129: *Construction Contract Project Data - FIT Data*

Field personnel may submit certain required records in electronic format, including those forms listed below:

TABLE 165-1 Electronic Forms

DT1315	Piling Record
DT1924	Pile Driving Data
DT1926	PCC Plant Automatic Controls Check
DT1347	Weekly Force Account Cost Record
DT1925	Sublet Request
DT1997	Progress Schedule
DT2220	Determination of PCC Field Batch Weights
DT1310[1]	Certificate - Materials Used on Highway Project

[1] Only available electronically in MIT or MTS. Instructions for accessing and using the DT1310 form are available at:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/qmp/mtguide.pdf#dt1310

165.10 Preservation of Records

The State Public Records Board has approved policies for retaining records and reports relating to construction contract administration in RDAs noted in CMM 165.1.3 Records Retention Policies above. RDAs specify required retention and disposition of records. They also provide direction for maintaining records in alternative formats, including microfilm, scanned images, and electronic databases. When/if records are maintained in electronic format, the department must also comply with the provisions of Chapter ADM 12: Wisconsin's Electronic Records Administrative Rule in order to ensure continued access to the record for the duration of the retention period.

The retention policies specified in RDAs approved by the Wisconsin Public Records Board meet standards defined in the FHWA's Highway Program Manual for the retention of records relating to federal aid contracts. See RDA # RDA 410: Region Construction Contract & Project File.

The retention periods provided in RDAs are minimums. Special circumstances that develop or become apparent after acceptance of the work may necessitate an extension. Place a hold on records disposition and do not destroy any records if/when any of the following occurs:

- Open records request for the records under s. 19.35(5), Wis. Stats. (Open Records Law).
- Audit involving these records has commenced.
- Litigation involving the records. For example, a potential lawsuit arising from a project-related traffic accident would require extending the retention period for plans, diaries, and photographs which provide information about the traffic control status at the scene of the accident.
- RDA amendments under development.

DOT Records personnel, auditors and General Counsel will provide notice when the records disposition restriction is lifted.

165.11 As-Let Plans

For all improvement program projects, a copy of the as-let plan is available for WisDOT staff only at: N4 Public (\\mad00fph):\Bhc\Let.

Local force account projects (negotiated agreements, service and supply, and cost reimbursement projects) will not have an as-let plan available. If a plan set is not available, please contact the Bureau of Project Development at (608) 266-1020.

Note that a project plan set might come one of two ways: (1) Several projects may be bid as one contract, and there may be only one title sheet for a plan set or (2) there may be several title sheets per contract.

1. If the contract only has one title sheet for multiple projects, scan the project with the lowest project ID as a whole set. For the project ID with a higher number, scan only the title sheet as an as-let, find the lowest project ID, and look at the lowest project to view the actual plan.
2. If the contract has multiple plan sets associated to it, separate the plan set into each individual project and scan with the appropriate title sheet.

165.12 As-Built Plans

165.12.1 Engineer Responsibilities

Upon project completion, the project engineer submits an electronic as-built plan. Changes from the as-let plan that were built into the project should be recorded in red using Adobe Acrobat Professional or equivalent software. Do not scan field notes to create the digital as-built plan.

It is critical that the project engineer note all changes as a project progresses. A working as-built copy may be kept and transferred to Adobe at the end of a project or the changes can be recorded directly in Adobe as work on the contract(s) continues. Using either method it is important to work on the as-built while the job is progressing, so changes can be entered while they are still fresh in your mind.

Follow your regions process when submitting the electronic as-built file. Do not password protect the electronic file that is turned into the region.

Note a plan set might come one of three ways:

1. One project may be bid as one contract, and there would only be one title sheet for a plan set. This is a whole set and only one as-built needs to be completed.
2. Several projects may be bid as one contract, and there may be only one title sheet for a plan set. This is a whole set and only one as-built needs to be completed.
3. Several projects may be bid as one contract but there may be individual plan sets, each with a separate title sheet. If the contract has multiple plan sets separate them and create an as-built for each project.

Use the correct project identification Number (ID) for labeling the as-built pdf file: 1234-56-78AsBuilt.pdf (If there are multiple projects label the file using the lowest project id).

When the project includes structure plans, use the PDF editor tool to copy all structure sheets in section 8 of the plan into a new PDF file named 1234-56-78AsBuiltStructure.pdf, where 1234-56-78 is the primary project ID. Do not remove the structure sheets from the complete as-built. A copy of the title sheet (with all markups) should be inserted as the first page of the newly created structure file. Add the word STRUCTURE in red text on the title sheet above the as-built plan text box.

An as-built should be prepared for structures that have the following affixes in their structure ID.

- B: Bridges
- C: Culverts
- P: Bridges with no plans (included for 'Rehab' only)
- S: Sign Bridges
- R: Retaining Walls
- M: Miscellaneous
- N: Noise Walls.

It is the responsibility of the project engineer to insert any addendum or replacement sheets into the electronic file with new electronic file sheets. To do this, renumber them similarly to the original plan sheet.

For example, "Revised Sheet 5" would replace sheet 5. However, all original sheets must remain in the as-built. If the sheet has been replaced cross it out with an x and indicate the number of its replacement sheet. If additional sheets were added insert them in the logical location and label them with the previous sheet number followed by an "A", "B", "C", etc.

Note the sheet changes on the title sheet under the ORDER OF SHEETS. The title sheet of the as-built plan should include the following (see figure 165-4: Example As-Built Plan Sheet):

- List of sheets revised and update the total number of sheets.
- Subcontractors list.
- As-Built Plan text box as outlined in the following paragraphs.

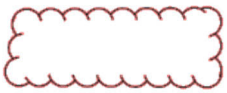
For the "As-Built Plan" box add a red text box on the title sheet, centered in top margin. The text size and properties should be; Font: Arial, Style: Solid, Border Color: Red, Opacity: 100%, Thickness: 1pt, Fill Color: No Color.

AS-BUILT PLAN Font size 24
STRUCTURE (if included) Font size 24
SUPERVISOR: Font Size 10
PROJECT ENGINEER: Font Size 10
PROJECT MANAGER: Font Size 10
PRIME CONTRACTOR: Font Size 10
CONSTRUCTION STARTED: Font Size 10
SUBSTANTIALLY COMPLETE: Font Size 10

AS-BUILT PLAN
SUPERVISOR: Steve Noel
PROJECT MANAGER: Bill Bertrand
PROJECT LEADER: John Spielmacher
CONTRACTOR: Vinton Construction Company
CONSTRUCTION STARTED 4/20/11
SUBSTANTIALLY COMPLETE 9/10/11

For changes or additions to the as-built use *Arial Font 10 and line thickness 1pt* unless it requires creative customization. In most cases you will not add a text box because the changes should fit in with the original labeling on the plan. Line out or cross out changed information and type the corrected information above the original or as close to it where ever possible. Use blank spaces on the plan so notes are not superimposed. Urban plans or those with excessive detail may require an alternate approach. Numbered changes or additions may-be shown on supplemental non-plan sheets.

To indicate other additions, use the clouding tool text box appearance may be changed to this line feature.



If there are no corrections or additions to the as-let put "NO CHANGE" in red text on the title sheet with other required as-built information.

If there is a Right of Way Plat (R/W) included in the plan a note must be added to the first page of Section 4, Sheet No. 4. Quite often the R/W plats are revised after the plan has been completed. The official right-of-way plat information is recorded at the County Register of Deeds Office. For WisDOT's most current information, the R/W Plat can be viewed on DOTView under the Real Estate Project ID. This information is managed by the regional Right of Way Plat Coordinator.

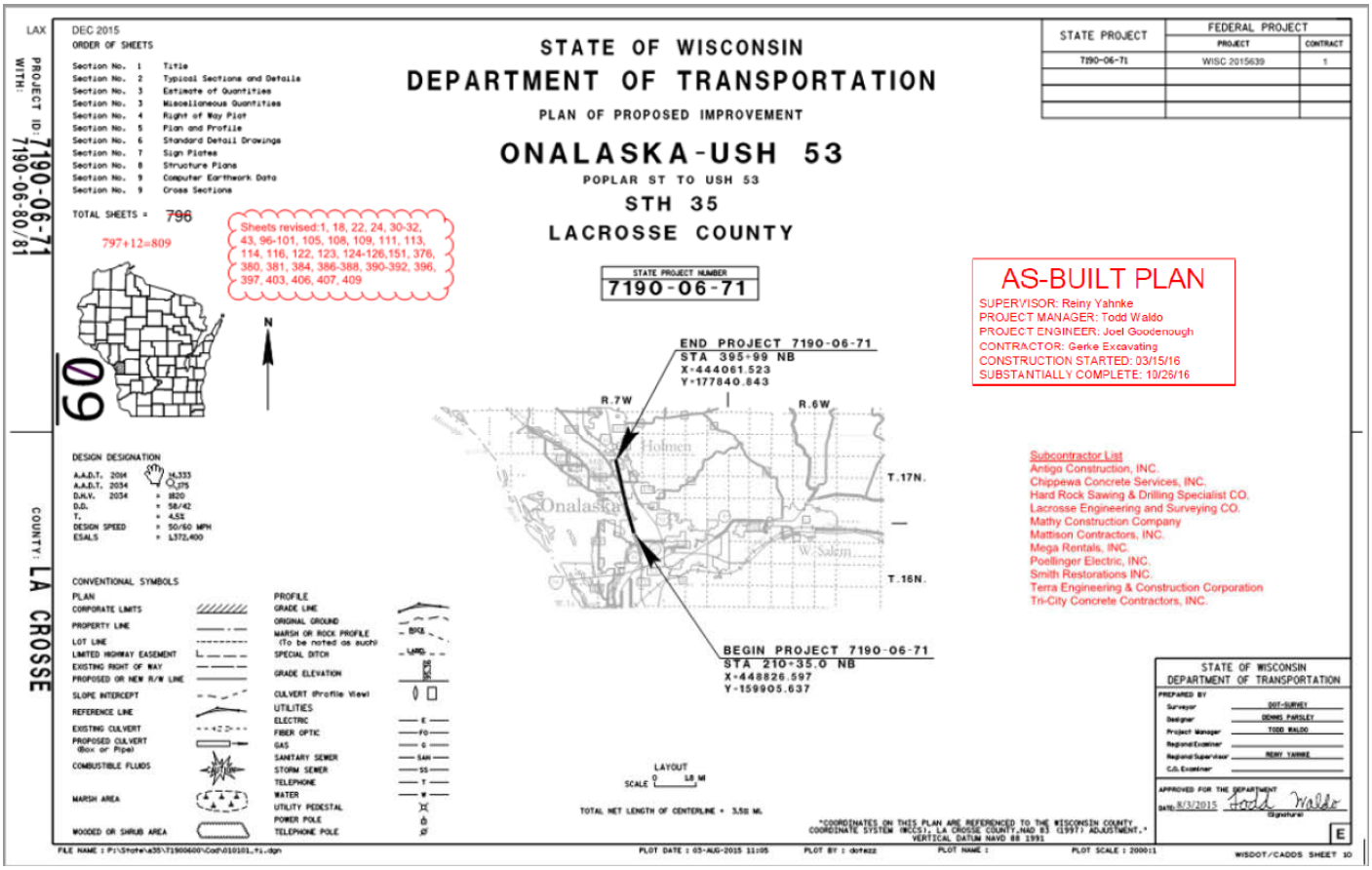
On the first sheet of section number 4, Sheet No. 4 in a blank space where it can be easily read add a red text box including the note: The most current Right of Way information should be viewed in DOTView using the Real Estate Project ID. The Plat information contained in this as-built Plan may not be the final records. Configure the properties as follows. Font: Arial, Style: Solid, Border Color: Red, Opacity: 100%, Thickness: 1pt, Fill Color: No Color, *Font size 16*

The most current Right of Way information should be viewed in DOTView using the Real Estate Project ID. The Plat information contained in this As-built Plan may not be the final records.

Do not include any of the following changes:

- Miscellaneous Quantities and Estimate of Quantities sheets.
- Every last grade or grade change. Just show the new LC, PC, PI and PT.
- Changes to the right of way sheets.

FIGURE 165-3 Example As-Built Plan Title Sheet



165.12.1.1 Highway Plans

For highway plans include the following notes on the title, plan sheets, and cross section sheets as applicable. Use this listing as a base and revise it to fit the individual project needs.

- Grade changes, changes in elevations for footings, culverts, manholes etc. Just show new LC, PC, PI, and PT.
- Relocated private and field entrances.
- Changes in size and location of culvert pipes.
- Undercut areas.
- Location of drain tiles found under drain tile exploration.
- Omissions, errors and discrepancies discovered during construction.
- Features added, revised, or deleted by change orders.
- Corrected or new bench marks. Cross out those that no longer exist.
- Locations of borrow pits common to the mainline.
- Changes to drainage.
- Project reference ties and land ties placed during construction.
- Relocated or added utilities spanning the highway, and those located underground.
- Material type, size, and manufacturer where optional materials are allowed by specifications.
- Final dimensions, elevations, details, sizes, numbers, lengths, locations, etc., if different from the original plan.

165.12.1.2 Structure Plans

For as-built structure plans include these notes on the title and detail plan sheets as applicable. Consider this listing as a base and revise it to meet individual project needs.

- Add the word STRUCTURE in red text on the title sheet above the as-built plan text box.
- Correct or new bench mark disk locations and elevations.
- Added or relocated utilities. Locate on the plan sheet and on the detail sheet if hanging from the superstructure.

- Changes in piling type.
- Added or relocated piles, location, type and length.
- Expansion joint type when options are allowed. Indicate the size and manufacturer. Cross out reference to joint types not used.
- Revisions, additions and deletions per change order.
- Final dimensions, elevations, details, sizes, lengths, numbers and locations if changed from plans.
- Controlling vertical clearances to the highway.
- Plain and protective surface treatment color, type, and manufacturer.
- Size of riprap or other countermeasures to counter scour.
- Underwater problems encountered that may reoccur.
- Top of water elevation together with date taken.
- Vulnerability to scour code obtained from bridge designer.
- Profiles and cross sections of streambed upstream and downstream.
- Angle of water attack relative to pier or abutment line.

165.12.2 Region Responsibilities

When the asbuilt and structure file is completed, DTSD has identified a standard location to place the completed asbuilts in cloud storage system, Box.com. Completed asbuits will be placed in the DTSD-Projects-Public construction id folder. Each construction id project folder has an identified 12345678\plan\asbuilt folder. If this location has not been shared, such as with consultant or work-share staff assigned to the project, the project manager for the given project should be notified. They will send out a Box invitation to allow access to upload the asbuilt.

Once received, the as-built plans will be verified by the region record coordinators and processed for access via DOTView. These automated tools also transfer any structure PDF files to the designated BOS location. The electronic as-built in DOTView is WisDOT's official record.

BOS will process the structure plans submitted by the record coordinators. This will make them available to internal and external DOT users by using the Highway Structure Information system (HSI). A WAMS username and password is required to access the HSI system. The link to HSI is:

https://trust.dot.state.wi.us/hsi/HSIController

Do not submit contracts having more than one project until all projects and structure PDF files have been completed.

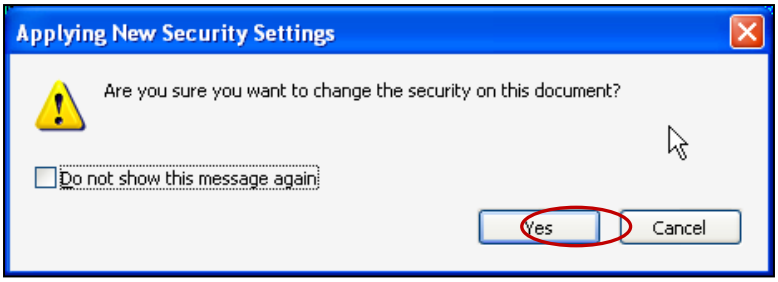
165.12.3 Bureau Of Project Development Responsibilities

The Bureau of Project Development (BPD) project services section is the custodian of the as-let and as-built data.

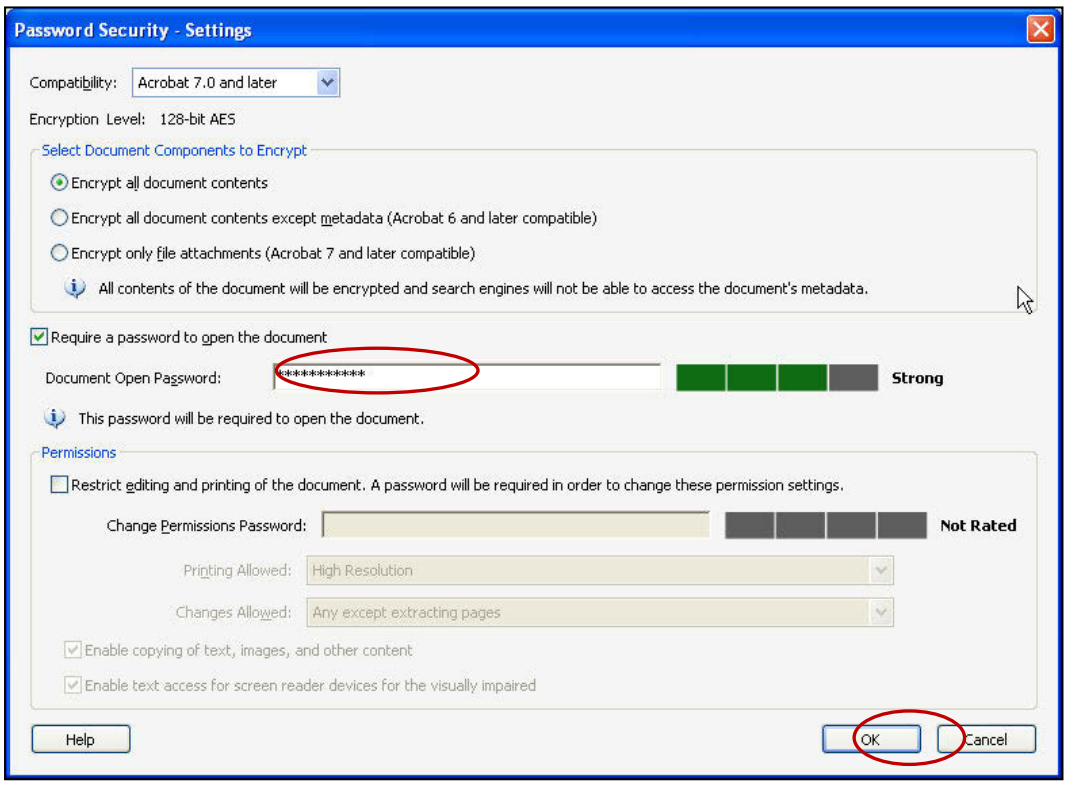
165.12.4 Local Municipality and other As-Built Distribution

If a local municipality or other outside source has an interest in obtaining an as-built before processing in DOTView the request should be routed through the project engineer or regional office contract specialist. Since the as-builts are submitted to the region as unprotected files, the following must be completed to send a protected digital copy to the requestor.

To protect an "As-built" file in Adobe go to the pull-down menu: After Advanced/Security/Password Encryption/ answer "Yes".



After answering "Yes" you will need to configure the Password Security - Settings. In the Permissions area Select the box to "Restrict editing and printing of the document. A password will be required in order to change these permission settings". Use "as-built" for the Change Permissions Password.



Configure the security as shown; make sure you indicate that printing is allowed. No changes are allowed but coping of text, images, and other content is. Once you have saved and protected a file, verify that the protection is functioning.

SECTION 170 Performance Measures

170.1 Contractor Performance Evaluations

The department has developed an objective, formal procedure for rating prime contractor and subcontractor performance following the Contractor Evaluation process in AASHTOWare Project Construction and Materials®. Project staff must rate the performance of the prime contractor and all subcontractors at the completion of contract work. The project engineer role creates electronic contractor and subcontractor evaluations. The project manager role is responsible for the review and approval of the evaluations.

The contractor's performance report provides input to personnel establishing the bidding limit for a contractor, and to monitor extremes in work performance. It also is used to monitor a subcontractor's ability to sublet work. The reports are considered confidential, and access is limited within AASHTOWare Project Construction and Materials®. Instructions for creating and reviewing Contractor Evaluations are available at:

https://awpkb.dot.wi.gov/Content/constr/LETContract/ContractFinals/ContractorEvals.htm

170.1.1 Rating of Prime Contractors

The primary purpose of the rating is to provide input when establishing the bidding limit. The bidding limit is determined by multiplying a financial factor (arrived at through the BPD proposal management section analysis of the contractor's prequalification submittals, including assets, liabilities, plant, equipment, and work force experience) by a work factor (determined by the BPD proposal management section), and is significantly influenced by "Overall Ratings" shown on department's Report of Contractor's Performance.

A secondary but important purpose is to monitor extremes in contractor performance. Extremely poor performance may warrant follow-up action by the BPD proposal management section beyond adjustment of the bidding limit. Exceptionally good, consistent performance will result in allowing the contractor to take on more work.

170.1.2 Rating of Subcontractors

The subcontractor rating allows monitoring of each subcontractor's eligibility to sublet work. Since the region construction sections have the authority to approve or disapprove a subcontractor, they are encouraged to use the reported data to guide them in their decisions.

A further purpose of the rating is to provide a basis for certification of DBE/WBE subcontractors. The reported data will provide a means for determining capability of performance and eligibility for certification.

170.1.3 Rating Procedure

The engineer will rate the prime contractor and each subcontractor at the time of contract completion or, if considered appropriate, when a subcontractor completes work at an intermediate stage of the contract. To accomplish the report, the engineer should make notes during the progress of construction for later reference. Input by the contractor to more fully explain problems will be considered, or the contractor may submit a separate report if the contractor so wishes. The engineer is encouraged to provide concise, meaningful comments in addition to the numerical ratings required by the report.

A separate report will be created electronically for each contractor and subcontractor. All the reports and the ratings for a contract are viewable online by limited staff.

The project manager role is responsible for the review and approval of the evaluations. The completed performance reports are to be considered confidential documents.

170.2 Consultant Performance Evaluations

WisDOT evaluates the work of consultants providing professional services at the completion of each contract or as necessary on multi-year contracts. DT1087 Construction Consultant Performance Evaluation Report is used to evaluate the performance of consultants providing construction engineering services to WisDOT.

Consultant performance evaluations are required on contracts of $3000 or more. Evaluations should reflect both the positive and negative aspects of the consultant's work on the project. WisDOT staff will affirm consultant successes as well as provide constructive feedback on how the consultant could improve its performance. The WisDOT engineer, project manager, or supervisor as appropriate will conduct evaluations.

The purpose of the evaluation is to reassure the consultant in areas of competence and to enhance future performance in areas needing improvement. The report is considered confidential and access is limited.

Each project ID on the construction engineering contract must be accounted for on a consultant evaluation. This means that although evaluations only need to be completed for each let project on a

construction engineering contract, all project IDs on the construction engineering services contract must be written on the consultant evaluation form.

An average construction consultant rating is calculated to the nearest tenth from the six rating items. Written comments are encouraged to better define the numerical ratings.

170.3 Performance Measures (PM)- Design Evaluations

Please refer to CMM 110.5.9, Quality Management, for a discussion of quality from a project management perspective.

170.3.1 Design Evaluations (DQI)

The DQI describes the constructability of the design plans. The index is determined by evaluating16 elements of design plans. At or near completion of project, the project engineer and the prime contractor will meet to fill out the Design Quality Index form online (provide comments for any ratings of 5 or less). A separate DQI is completed for every project ID in the contract. The online forms are completed within AASHTOWare Project Construction and Materials® under the Projects quick link on the DQI tab. For local projects, share a copy of the DQI with the local public agency. Instructions for creating and reviewing DQI are available at:

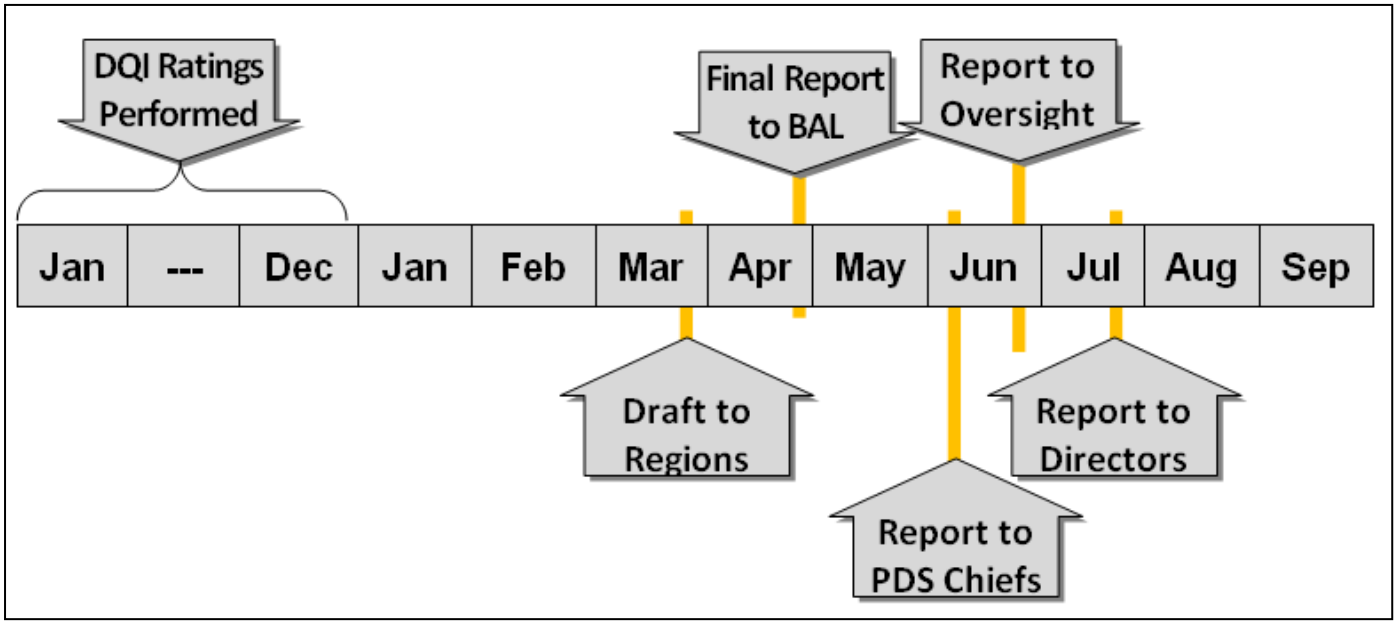
https://awpkb.dot.wi.gov/Content/constr/LETContract/ContractFinals/DesignEval-DQI.htm

TABLE 170-1 DQI Submittal Requirements

ACTIVITY	WHO	WHEN	SUBMITTED TO WHOM
Online DQI created for every project ID	Project Engineer and prime contractor	At or near project completion	Available for the region Project Manager to review within the AWP Construction and Materials®
Online (DQI) reviews complete	Contract Specialist or region representative	During finals process	Designer Local Public Agency
Region and statewide data summarized	Central office	Statewide data compiled and submitted by April 1	PDS Chiefs and Regional PM staff

Once ratings are complete, figure 170-1 shows a schedule of phases (from DQI rating to final report submitted to directors) the DQI goes through before it is posted.

FIGURE 170-1 DQI Schedule



200 Contract Management

CMM 210 Contracts and Agreements
CMM 214 Federal Aid Local Road Projects
CMM 215 Transparency Efforts for Projects
CMM 216 Consultant Contracts for Construction Services
CMM 218 Project Relationships and Communication
CMM 219 Construction Services by Local Units of Government
CMM 220 Public Relations
CMM 222 Notice to Proceed
CMM 224 Labor Compliance
CMM 226 Preconstruction Meeting
CMM 228 Laws and Standards
CMM 230 Right of Way
CMM 231 Use of Materials Found on the Project
CMM 232 Measurement and Payment
CMM 233 Payment - Local Force Account Agreements
CMM 234 Site Time - Damages and Incentives
CMM 236 Intermediate/Tentative/Final Estimates
CMM 238 Administrative Items
CMM 240 Prompt Payment
CMM 242 Change Orders
CMM 244 Cost Reduction Incentive
CMM 246 Force Account Work
CMM 248 Suspension of Work
CMM 250 Project Acceptance
CMM 252 Bonds and Warranties
CMM 253 Dispute Resolution Procedures
CMM 254 Contract Claims
CMM 256 Utilities
CMM 258 Railroad Agreement
CMM 260 Subcontracting

SECTION 210 Contracts and Agreements

210.1 General

A contract is a written mutual agreement between two or more parties and governs the relationship between the contracting parties. Each party to the contract has certain rights and corresponding obligations to fulfill, and neither party has the right to deviate from the scope of the terms or requirements of the contract without the written consent of the other party. A contract executed between the state and the contractor for an improvement of a highway provides that the performance of the work, including furnishing of labor and materials and fulfillment of other obligations, must conform to the plans, specifications, and other contract terms and requirements.

The construction, improvement, or maintenance of state highways and local roads is accomplished by means of contracts or agreements with private contractors, counties, municipalities, and state forces.

Several different types of contracts or agreements have been developed to accomplish the work in accordance with appropriate statutes and regulations. The "Project Managers Packet" will contain a copy of contracts or agreements to be administered by the project staff and information regarding any agreements administered by others that impact the project.

The basic authority for the department to contract for work on state highways is given in Wisconsin statute 84.06 for improvement work and Wisconsin statute 84.07 for maintenance work. Wisconsin statute 84.03 provides for contracting for work on local roads in connection with expending state and federal aid.

Refer to the following sources for information on the development of projects and contracts:

SOURCES FOR INFORMATION ON THE DEVELOPMENT OF PROJECTS AND CONTRACTS	
Project/Contract Type	Source
Improvement	FDM 3-5
State Highway Rehabilitation Maintenance (SHRM)	FDM Chapter 3 and Maintenance Manual Chapter 13
Authority for Expenditure (AFE)	CMM 600
Transportation Economic Assistance	FDM 19-35
Railroad Agreements	FDM Chapter 17
Utility Agreements	FDM Chapter 18
Policy, Negotiated Agreements	FDM 3-5

The type of contract used to accomplish the work necessary for a particular project depends on the work type, highway system, and organization performing the work and funding programs.

The following tabulates these conditions and provides a brief overview of each type of contract:

Contract Type	Abbr.	Work Type	Hwy System	Funding Source	Funding Program	Managing Office
Let	LET	Any	Any	Fed, State, Local	Any	BPD Region - PDS
Local Force Account - Local System	LFAL	Any	Local	Fed, State, Local	Any except SHRM	BPD Region - SPO
Local Force Account - State System	LFAS	Any	State	Fed, State, Local	Operations and SHIRM	BHO Region - SPO
Authority for Expenditure	AFE	MAINT	State	State	Maintenance	BHO Region - SPO
State Force Account	SFA	IMP.	State	Fed., State	Any Fed./State	BHO Region - SPO/PDS
Transportation Facilities Economic Assistance & Development	TEA	IMP	Local	Fed, State, Local	TEA	BHO/BPD Region - SPO/PDS
Railroad Agreement	---	Any	Any	Any	Any	DTIM - BLRRH
Utility Agreement	---	Any	Any	Any	Any	BPD - Region TSS

210.2 Let Contracts

The competitive bidding process can contract for both highway improvement and maintenance work. Wisconsin statutes intend for competitive bidding to contract for highway improvement work, and other methods of contracting will be the exception.

Under this method of contracting, the low bidder is determined based on estimated contract quantities and unit bid prices. Compensation to the contractor is based on actual quantities of work performed and unit bid prices that become contract unit prices. A special type of let contract is provided for by Wisconsin statute 84.076, namely "Disadvantaged Business Demonstration and Training Program." The majority of the unique aspects of projects in this program are applicable to the bidding process. However, there are a few unique contract requirements the engineer should be aware of:

1. At least 25% of the total number of workers in all construction trades must be disadvantaged individuals.
2. At least 20% of the total contract amount must be subcontracted to bona fide independent disadvantaged business subcontractors.
3. Pre-apprenticeship training must be provided to disadvantaged individuals.
4. A program of management and technical assistance must be provided to disadvantaged business subcontractors.

210.2.1 Unbalanced Bid Analysis

1. An unbalanced bid analysis will be performed under two circumstances:
   - If the department becomes aware of an error in a quantity of an item shown in the bidding documents.
   - If an item is found to be both significant to the contract and significantly unbalanced.
2. An individual item will be considered significant to the contract if any bidder has an item included in the proposal where the difference between the total cost of the item and the estimate, expressed as a percent of the estimated total contract cost, is greater than 0.50% for contracts less than $2,000,000 and greater than 0.25% for contracts $2,000,000 and larger.
3. An item will be considered significantly unbalanced if the difference between the low bidder's unit price and the estimate, expressed as a percent of the estimate, is greater than +50% or is less than -75%.
4. The unbalanced bid analysis must consist of the following steps:
   4.1 The estimated unit price for items identified as being significantly unbalanced will be reviewed for correctness. Corrections will be made as needed and the low bidder's unit price will be reevaluated to determine if the item remains significantly unbalanced (see item #3).
   4.2 Quantities for items found to be significant to the contract will be checked and verified. Quantities will be determined based upon the bidding documents and the construction methodologies depicted in the plan. These quantities will be used only for the purpose of performing the Unbalanced Bid Analysis.

4.3 Corrected quantities for items known to be in error (see item #3) plus corrected quantities for items significant to the contract will then be multiplied times the unit price bid for each contractor and a gross sum for the contract for each bidder will be calculated.

4.4 A comparison of the calculated gross sum totals will be made. If the calculated gross sum for the contract low bid is found to be higher than the calculated gross sum of another bidder, the low contract bid proposal is materially unbalanced. If the calculated gross sum of the contract low bid proposal is found to be less than the calculated gross sum of all other bidders, that bid is not materially unbalanced.

4.5 The comparison procedure explained in 4.4 above will be repeated as necessary using the next low contract bid proposal until a contract bid that is not materially unbalanced is found.

5. If the initial contract low bid proposal is found to be not materially unbalanced, the contract will be considered for award at the bid contract amount in accordance to the standard specifications. The contract will be based upon the bid amount and the quantities shown in the bidding documents.
6. If the initial low bid contract proposal is found to be materially unbalanced it will be considered irregular and will be rejected as non-responsive as reasonable doubt exists that the bid does not represent the lowest cost to the department.
7. If the initial low bid contract proposal is found to be materially unbalanced and rejected, the department may award to the next low bid contract proposal at the bid contract amount or may elect to reject all bids and re-let. Decisions will be made in the public interest and will consider consequences of re-letting the project.

210.3 Negotiated Agreements - Local Force Accounts

Highway improvement and maintenance work can be constructed by negotiating an agreement with counties and municipalities without bids. Compensation under a local force account (LFA) agreement is based on actual costs for labor, materials, incidentals, and established rental rates. LFA agreements do not provide an opportunity for profit or loss for doing the work.

Work performed by counties and municipalities on state trunk highways and local roads may be an LFA-local, LFA-state, or AFE type agreement.

Under LFA agreements, the county or municipality is authorized to purchase and furnish work materials such as culvert pipe, posts, and other similar manufactured items, but some other items may not be allowed to be purchased depending upon the circumstances of production and the quantity used. Items such as aggregates, premixed asphaltic materials, and other similar materials, when used in minor quantities necessary for associated work, may be purchased from third parties. When these items are produced exclusively for the job, or when their uses are among the major items of the contract, furnishing of these materials becomes performance of work under the agreement.

LFA agreements require the work to be performed with county or municipal forces and equipment. Agreements are negotiated only with counties or municipalities staffed, equipped, and capable of performing the required work. However, the need may occasionally arise for the limited use of an item of equipment the county or municipality does not generally use and would not have. In this case, the county or municipality can arrange with someone else for use of the equipment. The arrangement will be on a rental basis at an agreed rate per unit of time and may either include or exclude the operator.

LFA-state agreements are only for State Highway Rehabilitation Maintenance (SHRM) projects and are with the county in which the work is located.

The SHRM project designation denotes a specific funding program and may be with state funds and any federal funds for which individual projects are eligible. Construction of SHRM projects may also be accomplished by private contractors through the let process.

Administration of an executed agreement is performed by the region - SPO section.

210.4 Authority for Expenditure (AFE)

There are annual calendar year agreements that provide each county with a state highway maintenance budget and the approval for expenditures within that budget. These are similar to LFAS agreements in that reimbursement is for actual costs in accordance with established labor and machinery rates and materials costs. The department exercises general direction of the work and the county submits monthly, itemized invoices to the region.

The Authority for Expenditure (AFE) document is a department contract form. This form will contain a list of the work to be done, standards for compliance, and directions for billing, along with listings of county-furnished and state-furnished materials. For additional information on AFE contracts see chapter 6 of the Maintenance Manual.

210.5 State Force Account (SFA)

210.5.1 General

When improvement of a state highway involves items of work which the department's field crews are uniquely qualified to perform, and when the department would obtain a financial advantage financing the work with improvement funds rather than with other funds, the department may determine to perform the work with department forces as a separate project.

A State Force Account (SFA) is the agreement that is used to formalize the work to be done and the specifications for the work. Normally federal aid is involved in the project. Pavement marking, signing, and electrical work for which federal financing is available are the most common types of projects performed in this manner.

210.5.2 Administration of State Force Account Agreements

Records are maintained of the actual cost of the work by charging field crew time, their personal expenses, equipment rentals, and material costs to a special professional and technical project assigned by Bureau of Highway Operations (BHO). Field crews should also charge truck costs to the professional and technical project on their monthly truck reports. In addition, the crew chief should prepare and submit in the usual manner appropriate daily activity reports and electrical service reports, showing the professional and technical project number as the project on which they are working. These reports will include listings of the materials used. The BHO will charge the cost of these materials to the professional and technical project. Upon completion of the work, the total accrued cost is transferred as a lump sum to the construction project.

The engineer and staff will continue to charge time and expenses to the highway improvement project constructed with non-state forces.

The engineer must adhere to the following steps in administering SFA projects.

1. When field work begins, an interim site time will be recorded in AASHTOWare Project Construction and Materials®, showing the WisDOT as contractor.
2. At the time work on the project is completed.
    2.1 Record a completion date in AASHTOWare Project Construction and Materials®.
    2.2 Prepare a memorandum to the BHO and the BFS. This memorandum corresponds to the letter normally sent to the contractor upon acceptance of a contract and should contain a statement the work was inspected, found to be acceptably completed on a specified date.
    2.3 Prepare a memorandum to the BFS with a copy to the BHO including:
        - A statement that all work is completed.
        - A statement advising of the last month in which time, travel expenses and truck expenses were charged directly to the professional and technical project.
    2.4 Upon receipt of the memorandum mentioned in item 2.3 above, the BHO will ascertain whether or not all materials cost transfers have been accomplished. When these transfers have been made, the BHO will arrange to transfer the total cost of the professional and technical project to the construction project I.D., and will ask the BFS to close the professional and technical project.

210.6 Transportation Facilities Economic Assistance and Development (TEA)

210.6.1 General

Contracts for TEA projects may be accomplished only by let contracts. The TEA designation is a specific funding type and not a contract type. However, it is included here because of some unique rules and procedures. The contracts may be either state administered or locally administered.

210.6.2 State Administered

Contracts that are state administered are treated the same as any other let contract. In the event federal Economic Development Authority (EDA) funds are used by the local agency to help finance the project, the contract provisions will contain requirements for employment of local labor and provisions for small, minority, women, and labor surplus area businesses. FHWA requirements will also be included, except there will be no Disadvantaged Business Enterprise assignment.

210.6.3 Locally Administered

Contracts that are locally administered will have very little involvement of state construction staff. In some instances, construction staff may be asked to inspect the project and complete a TEA Project Completion certificate. In this event they will be certifying that the project was built and appears to be in substantial conformance with the approved plan and specifications, as amended by change order. The person doing the final inspection should be furnished with a copy of the plans, contract provisions, and any change orders. A detailed inspection is not necessary or expected. The inspection is primarily to determine that the project was built to the length and width specified, and the surfacing, curb and gutter, and

appurtenances are of the type specified and are in place. Copies of any change orders are to be attached to the certificate.

210.7 Agreements with Utilities and Railroads

When the improvement of a state highway requires the facilities of a railroad or a public utility company to be altered, rearranged or relocated, and when the cost of such alteration, rearrangement or relocation is an obligation of the department, Wisconsin statute 84.06(4) provides that the department may enter into an agreement with the railroad or public utility company for performing this work. The agreement is not based on bids, but is an agreement negotiated between the department and the railroad or public utility company covering performance of the work and basis of payment.

The basis of payment may be either an agreed lump sum price, or it may be a time and materials agreement with which the department will pay the actual costs incurred by the railroad or utility company for furnishing labor and materials and for use of equipment in performing work under the agreement. Equipment will be paid for at a rate agreed upon by the department and utility or railroad.

Utility agreements may require a utility subcontractor to perform all or a part of the work prescribed in the utility contract. Generally, at the time the prime utility agreement is negotiated, any work to be performed under a utility subcontract is noted and authorized. The engineer should be aware of any authorized subcontract as well as any subsequent approval issued to a utility to subcontract all or part of the work. Should unauthorized or unapproved subcontract work be performed under the prime utility agreement, the engineer should bring the matter to the attention of the area construction supervisor or team leader. For more information on utilities and railroads see CMM 256 and CMM 258.

SECTION 214 Federal Aid Local Road Projects

214.1 General

The Wisconsin statutes provide that improvements of local roads and streets, when federal aid funds are used for such improvements, will be under the jurisdiction of the department. The municipality (county or other local unit of government) where the proposed improvement is located provides the necessary funds for matching or supplementing the federal funds. The improvement of a local road or street, when authorized by state and federal authorities, is performed under a contract based on bids. This contract is executed between the department and the lowest responsible and competent bidder, unless the department finds it to be in the best interests of the public to have the improvement performed by the municipality under a negotiated agreement. In the latter case, the department enters into an agreement between the municipality, and the department. Normally this will be a local force account agreement.

The administration and inspection of work under federal aid contracts for the improvement of local roads and streets will be by the department's engineering forces or the department's management consultant or by a separate consultant. In some instances, the inspection of the grading, paving, curb and gutter, etc. may be by WisDOT forces (the management consultant or a separate consultant), and the inspection of specialty work such as sanitary sewer or water supply may be by municipal forces. Municipal forces may also perform other routine inspection duties, if they are pre-qualified. In either event, the agreement with the municipality should clarify that the engineer is in "responsible charge" of the project, and the local inspectors will report to the engineer.

214.2 Oversight Requirements - Project Components in State/Municipal Agreement

On some projects, portions of the work may be federally funded, and other portions may be entirely locally funded. Construction oversight (overall responsible charge) as defined in the standard specifications and the CMM by the management consultant or other consultant is required for all federally funded components of work performed.

Construction oversight of locally funded or locally let components should be limited to projects that were developed using the DOT/DNR Cooperative agreement. The oversight needs to be sufficient to ensure the construction activities comply with the terms of this agreement.

SECTION 215 Transparency Efforts for Projects

The Transparency Effort is a concept where state or local design services contracts may sometimes include providing consulting services to consultant construction project leaders during construction of highway projects. The intent is to provide a way of improving construction communications on consultant managed construction projects so that project leaders can make timely project decisions.

The full process for Transparency Effort is described in FDM 8-1-10. Here are a few of the highlights of that process.

- Since most of the questions from the field staff are discovered during review of the plans and contract documents in preparation for starting field work, the Transparency contract or work order is expected to be in place well before the project Preconstruction Meeting to ensure that the consultant designer is available to address design related questions.
- Transparency Projects will use the Design Issue Notice (DIN) WS2503 to document questions going to the design consulting firm so that there is no confusion with questions that may come from the contractor to the consultant construction Project Leader. The construction Project Leader must approve the DIN before the design consultant may begin work.
- Construction project personnel, including contractors, should be informed that the design consulting firm is under contract to provide answers to design questions to the construction project leader and that they are encouraged to use the program when needed. They should also be informed that the construction Project Leader must approve the DIN before the design consultant may begin work.

SECTION 216 Consultant Contracts for Construction Services

Since 1982, the department has entered into contracts with private engineering consulting firms for field services involving administration, engineering, surveying, inspection, and materials sampling and testing on road and bridge construction projects. The services of these firms have been used to augment the services of our permanent region personnel.

Each region has the authority and responsibility to select the needed consultants and negotiate contacts between WisDOT and the selected consulting engineering firms. Coordination and direction is provided by consultant services section.

Consultant personnel need to represent the department in the same competent, positive manner as WisDOT employees when meeting with contractors, utilities, general public, news media, public agencies, and local officials. They are expected to administer, engineer, survey, inspect, sample, test, and report by the same standards and with the same competency as department personnel.

The standard consultant contract contains the provisions, except when deleted by special provision, that the consultant will be evaluated by the department at a closeout conference before completion of the consultant contract. The supervisor and engineer are to be present at the evaluation. Both parties may designate additional representatives.

Information on consultant selection and contract provisions, negotiations, & format is in FDM Chapter 8.

See CMM 110.5.7 for a discussion of procurement from a project management perspective.

When consultants are contracted to provide construction-engineering services on WisDOT projects, the role of the project manager or on these projects is slightly different compared to projects that are staffed by department employees.

On both occasions the project manager provides oversight to ensure the project is built successfully. The project manager will also be called upon from time to time to resolve disputes between the contractor and the engineer.

The big difference between the two situations is that on a project with department employees the relationship between the project manager and field staff is an employee-employer relationship; on a consultant project the relationship between the project manager and consultant engineer is contractual.

Theoretically a consultant project should require less WisDOT oversight than a DOT staffed project because of less employee-employer supervision. Supervision of consultant employees is the responsibility of the consulting firm when consultant staff is used.

When deciding how much time should be spent on a consultant project the following factors should be taken into consideration:

1. The experience of the field staff.
2. The contractor.
3. The level of risk.
4. The level of controversy.
5. The level of inconvenience to the public.
6. Complexity of project.

These factors must be weighed in determining the number of times a project should be visited by the project manager. For instance, it may be appropriate to visit a town road bridge project on only one or two occasions during the life of the project, while an urban reconstruction project may warrant more visits.

Project managers should take advantage of current technologies such as mobile devices, teleconferencing, web conferencing, the AASHTOWare Project Construction and Materials® application, the Construction Contract Payment Viewing System (CCPVS), the contract log, the statewide Finals Tracking Report, etc. to reduce need for field visits.

Ideally, at least some of the visits should coincide with contractor operations that are deemed critical to be inspected. This ensures that the project manager is able to observe the consultant staff as they engage in inspection and contract administration activities. It is important that the level of supervision and number of site visits be carefully considered so that the project is adequately supervised, but not over-supervised as to unnecessarily raise the delivered cost of the project.

SECTION 218 Project Relationships and Communication

218.1 Authority of the Engineer

The term "engineer" as defined in the standard specs refers to the Secretary of the Department of Transportation or the secretary's authorized representative limited by the particular duties assigned to the representative. Of greater interest to project staff are the duties and responsibilities assigned to the engineer. While the specific duties and responsibilities may vary somewhat depending on the type of contract and region organization, the following general statements outline the engineer's role.

The statements also apply to negotiated agreements (local force accounts) where a municipality (county or other local unit of government) is performing the construction work on their own system. The term "contract" as used in this subject also applies to the negotiated "agreement", and the term "contractor" also applies to the municipality.

In general, the engineer is in "responsible charge" of the contract, which includes the field administration of the contract, control of the work, enforcement of the terms of the contract, and determination of the amount of work performed and materials furnished. These become the responsibilities of the engineer assigned to the project. Within the limits of the department's policies and control procedures and the approved program and policies of the region, the engineer is responsible for and has the delegated authority for obtaining work that fulfills requirements of the contract. The term project engineer as used in standard spec 105.7 is synonymous with the term engineer used in this manual.

The engineer may suspend the work wholly or in part for the contractor's failure to correct conditions unsafe for the project personnel or general public, for the contractor's failure to carry out provisions of the contract, or for the contractor's failure to carry out orders of the engineer.

The engineer is in charge of inspectors assigned to the project. Decisions regarding suspension of work, acceptance, or rejection of materials or work will be made by the engineer, or in some cases referred by the engineer to higher authority. Inspectors hired by third parties such as municipalities (counties or other local units of government) will also report to the engineer for decisions regarding work under the contract.

The engineer has the authority, under standard spec 108.4, to request, in writing, that the contractor remove from the project any employee who is intemperate, disorderly, or not sufficiently skilled.

218.2 Project Relationships

218.2.1 Contractor Supervision

Standard spec 105.5 requires the contractor to provide a competent superintendent or designated representative who has full authority to execute directions or instructions of the engineer without delay and to promptly supply all things needed to properly perform the work. The superintendent or designated representative of the contractor must be accessible to the engineer during all hours of each workday.

The engineer and inspectors must not act as foreperson, superintendent, or coordinator for the contractor. Instructions and suggestions concerning the work are to be given to the contractor, superintendent, or work supervision, but not to the workers. Any suggested changes are to be given solely for the benefit of the work and to be clearly differentiated from directions.

218.2.2 Cooperation Between Contractors

Standard spec 105.5 requires that contractors working on overlapping or adjacent contracts coordinate their operations so as not to interfere with the operation and progress of the other. They are further required to perform their work in proper sequence in relation to that of other work so that work may be accomplished in a timely and efficient manner.

Standard spec 105.5 also provides that in case of a dispute arising between two or more contractors engaged on the same improvement as to the respective rights of each under the specifications, the engineer will determine the matters at issue.

218.2.3 Project Staff and Contractor Relations

The contractor's goal is to acceptably perform and complete, at a profit, the work under contract with WisDOT. A municipality performing work under a negotiated agreement will not be making a profit on the agreement work. The goal of the department is to make certain that acceptable work is completed in accordance with contract terms, including the plan, specifications, and estimate.

To accomplish these goals there must be cooperation and understanding between the two parties. The contractor should expect to do what the contract requires, and the state should expect to pay for contract work done. The contractor should not expect to be paid for work that is done, but not required by the contract nor ordered by the engineer. The state should not require the contractor to provide more than the contract requires, unless the contractor is adequately compensated.

The conduct of relations with the contractor should be fair, courteous, and based on sound, reasoned judgment in compliance with specifications and policy. WisDOT decisions should be firmly conveyed to the contractor with clearly defined justification.

Good relations with the contractor should be promoted by advising, whenever possible, of unacceptable work while the operation is in progress, rather than waiting until the work is completed and then requiring its removal or a pay reduction.

The engineer and staff do not manage the contractor's operations. They are to give instructions about the work to the contractor or to the contractor's superintendent. Instructions are not to be given directly to the contractor's workers or the subcontractors except in emergency situations where safety is involved. Suggestions can be given if requested by the contractor. The prime or general contractor is responsible for coordinating the efforts of various subcontractors.

Project staff are not to make derogatory remarks about the organization, personnel, equipment, or methods of the contractor or subcontractors. Project staff are not to place themselves under obligation to the contractor by accepting gifts or services. Excessive fraternization with the contractor and contractor's personnel should be avoided.

Project staff should fulfill any reasonable request of the contractor that will allow accomplishment of work in accordance with the contract provisions and without delay but are not to perform tasks that are the responsibility of the contractor or subcontractors.

218.2.4 Project Personnel Relations

The engineer is responsible for administrative matters involving employees assigned to the project. To accomplish this duty, the engineer should have available current department and region policies concerning expenses, time changes, overtime, ethics, accident reporting, and similar subjects, and become familiar with contents of the policies. The engineer also should have on hand current agreements between the state and unions and associations representing project personnel and should become familiar with their provisions. The engineer should keep personnel informed of policy changes that may affect them.

Construction administration personnel assigned to the project are responsible to the engineer in the fulfillment of their duties. The engineer may delegate to assistant's authority as deemed necessary for the proper performance of their work but cannot relinquish overall responsibility. The other construction administration personnel assigned to the project are subordinate to the engineer, are subject to the engineer's directions, and are expected to cooperate in the best interests of the project.

Before the start of an employee's work assignment, the engineer will brief the employee on duties, responsibilities, job relationship with other construction administration personnel, pertinent region and department policies, and status of project construction.

218.2.5 FHWA and Other Federal and State Agency Relations

Federal-aid highway improvement projects are administered by the department based on a State-Federal agreement, even though there may be no state funds in the projects, only local and federal monies.

The FHWA has the responsibility to monitor projects constructed with federal aid highway funds for compliance with Federal aid requirements. Consequently, FHWA representatives may be in the region office and on the project site at various times to determine if the project is being administered by the department in compliance with plans, specifications, and estimates and in compliance with Federal laws and regulations and state adopted policies and procedures.

Department personnel are expected to be courteous and to cooperate fully with FHWA representatives, answering questions about the construction operations and staff responsibilities, and provide full access to all records and reports.

It should be understood the FHWA will not interfere with, direct, or supervise the contractor's operations and personnel. Representatives of the FHWA are primarily on the project to review and assess the department's procedures and controls for ensuring that the work is being completed in reasonably close conformity with the plans and specifications, and to evaluate the overall quality of construction.

It should also be understood the FHWA representatives do not have the authority to issue instructions to employees of the department or to employees or private consulting firms retained by WisDOT. These instructions are issued either by the engineer or supervisor.

During their review, FHWA representatives may also be reviewing and reporting on conditions that are pertinent to pending change orders. Other anticipated changes from the construction plan and contract should be brought to their attention by the engineer so the change orders may be expedited should it be necessary to submit them to the FHWA for approval.

Following completion of the project review, FHWA will send a copy of their written findings to the Bureau of Project Development and region office for information and for follow-up action when warranted.

Other Federal and State agency representatives may also be on the project at various times because of an interest in the construction. WisDOT personnel are to answer questions to the best of their ability and knowledge and to treat the visitors with courtesy. Personnel should be aware these persons do not have the authority to issue instructions and orders to the contractors, WisDOT employees, or employees of private consulting firms retained by WisDOT. These instructions are issued either by the engineer or supervisor.

The engineer or designated representative should accompany FHWA and other agency representatives during their visit to explain the work operations and work schedule, answer questions, and ensure the safety of the visitors from injury by construction machinery and activity.

Suggestions that may be offered by visitors should be accepted with the explanation that action cannot be taken until a decision based on facts is made by the engineer or the region office.

218.3 Project Communication

Please refer to CMM 110.5.4 - Communication Management and CMM 110.5.5 - Stakeholder Management for a discussion of communication from a project management perspective.

218.3.1 Project Progress Meetings

The engineer should hold regular progress meetings with project staff, the prime contractor superintendent, and subcontractors on WisDOT projects. The purpose of the progress meeting is to raise issues and bring them to resolution. The regular meetings provide a forum to:

- Review construction progress and future work activities
- Identify potential delays as early as possible for mitigation planning
- Raise issues and bring them to resolution
- Make subsequent action assignments when appropriate

Progress meetings will be conducted weekly on typical projects. However, there may be select noncomplex, low-cost projects where weekly meetings may not be necessary. The intent is that these meetings be kept as brief as possible to minimize demands on attendees and enable prompt distribution of notes.

218.3.1.1 Agenda

Normally the engineer is responsible for establishing the agenda and it should be distributed to attendees ahead of time as it forms the basic meeting outline. A weekly progress meeting agenda form is available in Pantry. Figure 218-1 is a copy of the weekly progress meeting agenda and shows a comprehensive list of agenda items for the meeting. The list is meant to provide a starting point for typical projects - some items may not need to be covered. However, it was developed to encourage discussion on items that routinely can become larger issues if left unaddressed.

218.3.1.2 Meeting Notes

WS1050 Progress Meeting Notes provides the engineer with a template for meeting notes. It's important to develop concise notes to document the discussions held. Notes should be concise, summarize the discussion topics, and only contain the details required follow-up on action items. Generally, the engineer or a designated recorder is responsible for the preparation of the meeting notes.

Recording of the meeting notes can take many formats. It is more important to capture items such as the meeting date and time, attendees, summary of issues discussed, actions to be taken, and action assignments made than to follow a prescribed meeting format. Some engineers prefer to simply add discussion summaries to the published agenda. Others have other styles they prefer. A brief description of the discussion is recorded, and it is noted if this is a new, old, or closed issue.

218.3.1.3 Action Assignments

If subsequent action assignments are made they must be documented in the published notes and followed up on as part of old business at each meeting to verify closure of item. Action assignments are given a due date and the responsible party "Ball-In-Court" person is identified by their initials. An item may carry over for several meetings and then a letter designation is added to the pre-assigned numerical number as updates are made so progress of resolution of an item can be tracked. "Closed" items are then dropped from the published notes so as to not add unnecessarily to the length of the notes. This note taking format has proven useful in building the next meeting agenda, tracking the progress on an issue, and identifying action assignments.

FIGURE 218-1 Progress Meeting Agenda Items

Weekly Progress Meeting Agenda

1. Review Previous Meeting Notes
    a. Outstanding issues
2. Contractor's Schedule
    a. Schedule update
    b. Work in progress
        i. Prime contractor
        ii. Subcontractors
    c. Controlling items of work
    d. Delays
        i. Controlling item
        ii. Non-controlling items
    e. Contract time
3. Utilities / railroads
4. Maintenance of traffic
    a. Lane closure system (LCS) issues
    b. Modification to traffic control
    c. Maintenance of traffic control
        i. Device condition
        ii. Device location
5. Materials
    a. Certification / test report submittals
    b. QMP testing; non-QMP testing
    c. Non-conforming materials
    d. Up-coming testing and materials submittals
6. Environmental
    a. Erosion control
    b. Weekly erosion control inspections / work orders
    c. ECIP revisions
7. Request for information (RFIs)
    a. Status of outstanding RFIs
    b. Upcoming RFIs
8. Change orders (change orders)
    a. Status of contractor information for pending change orders (pricing info)
    b. Status of pending change orders (contractor signature & department signature)
    c. New issues / concerns
9. Progress estimates
    a. Completed items
    b. Quantities for payment
    c. Finals process
10. Safety
    a. Work site safety
    b. Work zone safety
    c. Accidents / emergency incidents
11. Public relations
    a. Property owners / businesses

b. Local officials

12.EEO / Prevailing wage issues

a. Prompt payment (ASP - 4)

b. Payroll issues

i. Missing

ii. Underpayment of wages

iii. ASP - 7

c. Wage claims

13.DBE Commitment status

a. Contractor on track to meet DBE goals? Yes/No

b. Engineer must keep DBE office informed.

14.New issues / concerns; other items

15.Next meeting (if not regularly scheduled)

16.Action items / assignments

a. Contractor

b. Department

Meeting minutes will be distributed to the prime contractor and other attendees, as requested.

Hard copies will be available at the next meeting.

218.3.2 Request for Information (RFI)

218.3.2.1 Purpose

The purpose of a request for information (RFI) is to obtain clarification of the plans, specifications, special provisions, or other contract documents, with the intent of avoiding contract disputes and claims. RFIs provide a systematic collection of the analysis and resolution of questions that arise during the construction of the project. RFIs should not be construed to be a request for change order or to change any requirement of the contract documents.

The engineer and contractor work together to ensure that RFIs are appropriate and to control the number of RFIs. Contract documents should be reviewed first and if a question can be answered through research and clarification, do so and follow up with a conversation record in the daily diary.

218.3.2.2 Submittal

The contractor typically initiates the development of an RFI, however, either the contractor or department can submit an RFI for clarification of an issue.

Although subcontractors may initiate issues that lead to an RFI, they should not submit RFIs directly to the department. Subcontractors should submit the RFI to the prime contractor, who will then forward the issue to the department.

The contractor notifies the engineer of an RFI using DT2502. The contractor must clearly and concisely describe the issue for which clarification or interpretation is sought and why a response is needed. Appropriate references to specifications, plans, or drawings facilitate a timely response.

218.3.2.3 Response

The engineer is responsible to monitor, track, and expedite the response to an RFI. Responses should be provided on a timely basis so as to not impact the construction schedule. The desired response time should be indicated on the RFI submittal form to indicate the urgency of the question.

It's understood that RFIs by nature are time-sensitive, and that the responding party should make significant effort to produce a response as soon as possible. If the responding party requires a longer time than requested by the requesting party, the responding party must communicate that fact in writing, and let the requesting party know how long it will take to produce a response.

If the requesting party is not satisfied with the answer provided, they can re-submit the request as a new RFI with the short description "resubmittal."

218.3.2.4 Administration

The engineer will sequentially number the RFI and log it in DT2501. The engineer processes the RFI and coordinates the response by consulting with others as needed (e.g. project manager, designer, technical services expert, oversight engineer, etc.).

The engineer forwards one copy to the RFI requester, and files one copy in the on-site file for reference. The engineer maintains the RFI Log for tracking the status of an RFI and for a catalog of RFIs submitted on the project.

218.3.2.5 Resolution

The engineer and contractor's superintendent should discuss outstanding RFIs and potential RFI's as a standing agenda item at the project progress meetings. If there are disagreements regarding the response to an RFI, the project manager should immediately get involved to begin resolving the issue.

SECTION 219 Construction Services by Local Units of Government

In some instances, the department may negotiate with a local unit of government for field services involving administration, engineering, surveying, inspection, and materials sampling and testing on let road and bridge construction projects on the local system of highways. Local unit staff would perform duties of project engineer (as defined in standard spec 105.7) and inspector (as defined in standard spec 105.8).

Local unit personnel are expected to represent the department in the same competent and positive manner, as would WisDOT employees when meeting with the contractor, utilities, general public, news media, and public agencies. They are expected to administrate, engineer, survey, inspect, sample, test, and report under the same standards and to the same degree of competency as department personnel.

219.1 Prequalification

To provide construction engineering services on let projects on the local highway system, the local unit of government is required to be "adequately staffed and suitably equipped". The local unit must submit DT2060, Prequalification - Local Unit Performing Construction Engineering for consideration by the department to ensure that a local unit has capable staff and needed equipment to perform construction-engineering services. This form can be obtained from the Bureau of Project Development - Local Project Delivery Section.

The presence of qualified individuals will determine if a local unit is qualified to perform construction-engineering services. This would be documented on DT2060.

To perform construction engineering, the local unit must have at least one staff person that is registered as a professional engineer. Holding a current Certificate of Authorization to practice professional engineering in the state of Wisconsin (s.s. 443.08) is evidence of professional engineering registration.

Once prequalified to provide construction-engineering services, a local unit would indicate their desire to provide those services on a project by submitting a "Letter of Interest". That letter would state their desire to provide the services, discuss the staff available for the project, detail the staff's experience in providing construction-engineering services, estimate the time each of the staff would be needed, and request approval to provide the services.

WisDOT would review the "Letter of Interest" to be sure the correct number of staff are used, that the staff are available for the correct time, and that the staff are qualified for construction engineering services. If these elements are in order, the local unit would be authorized to provide the construction engineering services.

Requests by the local unit to provide construction engineering services for let projects in calendar year 2009 and beyond must meet the following requirements:

- The local unit must fill out and submit DT2060 with appropriate attachments.
- BPD Local Project staff will review the completed DT2060 and either approve it or request additional information.
- The department review of the DT2060 is expected to take less than 45 days.
- The Local Project Delivery Section will notify the local unit after final prequalification approval.
- Prequalification approval is good for three years from the date of approval.
- If conditions change that would eliminate or reduce the prequalification status, the local unit must immediately notify WisDOT so that the prequalification can be re-evaluated.
- A local unit must be prequalified to provide construction engineering services before to submitting a Letter of Interest to WisDOT.

219.2 Role of Project Manager

When local units are approved to provide construction engineering services on WisDOT-let projects, the role of the department project manager on these projects is slightly different compared to projects that are staffed by department employees. The responsibility of the department project manager is as defined in standard spec 105.1.

On both occasions the department project manager provides oversight to ensure the project is being built successfully. The project manager will also be called upon from time to time to resolve disputes between the contractor and the local unit engineer.

The big difference between the two situations is that on a project with department employees the relationship between the project manager and the field staff is an employee-employer relationship; on a local unit project the relationship between the project manager and local unit engineer is purely contractual.

Theoretically a local unit project should require less WisDOT oversight than a DOT staffed project because of less employee-employer supervision. Supervision of local unit employees is the responsibility of the local unit of government when local unit staff is used.

When deciding how much time should be spent on a local unit project the following factors should be taken into consideration:

1. The experience of the field staff
2. The contractor
3. The level of risk
4. The level of controversy
5. The level of inconvenience to the public
6. Complexity of project

These factors must be weighed in determining the number of times a project should be visited by the department project manager. For instance, it may be appropriate to visit a town road bridge project on only one or two occasions during the life of the project, while an urban reconstruction project may warrant more visits.

Department project managers should take advantage of current technologies such as mobile devices, teleconferencing, web conferencing, etc. to reduce need for field visits.

Ideally, at least some of the visits should coincide with contractor operations that are deemed critical to be inspected. This ensures that the department project manager can observe the local unit staff as they engage in inspection and contract administration activities. It is important that the level of supervision and number of site visits be carefully considered so that the project is adequately supervised, but not over-supervised as to unnecessarily raise the delivered cost of the project.

The department project manager will be responsible for evaluating the local unit staff performance like the evaluation done for consultants performing construction engineering, as discussed in FDM 8-25-5.

SECTION 220 Public Relations

220.1 General

The image created by WisDOT as a competent public service organization depends on the conduct of its employees as well as the quality of their work. Department employees are encouraged to answer, within their area of competency, questions from the general public and news media. The employee is responsible for the factual accuracy of information and for interpretation of state or departmental policy.

The relationship between WisDOT and the public is viewed in the context that WisDOT is a business providing a service, and the public is the customer who pays for that service.

Questions and criticisms concerning road and bridge construction are to be answered with courtesy and tact. Reasons for the improvement should be carefully and fully explained, and questions about the work should be answered, if possible. Those beyond the employee's knowledge or authority should be referred to the employee's supervisor.

An employee should not discuss the following confidential subjects with anyone:

1. Financial information requested from contractors, consultants, and minority business enterprises.
2. Construction estimates.
3. Real estate appraisals, price submittals, negotiation diaries, and administrative settlements associated with real estate acquisition.
4. Consultant contract negotiation files.
5. Appraisals of excess property offered for sale.
6. Data pertaining to matters in litigation.
7. Employee assistance files.
8. Employee social security numbers.
9. References concerning employees or prospective employees if the person providing the reference asks that it be kept confidential.

Department employees are encouraged to participate in informational activities contributing to a better understanding of state government and department programs. The text of speeches and written articles should be reviewed and approved by the employee's supervisor.

WisDOT policy allows the public and media access to most information on file in the department. Formal meetings of state agencies and advisory committees are open to the public and to the media, except where exempted by Wisconsin statute 19.85.

A copy of the minutes of meetings at which controversial subjects are discussed with the general public should be promptly sent to region construction and the Bureau of Project Development for their information.

State employees are not to endorse any proprietary method, process, product, material, machine, or item of equipment.

Please refer to CMM 110.5.4 - Communication Management and CMM 110.5.5 - Stakeholder Management for a discussion of communication from a project management perspective.

220.2 Traveling Public, Abutting Property Owners, Businesses, and Area Residents

220.2.1 General

Road and bridge construction can cause major changes in travel patterns and have significant impact upon these groups. Before work is started, they should be informed about the nature of the construction and its effects, such as road closures and detours, so they have the opportunity to plan alternate routes and schedules. A public meeting at which the contractor can present the work operations and proposed schedule should be held to answer questions and concerns of these groups. The meeting also provides an opportunity to identify the engineer and contractor.

The department recognizes how important it is that customers have access to businesses, regardless of any roadwork inconvenience. The website called "In This Together" is provided in the WisDOT Design and Construction pages to help business and community leaders prepare for local road construction.

https://wisconsindot.gov/Pages/projects/in-together/default.aspx

The site includes a workbook and case studies detailing successes in past roadway projects. Engineers may want to give this web address to local residents as they attend preconstruction public information meetings. Smaller meetings with residential and business owners should be considered in order to discuss specific topics, such as prior right of way agreements.

During the life of the project, the engineer should personally contact all businesses, property owners, and residents along the project route. A project extending over two seasons or affecting a great number of

people may warrant assigning an employee solely to public relations. Concerns expressed at these contacts should be addressed promptly and the result reported back to the person having the concern. The contractor should be informed of the disposition of concerns that may impact operations.

Partial or complete loss of access even for brief periods can be critical to businesses and an inconvenience for residents. Reasonably direct, safe, all-weather, 24-hour access should be provided whenever possible to homes and businesses along the project. If that is not possible, action should be taken to shorten the time that access is lost, or to develop an alternate route. Changes in access must be explained well in advance to each affected party.

Construction work zone signing should clearly inform the road user of the advisory speed and safety hazards to be encountered, be well maintained, and be removed from sight when work is not in progress. Flaggers should be used liberally and be well trained and equipped for their task.

Steps must be taken to minimize noise, smoke, and dust resulting from construction work operations.

Businesses and residents should be informed of significant changes in the nature of the work or in the schedule before they occur. Consider conducting periodic meetings to keep everyone informed.

220.2.2 Local Services

Many services such as mail-delivery, school buses, police, fire, and medical protection will require special attention. People in charge of these services should be informed well in advance of the construction. Arrangements should be made to provide access across or through the project. When access is not possible, a detour route should be developed for continuation of vital services, with maps showing the detour distributed to these service groups.

The contractor must provide an advance warning of twenty-four hours to the fire and police departments before blocking off a road.

220.3 News Media

220.3.1 General

Good relations with the news media are a great help in establishing and maintaining good public relations. Local reporters are usually well known to residents in the area and can have a significant influence on attitudes of local road users, business owners, and residents along the project route.

An atmosphere of mutual confidence between the department and the news media should be developed so the media feels confident the information given to them is correct and complete. Media reporters typically work quickly, seeking information for broadcast or publication within a few hours. Media inquiries, therefore, should be answered promptly.

The media should be informed early about the nature of the project work and the proposed scheduling. Invite the media to public meetings and consider a media tour of the project. Supply them with maps and current information about schedules, alternate routes, and major construction details. News releases written by the communications manager should be distributed at milestones such as changes in traffic patterns or detours.

Information should be presented to the media in an easily understandable form with technical terms held to a minimum. Remarks should be confined to factual statements. Personnel should not offer personal comments about department policies, supervisors, co-workers, subcontractors, or the contractor, and should politely turn aside questions on those subjects.

220.3.2 Public Communications Records

Department personnel may answer, within their area of competency, questions from the media relating to the project or the program under which it is being constructed. Contacts with the media should be reported via the Public Communications Record (PCR) as outlined in TAM 15. Staff should work with the region communications manager (RCM) or project communications manager (PCM) when handling media responses or completing PCRs. The project manager or the RCM/PCM will e-mail the PCR to the PCR distribution list at "DOT DL PCR (Core Distribution List)" and other appropriate personnel in the region and central office. The PCR template, TAM 15, and more detailed information on the PCR are available to department staff at:

https://wigov.sharepoint.com/sites/dot/Pages/Organization/opa.aspx

220.3.3 Consultant Staff

Occasionally members of consultant staff speak with the media about project-related issues. If consultant employees interact with the media, the overseeing state staff should be immediately informed of the contact. State staff will then determine if a PCR needs to be filled out and forwarded. If correspondence about local project issues needs to be written in a letter, the consultant must use either their company letterhead, or that of the local municipality they are representing.

Additional public information guidelines for consultants, including specific guidance related to local program projects, is available on the Web at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/pub-involve/default.aspx

220.3.4 Local Governmental Officials

Department involvement in local road and bridge projects occurs because local projects financed in part with federal or state funds must be directly administered by WisDOT in accordance with existing agreements.

The engineer should make the acquaintance of the local officials before construction starts and inform them of plan details and the schedule of operations. Invite them to the preconstruction conference. During construction, keep them informed of any changes that could impact them positively or adversely.

Both local governmental and elected officials are rightfully interested in the progress of the project and can be expected to be on the job site from time-to-time as observers. Whenever a local official visits the project, be courteous and answer questions in sufficient detail. Suggestions should be accepted, but with the explanation that action cannot be taken until facts of the situation are gathered. A decision will be made by the engineer, or by the region office, whether to accept or reject the suggestion.

The engineer or representative should accompany local officials during their visits, in order to explain the work operations and work schedule, answer questions, and ensure the safety of the visitors. Contractor involvement in these visits is encouraged.

SECTION 222 Notice to Proceed

222.1 General

The notice to proceed authorizes the prime contractor to proceed with work in the agreement. Authorization to proceed with acquisition of materials is often given to the contractor at the time the contract is sent to them for signature, by the Bureau of Project Development (BPD). The need for lead-time by the contractor should also be considered by the region in notifying them to proceed with construction.

Contract management and the contract work starts with the issuance of the notice to proceed, which occurs after the contract is executed by BPD. The notice to proceed should include the name of the region contact person, the expected schedule for construction, and the traffic control arrangement. See figure 222-1 for an example of a notice to proceed letter.

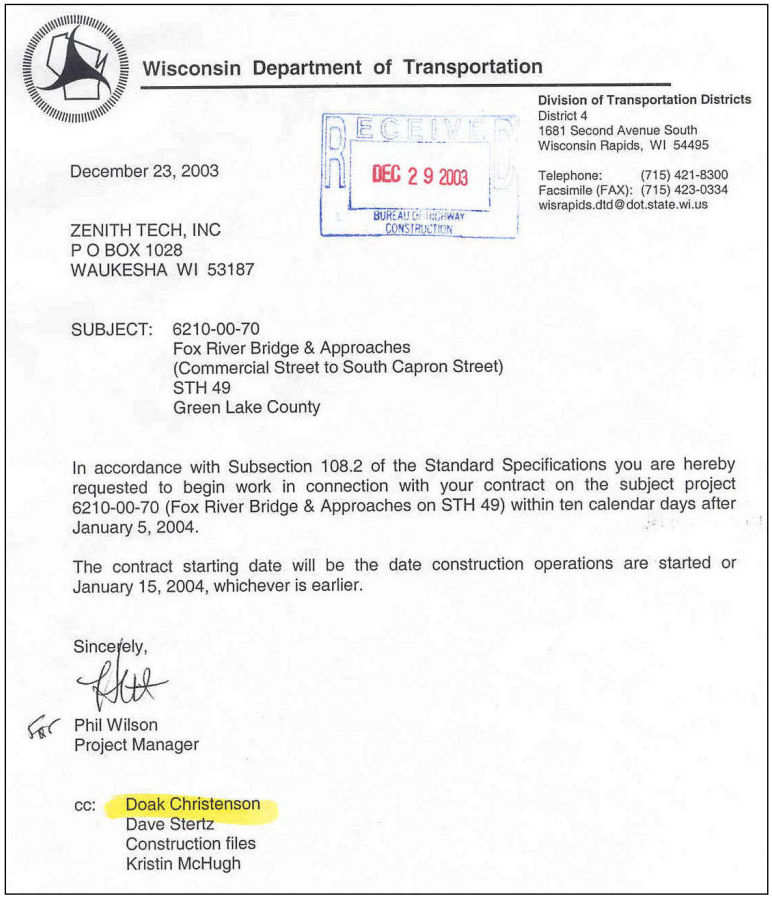
A notice to proceed should never be issued by the region before the execution of a contract by the BPD. The contract starting date is defined as 10 days after the date of written notification from the engineer. The contract starting date will be the date construction operations are started or the tenth calendar day following the date of notification, whichever is earlier. The contractor should notify the engineer at least three days before starting or resuming work. The contractor should notify the engineer at least one day before changing the project schedule.

A notice to proceed is needed for all working day, calendar day, and completion date contracts. No work or activity should begin or resume before receiving a notice to proceed. The contractor should not begin work on any activity at the project site until after the preconstruction conference; however, the engineer may make exceptions if needed. See standard spec 108.3 for further guidance.

222.2 Railroad Insurance Restriction

For projects requiring insurance in the name of a railroad, see standard spec 107.17.3 for further guidance.

FIGURE 222-1 Example of a Notice to Proceed Letter



Wisconsin Department of Transportation

Division of Transportation Districts
District 4
1681 Second Avenue South
Wisconsin Rapids, WI 54495

Telephone: (715) 421-8300
Facsimile (FAX): (715) 423-0334
wisrapids.dtd@dot.state.wi.us

RECEIVED
DEC 29 2003
BUREAU OF HIGHWAY CONSTRUCTION

December 23, 2003

ZENITH TECH, INC
P O BOX 1028
WAUKESHA WI 53187

SUBJECT: 6210-00-70
Fox River Bridge & Approaches
(Commercial Street to South Capron Street)
STH 49
Green Lake County

In accordance with Subsection 108.2 of the Standard Specifications you are hereby requested to begin work in connection with your contract on the subject project 6210-00-70 (Fox River Bridge & Approaches on STH 49) within ten calendar days after January 5, 2004.

The contract starting date will be the date construction operations are started or January 15, 2004, whichever is earlier.

Sincerely,

Phil Wilson
Project Manager

cc: Doak Christenson
Dave Stertz
Construction files
Kristin McHugh

SECTION 224 Labor Compliance

224.1 Labor Compliance Background

Contracts let to bid and entered into by the department for the construction of highways contain provisions governing the employment and payment of persons hired by contractors, subcontractors, and suppliers to perform the contract work. They are discussed in the following subsections.

224.1.1 Required Contract Provisions - Federal Aid Construction Contracts

These are required only in contracts with federal funding.

224.1.1.1 FHWA-1273 Part 1 - General

Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23. The contractor or sub-contractor must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts.

224.1.1.2 Part II - Nondiscrimination and Part III Non-Segregated Facilities

Nondiscrimination requires goals and timetables for minority and female participation to be stated in the contract. In addition, the contractor must not discriminate against any employee or application for employment because of race, religion, sex, color, national origin, age or disability. The contractor is required to do the following:

- Take affirmative action to ensure equal employment opportunity.
- Will designate and make known to the contracting officers and EEO office.
- Will disseminate the contractor's EEO policy to staff who are authorized to hire, supervise, promote and discharge employees.
- When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer."
- Wages, working conditions, and employee benefits must be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, must be taken without regard to race, color, religion, sex, national origin, age or disability.
- Will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees.
- If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women.
- Must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under.
- Must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result.

224.1.1.3 FHWA 1273 Part IV - Davis-Bacon and related Act Provisions

Minimum wages

Laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are allowed by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked.

Payroll and basic records

Payrolls and basic records relating thereto shall be maintained by the contractor during the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in

the applicable programs. The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract.

Apprentices and trainees

Apprentices will be allowed to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program.

Except as provided in 29 CFR 5.16, trainees will not be allowed to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

224.1.2 Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity

This notice lists, by county, the goals for minority group and female participation for each construction trade (Executive Order 11246).

224.1.3 Federal Wage Decision

A schedule of minimum prevailing wages for the county in which the work will be done is included in the contract. Issued by the United States Department of Labor (US DOL). **WI 10** wages are inserted in every contract with federal funding (applies to all work except work over a navigable waterway). **WI 15** wages are inserted into a contract if there is a bridge or structure located over a navigable waterway as defined by USDOL and the US Coast Guard (applies to all work occurring on the bridge/structure from bank to bank). **WI 08** wages are inserted into a contract if it contains sewer work that is over 20% of the contract amount. Building wages (**WI XX**-by county) are added when there is a building in the contract, for example a salt shed or bridge tender house. Wage determinations included in the contract remain in effect for the life of the contract. Contractors are responsible for determining the appropriate crafts necessary to perform the contract work. If a classification considered necessary for performance of the work is missing from the WD, the contractor must initiate a request for approval for a proposed wage and benefit rate by preparing an SF-1444, Request for Authorization of Additional Classification and Rate, for the unlisted craft. (Reference Title 29 CFR Part 5, Section 5.5(a)(1)(ii) and FAR 22.406-3).

224.1.3.1 Overtime

Overtime will be paid for all hours worked over 40 per week, at a rate not less than 1.5 times the basic rate of pay.

224.1.4 WisDOT Supplemental Required Contact Provisions

These are required for all contracts administered by WisDOT.

224.1.4.1 ASP9-S (State-Funded Only Projects)

WisDOT must report labor data to other agencies, Wisconsin's Native American Tribes, and various stakeholders. Labor data will be collected through labor reports in the Civil Rights Compliance System (CRCS).

https://wisconsindot.gov/hccidocs/contracting-info/asp-9.pdf

224.2 Native American Hiring Provision (NAHP)

Contractors need to follow the meeting set up and reporting provisions found in the contract Native American Hiring Provision (NAHP) special provision. Regional tribal liaisons, labor compliance specialists, and WisDOT's Tribal Affairs staff can help field staff implement and monitor compliance.

224.3 Trucking

Prevailing wages are required for:

1. Hauls from a dedicated AND virtually adjacent source (round trip). Borrow pit, stockpile site, concrete or asphalt batch plant source, etc., that has NOT been open and making sales of that material to the general public within the previous twelve months of the day the project was let to contract (bid opening date - not awarded), AND adjacent or virtually adjacent to the site of the work. Generally, WisDOT will consider any borrow pit, stockpile site, concrete or asphalt batch plant source whose boundary is located a half mile or less (as the crow flies) of the closest right of way boundary or termini to the project as adjacent or virtually adjacent.
2. Hauling materials or supplies from one location on the site of work to another location on the site of work. Entire haul is covered when hauling material from any point or place within the project limits to any other point or place within the project limits regardless of de minimis. Truck drivers who haul materials or supplies from one location on the site of the work to another location on the site of the work are "mechanics and laborers employed directly upon the site of the work," and therefore, entitled to prevailing wages.

3. Time spent loading/unloading materials on the site of work if such time is more than de minimis. There is no commonly accepted percentage of time used to determine de minimis. WisDOT will not determine or approve a percentage. In determining whether a truck driver's time spent on the site of the work is more than de minimis, USDOL recommends basing the percent of time spent on the site of the work on all of the hours the truck driver works in any given workweek rather than the truck driver's daily hours.
4. Excavated material or spoil hauled to a site indicated in contract (round trip). That location becomes part of the site of work and hauling material or spoil to that location would be prevailing wage, round trip.

224.4 Posting Requirements

The following material is furnished to the contractor for posting in at least one conspicuous place on the project accessible to both workers on the project and the public. The contractor is required to do the posting. The engineer will check that the contractor erects and maintains the proper postings on display and in good condition at all times during the performance of the contract work. Refer to the following for a listing of required document postings.

224.4.1 Posting Required for ALL Wisconsin DOT Projects (regardless of funding)

The postings listed are required for all WisDOT Projects regardless of funding:

- Front page of proposal with prime contractor listed (distributed by labor compliance specialist at precon)
- Contractor's EEO policy statement including name/signature of EEO officer and date signed
- Contractor's letter appointing EEO officer to the project signed by company CEO/President
- Construction Project Contact List (Emergency/Contact Phone Numbers)
- Employee Rights Employee Polygraph Protection Act (WH1462 REV 07/16
- Employee Rights Under the Fair Labor Standards Act (WH1088 REV 07/16)
- Employee Rights Under the Family Medical Leave Act (WH1420 REV 04/16) Prior version okay.
- Equal Employment Opportunity IS THE LAW" [EEOC-P/E-1 (Revised 11/09)]
- "EEO is the Law" Poster Supplement
- La Igualdad de Oportunidades en el Empleo es LA LEY (EEOC-P/E-1 (Revised 11/09))
- Suplemen to del document "IOE es La Ley"
- Job Safety and Health: IT'S THE LAW! (OSHA 3165-04R 2015) 8.5x14 Previous version okay.
- Notice to Employees About Applying for Wisconsin Unemployment Benefits [(UCB-7-P (R. 10/2017)]
- Pay Transparency Nondiscrimination Provision (undated) (OFCCP 12/2016) Either format acceptable.
- Wisconsin Department of Transportation Notice of Title VI and ADA Compliance (8/1/2017)
- Wisconsin Department of Transportation Notification Del Titulo VI Y Cumplimiento De La Ada (8/1/2017)
- Wisconsin Fair Employment Law [(ERD-4531-P (R.05/2014)]
- Wisconsin Family Medical Leave Act [ERD-7983-P (R-06/2014)]

224.4.2 Posting Required for Federal Aid Projects

The postings listed above in CMM 224.4.1 plus the item(s) listed below must be posted on federal aid projects.

- NOTICE - The highway construction under way at this location… [FHWA Form 1022 (Revised May2015)]

224.4.3 Posting Applicable to Projects with Federal Davis-Bacon Act

The postings listed are applicable to projects with Federal Davis-Bacon Act funding:

- Contract Wage Rates (US DOL, all pages - correct county/counties)
- Employee Rights Under the Davis-Bacon Act [WH 1321 Revised April 2009)]
- Derechos Del Empleado Bajo la Ley Davis-Bacon [(WH 1321 SPA (Revised April 2009)]

224.5 Enforcement of Contract Labor Provisions

224.5.1 General

The department is responsible for enforcement of the contract labor provisions to the same extent as any of the other contract requirements. The region labor compliance specialist will assist engineers with the detailed enforcement duties connected with contract labor provisions.

The enforcement duties are to be carried out on the same basis for state funded construction contracts and for federal aid contracts. Frequent reference should be made for guidance to the U.S. Department of Labor's Field Operations Handbook.

Project personnel should inform the contractor that the contractor's Equal Opportunity program may be selected for a compliance review by either state or federal personnel. If the project is selected for review, the contractor will be asked to verify that contract requirements are complied with. The engineer or other personnel may be asked for corroborating observations or statistics at these interviews.

224.5.2 Detailed Enforcement Procedures

The region labor compliance specialist will:

1. Make systematic spot interviews with laborers and mechanics engaged in contract work. Record their name, classification, wage rate, and employer's name.
2. Observe the type of work being performed.
3. Conduct sufficient interviews to ensure the rates being paid are not less than contract minimum rates for the work being performed.
4. Determine if the contractor's method of timekeeping ensures proper payment of workers and if not, suggest changes that will ensure proper payment.
5. Ascertain employee's paydays and examine some individual paychecks to determine if they conform to the employee's version of work performed and hours worked. Keep a record of these examinations.
6. When questionable practices are discovered, or complaints are received, try to have the matter adjusted through contacts with the contractor's office or job personnel.
7. When it appears violations may be taking place, make an examination of time cards, payrolls and other employment records as appropriate to establish the facts. Once there is evidence of a violation, the prime contractor will be notified and will be expected to ensure compliance.
8. If a question of the applicability of labor provisions to various construction activities arises, refer to the U.S. Department of Labor's Field Operations Handbook Davis-Bacon Resource Book, the WisDOT EEO/Labor Compliance Manual or consult with Central Office bureau of project development.
9. Advise the Chief, Labor Compliance/EEO in Central Office of possible violations and furnish copies of correspondence with contractors.
10. Check each project for required postings and arrange to have deficiencies corrected.
11. Have the engineer spot check records for construction contracts to verify all classification of laborers and mechanics performing work on the contract are listed.
12. Spot-check available records for correctness of rates, fringe benefit payments, and improper deductions.
13. Keep a record of payroll and final employment statements submitted and advise contractors that timely submission is required. If a contractor is consistently tardy with these submissions, appropriate action should be taken.

224.5.3 Role of the Engineer

The project engineer should discuss suspected violations of the employment provisions first with the contractor, whether they involve workers or practices of the contractor, subcontractors, or suppliers. Complaints and confirmed violations are to be brought to the attention of the region, to consult with the region labor compliance specialist as appropriate. Matters relating to Disadvantaged Business Enterprises should be brought to the attention of OBOEC in Central Office by the region labor compliance specialist.

224.6 Weekly Payroll and Compliance Statement Reports

Contractors must use the Civil Rights Compliance System (CRCS) to produce and submit an electronic weekly payroll report to the regional oversight Labor Compliance Specialist for all physical work performed on all let federal aid contracts. A compliance statement form must accompany the contractor's weekly payroll statement. The Weekly Payroll Report, DT1929 and the Compliance Statement to Accompany Contractor's Weekly Payroll, DT1816. These forms must be submitted electronically by all tier contractors within seven calendar days following the close of the payroll period.

Payroll submission requirements are further detailed online through the Labor and wage compliance page on the WisDOT website at:

https://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/default.aspx

General information contained in ASP-9 can be found at:

https://wisconsindot.gov/hcciDocs/contracting-info/asp-9.pdf

Additional Special Provision 9 (ASP-9) that is in the contract should be reviewed by the contractor for contractual payroll submission requirements.

SECTION 226 Preconstruction Meeting

The preconstruction meeting is a vitally important meeting in which department personnel, consultants, and contractor's staff can become acquainted and begin the process of creating the team that will build the project. Some of the primary goals of the preconstruction meeting include:

- Establish lines of authority and communication
- Clarify responsibilities of contractor's personnel, department personnel, consultants, subcontractors, and suppliers
- Identify potential issues and the process for resolution
- Resolve potential sources of misunderstanding
- Plan and discuss detailed arrangements necessary for a successful project.

At an early date following the award and execution of the contract, the region will arrange the preconstruction meeting. Its purpose is to allow a general and open discussion between region personnel, the contractor, utility companies, railroads, and other invited parties. The engineer will lead the conference.

Topics of discussion will include the contractor's plan of operations, designated materials contacts, utility and railroad company plans for alterations, and the contract plan and specification requirements. Environmental commitments, permits, requirements, and erosion control measures will receive special attention and emphasis, and be reviewed in detail. Environmental permits that are issued will be compared to the contractor's plan of operations to determine that the operations are covered.

Chapter Trans. 401 requires that the contractor submit an ECIP to the appropriate region office of WisDOT and the appropriate DNR region office at least 14 days before the preconstruction conference, or at a time otherwise agreed upon by the department, DNR, and the prime contractor. The contractor ECIP is discussed in CMM 645.

Other topics may include the following:

- Project-specific materials testing guide and designated materials contacts.
- Coordination between the contractor, railroad, and utilities.
- Stages for completing the work.
- Anticipated traffic problems and traffic handling procedures.
- Planned inspection of the work.
- Employment requirements of the federal and state governments.
- Field office and laboratory requirements.

Representatives of the contractor, WisDOT, and the consultant, if applicable, should individually or jointly study the plans, environmental permits, and contract provisions before the conference. In addition, a field review of the project site with plan in hand is encouraged in order to check the fit of the plans to the terrain. Necessary steps to be taken to adjust the plan for side roads, private entrances, erosion control, drainage, etc., can then be discussed at the conference.

A written record of the conference will be made for the region file and will include names of attendees, topics, plans, problems discussed, and decisions made. A copy will be sent to attendees upon request.

Refer to figure 226-1 for general guidelines for arranging and holding the preconstruction meeting. WS1030 is available for regions and project leaders to tailor as necessary to document the discussion at the preconstruction meeting.

FIGURE 226-1 Holding a Preconstruction Conference

HOLDING A PRECONSTRUCTION CONFERENCE

1. Preparing for the conference.

A. Arrange meeting details.
- Date
- Time
- Room
- Agenda handouts
- Recording secretary
- Registration sheets
- WisDOT forms
- Exhibits, maps, etc.

B. Notify interested agencies and companies.
- Prime contractor and subcontractors
- Utilities
- Railroads
- County highway departments
- Local units of government
  - Municipalities
  - Townships
  - Fire and police departments
- Federal agencies - FHWA, others
- Regional planning agency
- Consultant (if applicable)
- Local associations, chamber of commerce
- State agencies
- DNR
- WisDOT
  - Region
    - Project manager
    - Engineer
    - Labor Compliance Coordinator
    - Other sections of units
  - Central Office
    - Oversight engineer
    - Specialists
  - WisDOT, Division of State Patrol

2. Directing the conference.

A. Register persons in attendance. Provide sign - up sheets and get important data.
- Name
- Agency or company
- Office address
- Office telephone
- Is a copy of the minutes wanted?

B. Distribute the agenda.

C. Appoint a recording secretary.
- Ask secretary to record person entering or leaving during the conference.
- Record the minutes.

D. Introduce attendees and direct the meeting.
- Summarize each major discussion.
- Excuse utilities and railroad after their portion of the conference is concluded, if they wish to leave.
- Announce the wage and labor compliance meeting will start after the main conference.

E. Direct the wage and labor compliance meeting.
- Introduce representative.
- Register attendees.
- Have minutes recorded.

F. Direct other meetings as required.

3. Following up.

A. Have the minutes and attendance sheets typed.

B. Distribute to:
- Attendees requesting a copy.
- Region file.
- Others who should be informed.

SECTION 228 Laws and Standards

228.1 General

Standard spec 107.1 requires that the contractor must at all times observe and comply with all federal and state laws, administrative rules, local laws, ordinances, and regulations that affect the conduct of the work in any manner. The contractor must also comply with all orders, decrees, bodies, or tribunals having jurisdiction or authority over the work. The contractor must pay attention to the possible existence of laws and regulations that may govern construction, both on and off highway right of way. Standard spec 107.3 requires the contractor to procure all permits and licenses and comply with their requirements whether the permit is issued to the contractor, the state, or the maintaining authority. These contractual provisions do not bind the regulatory authority (e.g. DNR, EPA) that will prosecute the department if the contractor acts outside a permit or fails to obtain required permits. As a general rule, laws, rules, ordinances, and regulations are not reiterated in the standard specifications or contract special provisions. Occasionally there will be a contract special provision or specification related to noise restrictions, night work, weekend work, DNR permits and requirements, Corps of Engineers requirements, or OSHA requirements. These have been included for good reasons that may or may not be apparent and should be considered exceptions. It remains the responsibility of the contractor to research laws or regulations governing the contractor's work, although the department should verify that it is done.

Standard spec 107.1 does not intend or require the engineer to exercise police enforcement power, but if the contractor is observed violating a law or regulation of which the engineer is aware, the matter should be brought to the contractor's attention, requesting compliance with the law. Where flagrant violations affecting the work are observed, the engineer has the authority to halt operations and ensure compliance before allowing work to proceed.

228.2 Local Regulations and Permits

Department staff and consultants must consider both legal obligations and contractual requirements to determine whether they will require contractors to comply with local regulations and permits. It is important to distinguish between the legal authority WisDOT is granted in the statutes, and the contractual requirements that WisDOT places on its contractors. Furthermore, it is important to note that the statutes and our contracts do not exempt the department from any federal laws and permit requirements. From a legal perspective, the statutes give the department the latitude not to comply with most local permits for work done on highway right of way. However, the department has not generally passed this latitude on to contractors. Contractually, standard spec 107.1 and standard spec 107.3 require contractors to comply with local regulations and permits, unless the department decides to waive them.

The statutes indicate and courts have upheld that the department is not subject to local permit requirements for work done on highway right of way, unless the statute creating the permit authority specifically says that the state is included. However, borrow pits, aggregate pits, quarries, or any other work not on highway right of way are subject to local zoning ordinances and permits, unless the statute creating the permit authority specifically says that the state is exempt.

The department has the legal authority to waive local regulations and permits for our contractors in those situations where the department is not required to comply. While the department has this authority, we use it only as needed for unique circumstances. Again, contractors have a contractual obligation as required in standard spec 107.1 and standard spec 107.3 to comply with local regulations and permits, unless the department waives them.

During the design phase, the department will coordinate with local officials on their regulations and permits; and in most cases, reach consensus to either enforce or waive them. Generally, the department will waive local regulations and permits in the project special provisions. For example, the department can require the contractor to comply with a local noise ordinance, as stated in standard spec 107.1 and standard spec 107.3, or the department can waive the noise ordinance by special provision if the contractor needs to work at night.

As a general rule, engineers should not waive local regulations or permits during construction that have not been coordinated with local officials and waived in the special provisions. However, in unique situations, the department has used its legal authority to waive local requirements during construction. Region staff may contact the WisDOT Office of General Counsel for advice on a particular situation. Engineers must document their coordination with local officials and any decisions to waive local requirements. Examples of situations where engineers have waived local regulations and permits during construction:

- A local requirement the department wasn't informed of during design that is detrimental to the project.

- Local government charging excessive fees for permits. In some cases, the department waived the fees, and still required the contractor to comply with the terms of the permit.

Figure 228-1 shows an example standard letter that WisDOT staff and consultants can use to waive local regulations and permits. Print letter on region letterhead for signature by the engineer.

FIGURE 228-1 Sample Letter to Locals to Waive Local Regulations and Permits

Date:

Dear Local Authorities:

This letter is to notify the local unit of government that as a policy the State and its agencies are not required to comply with local regulations or pay permit fees when carrying out state governmental functions. This would include all contractors performing work on Wisconsin Department of Transportation (WisDot) construction projects. The courts have upheld this policy several times and have used the following statutes as reference:

86.07(3), Stats., reads: The prohibitions in this section, referring to 86.07(2) permit authority; do not apply to highway authorities in the performance of their duties.

13.48(13), Stats., reads in part: "[E]very building, structure or facility that is constructed for the benefit of or use of the state or any state agency, board, commission or department ... But the construction is not subject to the ordinances or regulations of the municipality in which the construction takes place except zoning ..."

13.48(10), Stats., specifically exempts state highway construction from the terms of the entire section. Subsection (10) reads in part: "This section applies to the department of transportation only in respect to buildings, structures and facilities to be used for administrative or operating functions"

The above quoted use of the word "section" must be read to apply to all sec. 13.48, Stats., rather than only to subsection (10) [**See sec. 990.001(5), Stats.,** regarding statutory references.]

Section 84.01, Stats., gives right of entry to enter private lands to make surveys or inspections to carry out the Services required by a Contract.

WisDOT contract specifications provide the contractor with information regarding compliance with local regulations. Hopefully, the contract reflects the coordination with the local authorities made during the planning and development of the project. If necessary, WisDOT can revise the contract to waive a local regulation or permit. The WisDOT engineer can answer any questions the local authority may have and provide a copy of the contract special provisions if needed.

Sincerely,

Engineer

228.3 Conformance to Standards

The department intends that its contracts will conform to applicable state, national, and industry standards. However, the engineer's primary responsibility is to ensure compliance with contract requirements and standards pertinent to the contract. Whenever there is a conflict between standards

required by the contract and other standards, the contract standards will be followed provided sound engineering practice is not violated.

228.4 Preference for US-Made Materials

Standard spec 106.2.2 refers to Wisconsin Statute 16.754 which requires the contractor to furnish materials manufactured to the greatest extent in the United States, when all other factors are substantially equal unless the contract provides otherwise. This statute applies to all materials used on WisDOT projects and is completely independent from the federal domestic materials preference (formally Buy America) provision covering iron and steel products and construction materials.

228.5 Domestic Materials Preference Provision

228.5.1 General

If a single design or construction contract within the scope of a National Environmental Protection Act (NEPA) document is awarded using federal-aid funding, Buy America provisions under Title 23 Code of Federal Regulations (CFR) Section 635.410 **apply to all contracts** within the scope of that NEPA document. As a result, WisDOT construction contracts are subject to the Buy America requirements. To ensure that the federal requirements are met, the department includes the Domestic Materials Preference provision in virtually all let contracts. Field staff need to review the contract documents to see if the Domestic Materials Preference provision is included.

A copy of the current Domestic Materials Preference provision is on-line at:

https://wisconsindot.gov/hccidocs/contracting-info/domestic-materials-preferences-provision.pdf

The FHWA has a Buy America Construction Program Guide available online at:

https://www.fhwa.dot.gov/construction/cqit/buyam.cfm

The Domestic Materials Preference provision requires the contractor to use iron and steel products, construction materials, and manufactured products as identified in; 23 CFR 635.410, 2 CFR Part 184, and 2 CFR Part 200.

Refer to the references in CMM 228.5.6 for a list of regulations and publications referenced in this section.

228.5.2 Classification of Articles, Materials, and Supplies

An article, material, or supply shall not be considered to fall into multiple categories and shall only be classified as an iron or steel product, a construction material, a manufactured product, or a temporary and excluded material.

An article, material, or supply must meet the certification requirements for only the single category in which it is classified, except in the case of precast concrete products and ITS/electronic hardware systems classified as manufactured products, which must also meet certain requirements for iron and steel as indicated in CMM 228.5.2.3. The classification of an article, material, or supply must be made based on its status at the time it is brought to the work site for incorporation into the project.

228.5.2.1 Iron or Steel Products

Iron or steel products means articles, materials, or supplies that consist wholly or predominantly of iron or steel or a combination of both. Predominantly of iron or steel or a combination of both means that the cost of the iron and steel content exceeds 50 percent of the total cost of all its components. Products that are classified as predominantly iron or steel do not meet the definition of a manufactured product and must be classified as an iron or steel product. The cost of iron and steel is the cost of the iron or steel mill products (such as bar, billet, slab, wire, plate, or sheet), castings, or forgings utilized in the manufacture of the product and a good faith estimate of the cost of iron or steel components from the manufacturer.

Manufacturing processes for iron and steel start from the initial melting stage through the application of coatings. Foreign sources of scrap and pig iron are acceptable sources of raw material if the melting of those materials is domestic.

The following are some examples of items that contain materials covered by the Buy America requirements for steel and iron.

- Anchor Assemblies, Bolts, and Rods (for structures and bases)
- Rail Posts, Sleeves, Shims, Rail Panels, Structural Fasteners, Expansion Devices, Cover Plates, Floor Drains, Guardrail Anchors, Bearing Assemblies, Steel Diaphragms
- Electrical Cabinets and Enclosures
- Castings (including inlet and manhole covers)
- Bar Steel (coated and uncoated)
- Steel Tie Wire

- Tie Bars
- Dowel Bars (including Baskets)
- Hook Bolts
- Concrete Culverts, Pipes, Endwalls, Catch Basins, Inlets, Manholes (steel reinforcement)
- Pre-stressed Concrete Members (steel reinforcement)
- Metal Pipes and Endwalls
- Delineator Posts and Hardware
- Drains and Downspouts
- Pull Boxes, Poles, Mast Arms, Metallic Conduit
- Fencing Fabric, Rails, Tension Wire, Barbed Wire
- High Strength Bolts
- Steel Piling
- Sign Bridges and Supports
- Steel Sign Posts
- Steel Grid Floor
- Steel Plate Beam Guard
- Structural Steel
- Stud Shear Connectors
- Welding Rods

228.5.2.2 Construction Materials

Construction materials identified in the remainder of this section refer to construction materials as identified in 2 CFR Part 184 and 2 CFR Part 200. All construction materials must comply with Build America Buy America (BABA) Act requirements, and all manufacturing processes identified in 2 CFR Part 184 must occur in the United States.

Construction materials means articles, materials, or supplies that consist of only one of the items listed below:

- non-ferrous metals
- plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables)
- glass (including optic glass)
- fiber optic cable (including drop cable)
- optical fiber
- lumber; or
- engineered wood, and
- drywall.

Items that consist of two or more construction materials that have been combined together through a manufacturing process, and items that include at least one construction material combined with a material that is not a construction material (including steel/iron) through a manufacturing process are treated as manufactured products, rather than as construction materials.

228.5.2.3 Manufactured Products

Manufactured products mean articles, materials, or supplies that have been processed into a specific form and shape, or combined with other articles, materials, or supplies to create a product with different properties than the individual articles, materials, or supplies. If an item is classified as an iron or steel product, an excluded material, or construction material, then it is not a manufactured product. Mixtures of excluded materials delivered to a work site without final form for incorporation into a project are not a manufactured product.

- For projects with let dates before October 1, 2025, manufactured products are exempt from Buy America as they are covered under a previous waiver from 1983.
- For projects with let dates on or after October 1, 2025, manufactured products must meet the “final assembly requirement”, which means the final step in the manufacturing process must occur in the United States.
- For projects with let dates on or after October 1, 2026, in addition to meeting the “final assembly requirement”, manufactured products must meet the “55 percent requirement”, which means the cost of the components that are mined, produced, or manufactured in the United States must be greater than 55 percent of the total cost of all components of the manufactured product.

- For precast concrete products classified as manufactured products, components that consist wholly or predominantly of iron or steel must meet Buy America requirements for iron and steel. The costs of such components will contribute toward meeting the “55 percent” requirement.
- For intelligent transportation systems and other electronic hardware systems classified as manufactured products, cabinets or other enclosures that consist wholly or predominantly of iron or steel must meet Buy America requirements for iron and steel. The costs of such cabinets or other enclosures will contribute toward meeting the “55 percent” requirement.

228.5.2.4 Temporary and Excluded Materials

Temporary materials and excluded materials meeting the definition of Section 70917(c) Materials as defined in 2 CFR 184, do not have any domestic materials requirements. Section 70917(c) Materials mean,

- Cement and cementitious materials,
- Aggregates such as stone, sand, or gravel, or
- Aggregate binding agents or additives.

Mixtures of excluded materials delivered to a work site without final form for incorporation into a project are not a manufactured product.

228.5.3 Minimal Use Threshold for Foreign Iron and Steel

A small amount of foreign material (iron and steel) is allowed if the value, as delivered to the project, does not exceed one-tenth of one percent (0.1%) of the total contract cost or $2,500, whichever is greater. The total contract cost is the contract amount at award.

The minimal use of foreign iron or steel under the minimal usage threshold must be approved in writing by the Engineer prior to incorporation into the project and any associated payment under the contract. If allowed, contractors must use the following process and ensure the that the minimal usage amount is not exceeded:

- To determine the foreign iron and steel allowance, calculate 0.1% of total contact cost. Use this value if greater than $2,500. Use $2,500 if the calculated number is less than or equal to $2,500.
- Individually track all foreign iron and steel and the associated costs of those non-compliant products and provide documentation verifying the foreign steel value including:
    1. Pay item(s),
    2. Description of associated foreign iron or steel product, or component,
    3. Invoiced cost of associated foreign iron or steel product, or component; and
    4. Current cumulative list of all foreign iron or steel products with the total dollar amount of foreign products in relation to the total contract amount.
- Upon completion of the project, certify to the engineer, in writing using department form DT4567 that all iron and steel, manufactured products, and construction materials conform to this Domestic Materials Preference Provision.
- Attach a list of iron or steel, manufactured product, and construction material exemptions and their associated costs using the Domestic Materials Exemption Tracking Tool and submit invoices and identification of non-complaint materials and “total applicable project costs” for inclusion in project records. The Domestic Materials Exemption Tracking Tool is available at:

https://wisconsindot.gov/hccidocs/contracting-info/domestic-materials-exemption-tracking-tool.xlsx

228.5.4 Public Interest Waivers

Two public interest waivers are found within the Waiver of Buy America Requirements for De Minimis Costs and Small Grants: 88 FR 57750 (2 CFR Parts 184 and 200), from the Office of the Secretary.

https://www.federalregister.gov/documents/2023/08/16/2023-17602/waiver-of-buy-america-requirements-for-de-minimis-costs-and-small-grants

These allow a limited waiver of Buy America requirements for de minimis costs and small grants.

- De minimis costs: The total value of the non-compliant products is no more than the lesser of $1,000,000 or 5% of total applicable costs for the project.
    - NOTE: The de minimis public interest waiver does not apply to iron and steel, subject to the requirements of 23 U.S.C. 313 on financial assistant administered by FHWA. The de minimis threshold in 23 CFR 635.410(b)(4) continues to apply for iron and steel.
- Small grants: The total amount of Federal financial assistance applied to the project, through awards or subawards, is below $500,000.

In applying the de minimis waiver, the “total value of the non-compliant products” does not include the value of those products subject to a separate Buy America waiver. “Total applicable project costs” are

defined as the cost of materials that are subject to a domestic preference requirement, including materials that are within the scope of an existing waiver.

WisDOT may restrict or prohibit use of the de minimis waiver for an individual let project. Follow requirements in the special provisions.

To utilize the de minimis public interest waiver, contractors must use the following process:

- Track invoices for the total material costs of project bid items that are subject to a domestic preference requirement.
- Material costs determined in the previous step represent “total applicable project costs” subject to a domestic preference requirement. When calculating "total applicable project costs", do not include temporary materials or excluded materials.
- To determine allowable de minimis cost utilize the Domestic Materials Exemption Tracking tool.
- Individually track all non-compliant products and the associated costs of those non-compliant products.
- Determine the total cost of materials for all non-compliant products for a project, not to exceed the allowable de minimis cost determined in the previous steps.
- Upon completion of the project, certify to the engineer, in writing using department form DT4567 that all iron and steel, manufactured products, and construction materials conform to this Domestic Preference provision.
- Attach a list of iron or steel, manufactured product, and construction material exemptions and their associated costs to the certification form using the Domestic Materials Exemption Tracking Tool and submit invoices and identification of non-complaint materials and “total applicable project costs” for inclusion in project records. The Domestic Materials Exemption Tracking Tool is available at:

https://wisconsindot.gov/hccidocs/contracting-info/domestic-materials-exemption-tracking-tool.xlsx

If the contract allows, contractors must follow requirements in the project special provisions to utilize the small grants waiver.

228.5.5 Documentation/Certification Requirements

When the Domestic Materials Preference provisions apply, documentation/certification is required for;

- steel and iron,
- construction materials, and
- manufactured products as indicated below.

In addition, documentation/certification must include project-identifying information to establish a clear connection to the project where the material was used.

Documentation/certification is needed for each of the following steps in the steel and iron production process when the Domestic Materials Preference provisions apply:

1. Location steel/iron was melted/cast.
2. Location steel/iron was rolled/drawn.
3. Location steel/iron was fabricated.
4. Location steel/iron was coated/galvanized.

NOTE: Items 1 and 2 are commonly done at the same location for structural steel. Not all of these steps apply to all steel products.

Documentation/certification is needed for construction materials in accordance with the construction materials standards in 2 CFR 184.6 (https://www.ecfr.gov/current/title-2/subtitle-A/chapter-I/part-184/section-184.6) when the Domestic Materials Preference provisions apply:

- Non-ferrous metals: All manufacturing processes, from initial smelting or melting through final shaping, coating, and assembly, occurred in the United States.
- Plastic and polymer-based products: All manufacturing processes, from initial combination of constituent plastic or polymer-based inputs, or, where applicable, constituent composite materials, until the item is in its final form, occurred in the United States.
- Glass: All manufacturing processes, from initial batching and melting of raw materials through annealing, cooling, and cutting, occurred in the United States.
- Fiber optic cable (including drop cable): All manufacturing processes, from the initial ribboning (if applicable), through buffering, fiber stranding and jacketing, occurred in the United States. All manufacturing processes also include the standards for glass and optical fiber, but not for non-ferrous metals, plastic and polymer-based products, or any others.
- Optical fiber: All manufacturing processes, from the initial preform fabrication stage through the completion of the draw, occurred in the United States.
- Lumber. All manufacturing processes, from initial debarking through treatment and planning, occurred in the United States.

- Engineered wood: All manufacturing processes from the initial combination of constituent materials until the wood product is in its final form, occurred in the United States.
- Drywall: All manufacturing processes, from initial blending of mined or synthetic gypsum plaster and additives through cutting and drying of sandwiched panels, occurred in the United States.

Documentation/certification is needed for manufactured products when the Domestic Materials Preference provisions apply:

1. For projects with let dates on or after October 1, 2025:
   - Location of the final step in the manufacturing process.
2. For projects with let dates on or after October 1, 2026:
   - Location of the final step in the manufacturing process.
   - Cost of the components that are mined, produced, or manufactured in the United States must be greater than 55 percent of the total cost of all components of the manufactured product.

     NOTE: In determining if the cost of components is greater than 55 percent of the total cost of all components, costs must be determined in accordance with 23 CFR 635.410(c)(3); https://www.ecfr.gov/current/title-23/chapter-I/subchapter-G/part-635/subpart-D/section-635.410#p-635.410(c)(3).

Field staff need to ensure Domestic Materials Preference requirements are met as follows for steel, iron, construction materials, and manufactured products.

- The contractor reviews the contract and identifies all bid items containing steel, iron, construction materials, and manufactured products subject to Domestic Materials Preference requirements.
- The engineer reviews the Materials Acceptance and Testing Guide in CMM 850 and the project-specific E-Guide to ensure compliance with contract requirements. Steel and iron items are flagged with a US Flag symbol in the upper right-hand corner of the E-Guide. Construction materials and manufactured products may not be flagged in the E-Guide but are still covered under Domestic Materials Preference requirements.
- Before incorporating steel, iron, construction materials, and manufactured products for structures into the work, the contractor needs to furnish a fabricator's certificate of compliance, manufacturer's certified report of test or analysis, or shop inspector's report as applicable. The engineer should not accept components without this documentation.
- Before accepting products, the engineer will review the documentation submitted under bullet item 3 above, Mill Test Reports, along with conducting a visual inspection of the material itself to determine its origin. Bar steel reinforcement markings can be compared with a listing of markings currently available in each region to identify the origin of manufacture.
- Shop inspection reports and other reports for steel, iron, construction materials, and manufactured products processed by organizational units other than the Quality Management Section, should state that the represented products comply with all applicable Domestic Materials Preference requirements.
- Steel, iron, construction materials, and manufactured products accepted on the project by a certificate of compliance or certified report of test or analysis as the sole or supplementary documentation will be acceptable if the documents indicate the product was manufactured in the United States. For steel and iron some mills state on their documents that the steel and iron represented complies with Buy America. This is also acceptable.
- For those items not requiring either a certificate of compliance or a certified report of test or analysis, it will be necessary to obtain from the manufacturer, through the contractor, a statement that the material was manufactured in the United States and complies with applicable domestic content procurement preferences found in FHWA's Buy America Act requirements (23 CFR 635.410) and the Build America, Buy America Act requirements (2 CFR part 184). An AASHTO-approved domestic materials self-certification form is also acceptable, if available.
- Shop inspection reports and other reports for steel, iron, construction materials, and manufactured products processed by organizational units other than the Quality Management Section, should state that the represented products comply with all applicable Domestic Materials Preference requirements.
- The contractor needs to provide the engineer all information that may have a bearing on a products origin of manufacture before it is accepted and incorporated into the work. A simple certified statement from the contractor is not sufficient evidence.
- The contractor needs to maintain a running total of the cost of products not meeting Domestic Materials Preference provision requirements already incorporated into the contract work. Cost determination is based on invoice costs or going rates for items without invoices. The engineer needs to make sure the contractor does not exceed applicable threshold/waiver amounts (where allowed) for foreign and undocumented products, or a project may lose all or part of its federal funding.
- After completing the work, the contractor must complete DT4567, along with the Domestic Materials Exemption Tracking Tool for products permanently incorporated into the work that do not meet Domestic Materials Preference requirements and submit to the engineer for inclusion in the project records.
- Utilities must submit DT2249 "Utilities Certificate of Buy America Compliance".

228.5.6 References

1. 2 CFR Part 184 – Buy America Preferences for Infrastructure Projects: Domestic procurement preferences found in Office of Management and Budget (OMB) guidance to federal agencies for implementing Build America, Buy America (BABA) requirements (https://www.ecfr.gov/current/title-2/subtitle-A/chapter-I/part-184).
2. 2 CFR Part 200 – Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards: Administrative requirements, cost principles, and audit requirements for Federal awards, and policy for collecting and submitting information on all Federal financial assistance programs to the OMB (https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200).
3. 23 CFR 635.410 - Buy America Requirements: Domestic procurement preferences found in Federal Highway administration's Buy America requirements (https://www.ecfr.gov/current/title-23/chapter-I/subchapter-G/part-635/subpart-D/section-635.410).
4. 88 FR 55817 Waiver of Buy America Requirements for De Minimis Costs and Small Grants: Notice from the department of Transportation finalizing limited waiver of Buy America requirements for de minimis costs and small grants (https://www.federalregister.gov/documents/2023/08/16/2023-17602/waiver-of-buy-america-requirements-for-de-minimis-costs-and-small-grants).

228.6 Contractor Debarment or Suspension

Causes for contractor debarment include the following:

1. Conviction of or a civil judgment for:
   - Fraud or a criminal offense in connection with an agreement or transaction.
   - Violation of a Federal or State antitrust statute.
   - Embezzlement, theft, forgery, bribery, falsification or destruction of records, false statements, receiving stolen property, false claims, obstruction of justice.
   - Any offense that shows a lack of business integrity or honesty that seriously and directly affects the individual's responsibility.
2. Violation of terms of a public agreement or transaction.
3. Doing business with a debarred, suspended, or ineligible person.
4. Failure to pay certain substantial outstanding debts.
5. Violation of a voluntary exclusion agreement.

Fraud, collusion, and false statements are of concern to construction industry. Each of these violations is discussed below.

228.7 Fraud

Fraud is a generic term that embraces all the way one person can falsely represent something to another to induce that person to surrender something of value. A contractor who knowingly provides the government with commodities or services that do not meet contract specifications has committed fraud in performance.

228.7.1 Minority/Woman/Small Business Fronts

A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of DBE participation. DBE fraud can be used as a vehicle to commit other crimes such as money laundering, tax evasion, and wage frauds. DBE fraud can be done several ways, including false fronts, pass-throughs, personal net worth misrepresentation, illegal check cashers, and false eligibility.

Potential indicators of DBE fraud include the following:

- DBE owner/employees not on-site.
- Flipping of employees from prime's payroll to the DBE payroll.
- No additional equipment added to site when DBE starts their portion of work.
- No commercially useful function.
- Dual party checks.
- No expertise in the work to be performed, licenses, or equipment.
- Job is too large for the DBE - check work history.
- Lease agreements between prime and DBE contractors.
- Prime contractor always using same DBE.
- DBE business owned by relative of prime contractor.
- Ghost employees or certified payroll irregularities.
- Brokering agreements.

228.7.2 Accounting Frauds

228.7.2.1 False Progress Payments

The price of the contract is fixed; the government pays the same amount upon the ultimate completion of the project regardless of the amounts of the individual progress payments. A contractor gains the time value of having the money in hand and places the government at risk for its failure to perform, by inflating or front-loading claims for progress payments.

228.7.2.2 Cost Mischarging for Materials and Labor

This involves consistent cost overruns on highway construction projects because of intentional under-estimating or bidding by the contractor to receive the contract. As a result, the cost overruns substantially exceed the original project estimates or highest bidder. The following examples could be an indicator of accounting fraud:

- Truck weight tickets showing loads of materials that exceed the capacity of the truck, production output of the plant amount needed for the job site, etc.
- Truck tickets that are handwritten or have missing information, such as initials of highway inspector, job site, and codes and temperature of materials, etc.
- Production plant records with altered, modified, or missing information such as job sites, loading times, and codes and temperature of materials, etc.
- Any manual entries or adjustments to electronic payroll records.

228.7.2.3 Product Substitution

The contractor may knowingly or unknowingly be supplying sub-standard materials to the project. The following are examples of illegal product substitution:

- Fabrication of inspection reports.
- Rigging of product tests.
- Mislabeling or mismarking of products and materials.
- Purchase of low-grade basic material.
- Use of false financial reports.
- Use of foreign suppliers for products and materials.
- Incomplete contractor files with no originals or copies of originals, such as, delivery records and certifications showing the source, specifications, and laboratory tests of products and materials.
- Unsigned certifications or certifications with forged or different signatures of authorized technical personnel from the contractor, subcontractor, suppliers, etc.
- Backdated, modified, altered, or falsified documents or certifications.

228.8 Collusion

Collusion is an illegal, secret agreement between two or more parties for a fraudulent or wrongful purpose. It is an agreement to do something illegal and one party furthers the agreement by action.

Collusion can take the form of market division, price rigging, bribery, and specification manipulation. Market division is when competitors allocate certain customers, products, or territories amongst themselves (X can sell to Y, as long as they don't sell to Z). Bribery is the corruption of the relationship between the government and its agents or the exploitation of one's official position for personal gain.

228.8.1 Price Rigging/Bid Rigging

The Sherman Act enacted in 1980, prohibits any agreement among competitors to fix prices, rig bids, or engage in other anticompetitive activity. The Antitrust Division will prosecute these violations.

Price rigging is an agreement among competitors to raise, fix, or otherwise maintain the price at which their goods or services are sold. This does not mean that competitors agree to charge the same price. And not all competitors have to be amongst the conspiracy.

Bid rigging occurs when conspiring competitors agree in advance as to who will win the bid for a contract, with the contract being let through the normal competitive bidding process.

There are 5 types of bid rigging:

1. Bid suppression. This is when one or more contractors, who typically would be expected to bid, agree to refrain from bidding or withdraw a previously submitted bid so that another contractor's bid will be accepted.
2. Complementary bidding. This is a form of bidding, where similar to bid suppression there is a predetermined winning contractor, but in this case, the competing contractors submit bids that are too high or where they violate special terms of the contract.
3. Bid rotation. All conspirators take turns being the winning bidder. The terms of the rotation may vary depending on agreement.

4. Subcontracting. This occurs when one party gets awarded a contract, then awards subcontracts to the conspiracy members in exchange for not submitting a winning bid.
5. Geographic. Repeated awarding of contracts to the same contractors in a particular geographical area.

Examples of bid rigging include the following:

- Establishing or adhering to price discounts.
- Holding prices firm.
- Eliminating or reducing discounts.
- Adopting a standard formula for computing prices.
- Maintaining a certain price differential between different types, sizes, or quantities of products.
- Adhering to a minimum fee or price schedule.
- Fixing credit terms.
- Not advertising prices.

228.8.2 Conflict of Interest

A conflict of interest occurs if consultants, architects, engineers, etc., who were hired by the government to develop contract specifications are affiliated with or later subcontract with the contractor receiving the contract. Specifications by government engineers or hired consultants, architects, engineers, etc., that appear to favor the services and materials of certain contractors, subcontractors, suppliers, or sole sources may be an indicator of collusion. Possible conflicts of interest violations are listed below.

- The disclosure by government officials or personnel of confidential information, such as bids, to contractors, engineers, etc., during any phase of the contract award process.
- Government officials or personnel or their family members having financial interest in the contractor or subcontractor who was awarded the contract.
- Government officials or personnel seeking employment for themselves or their family members with the contractor or subcontractor who was awarded the contract.
- Government officials or personnel assisting the contractor or subcontractor with preparing the bid, or leasing or renting any equipment to them for performing the contract.

228.8.3 Detecting Collusion

228.8.3.1 Administration

There are several administrative techniques to use to prevent or detect collusion.

- Use of computer systems.
- Strengthening of estimating techniques.
- Engineer estimate should remain confidential.
- States should continue to find improved methods of cost estimation.
- Bidders list must be confidential on project-by-project basis.
- Bid depositories must be located on State property.
- Department should continue to encourage competitive bidding and more responsive bids by having pre-bid meetings, increasing the number of pre-qualified bidders, and structuring the contracts properly.
- Ensure staff is trained in bid rigging.

228.8.3.2 Suspicious Bidding Patterns

- The same competitor always wins the contract, especially when there are the same competitors placing bids.
- The same competitors submit bids and they seem to take turns winning.
- Some bids are unnecessarily higher.
- Fewer than normal number of competitive bids.
- A company appears to bid substantially higher on some bids than others, with no apparent reason.
- Bid prices drop when a new or infrequent bidder submits a bid.
- Successful bidder subcontracts work to competitors that submitted unsuccessful bids.
- A company withdraws its successful bid and subsequently is subcontracted by the winning bidder.

228.8.3.3 Suspicious Pricing Patterns

- Identical prices may indicate a price-fixing conspiracy, when prices stay identical for long periods of time, prices previously were different, or price increases do not appear to be relative to increased costs.
- When discounts are eliminated, especially when they historically have been given.
- Vendors charge higher prices to local customers than to distant customers.

228.8.3.4 Suspicious Statements or Behaviors

- Irregularities in bids indicate that both parties combined efforts on bids.
- Bid documents contain last minute price alterations.
- One person submits bid for two parties.
- Submitting a bid when they are incapable of performing the contract.
- A company brings multiple bids to an opening and submits a particular bid based on whom else is submitting bids.
- A bidder, or person, makes a suspicious statement indicating some acknowledgement of a conspiracy.

228.9 False Claims

A false claim is any statement within the jurisdiction of government that contains any false, fictitious, or fraudulent representation. False claims include any documents or certifications with altered, backdated, modified, or missing information concerning the contractor's bond and pre-qualifications, minority or women owned business status, financial history, previous debarment and suspension, ownership of equipment and facilities, performance on other jobs, etc., for the purpose of obtaining the contract.

False claims also result from using multiple mailing addresses, post office boxes, or unusual mailing addresses on documents and certifications from the contractor, subcontractor, suppliers, etc. False documents can be contracts, subcontracts, invoices, certified payrolls, union submissions, tax returns, W-2's, accounting ledgers, checks, etc.

An anti-fraud statue originating from the federal-aid Road Act of 1916 (18 U.S.C. 1020, 23 CFR 633, 23 CFR 635.119) specifically provides that "willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of the federal law" and requires that the false statement poster, Form FHWA-1022, must be posted on the project.

http://www.fhwa.dot.gov/programadmin/contracts/fhwa1022.cfm

The False Claims Act (31 U.S.C. 3729(a) today is an extremely powerful civil enforcement tool, and allows the government to recover funds fraudulently obtained from federal programs. It penalizes the offender by imposing financial penalties and can be punitive. It also serves a strong deterrent to other would- be defrauders.

The four most commonly invoked provisions are:

Any person who:

1. Knowingly presents, or causes to be presented, to an officer or employee of the US government a false or fraudulent claim for payment or approval.
2. Knowingly makes, uses, or causes to be made or used, a false record or statement to get a false or fraudulent claim paid or approved by the government.
3. Any person who conspires to defraud the government by getting a false or fraudulent claim allowed or paid.
4. Knowingly makes, uses, or causes to be made or used, a false statement to conceal, avoid, or decrease an obligation to pay or transmit money or property to the government.

A person knowingly submits a false claim if he or she does one or more of the following:

- Knows the information contained in the claim is false.
- Acts in deliberate ignorance of the truth.
- Acts in reckless disregard of the truth or falsity of the information.

Examples of false claims:

- Prevailing wages.
- False certification of compliance with enumerated standards.
- Falsifying construction inspection and testing credentials.
- False invoices or vouchers.
- Claims based on false contractor's interpretations.
- Domestic Materials Preference (formally Buy America) violations.
- Subcontractor claims.
- Claims for contract adjustments.
- Falsified schedules/delay analysis.
- Inflated progress billings.
- Double billings.
- Substitutions of materials with inferior products.
- False credit in change orders.

228.10 What To Do If Fraud, Collusion, or False Claims Are Suspected

1. Take each complaint or allegation very seriously.
2. Call police immediately if a life-threatening situation or other reason to do such is warranted.
3. Gather preliminary information in-house. Confer with DOT counsel on the information gathered.
4. Decide with General Counsel if complainants may have criminal liability. Decide who should be contacted (police, FBI, OIG, IRS, State Tax Investigator, etc.).
5. Notify FHWA if Federal Funds are involved.
6. Appoint an investigator or provide information from a third-party investigator (try to get cooperation and share info with the third-party investigator if one exists).
7. Take Statements. Gather evidence (promise limited confidentiality if necessary).
8. Do a report.
9. Based on findings, take remedial action (i.e. notice of suspension or debarment - Trans 504).
10. Complete due process, including hearings, settlements, suspension, and debarment.

Interview persons in position of responsibility. Make copies of relevant documents. Do not alert employees to suspicions. Contact the Office of the Inspector General.

Call the OIG National Fraud Coordinator in Washington, D.C. at (202) 366-0681 or a Regional Fraud Coordinator at (312) 353-0106 for more information or to report fraud involving federally funded highway projects and other related transportation programs. Callers can remain anonymous, and all information is confidential. You are key to protecting government integrity by reporting fraud, waste, and abuse.

228.11 Resources

- Part 29 -- Government-wide Debarment and Suspension and Government-wide Requirements for Drug-free Workplace:

  http://www.fhwa.dot.gov/hep/guidance/superseded/49cfr29.cfm

- The federal government System for Award Management web page:

  https://www.sam.gov/portal/SAM/#1://www.epls.gov/

- The United States Department of Justice web page:

  http://www.usdoj.gov/

- FHWA Resources - Legislation, Regulations and Guidance:

  http://www.fhwa.dot.gov/legsregs/directives/notices.htm

The department's Office of General Counsel can also provide advice and resources to departmental staff and help coordinate with federal, state, and local agencies.

SECTION 230 Right of Way

230.1 Background

Right of way is the land acquired for the highway or devoted to highway-related purposes. It may include land for waysides, rest areas, and other uses directly associated with a highway. To guard against encroachment of the contractor's operations upon the public highway property, marker posts or a fence are installed to mark the right or way limits in rural areas.

230.2 Types of Acquisition

The type of acquisition is shown in the Schedule of Lands and Interests Required in the right of way plat for the project.

230.2.1 Fee

This is the full and complete acquisition of the land, including all rights and interests that run with the land.

230.2.2 Highway Easement

This is the acquisition of interest in property for highway purposes. It gives the department the complete use of the land as long as it is for highway purposes. This type of acquisition is fairly rare and usually involves another public or semi-public agency.

230.2.3 Limited Easements

This is the acquisition of selected interests in land that is limited in purpose and may be either permanent or temporary. Full title to the property is not acquired, only a right to use the property for a specific purpose.

230.2.4 Construction Permits

This conveys the right to enter on a small portion of a property. Construction permits are normally used for the purpose of making a property compatible to the roadway, such as matching lawns to slopes or sidewalk, replacement of driveway surfacing, or as a temporary work area. The limits of the permitted work area will be shown on the permit and on the plan or change order.

230.2.5 Right of Entry

This is a temporary permit to enter on lands for construction purposes. It is used when the acquisition cannot be obtained before the contract letting. In most cases the acquisition will have been completed before the start of construction. Right of Entry should not be construed to be the same as a construction permit.

230.3 Commitments

The engineer will be furnished with completed department form RE1528, Statement to Construction Engineer, covering commitments made by the department to property owners during the right of way acquisition stage. These commitments may include, for example, preservation of trees, time allowed for removal, or other factors affecting construction operations and progress. Careful attention should be paid to the commitments to ensure that they do not conflict with contractual requirements. If they do, notify the region real estate agent. If no commitments were made, a statement to that end will be on the form.

230.4 Encroachments

Most of the encroachments on newly acquired right of way were installed before acquisition of the land for highway purposes. These will have been listed by the region at the time of acquisition and a formal procedure for notification of the owner will have been followed, resulting in a legal notice for removal. These notices are sent sufficiently early to allow adequate time to remove encroachments before starting construction.

However, new encroachments may have been placed following right of way acquisition, existing encroachments may have been overlooked at time of acquisition, and some removal notices may not have been complied with. It is the responsibility of the engineer to correct these situations in the manner described below.

Shortly after arriving on the project, the engineer will record all encroaching billboards and other advertising signs, buildings or other structures and fences within the right of way limits. The engineer will then contact the region and identify the encroachments. A search will be made by the region real estate staff of their records for evidence that the formal notice procedure has been followed and the allotted time has expired. Subsequently, the region office will contact the engineer and indicate the status of each encroachment that has been recorded.

Following communication from the region office about those encroachments on which the proper notification procedure was followed and the time has expired, the engineer will contact the owner and

explain the need for immediate removal. An extension of time may be granted if the owner cannot remove the encroachment immediately and if construction operations will not be adversely affected by such delay.

The region real estate section will resolve encroachments on which the time has not expired, or the proper notification procedure was not followed. They will keep the engineer advised of the status of the encroachment and, if needed, will coordinate the removal with the engineer.

When the owner does not remove the encroachment within the normal or extended time period, the engineer will consult with the region office. If the region office determines to proceed with removal the engineer will order the contractor to remove the encroachment. It is advisable the engineer be in attendance during removal. A change order may be required.

Removal must be done in a manner that avoids damage to salvageable material. The contractor must dispose of unsalvageable material and material of little value. Salvaged material owned by the state must be done on the highway right of way in a location away from construction operations until removed. Salvaged material owned by a private person must be stored on the owners' property adjacent to the highway right of way. Salvaged materials that become the property of the contractor must be removed from the right of way. Advertising signs must be stored in the nearest county highway department facility for retrieval by the owner.

230.5 Urban and Commercial Areas

Within urban and commercial areas, overhanging marquees, signs, and railings generally have been erected under permit authority of the local unit of government or are allowed by ordinance. Encroachments noted by the engineer during the field review held before start or construction are to be brought to the attention of local officials. Arrangements for needed removals are usually handled by the local unit of government. Some encroachments do not interfere with highway safety and may be allowed to remain in place.

230.6 Access Control

Interstate system project plans should contain details for allowing the contractor to enter and exit the right of way.

If the contractor wishes to enter the interstate right of way at an undesignated and unplanned access point to facilitate construction, it will be necessary to first secure approval before breaking the access control. To request approval, complete the temporary interstate access request template found in FDM 11-30 Attachment 15.11 and forward to the WisDOT region project development chief and WisDOT Bureau of Project Development (BPD) construction oversight chief for their signatures. The region project development and BPD construction oversight chiefs within WisDOT will review and approve temporary interstate construction access requests on behalf of the FHWA Wisconsin Division. Allow a minimum of five (5) working days for review and approval.

Breaking the access control on a non-Interstate, controlled-access highway at an unplanned and undesignated access point to facilitate construction will require the approval of the region office before proceeding.

The right of way plat included with the project plan should be consulted to determine if access is controlled. In the absence of plat, the engineer should consult the region Real Estate staff for guidance.

230.7 Surplus Lands

The policy of the department is to acquire only those lands necessary for transportation purposes. However, there are circumstances in which "surplus land" exists or in created because of department action. Surplus land is land under the jurisdiction of the department that is unused and not anticipated to be needed for transportation purposes. All surplus lands will be identified on the real estate plat. If construction activities have altered right of way needs along the highway, a marked up copy of the most recent plat should be submitted to the region real estate section.

SECTION 231 Use of Materials Found on the Project

231.1 General

Standard spec 104.8 allows the contractor to use suitable materials encountered in roadway excavation instead of materials normally furnished by the contractor, from outside sources. These materials are to be taken from inside the vertical and horizontal limits of excavation.

When there are circumstances that benefit cost and schedule, use of aggregates and other granular materials beyond the roadway excavation limits can be considered. This use will require special evaluation and a change order. See CMM 231.3 below.

Sale of materials for use on other contracts or for purposes other than those required under the contract are not allowed.

231.2 Material Found within Excavation Limits

The contractor is allowed to use stone, gravel, sand, or other material that meets the specification requirements and is found within the vertical and horizontal excavation limits shown on the plans. A change order is not required.

231.3 Material Found Outside Excavation Limits

If the contractor believes there may be suitable materials within the right-of-way but outside the excavation limits, the contractor may request that the engineer allow them to test that material. The engineer needs to consider the environmental, access, and other aspects before allowing the contractor to access the right-of-way to test for potential use of materials.

The contractor may submit a proposal to use materials from outside the excavation limits. The project engineer with the help of region and central office staff will ensure that there are no concerns with using material from this area. Items to consider are:

- What are the proposed boundaries for mining additional materials?
- How will the property be restored or protected after materials are removed?
- Were federal funds used to purchase the right of way?
- Is there adequate and safe access?
- Is Interstate access approval required?
- How will future maintenance of the site be affected?
- Are there any environmental concerns?[1] Did the project's environmental process and documentation include the affected area? Additional environmental review and documentation may be required.
- What is the devaluation of the land upon its use as a borrow pit or waste area? Will its use as a borrow pit or waste area affect the current or future use of the land?[1]

[1] The region's Technical Services Section should assist with the environmental and real estate analysis. The BTS Environmental Section and Property Management Section should be consulted for the proposed change as well.

Once those concerns are addressed, the project engineer will document a Contract Modification Justification (CMJ) and change order.

At a minimum, the change order should include:

- Adjustment in the unit price of the item of work, as specified in standard spec 104.8.
- Measurement of the material.
- Restoration of the area.
- Materials required for restoration of the excavation area must be furnished by the contractor at the contractor's expense.
- Agreements between the contractor and the project engineer relative to methods of measurement, quantities of material, shrinkage factors, etc., when appropriate.

If this project is designated as oversight or a project along the Interstate right of way, the CMJ and change order is coordinated with FHWA. Also, if right-of-way was purchased with federal funds, FHWA coordination and approval is required.

SECTION 232 Measurement and Payment

232.1 General

Standard spec 109.1 states that the engineer will measure the completed work for final payment. As work progresses, estimated quantities may be utilized to pay for items on intermediate pay estimates. If using an estimated quantity, the engineer must reference the basis of payment for the quantity. A quantity may be estimated for intermediate payment by scaling the plans, station to station counts, or approximated field measurements. The engineer must still complete and document final measurement required under the standard specifications before making full payment.

Before acceptance and making full payment, the item must be considered acceptably complete. To be acceptably complete, the item must meet all of the following:

- Installation conforms to the contract.
- Materials test results conform to the contract.
- All quantities have been measured and documented for payment.
- Required documentation has been submitted.

Some items require materials testing after installation is complete. An example is the 28-day concrete strength testing required in a contract. If all requirements above have been met for full payment but contract-required test results are still forthcoming, not including final QMP plans, the engineer may withhold up to 5% of the payment due for an installed quantity, not to exceed $25,000 cumulative for any individual bid item. The department shall notify the contractor in writing of withholdings for each item and amount being withheld. After the required testing is complete and conforming test results are documented, payment is to be made in full for the quantity represented by the test results. If the item is not acceptably complete and the decision is to leave it in place, justification to accept and pay for the item must be documented.

232.2 Volume Measurements

The quantity of materials paid for on the basis of volume measured in the vehicle will be based on a load count by an inspector at the point of delivery. Since the quantity of materials normally measured by volume in the vehicle is small, it is not necessary to provide a double check on the quantity by maintaining another inspector at the source.

The inspector will maintain a daily log as a part of the permanent project record, showing the type of material delivered, identification and capacity of the haul vehicle, time of arrival of each load, and use of the material, including spread with reference to project stationing. The inspector must determine the hauling capacity by volume of each vehicle and ensure the volume of each load delivered is not less than the volume the contractor claims.

When excavated material is placed into a truck, it is fluffed up and occupies greater volume than it had occupied in its original position. When the intent of an excavation item is to measure the material in its original position, a volume correction factor must be applied to volumes measured in the truck to reflect the true volume that it would have occupied in the original condition. Values for this adjustment may typically be around 1.1 - 1.5, but each soil type and condition will vary, so the region soils engineer should be consulted to determine the applicable volume correction factor in each instance. The contractor and department should agree on the adjustment factor before any hauling or measurement of earthwork quantities in a truck box. A simple example to illustrate these ideas is shown in the following examples:

Example 3

The contractor wants to move a small amount of borrow using dump trucks. After consulting the region soils engineer, you agree with the contractor that the expansion factor for the particular soil being moved is 1.25. You have also mutually agreed that each loaded truck will hold 12 cubic yards of material. The contractor hauls 10 full truckloads of borrow excavation.

Contractor hauled 10 loads x 12 yards/load = 120 CY

Now apply expansion factor to get yards of material in its original position:

120 / 1.25 = 96 CY --- You pay for 96 CY of borrow excavation.

It's important to recognize that the volume of the material after it is placed and compacted will be different than in its original position. There is a separate factor to determine this volume.

Example 4

Determine the volume of the material from the previous example after it is placed and compacted. The factor from in place to compacted volume is 0.90.

96 CY x 0.90 = 86.4 CY --- The original volume of 96 yards in place expanded to 120 CY in the trucks, then was compacted to a final volume of 86.4 CY in the roadway foundation.

Refer to FDM 11-5-10 for a thorough discussion of earthwork expansion factors.

232.3 Measure and Payment of S.I. Metric/U.S. Standard Measure Substitutions

When typical section or plan detail dimensions are modified at the request of a contractor to accommodate a change from S.I. metric to U.S. standard measure or conversely, the quantities to be measured for payment will be the quantities of the various items actually constructed or the theoretical quantity based on plan dimensions, whichever is less.

When a manufactured product measured by mass, volume or area, is substituted for another of greater or lesser mass, volume or area, the quantity measured for payment will be the lesser of the quantity furnished and constructed or the theoretical quantity based on plan dimensions, whichever is less.

When a manufactured product is substituted for another or equivalent size, such as conduit or culvert pipe, the quantity measured for payment will be the quantity furnished and constructed.

232.4 Accuracy of Pay Units

Quantities of pay items are measured and reported by the unit of measure, such as cubic yard, linear foot, square foot, ton, each, etc., as designated in the contract for the particular item. The engineer is to accurately measure constructed contract items and carefully check the computations before submittal of each progress pay estimate.

Report measured items to the nearest full unit of measure in each progress payment unless otherwise specifically required in the contract or listed in table 232-2. Quantities for listed items should be reported in the pay estimate to the nearest indicated decimal. In any case, measure subtotals to any decimal of a unit commensurate with accuracy and value, and round the totals to the reporting decimal or whole unit for payment.

TABLE 232-2 Accuracy of Pay Units

Item	Unit	Accuracy
Clearing or Grubbing; Roadside Clearing	ACRE	0.01
Obliterating Old Road	STA	0.1
Asphaltic Material, Asphaltic Pavement	TON	0.1
Concrete Masonry	CY	0.1
Mortar Rubble Masonry	CY	0.1
Concrete Pavement Approach Slab	SY	0.1
Concrete Surface Drains	CY	0.1
Treated Lumber and Timber	MBM[1]	0.01
Storm Sewer	LF	0.1
Structural Plate Pipe	LF	0.1
Structural Plate Pipe Arch	LF	0.1
Calcium Chloride Surface Treatment	TON	0.1
Fertilizer	CWT	0.1
Agricultural Limestone Treatment	TON	0.1
Mulching	TON	0.1
Locating No Passing Zones	MI	0.01

[1] MBM = 1000 Board Feet, see: DT2074 Board-Foot Calculator.

SECTION 233 Payment - Local Force Account Agreements

233.1 Intermediate Payments

All locals must submit detailed statements to support their actual costs for Local Force Account (LFA) Agreement projects. Therefore, the local must track their actual cost throughout the life of the project. Failure to do so will risk the loss of all federal funds involved. Moreover, it is preferred that intermediate payments to a local for performance of work under a LFA agreement be based on the actual costs incurred for labor, equipment and materials. However, for intermediate payments only, and not for a final determination of the reimbursement due to the local, it is allowable to use estimated quantities and the unit costs following the process described in CMM 236.2. The unit costs come from the total cost estimate included in a LFA Agreement and are based on a detailed cost analysis (refer to FDM 3-5 Attachment 10.1 to 10.6 and FDM 19-25).

233.2 Final Determination and Payment

For all LFA projects there must be a final determination of the reimbursement due to the local and this determination must be based on the local's actual costs for labor, materials, incidentals, and established rental rates incurred for all work performed under the LFA. The actual costs must be verified by appropriate attachments. The local is required to submit detailed statements, including receipted invoices for all materials and rental equipment used. For labor, show the classification of the staff used on the project, the hours worked on the project, the hourly rate for each classification and the resultant total dollar amount. The staff and hours should be itemized for each day worked. For equipment, show the type of equipment used, the hours the equipment was used, the hourly equipment rate based on the current Machinery Agreement, and the resultant total dollar amount. The equipment and hours should be itemized for each day worked.

The Project Leader should carefully review the final statement of actual costs to ensure that labor classifications and equipment designations are correct.

SECTION 234 Site Time - Damages and Incentives

234.1 Incentive/Disincentive

Incentive/disincentive provisions provide an opportunity for the contractor to earn a bonus, and they also provide a penalty for not completing the work within the specified time. Incentive/disincentive provisions are usually in addition to liquidated damages specified in standard spec 108.11. They are included in critical projects where traffic inconvenience and delay must be kept to a minimum and access must be restored as soon as possible.

There are two types of incentive/disincentive provisions that are used in contracts. Incentive/disincentive for interim completion is the special provision that is used in most cases. The special provision provides for critical work to be completed and the highway opened to traffic without restrictions by a specified date. This incentive should be placed in the proposal before biding and should not be added to the contract after it has been awarded. If the department deems it necessary for an incentive to be added after contract award, be sure appropriate coordination with Bureau of Project Development and FHWA is made before beginning the change order process. The remaining work can be completed with the highway open to traffic. There may be cases where the department would not want any work being done on or adjacent to a highway open to traffic; therefore, the Incentive/Disincentive for Completion of Work provision is included in the contract.

Usually contract provisions modify the standard specs to remove weather delays, labor disputes, and material deliveries as reasons for granting time extensions for incentive/disincentive requirements.

234.2 Liquidated Damages

Standard spec 108.11 sets forth daily amounts of money to be deducted from monies due to the contractor for not completing the work within the allotted contract time. The contract provisions, especially in the case of large and or complex projects, may modify these amounts.

These amounts are compensation to the state for damages incurred by reason of inconvenience to the public, added cost of engineering and supervision, maintenance of detours, and other items. They are not considered to be a penalty. The courts have long held that a penalty cannot be assessed unless an opportunity to earn a bonus is also present.

234.2.1 Interim Liquidated Damages

Interim liquidated damages are not considered a penalty but are considered fixed and agreed damages due the state from the contractor by reason of inconvenience to the public, added cost of engineering and supervision, maintenance of detours, and other items which have caused an expenditure of public funds resulting from failure to complete the work within the time specified in the contract.

When routing of traffic over a detour causes inconvenience to the public that results in excessive vehicle operating costs, interim liquidated damages are usually included in the contract.

Interim liquidated damages motivate the contractor to complete a portion of the construction early, cancel detours, and reopen a section of highway to through traffic. They are in addition to liquidated damages imposed by standard spec 108.11 for failure to complete all the work under the contract.

Usually the contract provisions will modify the standard specs to remove weather delays, labor disputes, and material deliveries as reasons for granting time extensions to the time requirements for the portion of the work included under interim liquidated damages.

234.2.2 Interim Liquidated Damages - Multiple

If combining several small projects into one contract, it sometimes is necessary to complete one or more projects at a specified date or within a required time. When this is necessary an interim liquidated damage provision may be used. If not completed within the specified time, the contractor is assessed interim liquidated damages. Interim LD's are used to:

1. Reduce inconvenience to the public.
2. Shorten the detour time.
3. Reduce disruption to traffic.
4. Reduce effects on businesses, tourism, etc.
5. Reduce road user costs.

SECTION 236 Intermediate/Tentative/Final Estimates

236.1 Contractor Payments

236.1.1 General

Before payments are made, the project engineer must assure all required material testing and documentation has been completed and the test results have met all contract requirements There are three types of payments: progress payment estimates (intermediate), semi-final estimates (tentative final) and final payment.

Estimates are:

1. Prepared in AASHTOWare Project Construction and Materials®.
2. Approved electronically by all parties within AASHTOWare Construction and Materials®.
3. After an estimate has been approved by all parties, the Bureau of Project Development (BPD) forwards estimates to the Bureau of Financial Management (BFM) for payment to the contractor.

Estimates are numbered consecutively regardless of the type. Estimates are divided into projects and categories indicating the sources of funding.

236.1.2 Progress Payment Estimate (Intermediate)

As the project progresses, item postings are made in AASHTOWare Project Construction and Materials® for payment to the contractor.

Progress payment estimates are made bi-weekly if the contractor is due a payment of $1,000.00 or more. More frequent payments are appropriate for larger sums owed.

An item may be marked complete in AASHTOWare Project Construction and Materials® after it has been completed, measured, documented, and verified.

236.1.3 Semi-Final Estimate

The semi-final estimate documents the final quantities of all bid items used on the contract. All quantities will have been measured, documented, and verified before submittal.

A semi-final estimate is submitted upon final acceptance as specified in standard spec 105.11.2.4. All required documents (including materials test reports) are to be received and accepted before the semi-final estimate is sent to the contractor.

The contractor has 30 days to review and submit a written statement of agreement or disagreement with the final quantities. Should the contractor not submit a written statement within 30 days, the final payment may be processed providing all other contractual requirements have been met. See the diagram on page 8 of the "Finals Process for Let Project Closeout" document at:

https://wisconsindot.gov/rdwy/admin/finals.pdf

It shows a general process timeline process flow timeline, showing when the engineer should submit intermediate, semi-final, and final estimates in relation to project final acceptance.

236.1.4 Final Payment

All bid items must be marked complete in AASHTOWare Project Construction and Materials® before the final estimate is generated. The final payment will be made upon agreement of final quantities between the department and the contractor, or as specified in standard spec 109.7. All retainage will be released with the final payment for contracts awarded in November 2020 or earlier. Retainage is no longer held on contracts awarded in December 2020 or later.

236.2 General Instructions for Preparing an Estimate

236.2.1 Procedure

All estimates for contracts let to bid contracts are to be prepared in AASHTOWare Project Construction and Materials®

Following award of the contract Design and Construction Technologies Section will transition the contracts from AASHTOWare Project Preconstruction to AASHTOWare Project Construction. Once this process is complete, the proposal cannot be edited. Region staff with the Contract Specialist role will receive a system event notification email from the AWPSupport mailbox (AWPSupport@dot.wi.gov) each time a contract is awarded and transitioned from AASHTOWare Project Preconstruction to AASHTOWare Project Construction. Once the email is received, region staff can review and update key fields prior to activating the contract. Once a contract is activated, the project engineer and other field staff can begin administering the contract and entering data in AASHTOWare Project Construction and Materials®.

236.2.2 General Payment Considerations

Even though work may have been done and partial payment requested for only one of the projects under a multi-project contract, an estimate must be submitted for each project.

Updates of quantities should realistically reflect the work done by the contractor. The project engineer should be careful to avoid overpayments, particularly when nearing completion of construction. Quantity entries should always include items completed since the preceding estimate.

Pay quantities for all items should be reduced to reflect contingencies and costs still to be incurred, as indicated under standard spec 109.6. In particular, the project engineer should reduce the pay quantity for structural steel so there is a deduction of about $15.00 per ton of steel per field coat of paint still to be applied.

Items such as Field Office, Finishing Roadway, and Traffic Control should be included for payment in proportion equivalent to the work performed. For example, payment for Field Office can be pro-rated on the basis of the value of work done on the whole contract. Payment for Finishing Roadway and Traffic Control should be based on the project engineer's judgment of extent of completion of each item.

Defective, deficient, or adjusted price items that are authorized by the specifications for payment and not requiring signed and approved change order may be paid with administrative items or an adjustment to an existing contract item. A complete list of administrative items is provided in CMM 238. Reductions should also be made in the pay quantities for items that have predetermined reduced payment schedules for defective materials but may be incorporated in the work and paid for before the materials test reports are received.

236.2.3 Change Orders

The project engineer must not generate quantities of approved change order (CO) work for items not already in the contract until the change order has been approved.

Bureau of Financial Services receives a copy of the electronically signed change order, so they can enter it into the PeopleSoft system. On extra work done by force account under CO, the contractor is required to submit detailed statements, receipted invoices, or affidavits for all labor, machinery, and materials charged to the work. Partial payments of amounts up to a total of 90% of the estimated value of the CO may be made as the work progresses and before receiving detailed billing from the contractor.

236.2.4 Non-Compliance with Contract

If the contractor does not comply with the contract, the department has the authority under standard spec 109.6 to suspend progress payments. Should it become necessary to take this action, the department must notify the contractor immediately. The region needs to evaluate the situation, make a determination, and advise the contractor in writing of the suspension of progress payments, if that is the determination. The letter must state the reasons for suspension and the contractor needs to take in order to secure payment.

236.2.5 Concrete Masonry Superstructure Forming

Payment for concrete masonry superstructure forming allowed by the project engineer to be erected and to remain in place over winter in preparation for early-season concrete placement may be made by intermediate cost estimate at 30% of the product of the concrete masonry unit bid price and the plan quantity of concrete masonry in the formed and uncompleted portion of the superstructure. Forming must be complete and acceptable to the engineer before payment will be considered. No consideration for extra pay will be allowed for any refurbishment necessary in the spring to bring the forming to an acceptable condition for pouring.

236.2.6 Special Provision Items

Certain contracts may contain special provisions for payment for materials under conditions not provided for in the standard specifications. Payment policies generated by special provisions in these contracts are not applicable to materials furnished under other contracts. The other contracts are subject to the standard specifications payment requirements as explained above, unless modified by their own special provisions.

236.2.7 Delivered or Stored Material Prepayment (Stockpile Items)

For materials delivered to the job site or stored at approved locations off the job site, standard spec 109.6.3.2.1 provides that payment for the value of the materials may be made upon request by the contractor. Examples of stockpiled materials include piling, culvert pipe, bar steel reinforcement, steel plate beam guard, aggregates, and treated lumber.

Also, standard spec 109.6.3.2.1 stipulates that the value of materials that have been specifically manufactured, produced, or purchased for a project can be included for payment if stored at an approved

location such as in the fabricator's yard and accompanied by invoices or other evidence of costs incurred. Examples of these materials include fabricated girders, railings, expansion joints, sign bridges and supports, and prestressed girders. The contractor needs to provide evidence of costs incurred with invoices, freight bills, or other evidence including material description, identification, and cost data. The amount included in the estimate for these materials should include the sales tax paid and the freight costs.

In those instances when a transaction was not made, such as production of a gravel stockpile, the price to be prepaid should be based on the contractor's estimate of production costs and verified by WisDOT historical cost records.

The project engineer should document all transactions and should account for the payment of stockpiled items using the stockpile wizard in AASHTOWare Project Construction and Materials®. When creating stockpiles, if the bid item to be associated to a stockpile exists in two or more separate projects or categories, a separate stockpile should be created for each instance of the item.

The amounts paid for delivered, stored, or stockpiled materials will reduce the amount of other partial or final payments due to the contractor for the work performed as the materials are incorporated in the completed work.

All vendor claims must be satisfied within 30 days of receiving the payment, or the department may cancel the applicable payment in the next progress pay estimate.

SECTION 238 Administrative Items

238.1 Schedule of Administrative Items

The complete list of administrative items is provided in table 238-1. The correct use of these items in completing estimates is discussed in 236. Items with (xxxx) in the description should be further defined in the supplemental description in AASHTOWare Project Construction and Materials®. These items are considered a change modification in AASHTOWare Project Construction and Materials® but are not change orders requiring contractor approval.

238.2 Payment Instructions for Administrative Items

The engineer is not authorized to make entries other than those shown here in 238.

238.2.1 Railroad Flagging Reimbursement

Railroads may issue progressive bills. The engineer should notify the railroad when the work is completed and request a final bill from the railroad. The railroad will issue a final bill. The engineer should promptly pay railroad-flagging bills, less any charges that may be in dispute. The department will pay for flagging reimbursement under the Railroad Flagging Reimbursement administrative item. The department will withhold flagging reimbursement until any disputed charges are resolved and the final bill is paid. No reimbursement for flagging will be made by the department if a violation of subsection B is documented.

238.2.2 Nonconforming Work and Disincentive Work

CMM 810 presents important factors the engineer should consider when deciding to allow nonconforming materials to remain in place. The region oversight engineer should be involved in decisions involving nonconforming materials. If the decision is made to leave the material in place and apply a price adjustment, it is important to use the 800 series administrative items listed in table 238-1. The administrative items allow the statewide bureaus to track the frequency and types of work that require price adjustments.

238.2.3 Cost Reduction Incentive

Used to credit contractor for approved proposals for cost savings. Make sure to fill in the supplemental description to briefly describe of the nature of the CRI. Use the 800 series items listed in table 238-1. Refer to CMM 244 for a more thorough discussion.

238.2.4 Fuel Cost Adjustment, Credit, and Payment

Used to credit or charge for fuel cost adjustment. Use the 800 series items listed in table 238-1.

The department pays a fuel cost adjustment on contracts containing ASP 5, located after the special provision articles in the contract proposal. The department does not entertain contractor requests to apply adjustments for special provision bid items not included in the contract ASP 5.

238.2.5 Credit for Replacing Construction Stakes ($100/hr)

Standard spec 105.6 allows WisDOT to take a credit if the contract requires WisDOT staff to replace damaged stakes. Use the 800 series items in table 238-1.

238.2.6 Trees, Shrubs, and Vines Adjusted Price Payment

Use the standard 632.XXX item number with a supplemental description added for adjustment.

For example: bid item 632.0100 - Trees, Maple, 2-inch is a contract bid item. To pay for the item at 65% a new bid item would be added with an adjusted price and appropriate supplemental description. (i.e. 632.0100- Trees Maple 2-inch Adjusted Price 65%). If another adjustment is needed another item will be added. At the end of a proving period these items are changed to a zero quantity and the original contract item is paid in full, if applicable.

238.2.7 Special Provision Adjusted Payment Items

These items pertain to adjusted payments made under unique contract special provisions. Items with an adjusted price are added through AASHTOWare Project Construction and Materials® using the standard bid item number and description with a supplemental description added to differentiate between them.

In the following example, the contract has a unique special provision limiting payment under standard bid item 611.8110 Adjusting Manhole Covers, to 50% of contract bid price if the final cover elevation varies by at least 3/8-inch but less than 5/8-inch from abutting pavement elevation. Item 611.8110 was subsequently established by the engineer to cover a needed price adjustment using the supplemental description Adjusting Manhole Covers - 50% Price Reduction. It was assumed the contract bid price for item 611.8110 was $215.00, therefore this item's unit price is $107.50.

238.2.8 Item Transfer Between Categories

Item transfer between existing contract categories can be done in the AASHTOWare Project Construction and Materials® application.

238.2.9 Force Account Price Update

This involves updating the price, from the estimated CO price to the final audited price, of a force account item included in an approved change order.

238.2.10 Addition of New Project to Contract

New projects must be added in the AASHTOWare Project Construction and Materials® application by the region office and approved with a change order.

238.2.11 Addition of a Project Site

Revise 238.2.11 (Addition of a Project Site) to add administrative items for concrete pavement and structures.

New sites must be entered in the AASHTOWare Project Construction and Materials® application by the region office. New project sites could include intermediate completion dates or working days provided in the special provisions of the contract. Sites may be added at the engineer's request if additional site time is tracked using AASHTOWare Project Construction and Materials®.

TABLE 238-1 Administrative Items

ITEM	DESCRIPTION	UNIT	REFERENCE
800.0005	Non-Performance of QMP	DOL	Standard spec 701.5 and all QMPs
800.0010	Referee Testing	DOL	special provision and all QMPs
801.0104	Failing to Open Road to Traffic	DOL	special provision
801.0111	Failing to Open Road to Trains	DOL	special provision
801.0117	Railroad Flagging Reimbursement	DOL	special provision
801.0150	Cost Reduction Incentive (description)	DOL	standard spec 104.10.4.2
801.0400	Material from Right-of-Way	DOL	standard spec 104.8
801.0436	Dispute Review Board	DOL	CMM 253
801.0905	Fuel Cost Adjustment	DOL	ASP 5
801.0910	Steel Price Adjustment	DOL	special provision
802.0105	Removing Miscellaneous Concrete Structures	DOL	standard spec 204.5
802.0305	Removing Large Boulders	DOL	standard spec 205.5
802.0500	EBS Quantity Overrun	DOL	standard spec 205.5
802.0505	EBS Post Grading	DOL	standard spec 205.5
802.0510	EBS Post Placing Subbase	DOL	standard spec 301.5
802.0515	EBS Post Placing Base	DOL	standard spec 301.5
802.0520	Restoration Post Completion (Item)	DOL	standard spec 301.5
803.0100	Nonconforming QMP Base Aggregate Gradation	DOL	standard spec 730.5
803.0200	Nonconforming QMP Base Aggregate Fracture	DOL	standard spec 730.5
803.0300	Nonconforming QMP Base Aggregate Plasticity	DOL	standard spec 730.5
804.2005	Disincentive Density HMA Pavement	DOL	standard spec 460.5
804.2010	Disincentive Density PWL HMA Pavement	DOL	PWL special provision
804.2012	Disincentive Density HMA Pavement Longitudinal Joints	DOL	special provision
804.2015	Disincentive Air Voids HMA Pavement	DOL	PWL special provision
804.4306	Nonconforming QMP Asphaltic Material	DOL	standard spec 460.5
804.4308	Nonconforming QMP HMA Mixture	DOL	standard spec 460.5
804.4405	Excessively Diluted Tack Coat	DOL	standard spec 455.5
804.4410	Disincentive IRI Ride	DOL	standard spec 740.5
804.4420	Grinding for Bridge Ride	DOL	Bridge Ride special provision
804.4625	Nonconforming Tack Coat	DOL	standard spec 455.5
804.5005	HMA Delayed Test Strip	DOL	PWL special provision
804.5010	HMA Additional Test Strip	DOL	PWL special provision

ITEM	DESCRIPTION	UNIT	REFERENCE
804.5015	HMA Regional Lab Testing	DOL	PWL special provision
804.5105	Disincentive HMA Binder Content	DOL	PWL special provision
804.6005	Nonconforming Thickness Concrete Pavement	DOL	standard spec 415.5
804.6051	Disincentive Flexural Strength Concrete Pavement	DOL	standard spec 715.5
804.6052	Disincentive Compressive Strength Concrete Pavement	DOL	standard spec 715.5
804.6053	Disincentive Air Content Concrete Pavements	DOL	special provision
804.6054	Disincentive Delivery and Discharge Time Concrete Pavement	DOL	standard spec 715.5 and special provision
804.6055	Disincentive Strength Concrete Structures	DOL	standard spec 715.5
804.6056	Disincentive Air Content Concrete Structures	DOL	special provision
804.6058	Disincentive Delivery and Discharge Time Concrete Structures	DOL	standard spec 715.5 and special provision
804.6059	Disincentive Temperature Concrete Structures	DOL	standard spec 715.5 and special provision
804.6057	Disincentive Strength Concrete Barrier	DOL	standard spec 715.5
804.6060	Hot Weather Concreting	DOL	standard spec 501.5
804.7000	Crack Repair Concrete Pavement	DOL	standard spec 415.5
804.7010	Crack Repair Ancillary Concrete	DOL	standard spec 601.5
805.0252	Follow-Up Deck Crack Sealing	DOL	standard spec 502.5
805.0506	Excess Costs for Fabrication Shop Inspection	DOL	standard spec 506.5
805.5500	Pile Splices	DOL	standard spec 550.5
805.5505	Piling Quantity Variation	DOL	standard spec 550.5
806.0603	Nonconforming Smoothness Concrete Barrier	DOL	standard spec 603.5
806.0630	Failing to Perform Native Seeding Surveillance	DOL	standard spec 630.7
806.0632	Failing to Perform Landscape Surveillance	DOL	standard spec 632.5
806.2510	Restoration Post Acceptance Topsoil	DOL	standard spec 625.5
806.2810	Failing to Perform Corrective Action for Erosion Control	DOL	standard spec 628.5
806.2811	Failing to Mobilize for Erosion Control	DOL	standard spec 628.5
806.2812	Failing to Mobilize for Emergency Erosion Control	DOL	standard spec 628.5
806.5610	Electrical Service Lateral	DOL	standard spec 656.5

SECTION 240 Prompt Payment

240.1 Prompt Payment Compliance and Procedures

240.1.1 General

Payment issues should be discussed at preconstruction meetings. Additional Special Provision 4 (ASP 4) covers prompt payment while payroll reporting requirements are covered under ASP 7.

ASP 4 requires contractors to pay subcontractors for completed work within 10 calendar days of receiving a progress payment. If the prime contractor will not be making payment to a first-tier subcontractor within the prescribed 10 calendar days, they are required to notify that subcontractor and the engineer in writing and explain why they will be withholding payment.

ASP 4 affords similar prompt payment responsibilities and rights to lower-tier contractors and their subcontractors. Lower-tier contractors must notify their subcontractors and explain the reason for withholding payment in writing, but there is not a requirement to directly notify the engineer.

ASP 4 is incorporated in department contracts and is available online at:

https://wisconsindot.gov/hcciDocs/contracting-info/asp-4.pdf

The engineer determines whether a relationship constitutes subcontracting under ASP 4. Arrangements between contractors and suppliers frequently contain industry-standard delivery and payment terms. The department typically will not consider supplier relationships as subcontracting. Likewise, the department will not consider lower-tier contractual relationships a supplier might have as subcontracting.

The engineer should provide acceptance and payment information and attempt to facilitate discussions aimed at resolving first-tier prompt payment issues. Typically, the engineer needs to contact the affected subcontractor to hear their side of the issue. Hopefully follow-up conversations can resolve the issue before the subcontractor files a written complaint.

The department expects a lower-tier prompt payment issue to be resolved by the parties to that lower-tier subcontract. The engineer may offer an opinion as to whether the relationship in question constitutes subcontracting under ASP 4 and can provide acceptance and payment information. The department will entertain written complaints from lower-tier subcontractors.

240.1.2 Complaint Procedure

240.1.2.1 Complaints from First-Tier Subcontractors

The engineer should contact both parties and attempt to resolve the complaint. It is critical that the engineer document department actions when a prompt payment complaint is received as follows:

1. The project engineer writes a memo to the project files regarding the complaint received.
2. The project engineer/manager sends letters to all subcontractors asking if they have been paid promptly. Try to be as specific as possible. Cite the particular estimate dates that the complaint involves. Ask the subcontractors to respond within ten days regardless of if they have, or have not, been paid promptly. Copy the Bureau of Project Development oversight engineer for the region. An example letter is shown in Figure 240-1.
3. If the subcontractors' replies indicate that more than the complainant have payment issues, the project manager/area supervisor sends the prime contractor a letter directing them to pay within ten days or provide a "just cause" explanation for withholding payment. Direct the prime contractor to inform the engineer when all payments have been made. An example letter is shown in Figure 240-2. Copy the Bureau of Project Development oversight engineer for the region.
4. If the issue is not resolved, inform (via registered mail) the prime contractor that they are in default and that the department is referring the matter to the Bureau of Project Development for appropriate action. The Regional Project Development Chief should write this letter. An example letter is shown in Figure 240-3. Copy the Bureau of Project Development oversight engineer for the region. Copy the prime contractor's bonding company also.
5. If the issue is resolved send a closure letter to the complainant. Copy the Bureau of Project Development oversight engineer for the region.

240.1.2.2 Complaints from Lower-Tier Subcontractors

The engineer should notify the contractor when complaint is received and ask them to resolve the issue among the parties to the lower-tier subcontract. It is critical that the engineer document department actions when a prompt payment complaint is received as follows:

1. The project engineer calls or emails the contractor to notify them that a complaint was received and to request that the contractor resolve the issue.
2. The project engineer writes a memo to the project files regarding the complaint received and notification of contractor.

FIGURE 240-1 Example Letter

WisDOT Division of Transportation System Development
Southwest Region
3550 Mormon Coulee Road
LaCrosse, WI 54601-6767

Governor Tony Evers
Secretary Kristina Boardman
wisconsindot.gov
Telephone: (608) 785-9022
FAX: (608) 785-9969
Email: Lacrosse.DTSD@dot.wi.gov

January 10, 2025

Attn:
Subcontractor XYZ
120 Roy Road
Madison, WI 53711

Subject:
Project ID: 1202-02-72
Main Street; N. Village to S. Village Limits
County, STH XX

Dear Subcontractor XYZ,

Our records indicate that your firm either performed work or furnished materials for *AAA Construction* on the above referenced report.

Addition Special Provision 4 states, "Within 10 calendar days of receiving a progress payment for work completed by a subcontractor, pay the subcontractor for that work." We are asking all subcontractors on the approved sublet list if they have been paid promptly in accordance with ASP-4.

Please respond back to *John Smith* stating whether you have or have not been receiving prompt payment on this project. If payments have been received late or have not been received at all, please include details such as estimate number(s), date(s) payment was received, balances owed, and any other pertinent information.

I request that you reply to me on this matter by *May 20, 2021,* so that we can resolve any potential issues in a timely manner. If you have any questions regarding this issue or would like more clarification, please contact me at 608-555-5555.

Sincerely,

John Smith

John Smith
Project Manager

Cc: AAA Construction (Contractor)
BPD Oversight Engineer

FIGURE 240-2 Example Letter

WisDOT Division of Transportation System Development
Southwest Region
3550 Mormon Coulee Road
LaCrosse, WI 54601-6767

Governor Tony Evers
Secretary Kristina Boardman
wisconsindot.gov
Telephone: (608) 785-9022
FAX: (608) 785-9969
Email: Lacrosse.DTSD@dot.wi.gov

January 10, 2025

AAA Construction
6301 E. Martin Street
PO Box 8905
Eau Claire, WI 53700-8905

Subject:
Prompt Payment to Subcontractors, Project ID 1001-06-72
Manhat Street, City of Osseo, CTH XX,
Trempealeau County, WI

Gentlemen,

It has come to our attention that you have not compensated your sub-contractors for all their work completed on the subject project.

Addition Special Provision 4 states, "Within 10 calendar days of receiving a progress payment for work completed by a subcontractor, pay the subcontractor for that work."

The letter serves to inform you that you have ten (10) days to either pay for the satisfactory work performed by your sub-contractors or provide the Department with "Good Cause" for non-payment. Absent of "Good Cause", when your payment is made, please send a copy of the check to the Region Office as verification that you followed through on your contract obligations. If you fail to comply, the Department may proceed with "Terminating the Contract for Default" per subsection 108.12 of the Standard Specifications.

If you have any questions regarding this issue or would like more clarification, please contact me at 608-555-5555.

Sincerely,

Roy Robbe

Roy Robbe
Project Manager

Cc: BPD Oversight Engineer
Bonding Company
Region File

FIGURE 240-3 Example Letter

WisDOT Division of Transportation System Development
Southwest Region
3550 Mormon Coulee Road
LaCrosse, WI 54601-6767

Governor Tony Evers
Secretary Kristina Boardman
wisconsindot.gov
Telephone: (608) 785-9022
FAX: (608) 785-9969
Email: Lacrosse.DTSD@dot.wi.gov

January 10, 2025

AAA Construction
6301 E. Martin Street
PO Box 8905
Eau Claire, WI 53700-8905

Subject:
Prompt Payment to Subcontractors, Project ID 1001-06-72
Manhat Street, City of Osseo, CTH XX,
Trempealeau County, WI

Gentlemen,

It has come to our attention that you have not compensated your sub-contractors for all their work completed on the subject project.

Addition Special Provision 4 states, "Within 10 calendar days of receiving a progress payment for work completed by a subcontractor, pay the subcontractor for that work."

The letter serves to inform you that you have ten (10) days to either pay for the satisfactory work performed by your sub-contractors or provide the Department with "Good Cause" for non-payment. Absent of "Good Cause", when your payment is made, please send a copy of the check to the Region Office as verification that you followed through on your contract obligations. If you fail to comply, the Department may proceed with "Terminating the Contract for Default" per subsection 108.12 of the Standard Specifications.

If you have any questions regarding this issue or would like more clarification, please contact me at 608-555-5555.

Sincerely,

Roy Robbe

Roy Robbe
Project Manager

Cc: BPD Oversight Engineer
Bonding Company
Region File

SECTION 242 Change Orders

242.1 General

It is the contractor's responsibility and duty to construct the project in accordance with the requirements of the plans, special provisions, and specifications as originally drawn and written, unless revised by approved written change orders. Change orders (CO's) represent alterations or revisions of plans and item quantities, revisions of bid item method of measurement, omission of work items found unnecessary during construction, and extra work required to properly complete the project.

There are three components to consider when a contractor requests a change order:

1. **Entitlement:** If a contractor is seeking additional compensation or additional contract time, they must show a contractual basis of entitlement. Is payment or contract time already covered under the existing contract? Entitlement must be decided first before discussing the remaining components.
2. **Impact:** If the parties agree that there is a basis of entitlement, the contractor must provide evidence that their work activities are affected. It is possible for a contractor to have entitlement, but not have their work impacted. If there is no impact, there is no need for additional compensation or time.
3. **Cost:** Cost should only be discussed and negotiated after determining that the contractor has a basis of entitlement and confirming that their work is impacted.

In general, AASHTOWare Project Construction and Materials® considers any changes or modifications to the contract once awarded to be a change order. Not all modifications must go through the change order process with electronic approvals from WisDOT and contractor representatives. Examples of these include adding an existing bid item to a different category or adding an administrative or non-bid item to the contract as discussed in CMM 238. When items are added in this fashion, a sequential number is assigned automatically to change orders as they are entered. Therefore, change orders (CO) will not be in sequential order if a non-CO modification is made.

The CO is a written agreement executed between the contractor and the department that provides the ability to alter the contract. Change orders are specified in standard spec 104.2. The department reserves the right to alter the plans and terms of the contract by changes, additions, or omissions necessary to properly complete work under the contract. Alterations can include changes in plans, specifications, special provisions, item quantities, the performance of extra work, and other changes in the contract necessary for the acceptable completion of the project. It is a change in the contract that upon execution becomes a part of the contract.

During the progress of the work, the project engineer should anticipate alterations necessary to acceptably complete the project and furnish the detail to the region if needed in sufficient time to obtain prior approval without unnecessary delay to the contractor. Generally, consideration should not be given to alterations, unless one or more of the following conditions are satisfied:

1. The project cannot reasonably be constructed as specified.
2. A substantially equal product can be furnished with a cost savings to the project.
3. A superior product can be furnished at the original contract price.

Please refer to CMM 110.4.2.5 - Change Management for a discussion of change from a project management perspective.

242.2 Reasons for Change Orders

Revise 242.2 (Reasons for Change Orders) to reorganize, renumber and update guidance to match standard specification updates that occurred with ASP-6 effective with the February 2026 let.

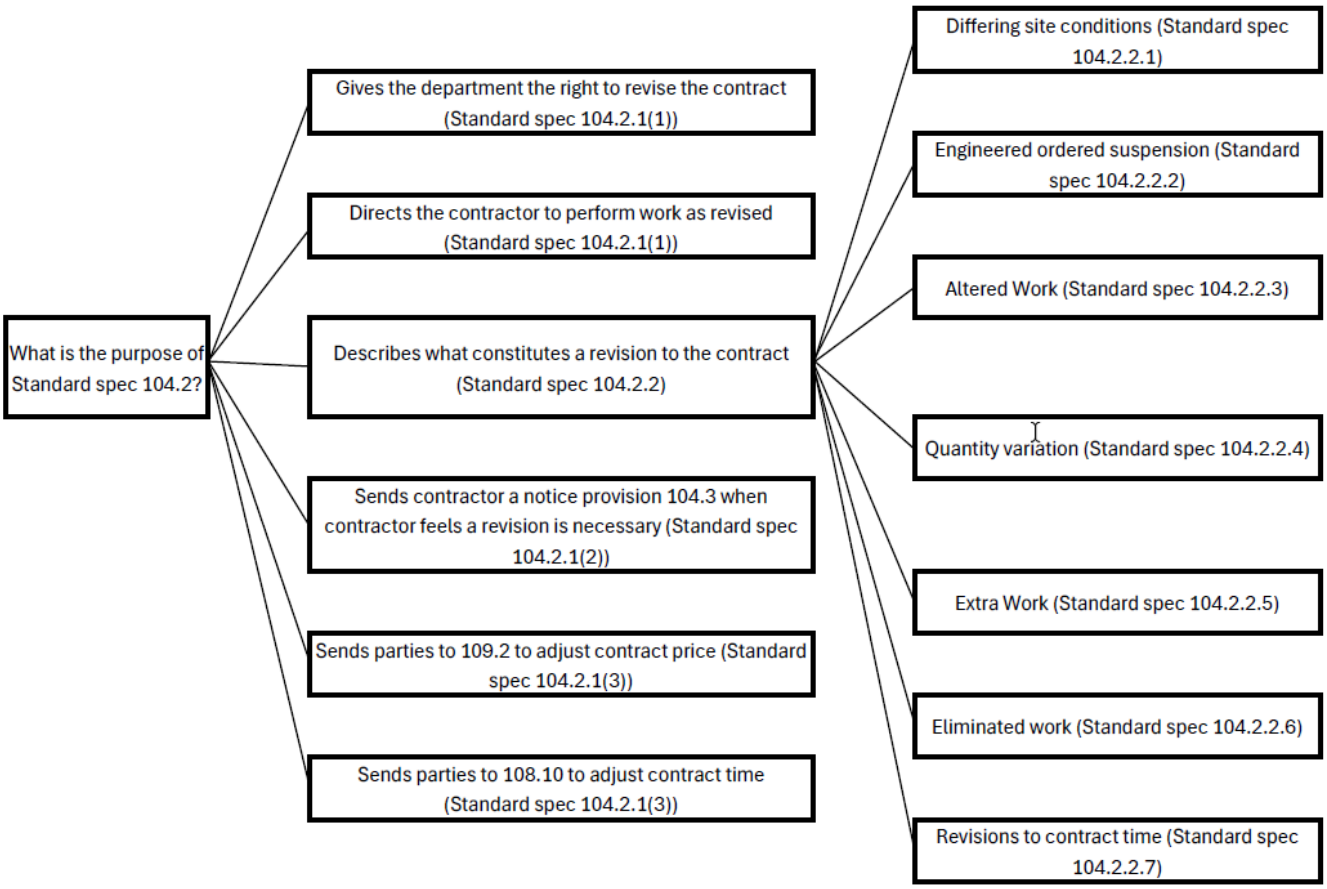
Change orders (CO) are not required for normal increases or decreases in the quantity of a contract item. They are not required for omission of minor items where no prior costs are involved; nor are they required where adjustment of an item is provided for in the specifications.

There are several reasons why a CO should be processed:

- Differing site conditions.
- Engineer-ordered suspensions.
- Altered work
- Quantity variation.
- Extra work.
- Eliminated work.
- Revisions to contract time.
- Unauthorized or unacceptable work.

No contract adjustment that results in a benefit to the contractor will be allowed unless the contractor has provided the required written notice.

FIGURE 242-1 Revisions to Contract



242.2.1 Differing Site Condition

A change order can be justified during the progress of work if one of two types of condition is encountered:

- Type I Condition - Subsurface or latent (not clearly visible) physical conditions are encountered at the site differing materially from those indicated in the contract.
- Type II Condition - Unknown physical conditions of an unusual nature are encountered, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract.

The party discovering such conditions must promptly notify the other party, in writing, of the specific differing conditions before they are disturbed and before the affected work is performed. One example of a differing site condition is the discovery of non-rippable bedrock of significant extent and not noted on the plans.

Upon written notification, the project engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing accordingly. The project engineer will notify the contractor of the determination whether or not an adjustment of the contract is warranted.

If differing site conditions require a change in operations to an activity or area that requires an environmental permit, the contractor must verify whether existing permits cover the change, or whether new permits are needed.

242.2.1.1 Type I Condition

Some examples of potential Type I conditions include encountering the following: more rock than indicated in the contract, larger rock, rock that is harder to drill, permafrost when the boring had given no indication of its general extent, or unexpected quantities of underground water not indicated on the boring logs.

While these are potential Type I conditions, in order to receive compensation, the contractor must prove the following by a preponderance of evidence:

1. Contract documents must have affirmatively indicated or represented the subsurface or latent physical conditions which form the basis of the contractor's claim.
2. Contractor must have acted as a reasonably prudent contractor in interpreting the contract documents.
3. Contractor must have reasonably relied on the indications of subsurface or latent physical conditions in the contract.
4. Subsurface or latent physical conditions actually encountered within the contract area must have differed materially from the conditions indicated in the same contract area.
5. Actual subsurface conditions or latent physical conditions encountered must have been reasonably unforeseeable.
6. Contractor's claimed excess costs must be shown to be solely attributable to the materially different subsurface or latent physical conditions within the contract site.

To prove these six elements, the contractor is only required to use a simple logical process in evaluating the information in the contract documents to determine the expected subsurface or latent physical conditions.

242.2.1.2 Type II Condition

Some examples of a potential Type II conditions include unanticipated hazardous waste deposits or unanticipated archaeological sites.

To recover costs under a Type II condition, the contractor must prove:

1. Contractor did not know about the condition.
2. Contractor could not have reasonably anticipated the condition after a review of the contract documents, a site inspection, and the contractor's general experience in that area.
3. Condition was unusual because it varied from the norm in similar construction work.

242.2.2 Engineer-Ordered Suspensions

Suspension of work may be included in the contract provisions or may be ordered by the project engineer. Complete suspension of work operations normally is related to seasonal or weather restrictions. However, the contract may also provide for complete suspension of operations for other reasons such as coordination of road or lane closures with off peak traffic volumes. See CMM 248 for more information on Engineer-ordered suspensions.

242.2.3 Altered Work

When the change involves alterations in the nature of the original proposed construction, the price should be adjusted as provided in standard spec 109.4.4.

The basis for the adjustment must be agreed upon before the performance of the work. The price adjustment should not include loss of anticipated profits. If a basis cannot be agreed upon, then an adjustment will be made either for or against the contractor, in an amount the department determines to be fair and equitable. If the alterations do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

242.2.4 Quantity Variation

A quantity variation is relevant when the final measured quantity for original contract work differs from the plan quantity for that bid item. A quantity change alone does not necessarily justify a price adjustment. To qualify for a contract change, the contractor must be able to show that the quantity change significantly changed the character of the work. If the quantity change meets the variation criteria in standard spec 104.2.2.4 and affects how the contractor is able to complete the work, then a price adjustment may be warranted.

The revision of unit prices must be adjusted on the basis of actual increased cost due solely to the change, plus a reasonable allowance for profit and applicable overhead. The work involved in significant changes will be paid for at adjusted contract unit prices except when portions of it qualify as extra work. If the quantity variation does not significantly change the character of the work to be performed under the contract, the work will be paid for as provided elsewhere in the contract.

242.2.5 Extra Work

Extra work is defined as all work performed by the contractor, with approval of the project engineer or, that does not appear in the proposal or contract as a specific bid item accompanied by a unit price, and that is not included under the price bid for other bid items in the contract. Extra work may also consist of additions to, or changes in, design of contract bid items or portions of contract bid items, if additions are wholly disassociated from or outside the scope of work in the contract, and if the work caused by these additions or changes must be performed under conditions or in a manner materially different from the conditions and manner existent for contract bid items under the original scope of work.

Work and materials that have been ordered performed by the project engineer that do not appear in the contract as specific items, and that are not included under other contract items, are considered to be extra work.

Extra work may also be additions or changes in the design occurring outside the original project scope, resulting in work performed under conditions and in a manner differing from the original. Extra work must be authorized before performance except when otherwise directed by the project engineer.

When the required extra work is essentially the same in character as that covered by unit prices in the contract, the change order will be drawn to perform the extra work at the contract unit prices. However, if the contract does not contain unit prices for the required items of work, or if the nature of the work or conditions associated with its performance are materially and inherently different from that intended for such items of work in the original contract, the change order will be drawn to perform the work at agreed unit prices or at an agreed lump sum price. If negotiations with the contractor fail to reach an agreement on fair and reasonable prices for doing the work, the project engineer may order the work to be performed on a force account basis and the change order will be written accordingly.

When the extra work is relatively minor in extent and can be performed concurrently with other contract work, the change order need not include any reference to contract time. However, if the work cannot be done concurrently, or if the amount of time required to perform the extra work is disproportionate to the time that would automatically accrue due to the increased value, the change order should provide for an appropriate time extension to avoid the assessment of unwarranted liquidated damages.

242.2.6 Eliminated Work

The department has the right to partially eliminate or completely eliminate work the project engineer finds to be unnecessary for the project. If the project engineer partially eliminates or completely eliminates an item, the project engineer will issue a change order to compensate the contractor for bid preparation, overhead, and restocking charges, as specified in standard spec 109.5.

242.2.7 Revisions to Contract Time

If a contractor wants to request an extension of the time allowed for contract completion, the contractor should submit in writing a request to the project engineer, including progress schedules and an analysis of the contract delay, consistent with the requirements specified in standard spec 108.10. Approval of requests for extensions of contract time has been delegated to the region office.

In analyzing requests, a thorough review of the contractor's progress schedule and the project engineer's diary and records is necessary. Of prime importance is the daily recording of information that will clearly establish the reason for delays in the progress of the work. The project engineer should identify and log in the diary delays to contract operation on a day-to-day basis. Recording of daily delays and clear indication of the percentage of delay to the item of work affecting overall progress is of particular benefit in the review of requests. If doubt exists as to whether a delay is important, it is better to record it, specifying the item of work affected by the interruption. It is far easier to disregard a superfluous daily entry than to retrieve truly factual and objective information from memory.

A contractor progress schedule is required under standard spec 108.4.

242.2.7.1 Excusable Delays

Excusable delays are unanticipated delays not resulting from the contractor's fault or negligence. Excusable delays are justification for granting a time extension only if the delay affects a controlling item of work. Contractors must provide documentation and schedule updates to support their requested time extensions, as specified in standard spec 108.10. The department may choose not to consider time extensions for delays unless the contractor notifies the project engineer and provides the correct documentation.

A telescoping delay is an excusable delay that occurs after the expiration of a granted time extension, when work could not be completed within the extended time, due to an unavoidable delay during the granted time extension. Telescoping delays will be considered for time extension.

242.2.7.2 Excusable Delays - Non-Compensable

Non-compensable delays are excusable delays that are not the contractor's or the department's fault. The Engineer will not pay for the delay costs listed in standard spec 109.4.7 for non-compensable delays. However, the Engineer will extend contract time under calendar day and completion date contracts if the contractor provides the proper documentation, and the department deems the delay as excusable. The department will relieve the contractor of associated liquidated damages if the Engineer extends contract time.

The following delay examples are subject to standard spec 108.10.2 but are not to be considered all-inclusive.

- Extraordinary adverse weather delays. A certain amount of lost time due to adverse weather is anticipated and included in the calculation of contract time allowed for calendar day and completion date contracts. In analyzing requests for contract time extensions due to weather delays see standard spec 108.10.2.2. Submit a request for severe weather days if the number of adverse weather days exceeds the anticipated number of adverse weather days specified in standard spec 108.10.2.2. Fractions of one-half day will be rounded to the benefit of the contractor.
- Materials shortages or delay in delivery. Generally, a materials shortage is recognized as a basis for a time extension if it can be shown that it is area-wide, or a second-tier supplier possessing a virtual monopoly in a particular material or market area cannot or will not supply a first-tier supplier, and the first tier supplier can show reasonable efforts have been made to ensure there are no other sources of supply.
- Delays due to work suspension or extra work. If project work has been suspended by the Engineer due to job conditions, or caused by others, i.e., as by a court order or by an act or omission of the department, a request on this basis will be considered. If extra work will be or has been performed, a request on this basis would be considered. Normally, the change order for extra work will provide for an extension of time if justified.
- Labor strikes. An individual contractor has little, if any, control over events leading to an organized strike. Therefore, if the contractor sustains delay to work operations for this reason, it will be fully considered as basis for an extension of time.
- Cataclysmic phenomena. Earthquakes, flood, cyclones, tornadoes, etc., fall into this category. A request made on this basis will be fully considered.
- Delays due to third parties. If a contractor's operations have been adversely affected by a third party's failure to perform under a separate contract, such failure will be fully considered as basis for a contract time extension to the first contractor.

242.2.8 Unauthorized or Unacceptable Work

Unauthorized and unacceptable work may be cause for a change order, but it does not always result in a change order. See CMM 238 for administrative items used to deduct payment to the contractor. These items will provide a means to deduct payment without creating a change order.

242.2.8.1 Unauthorized Work

Unauthorized work is work performed beyond the limits indicated by the lines and grades shown on the plans or other terms of the contract. It can also be additional work not authorized by written agreement. Unauthorized work will not be paid for and may, at the discretion of the Engineer, be ordered removed or otherwise corrected by the contractor at the contractor's expense.

242.2.8.2 Unacceptable Work

Unacceptable work is that which is not within reasonably close conformity with the plans and specifications, resulting in an inferior product. The contractor is required to immediately remove and acceptably replace or otherwise correct unacceptable work at the contractor's expense. If the contactor fails to comply with written directions for such corrective work, the Engineer will direct unacceptable work to be remedied, or to be removed and replaced by others. The cost will be deducted from any monies due or to become due the contractor.

Standard spec 105.3 provides that, should the Engineer find that the work is not within reasonably close conformity with the plans and specifications, but reasonably acceptable work has been produced, the work can be left in place and the contractor compensated as provided in the specifications for the particular item of work, or on a basis determined by the Engineer which reflects the reasonable value of the work. Examples of such work would be surface courses, base courses, and similar items which have minor defects, or which have been constructed with materials having minor defects.

Standard spec 105.3 further provides that if the Engineer finds that the materials, finished product in which the materials are used, or the work performed are not in reasonably close conformity with the plans and specifications, and have resulted in an inferior product, the work or materials must be removed and replaced or otherwise corrected by and at the expense of the contractor.

242.3 Contractor Notification

Standard spec 104.3 describes the process to used when contractors identify what they think is a potential change to the contract. This notification clause is intended to address communication problems and to have the following benefits:

- Early and clear notification of potential changes.
- Better exchange of information.
- Mechanisms to keep resolution process moving.
- Reduced number of claims.

The process is designed to resolve the issue as early as possible.

The sole purpose of the contractor notification process is to answer the entitlement question. Is the contractor entitled to a change order for the work in question, or is the department entitled to get the work done within the existing contract. The notification process is not used to negotiate the change order standard spec 108.10 and standard spec 109.4 provide direction to negotiate the time and cost aspects of the change.

The contractor starts by telling the project engineer what they perceive to be a contract change. If the project engineer would decide that this is a change, then both parties would proceed to revise the contract, or the project engineer could decide that it isn't a change and discuss it to the contractor's satisfaction such that the contractor would drop the issue.

In the event the issue hasn't been resolved in the first 5 days, one of the two following options could have happened. The project engineer didn't respond, or the contractor disagreed with the project engineer's initial decision that the situation isn't a change to the contract.

If the contractor decides to pursue the change, the contractor can provide a 5-day written statement. The content requirements for the 5-day statement are specified in standard spec 104.3.

The project engineer will attempt to resolve the issue and decide if there is a change to the contract. The specification requires the project engineer to respond in writing within 5 business days and the content of this response is described in standard spec 104.3.6. The project engineer can respond yes, no, or request for more information (Diamond 9). Once this is decided the contractor can then drop the issue, provide requested information, or pursue the unresolved change by filing a notice of claim as described in standard spec 105.13.

242.4 Change Order Types

CO's involving a change in the contract price, whether an increase or a decrease, must be fair and reasonable and adequately supported in the justification document, which must include a cost analysis.

The change order will provide for payment by one of the following methods:

- Contract unit price.
- Agreed unit price.
- Agreed lump sum for the work.
- Force account.

A CO may provide for payment for one or more items of work by one method, and for other items by another method. The project engineer should be alert for situations that might require a change order and should discuss the possible need with the region well in advance of the work to be done under the CO.

CO's relative to consultant construction engineering and inspection contracts will be directly submitted to the Consultant Services unit for processing.

242.4.1 Contract Unit Price

When payment for the work is by contract unit price, the CO language should include a statement that the work was negotiated at contract unit price.

242.4.2 Lump Sum and Unit Price Agreements

In presenting a change order for approval when payment for the work is on an agreed unit price or agreed lump sum basis, evidence of the method of arriving at the agreed unit or lump sum price should accompany it.

For CO work performed at contract unit price or at an agreed unit price, each unit as completed is measured and recorded. The CO should be concise and specific in detail. It should identify in what respect the contract is changed (plans, special provisions, standard specifications, etc.) and clearly stipulate any change involved in method of measurement and basis of payment. It should, where appropriate, show the increase or decrease in contract value.

COs should not include the reason for the change order; instead, the reason should be detailed in the project diary and should be fully explained in the justification document that supports and accompanies the CO. Also, the transmitting memo will include a description of the changed work and a cost analysis or justification if applicable. If a change order authorizes work in an area that requires an environmental permit, the memo must state whether the existing permits cover the change, or whether new permits or permit modifications are required. If permit modifications are required, the memo must state whether they have been obtained or applied for. Pertinent plan drawings are to be attached to the order.

242.4.3 Force Account Work

When extra work described in a change order is to be performed on a force account basis, evidence of the method of arriving at the estimated cost should accompany the order. Refer to CMM 246 for more detailed guidance on force accounts.

242.5 Creating the Change Order

The change order report is a legal contractual document identifying the details of the change order and should read as such. The contractual changes should read just as they do in the standard specifications and special provisions. Any item that is added that is not a standard bid item or does not have a standard special provision written for it should include the description, method of measurement, and basis of payment. The justification for the change needs to be documented on DT2355, Contract Modification Justification (CMJ).

The CMJ is used internally and not distributed to the contractor. The CMJ includes:

- Description and need for the change.
- Consequences if the change order is not approved.
- Alternatives considered.
- Estimated price.
- Justification of price.
- Consideration for affecting contract time.
- Local program projects to notify the local public agency as instructed in CMM 242.6.2.
- If the contract is subject to Federal oversight, then special attention should be given to completing the form conforming to the instructions in CMM 242.6.2.

If the CMJ estimate changes by more than $25,000 or 25%, or the CMJ is determined to no longer be required, a new CMJ should be drafted and routed appropriately for approval. The new CMJ will void the previous one. Attach a copy of the original CMJ to the new CMJ.

A CMJ is also required for administrative items that are not already in the proposal schedule of items. Administrative items are listed in CMM 238.1.

242.5.1 Reason Codes

Enter one of the following reason codes as the first 2 digits of the reason for each item entered on the change order report. It's important to enter the reason code that best describes the basis for the change order because the reason codes can help central office to identify statewide or region wide trends in areas requiring additional attention.

242.5.1.1 CR (Cost Reduction)

Items to compensate the contractor for cost saving proposals under standard spec 104.10.

242.5.1.2 MI (Miscellaneous)

Items not covered by other codes. Examples: On-the-Job training, time extensions, railroad conflict, abnormal or poor weather conditions.

242.5.1.3 PC (Plan Change)

Addition or deletion of items not originally contemplated, or a changed condition not known during design but determined to be necessary or advisable to construct the project. Example: retaining wall, change in pavement type, extending the project limits, change in scope, change in actual ground compared to borings.

242.5.1.4 PI (Plan Inadequacy)

Addition or deletion of items that are required to build the project but were not included or portrayed inaccurately. Example: concrete flumes, EBS (Unclassified).

242.5.1.5 RO (Request by Others)

Post-let items of work added by request from others. Example: request by a city, county, or town official or other agency.

242.5.1.6 SE (Safety Enhancement)

Addition to contract to safely construct the project. Example: traffic control, barrier, or sheeting.

242.5.1.7 SS (Change/Credit Standards and Specifications)

Items modified in original contract due to negotiation of change, or acceptance of items of substandard or different specifications. Example: defective material, change in plan to incorporate new standard details, change in asphalt specifications.

242.5.1.8 UC (Utility Conflict)

Compensation or contract time provided to the contractor due to utility conflicts, as allowed by the contract specifications.

242.5.1.9 DB (Disadvantaged Business)

Changes to previously approved DBE subcontractor commitments as described in CMM 242.6.3.

242.6 Approvals for Change Orders

242.6.1 General

For contracts administered in AASHTOWare Project Construction and Materials®, a change order is submitted for approval electronically within the application. Based on pre-established change order approval groups, the system will send email notifications to each approver when it is their turn to review the change order.

TABLE 242-1 Change Order Types, Approval Levels, and Order of Approval

Change Order Type	Description	Approval Levels / Order
ADMIN	Change Order with No Items Contract language changes without items or time extensions without items.	1 - Project engineer 2 - Contractor 3 - Project manager - Add supervisor and chief approval levels for time extensions.
STANDARD	Standard Change Order Must add items, have item increases/decreases, or time extensions with items to use this change order type.	1 - Project engineer (all) 2 - Contractor (all) 3 - Project manager (up to $49,999) 4 - Supervisor ($50,000 - $99,999) 5 - Chief ($100,000 +) - The default approval levels are based on the net value of the change order. The project engineer needs to calculate the absolute value and adjust the approval levels accordingly. - Add the supervisor and chief approval levels for time extensions. - A change order with administrative items only may be processed without contractor approval as directed by the Project Manager or Supervisor after a minimum of 7 days pending contractor approval in AWP and email notification to the contractor.
MAJORS	Mega/Majors Project Change Order Must add items, have item increases/decreases, or time extensions with items to use this change order type.	1 - Project engineer (all) 2 - Contractor (all) 3 - Project manager (up to $99,999) 4 - Supervisor ($100,000 - $499,999) 5 - Chief ($500,000 +) - The default approval levels are based on the net value of the change order. The project engineer needs to calculate the absolute value and adjust the approval levels accordingly. - Add supervisor and chief approval levels for time extensions. - A change order with administrative items only may be processed without contractor approval as directed by the Project Manager or Supervisor after a minimum of 7 days pending contractor approval in AWP and email notification to the contractor.
PbM	Performance Based Maintenance (PbM) Change Order	1 - County (all) 2 - Project engineer (up to $10,000) 3 - Supervisor ($10,000 to $49,999) 4 - Chief ($50,000 +) - The default approval levels are based on the net value of the change order. The project engineer needs to calculate the absolute value and adjust the approval levels accordingly.

A copy of the change order report should be distributed as follows:

TABLE 242-2 Change Order Distribution

Project Type	Approval	COPIES SENT TO: Region Office submits one copy of executed change order report		
		FHWA	Bureau of Project Development	Bureau of Financial Services
FHWA Oversight Projects	Region Office with FHWA prior approval of CMJ (refer to CMM 242.6.4)	YES	YES	YES
Non-FHWA Oversight Projects	Region Office	NO	YES	YES
Local Program Projects	Region Office with Local Public Agency Notification	NO	YES	YES

242.6.2 Local Program Project Changes

When changes occur to local program projects, notification to the local public agency (LPA) is required.

The Contract Modification Justification (CMJ) serves as notification to the LPA of the change and becomes the basis for a contract modification.

The department will notify the LPA of all CMJs and records the LPA contact's name and date notified, on the DT2355. Comments received from the LPA can be attached to the CMJ packet.

242.6.3 DBE Subcontractor Commitment Changes

When changes occur to a DBE subcontractor commitment, coordination with the department's DBE office is required. Examples requiring coordination are:

- Adding a DBE contractor.
- Removing or replacing a DBE contractor.
- Modifying a DBE contractor's work.

Changes that reduce an approved DBE commitment must be approved by the DBE office before completing a change order unless the change is initiated by WisDOT. If WisDOT initiates the change, the project engineer should notify the DBE office as soon as practicable to confirm that the prime contractor has communicated with the DBE.

Field staff needs to conform to the following process:

1. The prime contractor must notify the DBE office and copy the project engineer to request a change to a previously approved DBE commitment.
2. The DBE office approves or denies the change, informs the prime contractor and copies the project engineer.
3. The project engineer executes a change order if the DBE office approves the modification and informs the DBE office at the following email address: DBE_Alert@dot.wi.gov
4. The DBE office follows up with the prime contractor and project engineer regarding all commitment modifications.
5. The project engineer withholds payment from the prime contractor for unapproved changes.

At every weekly project meeting, the project engineer needs to discuss DBE participation with the prime contractor to ensure the amended commitment is still on track and inform the DBE office if it is not.

242.6.4 Changes to FHWA Oversight Projects

Federal Regulation 23 CFR 635.120 must be followed on all federally assisted contracts. This regulation requires WisDOT to effectively document change justifications and that FHWA prior approval is required for major changes. CMJs are used to document these changes.

To determine if the project is a FHWA Oversight project, check the folder on the Division of Transportation Development (DTSD) Collaboration Site – Project Management Reports web page on the WisDOT SharePoint site located at:

https://wigov.sharepoint.com/sites/dot-dtsd/SitePages/Project-Management-Reports.aspx

On this page there is a folder called "FHWA Oversight Project List" that contains a quarterly federal oversight report. This report identifies the type of FHWA oversight for projects. The proposal should also document if the project is subject to federal oversight.

If the project is a FHWA Oversight project and any of the three conditions below occur, the department is to obtain FHWA prior approval through signature on the CMJ before any work begins on changes to the plans, specifications, special provisions, significant plan quantities or extra work. The three conditions are:

- Is a change of +/- $250,000 or greater, based on the sum of the absolute value(s) of the estimated cost change(s) in the contract? (For example, the contract originally called for 6" concrete pavement, valued at $100,000. The area was reevaluated, and it was determined that 7" concrete pavement was required, and its value is $150,000. The net cost change is a positive $50,000 ($150,000 - $100,000), the absolute value of the change is $100,000 + $150,000 = $250,000. Since the absolute cost change is equal to or greater than $250,000, the CMJ has to be approved by FHWA.)
- Changes the scope or intent of the project, regardless of cost impact.
- Time extensions.

Work outside the project limits is not an acceptable practice and cannot be added to the project by change order. However, if there is an emergency or other unique and compelling reasons that support this approach, FHWA prior approval is required, regardless of participation in the change.

A DT2355, Contract Modification Justification (CMJ) is used to document issues that change the contract.

The CMJ serves as notification to FHWA of the change and becomes the basis for a change order. The project engineer completes a CMJ for each separate issue regardless of if prior approval is required. An issue may involve/include multiple related items of work that will be included in one CMJ.

The CMJ should capture all adjustments to the contract as a result of the change, such as:

- Impacts to schedule (*required per 23 CFR §635.120(c)*). Include an indication how changed item(s) affect the critical path and include documentation that supports why the revised time is appropriate.
- Changes to interim completion dates or changes to Interim Liquidated Damage rates.
- Traffic Management Plan (TMP) changes.
- Materials testing requirements.

The department will send all CMJs to FHWA. This includes CMJs for non-participating items. FHWA will review all CMJs. The only CMJs approved by FHWA are ones requiring prior approval. FHWA will notify the department if there is any concern regarding the CMJs reviewed before the Contract Modification is processed.

An initial independent cost analysis supporting the estimated cost should be attached to the CMJ with the prior approval request. Show the rationale behind the proposed lump sum or unit cost, such as average unit price history, actual bid history from As-read bids, Estimator®, or Bid Express®; or from labor, equipment, materials and time estimates. The department should discuss with the Federal Oversight Engineer the acceptable cost justification required for the issue.

A change order can include multiple CMJs. This allows for consolidation of accumulated CMJs and fewer Contract Modifications submitted for review. The net dollar amount of the change order can exceed $250,000. The need for prior approval is not based on the change order total but is instead based on the value of the individual CMJs as indicated above and as long as each CMJ represented does not exceed the $250,000 cost change threshold (based on the sum of the absolute value(s) of the estimated cost changes). Indicate which CMJs are included as part of the change order.

Changes that affect a local unit of government do not require the approval of the local unit (the change order does not require the local unit's signature). However, the region should keep the local unit informed of proposed changes and send them a copy of each approved change order that affects them.

Each region has its own process for change order distribution once the approval process is complete. Please direct any questions to the region office.

242.6.5 Prior Approval

FHWA prior approval is provided formally via the CMJ. FHWA prior approval requests are to be made via e-mail. The e-mail is to include the Contract Modification Justification. If immediate prior approval is required by FHWA, it can be given in person or over the phone. The project engineer is to follow up with an e-mail documenting the conversation including date and time it took place and print it. Copies of all CMJs for federal oversight contracts should be provided to FHWA. FHWA will only sign and return those that require FHWA's approval.

FHWA will not participate in funding the change orders and the project for instances where prior approval of a CMJ has not been granted. Only under unusual circumstances, with compelling justification, will

FHWA consider participating in work that should have been given prior approval but was not. If there is any doubt on whether prior approval is needed on a CMJ, the FHWA Field Operations Engineer (FOE) or Project Oversight Manager (POM) can be contacted and provide clarity. FHWA's preference would be to address the question earlier, rather than wait and there be a chance of Federal Non-Participation due to lack of notification.

It is FHWA's goal to give prior approval or reasons for denying approval via e-mail within five working days. The FHWA Project Team Leader should be copied to ensure back-up coverage in the event the FOE or POM is out of the office. If approval is needed within a shorter timeframe, this should be conveyed in the request to FHWA.

In rare instances FHWA will grant a conceptual prior approval, this approval can come via e-mail or phone. This is done only when work must be started at once, like in an emergency or unusual condition and an agreement on the price of the work or FHWA's participation, has not been determined. Conceptual prior approval is requested via e-mail or documented by the department via e-mail following the conversation. The department is to submit a fully documented change orders and Contract Modification Justification, or request for time extension, to FHWA via e-mail within five working days of receiving FHWA's conceptual prior approval.

242.6.6 Proprietary Items

If a change order specifies proprietary products, a proprietary product justification must be prepared for and approved by the region project development chief before the change order can be approved. Further guidance on the incorporation of proprietary products into WisDOT projects can be found in FDM 19-1-5.

242.7 Unacceptable Reasons for Change Orders

242.7.1 Out of Scope Work on Federal Aid Projects

Due to the congressional mandate to select contractors based on low bids, federal laws and regulations limit the ability of state departments to add work to federal aid work. This congressional requirement is not overridden by cost or convenience issues. Where safety does create an urgent need, the department should use emergency contracts to select contractors, not change orders. There is no set rule regarding the scope of a contract, but factors to consider include whether the work to be added falls within the physical area of the project work, and whether the work is within the environmental document.

242.7.2 Insufficient Time Allowed by the Contract

Generally, this is not considered a legitimate excuse. If the contractor believes there is insufficient time allowed in a proposed contract, the contractor should point this out before submitting a bid and get it corrected then. The only way shortage of time can be considered as basis for a contract time extension is if there is a demonstrated impossibility resulting directly from the terms of the contract.

There are three traditionally accepted criteria that may establish impossibility in state contracts.

1. Performance becomes impossible by operation of the law.
2. A contact relates to a specific subject matter and that subject matter has ceased to exist.
3. The contemplated means of performance have been destroyed or have ceased to exist.

242.7.3 Labor Shortages

While the department is aware of the difficulties a contractor faces when the contractor cannot obtain adequate number of skilled workers, the contractor is actually only competing with other contractors in the area for a work force. By absolving a contractor of responsibility for procuring an adequate work force on one job, the department would, in effect, be placing other contractors in that area at a competitive disadvantage.

Skilled and semi-skilled workers are often in short supply. This is a recognizable fact that should be evident to recruiters for construction firms. It is aggravated in larger metropolitan areas because of generally greater number of projects competing for a limited work force. Because of this, a labor shortage claim would not ordinarily be considered as sufficient reason for a time extension request.

SECTION 244 Cost Reduction Incentive

244.1 General

The purpose of the cost reduction incentive (CRI) clause is to encourage innovative, groundbreaking ideas involving improved work methods, new products, and cost-saving plan changes. The CRI can include more efficient techniques and substitution of contract items. A CRI concept may be rejected if it addresses contract change situations covered under standard spec 104.2, such as plan and quantity errors, differing site conditions, or elimination of work. The major intended result is cost savings for the department, but secondary results include decreased shutdown time for the motoring public, less material use, and savings for the contractor. The department equally shares the net cost savings with the contractor. This is a win-win situation for both the department and the contractor, and the department highly encourages using cost reduction incentives.

244.2 CRI Concept

The original cost savings idea may be generated by the department, contractor, or a subcontractor. The CRI submittal must be submitted in writing by the contractor. When the department proposes a cost savings idea and asks for assistance from the contractor to create the concept/proposal, a CRI concept may be submitted by the contractor. An engineer-directed change, which is developed by the department, may not be considered as a CRI. As specified in standard spec 104.10, the submittal of a CRI is a two-step process. The initial submittal is referred to as a concept, and the second submittal is a CRI proposal. The CRI concept contains the contractor's estimate of overall CRI savings, and the proposed costs involved to develop the proposal. If the department deems the concept has merit, and will not introduce an inappropriate level of risk, the department will notify the contractor in writing that the concept should be developed into a proposal.

244.3 CRI Proposal and Acceptance

244.3.1 General

Coordination in the region is encouraged at the time a proposal is being reviewed, to determine if the idea was considered during project development and rejected. Accepted proposals and the idea behind them become the property of the department for possible use on future contracts during the design phase.

The department is the sole judge of acceptability of a CRI proposal and will accept or reject the CRI proposal in writing. If a proposed CRI is initially deemed by the department to have merit, and the contractor develops the CRI, but the department later rejects the CRI, the department will reimburse the contractor for development costs. If the CRI concept is accepted, the department will write a change order directing the contractor to develop and submit the CRI proposal. Payment for the CRI is determined in standard spec 104.10.4.2

244.3.2 CRI Department Processing

The region staff, Bureau of Project Development (BPD) construction oversight engineer, and CRI validation team will work together through the approval process for CRI concepts and proposals. This collaboration will help ensure that CRIs are being administered in a consistent manner throughout the state.

The CRI concept is submitted to the project engineer for review. The project engineer should immediately forward the CRI concept to the WisDOT project manager, the region construction quality assurance engineer, and the BPD construction oversight engineer. The region staff are responsible for coordinating review efforts that may be necessary with the appropriate WisDOT technical staff, including: environmental, utilities, traffic, and structures.

After the necessary reviews are conducted for the CRI concept, the region will formulate a draft response to the contractor regarding the merit of the concept. Before sending the response to the contractor, the region will complete a CRI concept evaluation form and send to the WisDOT CRI validation team for their review and concurrence with the region’s proposed response. The email address for the validation team is: DOTDLDTSDCRIValidationTeam@dot.wi.gov.

Upon validation team concurrence the region sends the department’s response to the contractor. Region staff are responsible for logging all CRI concept submittals in the statewide CRI tracking database. The database is useful for sharing cost-saving ideas that may be utilized during the design of projects throughout the state.

244.4 Change Orders

The intent of the CRI specification is that the project engineer writes a change order to compensate for development costs just after approving the concept. In cases when the department has not initially paid the contractor for development costs, or when the timeframe between the development and completion of

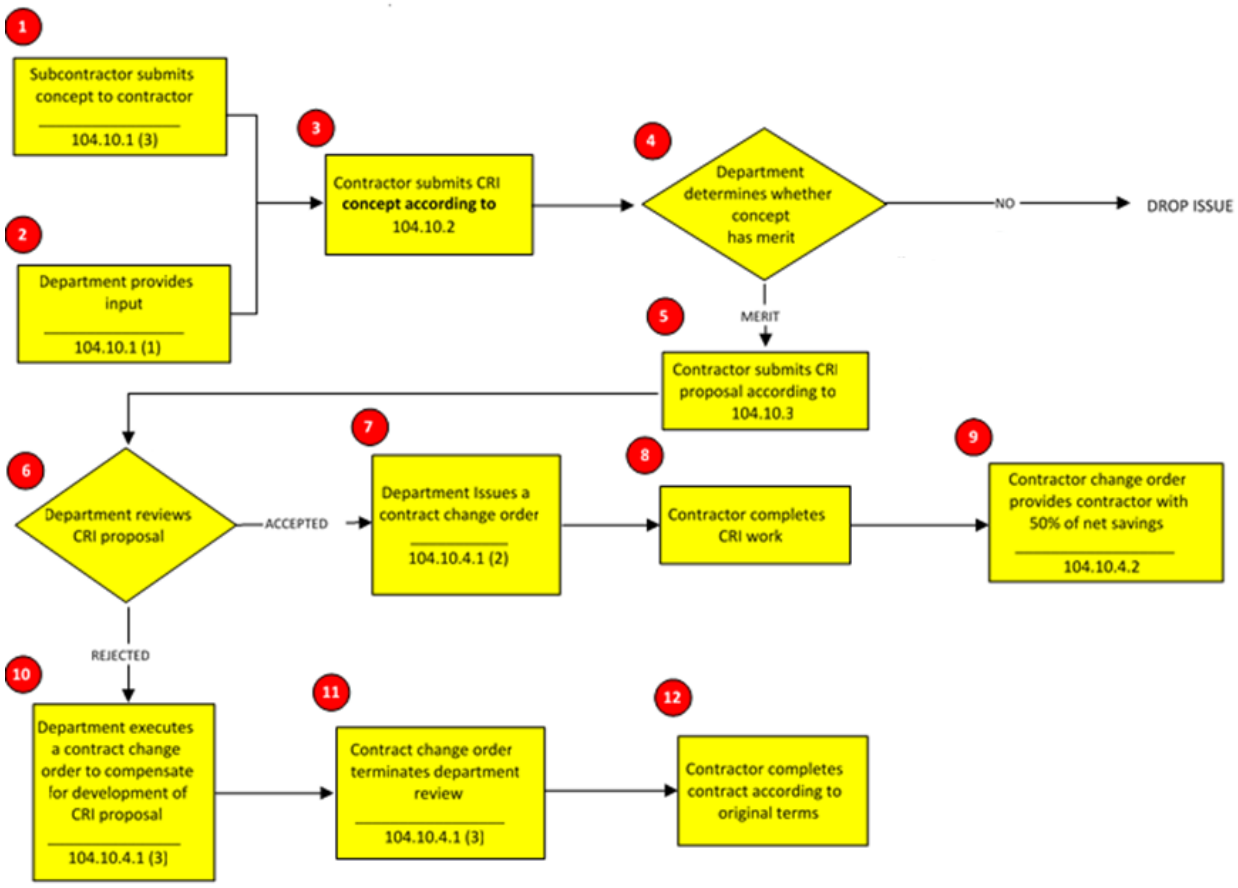
work is very short, the development costs and savings payment can be performed under one single change order.

It's important that all costs are carefully documented on the change order. Whether done under separate change orders or one change order, the development costs and the payment for 50% of department savings to the contractor should be paid using Administrative Item 801.0150. The change orders should adjust contract time and/or interim completion dates, if necessary.

See CMM 242 for additional instructions in completing the CO. The supplemental description on the CO will be utilized in the preparation of CRI reports for future use in incorporating the concepts in other projects, so provide a supplemental description that is specific enough to fulfill that purpose, in addition to the normal considerations.

244.5 CRI Process Flow Chart

FIGURE 244-1 Cost Reduction Incentive Process



SECTION 246 Force Account Work

246.1 Work Proposal

Before the contractor proceeds with force account work, the contractor is required to submit a proposal detailing the equipment, materials, labor, and schedule of operations planned to complete the work. The engineer should review the contractor's proposal and agree with the schedule and resources committed to the work. Equipment and labor rates, mobilization of equipment, availability of equipment, and hours of work should all be discussed and agreed on before beginning work. If a contractor proposes to have a particular piece of equipment available and on standby, the engineer should agree that the equipment needs to be readily available and should ensure that it isn't prudent to have the equipment mobilized when actually needed.

The engineer must consider the impacts to the project schedule when reviewing the proposed work hours. For non-controlling work, it may be unnecessary and wasteful to pay premium/overtime labor rates to complete the work, while if the work is on the critical path it may be prudent to consider overtime work in order to minimize the impact on the project schedule. This may reduce delay and abate time extensions and/or delay damages.

246.2 Inspection and Documentation

When the work is performed on a force account basis, a strict daily accounting must be made. The engineer or inspector will check daily with the contractor and record the classification and daily hours of all laborers and forepersons working on the force account work, as well as the daily hours of each unit of machinery. This information should be recorded on a Weekly Force Account Cost Record, which can be found in the Field Information Tracking system. Figure 246-1 provides an example. A daily itemization of materials must also be kept in the project records.

Before receiving any payment for work performed, the contractor is required to submit detailed statements, including receipted invoices or affidavits for all materials used and transportation charges made. Upon submission of the statements, the engineer is to thoroughly check charges made for agreement with daily records. Rates charged for all labor and machinery are the same as those designated in the change order. Rates other than those agreed upon in the change order are not acceptable and must be reconciled by either a revision of the contractor's statement, or a modification of the CO.

Engineers should carefully review force account agreements to ensure that labor classifications and machinery designations are correctly described on the force account cost record. Only rates for rented equipment and specialized equipment not contained in the Rental Rate Blue Book need to be included in the change order, together with agreed rates for wages.

Standard spec 109.4.5.5 states that equipment rates contained in the Rental Rate Blue Book apply to contractor-owned equipment used for work to be paid for on a force account basis. When equipment is brought to the site to perform force account work at the engineer's request but is idle for reasons that are not the fault of the contractor, the contractor is eligible to be reimbursed standby costs.

When equipment is required to be on standby, the contractor continues to incur certain ownership costs (cost of facilities capital), but does not incur operating costs. Blue Book equipment rental rates are generally based on equipment type, make, year, usage, and time. When equipment is on standby there is no wear and tear, nor fuel and oil consumption, therefore these published Blue Book rates need to be adjusted to eliminate costs included in the rental rate that are associated with usage. In other words, costs included in the published rental rates that the contractor has not incurred while the equipment is idle are not eligible for reimbursement because the contractor did not incur these operating costs. Operating costs have been estimated to be approximately 50% of the published Blue Book rental rate. The hourly standby rate is computed using the formula provided in standard spec 109.4.5.5.3.

At the end of each day the contractor's representative and the inspector are to review and initial the hours of force account work done. At the end of each week or when the work is completed, whichever comes first, the contractor's representative and the engineer should agree to the record of work done.

All final estimates on contracts which contain a CO for payment of work accomplished by a force account agreement must include a summary statement, unless previously submitted, showing costs for labor, equipment, and materials. Itemized statements are to be retained in the region office files.

The force account cost record in figure 246-1 is primarily intended to document extra work done on a force account basis by a contractor under a CO. It may also be used to report on other force account (service and supply) agreements with utilities, railroads, and municipalities. The form has space for recording information pertinent to labor, machinery, materials, and miscellaneous items.

FIGURE 246-1 Weekly Force Account

Wisconsin Department of Transportation
Weekly Force Account Cost Report

INSTRUCTION: Labor & machinery hours should be verified & initialed by contractor's rep. & state inspector daily.

Retain one copy in project files

Provide one copy for contractor

Contract ID: 20030217001
Contractor: LUNDA CONSTRUCTION COMPANY
Projects:
Description of Work:
Removal of bearing pins and delivery to fabrication shop for turning.

LABOR

Dates and Hours

NAME AND CLASSIFICATION	MON		TUE		WED		THU		FRI		SAT		TOTAL	
	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.
Supervisor	2.00		2.00		2.00		1.00						7.00	0.00
Laborer 2	6.00		4.00		5.00		3.00						18.00	0.00
Laborer 1	5.00		3.00		4.00		2.00						14.00	0.00
Crane operator	3.00		2.00		3.00		1.00						9.00	0.00

MACHINERY

Dates and Hours

DESIGNATION	MON		TUE		WED		THU		FRI		SAT		TOTAL	
	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.	S.T.	O.T.
Press	3.00		2.00		3.00		1.00						9.00	0.00
Portable crane	3.00		2.00		3.00		1.00						9.00	0.00
Flat bed truck	1.00		1.00		1.00		1.00						4.00	0.00

It is hereby agreed that labor and machinery hours during the week ending 02/07/2004 are correctly shown above.

Susie Foreman
Contractor's Authorized Representative

Jane Engineer
Project Engineer

FIGURE 246-1 Weekly Force Account (cont.)

FORCE ACCOUNT BREAKDOWN
CONTRACT CHANGE ORDER NO. 3

Labor - Base Rate						
Labor - Unskilled	170 Hours	@	$13.81	=	$2347.70	
Truck Drivers, 2 Axle	120 Hours	@	$14.01	=	$1681.20	
Labor Foreman	58 Hours	@	$14.01	=	$812.58	
Equipment Operators	81 Hours	@	$17.67	=	$1431.27	
Subtotal					$6272.75	
Labor – Overtime Premium						
Laborers – Unskilled	50 Hours	@	$6.91	=	$345.50	
Labor Foreman	18 Hours	@	$7.01	=	$126.18	
Equipment Operators	1 Hour	@	$8.84	=	$8.84	
Subtotal					$480.52	
Fringe Benefits						
Laborers	228 Hours	@	$2.00	=	$456.00	
Truck Drivers (health & welfare $85.42/wk/driver; pension $13.00/day/driver; other $0.40/hr)						
	3 Drivers	@	$85.42	=	$256.26	
	5 days x 3 Drivers	@	$13.80	=	$207.00	
	120 Hours	@	$0.40	=	$48.00	
Equipment Operators	81 Hours	@	$4.50	=	$364.0	
Subtotal					$1331.76	
Subtotal of Labor and Fringe Benefits					$8085.03	
Plus 35 percent of $8085.03					+ 2829.76	
Plus 24.07 percent of ($6272.75 + 480.52)					+ 1625.51	
Plus Workers Comp = 7.42 percent of $6272.75					+ 465.44	
Plus 15 percent of ($1625.51 + 465.44)					+ 313.64	
Total of Labor						$13,319.38
Material						
Concrete	10 CY	@	$100.00	=	$1000	
Top Soil	750 CY	@	$7.00	=	$5250.50	
Wire Mesh	288 SF	@	$2.50	=	$720.00	
Subtotal of Materials					$6970.00	
Plus 15 percent					+ 1045.50	
Total of Materials						$8015.50
Equipment						
End Loader, 2-1/2 CY47	47 Hours	@	$46.15	=	$2169.05	
Dozer, Cat D7G	34 Hours	@	$105.25	=	$3578.50	
Pickup, 3/4 Ton	58 Hours	@	$9.70	=	$562.50	
Trucks, 10 CY	120 Hours	@	$36.65	=	$4398.00	
Total of Equipment						$10,708.05
Total Labor, Materials, and Equipment						$32,042.93
Plus 5 percent for Administration						+ 1,602.15
FORCE ACCOUNT TOTAL						**$33,645.08**

Wisconsin Unemployment	=	9.75 Percent
Federal Unemployment Compensation	=	0.60 Percent
FICA	=	7.65 Percent
Liability and Property Damage Insurance	=	5.87 Percent
Total		23.87 Percent

246.3 Labor Costs

As detailed in standard spec 109.4.5, when the engineer directs the contractor to perform work under a force account, the contractor must submit itemized statements for all costs for that work. Often, payments for extra work use force account procedures to verify a contractor's costs. This is acceptable, as long as the proper procedures have been followed to prepare the force account bills.

Standard spec 109.4.5.2 states that the department will reimburse the contractor based on actual invoiced costs for labor that are paid to the workers, including subsistence and travel costs, health and welfare benefits, pension fund benefits, or other contractor-paid benefits. The department will pay an additional 35% markup for these wages and benefits.

Payroll additives are to be restricted to actual costs.

1. Workers compensation insurance is chargeable for all hours worked on a straight time basis. Overtime premiums are not eligible.
2. Truck drivers' total salaries must be excluded from computation of public liability and property damage insurance, as these insurance costs are covered by equipment ownership expense.
3. Federal unemployment insurance is contributed by the employer on the first $7,000 paid to each worker in a calendar year. Year to date employee earnings are to be reported in the force account bill. The federal rate is 6.0%. However, employers who have made all required payments to their state system in a full and timely manner receive a 5.4% "credit", making the effective federal rate 0.6%.
4. State unemployment compensation is contributed by the employer on the first $14,000 paid to each worker in a calendar year. Year to date employee earnings are to be reported in the force account bill. These percentages are subject to change by legislative action.
5. Federal Social Security tax is 6.2% plus 1.45% for Medicare, for a total of 7.65% on the first $118,500 paid to an individual as wages. After the first $118,500 in wages, the rate for Medicare continues at 1.45%.

Figure 246-2 provides an example force account bill that accounts for all of the labor cost complexities.

FIGURE 246-2 Sample Force Account Bill

This sample bill does not establish any policy relative to the amount to be allowed for any particular item of materials or equipment or as representing actual rates for insurance. It's the sole purpose is to standardize the form of force account bills.

SAMPLE OF A FORCE ACCOUNT BILL SHOWING FORM TO BE FOLLOWED
CONTRACTOR'S LETTERHEAD

Route: _____ Section: _____ County: _____ Auth. No: _____ Date Submitted _____

Force account bill for Additional Pipe & Collars Contract No.: 20070113099

	Days Worked			Standard Time	Over Time	Rate	Insurance Amount	Payroll Amount	Earnings to Date	Payroll Amount Eligible Unemployment Tax	
	7/2/06	7/3/06	7/5/06							F.U.T	S.U.T.
Joe Sachman, Foreman	6	8	10	22	2	$23.70	$568.80	$592.50	$35,000.00	$0.00	$0.00
Tom Sellers, Laborer	6	8	10	22	2	$20.70	$496.80	$517.50	$8,000.00	$0.00	$517.50
Ben Marcus, Laborer	6	8	10	22	2	$20.70	$496.80	$517.50	$6,000.00	$517.50	$517.50
Ed Miller, Laborer	6	8	10	22	2	$20.70	$496.80	$517.50	$7,100.00	$417.50	$517.50
John Hintz, Laborer	6	8	10	22	2	$20.70	$496.80	$517.50	$10,600.00	$0.00	$417.50
Sarah Bischell, Truck Driver	6	8	8	22		$21.00	$462.00	$462.00	$27,000.00	$0.00	$0.00
Lawrence Smith, Operator	6	8	8	22		$27.97	$615.34	$615.34	$40,000.00	$0.00	$00.0
					Subtotals, Labor		$3,633.34	$3,739.84		$935.00	$1,970.00
*Laborer Pension & Welfare Funds - 96 Hours @.32								+ $30.72			
*Operating Engineer Pension & Welfare - 22 hours @ .55								+ $12.10			
						Subtotals, Labor		$3,782.66			
						Plus 35% of $3,782.66		+ $1,323.93			
						Subtotals, Labor		$5,106.59			

Plus: Workmen's Compensation Ins.	3.48%	of	$3,633.44	$126.44	
Public Liability and Property Damage Ins. (excluding payroll of truck drivers)	2.0%	of	$3,171.34 *(3633.34 - 462)*	+ $63.43	
**Federal Unemployment Tax $2.0%	0.6%	of	$935.00	+ $5.61	
***State Unemployment Tax	6.8%	of	$1,970.00	+ $133.96	
Federal Social Security Tax	7.65%	of	$3,739.84	+ $286.10	
			Subtotals, Payroll Additives	$615.54	
			Plus 10% of $615.54	+ $61.55	
			Subtotals, Payroll Additives		$677.09
			Total Labor		**$5,783.69**

*These are not suggested rates, as these rates vary widely between Union Locals. This is intended as an example only.
**Do not include costs for employees which have reached the $7,000 ceiling on Federal Unemployment Tax (F.U.T.).
***Do not include cost for employees which have reached the $9,000 ceiling for State Unemployment Tax (S.U.T).

I hereby certify that the above statement is a copy of the portion which applies to the above stated work and that the rates shown for taxes and insurance are actual costs.

Signed: _____
(Contractor)

SECTION 248 Suspension of Work

248.1 Suspension of Work

248.1.1 Authority

Suspension of work may be included in the contract provisions or may be ordered by the engineer. Complete suspension of work operations normally is related to seasonal or weather restrictions. However, the contract may also provide for complete suspension of operations for other reasons such as coordination of road or lane closures with off peak traffic volumes.

Standard spec 105.1 provides that the engineer may suspend the work wholly or in part for the contractor's failure to correct conditions unsafe for the project personnel or general public, for the contractor's failure to carry out provisions of the contract, or for the contractor's failure to carry out orders of the engineer.

The standard specifications state that the engineer has the authority to require partial or complete suspension of operations for periods the engineer may deem necessary in the interest of public safety and convenience. Work may be suspended due to unsuitable weather or other conditions considered unfavorable for prosecution of the work, or due to the failure on the part of the contractor to perform provisions of the contract.

Orders to the contractor to suspend work operations should be in writing, with a copy retained in the engineer's files. Orders should specifically state the work included under the suspension and the basis for suspension.

Partial or temporary suspensions of work are in order when the contractor fails to comply with requirements of the contract or when working conditions are not suitable for continued prosecution of the work. A change order is not needed.

Some of the various reasons for partial or temporary suspension of work operations are:

1. Furnishing insufficient or unacceptable equipment or equipment requiring repair or adjustment.
2. Furnishing materials not meeting specified requirements. For example, when aggregates from a particular pit or source start consistently failing to conform to specified gradation requirements, the placing operations must be halted until acceptable aggregates are furnished.
3. When weather conditions at a particular time are not suitable for prosecution of the work.
4. For the correction of hazardous working conditions.
5. When periods of suspension become necessary to allow unimpeded traffic flow. For example, when increased traffic flow is anticipated during holiday periods, special events, or when the nature of the work being performed may require some of the work operations to be suspended at intervals to accommodate passage of traffic.
6. When a hazardous substance is encountered.

248.1.2 Maintenance of Traffic

If the suspension of work operations is due to conditions that are not the fault of the contractor, the surface maintenance of the traveled way must be at the expense of the state or local governmental unit as specified in standard spec 104.6.7. Replacement of materials and additional work made necessary because of the temporary use of the highway for reasons beyond the control of the contractor will be paid for, except for removal of materials or work used in the temporary maintenance.

248.1.3 Contract Time Charges for Suspension

If suspension of operations and contract time is provided for in the contract, no time charges will accrue on calendar day and working day contracts. If the engineer, for reasons beyond the control of the contractor, orders suspension of work, and if it is for controlling items of work, contract time charges will be suspended on calendar day and working day contracts.

Completion date contracts normally do not provide for suspension of time charges. The question of contract time on completion date contracts is resolved at the time of completion of work under the contract when a request for extension of contract time would be considered.

If the engineer, for reasons within the control of the contractor, orders suspension of work, and if it is not an unreasonable suspension of work, no additional contract time will be allowed due to the suspension.

248.1.4 Unreasonable Suspension of Work

If the performance of all or any portion of the work is suspended or delayed by the engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry), and the contractor believes additional compensation and/or contract time is due as a result of the suspension or delay, the contractor must submit to the engineer in writing a request for adjustment

within seven calendar days of receipt of the notice to resume work. The request must include the reasons and support for the adjustment.

Upon receipt, the engineer will evaluate the contractor's request. If the engineer agrees the cost and/or time required for the performance of the contract has increased as a result of the suspension, and the suspension was caused by conditions beyond the control of and not the fault of the contractor, the contractor's suppliers or subcontractors at any approved tier, and not caused by weather, the engineer will make an adjustment (excluding profit), and modify the contract in writing accordingly. The engineer will notify the contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the contractor has submitted the request for adjustment within the prescribed time.

No contract adjustment will be allowed under this clause to the extent performance would have been suspended or delayed by any other cause, or an adjustment is provided for or excluded under any other term or condition of the contract.

248.1.5 Resumption

Upon resumption of work, the contractor must continue improvements in every respect as though prosecution had been continuous, unless the contractor and engineer had previously otherwise agreed at the time the suspension began.

248.2 Termination of Contract

As stated in standard spec 108.14, under normal circumstances, the contractor's responsibilities are terminated when the contractor has completed all work, the department has approved and accepted the project, and the department has paid the final estimate.

However, the engineer may terminate the contract if the contractor has defaulted on the contract (standard spec 108.12), or if termination of the contract is deemed to be best for the public interest (standard spec 108.13). For federal oversight projects, the engineer must obtain FHWA concurrence with contract termination before issuing a notice of default as specified in standard spec 108.12 or a termination notice as specified in standard spec 108.13.

SECTION 250 Project Acceptance

250.1 Partial Acceptance

Standard spec 105.11 allows the engineer to relieve the contractor, upon request, of responsibility for maintenance of completed sections of the project by granting partial acceptance. Partial acceptance places the responsibility for maintenance of the accepted section upon the owner of the road. Partial acceptance should be granted for sections satisfactorily completed that can be safely opened to traffic. Stage changes and opening of closed lanes and shoulders should be considered when evaluating whether to grant partial acceptance, as the opening of a closed section of roadway may be required to continue the work necessary to complete the remainder of the contract. An entry from the project engineer in the project diary, including what date it was granted and the items partially accepted should be documented in AASHTOWare Project (AWP). The project engineer shall notify the contractor, in writing, within 5 business days from the request for partial acceptance. Notification should include whether the request has been granted or reasoning for not granting partial acceptance.

Partial acceptance should not be granted for individual bid items, with the exception of topsoil and erosion control items. More guidance on topsoil acceptance is provided in CMM 640. However, partial acceptance should not be denied solely on the failure to complete all bid items, as the plan and other contract documents may dictate temporary configurations on areas of acceptably completed work.

250.2 Final Acceptance

Before final acceptance can be extended to the entire project, a final inspection must be made as specified in standard spec 105.11. For the project to pass the inspection and receive final acceptance, all bid items, finishing operations, needed repairs, required corrections, and changes must be complete. As a matter of cooperation with the contractor and to speed acceptance, defects and special finishing requirements are to be called to the contractor's attention at the start of the finishing and checked while in progress.

To expedite "finaling-out," a composite punch list should have been developed from results of prior field reviews of all concerned agencies, so the contractor only has had to cover the project once to make corrections before the final inspection. This composite punch list is to be in writing to the contractor, including a statement addressing contract time, and identifying the contract as substantially complete.

When punch list items are completed on federal oversight projects, the engineer must inform FHWA that the project is ready for final inspection.

Representatives of the department, local units of government, and others as appropriate should be present or invited to be present at the time of final inspection. Special attention should be directed toward pavement markings, signs, traffic signals, railroad crossings signals, and lighting to be assured they are installed and operating correctly for the safety of road users. Final inspection should be held before the contractor's equipment and forces leave the project site.

Upon acceptance of the project, the contractor is to be notified by letter and a note is to be placed in the project diary.

250.3 Completion Certificate

The Completion Certificate indicates that all work has been completed in the field, but does not necessarily mean that all contract-closing articles are complete. This certificate acts as a notice to release bonding and maintenance of the contract. For contacts administered in AASHTOWare Project Construction and Materials®, print the Completion Certificate report for the contract within the application by following the instructions available at:

https://awpkb.dot.wi.gov/Content/constr/LETContract/Reports.htm

The Completion Certificate should be completed and distributed for the following contracts:

- Every construction and maintenance contract let to bid.
- Every contract or agreement entered into between the department and a county or other public agency for construction, temporary maintenance, etc.
- Contracts and agreements with railroad companies for construction, relocation, or adjustment of crossings, crossing protection, or other facilities.
- Contracts or agreements with utilities for relocating or altering their facilities.

The Completion Certificate should not be submitted for contracts covering engineering services, aerial surveys, appraisals, or other special services. In addition, since the contractor, county, railroad, or utility does not receive a copy of this form, they are to be notified by letter of the acceptable completion of the contract.

The completed form should show all project numbers and codes involved, and the dates shown should apply to the contract as a whole, including any extensions made to the contract by change order.

This form should normally be filled out and submitted after acceptance of the work. In those instances where acceptance is contingent upon formal acceptance by a local governing body, submittal of the form may be delayed until this acceptance is obtained. In this case, the acceptance date to be entered on the form would coincide with the date of acceptance by the local governing body.

Where federal aid is involved, the acceptance date of a project for the purpose of this form is the date the engineer accepts the work on behalf of the state. This date of acceptance may be at variance with the date of acceptance of the entire contract by the FHWA, as the federal acceptance is not given until all projects under the contract have been accepted.

If it is subsequently found necessary to perform additional work, the work should be performed under a new contact or agreement.

Copies of the signed Completion Certificate must be distributed to the bonding company and region files on all contracts. FHWA only requires a copy on all federal oversight contracts, but not all contracts with federal aid. All Completion Certificates sent to FHWA should be done so electronically and sent via email to: FHWAMaterialsWisconsin@dot.gov

SECTION 252 Bonds and Warranties

252.1 Bond Rights

WisDOT can require the prime contractor's surety to perform the contract (performance bond) and pay anyone (payment bond) who has a direct contractual relationship with the prime contractor for the labor, services, supplies, materials, plans, or specifications it performed, furnished, or procured for the public improvement.

WisDOT must file an action against the surety within one year of completion of work under the prime contract. Some interpret "action" to mean "lawsuit" rather than merely making a claim. This one-year limitation period does not begin to run when any one subcontract is completed; it applies to the completion of work under the contract as a whole.

WisDOT can recover at least the amount of the bond from the surety. The amount of the bonds is equal to the bid amount of the contract for performance of the work and an equal amount for payment for labor, services, supplies, materials, plans, etc.

252.2 When Is Completion of Work for Purposes of the Bond?

The bond rights are available for one year following "completion of work" on the prime contract. Completion of work, for purposes of determining when this one-year period begins to run, is most likely substantial completion, but may be later depending on the facts of the project.

Completion of work for this purpose is not the same as final acceptance, nor is it the same as "completion of the contract." Depending on the particular project, completion of work for this purpose may or may not include fine-tuning work, some final maintenance, and repairs. Completion of work most likely does not include paperwork required in the contract (payrolls, etc.). The surety can probably rely upon the Completion Certificate, discussed in CMM 250, as evidence that the owner believes the work is complete for purposes of bond actions.

252.3 Warranties

Generally, a warranty is a contractual provision guaranteeing that a particular good or service provided by a contractor will meet the owner's expectations for a particular period of time. A warranty is a separate, additional remedy apart from the performance and payment bond.

Any warranty that will expire within the one-year period of the performance bond is duplicative and likely unnecessary. Warranties work well when the acceptability of a contractual item may not be known within one year following completion of the prime contract.

252.4 Surety Notification

It is the contractor's responsibility and duty to construct the project in accordance with the contract requirements. Bond costs are an element of each contractor's bid, and it is WisDOT policy that those firms that through their internal quality control and subcontractor quality assurance efforts effectively perform in accordance with contract requirements, without excessive WisDOT oversight or surety involvement, should benefit from lower bond costs. However, contractors that fail to consistently meet contract requirements, and therefore generate greater WisDOT oversight and surety notification/involvement, should have this impact reflected in their bond costs.

It is important for WisDOT to notify a surety when there is a significant likelihood that a contractor has not, or will not, complete a contract in substantial compliance with the contract terms and conditions.

The engineer must notify a surety, in writing, in the following situations:

- When a contractor is being considered for termination for default.
- When a contractor is being terminated for default.
- When the engineer has issued a written order to remove and replace or otherwise correct nonconforming work or unauthorized work under standard spec 105.3.2.2 or standard spec 105.3.2.3.

The engineer should consider notifying a surety, in writing, in the following situations:

- When a contractor is significantly behind schedule.
- When a contractor is unable to consistently perform work according to the contract terms and conditions.
- When the engineer has to repeatedly identify work that is unacceptable or not complete under standard spec 105.11.2.2.

SECTION 253 Dispute Resolution Procedures

Dispute resolution procedures are mobilized into the contract in standard spec 104.3.6.

253.1 General

The department and the contractor are encouraged to resolve emerging disputes as early as possible. An early resolution of simple disputes may be facilitated by a third-party advisory opinion while more complicated or contentious disputes may benefit from employing a formal DRB review.

Interpret these terms, used within the departments dispute resolution procedures, as follows:

DRB agreement	Agreement between the department, contractor, and DRB members.
Dispute	An issue, claim, change order request, or other controversy that remains unresolved following good faith negotiations between authorized representatives of the department and contractor.
Dispute review board (DRB)	One or three neutral individuals mutually selected by the department and contractor to review disputes and render findings and recommendations based on the contract.
Project manager	Region project manager assigned to administer, oversee, and manage the project.
Construction oversight engineer	Bureau of Project Development engineer assigned to the WisDOT region in which the claim or dispute originated.
Bureau	The department's bureau of project development.

253.2 Third-Party Advisory Opinion

253.2.1 General

A third-party advisory opinion may be provided by the bureau and subsequently by a member of the statewide standing DRB roster.

If after attaining and considering the bureau's recommendation concerning a pending or active dispute, the parties still do not agree on entitlement, either party may request a third-party advisory opinion by a member of the statewide standing DRB roster.

A third-party advisory opinion may expedite the settlement process and is less costly and less time consuming than a formal DRB hearing. Where third-party advisory opinions have been used, their success in promoting resolution of the dispute has led to wide endorsement of this approach. When considering referral of an issue for a third-party advisory opinion, the parties should thoroughly consider and discuss the issue with each other. The parties should recognize that if the issues are complex, a third-party advisory opinion may be ineffective.

In making this determination, the disputing parties should take into consideration the complexity of the issues, whether experts may be necessary, and the length and complexity of the presentations. A DRB third-party advisory opinion does not require acceptance or rejection by the parties. DRB preliminary views on issues form a basis for negotiated settlements without further DRB assistance. Third-party advisory opinions are based only on information available at the time, are subject to change based upon further data, and are not used or referred to in future hearings on the issue.

If the issue is not resolved after the third-party advisory opinion and a subsequent dispute hearing is held, no reference to the third-party advisory opinion is allowed. All positions, evidence, and other relevant data are resubmitted at the hearing. If the dispute is later taken before a formal DRB, the DRB is not bound by the third-party advisory opinion.

Third-party advisory opinions are typically limited to entitlement issues and not quantum. The DRB may provide advice on the method to use in determining quantum without specifically determining quantum.

253.2.2 Availability

Under standard spec 104.3.6, after the contractor provides the department a 5-Day written statement and the department responds with a 5-Day written response, a third-party advisory opinion may be used in the dispute resolution process when mutually agreed upon by both the contractor and department.

253.2.3 Third-Party Advisory Opinion Process

253.2.3.1 General

In general, the DRB will operate in according to these guidelines. However, it is not desirable to adopt hard-and-fast rules for the functioning of the third-party advisory opinion process. The entire procedure should be kept flexible to adapt to changing situations. The DRB may initiate, with the department's and contractor's concurrence, new procedures or modifications to existing procedures whenever this is deemed appropriate and beneficial in resolving the dispute.

253.2.3.2 Request Third-Party Advisory Opinion

When both disputing parties have decided that a third-party advisory opinion would be beneficial in resolving an issue or dispute, the project manager will contact the construction oversight engineer for concurrence. If the construction oversight engineer agrees that the issue warrants a third-party advisory opinion, a DRB will be engaged by the bureau to hear the issues and render an opinion.

253.2.3.3 DRB Selection

The project manager will coordinate with the construction oversight engineer to select a single member DRB from the statewide standing DRB member roster.

253.2.3.4 DRB Advisory Agreement

The construction oversight engineer will execute the agreement to engage a DRB selected from the statewide standing roster of DRB members.

253.2.3.5 Meeting Procedures

When a DRB has been retained, the DRB in conference with both parties and bureau will set a date for presentations. The department will provide to the DRB, a set of plans, specifications, and pertinent project correspondence. The department will provide to the DRB and contractor, its 5-Day written response, and any other supporting documents pertinent to the dispute.

The contractor will provide to the DRB and department, its 5-Day written statement and supporting documents pertinent to the dispute.

The disputing parties may further supplement the 5-Day written statements by each preparing a short summary of its position and submitting it to the DRB and the other disputing party before the meeting. Normally the disputing parties do not submit comprehensive position papers.

Submittals will be provided to the appropriate parties 7 calendar days before the meeting. At the meeting each party is given ample time to present its position, make rebuttals, provide key contract documents, and respond to the DRB's questions and requests.

The time required for these meetings varies widely, depending on the scope and complexity of the issues, but they are often less than a couple of hours.

253.2.3.6 Findings and Recommendations

The DRB may verbally render an opinion at the meeting or soon thereafter.

After the meeting, the DRB will write the third-party advisory opinion, including the rationale, to ensure clarity. Copies are provided to the disputing parties and bureau.

In some circumstances, after hearing the parties' presentations, the DRB may determine that the dispute is too complex to issue a third-party advisory opinion. In such cases, they should immediately advise the parties and suggest engaging the claim process.

Occasionally the DRB, after deliberation, is unable to formulate an opinion and so advises the parties. Nonetheless, this opportunity for the parties to state their positions in a clear, uninterrupted fashion, and with subsequent questions from the neutral, is often a useful step in resolving disputes.

Third-party advisory opinions are often sufficient to enable the parties to promptly resolve the dispute without a formal DRB hearing.

253.2.3.7 Clarification

After third-party advisory opinions are rendered, either party may ask for clarification. If the DRB determines clarification is appropriate and helps resolve the dispute, the DRB will provide clarification.

253.2.4 Payment

The department will bear all costs and expenses of the third-party advisory opinion. DRB members will be compensated and reimbursed expenses as prescribed in the DRB advisory agreement executed by the department and DRB member.

The department will provide, at no cost to the contractor, administrative services such as coordination of the third-party advisory opinion and meeting facilities when state owned facilities are utilized. If other facilities and amenities are desired by both parties, these costs will be equally shared by both parties.

The following payment procedures will be used:

1. The DRB member will submit invoices to the construction oversight engineer for review.
2. After the oversight engineer has reviewed and approved the invoices, the invoices will be forwarded to the project manager.
3. The project manager will review and then forward the DRB invoices along with any non-state facility or amenity charges to the contractor.

4. The contractor will pay the department-approved invoices.
5. The contractor will submit to the project manager the invoices and documentation verifying payment.
6. The department will execute a change order to pay the entire DRB invoiced amount and 50 percent of non-state facility and/or amenity invoices.

There will be no markups applied to expenses connected with the DRB, either by the DRB members or by the contractor when requesting payment of the department's share of expenses.

The department will reimburse the contractor for the department's share of the third-party advisory opinion costs under the Dispute Review Board administrative item.

253.3 Formal Dispute Review Board

253.3.1 Overview

253.3.1.1 General

Any of the procedures for the formal DRB review established by these guidelines may be altered or modified by mutual agreement of the department and the contractor to better suit their needs in a particular dispute.

These guidelines describe the purpose, procedure, function, and features of the DRB. The agreement among the department, contractor, and DRB members will formalize creation of the DRB and establish the scope of its services and the rights and responsibilities of the department and the contractor. In the event of a conflict between these guidelines and the agreement, the latter governs.

253.3.1.2 Purpose

The purpose of the formal DRB is to provide an independent and impartial review of the dispute and provide non-binding written findings and recommendations based on the contract, applicable contract law, industry practices, and the facts presented.

It is not the purpose, or responsibility, of the DRB to resolve the dispute. That responsibility remains with the department and the contractor. However, it is anticipated that the DRB review will assist the department and the contractor in resolving the dispute.

Creation of the DRB is not intended as a substitute for department or contractor responsibility to make a good-faith effort to settle the dispute. The department will avoid indiscriminate referral of disputes to the DRB without prior attempts by the department and the contractor to resolve them.

253.3.1.3 Standard Specifications

Under standard spec 105.13, a DRB will be established to assist in the analysis of disputes when mutually agreed upon by both the department and contractor.

Using a DRB does not relieve the contractor or department from complying with all contract terms and conditions, and does not waive any notice or timeliness requirements prescribed in standard spec 104.3. However, if a dispute is referred to the DRB, the claim submittal and review times prescribed in the standard specifications may be superseded by times established by the DRB, and agreed to in writing by both the department and the contractor.

Both the department and the contractor will proceed diligently with the work and comply with applicable contract provisions while the DRB considers a dispute.

253.3.1.4 Requesting DRB

Either party may request a DRB review. Requests must be in writing and clearly state in full detail the specific issues of the dispute to be considered by DRB. Contractor requests are submitted to the construction oversight engineer assigned to the region in which the dispute has occurred. Department requests will be submitted to the contractor's home office address. The construction oversight engineer will coordinate the DRB process.

253.3.1.5 Summary

Individual DRB members are not the "representative of" or "advocate for" either party. The entire DRB will function as an objective, impartial, and independent body at all times. In order to avoid any suggestion of partiality, there should be no individual communication in regard to the project between DRB members and employees of the contractor or department during the life of the DRB. The parties will direct any matters needing attention between members of the DRB to the chair of the DRB.

The construction oversight engineer will engage the DRB process. The DRB will impartially consider disputes referred to it. The DRB will provide non-binding written findings and recommendations to the department and the contractor.

Although findings and recommendations of the DRB should carry great weight for both the department and the contractor, they are not binding on either the department or the contractor. However, the findings and recommendations are admissible in subsequent claim resolution proceedings.

253.3.2 Formal DRB Membership

253.3.2.1 General

The DRB will consist of either one or three members. If both parties cannot agree on the number of members for the DRB, a three member DRB will be established.

253.3.2.2 Criteria

253.3.2.2.1 Experience

It is desirable that all DRB members be experienced with the construction process including design, construction, contract administration, contract law, and resolution of construction disputes.

It is not necessary that the DRB members be intimately familiar with the specific type of construction involved in the dispute.

All DRB members will have attended the one-day DRB panel member workshop offered by the Dispute Review Board Foundation, or its equivalent in other training, or will be a qualified DRB panel member in another state which has training as a prerequisite to qualification for service on DRB panels.

253.3.2.2.2 Neutrality

DRB members must be neutral, act impartially, and be free of any conflict of interest.

The term "member" also includes the member's current primary or full-time employer, and "involved" means having a contractual relationship with either the department or the contractor, such as a subcontractor, architect, engineer, or construction manager.

253.3.2.2.3 Prohibitions; Disqualifying Relationships for Prospective Members

A prospective DRB member will be disqualified for one or more of the following:

- An ownership interest in any entity involved in the construction contract, or a financial interest in the contract, except for payment for services on this dispute review board.
- Previous employment by, or financial ties to, any party involved in the construction contract within a period of 6 months before award of the contract, except for fee-based consulting services on other projects.
- A close professional or personal relationship with a key member of any entity involved in the construction contract which, in the judgment of either the department or the contractor, could suggest partiality.
- Prior involvement in the project of a nature that could compromise the prospective member's ability to participate impartially in the DRB's activities.

253.3.2.2.4 Prohibitions; Disqualifying Relationships for Members

A DRB member will be disqualified for one or more of the following:

- Employment, including fee-based consulting services, by any entity involved in the construction contract.
- Discussion concerning, or the making of, an agreement with any entity involved in the contract regarding employment after the contract is completed.

253.3.2.3 Disclosure Statement

As a part of the selection process, each prospective DRB member will be required to submit a complete disclosure statement for the approval of both the department and the contractor. Each statement will include a resume of experience, together with a declaration describing past, present, and anticipated or planned future relationships, including indirect relationships through the prospective member's primary or full-time employer, to this project and with the department or the contractor, or others involved in the contract, including subcontractors, suppliers, design professionals, and consultants. Disclosure of close professional or personal relationships with key members of the department or the contractor or other parties involved in the construction contract must be included.

253.3.2.4 Statewide Standing Roster

The department and Wisconsin Transportation Builders Association have established a statewide standing roster of prequalified DRB members. A list of standing roster members is maintained. The list contains names of the pre-qualified members with addresses, email addresses, telephone numbers, resumes, and disclosure statements.

253.3.2.5 Selection Process

When establishing a 3-member DRB for a project or dispute, the department and the contractor will each select 1 DRB member. The two selected DRB members will then jointly select a chair for the DRB. The disputing parties may mutually place restrictions on the chair selection. Any restriction agreed on by the disputing parties will be communicated to the DRB members charged with selecting the chair.

When establishing a 1-member DRB for a particular project dispute, the department and contractor will jointly select the DRB member.

After being selected, DRB members must submit an updated disclosure statement to the department and contractor for review and approval. DRB members do not need to be on the statewide standing DRB roster in order to be selected. However, if a DRB member (chair or non-chair) is selected from outside the standing roster, the proposed DRB member must meet all the aforementioned criteria and disclosure requirements and both disputing parties must approve the selection.

If a party disputes the qualification of a proposed DRB member, from the statewide standing DRB roster or from outside the roster, the disputing party will identify what disqualifies the proposed neutral. The department and the contractor will jointly determine whether the candidate will be accepted on the DRB. If the candidate is rejected, the party responsible for the selection will select another candidate and again seek approval from the other parties.

253.3.2.6 Tenure of DRB

Once a DRB is engaged on a project, the DRB will be deemed established for any subsequent disputes that may require a DRB under standard spec 105.13.

The DRB will be dissolved as of the date of final payment to the contractor unless earlier terminated or dissolved by mutual agreement of the department and contractor.

253.3.2.7 DRB Review Agreement

After DRB member selections have been made, the DRB members, the construction oversight engineer, and authorized representatives of the contractor will execute the agreement.

253.3.3 Formal DRB Review Process

253.3.3.1 General

In general, the DRB will operate within these guidelines. However, it is not desirable to adopt hard-and-fast rules for the functioning of the DRB. The entire procedure will be kept flexible to adapt to changing situations. The DRB will initiate, with the department's and contractor's concurrence, new procedures or modifications to existing procedures whenever this is deemed beneficial and appropriate.

The department and the contractor will cooperate to ensure that the DRB considers disputes promptly, considering the particular circumstances and the time required to prepare appropriate documentation.

Procedures and time periods may be modified by mutual agreement of the disputing parties.

253.3.3.2 Contract Documents, Reports and Information

The department will provide a set of plans and specifications to each DRB member. The department and contractor will provide the DRB requested reports, documents, or other information needed to fully understand and review the dispute. The DRB may not request reports, documents, or other information that are not normally generated by the department or the contractor in the course of construction of the project.

253.3.3.3 Scheduling Review

The construction oversight engineer and DRB chair will schedule the hearing.

After conferring with both the department and the contractor, the DRB chairperson will establish a submittal schedule so that adequate time is allowed for each party to address the other party's statements and supporting documentation before the presentation.

253.3.3.4 Pre-presentation Requirements

Concise written position statements will be prepared by both the department and the contractor, with page number references to any supporting documentation. The position statement will be submitted to each DRB member and to the other party. Submit copies to the other disputing party at least 14 calendar days before the DRB hearing. Both parties will be allowed to amend or append information to their position statement up to 7 calendar days before the hearing. Any amendments or appendages will be copied to the involved parties as prescribed for the position statement.

In large dollar amount disputes or disputes involving complex issues, the DRB may meet privately to review the information provided, discuss the procedures to be followed in hearing the dispute and the method of presentation to be followed. The DRB may also call a pre-meeting conference to discuss procedures with both the department and the contractor.

At least 7 calendar days before the date scheduled for a hearing, each party must submit to the DRB Members and to the other party a list of the persons who will attend or represent them at the hearing.

253.3.3.5 Presentation

Unless the DRB, the department, and the contractor agree otherwise; the presentation will be conducted at the nearest department region office. However, any location that would be more convenient and still provide required facilities and access to necessary documentation is acceptable.

The department and the contractor will have representatives at all presentations. The DRB will establish which party will make its presentation first. The department and the contractor will be allowed successive rebuttals until all aspects are fully covered. The DRB members and the department and the contractor may ask questions, request clarification, or ask for additional data. Questions from the department or contractor will be directed to the DRB; cross examination will not be allowed. In difficult or complex cases, additional presentations may be necessary in order to facilitate full consideration and understanding of evidence presented by both the department and the contractor. Both the department and the contractor will be provided adequate opportunity to present their evidence, documentation, and testimony regarding issues before the DRB.

Unless the department and the contractor agree otherwise, presentations must relate to issues of entitlement only. When the department and the contractor agree that the DRB will review or give guidance on issues of quantum as well as entitlement, both the department and the contractor will complete their presentations on entitlement before quantum is presented.

Normally, a formal transcript of the presentations is not prepared. When requested by either the department or the contractor, the DRB may allow recordation and transcription by a court reporter with the cost to be allocated as agreed by the department and the contractor. A transcript, when prepared, will not constitute the official record of the DRB review. The record prepared by the DRB will be the official record of the DRB review. The DRB may provide for audio or video recordings of the presentations for DRB use only.

The department and the contractor may have their attorneys or other representatives in attendance at the presentations to counsel and advise them. If the department and the contractor agree, the representatives will be allowed to make brief opening and closing remarks to the DRB, but are not allowed to present project specific details. No other participation by attorneys at the presentations will be allowed unless the department and the contractor mutually agree.

If either the department or the contractor fails to appear before the DRB on the date scheduled for the presentations, without justifiable cause, the party that was absent will be liable for additional costs attributable to the cancellation of the hearing.

253.3.3.6 Deliberations

After the presentation is concluded, the DRB will confer to formulate its findings and recommendations. All DRB deliberations will be conducted in private, with all individual views kept strictly confidential from disclosure to others.

253.3.3.7 Special Services

If at any time in the DRB process, the DRB believes assistance from a technical expert or specialist is necessary or would facilitate dispute resolution, the DRB may request permission to retain those services. The DRB will provide the department and contractor a written request detailing the following:

- Services desired.
- Benefit of services requested.
- Proposed service provider.
- Qualifications of proposed service provider.
- Estimated fees for requested services.

The department and contractor must mutually agree to that assistance and approve the proposed service provider.

253.3.3.8 Findings and Recommendations

The findings and recommendations of the DRB concerning any dispute are non-binding.

It is not the responsibility of the DRB to resolve the dispute. The findings and recommendations of the DRB will be based upon the contract, applicable contract law, industry practices, and the facts. The DRB must also evaluate whether the burden of proof has been met.

The DRB's findings and recommendations will be provided in writing to both the department and the contractor within 28 days of the completion of the presentations. In difficult or complex cases, and in consideration of the DRB's schedule, this time may be extended by mutual agreement of the DRB, the department, and the contractor. The DRB should describe the logic and reasoning behind its findings and recommendations. The findings and recommendations will address entitlement only, unless it is mutually

agreed that the DRB will be asked to review or give guidance on issue of quantum as well. For relatively simple disputes, if both parties request and sufficient documentation is submitted, the DRB may also make a concurrent recommendation on monetary damages.

If the department and the contractor request the DRB to review issues of quantum and the exact value of the quantum cannot be determined expeditiously by the DRB, then quantum may be addressed in the DRB's findings and recommendations by providing guidelines to determine quantum. The department and contractor will then subsequently make the final determination of quantum. If there is still disagreement between the department and the contractor, then this disagreement may then be submitted back to the DRB for a final analysis and finding.

If the three-member DRB is unable to reach unanimity in its findings and recommendations, the DRB will so advise the department and the contractor in the report of the DRB. A dissenting member may, at their discretion, prepare a minority report to be included with the DRB report.

253.3.3.9 Acceptance or Rejection

Within 14 calendar days after the DRB finding date, the department and contractor will either accept or reject the DRB's recommendation. If rejecting the recommendation, written notice will be provided to the other party within those 14 calendar days. Unless extended by mutual agreement, a party's failure to provide notice within the established time constitutes acceptance of the DRB recommendation.

If either party rejects the DRB recommendation, the department will have 28 calendar days to confirm, overrule, or modify, in whole or in part, the DRB recommendation. Within 14 calendar days of the department's decision, the contractor will either accept or reject the department's decision.

If the contractor rejects the department decision, the dispute will continue under the administrative claims process prescribed in standard spec 105.13. Subsequent claim submittal and review times may be revised by mutual written agreement of the department and the contractor.

If, with the aid of the DRB's findings and recommendations, the department and the contractor are able to resolve their dispute, the department will promptly process any required contract changes.

253.3.3.10 Clarification and Reconsideration

Should the dispute remain unresolved because of a bona fide lack of understanding of the findings and recommendations or if evidence becomes available which was not available at the time of presentation, either the department or the contractor may, within 14 calendar days following the date of the DRB's findings and recommendations, request in writing that the DRB clarify specified portions of its findings and recommendations or reconsider its recommendation. This request will be submitted to the DRB and other party. The DRB will decide if it will provide further explanation or reconsider the matter. If the DRB decides to provide further explanation or reconsider its findings and recommendations, the 14-day timeframe for acceptance or rejection and the 28-day timeframe for the department's decision will be suspended until clarification or a new recommendation is received.

253.3.3.11 Admissibility

If the DRB's findings and recommendations do not resolve the dispute, the contract, the written findings, and recommendations including any minority report, and the qualifications of the DRB members, will be admissible as evidence to the extent allowed by law in any subsequent dispute resolution proceeding or forum to establish (a) that a DRB considered the dispute, (b) the qualifications of the DRB members, and (c) the DRB's findings and recommendations that resulted from the process.

253.3.3.12 Legal Relations

Each DRB member, in the performance of his or her duties on the DRB, is acting in the capacity of an independent agent and not as an employee of either the department or the contractor.

Each DRB member acts to facilitate resolution of disputes. The department and the contractor will agree that to the fullest extent allowed by law, each DRB member will be accorded quasi-judicial immunity for any actions or decisions associated with the review and findings and recommendations of disputes referred to the DRB. A DRB member will not be called as a witness by either the department or the contractor in subsequent proceedings on the dispute. Other than the DRB findings and recommendations, all DRB records, proceedings and deliberations are to be kept confidential to the fullest extent allowed by law. The DRB will, upon project completion, turn all records of the DRB over to the department for storage and preservation according to department policy and state law.

253.3.4 Payment

The department and the contractor will bear the costs and expenses of the DRB equally. Each DRB member will be compensated and reimbursed expenses as prescribed in the DRB review agreement executed by the department, contractor, and DRB member.

If the DRB desires special services such as legal, technical, or other expert assistance or testimony, or other consultation, accounting, data research, and the like, both the department and the contractor must agree to the special services.

The department will provide, at no cost to the contractor, administrative services such as coordination of the DRB and state-owned conference facilities. If other facilities or amenities are desired by both parties, these facility and amenity expenses will be shared equally by both parties.

The following payment procedures will be used:

1. The DRB members will submit invoices to the construction oversight engineer for review.
2. After the construction oversight engineer has reviewed and approved the invoices, the invoices will be forwarded to the project manager for review and approval.
3. After the project manager has reviewed and approved the invoices, the invoices will be forwarded to the contractor for review and approval.
4. If the contractor approves the invoices, the contractor will make payment of approved invoices.
5. The contractor will provide the project manager documentation verifying payment.
6. The department will then execute a change order to pay the contractor 1/2 of the contractor paid invoice.

There will be no markups applied to expenses connected with the DRB, either by the DRB members or by the contractor when requesting payment of the department's share of DRB expenses. Regardless of the DRB recommendation, neither the department nor the contractor will be entitled to reimbursement of DRB costs from the other party.

The department will reimburse the contractor for the department's share of the DRB costs under the Dispute Review Board administrative item.

SECTION 254 Contract Claims

254.1 Background

There are three components to consider when a contractor requests a change order:

1. **Entitlement:** If a contractor is seeking additional compensation or additional contract time, they must show a contractual basis of entitlement. Is payment or contract time already covered under the existing contract? Entitlement must be decided first before discussing the remaining components.
2. **Impact:** If the parties agree that there is a basis of entitlement, the contractor must provide evidence that their work activities are affected. It is possible for a contractor to have entitlement, but not have their work impacted. If there is no impact, there is no need for additional compensation or time.
3. **Cost:** Cost should only be discussed and negotiated after determining that the contractor has a basis of entitlement and confirming that their work is impacted.

In the mutual interest of all parties, WisDOT vigorously promotes resolution at the most immediate opportunity, and advocates timely submission of claims and responses to them. Objective claim analysis requires reconstruction of circumstances and events that occurred before submission of the claim. This analysis becomes more difficult with the more time that has elapsed since the events that caused the claim.

The purpose of a claim may be to recover extra costs due to changes in scope, differing site conditions, or delays. These instances should be easily identifiable by both the engineer and contractor, so the contractor is required first to request a revision to the contract under standard spec 104.2 and standard spec 104.3. If a revision is not agreed, the contractor may proceed using the claim process.

Standard spec 105.13 provides that the contractor must notify the engineer, in writing, of intent to file a claim for extra compensation. This notice must be filed before beginning any work that may provide a foundation for the claim. If the contractor does not notify the engineer in this manner, the department may deny the claim.

All parties involved in a dispute or claim are strongly encouraged to resolve the issue at the project level and within the terms of the contract. If the issue remains unresolved at the project level, and a claim is filed, it will be considered the department's claim review panel.

If the claimant is dissatisfied with the decision of the claim review panel, the decision may be appealed to the secretary of the Department of Transportation or directly to the State of Wisconsin Claims Board. The decision of the secretary may also be appealed to the state Claims Board.

254.2 Claims Process

Once the engineer has notice of a claim, notify the appropriate Bureau of Project Development (BPD) construction oversight engineer. For projects subject to federal oversight, WisDOT must notify FHWA early during the claims process, as well as request concurrence for the settlement amount resulting from the process.

The claims process is described in detail in standard spec 105.13.

254.3 State Claims Board

The Claims Board is composed of a representative of the governor, a representative of the Department of Administration, a representative of the Department of Justice, and the chairpersons of the senate and assembly committees on finance or their designees. The legislature has provided that whenever a claim upon which legislative action is necessary is presented, it must first be filed with the State Claims Board (Wisconsin statutes 15.105(2), 16.007 and 16.53). The board may, upon its own motion, and must, upon the request of the claimant, schedule claims for hearing. The board must give the claimant at least a 10-day notice of the hearing date. The board is not bound by common law or the rules of evidence and may hear testimony having reasonable value of evidence, excluding that which is immaterial, irrelevant, or unduly repetitious.

The board reports its findings and recommendations to the legislature for action. If it finds that the state is legally liable, or that the claim involves the casual negligence of any office, agent or employee of the state, or that the estate ought to pay, the board drafts a bill covering its recommendations and findings and submits the bill to the Joint Committee on Finance at the earliest possible time. The board's findings and conclusions are submitted to the claimant within 20 days after their determination.

After the Claims Board has acted, the legislature considers the claim. If it refuses the claim, the claimant may pursue a remedy by filing suit against the state (Wisconsin statute 775.01). The claimant must post a $1,000 bond to indemnify the state for costs if the judgment goes against the claimant. There is a limitation period imposed on the payment of claims by the Wisconsin Constitution, article 8, section 2, which provides that no money may be appropriated for the payment of claim unless it is filed within six years after the claim has accrued. In addition, the state may plead the state's six-year statute of

limitations on contract actions (Wisconsin statute 893.43). The date that the claim accrues is held to be the date that the indebtedness actually arises, not the date the legislature refused to pay the claim.

There is one exception to this procedure. If the board unanimously finds that payment of less than $4,000 is justified, it may order the amount paid on its own motion.

SECTION 256 Utilities

256.1 Background

Frequently, the facilities of utility companies affected by the construction or improvement of a highway or street occupy portions of the right of way by sufferance, subject to the superior right of the public as represented by the highway agency. These utility companies are obligated, at their expense, to move, relocate, and protect their facilities that are in the way of or that may interfere with construction of the project.

The utility facilities affected by a highway improvement may exist by agreement with the former landowner on newly acquired highway right of way. Where the cost of necessary alterations of a utility facility and release of the utility's prior rights is an obligation of the agency acquiring the new right of way, a release of the utility land interest is negotiated between the agency and the utility company, and a contract is made to alter or relocate the utility facility.

Utility companies are given advance notice of highway improvements. Plans of proposed improvements are also sent to utility companies so they may make necessary preparations for relocation of their facilities, and to establish relocation schedules for vacating the construction area before the start of construction of the highway project whenever practicable. Utility facilities that cannot be relocated or adjusted before construction are to be scheduled for alteration and coordinated with the contractor's schedule of operations at the preconstruction conference. For state trunk highway improvement projects, exclusive of connecting highways, Administrative Rule TRANS 220 formalizes the utility relocation process.

256.2 Trans 220

Refer to FDM Chapter 18 for further discussion on utility agreements. For TRANS 220 projects note FDM 18-1-15, TRANS 220.05(9), (10), (11), (13), and (14), and TRANS 220.06. These references are of importance to construction managers.

For TRANS 220 projects the term "work plan" is defined as "a plan of the utility facility owner to carry out utility facility alteration or relocation work to accommodate an improvement project of the department."

TRANS 220.05(9) requires the department to notify the utility owner 30 days in advance of when the utility is to begin work.

TRANS 220.05(10) requires the contractor for the department to alert a utility owner 14 to 16 calendar days in advance of when utility work is to begin at locations where the contractor must first do work. The contractor must send a follow-up confirming notice not less than three working days in advance of when the contractor's work will be ready for the utility owner to begin work.

TRANS 220.05(11) requires the utility owner to notify the department within 15 calendar days of starting its work, to complete the work in accordance with a work plan approved by the department, and to notify the department within 15 calendar days of completing its work.

TRANS 220.05(13) requires the department to notify the utility owner if, after the letting date, additional utility relocation or adjustment work is found necessary. The department and utility owner are to agree on a revised work plan to achieve the additional utility alteration or relocation.

TRANS 220.06 discusses responsibilities of the department, the utility owner, and the contractor. It should be referred to by the construction engineer if additional utility work is required, utility facilities are damaged, or the utility alteration or relocation is not completed in accordance with the approved work plan.

Change orders are not to be issued without full consideration of possible utility impacts and involvement of the impacted utility facility owner.

256.3 Identification of Utilities

Section 182.0175 of the Wisconsin Statutes requires owners of transmission facilities to mark in a reasonable manner the location of such facilities in the field, within three (3) working days after receipt of the notice by the contractor of intention to excavate.

The statute further provides that if the approximate location of a transmission facility is marked with paint, flags, stakes, or other physical means the following color-coding must be used:

1. Electric power: Red
2. Gas, oil, steam, petroleum or gaseous materials: Yellow
3. Communications, cable television, or alarm of signal systems: Orange
4. Water, irrigation, or slurry systems: Blue
5. Sewer or drain systems: Green
6. Temporary survey markings: Pink

7. Proposed excavation: White

These color-codings are also applicable to survey marks of WisDOT.

Department survey crews should use a paint color for survey markers different from the colors used for identifying utilities.

WisDOT project staff should not contact Diggers Hotline due to implied liability that can accrue.

256.4 Progress of Work

If work under a utility contract is performed in the absence of a highway improvement contract or before starting of operations under a related highway improvement contract, the region will assign an engineer to supervise the work under the utility contract. The starting date for work under a utility contract will be arranged between the region and the utility company. The engineer will notify the region office of the date work operations actually start and the date work is completed.

Where utility companies occupy portions of the right of way by sufferance, the region will notify the utility companies of the anticipated start of construction operations so necessary relocation or adjustment of their facilities may be made without delay to the contractor's operations. This might be done at the preconstruction conference if utilities attend. For TRANS 220 projects the relocation must be done in accordance with an approved work plan.

Utility companies should be invited to attend the preconstruction conference. On projects with complex or extensive utility improvement, it is advisable to schedule a meeting of affected utilities before the preconstruction conference to discuss schedules and coordinate efforts. This meeting would be arranged by the region utility coordinator and attended by the engineer.

The region survey crew should stake the right of way and other lines need by the utilities in their work, as soon as possible in the progress of the project.

In the interest of expediting the work, the engineer will make early contact with local officials of utility companies who have not started required adjustments of their facilities and advise them of the date the contractor intends to start construction operations, stressing the need for early completion of necessary alterations. Regardless of any advance notice given a utility by the region or the engineer, standard spec 107.22 requires the contractor give a written notice to the proper authority of a utility at least three working days before starting construction operations that may affect the utility.

During the progress of the project, the engineer should hold field meetings on a regular basis with the contractor's superintendent and the utility crew supervisor. The engineer should also be passing along to the contractor all notifications of utility work changes.

Where adjustments of utility facilities are accomplished during stages of construction operations and problems are created between the contractor's operations and the utility operations, the engineer will be the coordinator for any details not covered by the approved work plan. The project manager will keep a record of the progress of the utility adjustments and will report problems to the region office in the weekly report. Problems affecting contract work progress should be reported at once to the region supervisor.

256.4.1 Utility Relocation Claim (URC)

Section 84.063 of the Wisconsin Statutes defines a utility relocation delay as:

- A change in operations of a contractor or the rescheduling of work by a contractor that is caused by the uncompleted relocation or adjustment of a utility facility located in the right-of-way, regardless of whether the relocation or adjustment of the utility facility is identified in the approved work plan.
- The definition of a utility relocation delay allows the contractor to pursue compensation under the following parts of the standard specification:
  - Standard spec 104.2 - revisions to the contract.
  - Standard spec 108.10.3 - excusable compensable delays.

TRANS 220.06 (7c) requires the department to compensate the contractor for any costs caused by or attributed to a utility relocation delay and may not impose liquidated damages to the contractor. The utility owner will be liable, subject to the right to appeal the decision, for compensation paid by the department to the contractor for a utility relocation delay that was caused by the utility owner’s failure to complete a relocation in accordance with the approved work plan OR the utility owner’s failure to identify all necessary relocations within their approved workplan. This also includes facilities that were not identified in an approved work plan by the utility owner.

Steps of a utility relocation claim:

1. Contractor identification of a utility relocation delay.
   - If the contractor has identified a utility relocation delay, the contractor will notify the engineer as specified in standard spec 104.3 and the contractor must submit evidence that a revision to the contract is necessary per standard spec 104.2.1(2). Examples:

    - Construction work is delayed or altered by the utility facility owners' non-performance of utility relocations required in the contract.
    - Construction work is delayed or altered by a utility conflict that was relocated or left to remain and still conflicts with contract work.
    - Construction work is delayed or altered by a utility conflict that was not known to exist before construction.
- Temporary work (not specified in the contract) and contractor means and methods that conflict with a utility are not considered a utility relocation delay.
- Contractor notification per standard spec 104.3 constitutes a filing of a utility relocation delay damages claim as required in state statute 84.063(4m).
- The project engineer and contractor will track all cost associated with the utility relocation delay.
- The project engineer will notify the region project manager and the BPD construction oversight engineer.
- The project engineer will document specifics related to the utility relocation delay. A utility relocation claim documentation checklist is in the WisDOT pantry: https://awpkb.dot.wi.gov/Content/constr/Pantry/Pantry.htm.

2. Send notice of receipt of claim.

- The project manager or region utility coordinator will send the utility facility owner notice of receipt of claim (template located in WisDOT pantry, (https://awpkb.dot.wi.gov/Content/constr/Pantry/Pantry.htm).
    - The notice will be sent via electronic communication within 24-hours of receiving contractor notification.
    - **IMPORTANT** The notice will also be sent via certified mail within 5 business days of receiving contractor notification. The project engineer will document the utility facility owners' receipt of the certified mail.
- WisDOT region utility coordinator will provide the project engineer the utility facility owner contact information.
- Utility facility owner may provide WisDOT additional information related to utility relocation delay.

3. Determine if a utility relocation delay occurred.

- The project engineer and region utility coordinator will investigate, gather information, and present that information to the project manager for a final determination.
- The project manager will consider information provided by the contractor, and if applicable the utility facility owner.
    - A utility facility owner will not be liable when the failure to complete a relocation is caused by circumstances outside of the utility facility owner's reasonable control including a delay caused by another owner identified in the work plan or reliance on a 3rd party to identify and verify the location of a utility facility requiring relocation.
- If the project manager determines a utility relocation delay occurred continue to step 4 and provide the contractor and utility facility owner notification of the decision.
- If the project manager determines a utility relocation delay did not occur, provide notification to the contractor as required in standard spec 104.3.6 (1).
    - If the contractor contests the decision, the contractor will follow the steps outlined in standard spec 104.3.6 (2).
    - As necessary, the contractor will continue to the claims process as outlined in standard spec 105.13.
    - The project engineer and contractor will continue to track all cost associated with the utility relocation delay.

4. Resolve the utility relocation delay.

- The project engineer, project manager, region utility coordinator, contractor, and utility facility owner will resolve the utility relocation delay. There are many factors to consider when attempting to resolve the conflict. Factors to consider are safety, impacts to the traveling public, environmental impacts, schedule, cost, etc. Examples may include:
    - Alternate means and methods.
    - Design around the facility in conflict.
    - Protect utility facility.
    - Relocate utility facility. If this option is chosen, WisDOT project engineer will work with region utility coordinator to determine if Second Move applies and if additional utility work plans are required.
    - Discontinue use of utility facility.
- The department will make the final determination on how to resolve the utility conflict. The project engineer will document the decision with an appropriate level of justification.

5. Revise the contract and execute the revisions.

- Make necessary changes to the contract to address the utility relocation delay. Follow the process for revisions to the contract in standard spec 104.2.1 (3). Examples may include:
  - Revised plans and/or special provisions to update how the work will be completed.
  - Change orders for significant changes in the character of the work.
  - Change orders for equipment and labor standby costs.
  - Change orders to extend contract time.
- Revise contract price as specified in standard spec 109.4
- Extend contract time for the excusable delay as specified in standard spec 108.10.1.
  - The department will only extend contract time if an excusable delay affects the controlling item of work. The contractor must provide documentation and current schedule at the time the utility relocation delay was determined to support requested time extensions.
  - If contract time cannot be extended, revise the contract such that the work can be completed within the original contract time. The cost for the contract revisions must be incorporated into the utility relocation claim.
- Execute contract change order.
  - Include all relevant documentation and justification for the contract revision.
  - Use reason code UC, utility conflict.
- Contractor completes the work per the revised contract.
- Project engineer will compensate the contractor for the revised contract work.

6. Send assessment notice.

- WisDOT region utility coordinator will provide the project engineer the utility facility owner contact information.
- WisDOT region utility coordinator will complete DT1668 (WisDOT staff - https://wigov.sharepoint.com/sites/dot/forms-docs/Pages/AuthorizedForms.aspx) and obtain an invoice from fiscal services.
- The project manager or region utility coordinator will send the utility relocation claim assessment notice (template located in WisDOT pantry (https://awpkb.dot.wi.gov/Content/constr/Pantry/Pantry.htm) and the invoice received from fiscal services. These documents will only be sent once the contract has been revised and the contractor has received payment.
  - The notice will be sent via electronic communication.
  - **IMPORTANT** The notice will also be sent via certified mail. The region utility coordinator will document the utility facility owners' receipt of the certified mail.

7. Contested decision by utility facility owner.

- A utility facility owner may request a contested hearing case to review the decision of the department within 90-days of receiving the assessment notice. WisDOT project staff and region utility coordinator will defer such requests to Bureau of Technical Service (BTS) utility staff. BTS utility staff will coordinate with the Office of General Counsel (OGC).

8. Receive payment from utility facility owner.

- The utility facility owner has 90-days to reimburse WisDOT from the date the assessment notice was received.
  - If a contested hearing case has been requested, the amount owed will stay pending.
- WisDOT Bureau of Technical Services (BTS) utility staff will track reimbursements from the utility facility owners. BTS staff will provide notice to the project team if payment was received.

9. Utility facility owner fails to make payment.

- If a utility facility owner fails to make payment to the department, the department may seek remedy by filling a civil suit.
- BTS utility staff will coordinate with the Office of General Counsel (OGC) if payment is not received within 90-days from the date the notification letter was received.

10. Record retention and utility relocation claim tracking.

- The project engineer will document specifics related to a utility relocation claim.
- A utility relocation claim documentation checklist is in the WisDOT pantry (https://awpkb.dot.wi.gov/Content/constr/Pantry/Pantry.htm).
- The project engineer will complete a utility conflict report for each utility relocation claim. The utility conflict report will be used to track utility relocation claims.

256.5 Inspecting Work

The engineer or other region representative will inspect utility alterations to ensure alterations are made to the necessary extent and in a manner, which avoids any interference with, or detrimental effects to, the planned highway improvements.

Overhead installations such as power and communication lines should be checked in respect to location and elevation for proper clearance with the roadway, highway structures and appurtenances, and railway facilities. Poles, towers, and similar above-ground installations should be located in accordance with designated requirements governing proximity to right of way lines, construction operations, control-of-access lines, and planned improvements. Alteration of utility facilities for which permits are required and issued should conform to the requirements designated in the permit.

The engineer should determine that utility forces and the project personnel are using the same reference datum when setting grade stakes.

Underground installations are to be checked with respect to grade and location to provide acceptable clearance with existing foundations or facilities and planned construction items, such as structures, sewer lines, water lines, etc. Constructed utility manholes and other similar installations should be checked for compliance with required grade. Lines installed under the highway should be at the required depth and encased as required.

When utility facilities are installed in trenches within the highway limits, it should be determined that the foundation will provide the required support and backfill is properly placed and compacted with acceptable material so there will be no detrimental settlement which might affect the pavement, embankments, structures, or other facilities.

256.6 Contract Records

Regardless of the type of utility contract, the engineer should keep records and maintain diary entries to document inclement weather, lost time, verbal authorization for minor changes, progress records, coordination of highway and utility operations, and factual evidence that may be or is pertinent to the recommendation or verification of pay estimates. For TRANS 220 projects this information might become important in the event of contractor delay due to untimely utility relocations and to any claim that the department might make against a utility.

256.6.1 General

The engineer is to provide sufficient inspection activity to ensure the proposed utility work is accomplished in accordance with requirements of the contract and to furnish evidence necessary for recommending payment to the utility company. For audit-type contracts, inspections and record keeping are necessary to verify labor, material, and equipment charges. For lump sum type contracts, it is only necessary to verify that the materials used and the work completed conforms to what was agreed to in the contract.

256.6.2 Service and Supply (Force Account) Agreements

For this type of contract, the engineer should keep a daily record of the number and classification of workers employed, types and quantities of materials used, major items or equipment used, and any other pertinent information that may be of assistance to verifying billing charges. A record should be made of all materials removed from a job site and whether they are returned to stock or scrapped.

If the utility subcontracts the work on a service and supply basis, the daily record should show the subcontractor's operations, including workers and equipment, in the same manner as prescribed above for work performed by the utility on a service and supply basis.

256.6.3 Lump Sum Agreements

When a utility alteration is performed by a utility company under a lump sum contract, or when all or any part of the work under such a contract is performed by a subcontractor to the utility on a lump sum basis, daily records are not required of hours worked, material items, or equipment time, but the engineer must ensure the work is accomplished in accordance with requirements of the contract, including materials used. Records should be kept of work performed to document that the work has been accomplished in the manner prescribed in the agreement.

A daily record should be made of the work operations by station and the number of units or work completed.

256.6.4 Changes in Approved Work

Utility companies may be authorized by the engineer to do work involving changes in quantities or minor items not included in the approved estimate but found to be necessary to accomplish the intent of the

approved utility agreement. This action may be taken without necessity of formal approval with the understanding final billing by the utility will provide adequate documentation of such changes.

Substantial changes to the scope of work covered by the approved utility agreement and substantial change in location must be submitted either verbally or in writing to the department for approval and will, if necessary, be reviewed in the field. If the proposed changes are found to be acceptable, verbal authorization for the changes will be given and confirmed by letter. Refer to CMM 242 for information regarding change orders. Before or at the time of final billing, as-built plans will be required so the department's files will reflect the true location of the relocated facility. All changes, additions, or deletions to the original design of the adjusted facility should be reflected in the as-built plans.

Minor or major changes in work may necessitate revision of betterment or expended service life percentages established at the preliminary stage and agreed upon as being applicable to the final billing. Careful consideration should be given to those adjustments containing betterment and expended service life credit. Good judgment should be exercised in deciding the necessity for the revision of such percentages where either minor or major changes are involved. In case of question, consult the region utility coordinator.

256.6.5 Inspection of Recovered Materials

The purpose of inspecting recovered materials is to prevent the junking or scrapping of recovered materials with the resultant allowance of little or no credit to the department.

The engineer will obtain a copy of a letter from the utility company to the department stating the time and place where recovered materials sold or scrapped will be available for inspection. The engineer or WisDOT representative should make an inspection, prepare a memo verifying inspection of such materials, and place a copy in the project files. This will prevent any possibility the utility company may be cited for the salvage value of the materials when the audit is performed. It is emphasized the engineer or representative need not be concerned with placing a dollar value on the materials, but rather should ensure that proper classification and disposition is made.

Where a credit is received for salvaged material, the utility must submit a statement that all material from the original facility was covered in the credit or that the items scrapped were available for inspection and proper notice given. This statement should accompany final billing for the project.

256.6.6 Certification

The final paragraph of the region office memorandum transmitting the utility billing to the central office should real as follows:

"Based upon our inspection of the project and our review of the final billing, we certify the materials incorporated in the project and the construction operations performed substantially conform to the contract plans and estimates."

If the invoice or billing contains items to which the engineer is taking exception or which the engineer feels necessary to explain, the paragraph should have added as a final phrase "except for items commented upon above." This latter phrase, however, is not to be considered a substitute for a change order when required.

SECTION 258 Railroad Agreement

258.1 General

When a highway project crosses or otherwise affects railroad property and facilities, a force account agreement covering compensable work to be performed by railroad forces or a contractor hired by the railroad may have been negotiated between the railroad and the WisDOT, or between a local unit of government and the railroad. Refer to FDM Chapter 17 for discussion of railroad coordination.

On projects financed wholly or in part with state or state and federal funds, the Bureau of Transit, Local Roads, Railroads & Harbors (BTLRRH), Railroads & Harbors Section (RHS) negotiates for necessary occupancy rights from the railroads for parallel highway encroachment and highway-railroad crossings as needed. Where necessary, an agreement is also negotiated for relocation of railroad pole line facilities, track changes, crossing modifications, crossing warning devices, and highway underpass or overpass structures.

On off-state trunk system projects not funded with federal or state dollars, local units of government are responsible for making arrangements with railroad companies for grade crossing changes and encroachments. For off-system railroad crossing improvements and grade separation structures involving federal or state funds, the department is a party of interest, and RHS will negotiate the necessary agreements. The contracts manager in the Bureau of State Highway Programs (BSHP) approves these agreements.

Agreements negotiated for grade crossings specify location of the crossing and indicate what work the railroad will perform with its forces or its contractor, type and length of crossing to be installed, allocation of cost for the work, responsibility for crossing maintenance, and other requirements. At new crossing locations approved by the Commissioner of Railroads, the agreement provides necessary rights to construct, operate, and maintain a public highway across railroad lands at the described location. RHS usually negotiates for a highway easement to provide any additional right of way required on the state trunk system. For local road crossings this is done by the local government if federal or state funds are not used.

Stipulations are used for highway underpass or overpass structures and cover the location of the structure, construction requirements, insurance and flagging, assessment of benefits or cost-sharing, audit procedures, maintenance responsibility, and right of way or easements.

When a highway project is contained within a public street or highway right of way and no track grade adjustment is needed, and where no agreement covering compensable work has been executed, the region must notify the engineer in charge for the railroad during the plan development stage about the proposed highway improvement. At that time, the region must request the railroad to furnish information regarding any work planned by the railroad at or near the crossing.

The railroad's obligation under Section 86.13 of the Wisconsin Statutes will also be evaluated at that time. Where a change to a crossing is required, the region must determine with the railroad what is needed and RHS will negotiate an agreement. Construction funds will be used for the public portion of the crossing cost. See FDM 17-30-1 for more details on funding.

Wherever railroad facilities are affected by highway improvements or modifications, and where coordination of the contractor and railroad's activities is desirable, a railroad representative should be invited to attend the preconstruction conference and subsequent project meetings as needed.

The engineer should have copies of all railroad agreements connected with the project. Questions concerning the agreements should be directed to the Regional Railroad Coordinator (RRC) or RHS.

on Project Tracking.

258.2 Railroad Checklist

The "Railroad Checklist" below is intended to be a guide for the region person to discuss and coordinate the railroad work with the railroad supervisor or representative and railroad contractor.

FIGURE 258-3 Railroad Checklist

Contract Documents	Plans and special provisions
Train Traffic	Number /day, speed, schedule, construction window (s) - specific day of the week better than others?
Agreements & Stipulations	Identify roles, responsibilities, and work to be done. Get copies.
Status	Railroad work before construction is completed and on schedule?
Insurance	Is it needed, and documents required?

	Completed? Yes or No? If no, when will it be completed? Expiration date for the policy _____
WisDOT Standard Specs	Standard spec 107.17
COORDINATE	
Contractor and railroad anticipated work operations, staging, and schedule.	
Excavation near track - footings, foundations, piling, sheeting.	
If a temporary crossing is needed to build the project, arrangements are made in advance by RHS. If a temporary crossing is desired for the convenience of the contractor, the contractor is responsible for making arrangements with the railroad.	
Signals when will they be needed? Staging? Temporary needs?	
Signal supervisor or contact: Name _____ Phone_____	
Crossing work, when will it be done? Staging? Track supervisor or contact: Name _____ Phone_____	
Flagging required when within 25 feet of track centerline or as noted in contract special provisions.	
Lead time needed when requesting a flagger _____	
What should be done in emergency situations? 24-hour contact. Name _____ Phone_____	
Will there be any railroad maintenance operations anticipated through the life of the highway construction project? Impact on the project?	
Is the railroad a member of Diggers Hotline? Yes or No? If not, contact for locates Name _____Phone _____	
Utilities other than railroad located on railroad property _____	
Open trench across rails - agreement required - timing to remove/replace rails for sewer crossing, etc.	
Salvaged material? - If so, where will it be stored _____	
Other coordination items:	
UNDERSTAND	
If construction progress meetings are held, review checklist for action items.	
Project engineer provides railroad updates when schedule changes. Name _____ Phone_____ FAX_____	
Contractor will provide _____ lead-time to railroad for scheduling their work.	
Who should be contacted if flagger doesn't show up when scheduled? Name _____ Phone_____	
Procedure if flagger has to leave site - railroad flagger contacts the project engineer or inspector at the field office Phone_____	
Railroad contact project engineer if work is being done within track clearance zone without a flagger and advise region railroad coordinator.	
Contractor/project engineer document who they talk with at the railroad when requesting a flagger Name _____	
Railroad will be responsible for traffic control/ flagging of highway traffic during crossing construction, if needed.	
Injuries/incidents on railroad R/W must be reported to the railroad. Name _____ Phone_____	

258.2.1 Third-Party Railroad Protective Insurance

A special provision, either "Railroad Insurance and Coordination," or "Railroad Requirements and Coordination" may be included in the contract requiring the contractor to furnish third-party protective

insurance. Do not allow the contractor to start work on the railroad right-of-way until evidence of the required insurance is furnished to the region and the railroad, and the provisions of standard spec 107.17.3 have been fulfilled.

For more information on third-party railroad protective insurance see FDM 17-50-5 and FDM 19-15-35.

258.2.2 Work on Railroad Right-of-Way Requiring a Railroad Flagger

Standard spec 107.17 provides that work or operations within the right of way of the railroad company must be conducted in a manner that will not interfere with the safe and uninterrupted operation of railroad traffic, and that no equipment can be operated, or materials stored within specified limits, except under the protection of railroad flaggers, unless other arrangements have been made with the railroad and are covered in the special provisions.

The engineer should make sure the contractor does not operate within 25 feet of a railroad track without a railroad flagger present. Any violation of the contract in this respect might be cause to halt operations on or adjacent to the railroad track area.

The "Railroad Requirements and Coordination" special provision providing flagging requirements and costs involved will be included in agreements involving extended occupancy of railroad right of way for railroad grade separation and other projects. In some situations, the railroad provides flagging at no cost to the contractor.

Flagging has often been a sensitive and sometimes costly item and is often a disputed item between the contractor and the railroad. As an incentive to minimize the risks on projects with extended occupancies of railroad right of way, when provided in the special provisions, WisDOT will share these costs 50-50 with the contractor. Since this is not a bid item, these costs must be treated as overhead in the contractors bid. WisDOT pays its share of the cost through a change order after the contractor pays the railroad all flagging costs and bills WisDOT 50%.

258.2.3 Non-Compensable Work

The railroad is responsible for the maintenance of at-grade crossing surfaces on public streets or highways and associated warning devices. They generally receive no compensation for this work. Exceptions are grade crossings on state trunk highways, for which the railroad may be reimbursed up to 85% of reconstruction costs by the state. Maintenance costs for warning devices are partially reimbursed annually by lump sum based on the proportionate share of warning devices that the railroad maintains. Separation structure maintenance may also be required of the railroad at its expense, dependent upon terms of the agreement or stipulation in force.

The region office or local highway authority sends written notice to the railroad under Section 86.12 or Section 86.13, Wisconsin Statutes, advising of the proposed highway project that may affect a railroad highway crossing. The written notice is the means of notifying the railroad of an impending highway improvement that does not require an agreement with the railroad. On state trunk highway crossings, the department may have an obligation regarding the improvement or repairs to the crossing. Refer to FDM 17-5-5 for further discussion.

Railroad representatives should be invited to attend the preconstruction conference when railroad crossings are within the project limits. During construction, the railroad should be kept informed as to when work near the crossing will be done and when the highway will be opened to traffic.

In some situations, RHS arranges with the railroad to pave within the four-foot zone of railroad responsibility in exchange for the railroad providing flagging (usually up to three days), at railroad expense.

258.2.4 Compensable Work

Contract administration is a region function, and duties and responsibilities within each region vary. The region has the responsibility of prosecuting and overseeing railroad contracts to completion, inspecting the work for compliance with the plans and special provisions, preparing the contract completion certificate (when needed), and obtaining and submitting final invoices for payment.

258.2.4.1 Agreement Execution

RHS provides the region with a copy of the fully executed agreement including exhibits and railroad estimates. The RRC will provide the project engineer a copy for information and use. For more information on agreement types and contents see FDM 17-20-10 and FDM 17-20-15.

258.2.4.2 Preconstruction

If work is part of an improvement project, a preconstruction conference is held with the contractor and others. Railroad representatives are to be invited to attend. This conference should cover the contractor's

schedule of operations, the railroad's schedule and plans for its work, coordination between the contractor and the railroad, plans for handling traffic, and any special problems or conflicts.

258.2.4.3 Start Notice

Authorization to proceed with acquisition of materials is often given to the railroad at the time the agreement is sent to them for signature by RHS. The need for lead-time by the railroad should also be considered by the region in notifying the railroad to proceed with construction. A "start notice" is issued by the RRC to authorize the railroad to proceed with the work.

258.2.4.4 Project Schedule

A project schedule may or may not be included in an agreement. Generally, ordered work by the Office of the Commissioner of Railroads has a completion date associated with it. A Grade Crossing Repair project has a schedule driven by the railroad and subject to working out road closures and detours. Projects let to contract are included in construction project special provisions and schedules.

For more project scheduling information see FDM 17-20-5.

258.2.4.5 Inspection

The region must determine whether construction staff or the RRC will be responsible for compliance with the railroad agreement. The RRC is familiar with railroad construction and with the railroad agreement. The RRC is also the link to the RHS for additional technical expertise or assistance.

The engineer or RRC should maintain liaison with the railroad person in charge of the fieldwork in order to monitor the project and concur on the work completed, the workdays, and the type of equipment and machinery used on the project. The railroad is required to notify the region when it will begin work and when the work was completed or suspended. The RRC and engineer should arrange with railroad personnel for final inspection and acceptance of the project. Regardless of who will be responsible for inspection, notify the RRC when the railroad begins work on the project.

Work accomplished by railroad forces under a railroad agreement will be inspected and administered according to the following guidelines:

1. If railroad forces begin work before receiving authorization to proceed from the region, they should be informed the work may be at the railroad's expense. The project engineer is to notify the RRC when railroad work starts.
2. When the railroad company concurrently performs non-compensable work, the supervision and administration of the agreement by the department's forces extends only to the compensable work and only to the extent described in the contract, but sufficient records must be kept so that only compensable work is paid for when the railroad submits invoices.
3. Field notes for larger railroad agreements should be kept in the same fashion and in detail sufficient to review partial and final billings, to support change orders, additional work, and to clarify unusual problems. Field notes should include the following:
    - 3.1 Information relating to equipment used such as type, number, hours, and rates.
    - 3.2 Information relating to use of labor, such as class, number, hours, and wage rates. These labor costs should be reviewed weekly with the railroad work supervisor.
    - 3.3 Materials installed, removed, or recovered.
    - 3.4 Sufficient information for preparation of change orders if needed.
4. Field notes for lump sum railroad agreements should be adequate to document that the work was accomplished in accordance with the terms of the agreement including the furnishing of new or used material. Also, sufficient information should be recorded to enable preparation of a change order if needed.

If it appears that railroad force work may not start in a timely manner, or if the railroad force work is not being carried out in accordance with the railroad agreement, notify RHS in sufficient time for RHS to deal with higher authority on the railroad.

258.2.4.6 Recovered Materials

Salvage values of materials recovered by the railroad should be credited to the project. The RRC or engineer should review with RHS to establish material values. A copy of this record should be available for review at audit.

258.2.4.7 Final Bill

The RRC has the responsibility of monitoring the timeliness of final bills. The railroad accounting section will accumulate costs and submit their final invoice to the region. This invoice is to be marked "FINAL." The final bill is to be submitted within one year of the state's acceptance of the company's work in accordance with 23 CFR 140.922. If the final bill is not received by that date, the last detailed progressive bill will be considered to be the final bill.

258.2.4.8 Completion and Acceptance

The region monitors construction progress to completion. The region may keep a record of railroad work including labor, equipment, and materials used. The railroad should notify the region in advance, in writing, if they expect to suspend the work, later when they resume the work, and finally when work is completed.

The railroad is to notify the region, or in the case of ordered projects, the region and Office of the Commissioner of Railroads, in writing, advising that the project work is completed. If the railroad has not indicated that the railroad force work has been completed, the region should contact the railroad for information on the status of railroad work. The region and railroad should agree on the project completion date.

The RCH makes a final field inspection and notifies the railroad of acceptance by letter, with a copy to RHS and BBS.

258.2.4.9 Contract Modifications

Any significant modification to the extent or scope of the work under the Agreement, including associated work exceeding 25% of the original estimate for force work labor or the total cost of the work, must be covered by a written change order to document concurrence of the state. Any work done by the company under the agreement before authorization by the state must be excluded from payment under the terms of the agreement. For further discussion of change orders refer to CMM 242.

258.2.4.10 Claims

If a railroad company has a claim under a force work agreement and resolution is not reached at the regional level, RHS and ACAS should become involved. Information for processing let work claims can be found in CMM 254 and may offer general guidance on the claims process that may be of use with a railroad. It would be unusual for a railroad claim to progress to the level of DOT Secretary, or to the State Claims Board for resolution however.

SECTION 260 Subcontracting

260.1 Subletting the Contract

Standard spec 108.1.1 requires that before the prime contractor may sublet, sell, transfer, or assign any contract work, or otherwise dispose of the contract, a portion of the contract, or a right, title, or interest in the contract, the written consent of the engineer must first be obtained. Before subletting or subcontracting any portion of the contract work, the contractor must submit DT1925, Sublet Request and DBE Sublet Purchase Report. Figure 260-1 provides an example. A separate form must be submitted for each proposed subcontract. The form must be completely filled in and signed by the contractor or the contractor's authorized agent. If the prospective subcontractor is not pre-qualified with the department, evidence of competency to perform the work must be attached.

The engineer will not allow contract work to be performed by a subcontractor until the request for permission to sublet the work has been approved. A subcontract is a direct contractual relationship between the prime contractor and another company where the company operates independently to perform a defined portion of the contract. These contractual relationships are often referred to as first tier subcontracts. The authority to approve or disapprove will reside in the regions within these guidelines.

Occasionally, a question will arise as to whether a contractual relationship between a prime contractor and another company is a subcontract or an employee lease arrangement. FHWA has addressed this question in their Contract Administration Core Curriculum Participant's Manual and Reference Guide. In this manual, FHWA states that employee lease arrangements are acceptable for federal-aid projects if the leased employees are under the direct supervision and control of the contractor's superintendent or supervisor. Leased employees may be considered to be part of the prime's own organization if:

- The prime contractor maintains control over the supervision of the day-to-day activities of the leased employees.
- The prime contractor remains responsible for the quality of the work of the leased employees.
- The prime contractor retains power to accept or exclude individual employees from work on the project.
- The prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance, and all other federal regulatory requirements.

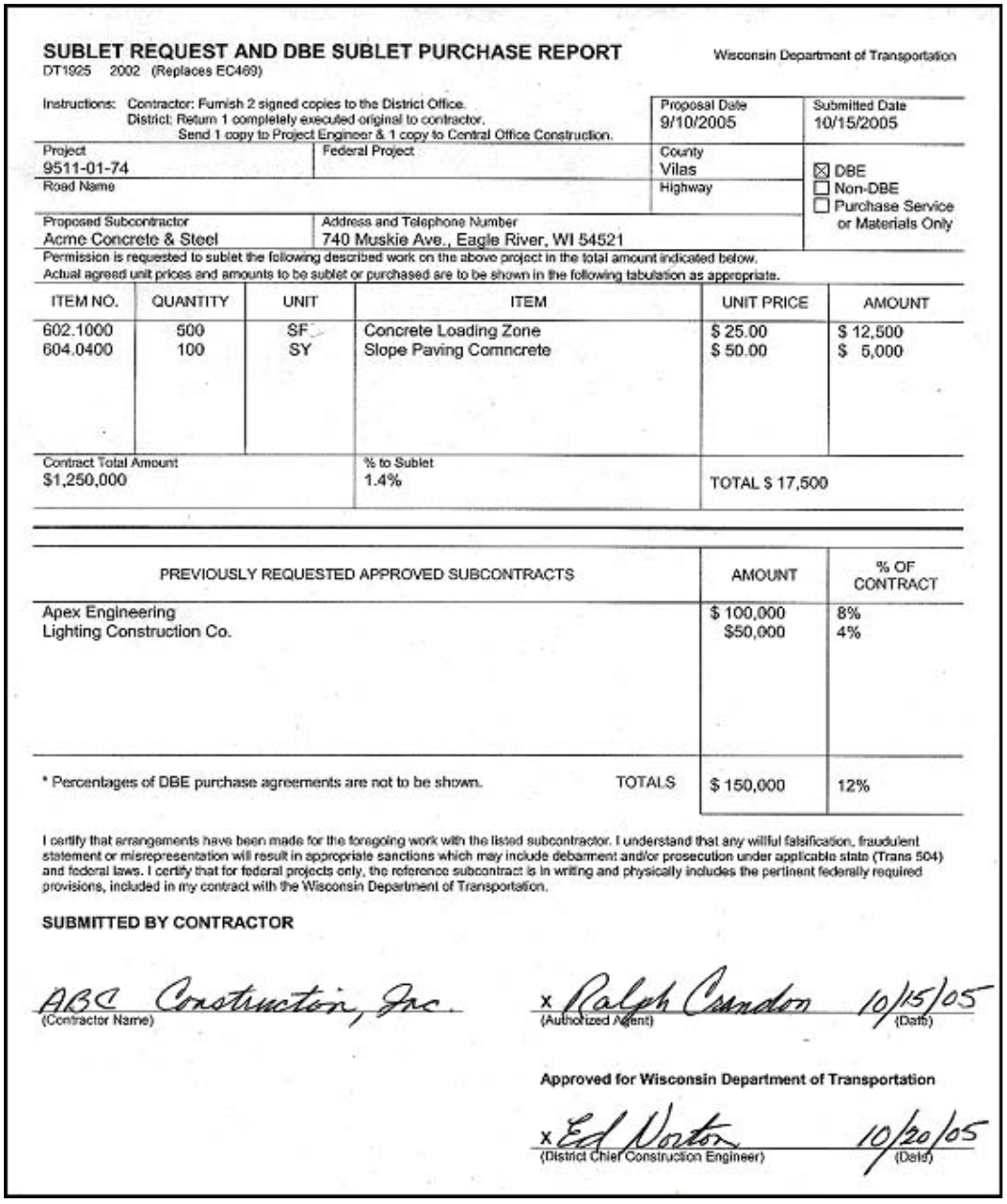
The key issue is supervision and control of any leased personnel. If the leased personnel are treated as employees of the prime contractor and would be considered as such but for their actual employment by a leasing agency, then for purposes of 23 CFR Section 635.116(a) they should be considered employees of the prime contractor's organization.

If the above conditions are met, the contractual relationship is an employee lease arrangement, not a subcontract. An employee lease arrangement is not subject to the 30% rule discussed later in this section, and a request to sublet is not required.

A sublet request is required for disadvantaged business enterprise (DBE) work regardless of subcontract tier, even if not done under an official subcontract. A sublet request is also required for reporting materials or supplies furnished by a DBE.

- The contractor must submit sublet requests on DT1925 for all DBEs named in the initial commitment, DT1506, regardless of tier.
- After approval of the initial commitment, notification of DBE sublet for second tier and below subs is indicated by the contractor entering them in the civil rights compliance system (CRCS).

FIGURE 260-1 Example Sublet Request and DBE Sublet Purchase Report



SUBLET REQUEST AND DBE SUBLET PURCHASE REPORT

DT1925 2002 (Replaces EC469)

Wisconsin Department of Transportation

Instructions: Contractor: Furnish 2 signed copies to the District Office.
District: Return 1 completely executed original to contractor.
Send 1 copy to Project Engineer & 1 copy to Central Office Construction.

Proposal Date	Submitted Date
9/10/2005	10/15/2005

Project	Federal Project	County	
9511-01-74		Vilas	☒ DBE
Road Name		Highway	☐ Non-DBE
			☐ Purchase Service or Materials Only

Proposed Subcontractor	Address and Telephone Number
Acme Concrete & Steel	740 Muskie Ave., Eagle River, WI 54521

Permission is requested to sublet the following described work on the above project in the total amount indicated below.
Actual agreed unit prices and amounts to be sublet or purchased are to be shown in the following tabulation as appropriate.

ITEM NO.	QUANTITY	UNIT	ITEM	UNIT PRICE	AMOUNT
602.1000	500	SF	Concrete Loading Zone	$ 25.00	$ 12,500
604.0400	100	SY	Slope Paving Comncrete	$ 50.00	$ 5,000

Contract Total Amount	% to Sublet	
$1,250,000	1.4%	TOTAL $ 17,500

PREVIOUSLY REQUESTED APPROVED SUBCONTRACTS	AMOUNT	% OF CONTRACT
Apex Engineering	$ 100,000	8%
Lighting Construction Co.	$50,000	4%
* Percentages of DBE purchase agreements are not to be shown. TOTALS	$ 150,000	12%

I certify that arrangements have been made for the foregoing work with the listed subcontractor. I understand that any willful falsification, fraudulent statement or misrepresentation will result in appropriate sanctions which may include debarment and/or prosecution under applicable state (Trans 504) and federal laws. I certify that for federal projects only, the reference subcontract is in writing and physically includes the pertinent federally required provisions, included in my contract with the Wisconsin Department of Transportation.

SUBMITTED BY CONTRACTOR

ABC Construction, Inc. (Contractor Name)

x Ralph Csandon (Authorized Agent) 10/15/05 (Date)

Approved for Wisconsin Department of Transportation

x Ed Norton (District Chief Construction Engineer) 10/20/05 (Date)

In addition to obtaining department approval for all first-tier subcontractors, standard spec 108.1.1 requires the prime contractor to notify the department of all lower tier subcontractors and all other parties working on the contract.

This notification is important, so the department is aware of all the parties working at the project site, and can properly administer labor compliance regulations.

260.2 Prime Contractor Participation

Standard spec 108.1.2 includes the federal requirement that the prime contractor perform at least 30% of the original contract work with the prime contractor's own organization. The purpose of this requirement is to prevent brokering. Brokering occurs when the company under contract with the owner sublets all or virtually all of the work to other companies.

The prime contractor's own organization is defined as workers the contractor employs and pays directly as well as equipment the contractor owns or rents, either with or without operators.

Occasionally, due to a wide variety of work within a single contract, FHWA may approve a reduction in the level of prime contractor participation before the contract is let. If a reduction is approved, it will be identified in the contract special provisions.

The department administers the 30% rule by:

- Reviewing the prime contractor's initial submittal identifying the work they will perform.
- Monitoring the total amount of work the prime contractor is proposing to sublet as shown on DT1925, Sublet Request and DBE Sublet Purchase Report.

260.2.1 Prime Contractor's Initial Submittal

As referred to in standard spec 108.1.2, standard spec 103.6 requires the prime contractor to submit documentation regarding the 30% rule during the same 10 business day time period the prime submits a signed contract, the contract bonds, and other department required forms. The prime contractor must demonstrate compliance with the 30% rule as a condition of contract execution.

The prime contractor is required to submit its 30% rule documentation on WS1081, "Prime Contractor Participation". Submit WS1081 using the automated process described below. The submittal must contain the prime contractor's best information, at the time of the letting, concerning the work the prime contractor intends to do.

The department recognizes the information on the prime contractor participation worksheet is subject to change as work proceeds on the contract. The prime contractor is not obligated to perform the work as shown on the initial submittal. At its discretion, the prime contractor may decide to complete the work differently provided it complies with standard spec 108.1.

The department will further monitor compliance of the 30% rule during the course of the contract by reviewing the total amount of work the prime contractor is proposing to sublet as shown on DT1925.

260.2.2 Installing the Prime Contractor Participation Worksheet Template

Users of WS1081 will need to save the worksheet template on their hard drive before using it the first time, by following these steps:

- Within File Explorer, create a C:\ws1081 folder.
- Open WS1081 by clicking here:

  https://wisconsindot.gov/hcciDocs/contracting-info/ws1081.zip
- Click <Save as>.
- Browse to the "C" Drive, select C:\ws1081 folder, then click <Save>.
- If a dialog window appears, ignore it and close the window.
- Within File Explorer, navigate to C:\ws1081 folder and open the ws1081.zip folder.

260.2.3 Completing the Prime Contractor Participation Worksheet

These instructions detail how to download a file of contract items and unit prices, import the items into the prime contractor participation worksheet, complete the worksheet, and send it to the department. The instructions assume that you are logged on to the WisDOT Web Access Management System (WAMS) where you will begin by downloading the list of contract items. This process can be used for a single contract or multiple contracts. For multiple contracts you will need to repeat Steps 2 - 12 for each contract.

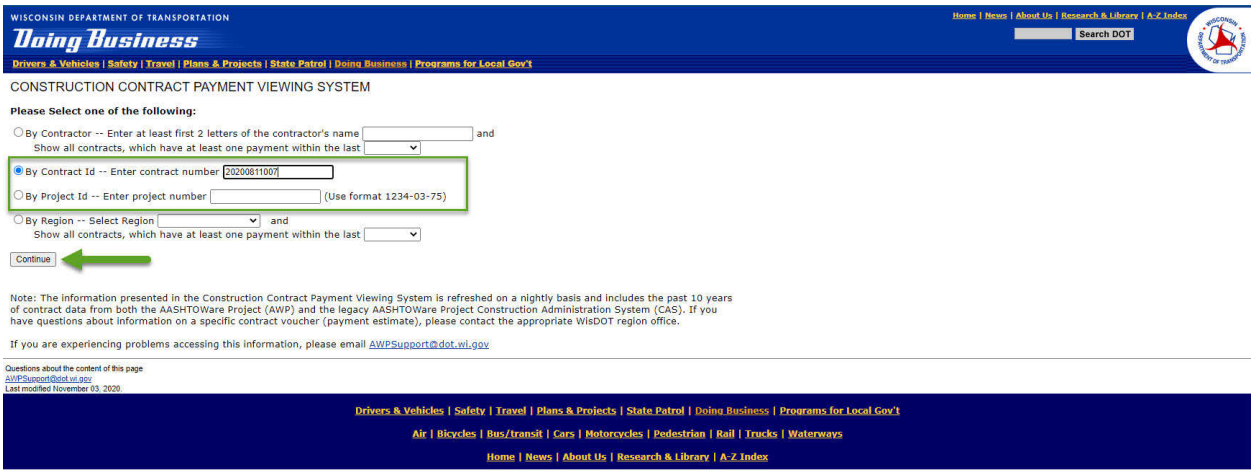
260.2.3.1 Download Contract Item File

Step 1: Go to the Construction Contract Payment Viewing System located on the department's Highway Construction Contract Information (HCCI) site at the following link:

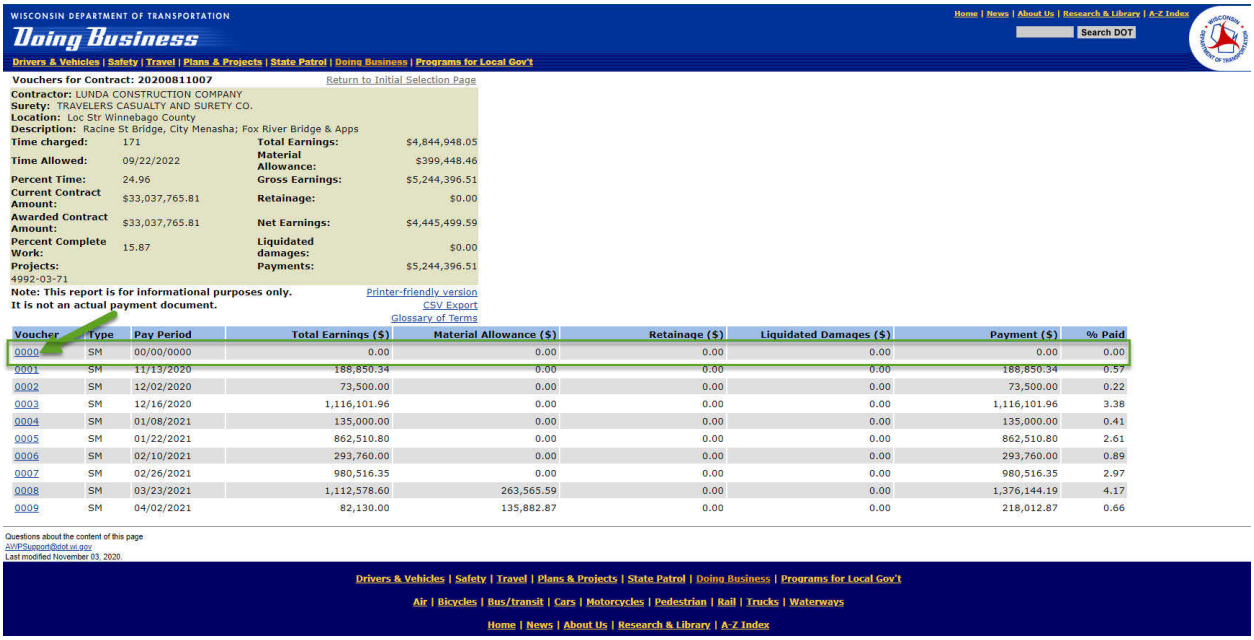
https://wisconsindot.gov/Pages/doing-bus/contractors/cntrct-pymts/default.aspx

- Click on the "Access to Construction Contract Payment Viewing System (CCPVS) link.
- Enter your Wisconsin Web Access Management System (WAMS) credentials.
- Click <Login>.

Step 2: Enter the contract number OR the project number in the fields provided and click <Continue>.

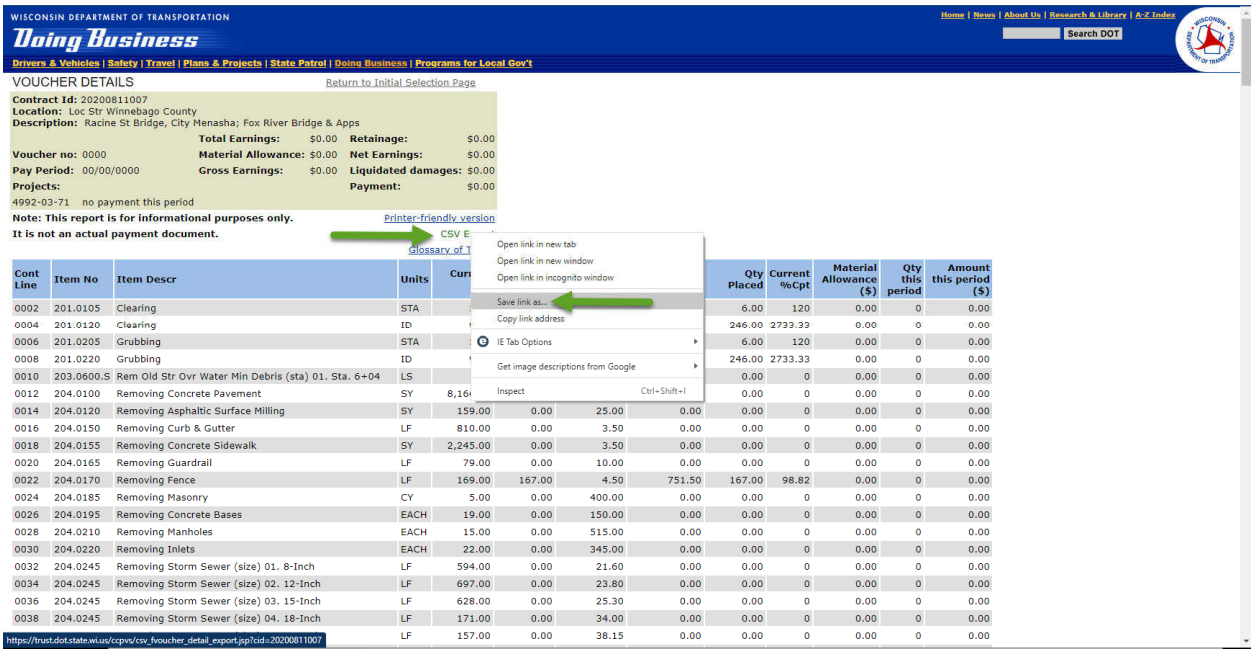


Step 3: Click on the 0000 voucher link.

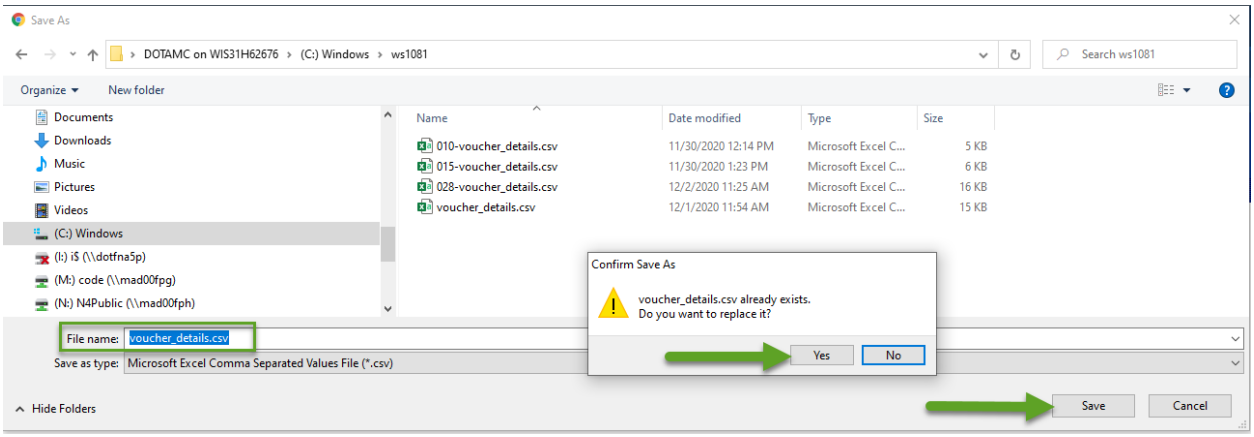


Step 4: Right-click on CSV Export link and select “Save link as…” in Google Chrome or “Save target

as…" in Microsoft Edge or Internet Explorer.



Step 5: Browse to C:\ws1081 and click <Save> to save the voucher_details.csv. If the voucher_details.csv file already exists, click <Yes> to replace the file. Step 6: Click Save.



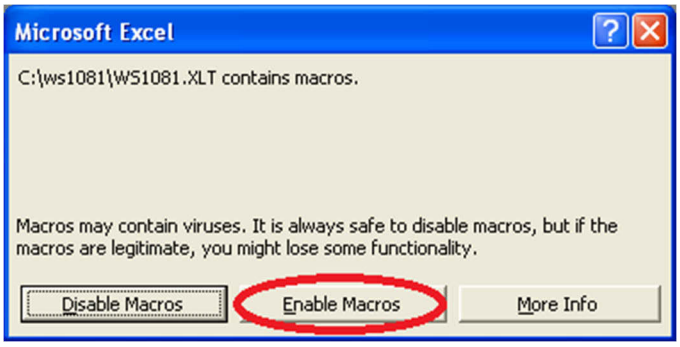
NOTES:

- Do not change the folder location or the file name. The csv file must be saved to the C:\ws1081 folder and the file name must be "voucher_details.csv". If you change either one, the worksheet will not import the data.
- The file already exists dialog box will not appear the first time you perform this step but will appear each subsequent time. If you have multiple contracts, continue through Step 9 before beginning to download data for the next contract.

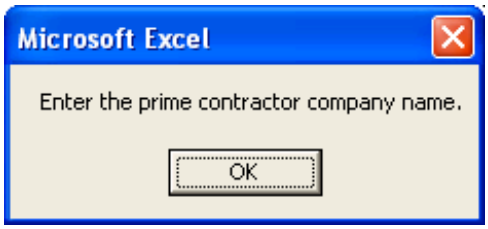
260.2.3.2 Import Contract Item File

Step 6: Close excel and all active spreadsheets. Navigate to the C:\ws1081 folder, open ws1081.zip folder, then open the ws1081.xlt file.

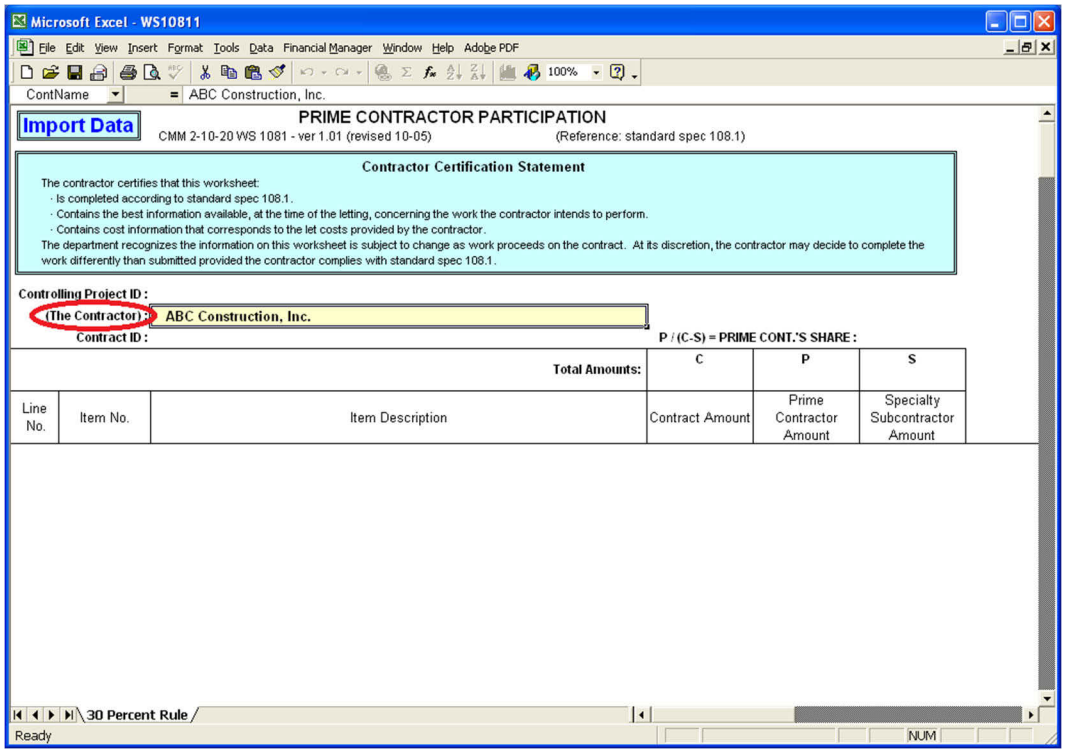
Step 7: When you open ws1081.xlt the following dialog box will appear. Click on Enable Macros.

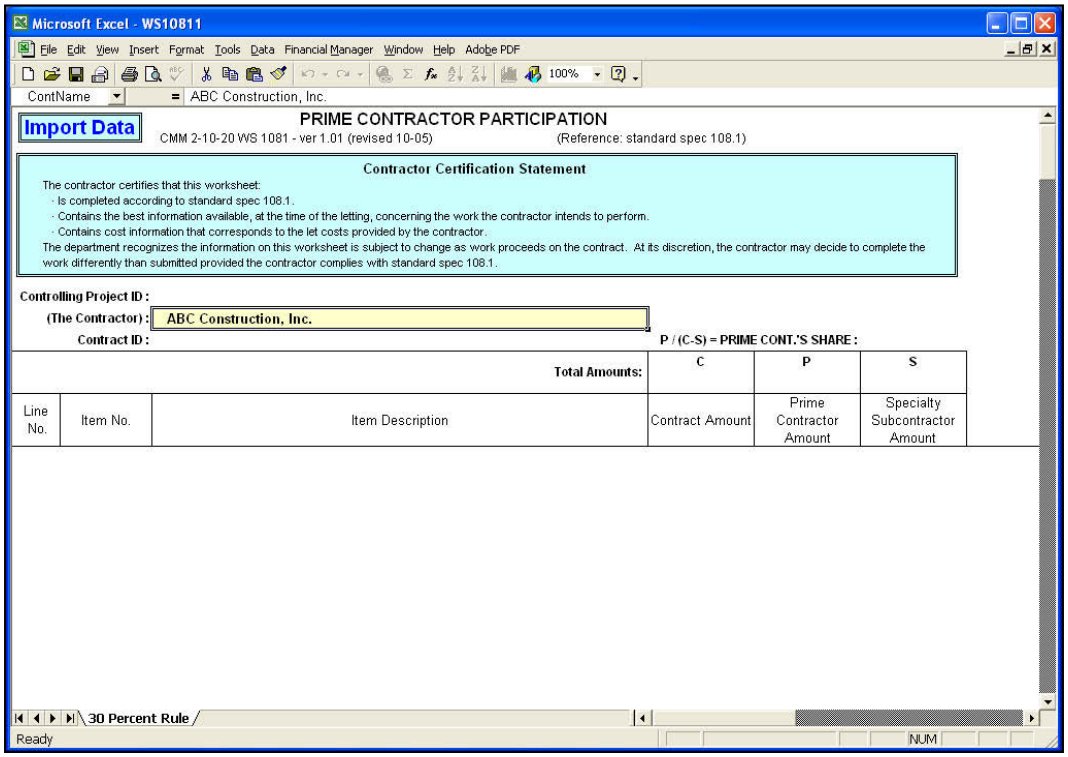


Step 8: Opening ws1081.xlt will create an empty worksheet. You will be prompted to enter the prime contractor name. Click OK.



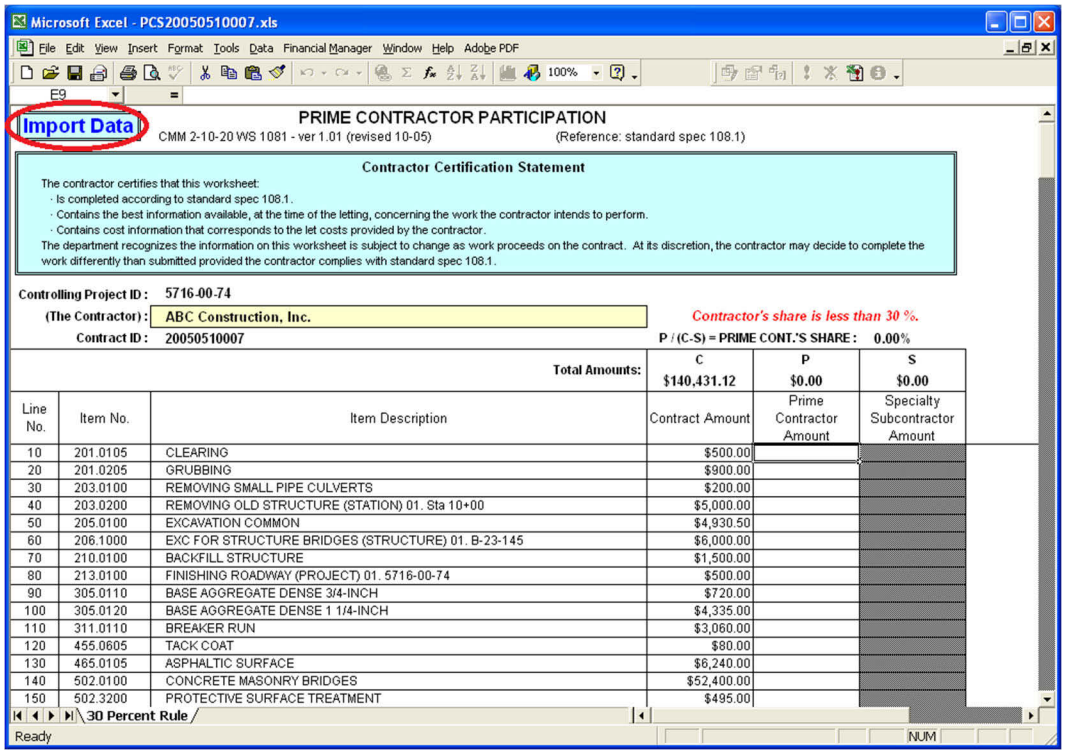
Enter the prime's name in the yellow highlighted box labeled (The Contractor).





By completing the worksheet the contractor agrees to the terms of the Contractor Certification Statement contained in the worksheet header.

Step 9: Click Import Data to populate the worksheet with the contract bid items.

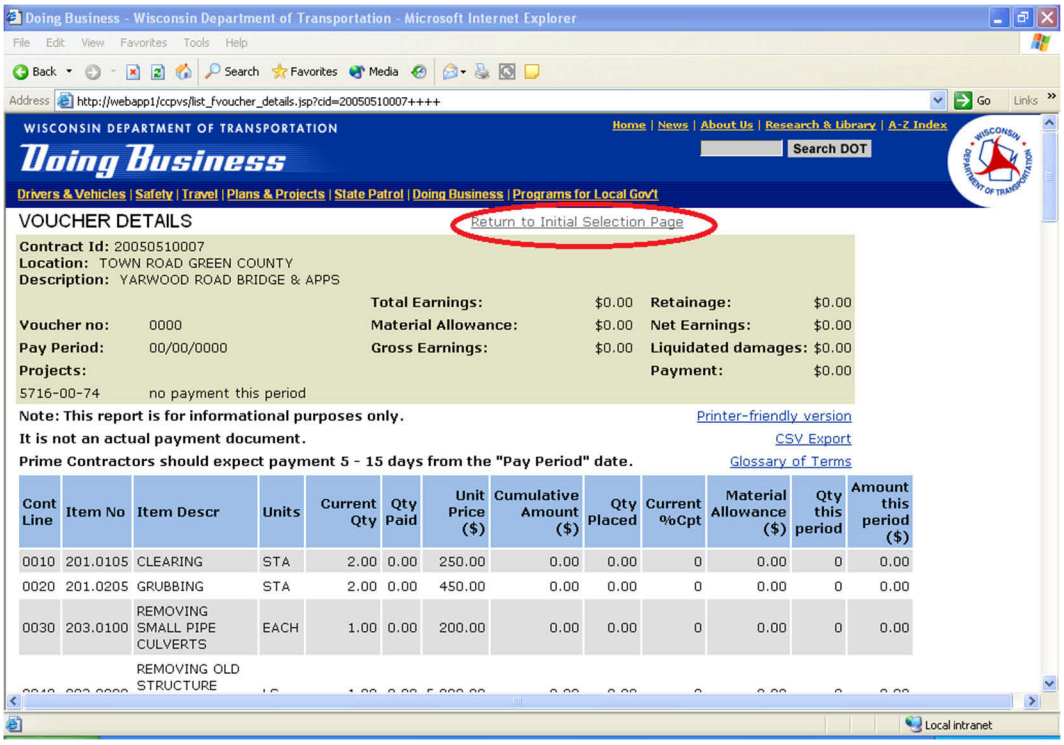


The data from the voucher_details.csv previously saved in Step 6 will be imported into the blank WS1081 worksheet file and will be automatically saved as the PCS"*contractID"*.xls file in the C:\ws1081 folder. The "*contractID"* designation in the file name is the contract ID for the contract entered in Step 2. You will see the file name displayed in the top blue bar of the open worksheet, for this example Microsoft Excel - PCS20050510007.xls as displayed in the above screen shot.

Step 10: If you want to continue filling out the worksheet, first close the Construction Contract Payment Viewing System and go to Step 11. If you have multiple contracts to download, follow Steps 2

-9 for each contract. Click "Return to Initial Selection Page" to return to the screen described in Step 2.

Remember to open a new ws1081.xlt worksheet file in Step 9 from your C:\ws1081 folder for each new contract ID.



260.2.3.3 Complete Worksheet to Determine Prime Contractor's Share

Please see standard spec 108.1.2 for a complete description of the prime contractor's share formula shown on the upper right. The prime's share is automatically calculated as the contract amounts for each bid item are placed in the desired columns.

As long as the prime's share is less than 30%, a note in red appears indicating such.

You can copy blocks of item "Contract Amounts" to the other columns using standard MS Excel copy and paste features.

Step 11: With desired contract worksheet open, as illustrated in Step 12, fill in the "Prime Contractor Amount" (P) column for each bid item as follows:

- Use let cost information.
- Indicate the dollar amount of work the prime contractor intends to perform, including materials the prime contractor purchases and installs.
- The prime contractor can indicate if it is performing the entire bid item or just a portion of it.
- Prime contractors can include in the (P) column any materials the prime contractor purchases for others to install, and can include the cost of trucking that the prime contractor pays for directly.
- For the mobilization bid item, the prime contractor should only include its mobilization costs in the (P) column.

Step12: Next, you have the option of filling in the "Specialty Subcontractor Amount" (S) column; however, this is not required. Identifying specialty subcontractor work will make it easier for the prime to achieve the required 30%.

Please note that the (S) column is not for identifying all subcontractor work but is only for specialty subcontractor work. If you decide to fill in the optional (S) column, use let cost information to indicate the dollar amounts of work specialty subcontractors will perform.

standard spec 108.1.2 describes specialty work as follows:

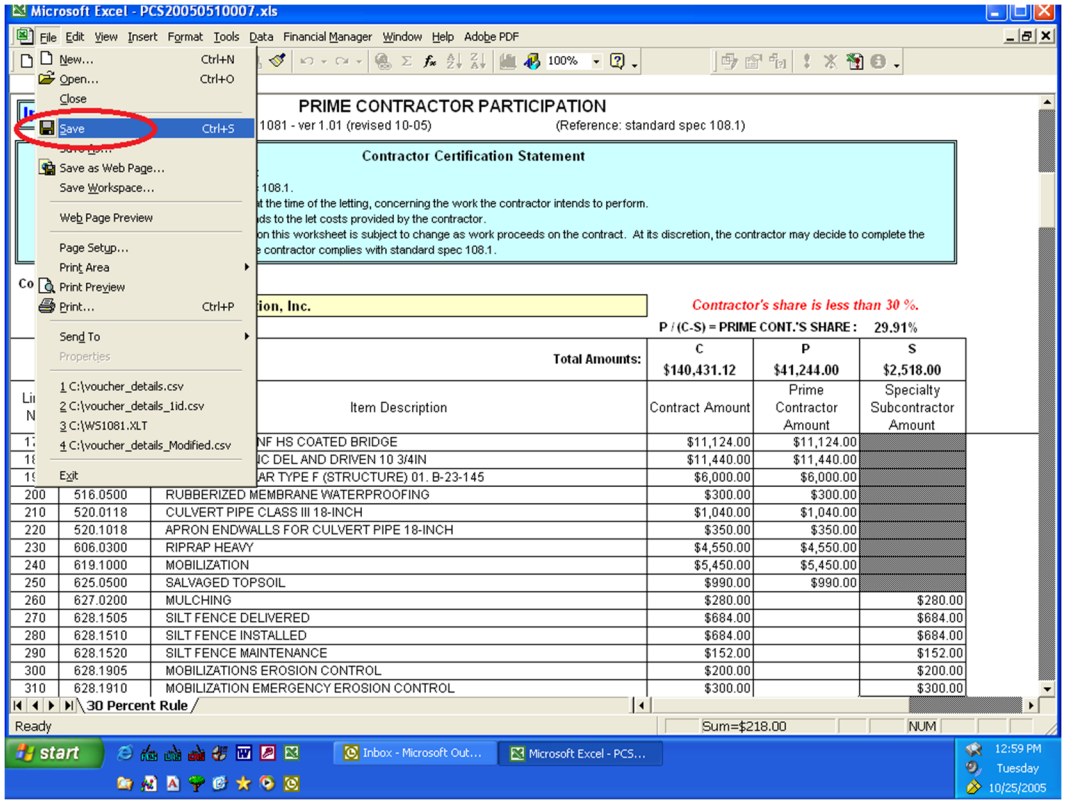
- Work that is subcontracted.
- Sanitary sewer system work and water main system work.
- Standard specification bid items eligible as specialty items.
- XXX.XXXX.S and SPV bid items similar to the identified standard specification bid items.

Standard specification bid items and XXX.XXXX.S bid items that are not eligible as a specialty

item have been grayed out on the worksheet, and you will not be allowed to enter a dollar amount. None of the SPV bid items have been grayed out on the worksheet, but they are not all eligible as specialty items.

A bid item should not be included in the (S) column unless it is subcontracted. If the prime contractor is performing the work on an eligible specialty bid item, it should be included in the (P) column.

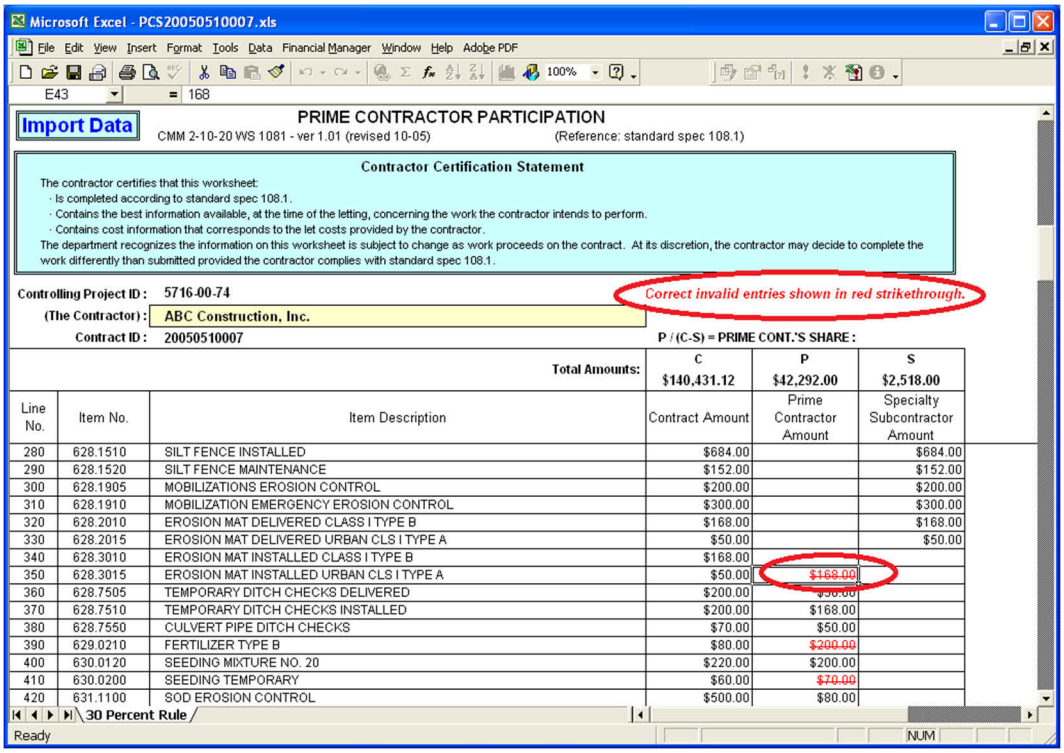
Step 13: When you have completed some or all of the worksheet you can save the worksheet by selecting File/Save from the MS Excel toolbar.



Step 14: If you make an entry error, the items that require correction will be shown in red strikethrough. A note in red appears indicating error, and the prime contractor's share percentage is not shown.

Errors include filling in a dollar amount that exceeds the contract amount for the item, or copying a block of dollar amounts into the wrong cells resulting in dollar amounts exceeding

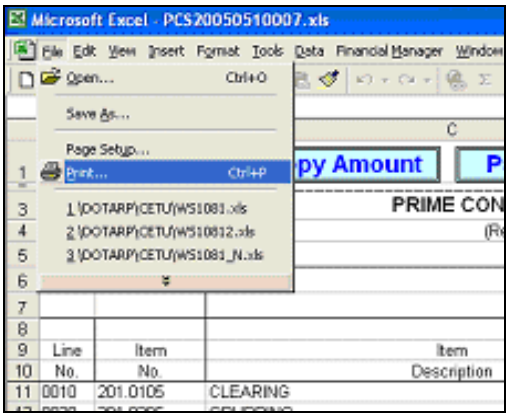
the contract amount for the item.



Step 15: Most of the cells in the worksheet are protected and are not available for entry or editing. If you attempt to make an entry in a protected cell the following warning message will be displayed.



Step 16: To print the worksheet select File/Print from the MS Excel toolbar.

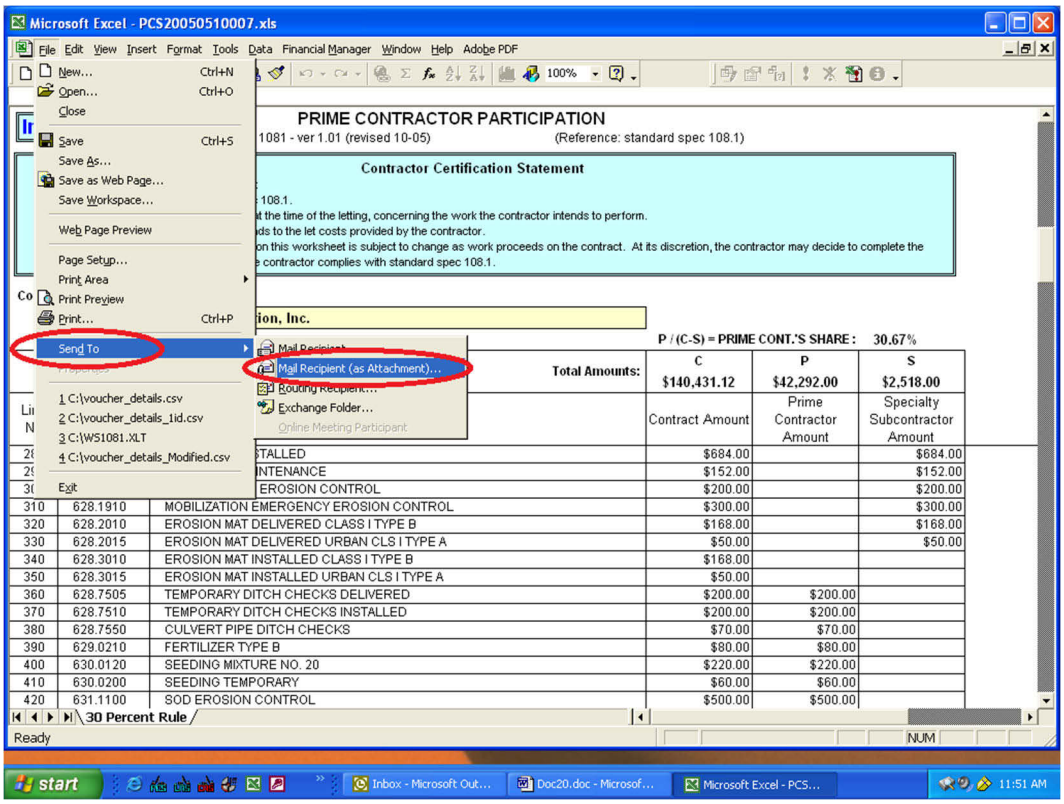


260.2.3.4 Send Completed Worksheet to the Department

Step 17: Send the worksheet(s) to the department by attaching them to an email message. Each completed worksheet must be sent by a separate email message. To send, use one of the following two methods.

260.2.3.4.1 Method 1: (for Outlook email users only)

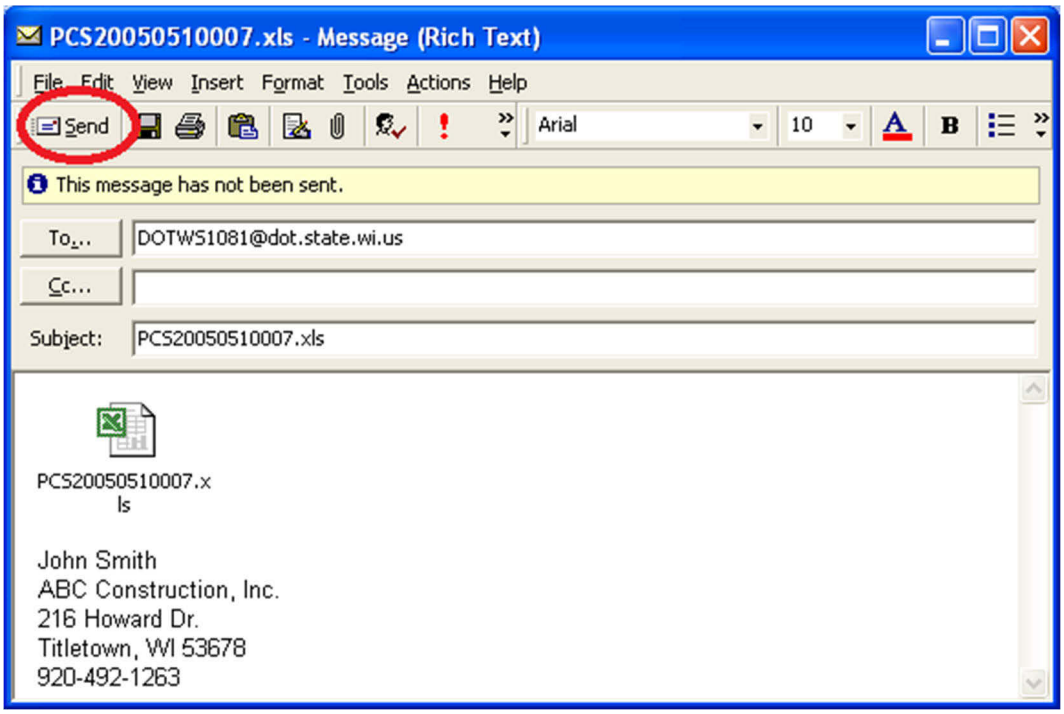
With the worksheet open, select **File/Send To/Mail Recipient (as Attachment...)**.



The email message will be automatically created, with the subject already filled in and formatted, and the worksheet attached. Provide contact information including name and phone number. Enter the following email address in the "To..." field:

DOTWS1081@dot.wi.gov

Click on **Send** to send the email to the department.



260.2.3.4.2 Method 2: (for all other email types)

Open your email application and create a new message and format the message as shown in above for method 1. Send to the following email address: DOTWS1081@dot.wi.gov. The subject line should be formatted PCS"xxxxxxxxxx".xls where "xxxxxxxxxx" is the contract id.

Attach your worksheet, provide contact information including name and phone number, and send to the department.

260.2.4 Region Access to and Use of Contractor's Initial Submittal

As described above, the prime contractor makes their initial submittal to the Bureau of Project Development. Following their review, the Bureau of Project Development will place the contractor's initial submittal on the following shared drive for access by the regions:

N:\Bhc\30% Rule Post-Letting Submittals

Regions can access the contractor's initial submittal; which again, is the prime contractor's best information at the time of the letting as to which bid items and what overall percentage of the work it will perform. This information can be particularly useful to the regions before the contractor submits a sublet request, and may also be of some value during the region's approval of sublet requests.

However, as noted earlier in this procedure, the prime contractor is not obligated to perform the work as shown on the initial submittal. At its discretion, the prime contractor may decide to complete the work differently, provided it complies with standard spec 108.1. In situations where the prime contractor is performing significantly more than 30% of the work, there is little need for the regions to do detailed crosschecks between the contractor's initial submittal and subsequent sublet requests. Conversely, when prime contractor's work is only slightly greater than 30%, regions are more likely to compare the contractor's sublet requests to its initial submittal. If they are quite different, regions may question the contractor on how it intends to maintain compliance with the 30% rule.

260.3 Public Improvement Liens

Information on filing a claim for a person providing services or materials to a prime contractor performing work for the department can be found at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/lien.aspx

260.4 Review of subcontracts

As part of the oversight agreement with FHWA, the department will perform reviews on any tier of subcontract. The purpose of this review is to ensure that any sublet agreements contain, at a minimum, the required documentation from the contract between the department and the prime contractor. Standard spec 108.1.1 allows the Engineer to request submission of a subcontract or other agreements for review.

The Bureau of Project Development (BPD) Oversight Engineer will review the sublet agreement for the following documentation:

- ASP-4: Payment to all Subcontractors
- FHWA 1273

The Oversight Engineer will choose one of the contractor's or subcontractor's sublet agreements to review. The review can take place at any time during construction of the project. For the sublet agreement that is chosen, the party issuing the agreement must provide an executed copy to the Oversight Engineer. The agreement issuer may redact specific financial information in the review copy presented to the Oversight Engineer.

The Oversight Engineer will review the sublet agreement for the required documentation and return the copy of the sublet agreement back to the contractor or subcontractor that submitted it for review.

If any of the required documentation is found to be missing, the Oversight Engineer may elect to review additional sublet agreements. The contractor will add the missing documentation to its sublet agreements and ensure that the missing documentation is attached to any subsequent sublet agreements at any tier.

300 Earthwork and Bases

CMM 310 Clearing and Grubbing
CMM 315 Removing Miscellaneous Structures
CMM 320 Roadway and Drainage Excavation
CMM 325 Structure Excavation
CMM 330 Embankments
CMM 335 Borrow Excavation
CMM 340 Granular Subbase Course
CMM 345 Dust Control
CMM 350 Rubblizing Concrete Pavement

SECTION 310 Clearing and Grubbing

310.1 General

Before allowing grading operations in a given area to start, it should be determined the clearing and grubbing has been acceptably completed. Generally, grubbing of roots and stumps is performed wherever clearing is required, except that grubbing is not required under embankments of 6 feet or more in height nor on areas provided by the state for disposal of marsh excavation.

The limits of clearing and grubbing areas are to be staked or marked, unless otherwise acceptably delineated. Due to changed conditions, clearing and grubbing areas shown on the plans may not coincide with those marked in the field. Clearing and grubbing areas and individual trees to be removed should be measured and quantities computed sufficiently in advance of the contractor's clearing operations to allow necessary recheck and verification of field measurements and quantities before the substantiating evidence is disturbed.

Dead and dying trees on the right-of-way, but outside the specified limits for clearing, should be removed to improve the appearance of the finished project. When the contract does not include an item for Roadside Clearing, the removal of dead or dying trees will be considered and paid for as extra work. Method of measurement will be specified in the change order.

Suitable trees, shrubs, and ground cover that could enhance the appearance and break the uniformity of the conventional lines of clearing, and which are situated outside the limits of construction operations, should be preserved in the interest of beautification of the highway.

Any trees or shrubs within a clearing area that are designated to be preserved are to be identified and marked by the engineer. The marking may consist of tying or attaching to the tree, where it will be readily visible, a suitable placard or a tag bearing the word SAVE.

Subsequent to the marking of clearing and grubbing areas and of trees to be saved, and before the start of work operations, the manager contractor or superintendent should travel the project together and discuss the trees and debris to be removed, so there will be no misunderstanding.

Generally, the merchantable timber removed in clearing becomes the property of the contractor. Exceptions are those shown in the contract or plans, and timber from lands acquired or reserved for highway purposes by use or certain easements and on which a private owner holds underlying title. A review of the right-of-way acquisitions and commitments may be required to determine rightful ownership of the merchantable timber. Logs and timber 4 inches or larger in diameter, which are the property of the contractor must be made available for commercial or fuel use before disposal by the contractor.

Before burning clearing and grubbing debris the contractor must determine if a WDNR permit and local permit are needed. If a permit(s) is necessary, it is the contractor's responsibility to obtain and abide by the terms and conditions of the permit(s). WDNR annual burning permits are only valid within WDNR Protection Areas and outside incorporated cities and villages. The contractor must also comply with local ordinances that may be more restrictive than state law. Contact the local fire department, town chairperson, or local municipal official with questions.

A good source of information on burning permits in Wisconsin is located on the WDNR web site. This site contains drop down list of counties. Selecting a county will open a map that is shaded to identify the regulatory authority. The site is available at:

http://dnr.wi.gov/topic/ForestFire/permits.html

The contractor should only burn the debris at permitted locations and must control the burn to avoid property damage or injuring trees to be preserved. The contractor should select burning sites on clearing and grubbing areas where the fire can be kept under control and sufficiently away from trees to protect them from injury by the heat. The engineer should check the terms of the burning permit before allowing burning.

WDNR regulations prohibit some materials from being used as accelerants to start or maintain a fire. These materials include but are not limited to used oil, clean oil, hydraulic fluid, diesel, gasoline, jet fuel or other oily substances, and other substances, like used tires, that create black smoke. Acceptable alternatives that have been used successfully are heat sources like heat wands used for HMA pavement or acetylene torches.

The contractor should not burn poison ivy, poison oak, or poison sumac because fumes released during combustion pose a serious health risk. In the past field staff persons have required hospitalization after breathing smoke from these materials. The harmful effects can even cause serious problems for persons a significant distance downwind from the burn.

Where open burning is prohibited by regulation or by ordinance, debris from clearing and grubbing operations may be disposed of by chipping, burying, removing from the highway right-of-way, or by

disposing in approved air curtain destructors where using such destructors is allowed. In areas where open burning is prohibited, the plans will usually indicate approved areas of the right-of-way outside the construction limits where debris can be buried. If such areas are not on the plans, the manager will approve or reject proposed burial locations. The debris should be confined, compacted, and covered with at least one foot of earth. All voids should be filled with earth. Debris remaining from open burning, when such burning is allowed, may be disposed of similarly.

Chipped material must either be disposed of off the right-of-way, stockpiled on the right-of-way at approved locations suitable for future use and loading, or be used on the slopes as mulch.

The Bureau of Project Development, Project Services Section is responsible for sponsoring the earthwork inspection course. Each region offers the course on an as-needed basis. Contact your region training coordinator to attend the course.

310.2 Oak Wilt

310.2.1 General

Concern has been expressed over the possibility of oak wilt being spread by our highway construction. Oaks are among the most valuable of our trees, both for their commercial uses and for their aesthetic qualities. Oak wilt fungus continues to be a serious threat in Wisconsin and each year valuable stands and specimen trees are lost.

Oak wilt is caused by a fungus spread from infested trees to healthy trees in two ways: (1) By natural root grafts that link closely spaced oak trees together, and (2) through fresh wounds in the bark that attract insects carrying the fungus spores. There is no cure for oak wilt, so control of the disease depends on our ability to prevent transmittal from tree to tree.

Symptoms of wilt differ between species of oak and may also be confused with symptoms of other tree disorders. Positive identification requires the assistance of a trained individual, usually the county forester. Apparent symptoms of wilt in red and black oaks, the most susceptible species, are pale leaves curling at tips or edges. These leaves will gradually turn brown or bronze. Leaf fall may be heavy, with full defoliation occurring in a few weeks.

310.2.2 Recommendations

310.2.2.1 Apparently Healthy Trees

The contractor should avoid pruning or cutting oaks, if possible, during the period when chances for infection are highest. This period runs from approximately April 1 through September 30.

If pruning or cutting is necessary from April 1 through September 30, all cut surfaces, abrasions and damaged areas on healthy oak trees and saplings must be painted immediately with asphalt base tree paint by the contractor. Cut surfaces on the stumps of all healthy oak trees and saplings, regardless whether the stumps are to remain in place or are to be grubbed, must also be painted with asphalt base tree paint by the contractor.

310.2.2.2 Apparently Diseased Trees

If any oak tree in an area to be cleared is wilting, or in any way appears to be under stress, the engineer should contact the county forester before work begins. The forester will assist in positive identification of the disease and provide advice on working with the diseased trees.

310.2.2.3 Dead Trees

No treatment is needed on oak trees that are dead before the start of clearing.

Work performed by the contractor to prevent the spread of oak wilt, beyond the measures contained in the standard spec 201.2 will be considered as extra work and will be paid for as such. Method of measurement will be specified in the change order authorizing the extra work.

SECTION 315 Removing Miscellaneous Structures

315.1 General

It is the intent of the specifications that miscellaneous structures are to be removed, whenever practicable, before the excavation for the roadway. However, it may be advantageous to remove surface and base courses, sidewalks, and other similar items during excavation operations.

Standard spec 205.3.2 requires that all pavements, asphaltic surfaces, or rigid base courses occurring within the area of the roadbed slopes and underlying proposed embankments must be removed completely to a depth of 2 feet below the proposed finished grade line, or such other depth as shown on the plans. The engineer must mark the pavement for removal.

When granular backfill is required, the removal of structures and backfilling of voids resulting from such removal must be accomplished before grading operations. Backfilling must extend to the elevation of the natural ground if in a fill section, or to the elevation of the finished subgrade or the finished slope if in a cut section. Backfilling is to be done as provided for the removal of old culverts and bridges in the standard specifications.

Measurement of the quantities of removed items should be made and recorded either before or at the time of their removal. Miscellaneous structures required to be removed from within the grading limits and not provided for as a separate pay item in the contract will generally be removed as a part of the item of roadway excavation, except that concrete structures exceeding one cubic yard and not specified for removal in the contract will be paid as specified in standard spec 204.5.

315.2 Abandoning Wells

The Wisconsin Administrative Code NR 112.26 provides that when a well is permanently abandoned, the owner must seal the well to prevent it from acting as a channel for contamination of the underground water supply. Frequently, the former owners have not sealed wells on newly acquired right-of-way and it becomes necessary for the department to perform this work, either as a part of a construction contract, or before any construction activity as part of a site clearance project, or under a negotiated agreement with the county. In any case, the sealing of wells should be undertaken as an early operation to prevent the well becoming "lost" as other operations proceed.

Methods for sealing dug and drilled wells under various circumstances are specified in standard spec 204.3.3. In the case of driven-point wells, it is permissible to pull the casing and point, but the resulting hole in the earth should be filled with concrete. A report of each abandoned well will be made.

315.3 Signs And Other Traffic Control Devices

Where official signs or other traffic control devices are located within the excavation limits, the engineer, before start of the contractor's operations, should advise the region office so that arrangements can be made for removal. The notice to the region office should be given as early as possible since the time required for removal of such devices will vary from a few hours for signs to several days for electrical equipment.

If it becomes necessary for the contractor to start construction operations in an area before all signs have been removed, the contractor should be requested to remove them carefully without scratching the sign faces and store them outside the construction limits.

If any blue specific service signs (identifying commercial entities providing gas, food, lodging, camping or attractions, etc.) in the project limits that would be affected by the construction, see standard special provision 638-10 for disposition instructions.

Any tourist oriented directional signs (TODS) or white arrow boards present within the project limits can be removed and reinstalled by the contractor. The contractor is responsible for any damage to the signs during this time.

315.4 Local Road Identification Signs

Local road identification signs may have to be removed during construction. The engineer should contact the appropriate official from each affected local unit of government. The official should be informed of the starting date of construction, the project limits, and the probable completion date. Each local unit should be given the opportunity to remove, transport, store, and reinstall the signs with their own forces or to make arrangements with others to perform the work.

If the signs have not been removed by the time construction begins, the contractor must carefully remove the signs. Arrangements for subsequently transporting and storing the signs are the responsibility of the local unit, either with their own forces or through an agreement with others. Storage must not pose a hazard to road users or maintenance workers.

Temporary signs needed to guide emergency vehicles during construction are the responsibility of the local unit to install, maintain, and remove, either with their own forces or by arrangement with others. When notifying the local units of the need to remove the permanent signs, the engineer should also remind them of the potential need for temporary signing.

Reinstallation of the local road identification signs is the responsibility of the local unit of government, either with their own forces or through an agreement with others.

Correcting or replacing signs damaged during removal, transport, storage, and reinstallation is the responsibility of the local unit of government and the contractor, or others retained by the local unit.

315.5 Mailboxes

Standard spec 107.11 states that it becomes the responsibility of the contractor to notify the owners of all mailboxes that will interfere with construction, and to arrange for removal and storage of the mailboxes.

Notification is to be in writing and should be done well in advance of work operations requiring mailbox removal. The contractor should also notify the local postmaster, so an alternative mail delivery procedure can be put in place.

If mailbox owners have not removed the box by the time construction starts, it becomes the responsibility of the contractor to remove each mailbox carefully and place it on the owner's property. After construction is completed, it is the responsibility of the owners to reinstall the mailboxes if they wish to have direct mail delivery, regardless of who did the removal.

If the reinstallation presents a hazard to highway users or impedes roadway maintenance, the engineer should contact the owner of the mailbox, explain the problem with the installation, ask for prompt corrective action and enter information about the contact in the field diary. If the problem is not corrected within a reasonable period of time, the engineer should enter that fact in the field diary and notify the region and the local postmaster. No further action by the engineer is needed.

Mailbox installations that present hazards to trucks, cars, motorcycles, and bicycles include those mounted on massive supports such as plowshares, concrete pillars, horizontal planks, and concrete-filled milk cans. The owner may be liable to others for personal injury or property damage resulting from the hazards and should be so informed during contact by the engineer.

Placement and design of a mailbox is the property owner's responsibility. If property owners have questions about mailbox installation or design the engineer can refer the property owner to the UW-Madison Transportation Information Center Hazardous Mailbox bulletin. The publication describes safety considerations of mailbox installations, in addition to recommended mailbox installation dimensions and details. The bulletin is available at the following site:

http://epdfiles.engr.wisc.edu/pdf_web_files/tic/bulletins/Bltn_014_Mailbox_Safety.pdf

315.6 Underground Storage Tanks

Removal of underground storage tanks discovered during construction is to be handled in accord with the standard specifications and the guidance in CMM 130.

SECTION 320 Roadway and Drainage Excavation

320.1 General

Roadway and drainage excavation includes all excavation necessary and required for grading and draining a roadway, other than excavation for structures, borrow excavation, or excavation specifically provided for in the contract for other items of work.

It is the intent of the standard specifications that all suitable material excavated while grading and draining a given section of the roadway is used, to the extent required, in the construction of the embankments in that section.

Borrow excavation or selected borrow excavation should not be furnished until all suitable excavated material from within a section of roadway has been utilized in the construction of embankments within that section. See standard spec 208.1.

If there are significant changes such as a significant increase or decrease in quantities, increased EBS, changes in staging, or having to waste unsuitable excavation that was figured in the mass haul for the division, the contractor may be justified in seeking payment by change order for additional hauling costs under standard spec 104.2.2.4.

It is the intent of standard spec 205.1 that the graded roadway will conform closely to plan requirements for finished elevation grade and section. Prior authorization by the engineer is required to excavate areas of the right-of-way outside the roadway grading limits, unless allowed by the plans or the contract in order to change the grade of the roadway, to balance quantities of excavation, or for other justifiable purposes. Minor adjustments of slopes may be made as required to meet existing conditions or to provide an improvement in general appearance, such as blending with the natural terrain at the beginning and end of cut sections. Low areas within the right-of-way may be filled, embankments uniformly widened, and slopes flattened with waste excavation to the extent that no interference with drainage or disagreement with general intent of the planned work will result.

Standard spec 205.3.4 requires that the finish grading operations closely follow the rough grading. On many projects, progressive, section-by-section completion of the rough grading operations will allow early completion of the finish grading and early placing of subbase and base courses. The engineer should ensure that rough grading does not damage adjacent completed trimming and finishing work on the roadway.

Excavation for a roadway may be classified or common in the contract. When classified, WisDOT will determine each class of excavation during the excavation and the necessary measurements will be taken to compute the quantity.

320.1.1 Before Construction

Before the start of grading operations, the engineer should review the project for special needs relative to grading. The engineer should observe the drainage of the adjacent lands and determine that required intercepting embankments and flumes have been staked at the correct locations. The needs, timing, location, and marking of slope stakes should be discussed with the contractor and a procedure should be established to avoid confusion and delay to progress of the work.

A complete photographic record of conditions related to drainage before start of construction operations is highly desirable for use if adjacent owners later claim a change in drainage patterns has been caused by the highway construction. The engineer should appoint a member of the project construction staff to take, label, and catalog the photos, which should then be placed into the project field file.

320.1.2 Environmental Concerns

It is required by standard spec 205.3.3 that the contractor provide and maintain drainage during the grading of the roadway. Keeping the grade smooth and slightly higher in the center for quick runoff of rainwater and maintaining ditches open for free drainage will help to prevent saturated subgrades. Where seepage is encountered in cut sections, immediate draining with temporary ditches will benefit working conditions. Observations should be made of the effects of the flow of surface water on backslopes. The points of water concentration should be noted so the need for flumes or other erosion control devices may be determined. In marsh excavation or disposal areas, it is necessary to maintain or provide for drainage. Ditches and channels should be kept in a well-drained condition with no standing water.

Standard spec 107.18, standard spec 107.20, and standard spec 205.3.6 establish controls relative to the contamination, pollution, or siltation of streams, lakes, or other waterways. The engineer should observe the area of rough grading open to the elements and the length of exposure, as well as the contractor's operations in streams and adjacent to streams or other waterways. The engineer should be prepared to restrict the exposed area of erosive land and the length of exposure or require changes in the contractor's operations to avoid or minimize contamination, siltation, or obstruction of waterways. It is essential that

temporary and permanent erosion control measures be coordinated and performed in conjunction with the grading operations to ensure effective and continuous erosion control. Refer also to CMM 645.

A sufficient area of grade needs to be opened up by stripping the topsoil off the excavation and embankment areas. This allows for initial surface drying of any underlying fine-grained soils. It also allows for more drying opportunity during grading operations. Larger areas allow both room and time for drying.

Standard spec 205.3.15 requires the contractor to minimize dust from the subgrade during grading. If the engineer determines dust abatement is needed, the engineer should ensure it is done, either under the contract or by change order, using water or approved dust control materials. Liberal use of dust control, without leading to a muddy subgrade condition, is encouraged to minimize air pollution, improve driving vision, and retain subgrade quality.

320.1.3 Borrow Pits Adjacent To Right-of-Way

When borrow excavation is required under the contract, and the contractor's borrow pit is located adjacent to the right-of-way where the roadway is in a cut section, it is often apparent that grading of the right-of-way, to remove the ridge of earth that would otherwise remain between the borrow pit and the roadway slope, would be beneficial to the general appearance of the finished roadway.

The quantity of excavation between the vertical plane of the right-of-way line and the slope line of the roadway excavation as determined from the slope stakes set for the roadway grading may be paid as borrow excavation if the engineer gives written approval to do so.

If the engineer does not agree to pay this material as borrow it must be measured and computed as a separate quantity of roadway excavation used to replace a like quantity of borrow excavation and will be paid for at the unit price designated in the contract or in a change order if required. In establishing the change order unit price for this excavation, consideration should be given to the following points:

- Use of the material to replace contract quantities of borrow excavation.
- Where the material will be used.
- Whether within or beyond the limits of the division applicable to its excavation.
- Necessity of excavation, such as correcting or improving the appearance of the roadside due to the contractor's borrow pit being adjacent to the right-of-way.

Pertinent requirements relating to limits of excavation, required restoration of site, including top soiling and seeding, and any other conditions of requirements applicable to the site, must be shown in the contract or change order.

320.2 Preparing Roadway Foundation

Standard spec 205.3.1 provides the requirements for preparing roadway foundation. Clearing and grubbing should be completed, and objectionable material should be removed in the proposed grading area before the start of excavation. Standard spec 107.20 limits the amount of area that can be exposed to erosive elements. When excavated materials are used in roadway embankments, heavy sod and other unstable soils should be removed and disposed of outside the roadbed foundation.

All pavements, asphaltic surfaces, or rigid base courses in the area of roadbed slopes or underlying proposed embankments should be removed completely within 2 feet below proposed finished grade line or as shown on the plan.

All material suitable for use as topsoil should be stripped and salvaged for use on the contract as salvaged topsoil or topsoil, consistent with the requirements of the erosion control plan. Standard spec 205.3.1 provides that if available, additional quantities of topsoil must be salvaged and used as salvaged topsoil to replace contract quantities of topsoil. This may require change order and price negotiation. Depending on the length of haul and availability of topsoil from outside the project, it may not be economical to make such a change.

The existing ground underlying proposed embankments, within the limits of assumed one-to-one slopes extending outward and downward from the finished shoulder lines, should be prepared in a manner to provide a firm and unyielding support for the roadbed. All heavy sod, perishable material, and unstable soils should be removed from the area, and the foundation compacted to the extent necessary to support the embankment and to allow attainment of the required density. The stability of fills will be improved through the removal of silty soils or frost susceptible material and backfilling with selected material from the excavation or, if the contract so provides, with granular backfill material. The inspector should carefully establish the limits of undercutting or EBS. Underdrains use may have to be investigated.

Where an embankment is to be constructed on a hillside, the creation of a plane of slippage should be avoided by benching the foundation. This is accomplished by cutting vertical and horizontal planes in the foundation as fill material is placed and compacting the cut material together with fill material. Benching is incidental to the embankment construction. It is not a separate pay item.

320.3 Salvaged Topsoil

Topsoil is usually removed for two reasons:

1. Undesirable foundation materials.
2. It is needed for salvaged topsoil.

Standard spec 205.3.1 shows the contractual requirements to remove topsoil because of being unsuitable foundation material and standard spec 205.3.3 shows how to pay for the item. Removal of topsoil for salvage purpose is described in standard spec 625.

Topsoil, when it is required to be salvaged and used under the contract, should be stripped to the extent available from cut sections and fill sections as necessary to fulfill the requirements of the contract. Salvaged topsoil may be stored on the right-of-way and outside the grading limits until used, provided it is stockpiled in a manner to preclude any interference with free drainage of the project. Seeding of the piles to avoid erosion will be paid by the state. The restrictions imposed by the ECIP must be complied with.

The engineer and the contractor should discuss early on in the project topsoil quality and quantities available and required. Topsoil should be removed from the sites of roadway excavation and embankment. Topsoil need not be removed in embankment areas outside the one to one unless it is needed to cover the slopes.

According to standard spec 205.3.3, within the roadbed foundation, the contractor will be paid for EBS to remove unstable topsoil beyond the quantities needed to cover the slopes.

On borrow jobs, the engineer must monitor the topsoil quantities and the removal of topsoil closely. The contractor should not remove topsoil that does not need to be removed since this will result in additional borrow quantity for the project. The quantity of excess topsoil removed and sold should be deducted from the quantity of borrow excavation if the excess could have been used outside the one to one.

320.4 Excavation Below Subgrade

Standard spec 205.5.2 provides specific requirements for EBS. EBS is necessary when frost-heave material, water-bearing soil, or other unacceptable materials are discovered in the roadway foundation. The unfit material must be completely removed to the limits the engineer directs, and the areas must be backfilled with selected soils that are carefully placed in layers and thoroughly compacted. Payment for excavating and backfilling EBS areas differs depending on whether or not the engineer has approved the subgrade.

If EBS is deemed necessary and the engineer has not yet approved the subgrade, excavation and backfilling of the "hole" are performed and paid for under the appropriate contract items, or as extra work if there are no appropriate items.

If the engineer has already approved the subgrade and subsequently directs EBS, the department recognizes that the costs to excavate and replace the unfit material may be greater than contract prices. To compensate for post grading EBS work, up to a limit of $25,000, the department will pay for excavation at 3 times the contract excavation price and backfill at the contract unit price. It's important to note the $25,000 limit includes both the 3 times EBS excavation work and the backfill work at contract unit price. If the contract does not contain bid items for this work, it will have to be paid as changed work. After the limit of $25,000 is reached, further required post grading EBS work will be paid for following the pricing procedures prescribed in standard spec 109.4.

Humus-bearing soils and other excavated materials not suitable for embankment construction must be disposed of in accordance with the requirements of standard spec 205.3.12.

320.5 Grading the Roadway and Intersections

In order to utilize all desirable material in the construction of the roadway, all intersections, approaches, and entrances should be graded at the time of excavating and grading the roadway. Requirements for the locating, layout, and grading of entrances are provided under CMM 780 Constructing and Restoring Access Points.

Frequent inspection will be necessary during the excavation operations to ensure the roadway, intersections, approaches, ditches, and channels are excavated to the required grade, width, and slope; that rock in the roadbed is properly undercut; and that proper disposal is made of any unsuitable or surplus material.

Inspection of the subgrade, especially in cut sections, is necessary to check for frost-susceptible materials, seepage, ground water, logs, stumps, or other conditions that could result in non-uniform or detrimental subgrade conditions. A careful inspection of ditches and backslopes will often give clues to the location of objectionable materials. Areas of seepage should be investigated to determine the need for underdrains. Pertinent information should be entered in the grade inspector's diary.

Standard spec 205.3.4 provides specific requirements for the excavation of frost-heave material, water-bearing soil, and other unacceptable material from below the subgrade. Backfill in these areas must be selected soils that are carefully placed in layers and thoroughly compacted.

The installation of underdrains frequently used to drain water-bearing soils and intercept flow of water from aquifers is covered in standard spec 612. Filter fabrics are often used in conjunction with underdrains or alone to solve specific subgrade problems related to underground water flow.

Special attention should be given to areas of transition from cut to fill. These areas should be investigated for potential undercutting to provide a gradual change in soil textures and conditions. Prompt inspection of these areas is important to complete necessary improvements before excavating equipment is moved from the area or before subbase or base is placed. According to standard spec 205.5.2, EBS done after rough grading operations are complete will be paid at a unit price of three (3) times contract bid price for common excavation.

Generally, the department does not pay for EBS in fills constructed under the contract but will pay for EBS if the fills were constructed under a previous contract.

The engineer is encouraged to seek assistance from the region for a joint inspection and analysis of any subgrade and related problems. The region will then recommend treatment of the subgrade and prepare solutions to related problems for the engineer's decision.

320.6 Rock Excavation

At the start of excavation, the contractor and engineer must set the methods used to determine rock from common excavation. See standard spec 205.2.2 and standard spec 205.2.3 to distinguish between common and rock excavations.

It is the intent of standard spec 205.3.7.1 that rock be excavated in reasonably close conformity with the designated limits. Blasting operations should be performed in a manner to avoid an excess of over breakage. Cross sections for determining rock quantities should be taken as soon as overburden has been removed and at that time as to cause a minimum of interference with the contractor's operations. Allowed overbreak will be paid for where rock excavation is the bid item. Overbreak will not be measured or paid for where pre-splitting rock is required. Sub-excavation of 6 inches below earth subgrade is required by standard spec 205.3.7.1.

Pre-splitting of rock slopes must be done before interior blasting. Pre-splitting may be done as a separate operation from interior blasting, or time delay fuses may be used to fracture the slope line before charges are detonated in the interior portion of the excavation.

Test sections up to 100 feet in length must be used to determine the best spacing, size, and loading of the drill holes. Testing must be performed before starting pre-splitting operations and whenever changes in the characteristics of the rock produce unacceptable slopes with the size and spacing of drill holes in use.

The test section plan should be approved before use. After the test section has been pre-split and the rock face exposed, a careful examination of the rock face should be made to determine whether adjustments in drill hole size or spacing, or in the size of the charge should be made to improve the split face.

Careful planning of offset benches should be done to ensure the toe of the completed slope coincides with the toe of the slope shown on the plans.

The completed drill hole must be measured for payment under the item of pre-splitting rock from the top of the hole to the ditch bottom, to the bottom of the rock if above the ditch bottom, or to a specified bench elevation, as appropriate to the situation or the plan and contract provisions.

320.7 Finish Grading

The finish grading operation consists of shaping and trimming the subgrade to the required lines and grade, and dressing the slopes of cuts, fills, channels, and ditches to a neat and finished appearance. Standard spec 205.3.12 requires that the finish grading operation follow as closely as practicable the completion of the rough grading.

Before the start of finish grading operations, the engineer should make note of the features to be corrected during finish grading and record them on a "punch list." The contractor will be given the engineer's punch list of work to be done during the finish grading operations. Frequent checking by WisDOT will be required to determine the finishing work is acceptable. The engineer should conduct level checks along ditches, as necessary, to determine they drain properly.

Standard spec 205.3.13 requires the slopes and banks of existing ditches, channels, dikes, and the like be rounded or modified to allow vehicles which have left the road to safely traverse such features. The

engineer should review with the contractor the location and extent of this work. Necessary excavating, topsoiling, fertilizing, and seeding will be measured and paid for under the pertinent contract bid items.

Blue top hubs are set before final grading to assist in securing the final grade, crown, and width of roadbed. However, the final test of the roadbed is its riding quality. The engineer should drive the entire roadbed to check crown and high or low spots and order any necessary correction.

All finish grading operations, including rounding of cut slopes, should be completed for a given area before the topsoil is placed.

320.8 Finishing Roadway

The work of finishing roadway as specified in standard spec 213 is required whether or not the contract contains a separate item for Finishing Roadway. If there is no bid item provided, Finishing Roadway is incidental to associated bid items.

Frequent inspections should be made during the finishing operations for assurance the specified work is acceptably performed.

Finishing Roadway requires, in addition to the clean out of drainage structures installed under the contract, that existing drainage structures be cleared of all material deposited in the structures as a result of construction operations. An inspection should be made, before the start of construction operations, of all existing drainage structures which are to remain in place, in order to ascertain the amount of material, if any, in the structures. The contractor is not required to remove any material deposited in drainage structures not resulting from the contractor's operations, unless otherwise provided on the plans or in the special provisions.

320.9 Surplus of Unsuitable Material

Standard spec 205.3.12 provides that material unacceptable for constructing embankments, but suitable to support vegetation must be used for salvaged topsoil if needed. All other surplus material that is not suitable for constructing embankments, but is suitable to uniformly widen embankments, flatten slopes, and fill low areas must be used for such purposes unless otherwise provided. Widening embankments and flattening slopes generally would mean used outside a 1:1 slope from the finished shoulder line.

Standard spec 208.1 requires using suitable material from roadway and drainage excavation or excavation for structures before furnishing borrow or selected borrow excavation.

Surplus excavation that cannot be used on the project must be disposed of by the contractor outside the right of way. When the contractor hauls the material outside the right of way for disposal, it becomes the contractor's property. Standard spec 205.3.12 contains the requirements for the disposal.

SECTION 325 Structure Excavation

Excavation for a structure includes all solid materials encountered and removed from within the limits required for the structure, including excavation for seals, girders, projections, and sub-foundation course. Examination should be made of the excavated footing area to determine the location, elevation, and dimensions are accurate; the foundation is firm with adequate bearing capacity; and it is dry, insofar as practicable, when the concrete is poured.

In examining the excavated footing area, the material encountered should be compared with the borings shown in the plans. If the material is sufficiently different, the engineer should immediately contact the region to determine if any changes in the footing should be made.

Excavation through water requires cofferdams. Cofferdams may include approved well-point systems as well as sheet piling and cribs. Under standard spec 206, the contractor is required to submit cofferdam plans to the engineer designed to provide room to perform the work and safely protect the work and workers. If a seal is required, the cofferdam should conform to the lateral dimensions of the seal. If the contractor's plan shows a cofferdam/seal larger than the contract plans show, the engineer should confer with BOS to verify that it is required. If required, BOS will direct the engineer to pay for the additional materials, otherwise measurement is based on the contractor's cofferdam plan up to a maximum of what the contract plans show.

The engineer should ensure that any required excavation in the vicinity of piers and abutments is completed to approximately the elevation of the upper limits of the structure excavation at these locations before grading operations are seasonally suspended.

In placing backfill about a structural unit such as an abutment or retaining wall, it is necessary the backfill be placed simultaneously on each side to avoid creating unbalanced stresses in the unit. Backfill about a structural unit, upon which an approach fill will be constructed for the support of a pavement, will require placing and compacting in a manner to ensure against detrimental settlement.

Where water is in the excavated area, acceptable consolidation of the backfill will be difficult, if not impossible to obtain, unless the water is first removed or the backfill is placed in a manner to force the water out.

To ensure obtaining acceptable consolidation, backfill material is placed in continuous horizontal layers of a thickness not exceeding that which can be readily and thoroughly compacted with the equipment in use, but not to exceed 8 inches thick, unless otherwise provided by the contract. Backfill may be end dumped from the structure or approach embankment if subsequently spread and placed in 8-inch horizontal layers. Backfill should be dumped gradually rather than in one mass. Compaction should be done using approved rollers, portable tampers, or vibrators before the next layer is placed.

If structure backfill is not specified by the contract for backfill, material from structural excavation or other sources may be selected to provide the most stable backfill available. Silty materials are to be avoided whenever possible because they drain slowly, become elastic, and are difficult to compact. Clays, although often used, are inferior backfill material as they drain poorly, swell when wet, shrink as they dry out, are apt to be quite compressible, and lead to undesirable settlement. Clays and silty soils, when wet, will exert a pressure against a structure of approximately three times that of a granular soil. Layers of backfill material containing clays or silts should not exceed 6 inches in depth. Whenever it is necessary to construct backfills with clay or silty materials, the region first should be consulted for advice.

Gravels, coarse sands, and free-draining sandy soils provide good backfill material. They compact readily in confined areas and provide acceptable load support. They are the most suitable materials to use in the presence of water in an excavation.

The following values may be used as a guide in estimating the bearing capacity of various foundation materials in non-critical situations:

TABLE 325-1 Bearing Capacity of Soils

Material	Pound per Square Foot
Alluvial Soil	100 - 200
Clays	200 - 800
Sand, Confined	200 - 800
Gravel	400 - 800
Cemented Sand and Gravel	1000 - 2000

SECTION 330 Embankments

330.1 General

The success of an embankment constructed to support a pavement structure depends upon proper preparation of the foundation, use of suitable materials, and proper placing and compacting of materials. To provide stability the material placed in an embankment is required to be uniformly compacted to proper density.

Uniform, proper density is best obtained in an embankment by placing the fill material in complete layers and compacting each layer to the required density. The maximum thickness of a layer of soil that can be readily and acceptably compacted will depend upon the character of the soil and the type and weight of the equipment in use, but generally should not exceed 8 inches. See standard spec 207.3.2, standard spec 207.3.3, and standard spec 207.3.4 for placing layers, placing in marsh, and placing rock.

Only materials determined to be acceptable for providing stability are to be placed in the portion of embankment that lies between one-to-one slopes extending outward and downward from the finished shoulders. Unsuitable materials or materials that will adversely affect the stability of the roadbed may be placed, in limited quantities, in the fill outside the assumed one-to-one slopes.

Most native soils, including silty soils and clays, are suitable for embankments when dried to optimum moisture content. Drying may take an extended period of time, especially if rain or cold affect progress of the work. It will then be a matter for the engineer to determine whether to allow the contractor to waste the native soil and backfill with a more suitable soil, or to require the contractor to proceed with drying operations.

If a problem with the embankment material is suspected, the engineer may request that the contractor run a loaded truck over the grade. Whether or not the engineer asks to see loaded trucks run the grade, it does not relieve the contractor of responsibility for the soundness of the grade. If the presence of excessive moisture content is shown by rutting, pumping, cracking, clipping, or collapse, placement and compaction of an embankment should not proceed. Operations should be halted and the material either allowed to dry or be manipulated and aerated using appropriate equipment such as graders, discs, or harrows. All ice and snow must be removed from the ground surface before placing embankment. Do not place embankment on frozen subgrade.

Where rock fills are constructed, to avoid or minimize future settlement, the rock should not be dumped in its final position but should be deposited slightly aside and bulldozed or otherwise shoved into position in such a manner that the various sizes of rock are uniformly distributed and all voids are completely filled with fine material.

Where embankments are required to be built in half-widths to accommodate traffic or for other reasons, it is advisable that the two be bonded together by cutting benches in the first part as the second part is placed.

When starting soil compaction work, it is good practice to perform several field compaction tests to determine proper compaction equipment, number of passes, and roller speed needed to attain density or stability. Usually, tests are made only after several passes (4-8) have been made using the contractor's equipment.

At the end of each day's grading operations, the subgrade surface should be sealed to aid in drainage of any surficial water and minimize water infiltration into the compacted subgrade, according to standard spec 207.3.9.

330.2 Compaction Methods

330.2.1 General

Standard spec 207.3.6.1 provides, except for hydraulic and rock fills and for backfilling of wet marshes, that all embankments must be compacted as provided for standard compaction, unless special compaction is required by the plans or contract. The terms special compaction and standard compaction have nothing to do with the desired soil density. Rather, they are terms for the methods used to check or observe that the desired soil density is being achieved.

Advantages and disadvantages of each compactive method are outlined below:

TABLE 330-1 Standard v. Special Compaction

Standard Compaction	
Advantages	Disadvantages
Less testing equipment.	Experienced personnel needed.
Allows broader enforcement.	Judgmental for highly variable soils.
Adequate for many soils, particularly granular.	Poorer coverage and lift thickness control.
Simplified record keeping.	Misleading in dry cohesive soils.
	Ambiguous specification.
	Less confidence in design.
	Misleading in clod-type soils.
Special Compaction	
Advantages	Disadvantages
Specific data at specific site.	Difficult to select standard lab density.
Enforceable in specific language.	Impossible or largely judgmental in highly variable soils.
Allows more control on problem soils as fat clay, silts, organics, etc.	Largely unneeded on granular soils, etc.
Easily documented.	Requires more equipment to be effective.
Better confidence in design for high fills,	Process often too slow to effectively control lifts: i.e., additional lifts go on before testing is complete.
Plastic soils in subgrade or similar critical uses.	
See subsection 207.3.6.1.	

The advantages and disadvantages noted above must be considered and applied to the combination of local soil conditions encountered, design parameters, and performance requirements. As these vary in numerous combinations, no exact parameters can be applied. However, the guidelines above can be used to set up recommendations made by the region to the engineer.

For plastic soils with liquid limits greater than or equal to 45, special compaction should be recommended. For soils with liquid limit less than or equal to 25, standard compaction, if done according to specification, should give acceptable performance. On some very bony soils, density tests of any type are virtually impossible. On these, no density requirements are expected, and are rarely needed.

Fill height should also be a criterion. Fills with heights exceeding 35 feet should have a controlled compaction specification and fills in excess of 50 feet should mandate both density and moisture controls. Silts in higher fills should have moisture controls and always be compacted at 2% to 5% below optimum moisture. Fills with heights exceeding 50 feet, if built of silts or clay, should have analyses based on tests to give design parameters. Also, low height fills of material having a liquid limit greater than 45 should have special compaction.

With a considerable amount of current construction being on short fills that are inherently difficult to compact, the region soils engineer should give special attention to these situations.

It is intended that a check density test be made on all embankments regardless of the acceptance method. Refer to CMM 832 for testing frequencies.

Also, the consequences of future settlements should be weighed. A higher fill will settle more than a shallow fill. For example, often a 25-foot fill will cause foundation settlement much more than 2-1/2 times that of a 10-foot fill. Also, the soil engineer should relate anticipated future settlement in the foundation to the fill design, for if there is to be a future settlement of say one foot in the foundation soil, then 3 inches of settlement in the fill due to lack of compaction may not be of primary concern.

For optimum field results, it should be emphasized that standard compaction without adequate overall control can be difficult. Similarly, grade inspections using special compaction should never depend on tests alone to control compaction. Use of correct equipment, method of placement, lift thickness, and compactive coverage under direct observation and inspection are essential.

See standard spec 207.3.6.1, standard spec 207.3.6.2, and standard spec 207.3.6.3 regarding compaction.

330.2.2 Standard Compaction

Standard spec 207.3.6.2 relating to standard compaction provides that each embankment layer must be compacted to the degree no further appreciable consolidation is evidenced under the action of the compaction equipment, before any material for a succeeding layer is placed on it. The embankment must be compacted across its full width from slope-to-slope. The standard specifications require the contractors hauling and leveling equipment to be routed over the complete area being compacted during placement, until adequate compaction is achieved. If this does not adequately compact the materials, the engineer may require the additional use of specialized compaction equipment. The engineer should ensure that the specialized compaction equipment being used is suitable for the soils encountered.

The engineer will base the determination on field evidence that demonstrates the compaction afforded by the contractor's hauling and leveling equipment is acceptable and the specialized compaction equipment is not needed. Field evidence should be recorded if verifying density using only hauling and leveling equipment. Include a record of soil type, types of equipment in use, specific pattern of uniform routing and distribution of hauling equipment over the grade, frequency and results of personal observation, measurement of rut depths or lack thereof, and back-up density tests. See standard spec 207.3.6.2.

Marginal or erratic compliance by the contractor with specification requirements concerning full and uniform compaction of each lift across the full width of the embankment must be immediate cause for requiring specialized compaction equipment or adjustment in the contractor placing operations.

The determination of when the degree of compaction required for standard compaction has been attained is one of judgment. Density tests are not performed as a control of compaction, and test results are not available for handy documentation.

The standard specifications provide that when standard compaction is employed, layers must generally not exceed 8 inches in thickness before compaction. This thickness may need to be reduced for some clay or clay-bearing soils.

Soils of different types require different degrees of effort to obtain compaction to required density, and their moisture content will influence the degree of density attained through the effort expended. Generally, soils will compact most readily when their moisture content is between 90% and 110% of their optimum moisture content.

Moisture content is more of a means to an end to achieve density than a desired property within itself. For example, a heavy clay compacted considerably dry of optimum will be compacted only with tremendous compaction energy, say 4 to 5 times normal compactive effort. A 2% increase in moisture content would allow the clay to be compacted with normal effort. Silts compacted at or above optimum moisture usually cannot be brought up to the desirable density and therefore should be compacted at 2-5% below optimum.

Some properties of soils are affected to a degree by compaction moisture content. A clay compacted fairly wet will have slightly less consolidation and slightly greater strength than it would exhibit if compacted rather dry. A check should always be made where moisture is of concern, either by drying a wet soil or wetting a dry material.

The observation and inspection of embankments compacted under standard compaction procedures is essential. The grade inspector should ensure each layer meets the thickness and placing requirements and is uniformly compacted across the full width of the embankment to the required degree.

To provide a record of compaction achievement and a basis of documentation, the grade inspector must make at least one entry per day in the inspector's diary for each embankment, excluding minor fills, being constructed. The entry should indicate the location, soil type, amount and type of hauling, leveling and specialized compacting equipment, relative moisture content of the material (very wet, wet, moist, dry, etc.), layer thickness and pertinent information on rutting or displacement, drying or aeration, addition of water, routing pattern of hauling equipment, coverage with compaction equipment, and any special difficulties encountered. Additional entries may be required when substantial changes in soils, moisture, or other conditions occur during the day. When equipment, soils, moisture, or other conditions remain the same from day-to-day, appropriate simplified diary entries may be made indicating this condition instead of a complete detailed statement reported daily.

Random density tests for informational purposes, to indicate the approximate level of standard compaction being achieved statewide, must be made at the frequency and in accordance with the requirements of CMM 832. On projects involving variable soil conditions or erratic contractor operations, the frequency should be increased.

330.2.3 Special Compaction

Where special compaction of embankment is required, the contractor may use suitable compacting equipment of the contractor's choice and is responsible for the proper moisture content of the soil for

consolidating to the specified density under the efforts of the equipment. It is the responsibility of the inspection forces to determine whether or not the embankment materials have been acceptably consolidated. Density tests for determining the attained density in the compacted material should be taken as frequently as necessary for adequate control under particular job circumstances and minimum frequency of the tests should be as required under CMM 832.

Compaction control of an embankment by density tests should be only for that portion of the embankment that is within the limits designated by assumed one-to-one slopes extending outward and downward from the finished shoulders. Portions of embankment lying outside the assumed one-to-one slopes will receive standard compaction effort.

330.3 Compaction Equipment

Under standard spec 207.3.6.2 the contractor is required to route dozers, trucks, scrapers, end loaders, and other leveling and hauling equipment laterally across the grade. Operations concentrated along fixed wheel paths will not provide adequate compaction. If the contractor's operations are spread out across the grade but still not providing adequate compaction, the contractor should adjust their operations and equipment to improve the level of compaction. If adjustments fail to produce the required level of compaction, the engineer should intercede to ensure that proper compaction is achieved.

The engineer may direct additional operational changes and, under standard spec 207.3.6.2, may also require that differing and additional compaction equipment be used. The engineer will expect that the additional equipment be designed specifically for compacting the soil types encountered but may also approve other equipment the contractor might suggest.

The specification allows the contractor to control their means and methods as long as the engineer determines that adequate compaction is achieved. The contractor might select equipment on the basis of soil type, the contractor's experience, availability of equipment types, required rate of production, or for other reasons.

The contract requires that compaction be done at or near the optimum moisture content for a given soil type. The contractor and engineer can use table 330-2 to get a general idea of the effectiveness of various pieces of construction equipment under those conditions. If there are issues obtaining adequate compaction, the contractor should coordinate with the engineer to determine the mix of engineer-approved equipment and construction operations appropriate for the work.

TABLE 330-2 Compaction Effectiveness

Soil Type	Equipment Type						
	Pneumatic Tired Vehicles				Smooth Drum Vibratory Roller	Padfoot Vibratory Roller	Padfoot or Sheepsfoot Static Roller
	Rubber-Tired Dozers	Off-Road Trucks	End Loaders	Scrapers			
Sand	Very Good	Very Good	Very Good	Very Good	Very Good	Fair	N/A
Sand & Gravel	Very Good	Very Good	Very Good	Very Good	Very Good	Fair	N/A
Silty Sand & Gravel	Very Good	Very Good	Very Good	Very Good	Good	Fair	Poor
Clayey Sand & Gravel	Good	Good	Good	Good	Fair	Good	Good
Silt	Good	Good	Good	Good	Fair	Very Good	Very Good
Clay	Good	Good	Good	Good	Poor	Excellent	Excellent

Construction equipment provides a combination of static or dynamic pressure, kneading, and vibration actions to compact/densify the subgrade soils. The most effective compaction action for the various types of soils depends on several factors including the soil type, moisture, and depth of required densification. Table 330-3 describes the general mechanical action provided by various types of equipment. Review of tables 330-2 and 330-3 will assist the engineer in ensuring the contractor employs the most effective equipment that provides the appropriate mechanical action for project and soil conditions.

TABLE 330-3 Mechanical Action Under Construction Equipment

Equipment	Mechanical Action
Vibratory Roller	The contractor may use vibratory rollers to compact granular soils. Vibration overcomes the friction between particles and reduces voids. A relatively light vibratory roller can equal or exceed the compactive effect of an extremely heavy unit. Generally, the slower the forward speed of a vibratory roller the more effective the operation. Track dozers have some vibratory effect, but their weight is distributed over such a large area that unit pressures are very low. Vibrations have little effect on cohesive soils.
Padfoot Roller	The pads on this roller transfer mechanical action to compact the soil. Each imprint receives a high pounds per square inch (psi) pressure at the bottom of each imprint. The soil is too wet to compact if the inspector sees material sticking between pads. Compaction will only happen if the soil is somewhere near optimum moisture content. If the moisture content is too high, the bottom of the imprint left by the padfoot roller will be soft. The roller compacts soil from the bottom up. The roller will ride higher and higher on the roadbed on successive passes over the subgrade. Under optimum conditions, the roller will "walk out" of the roadbed.
Sheepsfoot Roller	The long spikes on the drum of a sheepsfoot roller puts a lot of force on a small area. It breaks down the cohesion in silts and clays. This roller compacts soil from the bottom up. The feet penetrate to a bottom layer on the first pass. On successive passes, if the soil has the right moisture content, the roller will ride higher and higher until it "walks out". It is not effective on coarse grained non-cohesive soils.
Pneumatic Tired Vehicles	Rubber tired rollers provide both kneading and pressure. To a lesser extent, rubber tired earthmoving equipment has a similar action. It is effective on both cohesive and granular soils.
Smooth Drum Static Roller	A static smooth wheel roller is good for sealing the working surface after the days operation. This sealed surface assists in rain runoff and reduces water penetration. This roller does not provide adequate lift compaction.

330.4 Embankment Slopes

Standard spec 207.3.8 requires the embankment slopes be built to the lines and section shown on the plan or as directed by the engineer.

The engineer or inspector should check during grading operations that the fills are not being overbuilt without permission or direction by WisDOT. Overbuilding unnecessarily uses up the relatively inexpensive material excavated on the project and could require costlier borrow excavation to be imported from outside the project.

The contractor must build embankments to the planned slopes and section until we are confident that overbuilding can be done to absorb excess excavation, waste excavation, or surplus excavation without resulting in the need to purchase more borrow than required by the plan. Before proceeding with overbuilding, the contractor must obtain the approval of the engineer.

If overbuilt fills are discovered during the grading phase of the project and no direction or approval has been given by WisDOT, the engineer will order the contractor to stop the overbuilding and to correct the situation.

Overbuilt fills discovered after completion of the grading may require a reduction in the quantity of the classes of excavation used to construct the embankment.

SECTION 335 Borrow Excavation

Generally, borrow excavation is material obtained from outside the right-of-way to complete the construction of embankments. When there are instances where borrow is obtained within the right-of-way, please follow procedures in CMM 231.

The department will use the earthwork summary in the plans to explicitly show the areas intended for borrow during construction. Except for backfilling of excavated marshes or for other work for which borrow may be specifically required, borrow excavation should not be placed in an embankment until the roadway and drainage excavation for the applicable mass haul division has been substantially completed.

Standard spec 208.2.1 describes material quality. Original cross-sections for determining quantities of borrow are to be taken on the pit area after clearing and grubbing has been completed. Original cross sections may be taken either before or after removal of the topsoil as deemed desirable. Final cross sections, however, must then be taken either after the topsoil is replaced, if originals were taken before topsoil removal, or before the topsoil is replaced, if the originals were taken after topsoil removal. The contractor may be required to suitably shape the pit for taking accurate measurements. Refer to CMM 775 for guidance on borrow pit surveys.

Occasionally the contractor may want to move a small amount of borrow excavation from an isolated source that is not easy or convenient to section. In this case the project engineer may decide to measure that material by truck count. It is important to be aware that the pay volume for the borrow excavation is the original in-place volume, not the volume in the trucks. The two volumes are related by an expansion factor. Refer to CMM 232 for guidance and examples showing how to measure and pay for borrow excavation that is trucked.

The standard specifications provide for borrow pit cleanup, fertilizing, and seeding. Borrow pits, adjacent disturbed areas, and associated haul roads will usually be fertilized and seeded. Use standard seed mixtures specified in standard spec 630.2.1.5 and seeding rate requirements specified in standard spec 630.3.5. Standard spec 630.3.4 requires the contractor to seed the borrow pit and disposal sites off the right-of-way and consult with the landowner or landowner's agent when selecting the seed mix. Additional information is provided in CMM 640 about seeding and fertilizing.

See CMM 158 for archaeological, paleontological, and environmental considerations for borrow pits. All noncommercial borrow pits must be in compliance with local zoning requirements. The contractor must also follow the approved ECIP for selected sites.

SECTION 340 Granular Subbase Course

A granular subbase course is that part of the pavement structure constructed to provide a foundation for the base course, to distribute the superimposed loading to the subgrade and to provide drainage beneath the base and surface courses. It usually consists of natural sand or a mixture of sand with gravel, excavated and constructed with grading equipment as an item under a grading contract.

Before placing the subbase material, the subgrade or foundation must be properly prepared. It should be smooth, shaped to conform to required crown and grade, and be compacted to the required density. Where travel of the placing equipment ruts or disturbs the foundation, means must be employed to correct these conditions ahead of placing the subbase material. If the subbase is constructed on a rutted foundation, the roadbed will not drain properly and areas of weakness may develop in the pavement structure. Placing, shaping, and compacting the subbase material to conform its full width to the required grade, section, and density are necessary for acceptable construction of the proposed base course. The inspector should frequently check the subbase course for correct depth and spread.

The requirements for fertilizing and seeding granular subbase pits are similar to borrow pits. CMM 335 discusses borrow pit excavation.

CMM 860 discusses correction in pay weights for aggregates having moisture content in excess of 7% when furnished by the ton.

See CMM 813 for required testing and approval of scales used for furnishing granular subbase material by the ton measurement.

SECTION 345 Dust Control

Calcium chloride is applied to control dust or to provide a surface treatment for base course. Application rate is usually determined by the engineer, but is not to exceed 1.5 lbs. of 77% anhydrous chloride content per square yard. Calcium chloride may be applied dry or in solution.

345.1 Dry Application

When it is applied dry, calcium chloride is required to have an anhydrous chloride content guaranteed to be at least 77% by weight. Payment will be by weight measured directly in tons. Dry chemical is routinely supplied by manufacturers within a chloride range from 77% to 80%.

Example 1

100 tons of dry calcium chloride with an 80% chloride content was applied.

Determine maximum application rate and pay weight.

$$Maximum\ Applicatio\ nRate = 1.5x\frac{77}{80} = 1.44lbs./s.y.$$

Pay weight = 100 tons.

Note that there is no "bonus" or extra payment for a chloride content above 77%.

345.2 Application in Solution

When calcium chloride is applied in solution, an anhydrous chloride content of at least 32% by weight is required. Payment will be based upon measured weight in tons, adjusted on a basis of 77%.

Example 2

A 32% solution was sprayed on. 100 tons were applied.

Determine maximum application rate and pay weight.

$$Maximum\ Applicatio\ nRate = 1.5x\frac{77}{32} = 3.6lbs./s.y.$$

$$PayWeight = 100\ x\frac{32}{77} = 41.6tons$$

Example 3

A 38% solution of calcium chloride was sprayed on. 100 tons were applied.

Determine maximum application rate and pay weight.

$$Maximum\ Applicatio\ nRate = 80\,x\frac{77}{38} = 3.0lbs./s.y.$$

$$Pay\ Weight = 100\ x\frac{38}{77} = 49.4tons$$

SECTION 350 Rubblizing Concrete Pavement

350.1 General

The intent of rubblizing concrete pavement before a pavement overlay is to produce a structurally sound base that prevents reflective cracking by obliterating the existing pavement distresses and joints. A rubblized and compacted concrete pavement is an assemblage of concrete segments that form a tightly keyed, interlocked, high-density material layer. A rubblized concrete layer is fractured, lacks continuity, and cannot sustain flexural stress. However, it possesses high shear strength and rutting resistance. It is not a typical granular material and is not an engineered material like base course.

FDM 14-25-15 provides guidance on using rubblization of concrete pavement. The item Rubblizing, 335.0100, describes the rubblization process and the testing that is done to ensure that the intent of rubblization is being accomplished.

350.2 Preparation of the Concrete Surface

Any existing asphaltic overlay must be removed before rubblizing the underlying concrete. The cleaner the concrete surface is, the better the energy of the rubblizing equipment is transferred into the concrete. Occasional, thin layers of asphalt (often caused by the milling machine working over faulted concrete slabs) are acceptable if the rubblizing equipment can adequately break the concrete through these thin layers.

The rubblizing specification requires the removal of all loose asphaltic patching material, joint fillers, expansion material, or other similar materials from the compacted surface. These items do not need to be removed before rubblizing the concrete. If, after rubblizing and compacting the concrete, any of these items are loose at the surface, they must then be removed so as not to negatively impact the paving of the overlay. It may not be necessary to remove these items if an intervening base layer is placed over the rubblized concrete.

350.3 Drainage

If specified, underdrain systems should be installed and functioning before rubblizing begins. In areas of weak subgrade or high-water table, the drainage system should be functioning as far in advance of the rubblizing as possible to allow for the subgrade to be as stable as possible. The drainage system also serves to remove rainwater from the rubblized concrete layer, base layer, and subgrade during construction.

350.4 Utilities

Underground utilities must be clearly marked before rubblizing. Special attention should be given to identifying any covers or shutoffs that are not exposed at the surface, such as a manhole cover under an asphalt patch. When necessary, the breaking energy should be reduced in the proximity of sensitive utilities to avoid damage. The rubblizing specification also allows the contractor to remove the pavement over or around utilities and backfill with aggregate.

350.5 Rubblizing Equipment

The rubblizing specification requires using a self-contained, self-propelled breaker to break the concrete down to specified maximum particle sizes and to create a stable construction platform for the pavement overlay. There are two types of machines that meet this requirement and have been used in Wisconsin. One is the resonant breaker, which produces low amplitude, high frequency blows by vibrating a large steel beam that is connected to a foot (can be varied in width from six to twelve inches) that is moved along the concrete surface at the front of the machine. Resonant breakers require multiple passes to rubblize the full lane width.

The other machine is the multi-head breaker, which has sixteen 1,200 to 1,500-pound drop hammers mounted laterally in pairs with half of the hammers in a forward row and the remainder diagonally offset in a rear row providing continuous breaking of up to thirteen feet wide. Each pair of hammers is attached to a hydraulic lift cylinder that operates as an independent unit, develops between 2,000 and 12,000 foot pounds of energy depending upon the drop height selected, and cycles at a typical rate of 35 impacts per minute. The drop height of each pair of hammers can be instantaneously adjusted to control the amount of breaking energy that is transferred to the concrete. This allows the operator to adjust the breaking for varying conditions along and across the pavement. The multi-head breaker rubblizes a full lane width in a single pass.

Typical production rates for rubblizing have been one lane mile per shift per rubblizing machine. Several machines have been used when project schedules required.

350.6 Breaking the Concrete

The rubblizing specification requires the breaking of the concrete down to specified maximum particle dimensions while giving the engineer the discretion to direct or allow larger maximum particle dimensions.

These specified particle dimensions are what can be expected when rubblizing over a fair to good base/subgrade. The particle sizes that can be produced are directly related to the condition of the base/subgrade. A firm and stable base/subgrade will allow for the production of smaller particle sizes than when working over a less firm and stable base/subgrade. Engineering judgment must be used when evaluating the rubblizing process, keeping in mind that the intent of rubblizing is to produce a structurally sound base which prevents reflective cracking by obliterating the existing pavement distresses and joints. The intent is not to meet a gradation requirement.

Attention must also be paid to constructability. Even if it is possible to produce small particle sizes, the resulting rubblized layer must still provide a working platform for paving operations and a stable foundation for the pavement overlay. In cases of isolated, very weak subgrade, subgrade correction may be appropriate. Another way to compensate for a weak subgrade is to modify the rubblizing pattern to produce larger particle sizes that maintain more of the existing concrete pavement's structural support. Experience has shown that segments of twelve to eighteen inches in the lower half of the slab are still effective for eliminating reflective cracking.

Test holes are excavated to satisfy the engineer that the process is meeting the rubblization objectives. This provision is not intended to make the contractor dig a hole. Once the engineer has verified the specification requirements are being met, he can waive the digging of additional test holes. Numerous test holes create non-uniformity in the structure.

350.7 Compaction

When compacting rubblized concrete over weak or wet subgrade or in the proximity of sensitive utilities, it may be necessary to reduce the vibratory roller's amplitude to prevent damage to the subgrade or the utilities. In extreme cases the roller should be operated in the static mode.

When the multi-head breaker is used the contractor usually chooses to use a "grid roller" for the first two vibratory steel roller passes. The Z-pattern bars that are attached to the roller drum serve to further pulverize the broken concrete particles at the surface.

When an intervening base layer is placed over the rubblized concrete before the pavement overlay, compaction of the base layer will be as required by the specification for that base layer.

Observation of the compaction process is an effective way to determine the stability of the rubblized layer. If there still are concerns after compaction, proof rolling with a loaded tandem-axle truck is a quick and effective procedure for determining the stability of the rubblized layer.

350.8 Filler Aggregate

Filler aggregate is used to fill holes and localized depressions in the rubblized concrete. It should not be used to adjust the grade.

350.9 Partial-Width Construction

When partial-width rubblizing and paving is required, if possible, the contractor should leave a six to twelve-inch wide strip of rubblized concrete unpaved when overlaying the first lane. This strip provides additional space to operate on the second lane without encroaching upon the first lane's overlay.

350.10 Rain

Light to medium rain does not affect the rubblizing operation. For safety considerations, heavy rains or lightning will temporarily stop the rubblizing operation. Rubblized concrete drains well, especially if edgedrains are functioning, and paving operations can usually begin shortly after the rain has stopped. Caution is required when rubblizing over a moisture-sensitive subgrade. In these cases, rubblizing and paving should be coordinated to minimize exposure of the subgrade to rain.

350.11 Construction Traffic

Construction traffic on rubblized concrete should be monitored. The contractor should minimize the amount and weight of construction traffic on the rubblized surface. This is especially important in areas with weak subgrade.

350.12 Asphaltic Overlay

350.12.1 General

When designing the thickness of the asphalt overlay, the rubblized concrete layer is assigned a support value. The support value is the product of the layer coefficient assigned to the rubblized concrete and its thickness. Similar calculations are made for the subbase, if any present, and for the asphaltic surface. The required total pavement structure thickness is the sum of all calculated thickness; thus, the rubblized concrete becomes an integral part of the pavement structure in addition to providing a working platform for paving operations and a stable foundation for the asphaltic surface. The layer coefficient for rubblized

concrete in the WisPAVE program defaults to 0.22 with an allowable range of 0.20 to 0.24. As a comparison, base course (crushed stone) is assigned a value of 0.14.

350.12.2 Paving

The paving of an asphaltic overlay on a rubblized and compacted concrete surface is very similar to paving on a prepared base aggregate. Care must be taken to maintain the compacted condition of the rubblized surface up to the time of paving. If local traffic or construction traffic has impacted the rubblized surface, a vibratory steel roller is used to reestablish a stabilized surface before paving.

Because concrete rubblizing and asphaltic overlay projects often involve opening the roadway to traffic before the total designed thickness is paved, consideration must be given to the thickness of the first lift. It must be thick enough to adequately cover the rubblized concrete surface and carry traffic temporarily until the additional lifts are paved. The number of large trucks determines the minimum thickness needed to carry traffic. When making cross-slope corrections with the first lift, attention must be paid to maintaining an adequate thickness not only at the centerline but also at the edge of the pavement. Additional thickness may also be required in areas of low base/subgrade support.

If the thickness of the asphaltic overlay is decreased when approaching a bridge or overpass, rubblizing should stop at the point where the thickness of the overlay begins to decrease. It is important to maintain the designed thickness over all rubblized areas.

When a yielding subgrade is the suspected cause of depressions in the rubblized layer, consideration should be given to an asphaltic leveling course instead of using filler aggregate. This would add greater strength to the section over the yielding subgrade than filler aggregate, and may be a more effective means of achieving smoothness.

350.12.3 Traffic Control

Concrete rubblizing and asphaltic overlay projects are constructed using a wide variety of traffic control scenarios. As a general rule, public and construction traffic over the rubblized concrete should be minimized as much as possible. Low volume, low speed local traffic can be accommodated if the shoulders are adequate to carry this traffic. Low speed traffic can also cross rubblized concrete to gain access to driveways and crossroads. If possible, high volume intersections should be rubblized and compacted shortly before the first lift is paved. In cases where the rubblized concrete is exposed to public traffic, close attention must be paid to the condition of the rubblized surface.

350.12.4 Curb and Gutter and Partial-Depth Concrete Milling

Partial-depth concrete milling is sometimes used to create a butt joint along the gutter flange to match the thickness of the asphaltic overlay, or to reduce the thickness that is placed over the gutter. Partial-depth concrete milling is also used for cross-slope correction. Adjustments must be made when rubblizing this area as the reduced thickness of the concrete will cause this area to rubblize differently than the full-depth concrete. Typically, less energy should be used to rubblize this area in order to maintain a "structurally sound base." Sometimes one or more lifts are paved over the gutter to the curb face to reestablish the flow lines. If new curb and gutter is placed it should be allowed to cure before rubblizing adjacent to it.

400 Pavements

CMM 410 Concrete Pavement - General
CMM 411 Preparing the Grade for Concrete Pavement
CMM 415 Hauling and Placing Concrete
CMM 416 Concrete Consolidation
CMM 417 Concrete Finishing
CMM 418 Concrete Texturing and Tining
CMM 419 Protecting Freshly Placed Concrete
CMM 421 Pavement Joints
CMM 424 Concrete Paving Inspection
CMM 450 Asphalt Pavement - General
CMM 451 Asphalt Mixing Plants
CMM 453 Mix Production
CMM 454 Preparation of Foundation for Asphalt Pavement
CMM 456 Hauling Asphaltic Mixture
CMM 457 Asphalt Pavers
CMM 458 Placing Asphalt Mixtures
CMM 459 Asphalt Mat Inspection
CMM 461 Compaction and Density of Asphalt Pavement

SECTION 410 Concrete Pavement - General

410.1 General

Concrete pavement must be of high quality, with durability and structural soundness to adequately withstand destructive forces resulting from traffic, weather, and variable foundation conditions. A smooth riding surface with sufficient skid-resistant characteristics is also required.

Proper construction methods, operations, and procedures are necessary to produce sound, strong, and durable concrete. It is essential that only materials meeting quality requirements be used.

410.1.1 Certification for Materials Testing

In association with the department, UW - Platteville conducts a certification and training program for highway technicians. All individuals involved in materials testing on department projects need to be certified under the Highway Technician Certification Program (HTCP) administered by UW - Platteville. Department staff, contractor staff, and consultant staff working for either the department or contractor must have the appropriate certification for the specific tasks they will be performing. The current HTCP certification list is available at:

https://www.uwplatt.edu/highway-technician-certification-program

410.1.2 Durability and Structural Soundness

Durability and structural soundness are physical qualities of concrete pavement that are closely related to each other, and construction operations affecting the production of one will often, to a large extent, affect the attainment of the other.

Some of the factors essential to production of sound, durable concrete pavement include the following characteristics:

1. A uniformly stable foundation.
2. Aggregates meeting specified requirements for quality and gradation.
3. Accurate determination of batch proportions with adjustments for moisture content of aggregates.
4. Use of minimum quantity of mixing water required to produce a plastic, workable concrete mix of uniform consistency.
5. Strict control of all admixtures to ensure compatibility, proper introduction and correct quantity.
6. Thorough mixing for the required length of time.
7. Correct placing of steel reinforcement and dowel joint assemblies.
8. Placement within the specified temperature and time limits.
9. Proper consolidation and finishing of the concrete.
10. Strict compliance with required curing methods.
11. Timely sawing of transverse contraction joints.
12. Restriction of loads on pavement until it has gained the required strength.

410.1.3 Smooth Ride

A smooth form or track line, a uniformly stable foundation, and equipment in good mechanical condition and adjustment all contribute to good ride. Variation in the mix can cause variations in the pavement surface that lead to poor riding pavements. Steady progress of the paver, with a minimum of stopping and starting, and a uniform load of concrete being carried across the full width of the paver are also essential prerequisites for good ride.

410.1.4 Paving Methods

Standard spec 415 provides that, unless otherwise required by special provision, either slip-form or form methods of paving may be used for pavements having either rural or urban-type cross sections. The method used is the contractor's option.

410.1.5 Tining

The timing of the tining operation must be coordinated with the dragging operation and adjusted for conditions to produce a uniform depth of sharp, well-defined grooves. The finished surface should be free from rough or porous areas, irregularities, and depressions resulting from improper handling of the tining machine.

410.2 Paving Operations

410.2.1 Slip-form Paving Train

The paving train may include a spreader, a paver, floats, a longitudinal drag, a transverse tiner, and a curing compound sprayer. The paver may include a mechanical dowel bar inserter. The concrete from the

plant is either dumped or chuted onto the base in front of the spreader by truck, or it is dropped from a truck into a hopper at the side of the spreader and conveyed across the width of the slab.

The spreader lays out the concrete in a uniform lift and strikes off the concrete to approximately final elevation. The slip-form paver will strike off the concrete to final elevation, vibrate the concrete, screed it, then pan-float it to nearly the final finish. Straightening and re-floating may be by a tube float or (usually) by hand floating and straightening. This is done to test for trueness and iron out minor irregularities in the surface.

Final surface finish is accomplished by a longitudinal machine drag equipped with burlap or an artificial turf such as Astroturf. Dragging is followed by a tiner that drags a steel comb, or series of tines, transversely across the slab to produce a macro-texture.

The textured concrete surface and sides are then coated with an opaque curing compound, by means of a curing compound power sprayer, to seal in moisture and retain heat of chemical action. During cold weather periods, curing paper or polyethylene sheeting is required and the curing compound may be omitted.

The final major step is sawing of transverse and longitudinal joints, by means of power saws, to control shrinkage cracking of the slab.

410.2.2 Formed Pavement Paving Train

The operations of placing the concrete are essentially as stated above. There are major differences in the equipment employed, however. There may be a spreader to lay out and strike off the dumped concrete, but there will not be a paver to vibrate and screed the plastic concrete to the final elevation. Instead, specialized finishing machines consolidate and finish the concrete.

Initial finishing may be done by a double-screed machine. Float finishing is usually done with a finishing machine having a front screed, plus a trailing float pan that is independently suspended. The rest of the operation (straight-edging, dragging, tining, curing, and sawing) is as previously described for slip-formed pavement.

410.3 Continuously Reinforced Pavement

Revise 410.3 (Continuously Reinforced Pavement) to reorganize, renumber and revise subsection headings.

410.3.1 Paving Train

The paving train for continuously reinforced pavement is essentially the same as for non-reinforced pavement except that since the reinforcement is laid out on bar chairs ahead of the paver, the concrete has to be delivered from outside the form line or string line.

410.3.2 Concrete Reinforcement

Generally, storage requirements for steel reinforcement and requirements relative to rust will be the same as provided in CMM 515 for steel reinforcement used in structures. Light rust is acceptable but heavy rust or scale is not. Welds should be checked for breakage and re-welded as needed. The epoxy coating should be checked for damage during shipping and handling per subsections standard spec 505.2.4 and standard spec 505.2.6. All reinforcement steel received on the job must be held in approved storage and distributed along the work only as needed for immediate placement. Mesh reinforcement is no longer used by WisDOT.

410.3.3 Installation

Most efforts to control cracking in rigid pavements have involved experimentation with transverse joints. Continuously reinforced pavement eliminates transverse joints, except for construction joints and expansion joints. Cracking of the slab is allowed to develop in a random pattern. Sufficient longitudinal continuous reinforcement steel is placed to hold the cracks so tightly closed the pavement will retain its structural integrity.

Construction procedures and practices relating to continuously reinforced concrete pavement are generally the same as for non-reinforced concrete pavement, except for joints and reinforcement.

Reinforcement bars are laid out longitudinally, side by side, on the base in advance of the paving train. They are tied end to end, with the specified lap, and to transverse bars at the specified interval. The steel grid is placed on bar chairs that support it at the correct elevation. Placement of the concrete, spreading, and consolidation follows in one pass of the paving train.

The reinforcement should be checked to ensure that the correct bar laps have been made at the splices and that the bars are at the correct spacing and depth. Also, check that the correct bar sizes have been installed and that the epoxy coating has not been damaged during installation.

Checks should also be made to ensure that the bar chairs are secured to the base and the reinforcing bars are securely tied to the chairs with approved types of fasteners, as discussed in standard spec 415.4.

410.3.4 Pavement Gaps

Sometimes it is necessary to leave an unplanned temporary gap in the pavement to accommodate traffic at locations designated in the contract and for haul roads or other reasons approved by the engineer. Such gaps are not desirable and should be discouraged. When the leave-out is paved, the two adjacent free pavement ends may be subject to considerable daily movement because of changes in temperature, which may produce slippage of the reinforcement in the fresh concrete before sufficient bond strength is developed. A wide construction joint or wide transverse cracks may result.

The necessity for gaps or leave-outs can be eliminated if pavement is placed in these areas beforehand. Then there is only a short section of hardened concrete pulling on the two green slabs at each end. This method should be followed if possible.

When the gap cannot be paved beforehand, and if there is no plan detail, the following construction methods must be employed. At least 50% additional longitudinal reinforcement steel should be installed in the gap and across each construction joint at the ends of the gap. The additional members should extend at least 3 feet into the pavement ends adjacent to the gap and into the gap a minimum distance of 7 feet. Splices for the additional longitudinal steel in the gap should be lapped and staggered as provided on the plans.

The temperature of the concrete in the free ends of the pavement should be stabilized by applying a double layer of burlap to the surface of the pavement for 200 feet from each free end. The burlap must be kept wet and remain in place for at least 24 hours just before paving the gap and until the curing time has expired for the newly placed adjacent pavement.

Contractor requests to leave unplanned gaps are subject to the approval of the engineer.

410.4 Measurement of Clearances before Opening Roadway for Traffic

When pavement construction occurs beneath an existing bridge, the construction staff will measure horizontal and minimum vertical clearance upon completion of the pavement. Send the measurements to the Structures Development Section, BOS, and the regional bridge maintenance engineer. The Structures Development Staff will enter the clearances in Highway Structures Information System (HSI).

SECTION 411 Preparing the Grade for Concrete Pavement

411.1 Preparation of Foundation for Concrete Pavement

411.1.1 Base Course

Preparation of foundation for concrete paving is usually a minor item that includes reshaping of the completed base course to remove holes and ruts, correction of isolated soft spots, and minor grade adjustments. If the base course and concrete pavement are included in the same contract, preparation of foundation for concrete pavement is usually not a bid item. The exception to this is when the base course is used to carry traffic or is expected to lay over from one season to another. The reason being that, factors beyond the control of the contractor may disrupt the base course after its placement and before paving. Regardless of whether the item is bid or not, the work to be done is the same.

The base course must provide a smooth, uniform, and substantial support for the pavement. If it does not, random slab cracking between joints, tilting, or subsidence of the complete slab may occur.

The foundation for the concrete pavement is considered to extend 12 inches beyond the edge of the pavement. The base course should be trimmed and shaped to the required elevation for the full width and compacted to the required density. Unless the contract specifies special compaction, required density means the degree of compaction necessary to preclude rutting or displacing of the material under traffic as required for standard compaction of base courses under standard spec 301.3.4.2.

The base should be compacted to about 1 inch higher than plan elevation to allow the trimming machine to cut across the whole top of the base. It will be necessary to recompact disturbed base material after trimming. Excess base course material should be disposed of outside the track line in a manner as not to interfere with paving operations.

The base should be completed for a minimum of not less than 300 feet in advance of paving operations to avoid stops and starts in paving. Soft spots should be removed, replaced, and compacted before starting to pave. Ruts and ridges should be rolled out. Damaged areas resulting from hauling trucks must be corrected before being overlaid by pavement.

411.1.2 Slip-Form Method

Standard spec 211 requires the areas that support the slip-form paver to be brought to the required grade by a properly designed machine, and the area on which the pavement is to be placed to be brought to the required grade and cross section by means of a machine designed specifically for trimming foundations. The machine must use automatic sensors to trim to the required grade and cross section.

411.1.3 Form Method

The final, true cross section of the base is established after the forms have been set. This is accomplished by using a subgrade trimming machine which rides on the forms. It is equipped with cutters that trim the grade to its true cross section and with a belt conveyor that deposits excess material outside the form line. During this operation the subgrade surface is generally disturbed to the extent that rolling is required to restore it to the original state of compaction.

411.2 Testing Base Course

The base must be tested or checked by the contractor for grade and cross section immediately before placing of concrete when slip-form methods are used.

When forms are used and hauling, or other equipment is allowed on the prepared foundation, a subgrade planer must be operated ahead of the concrete being deposited or the foundation must be restored as necessary.

411.2.1 Slip-Form Method

One of the more important aspects of slip-form construction is fine grading base materials to very close grade and cross section tolerances. Tight tolerances are essential with slip-form methods because of the effect base condition has on concrete quantity, slab thickness, and ultimate pavement strength and rideability. Checking these tolerances will probably prove more difficult with slip-form than with form paving methods due to the absence of side forms that may be used for elevation reference.

The base must be checked to ensure adequate pavement thickness using stringlines, levels, a rolling template, a dry run of the slip-form paver, or other methods. The grade must be finally checked after corrections and adjustments are made and just before placing concrete on the grade. Equipment, methods, and procedures used by the contractor in testing the grade are subject to approval by the engineer.

411.2.2 Form Method

The purpose of the subgrade planer is to plane off uneven projections in the base and to act as a template to check the required depth and cross section of the pavement slab. It should be heavy enough

to accomplish this without raising the wheels off the forms. Where the grade is high and considerable material is carried ahead, or the base is disturbed excessively, corrections should be made in the grading or shaping operation in advance of the paver. It may also be an indication that form settlement is taking place. Loose material carried by the planer must be removed from the grade and not used to fill low spots. Fillets of loose material along the bottom edge of the forms should be removed and the bottom edge of the forms exposed. Frequent checks should be made to ensure the cutting edges are set for the proper depth and are tightened securely to the frame. Notes relating to such checks should be entered in the paving diary and should include date and time of check, together with the location and stationing of the check.

411.2.3 Adjusting Pavement Grades

Due to traffic, maintenance, or other causes, the profile grade of a base course constructed under a previous contract may deviate from the proposed grade. If minor adjustments need to be made in the pavement grades, the goal should be to disturb the base course as little as possible. The adjustments are limited to the extent that smooth transitions, surface drainage, foundation strength, and good riding qualities are not impaired. When adjustments are made, the rate of transition should not exceed 1 inch in 100 feet.

To establish a pavement profile that will most closely conform to the existing base, elevations should be taken well in advance of the time of construction to afford ample opportunity to select a profile that best meets the conditions.

If the base thickness is close enough to plan thickness to be acceptable, no base material should be added. Avoid cutting when it results in less than the plan thickness of base. If an extensive area of significantly deficient thickness is encountered within the pavement limits, it should be called to the attention of the engineer for determination of proper corrective procedure.

No adjustments should be made in grades established by a municipal ordinance.

411.3 Concrete Paving Over Existing Surfacing

Concrete pavement placed over existing asphaltic or concrete surfacing may require:

- Patching of the base.
- Wedging to achieve a smooth grade line by filling in sags with asphaltic mixture.
- An asphaltic leveling course may need to be placed to restore profile and provide a bond breaker over existing concrete pavement. This is a design consideration and if necessary, should be provided for in the contract.
- A polyethylene bond breaker may need to be placed over existing concrete pavement to avoid reflective cracking. This is a design consideration and if necessary, should be provided for in the contract.
- Defective areas and patches in the existing surfacing will need to be found and marked for repair or removal.
- The existing profile will need to be surveyed and plotted to locate low areas and sags. Wedging limits will need to be marked on the pavement.
- Cross slope and crown will have to be surveyed and plotted to determine if super-elevation and crown need to be corrected before overlay.

411.4 Setting String Lines and Forms

411.4.1 String Lines

If the slip-form method of paving is used, string lines are set to indicate alignment to the automatic sensing devices that guide the paver. The autograder used to trim the base to final elevation also uses the string line for grade as well as for alignment. To establish the string line, the survey crew will drive hubs with tacks and the contractor then will set the string line from these hubs. The inspector and the contractor should know which elevation has been set by the survey crew. An alternative to the hubs would be paving pins set on line, with elevation marked by tape.

The paving inspector is responsible for the following tasks:

- Inspect the string lines for correct elevation and line.
- Obtain the horizontal and vertical offsets from the survey crew or from the guard stake information.
- Visually check for straightness or for a smooth curve.
- Measure between the string lines for a check on pavement width.
- Check the firmness of the line supports and bracket arms, and the tautness of the strings.

Use string lines to establish a smooth grade on approaches to bridges, railroad grade crossings, or adjacent pavements. Twenty or thirty feet of the approach nearest the structure or crossing should be on the same plane as the structure to ensure a smooth riding approach. When setting string line or forms for

pavement underneath a structure, the required vertical clearance above the pavement should be checked.

Excess base course material trimmed off by the autograder should be conveyed to the side of the roadway. If not removed at once, openings should be cut through the windrow at intervals to allow water to drain off the base.

411.4.2 Forms

Standard spec 415.3.1.6 is explicit in the requirements for steel forms. When forms become so deformed or badly worn they cannot provide and maintain specified alignment for the face and top, or the keys and locks fail to provide the necessary rigidity under the mass and forces of the finishing equipment, they should be rejected and not used until acceptably repaired or replaced.

Form depths should equal the depth of the pavement to be constructed, but the specifications allow using built-up forms where the area of any specified thickness does not exceed 2,000 square yards. According to standard spec 415.3.7 metal or wood plates providing adequate support must be used to build up the form and must be securely attached to the form.

Permission to use forms of a depth not to exceed one inch greater than pavement depth may be granted by the engineer under special circumstances.

The construction survey crew will establish line and grade for the paving operation. The survey crew will place paving pins at a predetermined offset from the edge of pavement and will mark an elevation, usually the edge of pavement, on the pins. Be sure the inspector and the contractor know which elevation is being used.

The forms must support heavy loads and withstand lateral forces imparted by the finishing equipment. It is important that the foundation is thoroughly compacted, and uniform support is provided for the full length and width of the form base. If it is necessary to trim more than 2 inches from the base or to raise it more than 2 inches to set forms, the full base should be corrected before forms are set. After the forms have been set, material under the forms must be thoroughly tamped, either with a mechanical tamper or a suitable hand tamper, under the face and back of the form. Probing with a steel pin readily discloses how effectively this has been done. Guard against excessive tamping in one spot as this has a tendency to raise the form above the true grade. After setting and tamping, the forms should be visually checked for grade and alignment and adjusted, if necessary, to provide a smooth uniform grade and proper alignment.

The foundation under forms placed before a rain should be checked for stability. Careful probing underneath the forms will disclose whether the material is firm enough to prevent settlement under the heavy equipment. Instances of deficient pavement have been attributed to such settlement.

The inspector should be making the following checks:

- Check the top of forms for straightness on tangent or for smoothness on curves.
- Measure between form faces for a check on slab width.
- Be sure the forms are set at the correct elevation.
- Check that the forms are true and not warped, are of the correct depth for the proposed concrete slab depth, are set with the face vertical, and are heavy enough to support the paving train.
- Check that the forms are locked and pinned securely.
- Check for form settlement.

Forms should be sprayed with oil before use to prevent sticking. Forms should be set well in advance of the paving to ensure that placement of the concrete will be smooth and continuous to avoid a rough surface. Standard spec 415.3.7.1 requires forms to be set and maintained for at least 1200 square yards in advance of paving.

Any excess base between the forms should be trimmed off well in advance to avoid delay in paving. The excess base will be trimmed off by a subgrade machine riding on the forms, and the excess base course material will be conveyed to the side of the roadway. The resulting windrows should either be removed at once or openings should be cut to allow water to drain. Otherwise, the base may become waterlogged during rains as water is ponded by the windrows and will rut under construction traffic and result in thin, rough pavement.

The subgrade trimming machine must be heavy enough to stay on the rails and not be raised off the rails in areas of heavy trimming. The inspector should check to ensure that the base has been removed to the correct depth at the face of the forms. After the trimming, the base should be re-compacted.

SECTION 415 Hauling and Placing Concrete

415.1 Hauling Concrete

For dual lane construction, ready-mixed (central-mixed, transit-mixed, shrink-mixed) concrete should be delivered to the site of the work at a rate that will allow placement of not less than 78 cubic yards per hour.

Concrete may be hauled in transit-mix, agitating, or non-agitating type trucks. Standard spec 501.3.5.2 sets forth the allowable delivery times for the different types of vehicles. Standard spec 501.3.5.3 sets forth the requirements, including minimum and maximum revolutions, of truck mixers. The delivery time and revolutions should be checked on an intermittent or spot basis unless inspection tickets, as specified in standard spec 501.3.5.4, are required.

Concrete may be deposited directly on the grade, into a hopper type spreader, or into a conveyor hopper outside the track line. When the concrete is deposited directly on the grade there is a greater possibility of segregation. Use of a hopper type spreader or a conveyor hopper provides more even concrete dumping. Use of a conveyor hopper avoids truck damage to the base.

Standard spec 415.3.7.2 specifies that concrete should be delivered by vehicles operating outside the lanes being placed. If the engineer allows delivery vehicles to operate in the lane where concrete is being placed, means must be provided to correct induced irregularities and to restore the foundation before to placing concrete.

When slip form methods are used, the condition of the base is especially critical because the slip form paver rides directly on the base. The consequence of damage to the base by hauling vehicles may be either deficient pavement depths or excessive roughness or both. If delivery vehicles are allowed by the engineer to operate in the lane which concrete is being placed, reasonable limits need to be placed on the operation of the hauling vehicles. Trucks delivering concrete should not be allowed to cross the track line at indiscriminate locations. Any crossing of the track line should be confined to a distinct area, and as the paver approaches that location another area should be designated 300 feet ahead. Previously crossed track lines should have irregularities corrected using a stringline for reference.

415.2 Placing Concrete

Unless otherwise specified in the contract, pavement of rural cross section should be placed to its full width in a single construction operation, except that pavement constructed directly on crushed aggregate base course, open graded may be placed to a single lane width in a single operation.

The standard specifications require concrete to be deposited on a moist base. When concrete is deposited on a dry base, the base absorbs some of the water that is required in the mix for proper workability, and the concrete becomes difficult to finish. When sprinkling of the base immediately ahead of the paver is not sufficient to correct this condition, the contractor should thoroughly wet the base well in advance of the paving operation. If the surface of the base dries before the concrete is placed, additional sprinkling ahead of the paver will be required.

No single factor affects the durability of concrete as much as the relationship between the quantity of water contained in the mix and its cement content. Standard spec 501.3.5.3 specifies that the mixing water must be added at the batching plant, but if additional mixing water is required to obtain the specified slump, water may be added at the site with the permission of the engineer. The total of all free water may not be in excess of what the specifications allow. Standard spec 501.3.5.3 further provides that if additional water is added at the site of the work, a minimum of 20 revolutions of the truck mixer at mixing speed will be required before discharge of any concrete. This precludes adding water to concrete delivered by non-mixer type trucks. If it is necessary to add water at the site, the plant operations staff and inspector should be notified so the amount of mix water can be adjusted at the plant. Consistency of the concrete is very important and should not vary between loads. This may happen if water is added at the paving site and concrete is delivered by a mix of vehicles which includes dump trucks and transit mix trucks.

In the case of a contract that includes the QMP provisions, the above statements regarding adding mixing water also apply except that Quality Assurance personnel should be involved, and permission of the engineer is not required.

Standard spec 415.3.7.1 requires concrete to be placed across the full width of the pavement in a manner that requires as little re-handling as possible. This will control segregation and promote consolidation and settlement in the concrete. When a hopper-type spreader is used, the hopper should be partially filled at all times for its full width as it moves ahead to spread the concrete. The discharge chute must be kept in motion in order to distribute the concrete over as wide an area as possible. Windrowing or piling of the concrete is not allowed.

Concrete should be delivered to the paver at such a rate as to allow uniform progress, with stopping and starting of the paver held to a minimum. This is especially critical for operation of a slip form paver.

415.3 Dowel Bars

415.3.1 Dowel Bar Assemblies

Conventional concrete pavement design requires dowel bar (load transfer) assemblies at specified spacing along the length of the slab. They are used to transfer or carry wheel loading across the transverse joint sawing at each of those points.

Dowel assemblies should conform to the basic design of the latest revision of the Standard Detail Drawings and be approved before. Field inspection should ensure that one end of the dowel bar is sawed and free from burrs or protruding edges and that there are no ridges or indentations beyond or within the normal circumference of the bar. Any deviation in the roundness of the bar that will restrain the free movement of the concrete is considered cause for rejection or correction. Dowel bars must be epoxy coated. Damaged coating must be repaired in accordance with standard spec 505.2.6.1.

Generally, storage requirements for steel reinforcement and requirements relative to rust will be the same as provided in CMM 515 for steel reinforcement used in structures. Light rust is acceptable on the assembly, but heavy rust or scale is not. Each dowel should be lightly greased.

The importance of the proper installation of load transfer dowels and the subsequent placing and manipulation of the concrete around them cannot be overemphasized. A joint can become a potential point of weakness if the correct installation procedures are not observed. Any restriction to the free movement of the concrete may result in a crack near the joint. The supporting assembly or basket must be staked down securely to prevent its displacement and it must be rigid enough to hold the dowel in its true position when the concrete is manipulated around it. The bars should be parallel to the pavement centerline as to both alignment and grade before the installation is approved. The exact location of each end of each assembly should be marked with a flag or stake set outside the paving limits so the transverse joint can be sawed at the exact center of the assembly.

At each dowel assembly there is a greater concentration of steel that tends to prevent the free flow of concrete at the point. Unless particular efforts are made to properly place and consolidate the concrete around the assemblies, void pockets may be created with a resultant loss of strength. The specifications state that the concrete needs to be consolidated along the full length and on both sides of the joint by vibration in a manner that precludes displacement of the dowels.

415.3.2 Dowel Bar Inserter

Some paving machines have the capability of implanting a row of dowel bars without the need for an assembly to position the bars and secure them against movement. The paving inspector should check that each dowel is lubricated, and the full array of bars is being placed at each location.

The dowels should be placed within the tolerance given in standard spec 415.3.8. Any marring of the pavement should be removed by subsequent finishing operations.

The exact location of each row of dowels should be marked on both sides of the pavement to facilitate sawing of the transverse joint.

415.4 Adjusting Drainage and Utility Fixtures

The adjustment of manhole, catch basin, inlet covers, or frames should be carefully performed and inspected as described in CMM 620.

415.5 Checking Depth

Standard spec 415.3.18 specifies that contractor probing is the primary method for determination of thickness of pavement. Details of the probing equipment and procedure are outlined in CMM 870. The engineer will periodically observe the contractor's testing procedure to ensure that the test is being performed properly. Also, the engineer will use probing to verify that the pavement thickness is acceptable. Verification tests will be performed at a minimum frequency of once for each half-day of paving. The engineer may elect to increase the verification testing frequency as necessary to ensure that the pavement has an acceptable thickness.

The engineer will select a longitudinal location at random and designate the transverse positions for a series of two probes in each lane of pavement at that location. The contractor must secure metal plates to the grade and perform the probing as directed by the engineer. The engineer will be present and observe both placement of the plates and probing of the freshly placed concrete.

In the case of contracts containing QMP provisions, the contractor is responsible for performing thickness measurements of the newly constructed pavement. The method and transverse locations of probing will

be described in the contractors Quality Control plan. The method of Quality Assurance is described in the QMP manual.

415.6 Hand Methods

Using hand methods instead of placement by machine is limited by the requirements of standard spec 415.3.11.2. It is generally agreed that pavement gaps 200 feet or less in length are too short for efficient and cost-effective use of a paver and therefore can be placed by hand, although bridge finishing equipment has been allowed on such short gaps, with acceptable results. Each situation must be evaluated by the engineer before hand placement is allowed.

Consolidation of hand-placed concrete is important and is discussed in detail in standard spec 415.3.11.3. Over-vibration is to be avoided.

The concrete should be placed close to its final location to minimize segregation and air loss from excessive manipulation, and to avoid time delays in finishing and curing. Walking in the concrete should be kept to a minimum.

Other general requirements discussed previously for placing by machine, such as pre-wetting the base, are applicable.

SECTION 416 Concrete Consolidation

416.1 Slip-Form Method

Spread concrete is consolidated by vibration or a combination of vibration and tamping. Internal vibration may be performed by either horizontal tube or multiple spud-type vibrators. The location of vibratory units and their operating amplitude and frequency is not a hit and miss proposition. The contractor should not be allowed to indiscriminately alter the location of vibrators without the technical advice of the paver manufacturer. Tube-type vibrators are required to have not less than 5,000 impulses per minute and internal spud-type not less than 7,000 impulses per minute unless modified by the manager. Frequency may be checked using a vibrating-reed tachometer which, when placed in contact with the vibrator, will vibrate at the same frequency as the vibrator. The frequency may then be read on a scale in revolutions per minute and directly compared to standard spec 415.3.1.3.

Slabs are shaped behind vibrators by a conforming plate or oscillating screed adjustable for various crowns. A preliminary surface finish is imparted to the concrete through this shaping action. Following these screeds or plates, the concrete is given a final mechanical toweling, usually by a pan float.

The finished slab should be checked for proper crown as soon as possible after startup of paving operations and periodically thereafter.

In conjunction with this operation, it is appropriate to note several aspects of slip-forming that are frequently the subject of discussion. The first of these is edge slump. Since edge slump is to some extent a function of the mix consistency, it is necessary to use relatively stiff concrete, with a slump less than 2-1/2 inches. In addition to mix consistency, the method and length of trailing form has some effect on edge slump. Different types of pavers employ different forming methods, but it has been conclusively shown that long lengths of trailing forms are not necessary to prevent this slumping; indeed, longer lengths may be a contributing factor. A rule of thumb is to use the shortest length of trailing form that will give acceptable results.

Standard spec 415.3.11.8.4 allows an edge slump tolerance, exclusive of edge rounding, of 3/8 inch or less where an adjacent lane or ramp is not to be constructed, and 1/8 inch or less where an adjacent lane or ramp is to be constructed. Edge slump greater than these figures should be corrected before the concrete hardens.

The paver should push a roll of concrete about 6 inches high ahead of the strike off so no low areas with deficient density result. On super-elevated sections, the roll should be about 12 inches high. The correct depth of concrete should be checked at three or more points across the slab width. A finishing bridge will allow taking measurements.

Inspectors should check that centerline tie bars are being inserted at the correct alignment, spacing, and depth. Normally, a mechanical inserter is required, but the engineer may approve manual insertion.

Bent steel reinforcing tie rods will be mechanically inserted at this time into the sides of the slab if curb and gutter or adjacent slabs will be poured later. Check for correct longitudinal spacing and depth from top of slab and that they are parallel with top surface of the pavement so they do not protrude or bulge the surface. The steel should be in full contact with the concrete with no voids below or around the rod. After the concrete hardens, the inspector should make sure the contractor straightens the bent rods so that they are as straight as possible.

Concrete with a slump which is too low can also create problems. Because of the relatively large area of the screed on slip-form pavers, very low maximum unit pressures can be developed on the concrete under the screed. Thus, when low slump concrete with less than 1-inch slump is used, the paver tends to float up above the desired grade. The contractor may need to employ additional measures to provide grade control and maintain a smooth pavement.

Rain can damage slip-formed pavement. Although the contractor is responsible for rain damage, the potential severity of this damage in a slip-form operation is reason for the inspector to be especially conscious of forecasted rain. Specifications require the contractor to have adequate protective covering material, including side forms, for use as pavement protection in case of rain. The inspector should ensure that such materials are available. The contractor is allowed to refinish rain-damaged portions of pavement by re-dragging or re-tining the concrete while in the plastic state. See CMM 424.

416.2 Form Method

Consolidation of the concrete is usually accomplished using mechanical finishing equipment. The specifications allow vibratory equipment as an option to the mechanical finishing equipment. In the construction of continuously reinforced concrete pavements, vibratory equipment is required.

416.2.1 With Mechanical Finishers

The contractor adjusts transverse finishing machine screeds to produce pavement crown. The finished slab should be checked for proper crown as soon as possible after startup of paving operations and periodically thereafter. The screeds are normally tilted to improve density and finish of the concrete. The front screed is usually tilted about 1/8" and the rear screed is usually flat or only slightly tilted.

For oscillating screeds, the stroke and forward speed are adjusted for the mix. For stiff mixes, the stroke is long and rapid and the forward speed slow, to work up mortar for finishing. For softer mixes, the stroke of the screed is short and slow and the forward machine motion more rapid to prevent work up of too much mortar and water to the surface. The wheels of the finisher should be clean and not riding on concrete on the forms.

416.2.2 With Vibratory Equipment

The vibratory equipment for general consolidation of the pavement concrete is of two types: the internal or spud type and the external or pan type. The internal type consists of a series of spud vibrators, having a minimum of 7,000 impulses per minute arranged on a framework that allows control of the depth and angle of insertion into the concrete. The pan-type vibrator is generally a cellular, T-shaped bar, whose under surface is elliptical in shape. It should be slightly shorter than the pavement width so as not to come in contact with the side forms. It is required to have a minimum of 4,000 impulses per minute, unless modified by the engineer. The vibrator pan acts across the pavement as a unit, and the direction of the vibratory impulses is vertical. To be uniformly effective there should be a slight excess of concrete ahead of the pan at all times to ensure that it is in full contact with the concrete surface.

Both types of vibratory equipment are operated attached to either the mechanical spreader or the finishing machine. The vibrating is done after strike-off and preceding the screeding of the concrete and only when the machine is in forward motion. To preclude over vibration of the concrete, the vibration is limited to one pass of the machine, unless directed otherwise by the engineer.

The vibratory screed is a modification of the pan-type vibrator and is intended principally for use in hand finishing operations, where hand finishing of concrete pavement is allowed. It may be either a metal or wooden screed to which is attached a small power unit which provides the vibratory action to the screed. It is used to strike off and consolidate the concrete. It should be restricted to not more than two passes; each pass being made with a uniform forward motion. The second pass should be made with a slight roll of concrete in front making sure the screed is held firmly to the forms so a smooth, uniform surface results. It should not be allowed to remain in one position long enough to bring an excess amount of mortar to the surface. The screed should be held at right angles to the surface with the screed in full contact.

Vibration, when properly controlled, is a very effective means of attaining well-consolidated concrete. However, the uncontrolled use of a vibrator may result in bringing an excess of mortar to the surface, which generally is detrimental to the production of sound concrete. Where the general consolidation of the pavement concrete is by the finishing machines, the hand operated internal spud vibrator can be used to good advantage in consolidating the concrete at locations where using the finishing machine is restricted, such as connections to a bridge deck, around manholes, at transverse joint dowel assemblies, or along the forms. Honeycombed concrete is objectionable at these locations, and the proper and judicious use of a vibrator can help to achieve thorough consolidation.

When using an internal type hand vibrator, the vibrator head should be slowly inserted into the concrete and withdrawn before over vibration of the concrete occurs. It should then be moved to a new location and the procedure repeated until the desired area has been completely vibrated.

The operating frequency of external pan vibrators, internal tube vibrators and internal speed vibrators can all be checked with a vibrating reed tachometer available through the region office. The tachometer gives a frequency reading in revolutions per minute, which is equivalent to vibrations per minute or impulses per minute.

Where the general consolidation of the pavement concrete is performed with vibratory equipment, the slump of the concrete is limited to a maximum of 2-1/2 inches. However, when the mix design or the type and gradation of the aggregates produce a workable or plastic mix, the slump may often be reduced without creating serious finishing problems.

SECTION 417 Concrete Finishing

417.1 Form Method

417.1.1 Finishing Machines

Finishing machines are used to give the final cross section and finish to a pavement and, by the action of screeds, consolidate the concrete. To accomplish this, each screed will require a certain amount of adjustment. When these adjustments are made they should be correlated such that each succeeding screed will carry forward a lesser amount of material, and the final float acts to remove minor irregularities left by the preceding screed with little or no material being carried ahead of it.

417.1.2 Screeding

Standard spec 415.3.11 requires the finishing machine to make as many trips as required to take advantage of the condition of the concrete, to give proper compaction, and to produce a surface of uniform texture true to grade and contour. Prolonged operation over a given area should be avoided. The final pass with a machine using a transverse screed should be delayed as long as practicable to allow some settlement in the concrete to take place. Unless every batch is uniform, the settlement in concrete is non-uniform, and early finishing results in irregular settlement, which causes poor riding qualities in a pavement.

The relation of forward speeds with the action of the transverse screed is important. With stiff mixes the screed speed should be fairly rapid and lengthy and the traction speed relatively slow. With more workable mixes, the screed action should be decreased in both speed and length and the traction speed increased accordingly. Any machine that is incapable of being adjusted to overcome a forward motion that is jerky and hesitant and causes racking of the forms should not be used.

417.1.3 Float Finishers

The float finisher is used to provide the final mechanical finish of the pavement surface. The primary purpose of the finisher is to remove minor irregularities and float the surface.

Two types of float finishers are in use. One has a screed and a float pan and is attached to and towed by a finishing machine. The acceptable performance of this machine depends largely on the action of the finishing machine. For best results, it must move forward at a steady uniform speed.

The second type is a self-propelled unit equipped with a conventional screed in front with a screed and float pan in the rear. In each case, the rear screed and float pan is suspended from the frame and has no contact with the forms. The suspended screed shapes the final surface and the float pan irons out minor irregularities.

Precise correlation in adjustment is required. A slight roll should be carried by the screed and the float pan should rest on the surface with just enough pressure to iron the surface without cutting. The timing of this operation should be closely controlled. Finishing too soon is likely the reason why pavements, which straight-edge acceptably when placed, are rougher than expected the following day. It is also important that it be a continuous operation without any stops for a distance of at least 40 feet.

417.1.4 Final Finish

When finishing operations become difficult due to the rapid loss of the moisture in the concrete, it may be an indication the base is too dry and is absorbing water from the mix that is needed for finishing. A more thorough wetting of the base will help relieve this condition.

It may become necessary to increase the slump of the concrete or it may be in the interest of better workmanship for the finishing equipment to operate closer to the paver than normal. Temporary measures taken to overcome emergencies should continue only as long as the need exists and normal procedures should be restored as soon as possible.

Texturing and curing operations are covered in procedures CMM 418 and CMM 419, respectively.

Standard spec 415.3.11 allows a testing and floating procedure accomplished by a tube float instead of straight-edging when equivalent results are obtained.

Tube floats provide help in providing a uniform surface appearance. Their back and forth operation works a small amount of grout to the surface which can then be spread to fill minor surface imperfections. As with any concrete finishing operation, however, the surface should not be worked to the point that concrete quality is sacrificed.

If the tube float method of finishing is used, transverse machine operation should be smooth and continuous, with only one pass over the slab to prevent excess water being worked up. A very slight roll of concrete should be carried ahead of the float, usually 1 inch or less. Water should not be sprayed from the float to ease finishing.

Standard spec 415.3.11 provides that only minimal amounts of water can be used in the operation of the tube float and in correcting deficiencies found in straightening when the engineer allows. Excessive amounts of water create a soupy roll of mortar which, when spread over the surface, can result in early scaling, rapid surface wear, and deterioration, especially in connection with chloride use.

Whether hand straight-edging is necessary to supplement the tube float and where it should be done in relation to the tube float is a matter of opinion. On some projects, hand straight-edging may prove indispensable; on others, it may be just another operation that increases the risk of overworking the fresh concrete. Most contractors have discontinued using the tube float in recent years in favor of hand straight-edging.

Frequently small air voids appear on the surface, and in an effort to remove them the surface is over manipulated. This is more detrimental to the concrete surface than leaving the air voids alone.

A very common practice that prevails among finishers is to sprinkle water on the surface to facilitate the finishing operation. This should not be tolerated. The additional water in conjunction with the surface manipulation dilutes the surface mortar to the extent that a loss of as much as 25% in surface strength results. A loss of air entrainment can also be expected, resulting in a pavement surface that offers less resistance to surface spalling and the extremes of freezing and thawing.

Workers should not be allowed to walk in or on the concrete. They should cross the slab by means of a finishing bridge.

The edges of the pavement should be finished to a 1/4-inch radius, or less, at this stage.

417.2 Slip-Form Method

In a slip-form operation the absence of side forms to retain the pavement edge plus the speed of the paving train may require some mechanical method of finishing, either instead of or to supplement hand methods.

Mechanical finishing may include a diagonal, tube-type float described above. The finishing operation may also include a metal V-shaped float that is pulled immediately behind the paver and in advance of the hand finishers. The float is used to iron out irregularities and smooth the surface and should not be cutting or pushing concrete.

The straightening and hand finishing operation behind a slip-form paver is the same as that behind a form paver as described above.

417.3 Straight-Edging and Hand Finishing

After the mechanical finishing is complete, but while the concrete is still plastic, the slab should be tested for trueness with a hand-held, 10-foot wide straight-edge. Irregularities (high spots and depressions) must be corrected and the area then retested.

Where necessary, excess water and laitance should be removed with the straight-edge and wasted. The straight-edge should be rigid enough to scrape off high spots, if necessary, instead of merely riding over the surface. Straight-edges should be periodically checked for trueness. Long handled floats may occasionally be necessary to close open-textured areas but their use should be discouraged. If open-textured areas persist, it is an indication that deficiencies exist in the mix proportions, and an effort should be made to correct them.

417.4 Pavement Stamping

Upon completion of finishing operations, while the concrete is still sufficiently plastic, and before the application of the curing compound, the inspector should stamp the station numerals in the pavement, if required. Station numerals should be stamped at intervals on the right-hand edge, advancing with the stationing, on all rural concrete pavement. Before start of paving operations, the engineer should procure from the region, the stamps for stamping the station numerals. On urban pavement, stamping of the station numerals may or may not, at the discretion of the engineer, be performed.

Standard spec 415.3.11 requires the contractor to stamp the contractor's name and the year of construction in the pavement at the beginning of each day's run and at the end of the job. This stamping should be done while the concrete is still plastic and before applying the curing compound.

SECTION 418 Concrete Texturing and Tining

Standard spec 415.3.8 provides that pavements with a design speed of less than 40 MPH receive an artificial turf drag texture. Pavements with a design speed of 40 MPH or greater receive the turf drag texture, followed by a machine-applied transverse tining.

The finish imparted to the pavement by the turf drag or turf drag and tining machine is critical for safety. High skid resistance is necessary for motorists to maintain control of their vehicles under slippery conditions. Properly textured and tined pavements can help save lives.

418.1 Texturing

Artificial turf is dragged longitudinally over the pavement behind the finishing machine. The drag should produce a good longitudinal micro-texture, but should not tear the surface. If it is not producing a good micro-texture due to slumping fresh concrete, the contractor should move the drag away from the finisher. If the surface is tearing, the contractor should move the drag closer to the finisher.

Pressure on the concrete can be increased by lengthening the drag in contact with the pavement or decreased by shortening the drag. Usually 3 feet to 5 feet are in contact with the surface. Check the drag material before paving and from time to time during finishing for tears, worn surface, or hardened concrete. The contractor should clean or replace the drag as often as necessary to maintain a well-defined micro-texture.

The turf drag should not be applied when the surface is so wet or plastic that the ridges formed flow back into the valleys when the drag has passed, nor should dragging be delayed until the concrete is so hard that sharp ridges cannot be formed by the drag. Surface conditions may not be fully uniform, however, and dragging should be timed to maximize skid resistance. The contractor should not pull the drag ahead with the finishing equipment.

The inner and outer 6 inches to 12 inches of the slab should be hand dragged to prevent edge slumping or tearing. An acceptable broom finish can be applied to small areas of pavement or driveways where a turf drag cannot be operated.

418.2 Tining

The turf drag, followed by a tining machine, drags a steel rake across the slab, producing macro-texture. This macro-texture improves wet pavement friction by providing escape channels for water trapped under vehicle tires. All tining will be longitudinal to the direction of traffic unless the project leader directs or allows otherwise.

418.2.1 Longitudinal Tining

A Marquette University study showed that longitudinal tining gave the quietest riding pavement and that longitudinal tining does not diminish the friction factor to a degree that it could be considered a safety risk. There was also no significant difference in the performance of a longitudinally tined surface and a transversely tined surface in wet or rainy environmental conditions. The research concluded that longitudinally tined surfaces performed as well as transversely tined surfaces in all conditions tested and that they had the advantage of being quieter in most cases.

418.2.2 Transverse Tining

The contractor should only use transverse tining in locations where the project leader directs or allows. This flexibility is provided under the specification to help address project-specific difficulties, such as equipment breakdown or malfunction that may come up, or in areas where matching the adjacent tining is necessary. Transversely tined pavements, particularly those with uniform tine spacing, may however produce an objectionable tire/pavement whine.

418.2.3 Hand Tining

The specification also allows hand tining of areas such as ramps, gaps, intersections, etc. where machine tining is not practical. In these areas it may be difficult or impossible to maneuver the tining machine, or the machine may be in use elsewhere on the project when these areas are poured.

The specifications require longitudinal tining for all handwork unless the project leader directs or allows otherwise.

418.2.4 Quality Control

The rake should be checked for missing, bent, or broken tines before tining. Also check the tine spacing and make sure the tines are clean. The specification is based on the dimensions of the rake, not the spacing of the grooves created in the pavement. The flexible tines cause variability in the spacing of the grooves created in the pavement and thus make it impractical to measure the groove spacing. If the rake is constructed as specified and well maintained, the pavement grooves should have the desirable uniform

spacing of 3/4 of an inch for longitudinal tining and 5/8 of an inch for transverse tining. If the pavement consistently shows spacing outside these limits, examine the rake for problems.

During the tining, check the concrete grooves for uniform depth within the limits specified in standard spec 415.3.8.3.1. If the surface is tearing, the contractor should decrease the transverse speed of tining or move the tining machine closer to the paver. If the groove is slumping, the concrete is not stiff enough; the contractor should move the tining machine away from the paver. If the grooves are not deep enough, the contractor should adjust the machine or move it closer to the paver.

The timing of the tining operation must be coordinated with the dragging operation and adjusted for conditions to produce a uniform depth of sharp, well-defined grooves. The finished surface should be free from rough or porous areas, irregularities, and depressions resulting from improper handling of the tining machine.

SECTION 419 Protecting Freshly Placed Concrete

419.1 General

Freshly placed concrete must be protected until it develops sufficient strength to open it to service. The three objectives are listed below:

- Maintain adequate moisture throughout the concrete mass to support hydration, especially at the exposed surfaces.
- Prevent freezing of the concrete throughout the concrete mass, especially at the exposed surfaces.
- Protect the concrete from damage caused by mechanical loading, thermal-induced stress, or moisture-induced stresses.

These three objectives address with the final goal of obtaining opening strength as prescribed in standard spec 415.3.15.

419.2 Curing

Curing is the maintenance of a sufficient moisture content and temperature throughout the concrete mass to support hydration until the concrete has developed sufficient strength to open it to service. Concrete develops strength due to hydration, a chemical reaction that occurs when portland cement is combined with water. Concrete does not harden as it dries; quite the contrary, if freshly placed concrete dries out, hydration ceases, and the concrete quits gaining strength. Optimum durability is achieved as the concrete approaches full hydration. Proper curing is critical for the development of strong, durable, high quality concrete.

Curing should begin as soon as the free water "sheen" has disappeared from the surface. Paving operations should be slowed or suspended when the contractor's curing operation falls behind.

Spray-on impervious membrane materials and impervious sheeting materials must seal in the moisture required for hydration and prevent rapid drying of exposed surfaces. Except during cold weather, these materials must be colored white to reflect radiant heat that could cause surface overheating and impose thermal stress on the concrete. In cold weather, black or clear sheeting materials may be used.

Two principal types of curing compounds are currently specified for use on WisDOT work:

- Poly-alpha-methylstyrene (PAM) curing compound (standard spec 415.2.4)
- ASTM C309 water based wax curing compound (standard spec 501.2.9)

Each of these types of curing compound has different performance characteristics and is appropriate in different applications. PAM may be used in all applications except for pavement that will be overlain under the contract use curing compound conforming to standard spec 501.2.9.

PAM curing compound has very good water retention characteristics. For WisDOT work the principal use for PAM is concrete pavement on rural highways and on expressways and high-performance concrete (HPC) in urban areas as well.

Traditional wax curing compound provides adequate water retention for miscellaneous ancillary items and allow better bonding to items that will be covered up in service. In the concrete pavement area, the principal use for the traditional wax cure is for concrete base and concrete base patching, both items that will be covered up in service. The wax cure wears off faster, and is more easily removed, allowing better bond of the concrete base to the final pavement layer placed on top of it. A concern is that use of PAM or linseed cure would be more likely to cause debonding of the overlay from the concrete base.

419.3 Thermal Protection

Freshly placed concrete must be protected from thermal stresses until it has developed sufficient tensile strength to resist thermal cracking. Covering should be considered, even in warm weather, when nightfall or approaching storms may lead to rapidly falling temperatures that might cause surface damage.

Standard spec 415.3.13 prescribes specific measures that must be taken to protect concrete from freezing. This protection is not required unless the predicted or actual air temperature on the project falls below 28 F for the following reasons:

- The temperature of the concrete at the point of placement is well above freezing as prescribed in standard spec 415.3.13.
- The fresh concrete has a high thermal mass and thus loses its initial heat relatively slowly.
- The hydration reaction produces considerable heat.

The contractor is responsible for frozen or frost damaged concrete. If this damage is not identified before the concrete achieves the opening criteria prescribed in standard spec 415.3.15, the department can still recover the costs of repair or replacement of the defective concrete under the standard specification provisions of standard spec 107.16, No Waiver of Legal Rights.

419.4 Equivalent Curing Days for Opening to Service

Revise 419.4 (Equivalent Curing Days for Opening to Service) language to clarify information.

The contractor should provide compressive strength information as prescribed in standard spec 415.3.15 whenever practical. The equivalent curing day minimum curing period is intended as a default option when the contractor fails to provide valid strength data.

The department should allow the contractor to open concrete pavements and associated appurtenant construction to traffic or service when 3,000 psi compressive strength is achieved and the inspection has been performed. The contractor is responsible for providing accurate and reliable compressive strength results. If the contractor fails to provide this strength information the engineer will unilaterally decide when the concrete can be opened to service.

Standard spec 415.3.15 uses the concept of equivalent curing days to adjust the time recommended for opening to service when no reliable compressive strength information is available. The specification does not require opening after the specified period. The engineer will adjust the minimum curing period based on their assessment of the average daily air temperature on the project. The engineer is empowered to extend these periods as necessary to be assured that 3000 psi has been achieved. If the contractor disagrees with the engineer's determination they should submit actual compressive strength data for the concrete in question.

SECTION 421 Pavement Joints

421.1 General

Saw cuts should be straight, clean, and vertical. If the surface is being torn or chipped, the slab is either too "green," the saw is dull, or is turning too slowly, or is traveling ahead too rapidly. Sawing may be done dry or with water. Be sure the water doesn't have oil in it from a leak in the equipment. If sawing is being done next to a traffic lane, be sure dust or water is not causing problems for vehicles.

421.2 Sawed Contraction Joints

The sawing of joints is one method used to control random cracking in concrete pavements. Joint sawing should conform to the depth and width shown on the plans. Concrete joints should be laid out according to SDD 13C18.

A crack is induced at selected locations where planes of weakness or "joints" are created by sawing. As the time of sawing is important, it is helpful to keep in mind the behavior of concrete slabs and the changes that occur under varying temperature conditions.

Under normal summer conditions, pavements placed early in the day are subjected for a longer period to the higher daytime temperatures, which augment the internal heat generated in the concrete by the hydration process. The maximum temperature is reached in six to eight hours, after which it begins to drop, and contraction stresses are set up. These are the stresses that cause pavements to crack. The maximum temperatures of pavements placed at later hours become lower and the contraction stresses gradually diminish, thus reducing the tendency to crack.

It is necessary to saw transverse joints as soon as it can be done without excessive tearing. Sawing should be completed by midnight unless the condition of the pavement prevents it. If sawing must be deferred until the following day, it should not be resumed until the air temperature is quite warm and contraction stresses have diminished.

Early morning is an ideal time to examine un-sawed pavement for cracks that may have occurred adjacent to a proposed joint location. If a crack has developed, sawing should be omitted at the joint location.

Joints must be sawed in a double-phase operation if the joint is to be sealed. The initial cut is made as soon as the saw can be operated without damage to the pavement. After the curing period has expired, the second cut is made coincident with the first to the required dimensions.

It may be desirable to employ the "skip" method of sawing to relieve stresses in the pavement. In this method, the initial cut of every third joint is made as soon as possible, and the initial cuts of the remaining joints are then done as soon as practicable.

421.3 Transverse Construction Joints

421.3.1 General

Construction joints are formed at the end of the day's run or whenever paving is discontinued for a period of time in which the concrete would attain its initial set. A header board that conforms to the true cross section of the pavement should be used to form the end of the slab. Holes should be drilled in the header for the insertion of tie bars at their proper locations. An alternative method is to use a "split header" consisting of two boards with a gap between, through which the tie bars are hand inserted into the fresh concrete.

Only concrete of good quality should be placed against the header, and it must be thoroughly vibrated with hand vibrators. Mortar and laitance and segregated concrete brought ahead by the finishing equipment should be wasted over the forms. Header boards for continuously reinforced pavement must be constructed to allow easy disassembly, and steel reinforcement extending beyond the header must be supported and secured to preclude movement.

Construction joints are to be edged to a radius of 1/4 inch or less.

421.3.2 Placing Construction Joints

In addition to the "tied" construction joint shown on SDD 13C11 and SDD 13C13, contractors will be allowed the option of placing construction joints in the following manner:

421.3.2.1 End of a Day's Paving Run

1. Run the paver out of concrete and allow the concrete to set.
2. Make a full depth transverse saw cut, "normal" to the centerline, at a point along the slab that will provide the desired transverse and longitudinal profile, as well as the minimum distance specified on the standard detail drawing from the last contraction joint. Sawing of the concrete to create the construction joint should be done in conjunction with routine transverse joint sawing operations. If damage to the slab occurs as a result of sawing, sawing must cease until such time as it can be completed without further damage.

3. The following morning (minimum of 10 hours after conclusion of the previous day's paving), remove the concrete to be wasted and drill holes in the vertical face of the construction joint. If damage to the slab occurs as a result of drilling, drilling must cease until such time as it can be completed without further damage. In the event of severe damage to the slab as a result of drilling or any other circumstances, the engineer may require that a new construction joint be sawed beyond the damaged concrete, or in extreme cases, removal of the concrete to the nearest contraction joint.
4. Drilled holes in the face of the construction joint must conform to the following dimensions:
    - Mid-depth of slab
    - 12 inches center-to-center, starting 6 inches from the edge of slab
    - 9 inches deep
    - Hole diameter = diameter of the dowel +1/8 inch
5. After completion of the drilling operation a non-shrinking high strength epoxy mortar must be injected into the back of each hole and dowel bars must be inserted in the holes in accordance with standard spec 416.3.7.
6. 1- 1/4 inch x 18 inches dowel bars must be inserted in the holes to one-half their length and be parallel with the centerline and grade. If the pavement is 10 inches or greater in thickness, dowel bars should be 1-1/2 inch diameter.
7. Construction joints must be saw cut in conjunction with the second stage sawing of adjacent contraction joints if the joints are to be sealed.

421.3.2.2 Planned Concrete Pavement Gaps

1. The two construction joints resulting from planned gaps must be constructed by applying the rules above for construction joints at the end of a day's run.
2. Since there is no urgency for early drilling of holes in the vertical face of the construction joints, this operation should be delayed closer to the time when paving of the temporary gap is expected.
3. Since gaps can have a wide variation as to length, great care should be exercised in planning their location. This applies to locating the construction joints both in relation to transverse contraction joints outside the gap limits, as well as any required contraction joints between the construction joints when the gap is poured.
4. Dowel basket assemblies should be placed at all contraction joints required between construction joints in gap areas.

421.3.2.3 When Paving Away From the Construction Joint

1. Remove the header, if applicable.
2. Uncover the tie bars, if applicable.
3. Grease the dowel bars lightly, if applicable.
4. Pre-wet the base.
5. Place concrete against the header or saw-cut slab end. Consolidate with hand-held vibrators, with particular attention paid to the area around dowels or tie bars.
6. Position the paver next to the slab end. Be sure no part touches the tie bars, dowels, or hardened concrete.
7. Use the paver to place, consolidate, and finish concrete, proceeding away from the joint.
8. Hand finish the fresh concrete at the joint to plan elevation and typical section. Check the evenness with a straightedge conforming to standard spec 415.3.11.5.

421.4 Longitudinal Construction Joints

A longitudinal construction joint is formed when a pavement is placed to partial width and the first lane of pavement acts as a form for the concrete in the second lane. Because finishing defects at the edge of the original lane will be reflected into the second lane, careful attention should be directed to the finishing in both lanes to prevent an uneven surface across the joint which will cause poor riding qualities or create obstructions to surface drainage.

Tie bars across the joint should be carefully installed at the correct spacing and skew as shown on the detail drawing. Bar shields, when used, should be placed and maintained tightly against the forms so the second half of the bar is completely exposed when the forms are removed.

Standard spec 415.3.1.2 provides that the slip-form paver must be equipped with a suitable mechanical device that can accurately space and position tie bars and will allow insertion by mechanical or manual means. It is essential the contractor's equipment and methods are reviewed to ensure that adequate bond and true, non-slumping pavement edges will result.

Positioning of the tie bars should be checked during placement to ensure they are being inserted level and at the correct depth, spacing and skew.

Edge slump is limited to 1/10 inch. If edge slump is in excess of this requirement, correction should be made at once.

421.5 Expansion Joints

Expansion joints may be formed at bridge approaches and where specified in urban construction to absorb the pressure exerted by pavement through temperature expansion and "growth." The performed filler should conform to the cross section of the pavement and have its top edge 1/2 inch below the pavement surface. Concrete at the face of the joint must be thoroughly consolidated by spud vibrators.

The joint must be edged to a 1/2-inch radius, or less. Refer to standard spec 415.3.11.7.

421.6 Cleaning and Sealing Joints

The following discussion applies only to projects on local highways where joint sealing has been requested by the local government and approved by WisDOT. WisDOT no longer allows the curing, sealing, or filling of joints in concrete pavement on highways under their jurisdiction. Local streets and roads for which WisDOT has project administration responsibility only (no project financing) may have joints sealed if the local government has expressed a preference for sealing and WisDOT has concurred.

Proper cleaning of the joints is essential if a long-lasting seal is to be obtained. In all cases, the cut should be blown clear of dirt and should be dry before sealing. The saw cut is cleaned with compressed air or pressurized water. Be sure there is no oil in the air or water as a result of equipment leaks. The saw cut must be absolutely clean if the joint sealer is to adhere to the side walls of the cut.

A backer rod will then be inserted into the clean saw cut and pushed down to the correct depth. This forms the base for the joint sealer. The backer rod should be tight against the sides of the cut; be sure the right size of rod is used.

When cold-poured silicone joint material is used, the joint must be completely dry. If there is any moisture present in the joint at the time of sealing, a skin will form on the sides of the sealant, preventing adhesion to the concrete. Following a rain or damp weather, all of the moisture must be removed from the joint before sealing. The contract special provisions will specify the sealant type. The plan may also contain a special detail drawing.

Cold-poured silicone is most frequently used. Although cold-poured silicone is an improvement over the old hot-poured sealers, frequent failures are experienced. Most of these failures can be attributed to inadequate cleaning and drying of the joint or faulty installation procedures. A check of many joints sealed with cold-poured silicone indicates the sealant has adhered to only the upper edge of the joint and not to the sides. Dirt or moisture on the sides of the joint prevents adhesion. Also, it is likely that insufficient pressure was used during the extrusion of the sealant into the joint to ensure full contact with the sides of the joint. To ensure positive contact the joint must also be carefully "tooled" after extrusion. The surface of the sealant after tooling must be concave upward and lie about 1/4 inch below the pavement surface.

If the joint sealer is of the solid pre-formed elastomeric compression seal type, it will be necessary to lubricate the seal or joint faces before installation. A special tool is used for installation; sharp instruments that may puncture the seal must not be used.

421.7 Joint Layout in Intersections

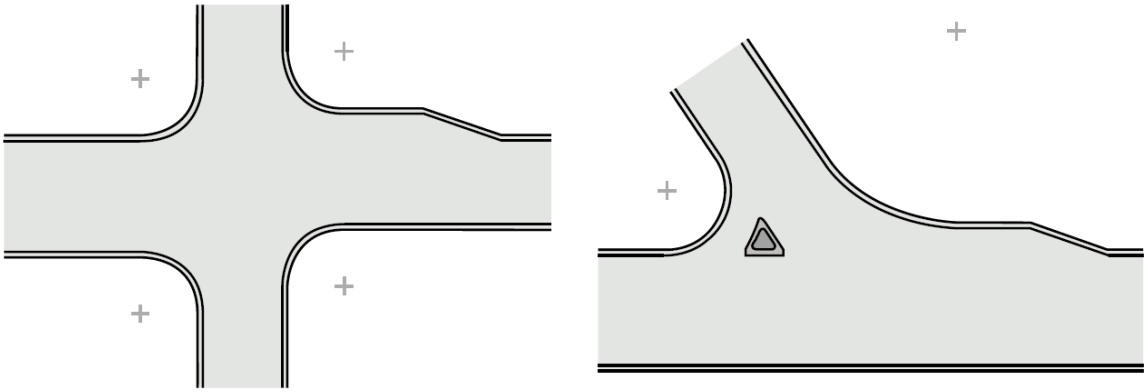
An industry-provided ten-step method provides intersection joint layout fundamentals. Detail diagrams show preferable alternates, but there may be intersections with unique geometry that the methodology does not fully address.

A primary goal of this method is to minimize or eliminate joints that intersect another joint or the pavement edge at an acute angle. Experience shows that cracks often occur near acute angles, especially angles less than 60 degrees. For most intersections it is possible to eliminate all angles less than 90 degrees from the roadway slabs. There may be some acute angles in the curb and gutter. For skewed intersections it is likely that some joints will intersect at angles less than 90 degrees. However, even for skewed intersections it is preferable to avoid angles less than 60 degrees.

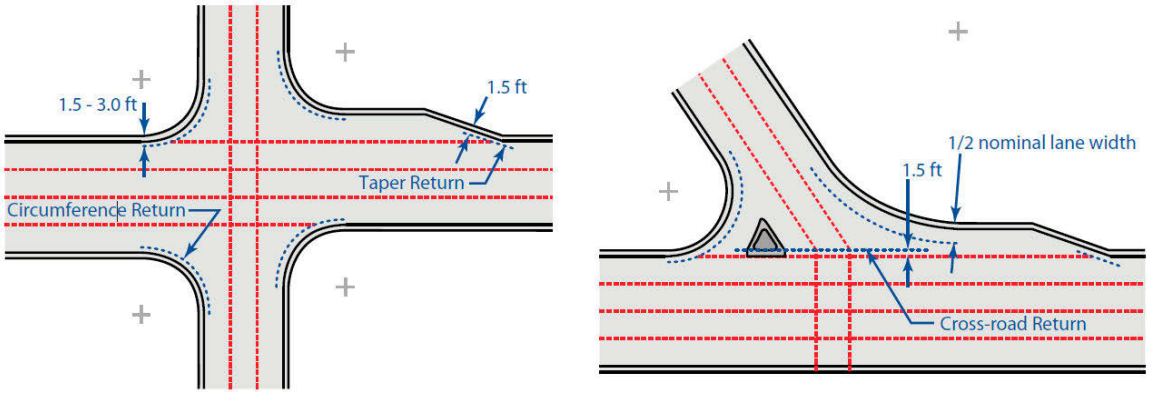
The method works equally well for integral curb and gutter, as well as for separate curb and gutter. The diagrams show how to place joints through curb and gutter and along curves between the intersecting roadways. The method also helps produce a plan that is easier to construct by avoiding width changes along the edge of the mainline or primary paving lane.

FIGURE 421-1 Ten-Step Method for Jointing Intersections

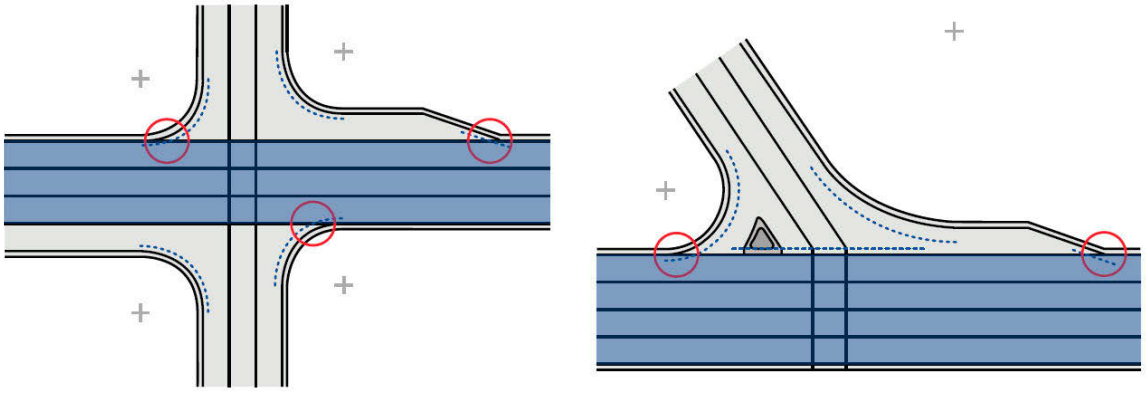
1. Draw pavement edge and back-of-curb lines on the plan view.



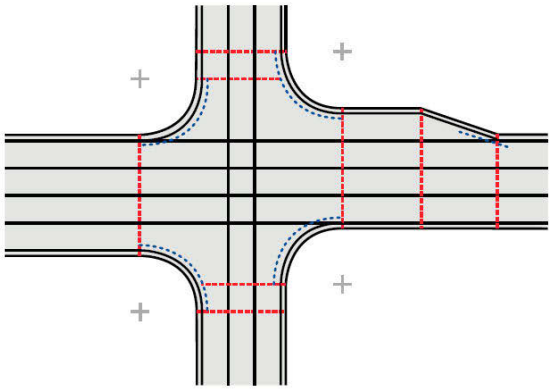
2. Lightly draw the circumference-return, taper-return, and the crossroad-return lines.
3. Draw lines that define lanes on the mainline and crossroad. Do not extend these lines past the circumference-return, taper-return or crossroad-return lines.

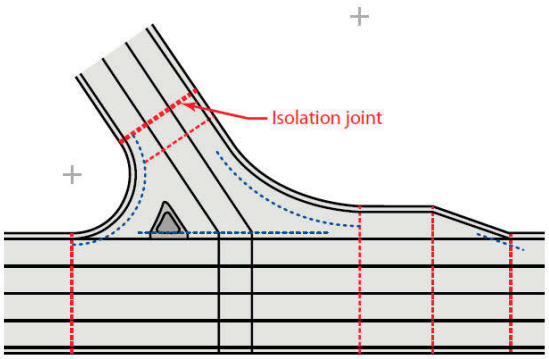


4. Define the mainline lanes for paving. Find locations where the mainline lanes intersect circumference-return or taper-return lines. At these locations only, extend the mainline paving edge lines past the circumference-return or taper-return lines. Any block-outs for doglegs at these locations are preferable in the gutter for the curb.



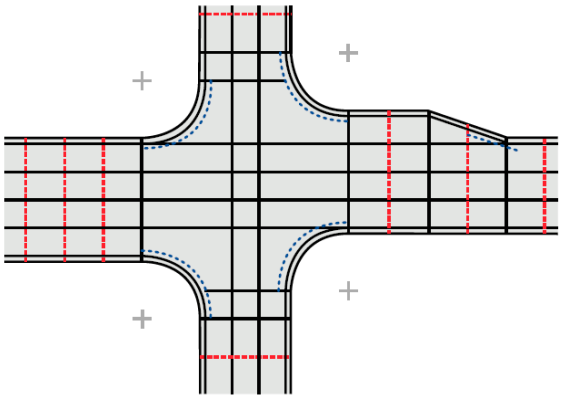
5. Add transverse joints at locations where the pavement changes width, extending the joints through the curb and gutter. Do not extend joints that intercept a circumference-return or crossroad-return line, except at the tangent points. The joint at the tangent point farthest from the mainline becomes an isolation joint in the crossroad for T and unsymmetrical intersections.

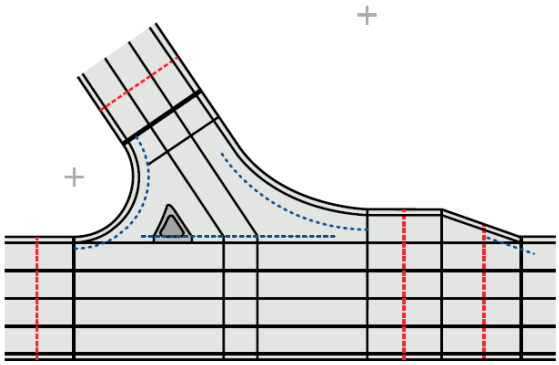




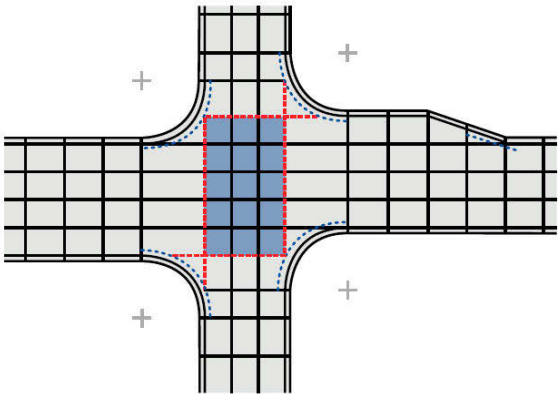
6. Add transverse joints between and beyond the joints you defined in Step 5, but do not add joints to the center of the intersection yet. Attempt to keep the distance between joints less than the maximum desirable length. Usually the maximum length is about 15 ft.

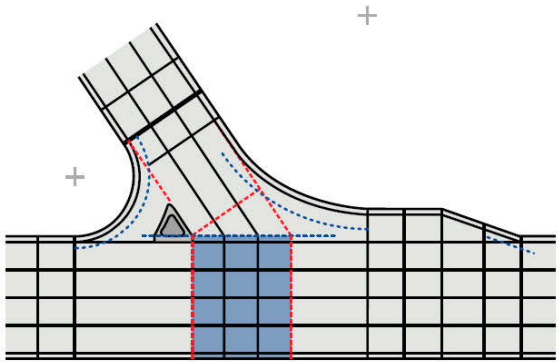
   To calculate: ML = Dx24 for slabs on granular or unstabilized subbases; ML = Dx21 on stabilized subbases or existing asphalt or concrete pavements; ML=maximum length; D=slab thickness.



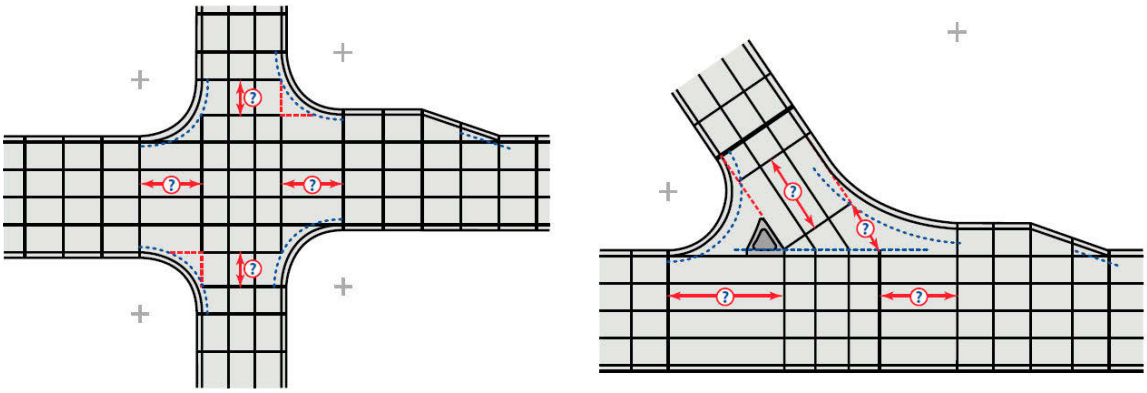


7. By extending the edge of pavement lines for the crossroad and any turning lanes, define the intersection box. For skewed intersections do not extend the lines for the turning lanes. Instead, place a transverse joint normal to the crossroad centerline starting from the corner of the intersection box that is nearest to the acute angle of the intersection.

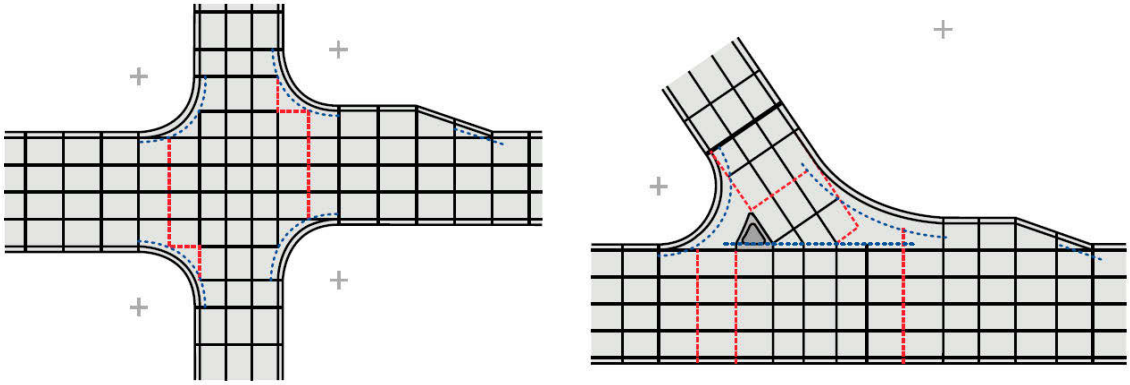




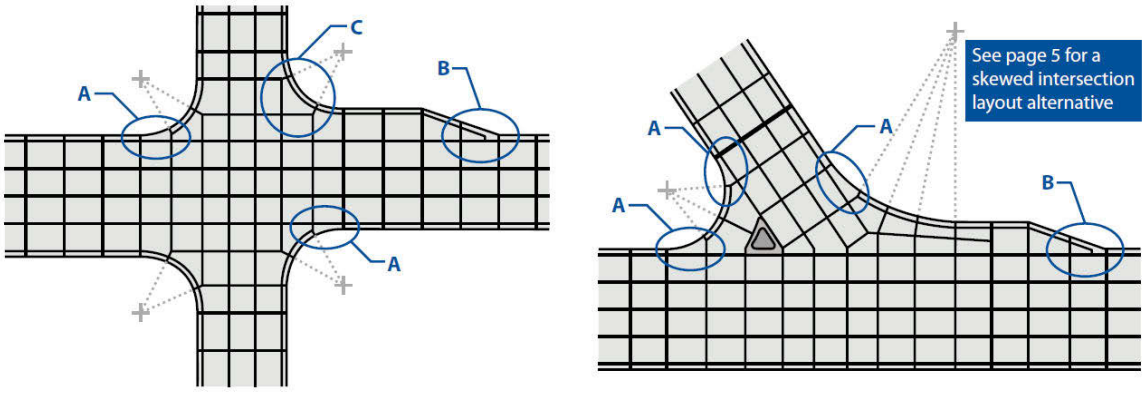
8. Check the distances between the "intersection box" and the surrounding joints.



9. If the distance is more than the maximum desirable joint spacing, then add transverse joints at an equal spacing. Do not extend these joints past the circumference-return or crossroad-return lines.



10. Lightly extend lines from the center of the curves to the points defined by the "intersection box," any intermediate joints surrounding the "intersection box" and points along any islands. Add joints along these radius lines. Finally, make slight adjustments to eliminate doglegs in mainline edges.



SECTION 424 Concrete Paving Inspection

CMM provisions mobilized by the contract:

CMM 424.6 ..... Concrete Transverse Crack Repair cost responsibility.

CMM 424.7 ..... Ancillary Concrete cost responsibility for crack repairs.

424.1 Responsibilities of the Paving Inspector

Following are additional duties normally assigned to a paving inspector. These are intended for a non-QMP contract when WisDOT is responsible for the inspection. Refer to the contract provisions and the QMP Manual for a definition of contractor and WisDOT responsibilities in the case of a contract containing the QMP provisions.

1. Inspection/delivery tickets must be collected from the truckers, initialed, totaled, and turned in each day to the engineer.
2. Reports and records as specified by the engineer must be recorded in the field notebook and daily diary. These should include:
   - A count of revolutions on ready-mix trucks
   - Delivery times for the ready-mix.
   - Samples taken - where, when, and how
   - Tests performed and results.
   - Cubic yards of mix placed and location
   - Weather and working conditions
   - Equipment used, and breakdowns and delays
   - Contractor's personnel
3. Required reports will have to be filed with the engineer at the specified frequency and in the specified number.
4. Unsafe conditions should be brought to the attention of the contractor for immediate correction. The inspector should follow-up to be assured they are corrected. These may include:
   - Inadequate or improper signing and flagging
   - Unsafe parking of private vehicles
   - Unsafe concrete truck delivery and waiting traffic pattern

424.2 Checking Surface Cross Section

It is essential that careful inspection of the initial pavement slab be performed by checking the crown, straightening both transversely and longitudinally, string lining, and using other visual procedures to detect improperly adjusted equipment or poor paving procedures.

Before paving has progressed too far, a check of the surface cross section of the pavement should be made in order to determine if the finishing equipment has been properly adjusted to the correct slope and crown of the pavement.

Two blocks of uniform height should be placed on the forms or base on either side of the slab and a fine line stretched across them from which measurements are taken to the surface at one-foot intervals. Variations in the measurements from the theoretical will indicate if adjustments are required in the screed. When plotted on an exaggerated scale any deficiencies are immediately determined and corrections can be made accordingly. Periodic checks should be made thereafter as the job progresses.

If correction is necessary, the contractor must be immediately notified, and any required corrective action must be taken before additional pavement can be placed.

All checks must be documented in the inspector's field notebook and daily diary. Any identified deficiencies and subsequent corrections must be recorded in the field notebook and daily diary. Include the date and time, location of deficiency and name of on-site foreman or supervisor representing the contractor.

424.3 Measurement and Payment of Concrete Items

Concrete pavement, including concrete pavement replacement areas, is measured by the square yard in place. Frequently questions will arise concerning the contract items and payment associated with concrete pavement repair and concrete pavement. The following should help explain these differences.

424.3.1 Sawing Asphalt and Sawing Concrete

When specified in connection with pavement removal, this work is measured and paid for by the foot. When this work is not specified, but is done for the convenience of the contractor, it is not measured and paid for. The measurement of Sawing Concrete, when performed in conjunction with the pavement patching and repair items, is further restricted by standard spec 690.4.

Saw cuts for longitudinal and transverse joints are not measured for payment.

424.3.2 Dowels

Dowel bars installed in new concrete pavement are not measured for payment. Dowel bars that are installed in existing concrete pavements by drilling and epoxying are measured and paid for as Drilled Dowel Bars.

424.3.3 Tie Bars

Tie bars installed in unhardened concrete pavements are not measured for payment. Tie bars installed to tie existing concrete pavement by drilling and then driving or epoxying the bar into new concrete pavement are measured for payment as Drilled Tie Bars.

424.3.4 Compressive Strength

Contracts containing the QMP Concrete Pavement special provision contain an incentive/disincentive pay adjustment clause based on 28-day compressive strength. Determine pay adjustments using the Materials Reporting System (MRS). The QMP Concrete Structures specification also has strength incentive computed by the MRS. The MRS can be found at the following link.

http://www.atwoodsystems.com/

If the contract contains the Incentive IRI Ride bid item 740.0440, the contractor must measure ride quality with a lightweight inertial profiler. Mainline paving and other specified areas are tested to determine the International Roughness Index (IRI) for each wheel path. The QMP Ride provisions has incentive/disincentive pay adjustment based on the measured IRI. Determine pay adjustments using the department's Materials Reporting System (MRS) software available at:

http://www.atwoodsystems.com/

In addition to the IRI based pay adjustment, the QMP Ride provisions may also have a disincentive for area(s) of localized roughness in each wheel path.

424.4 Surface Smoothness

Under standard spec 415.3.10.1 the department may require the contractor to test the smoothness of the hardened pavement surface using a 10-foot straightedge or other engineer-approved device.

High spots of 1/8 inch in 10 feet or less are acceptable. The engineer may direct that high spots exceeding 1/8 inch in 10 feet, but less than 1/2 inch in 10 feet be ground down to 1/8 inch in 10 feet or less. The engineer may direct that concrete having high spots in excess of 1/2 inch in 10 feet be removed and replaced with no additional cost to the department.

If testing reveals more than an occasional minor infraction of the specified straightedge tolerance, it may indicate a malfunction of the paving equipment or improper procedures in the paving process. If this occurs, paving should be immediately discontinued until the source of the trouble can be identified and corrected.

Standard spec 415.3.10.1 requires grinding, when necessary, to correct surface irregularities. The work should be accomplished in a manner that does not adversely affect either the ride or the appearance of the ground pavement. After the high spot or spots have been ground down, additional light grinding may be necessary to leave a neat rectangular area of uniform appearance. Grinding must be done parallel with the roadway centerline.

The grinding should leave grooves comparable to grooves made by tining but should not damage the pavement.

424.5 Deficiencies and Probable Causes

Table 424-1 outlines pavement deficiencies that sometimes show up in the finished pavement. The inspector should be aware of these deficiencies and their probable cause. If one or more of these conditions occur, the engineer should review region and departmental correspondence and the engineer's own experience before deciding to accept the pavement or to require corrective action by the contractor. If the engineer feels guidance is needed in the decision, or if conditions are severe enough to warrant investigation by persons with specialized training, the lab should be notified.

TABLE 424-1 Pavement Deficiencies and Causes

Pavement Condition	Possible Causes
1. Spalling	- Water content too high - Air content too low - Excessive finishing
2. Raveling and sanding	- Water content too low. - Incomplete mixing. - Spot repairs to correct surface defects resulting from walking in the finished concrete, or to correct low concrete under the paver. - Inadequate curing. - Air temperature too high or too low.
3. Random and shrinkage cracking	- Paving in too hot weather. - Steel set too low. - Late curing or sawing. - Water content too high.
4. Thin slabs	- Rutted and ridged base. - Wrong base elevation (too high). - Poor base trimming. - Wrong form depth. - Sinking forms or track line under the paver train.
5. Surface pop-outs	- Chert in the aggregate. - Steel set too high.
6. Slippery pavement	- Inadequate texturing. - Rain damage.
7. Rough centerline joint	- Excessive edge slump.
8. Rough ride	- Forms settlement; forms not on grade. - Soft base under slip-form paver. - Stop-and-start paver operation. - Dirty finisher wheels. - Defective longitudinal controls on slip-form paver. - Varying depth of concrete ahead of slip-form paver. - Non-uniform concrete slump.
9. Nonfunctioning Joint	- Poor sawing technique.
10. Slab tilt, faulting or subsidence	- Poor base.

Responsibility for the costs of crack repairs, mobilization for traffic control, and traffic control devices prescribed in 424.6, table 424-3 are mobilized into the contract by standard spec 415.5.3.

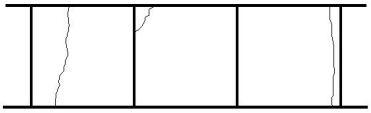
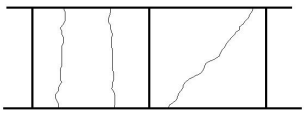
424.6 Concrete Transverse Crack Repair

Standard spec 415.3.17 states that the engineer is responsible for conducting two inspections of the concrete pavement and selected ancillary concrete items listed in standard spec 601.5.2. The first should be performed after the pavement reaches opening strength but before opening to construction or public service. The second is done before opening to public service, or before partial acceptance, whichever comes first.

If cracking occurs, the engineer, with input from the contractor, is responsible for determining if a repair is needed and for assigning the responsibility for the cost of repairs, costs for mobilization for traffic control, and costs for traffic control devices. All repairs should be made according to the appropriate standard detail drawing or plan detail.

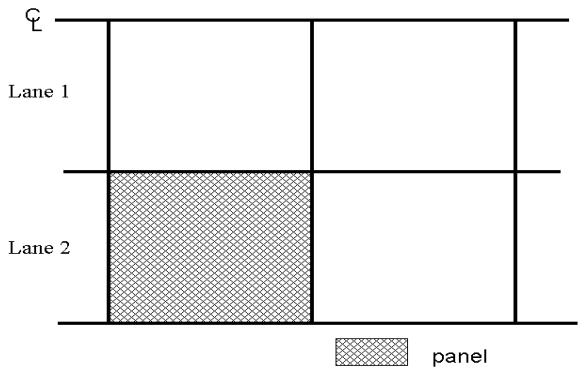
Table 424-2 outlines repair options and when it is appropriate to use the type of repair described. These options may not address all cracking situations. Please contact the BTS Pavement Unit regarding situations not covered in the table, or for any questions.

TABLE 424-2 Transverse Crack Repair Options

REPAIR OPTION:	CONDITION:	EXAMPLE:
A. Do Nothing	A1. Pavement will serve original function or purpose. A2. Crack will not be a local or aesthetic issue. A3. Crack will not be a future maintenance issue. A4. Pavement has minor vertical or horizontal displacement.	No Example
B. Seal Only (Work includes seal with approved joint filling material)	B1. Crack has minor spalling or other distresses.	No Example
C. Rout and Seal Cracks Only Un-doweled or Doweled (Work includes standard routing equipment with routing the full length of crack, sealed with approved joint filling material)	C1. Crack has minor spalling or any other distresses. C2. Joints are sealed because of local preference. C3. Cracked panel is in an intersection and has irregular geometry.	No Example
D. Retrofit Dowel Bar	D1. Crack is in center one-third of panel. D2. Crack is transverse and less than a 6:1 skew. D3. Crack is a clean, single crack with minor spalling or parallel cracks. D4. Do not use if panel is in more than two pieces.	 D
E. Partial Panel Replacement	E1. Mid-panel crack occurs. E2. Corner crack occurs. E3. Majority of crack occurs within 3 ft. of a joint.	 E1 E2 E3
F. Full Panel Replacement	F1. Panel is in 3 or more pieces. F2. Crack is diagonal and encompasses a majority of the panel. F3. Local preference or aesthetic reasons.	 F1 F2

A panel is defined as the limits between two adjacent transverse joints and two adjacent longitudinal joints or pavement edge.

FIGURE 424-1 Definition of Panel



The department will allocate responsibility for costs as specified in table 424-3. If the cause is unknown the department and contractor will share the cost of repair and calculate the applicable contractor-shared reimbursement as described in the contract specifications.

Investigation of the cause will help determine the responsibility for costs of the crack repair. Suggested causes for cracking are listed below but are not intended to be a complete list.

- A pavement/subgrade not built in compliance with plans & specifications.
- Differential subgrade layers and cross section.
- Improper sawing methods (e.g. location, timing, mix type).
- Improper joint layout.
- Interface between different mixes.
- Utility work and trenching.

TABLE 424-3 Transverse Cracking Policy for New PCC Pavements

Cracking Occurs	Responsibility	Location of Crack	Repair Options	Cost of Repair	Cost of Mobilization for Traffic Control	Cost of Traffic Control Devices
1 Crack occurs BEFORE opening to service as defined by standard spec 415.3.17	Contractor	A Crack occurs within 3 feet of a transverse pavement joint.	Use partial or full panel replacement	100% contractor	100% contractor	100% contractor
	Contractor/ department (cause unknown)	B Crack occurs beyond 3 feet of a transverse pavement joint and pavement is constructed in compliance with specs.	table 424-2	standard spec 415.5.3	100% contractor	100% department at contract unit prices
	Contractor	C Crack occurs beyond 3 feet of a transverse pavement joint and pavement is NOT constructed in compliance with specs.	table 424-2	100% contractor	100% contractor	100% contractor
	Department (cause by others, utility, or public)	D Crack occurs beyond 3 feet of a transverse pavement joint and pavement is constructed in compliance with specs.	table 424-2	standard spec 415.5.3	100% department	100% department at contract unit prices [1]
2 Crack occurs AFTER opening to service as defined by standard spec 415.3.17	Contractor/ department (cause unknown)	A Crack occurs at any location from a transverse pavement joint and pavement is constructed in compliance with specs.	table 424-2	standard spec 415.5.3	100% contractor	100% department at contract unit prices [2]
	Contractor	B Crack occurs at any location from a transverse pavement joint and pavement is NOT constructed in compliance with specs.	table 424-2	100% contractor	100% contractor	100% contractor
	Department (cause by others, utility, public)	C Crack occurs at any location from a transverse pavement joint and pavement is constructed in compliance with specs.	table 424-2	standard spec 415.5.3	100% department	100% department at contract unit prices [1]

[1] When utility is responsible for cracking, WisDOT will pay for concrete repair and pursue reimbursement from the utility.

[2] This cost is 100% contractor if crack occurs before opening to service and contractor chooses to make repair after opening and project engineer determines it is feasible to have done before opening to traffic.

424.7 Ancillary Concrete

Responsibility for the costs of crack repairs, mobilization for traffic control, and traffic control devices prescribed in 424.7, table 424-4 are mobilized into the contract by standard spec 601.5.2.

Ancillary Concrete is defined as curb and gutter (separate or integrally placed), curb, gutter, medians, raised medians, sidewalks, driveways, loading zones, safety islands, and steps. The engineer should allocate responsibility for costs, repairs, and traffic control according to table 424-4.

Cracks resulting from the following will be considered contractor-caused:

- Mismatched joints from pavement to curb to driveway/sidewalk etc.
- Inconsistent or no attention paid to expansion.
- Damage by public/business traffic due to non-protection of work.
- Damage by contractor operations (prime or subcontractor).
- Joint layout.

Cracks resulting from the following will be considered department-caused:

- Poor design.
- Damage by public/business traffic.

When a utility is found to have caused the crack, WisDOT will pay for concrete repair and pursue reimbursement from the utility.

If the cause of a crack is unknown, the contractor and department will share the responsibility.

TABLE 424-4 Cracking Policy for Ancillary Concrete

Responsibility	Location of Crack	Required Repair	Cost of Repair	Cost of Mobilization for Traffic Control	Cost of Traffic Control Devices
Contractor/ Department (Cause Unknown.)	A Crack occurs at any location and is constructed in compliance with plans and specifications and cannot be attributed to the contractor operations.	A1 Remove and replace.	standard spec 601.5.2	100% contractor	100% department
		A2 Leave in place.	No cost	No cost	No cost
		A3 Saw only (for C&G only).	100% contractor	100% contractor	100% department
Contractor	B Crack occurs at any location and is NOT constructed in compliance with plans and specifications.	B1 Remove and replace.	100% contractor	100% contractor	100% contractor
		B2 Leave in place.	No cost	No cost	No cost
		B3 Saw only (for C&G only)	100% contractor	100% contractor	100% contractor
Department (Cause by others, utility, public.)	C Crack occurs at any location and is constructed in compliance with plans and specification and cannot be attributed to the contractor operations.	C1 Remove and replace.	standard spec 601.5.2	100% department	100% department
		C2 Leave in place.	No cost	No cost	No cost
		C3 Saw only (for C&G only).	100% contractor	100% contractor	100% department

424.8 Rain-Damaged Pavement

As detailed in standard specification 415.3.14, the contractor must have materials available for protecting cover unhardened concrete when rain is imminent. If rain is suspected or forecast, contractor should have plastic film ready for covering the pavement to protect the unhardened concrete surface and edges against rain damage. Contractor should follow weather forecasts closely to prevent being caught unprepared in case of rain. If rain is prolonged, contractor should consider halting paving operations. Unhardened concrete should be covered immediately with plastic or other engineer-approved material and secured along pavement edges. Failure to properly protect concrete may constitute cause for removal and replacement of defective pavement if pavement cannot be repaired or restored to an

acceptable condition. Pavement surfaces which have slight surface damage caused by rain may be re-dragged or re-dragged and re-tined if the concrete is still plastic and the curing compound was not applied. Pavement surfaces that have lost the texture and are no longer plastic should have the necessary texture reestablished by grinding to avoid accidents caused by slick pavement. Grinding should be parallel to the centerline, and the finished areas should be rectangular, neat, and not distracting to motorists. If diamond grinding is required to repair the rain-damaged pavement, thickness measurements should be conducted before and after the grinding is completed.

424.9 Concrete Pavement Repair and Replacement

Concrete Pavement Repair and Replacement, and Special High Early Strength Concrete Pavement Repair and Replacement are defined in standard spec 416 and detailed in SDD 13C9.

Repair lengths of 15 feet or less are constructed, measured, and paid for under standard spec 416. Repair sections between 15 and 100 feet in length should be paid as Concrete Pavement Replacement. Repair sections 100 feet or longer should be paid as Concrete Pavement, as provided in standard spec 415.

All concrete pavement repair and replacement items are measured by the square yard in place. Saw cuts, tie bars, and dowel bars installed in existing concrete pavements are paid separately. For concrete pavement items, tie bars and dowel bar assemblies at contraction joints are included in the contract price.

The plan will show a breakdown in the miscellaneous quantities of areas designated as repair or replacement. The length of 15 feet was chosen as the distinction between repair and replacement, based on the maximum joint spacing. A "repair" section will not contain contraction joints, dowel assemblies, or tie bars.

The item of Special High Early Strength Concrete Pavement Repair is used when same day opening to traffic is necessary. Frequently the sawing is done one or more days before the removal and replacement operation.

The major differences between the repair and replacement items are outlined below:

1. Measurement and payment.
    - Pavement repair items include removing pavements and repairing shoulders, while saw cuts, tie bars, and dowel bars installed in existing concrete pavements are paid separately.
    - For pavement replacement, concrete pavement is measured by the square yard, and removing pavement and shoulder repair are paid separately.
2. Concrete mixes.
    - Grade C mixes are specified for concrete pavement repair and a special 8-hour concrete mix is specified for special high early strength concrete pavement repair.
    - Concrete pavement may be constructed with Grade A concrete.
3. Opening to traffic.
    - Repair areas must be opened to traffic based on cylinder tests of 2,000 psi.
    - Special high early strength concrete pavement repair areas must be opened to traffic by sunset on the same day the old pavement is removed.
    - Concrete pavement may be opened to traffic based on either test cylinders or minimum time periods related to atmospheric temperatures.

424.10 Opening to Service

Refer to standard spec 416.2.4 for strength requirements for opening to service.

SECTION 450 Asphalt Pavement - General

450.1 QMP for Plants and Mixtures

The contractor's quality control (QC) program requirements and the department's quality verification (QV) program requirements, for asphaltic mixtures are covered by standard spec 460.

QMP requirements are incidental to HMA pavement items, as provided in standard spec 460. There are three sub-conditions in standard spec 460 relative to testing requirements:

- If the contract contains 5,000 tons or more of asphaltic mixture all the testing requirements apply.
- If the contract contains less than 5,000 tons of asphaltic mixture the QC testing may be conducted in an off-site laboratory and field tensile strength ratio (TSR) tests are not required.
- If the contract contains less than 500 ton of asphaltic mixture or if the mixture is for temporary pavements and will be removed before completion of the contract, all testing may be waived by the project manager.

450.1.1 Contractor Responsibility

The contractor is responsible for all activities, including mix design, control of materials, process control inspection, sampling, testing, and necessary adjustments in the process related to the production of a hot mix asphaltic mixture that meets the requirements of the specifications.

The contractor should have a documented plan that provides an outline of how the quality control responsibilities will be provided for. A suggested list of items to be included in the quality control plan is included in CMM 830.

450.1.2 WisDOT Responsibility

The department is responsible for validating the material quality and contractor's QC test results by conducting QV testing, observing sampling and testing performed by the contractor, and for monitoring required control charts prepared by the contractor.

450.1.3 When QMP Does Not Apply

According to standard spec 460.2.8.2.1.3.4 the project engineer may waive testing for temporary pavements. The QMP testing requirements in standard spec 460 are not applicable to asphalt surfacing items defined in standard spec 465, or to asphaltic base course and asphaltic base course widening items defined in standard spec 315. The contractor is responsible for providing a mix design for these items and controlling the production process to provide a mix that meets the specifications. The department reserves the right to request a sample and verify conformance with specifications at any time, even if the project is exempt from QMP. Any nonconforming material with requirements listed in standard spec 460 is to be handled in accordance with standard spec 460.5.

450.2 Environmental Regulations

Standard spec 107.18 states that the contractor must comply with laws and regulations controlling environmental pollution. In the production of asphaltic mixtures, the conditions most apt to occur, which would be in violation of air quality standards, involve blue smoke and dust.

Blue smoke results from overheating asphalt, either in its uncombined form or as salvaged asphaltic pavement, to a high temperature sufficient to release unburned hydrocarbons. It is identified by a blue plume from the smokestack. When a violation is observed, the project manager will inform the contractor and request steps be taken to correct the problem. Remedial action might involve reducing heating temperatures, covering salvaged or reclaimed asphaltic pavement piles to reduce moisture or reducing the percentage of salvaged or reclaimed asphaltic pavement in the mixture.

Black smoke from the plant usually comes from incomplete burning of fuel oil used to fire the drier or heat the drum mixer. It can be corrected by adjusting the burner flame to burn cleanly.

Most dust observed around asphalt mixing plants is produced by the process of heating and drying the aggregate. However, dust can be produced wherever it is conveyed through the plant before mixing. If a dust cloud is observed around the plant, the project manager will inform the contractor and request steps be taken to correct the problem. All plants should be equipped and operated with dust collectors to minimize the dispersion of dust and meet the limits on particle emissions prescribed in the Wisconsin Administrative Code, Rules of the DNR. Collected dust can be reintroduced into the mix in calculated amounts or wasted in a settling basin. Dust caused by hauling equipment can be settled by application of water or calcium chloride.

The Department of Natural Resources (DNR) is responsible for enforcing air quality regulations, and their personnel may be on the project from time to time to observe the plant operations for compliance to standards. Project staff is expected to be courteous and to comply with reasonable requests by DNR to have the contractor comply with air quality standards.

450.3 Salvaged or Reclaimed Asphaltic Material

Salvaged asphaltic pavement material is defined as recovered material from existing asphaltic pavement located within the project. Reclaimed asphaltic pavement material (RAM) is defined as recovered material from existing asphaltic pavement located outside the project.

HMA Pavement, Type ____ may include a specified percentage of salvaged asphaltic pavement. If the contract does not specify including salvaged asphaltic pavement in the mix, the contractor may optionally incorporate RAM when adhering to the maximum binder replacement percentages in standard spec 460.2.5.

If salvaged asphaltic pavement is a contract item, the salvaged asphaltic pavement is measured and paid for separately. Standard spec 460.2.5 states that salvaged asphaltic pavement not incorporated into the work and not otherwise specified in the contract provisions becomes the property of the contractor. Such excess salvaged asphaltic pavement may be used as RAP on future contracts.

Standard spec 104.8 allows the contractor to use, on the project, aggregates and other material found in roadway excavations. This does include existing asphaltic pavements not specified in the contract for use in pavements or base.

Standard spec 204.3.2 states that removed asphaltic surface becomes the property of the contractor. Thus, existing asphaltic pavement material from the item Removing Asphaltic Surface could also be used as RAP by the contractor.

450.4 Measurement of Clearances before Opening Roadway for Traffic

When pavement construction occurs beneath an existing bridge, the construction staff will measure horizontal and minimum vertical clearance upon completion of the pavement. Send the measurements to the Structures Development Section, BOS, and the regional bridge maintenance engineer. The structures development staff will enter the clearances in Highway Structures Information System (HSI).

SECTION 451 Asphalt Mixing Plants

451.1 General

There are two basic types of hot asphalt mixing plants, the drum mixer and the batch plant. Drum mixing is a continuous mixing process, whereas batch mixing is an intermittent process of preparing individual batches of hot mix. Each type may be of a stationary, commercial setup, or may be assembled for use on a specific project and moved upon completion of the project.

Regardless of type, all asphalt mixing plants have certain basic functions and components that perform those functions:

- Storage in aggregate stockpiles, the asphalt storage tank, and the burner fuel storage tank.
- Proportioning and feeding by the aggregate cold bins and cold feeds, and by the asphalt pump, meter, and pipeline.
- Heating and drying using the aggregate dryer or the drum mixer.
- Mixing in the mixing chamber of the batch plant or in the drum mixer.
- Storage of hot mix in the storage silo or surge bin.
- Controls contained in the control house.
- Dust collection by the primary (mechanical) collector and by the secondary (baghouse or wet scrubber) collector.

The contractor is responsible for setting up and maintaining the plant, for operations of the plant, and for providing the quality control necessary to produce an asphalt mix meeting the specifications. The contractor is responsible for recognition of defects and their timely correction.

The quality assurance team is responsible for ensuring that quality control by the contractor is adequate. This is accomplished by:

- Conducting assurance testing.
- Observing the sampling and testing performed by the contractor.
- Monitoring the required control charts prepared by the contractor.
- Directing the contractor to take additional samples for quality assurance testing.

The quality assurance team will not issue instructions to the contractor relative to the setting of dials, gauges, meters, or other adjustments to the plant.

451.2 Stockpiling Aggregates

Aggregates are delivered to the plant site before and during production by truck or rail car. They must be stockpiled in a manner that minimizes segregation and avoids contamination. The stockpile areas must be level, free from water and ice, and large enough to prevent mingling of piles. The foundation must be firm and free of rocks, vegetation, and debris. Stockpiles should be built in layers no more than 5 inches in thickness. If a central conveyor is used to build the piles, it should be traversed frequently to avoid coning, which segregates the particles. If a crane with a clam bucket is used, the aggregate should be dumped rather than cast. Loads hauled upon the pile by truck should be dumped rather than spread. Leveling of the layers should be done by rubber-tire equipment to minimize segregation and degradation. Each layer should be completed before the next layer is begun.

If bulkheads or partitions are used to separate stockpiles, they should be sufficiently strong to withstand overturning forces and should be free of holes and cracks.

The source for the aggregate should have been tested for quality before stockpiling begins.

451.3 Asphalt Storage

Asphalt storage consists of a tank, or tanks, for storing and heating the asphalt until it is needed. Heating is done by circulating hot oil through an internal piping system, or by using internal electrically-heated coils.

The QV team should check that the tank and lines don't leak, the asphalt is being heated to the specified temperature, and is being maintained at that temperature. The tank volume should be calibrated so a depth measurement can be readily converted to a volume.

451.4 Hot Asphaltic Mixture Storage System

The hot asphaltic mixture may be conveyed to a storage silo or a surge bin in an enclosed bucket elevator designed to reduce heat loss and segregation to a minimum.

Silos are heated and insulated to allow storage of the mix without major heat loss. For best results, they should have a hopper at the top that collects mix from several incoming buckets and drops the collection en masse into the silo, thus reducing chance of segregation. The stored mix is dropped, upon demand, through surge gates (located at the bottom of the silo) directly into a truck, or it may be dropped into a

batcher where it is weighed and then dropped into a truck. If there is no batcher, a truck scale is needed to obtain the loaded truck weight. Standard spec 450.3.2.2 allows mix to be stored in silos.

Surge bins are uninsulated, unheated metal bins suitable for holding hot mix up to two hours. Longer storage will result in major heat loss. Usually the bin empties, upon demand, directly into a truck so that a truck scale must be provided.

451.5 Automation and Interlock

Standard spec 450.3.1.1.2 requires that all batch plants used on projects involving 10,000 tons or more of asphaltic mixtures have automatic controls which control the entire mixing and discharge of a batch by a single switch or button. This subsection specifies in detail the interlock requirements for automatic operation and specifies the tolerances that are applicable to the incorporation of the various components in the mix.

Manual or automatic batch plants can be used on projects under 10, 000 tons of mixture. When a contractor elects to operate a batch plant in the automatic mode when not required, the plant operation must still meet all the requirements for automatic operation, except that recordation is not required. A contractor may, however, elect to operate an automatic plant in the manual mode when the specifications do not require automatic operation.

The inspector should not plan on observing any checking or testing of the automation or interlock controls unless there is a problem with the mix.

There are no similar specification requirements for continuous mixing or drum mixing plants.

451.6 Recordation

Automatic digital recordation is required on all contracts involving 10,000 tons or more of asphaltic mixture using either automatic batch recordation conforming to standard spec 450.3.1.1.3, or a digital recorder installed as part of the platform truck or storage hopper scales conforming to standard spec 450.3.1.1.4.

In the event of a breakdown of the automatic recorder on such contracts, the plant may be used with manual recordation for not more than two days.

Manual recordation may be used on contracts involving less than 10,000 tons of asphaltic mixture. The QA team should confirm that the recordation has been checked before production for the contract.

The truck scale can be checked by weighing a loaded truck and comparing to the weight of the same load on a certified commercial scale. The batch scales can be checked by comparing batch weights to a loaded, tared truck weight from a contractor's certified aggregate scale. This method is only a check on the recordation and does not replace accuracy requirements for plant scales, truck scales, or storage hopper scales.

451.7 Plant Safety

By its very nature, the plant can present hazards not normally encountered on the job. Danger of burns, the possibility of fire and explosion, and the presence of moving conveyor belts and other machinery in motion are some of these hazards. Unsafe conditions should be brought to the attention of the contractor for prompt correction.

Although there can be a multitude of unsafe conditions, the following list includes some of the most serious. Several are specifically regulated by OSHA.

- Unsafe stairs, platforms, and ladders. Permanent walkways should be provided to all areas of the plant. They should have railings.
- Smoking in prohibited areas. There should be no smoking, no open flames, and no welding operations around fuel storage tanks and asphalt storage tanks (OSHA 1926.151, 1926.352).
- Unsafe traffic patterns and parking patterns. Safe entrance and exit points at the highway should be established. A non-crossing traffic pattern should be established within the site. Vehicles should be parked in a defined area away from highway and plant traffic.
- Dust clouds that obscure the vision of truckers and plant workers. Dust should be controlled by the plant's dust collection system. Travel ways should be periodically wetted down (OSHA 1926.57).
- Exposed belts, pulleys, and drive mechanisms. These should be shrouded to prevent worker injury (OSHA 1910.219).
- Leaks in asphalt lines and heating oil lines. These should be regularly inspected for leaks to avoid possibility of fire and explosion (OSHA 1910.106).
- Hard hats not used. Hard hats should be worn by all workers and visitors at the site to protect against falling objects (OSHA 1926.100).
- Slumping stockpiles. Workers should not stand on stockpiles or bins while the plant is operating to avoid falling and being buried.

Refer also to CMM 135 for further guidance regarding safety rules and regulations for general construction.

451.8 Records and Reports

The necessary records and reports will be prescribed by the engineer and normally include:

- QV team's diary
- Paving Inspector's diary
- Log of mix produced, wasted, sold to other, or rejected
- Log of asphaltic material received and used
- Log of additives used
- Record of samples, tests, and results
- Load tickets and truck tare record
- Mix design changes
- Scale and thermometer testing

Records should be kept current. Reports should be submitted at the required frequency. At the end of the project all diaries and logs should be transferred to the engineer.

SECTION 453 Mix Production

453.1 Mix Design

The primary goal of a mix design is to determine a specific blend of aggregates and asphalt binder to produce an economical mixture that meets specifications. In order to provide the necessary performance, the mix must have sufficient asphalt content (AC%), air voids, quality of aggregate, and required compactive effort. The resulting HMA mix design is to as a job mix formula (JMF).

Virgin asphalt and aggregate materials used in HMA mix designs must be from approved sources. Refer to the following for the lists of approved materials:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/appr-prod/default.aspx

Region staff responsible for materials quality should furnish the QV team with the following:

- Asphalt binder must conform to the Combined State Binder Group (CSBG) Method of Acceptance for Asphalt Binders available at:

  https://engineering.purdue.edu/~csbg/method.html

- Coarse aggregate materials must be from an approved source and conform to the requirements of standard spec 460.2.2.

The contractor's HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technician develops and submits an asphaltic mixture design for each layer of HMA pavement according to CMM 866.2 to the BTS, Truax Lab. The central materials laboratory reviews the quality of the aggregate and asphaltic mix design and issues a report to the contractor and copies the region office. The department also enters approved mix designs into the Materials Tracking System (MTS). Each approved mix design has a three-year life cycle. The current list of approved mix designs can be found on the APL.

After production has begun, it may become necessary to adjust the job mix formula. The contractor's HTCP-certified Hot Mix Asphalt, Trouble Shooting, Process Control (HMA-TPC) technician or HMA-MD technician may submit a request for a JMF change according to CMM 836.

453.2 Preconstruction, Start Up, and Production

CMM CMM 836 provides a list of items that the QV team is responsible for obtaining before construction. Several of these items require communication with QC team personnel. In addition to these items, it is essential that a pre-pave meeting is held before paving to ensure each project is completed according to plans. General guidelines for pre-pave meetings are in CMM 226. In addition to the state-wide WS1030 Preconstruction Meeting Agenda, several regions have produced their own pre-pave meeting forms that should be used. Region-specific forms can be found at the WisDOT AASHTOWare Project Knowledge Base (AWPKB) website:

https://awpkb.dot.wi.gov/Content/constr/Pantry/RegionSpecific.htm

A department representative should be present at the QC laboratory on startup day. Procedures to follow are outlined in the quality assurance portion of CMM 836. The specifications do not allow latitude in meeting the requirements due to start-up or initial mix productions.

Standard spec 460 defines the quality management program that must be maintained during production. This includes QC and QV team responsibilities. CMM CMM 836 goes on to describe the QV team's responsibilities during production related to sampling, testing, monitoring control charts, and documentation. This also includes instructions for trouble shooting and dispute resolution testing to use when testing results do not conform with specification limits.

453.3 Temperature of the Mix

Standard spec 450 specifies the temperature at which the mixture must be prepared, stored, and delivered. Requirements for covering asphalt loads during inclement weather are also specified there.

The temperature at which HMA mixes are compacted is critical to achieving proper mat density. The amount of time available for compaction is based on several factors including:

- Mix temp.
- Layer thickness.
- Ambient air temp.
- Wind speed.
- Ground temp.

Multicool is an application, developed by the National Asphalt Paving Association (NAPA), that can determine the rate of cooling for an HMA mat during construction. It can be accessed at:

http://www.asphaltpavement.org/multicool

The HMA temperature determined by the contractor may need to be adjusted during construction to attain proper compaction.

Overheating can be as undesirable as under-heating. At no time should the temperature exceed the specified limits. The temperature at the paver hopper should be checked regularly. If loads appear too hot, as indicated by smoking or crackling sounds, corrective action needs to be taken.

453.4 Change in Asphalt Source

The contractor can obtain asphalt from the source or sources of their choice. The contractor can change asphalt sources as long as the source is department-approved and listed in the CSBG document.

453.5 Sampling and Testing

453.5.1 HMA Mixture

The volumetric properties of the HMA mixture determine how the mix will perform after placement. Standard spec 460 and CMM 836 provide requirements for mixture sampling and testing during production.

The contractor's QC program must outline sampling and testing activities and be shared with the QV team before production starts. Contractors sample mixtures at the production plant.

For non-PWL projects, the required frequency of QC testing is based on the total daily plant production. At the beginning of each day, the contractor must anticipate the quantity to be produced and inform the engineer. The frequency of sampling is then determined based on the anticipated daily plant production. The final tonnage and resulting number of tests may need to be adjusted if the actual tonnage produced each day exceeds the anticipated tonnage. The results of these quality control tests will be reported on daily control charts. In addition to quality control tests, the contractor is encouraged to conduct additional process control tests for their internal records during production.

For non-PWL projects, the minimum number of department tests is based on the total tonnage for each mix design. The QV team must witness and take immediate possession of any samples collected for department testing. Additional QV samples may be taken at the discretion of the engineer. Samples collected for the development of ignition oven correction factors are not required to be witnessed by the QV team. However, if the sample will be from plant produced material, the QV team must be notified before production so they have the opportunity to witness the sampling.

PWL projects are sampled and tested at the frequency specified in the PWL specification.

Asphalt binder samples collected during production according to CMM 850 are collected by the contractor and witnessed by the QV team.

No testing is required during production for asphaltic surface placed under standard spec 465.

453.5.2 HMA Density

HMA mat density is one of the most important factors when producing a durable and impermeable pavement. Standard spec 460 specifies pavement density and CMM 815 provides guidance for density testing. In general, projects are either tested and accepted by the QV team alone or, if a QMP density special provision is included in the contract, by QC testing verified by the QV team.

453.6 Acceptance

Under the standard spec acceptance of HMA Pavement mixtures is based on the results of the contractor's and department's random testing.

To accept HMA mixtures, the running average of 4 QC tests is compared with the control limits for aggregate gradation, AC%, air voids, and VMA. Each individual AC%, air voids, and VMA QV test is also evaluated for acceptance.

Acceptance of virgin asphaltic material is based on CSBG requirements. Asphaltic materials included in salvaged or reclaimed asphaltic pavements are accepted as a part of the asphaltic mixture.

453.7 Measurement

HMA mix is either produced one batch at a time in a batch plant or continuously in a drum mix plant. Standard spec 450 provides requirements for plant scales, recording batch weights, recording truck loads, and the information required on each printed or digital record. Weigh tickets showing the net weight of each load are supplied to the engineer.

453.8 Corrective Action

Standard spec 460 specifies corrective action the contractor must take based on QC test results compared with the control limits. This corrective action should be communicated to the engineer. An open line of communication between the contractor and engineer helps to minimize problems with material conformance.

453.9 Reduced Payment

The standard spec specifies reduced payment for various non-conforming items that are allowed to remain in place. The department uses the administrative items in CMM 238 to reduce pay.

The running average of 4 QC tests is compared with the control limits given in standard spec 460 to determine if reduced payment is necessary. Also detailed in this specification is reduced payment, and removal and replacement of unacceptable material based on QC testing data.

If a QV test result indicates material is outside the acceptable verification parameter limits specified in standard spec 460, BTS will test the material in question and use BTS test data in the dispute resolution process to determine the appropriate payment factor or mix acceptability according to CMM 836.

453.10 Temperature/Volume/Mass Conversions

Emulsified asphaltic materials are measured by volume in gal or by tons. The volume of asphaltic materials in storage tanks is measured and converted to volume at 60 F, or to weight, to get an accurate estimate. This conversion is calculated as specified in standard spec 455. The density for the asphaltic material can be obtained from test report data required under standard spec 455.

453.11 Mixture Appearance

453.11.1 Uniformity

Mixtures should be uniform in appearance and uniform in texture.

Nonuniform appearance may be caused by:

- Improper or insufficient mixing.
- Improper proportioning of aggregate, asphalt, or salvaged material.
- Improper blending of aggregate.
- Incomplete breakdown of salvaged material.
- Slugging, masses of unmixed ingredients, in the aggregate bins or feed.
- Bad screens or bad screening procedures.

Nonuniform texture may be caused by:

- Segregation of aggregate in stockpiles, bins, or feeds.
- Improper mixing of aggregates.
- Insufficient heating, dispersion, or mixing of salvaged asphaltic pavement with virgin aggregate and virgin asphaltic material.
- Segregation in the mixer or mixer discharge.
- Nonuniform blending of aggregates.
- Slugging, masses of unmixed ingredients, in the aggregate bins or feed.
- Bad screens or bad screening procedures.

Uncoated particles may be caused by excessive moisture, coatings (clay or silt) on the aggregate that interfere with the asphalt/aggregate bond, or aggregates that bond poorly to asphalt. Increased drying time, increased washing, or using anti-stripping chemical agents, may cure these problems.

453.11.2 Color and Texture

An acceptable mix is colored dark-brown to black, all particles are well coated in asphalt with fines evenly distributed within the coarse aggregate of the mix. A classic description of an acceptable mix is "wormy and alive", indicating that the mix appears to "crawl" when agitated and the general texture of the finer portions shows a sugary appearance. A mix that appears a lighter brown in color or dead, does not have a wormy appearance when disturbed, or segregates unduly on discharge, indicates a low asphalt content or wet aggregate. Items to check include mixture proportions, aggregate gradation for excessive fines, tare of asphalt bucket, or the calibration and operation of the asphalt pump. Also, the dryer or mixture temperature, cold feed settings, and moisture content of aggregate or mixture are possible causes.

A mix too rich in asphalt shows excessive asphalt coating. Fines tend to ball up instead of being evenly distributed or appearing sugary, and on discharge the mix tends to flatten out instead of building a mound. Items to check include mixture proportioning, aggregate gradation for lack of fines, tare of asphalt bucket, or the calibration and operation of the asphalt pump and distribution line within the drum.

Temperature of the mix should be within the range allowed by the specifications. There should be no odor of burned asphalt. If there is, the contractor should reduce the temperature of the plant's asphalt heater or mixer.

453.11.3 Segregation

Segregation can be caused by accumulations in the mixer, improper use of storage hoppers, dropping mixture into a truck from too great a height, or filling the truck completely from only one position. Segregation needs to be controlled to the greatest feasible degree at the plant, since it cannot be entirely corrected later.

453.12 Asphalt Mix Problems and Causes

Figure 453-1 provides a matrix, detailing common asphalt mix problems and the possible causes.

FIGURE 453-1 General Problems and Causes in Producing Asphaltic Plant Mixes

Types of Deficiencies That May Be Encountered in Producing Hot Plant-Mix Paving Mixtures.	Asphalt Content Does Not Check Job Mix Formula	Aggregate Gradation Does not Check Job Mix Formula	Excessive Fines in Mix	Uniform Temperatures Difficult to Maintain	Truck Weights Do Not Check Batch Weights	Free Asphalt on Mix in Truck	Free Dust on Mix in Truck	Large Aggregates Uncoated	Mixture in Truck Not Uniform	Mixture in Truck Fat on One Side	Mixture Flattens in Truck	Mixture Burned	Mixture Too Brown or Gray	Mixture Too Fat	Mixture Smokes in Truck	Mixture Steams in Truck	Mixture Appears Dull in Truck
Aggregates Too Wet			A					A				A	A				
Inadequate Bunker Separation		A	A					A									
Aggregate Feed Gates Not Properly Set	A	A	A														
Over-rated Dryer Capacity				A													
Dryer set too Steep				A				A									
Improper Dryer Operation				A				A			A						
Temp. Indicator Out of Adjustment				A				A			A				A		A
Aggregate Temperatures Too High				A				A				A			A		A
Worn Out Screens		B															
Faulty Screen Operation		B	B					B					A				
Bin Overflows Not Functioning		B	B		B												
Leaky Bins		B	B		B												
Segregation of Aggregates in Bins		A	A		A			A					A				
Carryover in Bins Due to Overloading Screens		A	A		A			A									
Aggregate Scales Out of Adjustment	B	B	B		B	B		B	B				B	B	A		
Improper Weighing	B	B	B		B	B		B	B								
Feed of Mineral Filler Not Uniform		B	B		B			B	B								
Insufficient Aggregates in Hot Bins		A	A		A			A	A								
Improper Weighing Sequence							B										
Insufficient Asphalt	A							A				A					
Too Much Asphalt	A						A					A					
Faulty Distribution of Asphalt to Aggregates	A						A		A		A		A	A			
Asphalt Scales Out of Adjustment	B						B		B		B		B	B			
Asphalt Meter Out of Adjustment	C						C		C		C		C	C			
Undersize or Oversize Batch	B	B			B		B		B	B	B		B	B			
Mixing time not proper	B	B							B	B							
Improperly Set or Worn Paddles	B								B	B							
Faulty Dump Gate							B										
Asphalt and Aggregate Feed Not Synchronized	C						C		C		C		C	C			
Occasional Dust Shakedown in Bins		B	B						B	B							
Irregular Plant Operation				A				A			A		A	A			
Faulty Sampling	A	A	A						A	A							

A—Applies to Batch and Drum Mix Plants. B—Applies to Batch Plants only. C—Applies to Drum Mix Plants only.

SECTION 454 Preparation of Foundation for Asphalt Pavement

454.1 General

The preparation of the foundation for an asphaltic pavement is a critical operation and the smoothness of the finished surface will depend, to a great extent, on the smoothness and firmness of the foundation on which it is placed. Modern asphalt pavers will tend to eliminate sags or bumps in the pavement, but the best course is to eliminate such deviations in the foundation when possible.

The shaping of an aggregate foundation or base is often neglected or only partially performed. A combination of proper application of water, scarifying, or deep blading and using adequate compaction equipment operated in conjunction with the shaping operation is essential.

454.2 Subgrade

During inspection of the subgrade, the inspector should look for areas of soft or yielding soil that are too weak to properly support the paving equipment. These areas should be corrected before paving. Checks should be made of both the cross slope and longitudinal grade of the subgrade. The crown should be checked at frequent intervals and should be held to within a close tolerance of the crown shown on the plans. Variations in crown or superelevation are bound to be reflected in the finished mat. Such variations frequently cause an uncomfortable ride, and they are dangerous, affecting the steering and path of the vehicle. A good blade operator can shape the base to within 1/4 inch of the crown or superelevation specified (per lane pavement) or 1 inch per 100 feet of grade. Greater variations should not be allowed.

Usually, it should not be necessary to set grade stakes to get an acceptable crown and profile. Crown or cross slope can be checked readily throughout the shaping operation with a level board (a board with a level attached and a leg on one side equal to the height of the crown in the length of the board). Driving the base course at reasonably fast speeds will reveal sags or bumps that need correcting.

454.3 Crushed Aggregate Base Course

All base courses are to be shaped to plan grade, elevation, and typical cross section using red top stakes, unless these criteria can be met by other measures for control.

The base course must be shaped and compacted to the proper crown or transverse slope and to a smooth, true profile. A combination of the proper application of water, scarifying, or deep blading and using adequate compaction equipment operated in conjunction with the shaping operation should incorporate all the coarse "float" material into the base in most instances. Any excess material can be spread on the shoulders. Generally, the tendency is to use an insufficient amount of water in the shaping and compacting of an aggregate base, but in the case of a layer of aggregate over an old pavement, it is possible to saturate the base material to the extent that it loses stability.

The inspector should check for a smooth profile. It is not uncommon to find that the required elevation at each red top stake has been met by the grader, with a sag in profile between stakes.

As mentioned previously, the crown and cross slope should be checked frequently by the inspector, and deficiencies corrected by the contractor before paving.

454.4 Old Concrete Pavements

When an asphalt overlay is to be placed over old concrete pavement, the old pavement should be inspected to determine the need for any patching before the new overlay is placed. Many old concrete pavements, when uncovered by salvaging existing asphaltic overlays, are found to be in much worse condition than when originally resurfaced, and in need of extensive patching. If the old concrete pavement is not scheduled for rubblizing and must carry traffic, the asphaltic material is generally removed by milling part of it and leaving enough asphalt pavement in place to carry traffic until resurfaced.

Pavement that has broken into pieces that are 3 inches or less on any side or chunks that rock or move under normal traffic loads should be removed and the pavement patched. If the patching is to be concrete, the area removed and replaced should be large enough to resist movement under traffic. Asphaltic patches or road mix mats placed over old concrete pavement should be carefully inspected before covering with hot mix and any material of questionable stability removed. Waviness, shoving, or rutting of the old mat are direct evidences of instability. A rich-appearing, soft surface indicates either excessive asphalt content or migration of the asphalt to the surface. Any of these conditions can result in failure of the new hot mix mat.

Any asphaltic mat or patch that does not appear stable and "cured out" from the surface should be examined internally by cutting or chopping out sections. In many old mats, especially those mixed with slow curing oils, the asphalt has stripped from the aggregate in the lower portions of the mat and oxidized or migrated to the surface leaving the aggregate loosely bound. Mats in this condition should be removed. Mats or patches that are stable and cured out may be covered with a new hot mix mat.

All surplus crack and joint sealing material must be removed from the old pavement. All protruding joint materials, including fillers and sealers, must be removed down to at least the surface of the old pavement. Ordinarily, it is not necessary to remove such joint materials below the old pavement surface unless the sealer characteristics are likely to cause bleeding or instability of the new surface over the joint areas.

Some contracts may require an existing concrete pavement to be cracked and seated before overlay. The intent of cracking is to create concrete pieces small enough to reduce joint movement and reflective cracking, yet still large enough and with enough aggregate interlock to maintain most of the pavement's original strength. The intent of seating is to set the cracked pieces firmly on the subgrade and to eliminate voids under the concrete. Refer to standard spec 340.

Equipment used to crack the pavement must consist of a vehicle-mounted spade or guillotine-type cracker, capable of exerting at least 12,000 ft-lb. of energy, and must not cause undue displacement of the concrete, damage to drainage structures or utility lines, or displace the base or subgrade. A vibratory roller is used to seat the pieces.

Cracked pieces are to be approximately 4 to 8 square feet in surface area, with the greatest dimension oriented at right angles to the road centerline. Breaking should not be done within 30 inches of a transverse joint. After being firmly seated and before use by traffic, the surface should be swept clean. Sweeping should be repeated before overlay.

454.5 Old Asphaltic Surfaces

The principles outlined in the section about old concrete pavement patches may also be applied to patches in old asphaltic surfaces. The asphalt in rich or uncured patches will soften under the elevated temperature of the hot mix and infiltrate the mixture, causing it to soften.

Some contracts may require the existing asphaltic pavement to be milled off for salvaging. The milling machine is to be self-propelled and specially designed and constructed for milling pavements without tearing or gouging the underlying surface. The teeth must be spaced on the drum to mill an acceptable surface finish. The drum must be shrouded to prevent discharge of any loosened material into adjacent work areas or live traffic lanes. An acceptable dust control system is required. The machine must also be equipped with electronic devices which will provide accurate depth, grade and slope control.

The milling operation is to be done in a manner to prevent damage to the remaining pavement. It should result in a reasonably uniform plane surface free of excessively large scarification marks, and with the uniform transverse slope required on the plans or directed by the project engineer. The sequence of the milling operations should be such that no exposed longitudinal joints two inches or more in depth remain during nonworking hours and one lane of the roadway is maintained for traffic at all times during actual construction operations. Windrowing or storing of the salvaged asphaltic pavement on the roadway should only be allowed in conjunction with a continuous removal and pick-up operation. Unless waived by the project engineer on a highway closed to traffic during nonworking hours, the roadway must be cleared of all materials and equipment. Shoulders adjacent to the salvaged asphaltic pavement area must be graded to provide positive drainage of the pavement by the end of each working day.

454.6 Tack Coats

454.6.1 General

Tack coat consists of the application of an asphaltic material to an existing pavement or to lower layers of asphaltic pavement before overlaying. Tack coats are intended to enhance the bond between existing pavements and new asphaltic surfaces and at the interface between layers of asphaltic pavements. Research has shown that the bond developed between the layers is critical in providing long-term performance of an asphalt pavement.

454.6.2 Applications

454.6.2.1 General

The surfaces to which the tack coat is to be applied must be clean and dry. The surface may be pre-wetted before applying tack coat material, though no standing water is allowed. The tack coat should not be applied before impending rain.

Normally, the road is kept open to all traffic during the performance of this work. Tacking operations must be planned and prosecuted so traffic will be adequately provided for without harm to the work.

The surfaces of structures, railings, curbs, gutters, and pavements designated to remain in place without resurfacing must be protected from being spattered or marred.

Care must be taken that the water from the emulsion has evaporated before paving over the tack coat. Otherwise, the resultant water vapor may inhibit the bond between the two surfaces and contribute to premature pavement failure.

454.6.2.2 Distributor

Tack coat is applied with a truck or trailer-mounted distributor that can evenly distribute the asphaltic material across a variable width surface at the typical rates outlined in CMM 454.6.2.5. A hose and spray nozzle attachment is provided for applying the asphaltic material around islands, radii, and other areas not accessible to the distributor spray bar. Areas may be protected with materials such as asphalt roofing felt to prevent areas from being sprayed inadvertently.

The spray bar of the distributor should be adjusted so that the nozzles are vertical. Nozzles should also be set at an angle of 15 to 30 degrees from the long axis of the spray bar to prevent the fan-shaped spray patterns of each nozzle from interfering with one another while still providing sufficient overlap. Each nozzle should be set at the same angle. The two outside nozzles should be set so their spraying pattern is parallel to centerline of the highway. The spraying pattern should be checked regularly for full and even coverage. The distributor should not be allowed to operate with clogged or improperly set nozzles.

Another key spray bar adjustment that is essential for uniform coverage is adjustment of the spray bar height. The fan-shaped spray patterns from the nozzles overlap to different degrees, depending on the distance between the spray bar and the surface to be covered. The spray bar should be set high enough above the roadway for the surface to receive double coverage. This height will vary according to the nozzle spacing of the spray bar and the angle at which the nozzles are set.

454.6.2.3 Asphaltic Material

The asphaltic material must be one of the emulsified asphalt types listed in standard spec 455.2.5 unless otherwise specified in the contract. Cutback asphalts are not allowed. In order to meet the 50% Residual asphalt content of as-placed material specified in standard spec 455.3.2.1, the following information must be provided to the department:

- Residual asphalt of the original emulsion on the bill of lading.
- Dilution rate of the original emulsion on the bill of lading.
- Any further dilution provided in writing to the department.
- Calculations of residual asphalt content provided in writing to the department following Example 1.

Example 1: Residual Asphalt Content of As-Placed Material

The residual asphalt in the original emulsion is 63.5% which means it has 36.5% water. The dilution rate of the emulsion is 80/20 (80% orig. emulsion / 20% water).

Residual Asphalt Content of As-Placed Material = 63.5% * .80 = 51%[1],

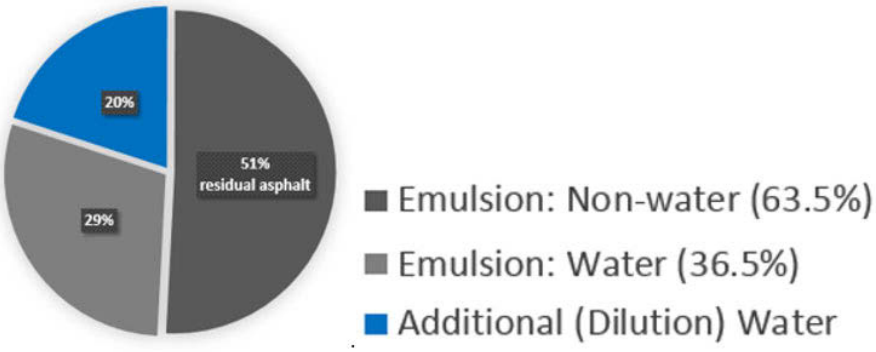
Water content in emulsion= 36.5% * .80 = 29%

Water added to emulsion = 20%

Total water = 29% + 20% = 49%

1. The As-Placed Materials meets the minimum requirement of 50% for Residual Asphalt Content

A graphical representation of this example is:



454.6.2.4 Temperature

The temperature of the asphaltic material at the time of application should be between 68 F and 158 F to allow ready application. The air temperature should be 40 F or more.

454.6.2.5 Rate

The tack coat is normally placed in a single application at a rate approved by the project engineer. The emulsified asphaltic material should be applied as a uniform fog spray which leaves a coat about as thick as a light coat of paint. A suggested initial application rate is 0.05 gal/SY on new surfaces and 0.07 gal/SY on older or milled surfaces. This rate may have to be adjusted after initial application and observation.

454.6.3 Measurement and Payment

Asphaltic materials for tack coat will be measured by volume in gallons or tons as provided in the contract. Emulsified asphalts required to be diluted will be measured after dilution and the volume measured for payment will include the volume of water required for dilution.

When measurement is by the gallon, the quantity determined by volumetric calibration of tanks must be corrected to a temperature of 60 F. A corresponding temperature should be recorded for each volumetric reading taken. Any amount wasted or otherwise not incorporated in the work should be deducted.

Example 1: Volume Correction for Emulsified Asphalt

2,000 gallons of emulsified asphalt at a temperature of 120 F were used.

Use the equation in standard spec 455.4.1 to determine the pay volume.

V =2,000/(0.985+0.00025*120) = 1,970 gallons

Measurement by the ton will be based on net weights of asphaltic materials shipments less the weight that is wasted or otherwise not incorporated in the work.

454.7 Drainage and Utility Fixtures

Street fixtures such as manholes, catch basins, and utility fixtures must be adjusted before or during an overlay or resurfacing operation.

It is difficult to anticipate final elevations before placing of the leveling layer and the first pavement layer, and thus to preset manhole covers and other castings encountered in municipal work to the proper elevations. To avoid unsightly patching in the surface course, the contractor may choose to reference the locations of the underground structures, pave over with the leveling or lower layer course, and then dig out and adjust the height just before placing the upper layer.

Adjustments of manhole, catch basin, or inlet covers or frames should be carefully performed and inspected. Observations of structures of various ages have disclosed numerous cases where the covers have settled below the adjacent pavement or gutter, and investigation has revealed that the materials used to support and adjust the cover have deteriorated to the extent that such materials could either be removed by hand or had already fallen into the structure. Such conditions are the result, at least in part, of the improper methods used in setting or adjusting the covers when they are installed. Covers are often observed temporarily supported on a variety of shims or wedges while the adjacent pavement is being placed. Later, a cosmetic layer of mortar is applied from the inside of the structure, with little, if any mortar getting under the flange of the casting. This practice is prohibited. Covers should be set on a full bed of mortar.

Adjustment castings or rings are often used to accommodate an overlay. Some rings are of the adjustable universal type while others must be ordered in depths to fit the individual manhole, etc. When covers are badly tipped, adjustment rings should not be used; instead, the frame should be adjusted or reconstructed. After they are raised and before the overlay, exposed fixtures should be marked with flags or barricades to denote a hazard.

454.8 Leveling Layer

On new base course, there should be no occasion for a leveling layer if the base has been properly prepared. When resurfacing old pavements, the foundation on which the surfacing is to be placed should first be checked for sags, bumps, changes in crown, and rate of superelevation. It is recommended all disclosed irregularities not corrected by milling or grinding be corrected so far as possible by placing leveling layers before starting the placement of the upper layer. Such irregularities cannot feasibly be corrected by varying the thickness of the new pavement layers, or by relying on the paving machine to automatically compensate for such irregularities. The leveling action of the paving machine will tend to smooth out short sags or bumps, but the longer undulations and sudden changes in crown, which are objectionable to fast moving traffic, generally cannot be corrected by the equipment alone. The ideal condition would be to correct all irregularities with the leveling layers so the upper layers could be placed without making any thickness adjustments. This is never entirely accomplished, so any remaining irregularities should be watched for and corrected with each successive layer.

Checking of the foundation can be accomplished in a variety of ways. One way is to drive the job at various speeds, taking note of places where corrective work is needed. Stakes or other markers can be thrown from the car to the shoulder in passing to indicate areas requiring further investigation. These locations can then be stringlined to locate the ends of the required leveling layer. These limits may be marked on the pavement, along with required depth of the lift, at frequent intervals not exceeding 30 feet. As an alternative, profiles may be taken at the centerline and pavement edges. After an acceptable grade line is established, it should be referenced to offset stakes, or a stringline reference should be erected for use with automatic controls.

The superelevation of curves on old pavements may need correction to current standards, either by increasing the rate of superelevation or removing the crown, or both. The depth of required wedging can be determined from observations at 60-foot intervals around the curve with a hand level or stringline level and comparing the slope in the old pavement with the slope of the new pavement. The thickness of the leveling layer required to correct the superelevation should be marked on the pavement at the edge and the centerline. The transition from normal crown to superelevation should be the distance indicated on the plans for the new pavement.

The specifications allow the leveling layer to be placed either by hand, by blade grader or by asphaltic paver. Hand methods will generally be limited to small areas where it is impossible or impractical to use mechanical means.

When using the blade grader to place the leveling layer, the asphaltic mixture is spread on the pavement in a thin layer directly from the dump truck. A roller, preferably pneumatic-tire, should work in conjunction with the blade at all times during this operation. The material should be shaped and compacted in thin layers. Additional material should be added as needed, but without dumping an excess of material that would be wasted. The surface profile and cross section should be checked throughout the operation. Profile can be checked with a long stringline stretched tight to detect sags or depressions. Crown can be checked with a straightedge and carpenter's level, line level, or hand level.

Better results are obtained when placing leveling layers with the asphaltic paver equipped with the automatic screed control system. When the stringline is used as a reference, great care is needed in setting the grade line to provide the proper minimum thickness of cover over the controlling high spots in the base while taking into consideration the predetermined cross slope.

When the automatic screed control system is not used, the amount of profile improvement depends largely on the ability of the screed operator to anticipate the required thickness of the course at any point and make the necessary adjustments far enough in advance, so it is obtained. If the variations in thickness or crown are small and gradual, acceptable results can be obtained by this method, but if the changes are extensive, complete correction of the irregularities may not be realized. Also, any attempt to visually follow a stringline or other reference set to the desired grade usually fails due to over-manipulation or under-manipulation of the screed controls.

Regardless of the method used to lay leveling layers, the maximum thickness placed at any time is not to exceed 3 inches in compacted thickness. Where the required thickness of the leveling layer cannot be placed in a single layer, the surface of each layer should be parallel to the finished grade starting with a short pass in the area needing the most correction. Each layer should be feathered out at the ends and each successive layer should overlap the ends of the previous layer until the desired surface profile is obtained. Unless each layer is feathered out, a bump will be reflected in the finished surface where the leveling course began and ended.

To obtain acceptable compaction, the minimum thickness of a leveling layer should conform to the thickness and gradation requirements of standard spec 460.3.2 and in no case be less than 1 inch. "Scratch Coats," which get their name from marks left by aggregate being dragged by the screed, should never be used as they cannot be acceptably compacted.

Between each successive layer or course, the job should be driven to locate areas where further improvement of the profile, crown, or superelevation can be accomplished. By stringlining the pavement ahead of the paver, sags are detected and can be marked for correction, either as a separate operation or in conjunction with placing the next layer or course.

Materials used to construct leveling layers will be measured and paid for under the pertinent contract items if the plan contains a quantity for leveling layer. In the absence of a plan quantity for leveling layer, it will be paid for as extra work in accordance with standard spec 104.2.

454.9 Milling Adjacent to Concrete Curb and Gutter

When milling pavement adjacent to curb and gutter the engineer and contractor will review the existing curb and gutter adjacent to planned milling operations prior to the start of the milling operations. The

engineer and contractor will agree on the existing curb and gutter to remain in place and the curb and gutter to be removed and replaced or repaired under the contract.

Typical urban rehabilitation projects include spot replacement of curb and gutter in addition to milling of the existing roadway surface followed by an overlay. To the greatest extent practicable, the contractor shall conduct work operations to avoid damage to curb and gutter. If project staging or traffic needs dictate milling work to follow curb and gutter placement, some minor damage to the new curb and gutter is expected.

In situations where milling cannot occur prior to curb and gutter replacements the engineer and contractor should consider:

- Prohibiting forming new curb and gutter against old pavement.
- When new HMA pavement or HMA patching is planned to be paved adjacent to new curb and gutter, leave the HMA pavement or patch below the flag-line of the curb and gutter equal to the depth of the proposed milling. The HMA may be tapered at a 4:1 slope to match the existing pavement.
- Consider paper joints in areas where new HMA pavement cannot be left down, i.e. at pedestrian ramps, etc.
- If project schedule requires milling existing pavement adjacent to new curb and gutter, minor damage to the flag and pan of the new curb and gutter may occur. The engineer and contractor shall review after milling operations and again after HMA paving operations are complete. Minor to moderate damage to the flag and pan of the new curb and gutter may be repaired with approved concrete surface repair materials where the damage would create significant drainage issues. Areas exhibiting significant damage will be removed and replaced.

SECTION 456 Hauling Asphaltic Mixture

456.1 General

Mixture must be transported from the mixing plant to the point of placement in vehicles conforming to standard spec 450.3.1.2. Each truck must be clearly numbered or otherwise identifiable.

Before being loaded, the truck bed must be cleaned of foreign material and hardened asphalt, be lightly coated with a release agent (lubricant) that assists in preventing fresh hot mix asphalt from sticking to the surface of the bed and be well drained. Before loading, each day the truck must also be weighed under average fuel conditions to establish a tare weight (unloaded weight). The tare weight is later subtracted from the loaded weight of the truck to determine the weight of hot mix the truck is hauling. Truck scales should be calibrated and checked in accord with CMM 813.

Mixture must be delivered to the receiving hopper of the paver at the specified temperature and covered in transit during cold or inclement weather.

Loads should not be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight hours unless artificial light acceptable to the engineer is provided.

Sufficient trucks should be provided to ensure continuous paving.

Hauling patterns of the trucks should not impede the steady progress of the paver, disturb the base, or present hazards to road users.

456.2 End Dump Trucks

The rear of the bed of an end dump truck must overhang the rear wheels enough to discharge mix into the paver hopper. If it does not, an apron with side plates must be added to increase the overhang and prevent spillage of mix in front of the paver.

The bed must also be of a size that will fit into the hopper without pressing down on the paver. The hydraulic system for the truck bed hoist should be frequently inspected to guard against hydraulic fluid leakage. Such leakage on the roadway surface will prevent good bonding between the roadway and the new mat. If enough oil is spilled for the mix to absorb it, the mix can become unstable at that spot. In short, leaking trucks should not be used.

During delivery, the driver must direct the truck squarely against the paver and should stop the truck a few inches from the paver, before the truck tires contact the paver roller bar. Backing the truck against the paver can force the screed back into the mat, leaving a bump in the pavement even after the mat is rolled.

The truck bed must be raised slowly. When the mix is dumped too rapidly, segregation occurs, as the coarser aggregates will roll down the sides of the load.

456.3 Bottom Dump Trucks

If bottom dump trucks are used, the paver must be equipped with a pick-up device to feed the windrow directly into the paver hopper, or intermediate transfer equipment may be used. Standard spec 450.3.1 gives the specifications for such a device or equipment.

The pick-up device and paver should not be in contact. If the loader and paver are directly coupled, vibration of the pick-up devices may be transmitted into the paver, and cause ripples and roughness in the mat surface. Such vibrations generally result from worn and defective parts, or from improper mounting or adjustment.

Only occasional uncoated particles should be showing in the compacted mix. Nearly all of the windrowed material should be picked up by the device and not left as high-priced, poorly compacted base course.

There are two common methods for unloading bottom-dump trucks. One method involves using a spreader box designed to be operated under the gates of the truck. The amount of material placed in the windrow is governed by the width of the spreader box opening. The disadvantage to this method is that the spreader box can restrict the amount of material to less than the required amount.

The second method is to use chains to manually control the dump gate opening. This is the most commonly used procedure. Automatic devices are available for controlling gate openings; however, their use is somewhat limited because of the additional cost.

Variations in the size of the windrow deposited by the bottom-dump will cause variations in the amount of material fed to the paver hopper. This often causes variations in the finished surface. It is therefore essential the windrow deposited by the truck be as uniform as possible. If the windrow contains too much mix, a short gap in depositing from the next truck will compensate for the excess. The windrow length must also be controlled, particularly in cool weather. Windrowed material will cool below optimum spreading and compaction temperatures in cool weather, particularly when delay occurs because of

paver malfunction. To prevent excessive cooling of the mix in cold weather, the limit of windrow should be no more than one truckload ahead of the pick-up device.

456.4 Asphalt Release Agents

Asphalt release agents are used for coating truck beds, pavers, rollers, and slat elevators to prevent asphalt binder or hot mix asphalt (HMA) from adhering. These materials should perform this function without causing degradation (stripping) of the hot mix asphalt. An asphalt release agent must be approved before use for a department project. Approved asphalt release agents, as well as requirements for approval, are listed on the APL.

Approval requirements include thresholds for 7-day Asphalt Stripping Test, Mixture Slide Test, and Asphalt Performance Test. Product acceptance is based on the National Transportation Product Evaluation Program (NTPEP) testing performed according to AASHTO TP 102.

Any change to the approved asphalt release agent (in formulation or composition) requires re-evaluation of the material and the new product must receive departmental approval before use. Product approval is valid for a period of three years. After confirming that a product is on the WisDOT approved products list, date of use must not surpass the expiration date indicated on the approved list.

Under standard spec 106.3.2, the department may sample material at any time from projects for evaluation, and may remove the material from the APL if:

1. The material does not meet the requirements listed in the asphalt release agent APL.
2. Test results are significantly different from the original NTPEP test results.

SECTION 457 Asphalt Pavers

Before beginning to place asphaltic mixtures with the paver, the inspector should become familiar with the basic operating principles of the machine and should check the condition and adjustment of the various working parts that affect the quality of the finished product.

All machines consist of two basic units; the tractor unit and the screed unit.

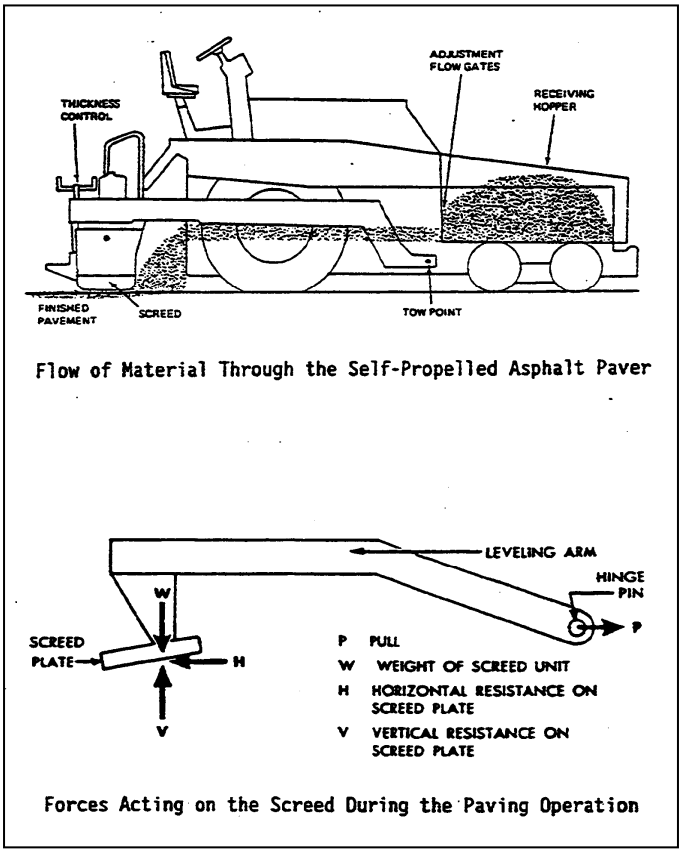
457.1 Tractor Unit

457.1.1 General

The tractor unit provides moving power for the paver wheels or tracks and for all powered machinery on the paver. The tractor unit includes the receiving hopper, feed conveyor, flow control gates, distributing augers (or spreading screws), power plant (engine), transmissions, dual controls, operator's seat, and wheels or tracks.

When in operation, the tractor unit power plant (engine) propels the paver, pulls the screed (leveling) unit, and provides power to the other components through transmissions. Hot mix is deposited in the hopper from where it is carried by the feed conveyor through the flow control gates to the distributing augers (spreading screws). The augers distribute the mix evenly across the full width of the paver for uniform placement onto the roadway surface. These operations are controlled by the paver operator by means of dual controls within easy reach of the operator's seat.

FIGURE 457-1 Asphalt Paver Flow of Material and Screed Forces



Many pavers have hydrostatic drive systems that allow an unlimited number of speeds within the operating range and once set, will automatically maintain the desired speed.

457.1.2 Pneumatic Tires and Crawler Tracks

The tractor unit may be equipped with either rubber tires or steel tracks.

If the paver is equipped with pneumatic tires, tire condition and air pressure must be checked. It is particularly important for the pressure to be the same in tires on both sides of the paver. If the paver moves on tracks (crawlers), the tracks should be checked to be certain they are snug but not tight, and the drive sprockets should be checked for excessive wear. Low tire pressure or loose crawlers can cause unnecessary movement of the paver, which when transmitted to the screed unit results in an uneven

pavement surface. There should be no build-up of material on tires or on tracks. Excessively worn parts should be replaced.

457.1.3 Governor

The governor on the engine must be checked to be sure there is no periodic surge in the engine RPM. If it is not working properly, there can be a lag in power when the engine is loaded. Such a lag causes temporary failure of the vibrators or tamping bars in the screed unit, resulting in a stretch of pavement that is less dense or contains slightly less material than the immediately adjacent area. After rolling, such an area shows up as a transverse ripple in the pavement. A power lag can also interfere with the smooth and consistent operation of electronic screed controls.

457.1.4 Hopper, Flow Gates and Augers

The hopper, the slats on the feed conveyor, the flow gates, and the augers should be checked for excessive wear and observed to be certain they are operating properly. Necessary adjustments should be made by the contractor to ensure these components are functioning as designed and are able to deliver a smooth flow of mixture from the hopper to the roadway.

Paving machines have adjustable flow control gates, which regulate the amount of the paving mixture, which is carried on the slat feeders from the receiving hopper to the distributing augers. The slat feeders should be operating most of the time (80% to 90%) and the flow control gates should be set to keep the augers at least two-thirds covered with material. It is very important that the level of the material in front of the screed be kept constant. If the level of material is allowed to intermittently rise and fall and thereby flood or starve the screed, a rough mat, segregation of the material, and imperfections in the surface will result. Some pavers are equipped with automatic controls to maintain a uniform depth of material ahead of the screed; the adjustment of the sensing device and the flow gates should be coordinated so the slat feeders operate most of the time as stated above.

Quarter-line cracking or raveling of the mat is believed to be caused by worn interior augers, paddles, and baffles that tend to starve the screed near the center of the paver. Such equipment should be regularly inspected, and if excessively worn, should be replaced or rebuilt to original dimensions.

Feeders, gates, and augers should be checked for excessive wear. They should be observed while operating without mixture to be assured they are functioning properly and in synchronism with each other.

457.2 Screed Unit

457.2.1 General

The screed unit strikes off the mix, controls thickness, imparts smoothness, and provides initial compaction of the mixture. Screed extensions must be able to match the varying cross slope specified for the width of paving, including the shoulder, if paved integrally.

A typical screed unit is comprised of the following:

- Screed tow arms.
- Screed plate.
- Hearing unit.
- Tamping bars or vibratory attachments.
- Controls.

The screed unit is towed by long arms attached to pivot points located forward on the tractor unit, allowing the screed to operate on a floating principle which tends to compensate or dampen irregularities in the base that affect the tractor unit. Mat thickness is adjusted manually by tilting the screed up or down around a pivot pin just above the screed. When operating an automatic grade control, the screed compensates for irregularities in the base by adjusting the screed arm at or near the pivot point of the screed arms.

As the manual thickness controls are adjusted, the screed seeks a new level, up or down, as the machine moves forward, but the total effect of the change may not be realized until the machine has moved several feet. Consequently, the machine should be allowed to move 50 feet before any further adjustments are made. The sensitivity of the controls differs between makes of machines and consequently the maximum amount of adjustment that should be made at any time differs with the machine. The amount of change in thickness produced by any given adjustment on the controls depends on the mixture being placed, so it is impossible to state that a particular adjustment will change the mat thickness by a definite amount. Refer to figure 457-1.

Screeds with tamping bars or vibratory mechanisms are designed to strike off and then compact the mixture slightly as it is placed. There are two purposes to this screed action. It achieves maximum leveling of the mat surface, and it ensures minimum distortion of the mat surface, and it ensures that

minimum distortion of the mat surface will occur with subsequent rolling. Because the different screed compaction systems function differently, they are discussed separately below.

457.2.2 Tamping Bar Type

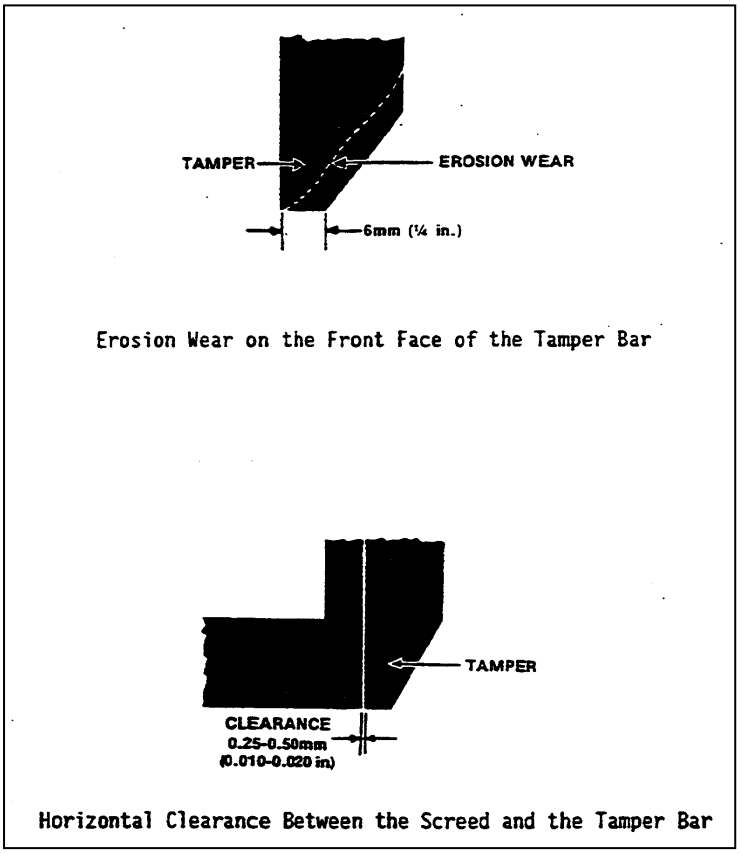
Tamping bar type screed compactors compact the mix, strike off the excess thickness, and tuck the material under the screed plate for leveling. The tamper bar has two faces; a beveled face on the front that compacts the material as the screed is pulled forward and a horizontal face that imparts some compaction. The horizontal face primarily strikes off excess material, so the screed can ride smoothly over the mat being laid.

The adjustment that limits the range of downward travel of the tamping bar is the single most important adjustment affecting the appearance of the finished mat. At the bottom of its stroke, the horizontal face should extend 0.016" - about the thickness of a fingernail - below the level of the screed plate. If the bar extends down too far, mix builds up on the screed face that tends to scuff the surface of the mix being placed. In addition, the tamping bar will lift the screed lightly on each downward stroke, often causing a rippling of the mat surface.

If the horizontal face of the tamping bar is adjusted too high (either by poor adjustment or due to wear of the bottom of the horizontal face), the bar does not strike off excess mix from the mat. Consequently, the screed plate begins to strike off the material, which results in surface pitting of the mix being placed as the leading edge of the screed plate drags the larger rocks forward. Therefore, the tamper bar should always be checked before operating the paver. If necessary, the contractor should adjust it, and before it approaches knife-edge thinness it should be replaced.

Clearance between the rear of the tamper bar and the leading edge of the screed frequently is overlooked. Properly adjusted, there should be just enough clearance to allow free movement of the tampers - approximately 0.010" to 0.020".

FIGURE 457-2 Asphalt Paver Tamper Bar Erosion Wear and Horizontal Clearance



Screed plates will wear out first about 4" to 6" in from the trailing edge. The first indications will be either an indentation or an actual ripple in the surface of the screed plate. These should be checked periodically and replaced as needed.

457.2.3 Vibratory Type

The operation of vibratory screeds is similar to that of tamping screeds, except that the compactive force is generated not by a tamping bar, but by either electric vibrators, rotating shafts with eccentric weights, or hydraulic motors that vibrate the screed plate. On some pavers, both the frequency (number of vibrations per minute) and the amplitude (range of motion) of the vibrators can be adjusted. On others, the frequency remains constant and only the amplitude can be adjusted. Frequency and amplitude are set in accord with the type of pavers, speed of the paver, thickness of the mat, and the characteristics of the mixture. Once set, frequency and amplitude do not normally need adjustment until mat thickness or mixture change.

Some pavers have a "pre-strike-off unit" or a curved strike-off blade at the leading edge of the screed for use with "critical" material. It is attached to and receives vibration from the screed plate itself. It meters the amount of material going under the screed plate and can be adjusted vertically.

Some other pavers have a round-nose strike-off bolted directly to the screed frames and welded to the screed plate so no adjustment can be made. In these, the screed shield assembly is the only part of the screed that is adjustable. It can be moved up for normal material flow or down for dense mixes and thin lifts.

As with tamping screeds, the screed plates will begin to wear first about 4" to 6" in from the trailing edge. Those with excessive wear should be replaced.

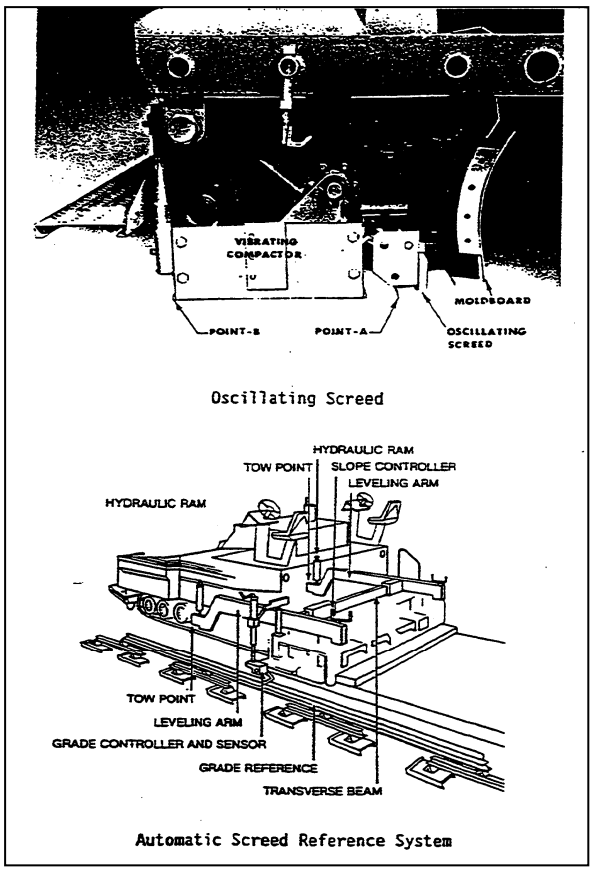
457.2.4 Oscillating Type

Some pavers are equipped with both an oscillating screed and a vibrating compactor. The oscillating screed, beveled for initial compaction, operates at 600 strokes per minute, with 1/4" transverse strokes, striking off the material for the desired depth.

The vibrating compactor, mounted to the rear of the oscillating screed, supports the screed unit, imparts additional compaction, and irons out the surface of the mat.

The most critical adjustment is positioning the oscillating screed relative to the vibrating compactor. The bottom rear edges of the oscillating screed and the bottom rear edges of the vibrating compactor must be parallel. The compactor should be sloped or tilted so that a projection of the plane of the bottom will intersect at a point 0.4" above the bottom of the screed. Minor adjustments in this differential may be necessary to obtain a uniform appearance in the mat.

FIGURE 457-3 Asphalt Paver Oscillating Screed and Automatic Screed Reference System



457.2.5 Crown Adjustment

All machines have provision for adjustment of crown in the screed. Usually it is desirable to provide a slight amount of crown in the screed to avoid the appearance of the mat being low in the center of the lanes. The usual crown allowed per lane on rural-type pavements is 0.10"; however, urban cross sections may require special adjustment. Also, the amount of crown at the front edge of the screed is generally increased somewhat from that required at the back, with at least a 0.08" increase usually being recommended. The amount of this differential may be varied with the material being used and is sometimes helpful in reducing and eliminating non-uniformity of the surface texture across the paved width. Too much crown in the leading edge of the screed will create an open texture along the edges. Too little crown in the leading edge will create an open texture down the center of the mat.

457.2.6 Automatic Screed Controls

Standard spec 450 provides that the paver must be equipped with an approved automatic control system, which controls longitudinal grade and transfer slope, except when paving miscellaneous areas or when the engineer finds using this system impractical. The specifications require using longitudinal control, unless the engineer allows its omission on the final surface course. Exceptional conditions could arise, however, where omission of the longitudinal grade control in the interest of a smoother ride can be allowed.

The engineer may discontinue use of the automatic equipment and require manual control when it appears better results may be obtained thereby. Such might be the case on work which includes sections with an urban-type cross section with non-uniform crown, or on intersections, interchanges, or similar areas.

Pavers not equipped with automatic controls may be used when the engineer allows, such as on small specialized projects, jobs entirely urban with variable crown, or jobs having frequent intersections or other features which are not adaptable to automatic control.

Standard spec 450 also provides that when the automatic grade control fails, the paver can be operated under manual control for only the remainder of the working day on which the automatic control system broke down.

The automatic control systems use electronic sensors to control grade and to control transverse slope. Refer above to figure 457-3.

The sensor gets its information from a sensing device riding on a fixed stringline, a mobile stringline, or a traveling straightedge. The specific type of sensing device used on the initial lane of a layer or course is subject to the engineer's approval. For paving subsequent lanes of the course or layer, the paver may use a shoe or straightedge riding on the adjacent lane as a sensor.

There are several grade sensor types and transverse slope sensor types. Some systems make screed adjustments by raising or lowering the pull arm pivot points with hydraulic rams activated through solenoids. Some adjust by varying the angle of hinged pull arms through electrically driven screws. Others adjust the thickness control screws with electric servomotors. In operation, once the screed is set for the desired depth of spread, the automatic system takes over to produce a smooth mat. Transverse slope is controlled by a pendulum that acts through switches to activate the appropriate piston. The sensitivity of the controls is critical to the smoothness of the mat. The sensors should be properly nulled as provided in the manufacturer's instructions.

457.2.7 Heaters

The screed assembly is equipped with heaters to prevent the mix from sticking to the screed plate. They are used to heat the screed plate at the start of paving operations or on a cool, windy day. Heaters should never be used to heat mix being delivered to the paver. Heaters should be observed while lit to assure they produce sufficient heat.

457.2.8 Screed Extensions

Extensions should be attached properly to the main section of the screed. They should be, as their name implies, an extension of the plane of the tamper bar and the screed section if uniform compaction behind the paver is to be attained.

Pavers with a vibratory main screed and vibratory side extensions should be checked by the inspector for acceptable frequency. Use of a vibrating reed tachometer held against the main screed unit and each extension will give quick, reliable, and measurable results to be compared against manufacturer's authentic data. The accuracy of variable vibratory frequency control supplied on some models could also be checked with the tachometer.

457.3 Maintenance

An important item of paver operation, often overlooked, is proper cleanup of the paver at the end of the working day. While the machine is still warm from its day's operations, the hopper, feeder augers, tamper bars, and screed plates should all be cleaned and sprayed with a light oil to assure smooth start-up the next day of use.

457.4 Reporting

Checks of the paver made by the inspector, results, and necessary adjustments should be recorded in the inspector's diary. For instance, a check of the vibratory screed and its vibratory extensions might be made by means of a vibrating reed tachometer. The results of that testing and any subsequent machine adjustments would be recorded, together with authentic vibratory control data available from the manufacturer of that paver model.

All contracts contain the QMP Ride requirements that requires measuring ride quality in terms of the international roughness index (IRI). Incentives and disincentives for ride are defined in standard spec 440. The dollar values and required ride quality specification limits depend on whether the pavement is placed in a single or multiple layers.

SECTION 458 Placing Asphalt Mixtures

458.1 Pre-Pave Meeting

A meeting should be held with the contractor well in advance of the paving. At that time, all aspects of the paving operation should be discussed and agreed upon.

Advance preparation for the meeting will be needed to collect names and telephone numbers of WisDOT, consultant, and contractor contact persons. It will also be necessary to check out equipment and materials against the standard specifications and contract provisions before the meeting.

A suggested list of topics is shown in figure 458-1. Keeping a written record of the meeting agreements is suggested. A copy can then be furnished for reference during paving, if requested.

FIGURE 458-1 Hot Mix Asphalt Pre-Pave Agenda

Pre-Pave Agenda

Project ID _____ Length _____

Termini _____

Hwy _____ County _____

Pavement Type _____

Meeting Date _____ At _____

Attendees: _____

_____

List for Discussion and Agreement

A. These items are to be checked before the pre-pave meeting, provide available information at the meeting. Not all items below will be applicable.
   1. Personnel (Names, Phone)
      - DOT/consultant
      - Quality assurance team
      - Survey/staking crew chief
      - Scale inspector
      - Paving inspector
      - Density checker
      - Engineer
      - Contractor
      - Quality control team
      - Plant operator
      - Scale person
      - Paving crew foreman
      - Superintendent
      - Staking crew chief
      - Profiler Operator and Supervisor
   2. Equipment (check against specification)
      - Trucks
        - Overall condition?
        - End dump truck or bottom dump?
      - Paver
        - Loading device or intermediate transfer equipment?
        - Tampers and vibratory system
        - Screed
        - Screed extensions tamper/vibratory system

        - Heater
        - Automatic controls
        - Auger
        - Overall condition
    - Profiler
3. Traffic Control (number, hours of operation).
    - Vehicles; use of flashing lights
    - Radios
    - Signs, message boards, arrow boards, barricades
    - Public information sources
4. Materials (grades, gradations, storage, stockpiling, sampling-daytime and off hour, testing).
    - Virgin aggregate
    - Asphalt
    - Salvaged surface
    - Admixtures
    - Fillers
    - Tack
    - Job mix formula
        - Leveling/wedging/widening
        - Lower layer
        - Upper layer
        - Salvage percentage

B. These items are suggested for discussion at the pre-pave meeting. (Not all will apply to your contract.)

1. Paving Operations
    - What are the anticipated dates of paving?
    - What are the anticipated hours of paving?
    - Are there work restrictions in the contract?
    - What is the approximate timeframe for acceptance profiling?
    - What are the traffic control plan provisions that will apply during working and non-working hours? (These should apply to all vehicles and trucks.)
    - Who will be in responsible charge of paving and traffic control during working and nonworking hours?
    - Is the paving being coordinated with other construction operations under this contract or in the area?
    - Has the base or foundation been adequately prepared as required by contract specifications and special provisions?
    - What are the initial proposed mix temperatures (1) at the plant and (2) at the delivery point?
    - Discuss the procedure for filling out, transferring, accepting, and recording tickets for delivered mix.
    - What will be the staking needs? Who will perform them?
    - What will be the minimum/maximum thickness of each layer or course?
    - Are there special requirements when placing wedging, leveling, widening, or curbs?
    - How many trucks will be needed? What is the haul distance, haul route, and dumping pattern? Has the haul road been initially inspected? Who will inspect it during paving and how often?
    - Discuss the acceptable procedure for constructing traverse joints. Discuss procedures for hand raking longitudinal joints and areas the paver can't operate.
    - Will density be tested by nuclear meter or by cut samples? How many tests will be made and when? Will tester require contractor help and protection from traffic?
    - Will estimated tonnage or the specified pavement depth govern?
2. Contingency Plans
    - Are there contingency plans for:
        (1) Cold weather.
        (2) Rain.
        (3) Plant pollution correction.

(4) Major plant corrections and stoppages.

(5) Minor plant adjustments for changing mix percentages, temperature, etc.

(6) Accidents at the plant or on the grade.

- Is backup equipment available in case of breakdown of trucks, paver, or rollers?
- What is the timing of the shouldering operations? Have traffic control needs been considered?
- Will shouldering be done in more than one operation?

458.2 Maintenance of Aggregate Base

On aggregate bases carrying traffic, chuck holes and raveled areas frequently develop in the base between the time it is shaped and the mat is placed. If the damage to the base is extensive, it may be necessary to reshape, but usually the base can be acceptably restored by filling the depressions with the paving mixture. If the depths of the depressions are approximately one inch or more, they should be filled and compacted ahead of the paving operation.

458.3 Ambient Air Temperatures

Air temperature is measured as described in standard spec 450.3.2.1. This section has separate temperature restrictions for paving asphalt upper and lower layers. When paving asphalt bid items (and the contract has special provisions supplementing section 460/465 bid items paid by the ton) and the ambient temperature is anticipated to be below the specified threshold, the contactor is to submit a cold weather paving plan, see CMM 458.10. The department pays for cold weather paving measures in the cold weather paving plan under the Cold Weather Paving Bid Item.

The standard specifications do not allow asphaltic mixtures to be placed upon unstable roadbed, frozen base or subgrade regardless of the ambient air temperature. Asphalt mixtures are to be placed on a prepared, firm, and compacted base, foundation layer, or existing pavement substantially surface-dry and free of loose and foreign material.

458.4 Inspection of Delivered Mixtures

458.4.1 Covering of Loads

All loads of hot mixtures must be covered to minimize heat loss during transport if (1) there is inclement weather, or (2) the ambient air temperature falls below 65 F.

458.4.2 Appearance of Loads

When arriving at the paver, the covers should be rolled back, and the inspector should observe the appearance of the load before it is dumped into the paver. A properly designed and controlled mix will arrive in a slightly mounded condition, be of uniform color and texture, and be without separation of aggregate from asphalt binder. The less stable but still acceptable mixes may flatten out in the truck box, but any loads arriving in a fluid condition or with free asphalt on the surface contain excessive asphalt content and should be rejected. Likewise, close visual inspection will detect loads with excessive uncoated particles, evidence of segregation, loads that are too hot as evidenced by blue smoke, or loads that have lost too much heat in transit as evidenced by hardened crust on the surface or on the edges; these should all be rejected.

458.4.3 Mix Delivery Temperature

As provided in standard spec 450, the mix delivery temperature designated on the asphaltic mix design should be entered in the paving inspector's diary. The temperature of the delivered mixture should be checked periodically and entered in the paving inspector's diary. If the temperature exceeds +/- 20 F of the temperature recommended by the asphaltic material supplier, both the paving foreman and the project leader should be notified immediately The optimum delivery temperature will vary with the materials used and the prevailing atmospheric conditions, but generally the delivery temperature should be as low as possible for proper workability, placement, and compaction on the road, while still allowing for proper mixing and coating of the particles at the plant.

458.4.4 Weigh Tickets

The paving inspector must receive a weigh ticket from the truck driver for each load of asphaltic mixture delivered. When recordation or random-checking weighing procedures are not used, the weigh ticket must have been signed or initialed by the inspector observing the weighing, and the paving inspector must inspect the ticket to see it has been validated. If the load appears acceptable on the basis of this visual inspection, the paving inspector will sign or initial the ticket to verify the material was delivered and

incorporated in the work. The inspector will accumulate the tickets and turn them over to the project engineer daily.

458.5 Longitudinal Joints

It is very important that the highest degree of density achievable be obtained in material placed adjacent to a previously placed lane or existing pavement. If material is placed below the level of the previously placed mat, the previous mat will support the roller, and the newer material along the joint will not be adequately compacted. This occurrence is commonly referred to as "bridging" since the roller bridges over the joint while supported by the higher mat. This frequently leads to raveling of the joint at an early age, particularly when the mat is placed in cool weather in the fall, with rapid cooling of the newer material next to the joint and without the beneficial effect of warm weather and traffic before winter sets in.

The paver screed should overlap the previous pass by 1" +/- 1/2" and should leave the material higher than the previous pass by an amount slightly greater than the consolidation being obtained under the rollers. To ensure that the joint is not starved of material and no bridging of the roller will occur, the material placed on the hot-side of the joint should be slightly higher (approximately 0.1 inch) than the cold side after rolling. Do not rebroadcast excess material across the mat.

SDD 13c19 shows longitudinal joints. The notched wedge joint is the standard joint used at HMA pavement centerlines and lane lines. Lanes paved in echelon are considered confined on both sides of the joint regardless of joint design. The contractor should use a vertical joint for SMA pavements when the notched wedge is not required for traffic.

When constructing notched wedge joints, the paving inspector should ensure that an effective device is used to shape wedge and notches as follows:

- Should be similar to TransTech Notched Wedge Joint Maker, Carlson Tapered Notch, or Willow Notch Wedge Pneumatic Solid Wheel Design, unless the department approves otherwise.

When inlay paving below the elevation of the adjacent lane, the longitudinal joint along the adjacent lane is considered unconfined.

458.6 Transverse Construction Joints

458.6.1 General

There are many variations in the methods used by the various contractors to build transverse construction joints. The emphasis should be on obtaining a smooth riding transition from the cold to the hot mat, and any method proven capable of producing such a joint is acceptable. Basically, some method must be used to cut back the end of the cold mat to a vertical edge and full depth of the course. The joint may be at right angles to the roadway or on a skew. When proceeding away from the joint, the paver is placed so the leading edge of the screed is back of the joint and the screed is supported on the compacted mat by wood or metal strips having a thickness about equal to the amount of consolidation expected due to compaction. The screed should be well heated, and the distributing screw box filled with hot material to the normal operating level before starting the machine. After paving, the joint should be cross-rolled and straight edged to ensure a continuous smooth profile before proceeding.

The following specific procedures are recommended:

458.6.2 Ending a Lane

When terminating paving operations at the end of a day's work, the pavement mat must be cut off vertically, so a full depth lift can be placed squarely against it. This requirement can be satisfied by the following procedure:

1. When the paver is placing the last load of the day, it is shifted into low gear as it approaches the location of the proposed joint.
2. As the hopper empties and the amount of material in the screed chamber decreases below normal operating level, the paver is stopped.
3. The screed is raised and the paver moved out of the way.
4. Asphalt mix is then shoveled away from the end of the mat to form a clean, vertical end.
5. A board or heavy wrapping paper is placed along the edge.
6. The material that was shoveled away in Step 4 is replaced and used to form a taper.

458.7 Resumption of Paving Operations

When construction is ready to resume, the following procedure is used to form a suitable transverse joint.

1. The taper of material is removed along with the board or paper.
2. A straightedge is used to check the longitudinal grade of the mat. Because the paver was running out of material as it laid the last few feet of mat, it is possible those last few feet taper slightly (ramp down) from

the specified level of the mat. If this is the case, a new transverse end must be cut behind the point where the ramping down begins.

3. The vertical face of the mat end is tack-coated.
4. The paver is backed up to the end of the mat and the screed rested on the mat surface.
5. The screed is heated while it rests on the mat. This provides some heat to the material at the end of the mat.
6. The heated screed is raised and shims as thick as the difference between the compacted mat and the uncompacted mat are positioned under its ends.
7. The truck with the first load of hot mix is backed carefully to the hopper. During discharge of the mix from the truck bed to the paver, it is essential the truck not bump the paver and cause it to move.
8. The paver starts forward in a low gear.
9. Once the paver has moved away, excess hot mix is cleaned off the surface of the mat and the evenness of the joint is checked with a straightedge.
10. If a joint is acceptable, a 6-inch width of the hot mix is rolled transversely and the joint checked for smoothness. If the joint is acceptable, transverse rolling is continued in 6-inch to 12-inch wide increments until the entire width of the roller is on the new hot mix. If straight edging shows an uneven joint, the surface of the new mat must be scarified while still warm and workable. Scarification is done preferably with tined lute. Excess material can then be removed or additional material added, and the joint rolled. During rolling, timbers should be placed along the edges of the mat to prevent the roller from driving off the longitudinal edge and distorting it.

Dirty and rolled-down transverse joints should be cleaned and tacked, where needed.

Standard spec 450.3.2.8 requires joints whenever a mat is laid adjacent to an existing asphaltic pavement. Butt joints are used at the ends of projects and at intersecting side roads or streets having asphaltic surfaces. Feather-type joints should be used only when the asphaltic surfacing to be matched is so soft, thin or disintegrated that a butt-type joint would be impractical.

458.7.1 Hand Placing

Spreading of hot mixtures by hand in areas not accessible to equipment is permissible but placing of material or raking over surface courses placed by machine methods should be avoided unless necessary to correct defects. Any mat defect requiring continued hand correction may result from malfunctioning, improperly adjusted, or improperly operated equipment, and the source of the trouble should be located and corrected at once.

When placing material by hand, a greater allowance must be made for compaction than when placed with the paver. The material should be placed by shovel to required depth and shaped to grade and contour with lutes or rakes, rather than spread broadcast with the shovel, which results in segregation of the coarse and fine portions of the mix.

It is desirable to end a mat with a butt joint, but if it is necessary to feather out a mat over an old pavement, the pavement should be given a tack coat, and a thin, feathered edge should be formed by raking out and removing the coarse aggregate.

458.7.2 Shoulders

Shoulders paved separately from travel lanes may be placed to a depth not exceeding 4 inches per layer after compaction. The lift thickness of shoulders paved integrally will match that of the travel lane being placed.

If the paving equipment and compaction equipment used for the travel lanes are too wide for the shoulders, the project engineer may approve other equipment either designed for shoulder operations or deemed to be adequate for that purpose. If the shoulders are being paved integrally, paving equipment must be capable of constructing the designed cross slope of the travel lane and shoulder simultaneously.

458.8 Paver Operation

For best results, the paver should be operated as continuously as possible. To avoid stopping and starting the machine for each load of mix, the speed of the paver must be in balance with the plant production. Furthermore, the speed of the paver must not exceed the speed that produces a dense mat of uniform appearance. Any condition of the paver that causes difficulty in the spread will be magnified at higher paving speeds.

There is a tendency for the paver operator to run the machine at a fast rate for a few minutes and use up the material on hand, then stop and wait for more material to arrive. This type of operation should not be allowed, since during the wait the working parts of the machine and the remaining mix cool off and the screed may settle into the mat. When the paver starts up again, a bump in the pavement as well as a scarred and open texture on the surface may result.

Care and coordination between the paver operator and the truck driver is necessary to prevent twisting or jerking of the paver when the paver picks up the truck. Twisting or jerking of the paver can result in bumps or irregularities in the mat, which can contribute to a poor ride.

The slat feeders should be operating most of the time (80% to 90%), and the flow control gates should be set to keep the augers at least 2/3rd covered with material. It is very important the level of the material in front of the screed is kept constant and the augers in front of the screed are operated nearly continuously while paving. If the level of material is allowed to intermittently rise and fall, thereby flooding or starving the screed, a rough mat, segregation of the material, and imperfections in the surface will result.

In the event of a breakdown of the automatic control system, pavers may be operated manually for only the remainder of the working day in which their automatic control system has broken down.

458.9 Screed Extensions

Any use of screed extensions should be monitored, especially when the extensions are 20 inches or more in length.

Extensions of 10-inch length are generally furnished as a static extension and are acceptable for paving both travel lanes and shoulders. Power actuated (vibratory) extensions of 10-inch length are also acceptable and available.

Under standard spec 450, extensions of 12 inches or more used in paving travel lanes must be power actuated. When screed extensions are used to pave a travel lane, the augers used for spreading material in front of the screed must extend to within 12 inches of the edge of the travel lane. Extensions of 20 inches or more used in paving shoulders may be static (assembled by bolting together several 10-inch static extensions), or they may be power actuated. There is no limitation on the length of static extensions added to the shoulder end of the paver screed for paving shoulders.

Frequency of both static and actuated screed extensions should be checked with a vibrating reed tachometer. Frequency obtained in this way for static extensions should be compared to the frequency of the main screed, and for actuated extensions be compared to the manufacturer's recommended frequency or the desired frequency for the type of mixture being placed. The tachometer will read in RPMs, which is equivalent to vibrations per minute.

Should a significant difference or variation in frequency exist for an actuated screed, adjustment or replacement is called for. If tearing or a difference in texture is observed under a static extension, or if the frequency check indicates a significant difference in frequency between the main screed and the static extension, replacement with an actuated extension is called for.

458.10 Cold Weather HMA Paving

The main challenge of cold weather HMA paving is to achieve a uniformly consistent mat with adequate compaction while the mixture is rapidly cooling. Generally, if adequate density is obtained, the pavement will perform as expected. Cold weather compaction depends upon having enough time for the mixture to remain workable and enough equipment to obtain adequate density.

The project team and contractor should make a concentrated effort to make sure paving takes place during the acceptable paving times listed below:

- Northern Asphalt Zone (May 1 - October 15)
- Southern Asphalt Zone (April 15 - November 1)

See figure 458-2 for zone definition.

A cold weather paving plan per CMM 458.10.1 is required if temperatures during the time of paving are less than 40 F. Paving is only to take place for lower layers if temperatures are >32 F, and for upper layers > 36 F and rising. Temperatures are to be taken approximately 3 feet above grade, in shade, and away from artificial heat sources. If less than 40 F, a valid project engineer-approved cold weather paving plan is required and remains in effect throughout the entire day of paving and will be re-evaluated each subsequent day of paving. In summary, while temperature 24 hours in advance allows for planning, temperature at the time of paving dictates actions as follows:

40F or Above
Upper Layer Normal Paving
Lower Layer(s) Normal Paving

< 40F to > 36F
Upper Layer Pave with Cold Weather Plan
Lower Layer(s) Pave with Cold Weather Plan

< 36F to > 32F
Upper Layer NO PAVING
Lower Layer(s) Pave with Cold Weather Plan

Below 32F
Upper Layer NO PAVING
Lower Layer(s) NO PAVING

EXAMPLE #1:

Temp. 24 hours in advance: Over 40 F

Actual temperature day of paving: Below 40 F

Discussion:

If the forecasted temperatures are close to 40 F, discussions should take place between the department and contractor regarding how long the temperatures look to be below 40 F, and whether or not the start time needs to be adjusted. A cold weather paving plan should be confirmed or revised as needed. If paving below 40 F, the cold weather paving plan is in effect. The cold weather paving plan would be in effect with full specifications, and the cold weather paving item would be measured and paid for accordingly.

EXAMPLE #2:

Temp. 24 hours in advance: Over 36 F

Actual temperature day of paving: Below 36 F

Discussion:

If the forecasted temperatures are close to the 36 F allowable temperature, discussions should take place between the department and contractor regarding how long the temperatures look to be below 36 F, and whether or not the start time needs to be adjusted. Regardless, upper layer paving is not to occur until 36 F is reached. Additional conversation between the department and the contractor should occur before loadout. Once temperatures are reached, the paving plan is in effect and remains for the entire day with full specifications.

EXAMPLE #3:

Temp. 24 hours in advance: Over 32 F

Actual temperature day of paving: Below 40 F, but over 32 F

Discussion:

Cold weather paving plan is in effect and remains for the entire day with full specifications. The tonnage placed is calculated and the cold weather paving item is measured and paid.

EXAMPLE #4:

Temp. 24 hours in advance: Below 40 F

Actual temperature day of paving: Above 40 F

Discussion:

Paving is to occur as planned. Additional conversations should occur between the department and the contractor before production starts to ensure both parties are on the same page. If the project engineer and contractor agree to pave under the cold weather paving plan in advance, and the contractor has already added the warm mix additive to the tanks of PG Binder, the project engineer and contractor will discuss how to proceed and whether or not payment for the cold weather paving item is reasonable.

GENERAL RULES:

- If temperatures 24 hours in advance look like they will drop below acceptable paving temperatures, no paving is to occur (or not until required temperatures are met-and still allow for anticipated production tonnage). For temperatures below 40 F (but $\geq$ 36F for upper layer, and $\geq$ 32F for lower layer), a cold weather paving plan is to be in place and full specifications apply.

- In all cases, conversations need to occur between the project engineer the day before paving, and before production starts for the shift on the day of paving. This conversation is to ensure both parties are in agreement on the operations and if the cold weather paving bid item is in effect or not.
- Standard spec 108 discusses how to handle adverse weather in the contracts and applies to cold weather for paving as well.
- Use of warm mix additive as a compaction aid will help with compaction of the mix above 40F, and should be considered as appropriate, and agreed to by the project engineer and the contractor in advance.
- Contract schedule and future forecast should not be used to limit when the contactor can pave using the cold weather paving item. There are many times near the end of the construction season when several contracts need to be completed, and not all of them can wait for ideal conditions to pave.
- Also note, that paving below 32F should not occur, unless under an emergency or temporary traffic control situation. STSP 450-010 for extreme cold weather paving is used only for temporary traffic and staging conditions, and should not be used as an extension of the paving season.
- Ideally, all paving will be completed above 40F, and the cold weather paving provisions will be rarely used. Interim completion dates for paving items, mandatory start dates for contracts, and project completion dates should all be used to minimize asphalt paving in early spring or late fall conditions.

458.10.1 Cold Weather HMA Paving Plan

Generally, if the contract has the HMA Cold Weather Paving bid item, a cold weather paving plan is required. Standard spec 450.3.2.1 requires the contractor to provide a cold weather paving plan at the preconstruction meeting. The project engineer needs to review and provide written acceptance of the cold weather paving plan before placement. At a minimum, the contractor is required to include the following items:

1. Use a department approved warm mix additive to help aid in compaction during cold weather paving. Foaming additives that introduce water are not allowed as a cold weather compaction aid.
2. Type/name of additive and dosage rate should be documented by the contractor in the cold weather paving plan. Load tickets will identify when the cold weather paving item is in effect.
3. Identify the measures taken to ensure that the lot density is achieved. Specify intended modification to the compaction process that will be utilized when applicable.

Achieving compaction in cold weather can be a challenging task. The items above may be supplemented by other techniques to aid in achieving compaction. Other recommended techniques include:

1. Avoid handwork or feathering of the HMA mix. These operations take additional time allowing the HMA mix to cool below temperatures needed to achieve good compaction.
2. Adjustments could be made to the mix temperature per the PG binder and WMA additive manufacturer production temperature recommendations.
3. Use heated or insulated boxes on trucks hauling asphalt. Tightly tarp the loads for longer hauls and to prevent exposure to the elements, as loose, flapping tarps may actually increase heat loss.
4. Keep the rollers as close to the paver as possible.
5. Using more or higher capacity rollers such as rubber-tired rollers. However, measures are needed to prevent tracking of the asphalt when using rubber-tired rollers, and heating the tires is recommended. The rollers can be fitted with skirting around the tires. Additionally, consider ducting engine exhaust inside the skirt enclosures to keep the tires hot. A WisDOT approved release agent could be added to the roller water to prevent tracking by the tires.
6. Use of transfer device may be helpful.

458.10.2 Cold Weather HMA Paving Observation

If cold weather paving is occurring, certain items should be noted and monitored by the project engineer:

1. Is the base inadequately compacted, frozen or excessively moist or a unstable roadbed? If so do not allow paving. Likewise check condition of existing pavement that is being overlaid, ensuring that it is dry.
2. Review the cold weather paving plan before the start of cold weather paving to ensure conformance and provide written acceptance before placement. At the close of business and before the next shift, determine whether or not the contractor is allowed to pave. The quality assurance team should be given proper notification when conditions qualify as cold weather paving.
3. Is the cold weather mix design being used and identified on the truck tickets as having a warm mix additive? Was the mixture used throughout the entire day of production?
4. Monitor the temperature of the mix to ensure that it conforms to the recommended mixture temperatures according to the mix design.
5. Document the additional steps (if needed) the contractor took to comply with the cold weather paving plan in order to meet the minimum density requirements.
6. Are the rollers operating close to the paver to ensure compaction occurs while the asphalt is in the proper temperature range? Do not allow over rolling of the mat.

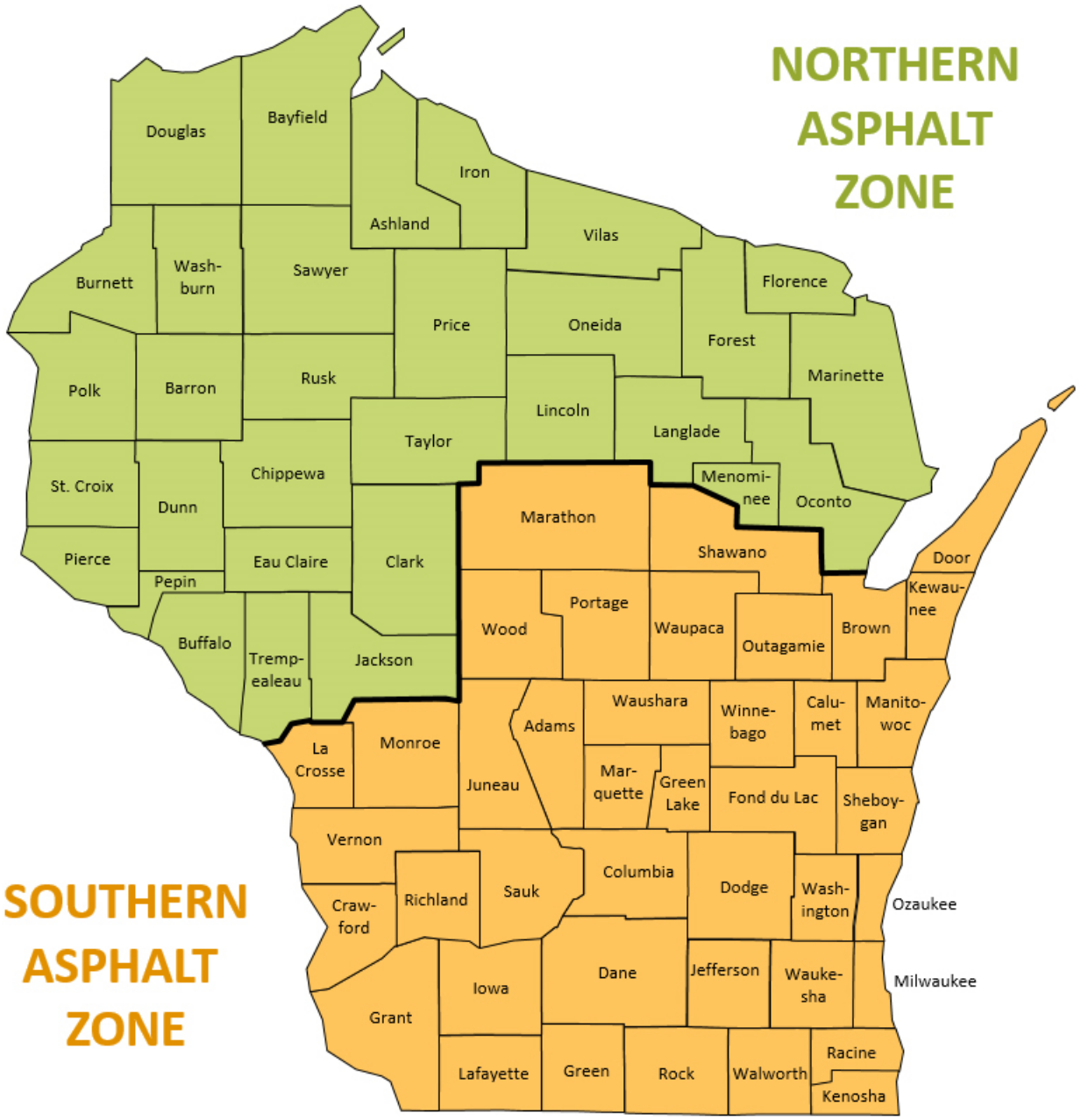
458.10.3 Compaction Time

Determining time for compaction can be done easily with Multicool software available from the National Asphalt Paving Association at:

http://www.asphaltpavement.org/multicool

It is generally accepted that thicker pavements cool slower than thinner pavements resulting in a longer compaction time window. Increased wind speed can also lead to a quicker cooling of the layer. These variables (and others) can be input into the Multicool software to see the effect on the necessary compaction time. This software can be used by the contractor and, as necessary, engineer to monitor the effectiveness of the cold weather paving operations.

FIGURE 458-2 Asphalt Zone Map



SECTION 459 Asphalt Mat Inspection

459.1 Duties of the Paving Inspector

The inspector must be thoroughly familiar with the specifications and see that they are complied with during asphalt paving operations. When inspecting paving operations, the inspector should:

- Ensure that each load of mix is acceptable, that data from the truck tickets are recorded accurately, and that the paver is operated properly.
- Ensure corrections are made before the mix cools if any deficiencies appear in the mat during placing.
- Pay attention to details such as proper thickness of the spread, proper crown, properly constructed and matched joints, correct surface texture and uniformity, and the rate of "tack" application.
- Monitor the hot mix to ensure that proper mix temperature is maintained during the paving operation.
- Maintain a diary recording anything unusual or events that may be useful for future reference.

The inspector must keep accurate records. In addition to the information included on haul tickets, there are other important items that must be recorded as part of the permanent records. Any unusual occurrences or changes in construction methods, equipment, appearance, or handling properties of the mix should be noted in the diary along with the station (location) on the roadway where the change was made. The daily diary is for the inspector's convenience during construction, but upon completion of construction it becomes a part of the permanent records of the project. In addition to the information shown above, the inspector should include summaries of test reports of density of pavement samples for each type of mixture used. The inspector should also note any delays and their causes, as well as list all visitors to the project.

The inspector must be able to identify deficiencies in the finished pavement and understand possible causes of those deficiencies. Keep in mind that a given deficiency may have several possible causes. In many cases, sampling and testing is the only reliable means for analyzing a pavement problem. Refer to tables 459-1 and 459-2 for troubleshooting guides to mat deficiencies, problems, and imperfections.

459.2 Temperature of the Mix

The mix temperature is usually checked in the truck; occasionally, it should be checked behind the paver. This is particularly important early in the day when both the surface on which the material is being placed and the air are cool. It must also be checked whenever the mix appears to be cold or when the breakdown roller is falling behind.

Mat temperature is taken by inserting the thermometer stem into the uncompacted mat to the mid-point of the mat's thickness and compacting the mat against the stem by lightly tamping the mat surface with one foot.

459.3 Torn or Open Texture

The texture of the mat before compaction should appear uniformly dense, both transversely and longitudinally. If tearing or open texture appears only at the beginning of a day's run, it is probably caused by the screed not being heated sufficiently. If a tear appears under screed extensions, the alignment of the extension and the tamping bars and vibrators need to be checked. Tearing and scuffing will also result from improper setting of a paver equipped with a tamping bar in the screed unit.

If there is an open or torn texture at the center of the mat behind the paver, additional lead crown may be needed in the front edge of the screed. This forces more mix into the central portion of the screed, closing the texture. If the tears occur on the outer edge, there may be too much crown in the leading edge, forcing too much material in the center and too little at the edges. Reducing the center crown slightly will distribute more material toward the edges and provide a more uniform mat.

Tearing often occurs in a mix that is too cold, or which appears open and coarse.

A mix containing excess moisture will not lie properly and will have the appearance of a cold mix or an over-asphalted mix. In addition to possibly tearing, the mix will bubble and blister.

459.4 Surface Smoothness

Pavement smoothness is adversely affected by a lack of uniformity in the paving operations, improper aggregate gradation, variations in paver speed, improper operation of trucks, and poor joint construction practices.

Stopping the paver can cause roughness in the pavement. Every time the paver stops, there is a possibility of the screed leaving a mark on the surface of the mat. If the screed settles into the mix, it causes the automatic sensor to act as if the paver has traveled into a depression. As the paver starts off, the screed lays a thicker mat. This continues until the sensor recognizes the excessive thickness and decreases the slope of the screed. Then a dip is developed until the screed levels out, approximately 50 feet from where the paver stopped.

Rough pavements also result from changes in amounts of material introduced in front of the screed. If there is not enough material in front of the screed, the screed will drop. If there is too much material in front of the screed, it will rise. The ideal situation is to maintain a uniform amount of mix ahead of the screed at all times.

Excessively coarse aggregate may result in a harsh mix that creates a coarse texture and an uneven surface. Excessive fines may cause a low stability in the mix and allow ripples to form. Remediation will have to begin with revisions to the aggregate sizing and gradation.

TABLE 459-1 General Problems and Causes in Placing Asphaltic Pavements

	Excess 75 µm material	×			
	Too hot or too cold	×			
	Too dry or too rich		×		
	Lack of fines		×		
	Too cold		×		
	Improper mat thickness vs. aggregate size ratio		×		
	Mixing temperature fluctuations			×	
	Segregated aggregate stockpile				×
	Poor cold feed				×
	No. 1 hot bin segregation				×
	Insufficient dry mix time				×
	Truck brake set too hard			×	
	Improper loading of truck				×
	Improper rolling			×	
	Over-rolling where base deflects	×			
	Turning too abruptly	×			
	Reversing too abruptly	×		×	
	Build-up in hopper sides				×
	Flushing of fines				×
	Screed over-control			×	
	Over-loading spreading screws			×	
	Screed rams holding			×	
	Condition of tamper or screed		×		
	Adjustment of tamper or screed		×		

TABLE 459-2 Specific Problems and Causes in Placing Asphaltic Pavements

Types of pavement imperfections that may be encountered in laying plant-mix paving mixtures.	Bleeding	Brown, dead appearance	Rich or fat spots	Poor surface texture	Rough uneven surface	Honeycomb or raveling	Uneven joints	Roller marks	Pushing or waves	Cracking (many fine cracks)	Cracking (large long cracks)	Rocks broken by roller	Tearing of surface during Laying	Surface slipping on base
Operating finishing machine too fast				×	×								×	
Excessive segregation in laying			×	×	×	×	×						×	
Labor careless or unskilled				×	×	×	×	×						
Excessive hand raking				×	×	×	×		×					
Excessive prime coat or tack coat	×		×											×
Excessive moisture in subsoil										×	×			×
Overweight rollers					×			×	×	×	×	×		×
Roller standing on hot pavement					×			×						
Rolling mixture when too cold				×	×	×	×	×						×
Rolling mixture when too hot				×	×		×	×	×	×		×		
Over-rolling				×						×	×	×		×
Inadequate rolling				×	×	×	×	×						×
Spreader in poor condition				×	×	×	×		×			×	×	
Poor spreader operation				×	×	×	×		×			×	×	
Mixture too cold				×	×	×	×	×				×	×	×
Mixture too hot or burned		×							×				×	
Excess moisture in mixture		×							×					×
Unacceptable batches in load	×		×	×	×	×			×					
Improperly proportioned mixture	×		×	×	×	×		×	×	×		×	×	×
Excess asphalt	×		×					×	×					×
Insufficient asphalt		×				×				×			×	
Excess fines in mixture				×				×	×	×				×
Mixture too coarse				×	×	×	×					×	×	
Improperly cured prime or tack coat					×				×					×
Insufficient or non-uniform tack coat					×				×					×

TABLE 459-2 Specific Problems and Causes in Placing Asphaltic Pavements (cont'd)

Part A	CAUSES																	
PROBLEMS	Fluctuating head of material	Feeder screws overloaded	Finisher speed too fast	Too much lead crown in screed	Too little lead crown in screws	Over-correcting thickness control screws	Excessive play in screed mechanical connection	Screed riving on lift cylinders	Screed plates worn out or warped	Screed plates not tight	Cold screed	Moldboard on strikeoff too low	Running hopper empty between loads	Feeder gates set incorrectly	Kicker screws worn out or mounted incorrectly	Incorrect nulling of screed	Screed starting blocks too short	Screed extensions installed incorrectly	Vibrators running too slow
Wavy surface - short waves (ripples)	4	4	4				4	4		4									
Wavy surface - long waves	4	4				4	4	4					4	4					
Tearing of mat - full width			4						4		4								
Tearing of mat - center streak					4				4		4			4	4				
Tearing of mat - outside streaks				4					4		4	4		4				4	
Mat texture - non-uniform	4	4	4					4	4	4	4		4					4	4
Screed marks							4												
Screed not responding to correction			4				4	4		4									
Auger shadows		4																	
Poor pre-compaction			4					4											4
Poor longitudinal joint	4	4				4		4											
Poor transverse joint		4					4	4		4						4	4		

1. Find problem above.
2. 4's indicate causes related to the paver.
3. X's indicate other problems to be investigated (continued on next page.)

Note:

Many times, a problem can be caused by more than one item; therefore, it is important that each cause listed is eliminated to ensure solving the problem.

TABLE 459-2 Specific Problems and Causes in Placing Asphaltic Pavements (cont'd)

Part B	CAUSES																		
PROBLEM	Grade control mounted incorrectly	Grade control hunting (sensitivity too high)	Grade control wand bouncing on reference	Grade reference inadequate	Sitting long period between loads	Improper joint overlap	Improper mat thickness for max. agg. size	Trucks bumping finisher	Truck holding brakes	Improper base preparation	Improper rolling operation	Reversing or turning too fast of rollers	Parking roller on hot mat	Improper mix design (aggregate)	Improper mix design (asphalt)	Mix segregation	Moisture in mix	Variation of mix temperature	Cold mix temperature
Wavy surface-short waves (Ripples)	4	4	4	4						×	×			×	×	×		×	
Wavy surface-long waves	4			4	4			×	×	×		×	×			×		×	
Tearing of mat-full width							×							×	×	×	×	×	×
Tearing of mat-center Streak																			×
Tearing of mat-outside streaks																			×
Mat texture-nonuniform					4		×			×				×	×	×		×	×
Screed marks								×	×										
Screed not responding to correction	4						×											×	×
Auger shadows														×	×	×			
Poor pre-compaction							×			×									×
Poor longitudinal joint	4	4	4			4					×								×
Poor transverse joint											×								×
Transverse cracking (checking)										×	×			×	×		×	×	
Mat shoving under roller										×	×	×		×	×		×	×	
Bleeding or fat spots in mat														×	×		×	×	
Roller marks										×	×	×	×					×	
Poor mix compaction										×	×	×	×	×	×		×	×	×

1. Find problem above.
2. 4's indicate causes related to the paver.
3. X's indicate other problems to be investigated.

Note:
Many times, a problem can be caused by more than one item, therefore, it is important that each cause listed is eliminated to assure solving the problem.

459.5 Pavement Geometrics

Geometrics refer to the size and shape of the finished pavement. It includes longitudinal grade, cross slope, alignment, crown, and thickness. Checking the geometrics involves first knowing the plan typical section, taking measurements, and comparing results against the plan. Measurements should be done as early as possible to catch errors in the paving operations, and then be repeated as needed at changes in the plan typical section.

Mat thickness will need to be checked regularly. It will have to be measured before rolling and after rolling to determine the decrease in thickness due to the compaction caused by rolling. It will also have to be checked regularly during paving to calculate yield or spread. Mat thickness can be determined before compaction by using a depth gauge, or by extending a straightedge over the edge of the mat and measuring the distance between the straightedge and base. After compaction, measuring with the straightedge is repeated. Also, cores of compacted mixtures may be cut out of the finished pavement for measurement and testing.

459.6 Segregation

The development of open or segregated areas or spots in the placement of asphalt pavement layers should be recognized as significant cause for alarm and subsequent corrective action. This is particularly critical in the laying of the upper layer.

Segregated areas are prone to early failure as evidenced by the poor performance of these areas only a few years after placement. These are the areas that lead to the need for early correction such as seal coating and spot patching several years in advance of the expected or experienced life of the surface as a whole.

When it becomes evident that segregation is a problem, every effort should be extended to determine the cause of the problem and make correction. Table 459-3 provides general steps to avoid segregation:

TABLE 459-3 Steps to Avoid Segregation

Mix Design	Ensure that the aggregate gradation is well within tolerances and there are no gaps.
Stockpiles	Build horizontally. Limit layers to 6 feet. Avoid building cones by central conveyor.
Mixing Plant	Adjust mixing time to completely coat the aggregate. Use the specified percentage of asphalt. Keep aggregate bins full. Do NOT empty completely.
Storage	Equip the silo top with a gob hopper or a rotating chute. Fill the gob hopper complete before it is discharged. Drop the mix vertically into the gob hopper. Completely empty the gob hopper at each discharge.
Trucks	Use a weigh batcher to load into trucks. Load in three separate drops: front first, rear next and middle last.
Paver	Have truckers dump the full truckload to fill the hopper. Do NOT complete empty the hopper between each truckload. Do NOT dump the hopper wings when the hopper is empty. Keep the augers 2/3rds covered with mix. Run slat feeders 80-90% of the time. Operate the paver in a continuous manner. Do NOT stop between truckloads. Adjust the paver to run at the production speed of the plant.

459.7 Checking Yield or Spread

In estimating the quantity of asphaltic mixture required for a project, 112 pounds per square yard per inch of thickness is normally used for the travel lanes, with an additional allowance up to 10% to provide for wedging, curve correction, and side road approaches. Since the contract quantity is an estimate, ensure that the contractor provides the plan mat thickness rather than the contract quantity. Consequently, expect some under-run or over-run.

In resurfacing work, the course thickness varies over its cross section due to variations in crown and surface irregularities in the base. In this case, unless the contract specifies otherwise, the plan thickness is considered the minimum dimension and any irregularities should be corrected by additional thickness

of mat. In surfacing over new bases, the plan thickness should be closely approached, but minor variations can be tolerated.

Average thickness being placed should be checked periodically based on the mixture placed over time (several hours, half day or day), compared with the theoretical, and adjustments made. Compute the amount of material that theoretically should be used for the desired mat thickness using the density in pounds per cubic foot being determined from density samples taken from pavement on the job.

Example 1

Determine average actual thickness of a surface layer, compare against theoretical thickness and adjust as needed.

Density by test = 146.1 lbs./cubic foot

Plan depth = 3" (lower layer)

Width placed = 12'

Length placed = 3,250' in 4 hours (measured)

Tons placed = 650 tons (by ticket)

Weight/S.Y./Inch depth = $146.1 \times \frac{27}{36} = 109.58$ lbs.

Theoretical mass = $\frac{3{,}250' \times 12' \times 3" \times 109.58}{9 \text{ S.F.} / \text{S.Y} \times 2{,}000} = 712.27$ tons

Comparison with the 650 tons actually placed indicates less than plan thickness has been placed. The difference is over 8%. Adjust by decreasing the distance paved per truckload as calculated below.

Example 2

Determine new required distance per truckload.

$146.1 \times \frac{1}{12} \times 3" \times 12' = 438.3$ lbs./ft. is currently placed.

$438.3 \times \frac{712.27 \text{ Tons}}{650 \text{ Tons}} = 480.3$ lbs./ft. should be placed.

Length paved per truck should be = $\frac{\text{Net Weight of Load (lbs.)}}{480.3}$

Example using 30,000 lbs. load:

Length paved should be = $\frac{30{,}000}{480.3} = 63$ ft.

After the paver is set to yield a compacted mat of the desired thickness, a correlation can be made between the loose depth behind the paver and the compacted thickness. Once established, for proper foundation preparation and leveling or wedging course placement, adjustment of the paver thickness control should be minimized. If the inspector observes a 1 1/2" compacted thickness is achieved by placing 1 7/8", between regular yield calculations the inspector will, for that mixture, only have to check occasionally for a loose depth of 1 7/8".

Example 3:

Say 3/4-inch was allowed for consolidation, so 3-3/4 inches were being placed (un-compacted depth), but it has been shown to be insufficient from Example 1.

$(\frac{712.27}{650} \times 3) + 0.75$ inch = 4.04; say 4 inches

Increase un-compacted depth behind paver to 4 inches. Recheck per Example 1 above.

SECTION 461 Compaction and Density of Asphalt Pavement

461.1 General

Compaction of the asphaltic pavement or surface is geared to achieving the required density and ride qualities. The contractor is responsible for mixture design, quality control of the production of the mix, and attainment of required pavement density. Specific rolling patterns and compaction equipment specifications have mostly been removed from the standard specifications. The one exception requires a minimum number of rollers for mixture compacted by the ordinary compaction procedure.

Standard spec 460 sets forth the specifications for required densities and establishes reduced payment schedules for pavements deficient in density. Regardless of reduced payments the intent is to achieve the required density. Section 460 requires that the contractor not operate below the specified minimum density on a continuing basis. If the minimum required density cannot be obtained production must be stopped until the source of the problem is determined and corrective action taken to bring the work into compliance with the specifications.

461.2 Initial Rolling

Initial or breakdown rolling should be accomplished as soon as possible after the material has been spread. Vibratory three-wheel or tandem steel wheel rollers are generally used. Pneumatic-tire rollers may be used for breakdown rolling provided detrimental pick-up does not occur and the rutting can be removed in subsequent rolling operations. Use of pneumatic-tire rollers may be particularly effective when overlaying rutted or irregular pavements, since bridging over the uneven surface will be minimized.

The lead wheel of a roller should be driven so the mix is drawn under the roller and not pushed ahead in a wave. Usually, each drum of a vibratory roller is driven. The roller should be operated very slowly to minimize displacement and promote particle orientation for increased density.

Vibratory rollers are usually not operated in the dynamic mode at speeds in excess of 2-1/2 miles per hour. Vibratory rollers are equipped with variable amplitude and frequency controls. Amplitude is the total vertical motion of the drum. Frequency is the speed of rotation of the eccentric mass and is measured in vibrations per minute. To be effective, the settings for amplitude and frequency must be selected to satisfy job conditions. The total applied force must be great enough to attain the specified density but low enough to avoid decompaction or a reduction in density. For thick lifts over 2 inches in thickness, a high amplitude and low frequency is best. For thin lifts under 2 inches in thickness, a low amplitude and high frequency is best.

Rolling of the first lane paved should begin on the outside or low edge of the lane and progress toward the inside or high side, each pass overlapping the previous one. In general, to avoid stress cracks near the unconfined pavement edge, the roller should overhang the unconfined edge of the pavement by approximately 6 inches on the first pass. If stress cracks result from overhanging the roller over the unconfined edge on the first pass, an alternative method is to make the first pass 6 inches back from the unconfined edge. The best rolling method may be mix and lift thickness dependent. The roller should roll up as close to the paver as possible on each pass. Stopping and reversing the roller at the same transverse location in adjacent passes should be avoided.

The same roller procedure is followed on successive lanes, except the longitudinal joint is rolled first, with the roller riding on the hot mat leaving a gap of 6 to 8 inches at the joint which is not rolled on the inward pass, and then on the reverse pass riding on the hot mat and overlapping 6 to 8 inches onto the cold mat. The pavement outside of the roller edge should be closely monitored to ensure that stress cracks are not forming in the hot mat on the first pass. If stress cracks are observed, an alternate method such as overlapping 2 to 5 inches onto the cold mat on the first pass may be considered.

Rolling of "tender mixes" (slow-setting mixes) may need experimentation to achieve uniform, required density. Delaying the initial rolling until the mixture cools and gains internal viscosity may be one approach. Initial rolling by a vibratory roller with the vibrating system shut off on the forward pass may be helpful. Frequency and amplitude should be adjusted on the return pass to avoid decompaction. Immediate testing by nuclear meter after each pass can serve as a check on the effectiveness of the rolling procedure. Results may allow the roller operator to avoid unneeded passes, incorrect vibrator settings or correct other detrimental techniques.

461.3 Intermediate Rolling

Pneumatic-tire rollers may be used for intermediate rolling while the mat is still warm. Rollers should be operated continuously between the hot and cold roller. Rolling patterns should be the same as for initial rolling, but higher speeds are normally permissible and desirable to obtain more coverage.

One problem with pneumatic-tire rollers is the hot mixture sometimes sticks to the tires. This is often used as an excuse for not rolling the mat when it is hot enough for the rolling to be effective. However, a slight

amount of pick-up can be tolerated, and one or more of the following measures may be used to minimize or prevent pick-up. First, the tires must be cleaned of any clinging asphalt. The tires should then be allowed to warm up uniformly over the tire surface, using as little water on the wheels as possible. A small amount of nonfoaming household detergent or soluble oil added to the roller water at the rate of one part of oil to 50 parts of water helps to prevent pick-up. Use of frame-mounted skirts or scrapers may be effective in removing picked-up asphaltic mix from the tires.

461.4 Final Rolling

Final rolling is performed when the mat has cooled to the degree that few or no roller marks are left by the roller, and densification can be accomplished without shoving the mix excessively or causing the surface to "check." Rolling should be continued until all evidence of increased compaction disappears; checks, creases, ruts, and ridges from previous rollings are eliminated; and all bumps are ironed out.

461.5 Reporting

It will be necessary for the inspector to record in the inspector's diary all the particulars that will give a clear and complete picture of the compaction train. This includes the following:

- Number of rollers.
- Make and model of the roller(s).
- Actual compactive weight.
- Rolling pattern and number of passes.
- Tire pressure (pneumatic-type only).
- Frequency and amplitude (vibratory-type only).
- Beginning and ending stations.
- Ambient conditions. - Tons placed.
- Time elapsed.
- Problems encountered and changes made to resolve problems.

461.6 Compaction Procedures

461.6.1 Ordinary Compaction Procedure

Standard spec 450.3.2.6 provides that all asphaltic patching, leveling, or wedging layers and base courses be compacted to the degree no further appreciable consolidation is observed under the compaction equipment. All asphaltic surface courses, except safety islands, should be compacted under this procedure.

Determination of adequate compaction by this procedure is based on the observer's judgment. At least two passes of the roller will be necessary to determine if additional consolidation is occurring.

461.6.2 Specified Density Procedure

All layers or courses not compacted by the ordinary compaction procedure will be compacted by the specified density procedure, in which compactive effort is applied until a pre-determined density has been achieved.

461.7 Field Densities

Field densities are usually taken by nuclear methods in accordance with established procedures in chapter 4. When nuclear methods are not used, the immersion method must be used. Once a method has been selected for determining mat density, that method should be followed throughout the work.

When the immersion method is used, a field density determination should be made on pavement samples before they are submitted to the laboratory. This density should be noted on the shipping tag or letter of transmittal (when used). Both the density obtained in the field and in the laboratory, will be indicated on the test report.

500 Structures

CMM 510 Concrete Masonry
CMM 515 Concrete Structures
CMM 520 Steel Bridges
CMM 525 Bridge Decks
CMM 528 Concrete Deck Removals, Overlays, and Structure Repairs
CMM 530 Painting
CMM 540 Piling
CMM 545 Railing
CMM 550 Pipe Culverts
CMM 555 Noise Walls
CMM 560 Retaining Walls
CMM 565 Temporary Structures
CMM 570 Ancillary Structures

SECTION 510 Concrete Masonry

510.1 General

Instructions in this section apply to the proper control of procedures and operations used to produce concrete in its plastic state. These instructions are applicable to all grades and classes of concrete used in the construction of pavement, structures, and miscellaneous items.

Placing, consolidating, finishing, curing, and protection of the mixed concrete are discussed elsewhere in this manual under the specific work items, such as pavement, structures, curb and gutter, etc.

Procedures for sampling and testing of the cement, aggregate, admixtures, and concrete are included in CMM 800.

510.2 Stockpiling Aggregates

Concrete mix designs are based on uniformly graded aggregates containing the proper proportions of the various sizes from coarse to fine.

Segregation is the separation of the coarser and finer particles, where an excess of either one tends to accumulate over a particular area. Contamination is the presence in the aggregates of foreign materials that are unsuitable and detrimental in a concrete mix.

The following procedures should be followed in handling aggregates to reduce segregation and contamination to a minimum.

1. The site selected for stockpiling should be cleared and graded to a firm foundation. The area should be sloped to drain, preferably in a direction away from the side on which trucks or equipment will operate when building the stockpile. Equipment should never be allowed to operate over soft or muddy ground when it tracks in muddy soil and contaminates during construction of stockpiles.
2. If lack of room does not allow the complete separation of the stockpiles, partitions or bulkheads are required between them to prevent intermingling of the fine aggregate and the several sizes of coarse aggregates.
3. Standard spec 501.3.3.1 requires coarse aggregate stockpiles to be constructed so that separation of the coarse and fine fractions is minimized. Significant segregation or variation in gradation will result when stockpiles are built cone-shaped or by dumping on a slope, so stockpiles should be constructed in layers. Judicious use of rubber-tire bulldozers or front-end loaders can be allowed if continued travel over the same area does not cause excessive aggregate breakage.
4. Uniformity of moisture content, particularly in sand, is essential in the production of a concrete mix of uniform consistency. Sand coming directly from the washing plant must be stockpiled for 12 hours before being used, to allow it to drain to a reasonably uniform moisture content. If conditions allow, the engineer may reduce this waiting period. When an excess of moisture collects in the bottom of the pile, sand from this location should not be used until a moisture determination has been made. A similar condition may exist in the bottom of the aggregate bins, particularly after a rain when material has not been used for some time. To avoid excessively wet initial batches, the first batch or two should be dumped back in the stockpile when operations are resumed.

510.3 Ready-Mixed Concrete

Standard spec 501.3.5.1 provides that ready-mixed concrete may be central-mixed concrete, transit-mixed concrete, or shrink-mixed concrete.

510.3.1 Central-Mixed Concrete

In the case of central-mixed concrete, the concrete is mixed in a stationary mixer located at the batching plant and the mixed concrete is transported to the job site. Stationary mixers may be of a comparatively large capacity, up to 10 cubic yards. For mixers having a rated capacity greater than 1 CY, the mixing time should be a minimum of 60 seconds, provided plant operations are reasonably stabilized and controlled, and apparent blending of materials during charging is achieved to the satisfaction of the engineer.

Should the stabilization, control, and blending not be accomplished the engineer may increase the mixing time to 75 seconds. The maximum mixing time should not exceed the minimum by more than 60 seconds. Exceptions to the minimum mixing time should be made only as allowed in standard spec 501.3.5.3.

Where central-mixed concrete is used, it is a requirement of the specifications that positive mechanical control of the mixing time be maintained by means of a timer and interlock, which prevents discharge of a batch before the required mixing period has been completed. Adequate provision for inspection control must also be maintained.

Proper blending of the materials being charged into the mixer is required. Standard spec 501.3.5.3 describes the sequence of charging the mixer to obtain the proper blending of the materials.

Stationary mixers operated by the contractor for producing central-mixed concrete should be checked for operating features that provide control of the mixing.

510.3.2 Transit-Mixed Concrete

Transit-mixed concrete is concrete completely mixed in a truck mixer. When transit-mixed concrete is used, truck mixers should be checked for mixing blade condition and assurance that there is no leakage from the water tank into the mixer.

Truck mixers are required by standard spec 501.3.5.3 to be equipped with an approved revolution counter. It should be read at the time of loading and marked on the load ticket for comparison with the revolution reading at time of discharge of the load.

Truck mixing must be done at the job site or the batching plant unless the truck is equipped with an accurate and dependable device to indicate and control the number of revolutions at mixing speed. This requirement is waived for truck mixers operating from plants erected for the sole purpose of supplying concrete to highway projects when the delivery time is so short the maximum 110 mixing revolutions cannot be exceeded. Truck mixers should be set at mixing speed when leaving the plant. Truck mixers are to be operated at agitating speed between the batching plant and the job site unless equipped with the above device.

When the mixing must be performed at either the job site or the batching plant, the plan selected must be by mutual agreement between the engineer and contractor (ready-mix dealer) based on consideration of all pertinent factors.

Generally, best control can probably be maintained by complete mixing at the batching plant, and this is recommended when an additional person can be made available to inspect the operation. When personnel consideration prevents adoption of this procedure, job site mixing may be resorted to.

Mixing of concrete in truck mixers, for either initial mixing or after adding extra water, must be at the mixing speed (drum revolutions per minute) recommended by the manufacturer as shown on an attached plate. In the case of complete mixing at the batching site, it is recommended the minimum 70 revolutions be accomplished, allowing an additional 40 revolutions at the job site if additional water is required. For job site mixing, (or batch site mixing before uniform conditions have been established), a better procedure may be to mix for 50 revolutions, examine the mix, add water as necessary and mix an additional 20 revolutions. Any added water must be carefully measured and noted on the inspection ticket.

In any case, truck mixers or agitators delivering ready-mixed concrete must be operated at mixing or agitating speed until discharge of the batch.

510.3.3 Shrink-Mixed Concrete

This type of ready-mixed concrete has been partially mixed in a stationary mixer at the batch plant, with mixing completed in a truck mixer. Requirements discussed above for central-mixed and transit-mixed concrete apply.

510.3.4 Commercial Ready-Mix Plants

Commercial ready-mix plants are usually located in metropolitan or urban areas to supply concrete for general public use. They must meet all the requirements applicable to batch plants that supply concrete for state use, and all materials used must conform to WisDOT quality and gradation specifications.

510.3.5 On-Site Mixer (Concrete-Mobile)

Site-mixed concrete is used in highway construction for Grade E overlays and can be used for items from other grades when the engineer allows. Standard spec 501.3.6 covers requirements for on-site mixers, including volumetric mixers.

Volumetric mixers are truck-mounted, mobile continuous concrete mixers which, when properly calibrated, will produce high-quality, uniform concrete masonry. The mixer has two aggregate bins, one for fine aggregates and one for Size No. 1 coarse aggregate, a cement bin, a water tank, and admixture dispensing equipment as needed. The sand and coarse aggregate should be as dry as possible. Excessive water carried in the fine or coarse aggregates will throw the proportioning of the ingredients out of balance.

Ingredient proportioning with the concrete mobile is based on the known unit dry weight of each ingredient. These weights are translated to the mix by volume-weight equivalent settings on specially prepared mix control setting charts. The charts are provided for the convenience of the operator and to enable delivery of the specified concrete without the necessity of making any calculations in the field.

Proportioning adjustment or mix controls (in the form of large dials with pointers, controlled by handwheels) are provided for both sand and coarse aggregate. With these controls, the operator may, in accordance with design formula specifications, change the proportions of both sand and coarse aggregate that are delivered into the mixer during each revolution of the cement feeder. Once they are properly set, the mix controls may be locked to ensure constant and exact proportioning of the three dry ingredients (cement, sand, and coarse aggregate) to produce the desired mix.

Cement is fed into the charging end of the mixer by a positive rotary vane-type feeder at a constant rate directly proportional to the rotational speed of the shaft on which it operates. The accuracy of this feeder is the key to the entire proportioning operation.

Sand and coarse aggregate are ribbon-fed into the charging end of the mixer by a belt-type apron feeder system synchronized with the cement vane feeder to deliver a calibrated proportional amount of each type of aggregate during each rotation of the cement feeder. Because the cement and aggregate feeders are mechanically synchronized, the proportions of each of the dry ingredients are constant once the proportioning controls are set and locked.

A meter actuated by the cement feeder shaft enables the operator to easily check the number of accumulated revolutions of the cement feeder at any time during operation. This information enables a determination of the exact amount of concrete produced and delivered.

Water is fed into the charging end of the mixer under controlled pressure. A flow meter enables the operator to adjust the rate of flow, so it provides the exact amount of water needed to produce the concrete design specified by the engineer.

The mix setting charts include the proper settings for both the sand and coarse aggregate mix controls as well as for the rate of flow of the water, in liters per minute, to produce "design" concrete. Any variation from these settings will change the proportioning of ingredients and alter the predetermined concrete design.

The three major proportioning controls may be properly adjusted and locked within seconds. This makes it possible for the operator to deliver concrete of one design, stop production and change the control settings, then deliver concrete of an entirely different design at one call. The settings never should be changed while the concrete mobile is proportioning and mixing.

A possible exception to the above statement occurs when the inspector asks for more water for easier handling or more slump. This can be done by adjusting the water valve to increase the flow of water while the concrete mobile is in operation.

Determination of mix and admixture settings and the calibration of the mixer and admixture dispensing equipment must be in accordance with the manufacturer's manuals and charts.

510.4 Types of Batching Plants

Generally, batching plants for proportioning of aggregates for the mix consist of bins for immediate storage of each aggregate, hoppers for containing aggregates during weighing, and scales for weighing the aggregates. A separate and similar arrangement of bins, hoppers, and scales is provided for proportioning of cement.

There are various types of plants for batching concrete, from the simple manually controlled type to the complex fully automatic batchers that print a record of each batch. Batching plants may generally be classified as manual, semi-automatic, or automatic.

510.4.1 Manual Plants

As the term implies, in a manual plant the operator controls all the functions necessary to complete the weighing cycle. As the correct weights are dependent on the operator's skill and reliability, the plant inspector should be constantly alert to see that the correct amount of material goes into every batch.

510.4.2 Automatic and Semi-Automatic Plants

The mechanical operation of automatic and semi-automatic plants is similar. An automatic plant is considered as one where the complete batching cycle is set in motion by a single control button. A semi-automatic plant is governed by controls, which are actuated in a certain sequence to complete the batching cycle.

Semi-automatic and automatic plants produce more uniform and more accurately proportioned concrete, when properly adjusted, than manual plants, so a full-time inspector is not required to observe the batching.

Standard spec 415.3.3 requires that semi-automatic or automatic batching plants must be used on projects having 15,000 SY or more of concrete pavement. A combination of semi-automatic or automatic batchers may be used; for example, a semi-automatic aggregate batcher and an automatic cement batcher or vice versa. Each system must meet the applicable interlock and other requirements.

Manual as well as semi-automatic and automatic plants can be used for projects having less than 15,000 SY of pavement or on projects involving concrete masonry for other purposes. When a contractor elects to operate a batch plant in the semi-automatic or automatic mode, when not required, the plant or operation must, nevertheless, meet the requirements for semi-automatic or automatic operation, as the

case may be. A contractor may, however, elect to operate a semi-automatic or automatic plant in the manual mode when the specifications do not require semi-automatic or automatic operation.

510.5 Ready-Mixed Concrete Plant Operation

510.5.1 Background

Batching is the first step in the physical production of concrete. It consists of the accurate measurement of the ingredients to form a production unit of concrete. Following batching, the material is thoroughly mixed until it is uniform, and all materials are evenly distributed.

The goal of batching and mixing is to produce a uniform concrete containing the required proportions of materials. The proportions of materials must be consistent in order to ensure this uniformity. Errors in the measurements of the ingredients during batching will cause variation in the workability, strength, and durability. The six requisites to batching and mixing are listed below:

- Materials must be homogeneous and non-segregated before and during production.
- The batching and mixing equipment must accurately handle material and must be capable of easily changing the quantities when required.
- The proper proportions of materials must be maintained from batch to batch.
- Materials must be introduced into the mixer in the proper sequence.
- Thorough mixing occurs when all aggregate particles have been completely coated with cement paste.
- The concrete discharged from batch to batch must be uniform and homogeneous.

510.5.2 Production Sequence

1. Batching

   1.1 Aggregates in the stockpiled size ranges are loaded onto conveyors and elevated to their separate bins.

   Conveyor belts should be positioned so the aggregates will drop into the bins without hitting the sidewalls. Aggregates can become undersized as a result of handling operations, thus altering the gradation. Aggregates should not fall from great heights because degradation, segregation, and loss of fines can occur. Bins should be kept nearly full to reduce breakage and segregation.

   1.2 Aggregates drop from their separate bins into their separate batchers where they are weighed and held before entering the mixing drum.

   1.3 Cement from its separate storage tank enters its own batcher where it is weighed and held before entering the mixing drum.

   The cement storage system should provide for dry storage, since even the moisture in the air can cause partial hydration of the cement. The silos should be weatherproof and vented to prevent moisture from accumulating. Interiors of bins should be smooth to allow for the free removal of cement. Each bin or silo is equipped with a gate and conveyor system. The conveying system should provide consistent flow of cement with precise cutoff. Bins or silos should be free of cracks to prevent leakage from the container.

   Cement silos should be emptied periodically, and an inspection made to ensure there is no build-up of cement. Drawing the silo empty once a month can prevent cement caking. Cement build-ups could break off and produce cement lumps in the finished concrete.

   1.4 Fly ash and ground granulated blast furnace slag, when used, are handled similarly to cement.

2. Mixing

   A mixing cycle consists of these four steps regardless of the type of mixer: charging time, mixing time, discharge time, and return time.

   2.1 Charging time begins when the batching is completed, and materials are entered into the drum. Charging continues until all solid materials are in the mixer and it is ready to start the mixing cycle.

   The charging of materials into the mixer is an important consideration. Loading must be done in a manner to prevent the packing of material in the head of the drum. A blend of water, cement, and aggregate from start to finish may cause problems such as head pack (sand and cement) and poor mixing.

   Refer to standard spec 501.3.5.3 for the charging sequence.

   In general, admixtures should be uniformly added with the water. In some instances, if the admixture is not working, it may be added after the water, in an attempt to solve the problem. When more than one admixture is used, separate discharge pipes should be provided for each. Care should be taken to keep admixtures from coming together before they enter the mixture.

   During charging, each batcher scale read-out system should be visually monitored to ensure it returns to zero after the material has been discharged from it. If it does not return to zero, this would indicate some material was left in the batcher and the resulting batches are light in that component.

2.2 Mixing time begins with the first mixing revolution of the drum. In a stationary-type of mixer this begins when the charging ends with all solid materials in the drum. The mixing time ends when the first mixed concrete is discharged from the mixer.

2.3 Discharge time is the time from when the first particle of concrete starts leaving the mixer until the mixer is empty.

2.4 The return time is the time from the instant the mixer is empty to when it is ready to be charged again. In a central mix operation this return time could be only a matter of seconds.

510.6 Plant Checkout

510.6.1 General

Before start of production operations, a thorough inspection of the concrete batching plant and mixing equipment should be made to determine the batching plant and mixing equipment conform to requirements of the specifications and are capable of producing the specified product. The inspection should be made as early as feasible in order to provide sufficient time for the contractor to complete any necessary alterations or corrections before start of production.

The results of the inspection should be reported. One copy of the report should be kept available for review in the engineer's office. If any items listed are found to be not in accordance with the specifications, the corrective measures taken should be indicated on the report. Additional inspections should be made during production to ensure that proper operating conditions are maintained.

510.6.2 Testing Scales

All scales used for weighing of aggregates or cement must be tested before start of proportioning operations and checked as often thereafter during the progress of the work as is necessary for assurance of their continued operation within the degree of accuracy required. Scales should be checked and tested in accordance with requirements stated in CMM 813.

High production plants may require more frequent scale checks than usual. The engineer should determine the frequency of scale tests on the basis of the particular plant operation.

An "over or under" indicator is required on beam scales, which indicates when the required load in the weigh hopper is being approached or if there is a deficiency or excess in the amount of material in the hopper. The beam poises should be checked frequently to see that they are fastened securely in their correct position. Accumulation of material in the hopper or on any part of the scale mechanism should not be allowed. When dial scales are used, markers must be attached to the dial rim to mark the proper weights for each aggregate. Scales should be accurate to within 0.4% of the net load in the hopper. The weigh beams or dial should be graduated to allow settings to be made within this tolerance. Some plants may be equipped with digital scales, which provide a continuous numerical read-out.

510.6.3 Aggregate Bin Checks

Batching bins provide intermediate storage for the aggregates. They are divided into compartments for the separation of the different sizes or kinds of aggregates. Each compartment has a discharge gate by which the required amount of each aggregate is metered into the weigh hoppers.

The separating partitions should extend above the top of the bin a sufficient distance to prevent the intermingling of the aggregates when they are heaped.

Batch bins should be erected on firm foundations to preclude uneven settlement after they are loaded. The accuracy of a scale depends on its operation in a true horizontal position. The bins should, therefore, be checked for level after a short period of operation and at frequent intervals thereafter.

Before batching operations are started, the bins should be loaded to their capacity for a minimum of five hours before testing the scales to allow for settlement and adjustment to working conditions, as required in standard spec 501.3.4.5.

510.6.4 Posting Batch Weights

After the mix proportions have been computed and the moisture determination has been made, the weights of each kind of material per batch should be posted on the scale in full view of the scale operator and the weigh inspector. Any subsequent change should be posted promptly so that at no time should there be any question as to the weight of material to be batched.

510.6.5 Tolerance and Interlock Checks

An automation and interlock checkout of the plant should be performed as early as feasible to allow sufficient time for the contractor to make any necessary repairs or adjustments. The contractor should furnish trained personnel to perform the automation and interlock tests, and to check the tolerance settings. Most operators do not like to perform tolerance checkouts; however, most plants are operated with either no tolerances or very large tolerances, so a checkout should be required.

Before performing the initial tolerance check, the batching scales should be checked. The entire plant should be inspected, and the operation of all interlocks, except interlocks having specified tolerances, should be checked.

The engineer or plant inspector should observe the checkout and verify and record the results. A report of results obtained should be recorded each time an automation and interlock checkout is performed. The record should be retained with the project records and be available for inspection.

In addition to the initial check-out performed before the start of plant operations, a subsequent tolerance and interlock test should be made during the first week of operation and at least weekly thereafter. Checkouts and tolerance tests should also be performed whenever equipment malfunctions indicate a need.

Standard spec 501.3.4.5.4 requires that in automatic plants the batcher charging mechanism must be interlocked, (1) against opening until the batcher is entirely discharged and the scale is balanced with 0.3% of the scale capacity, and (2) against opening when the batcher discharge gate is open. They also require that the batcher discharge must be interlocked, (1) against opening when the batcher charging mechanism is open, and (2) against opening if the batch is either over or under weight by more than 1.5% of the specified batch weight in individual batchers, (1.0% for cement) or 1.5% of the specified intermediate and final cumulative batch weights in cumulative batchers. The batcher discharge of semi-automatic plants must be interlocked against opening if the batch in the hopper is either overweight or underweight by more than 1.5% of the specified intermediate and final cumulative batch weights in cumulative batchers.

Tolerance and interlock checks should be performed in accordance with manufacturer's instructions or the following procedure. A complete tolerance and interlock checkout may not be necessary at commercial ready-mix plants; however, the inspector should be assured the interlocks are operating satisfactorily.

Standard spec 501.3.4.5.4 and standard spec 501.3.4.6 do not require automatic or semi-automatic concrete batch plants to be equipped with a dial puller or device to apply pressure on a scale lever to simulate weights and facilitate tolerance checks. This equipment is desirable; however, the tolerance checks can be accomplished by loading the batchers with material in the required amounts.

Typical batch computations for individual and accumulative batchers are shown in Example 1. The calculation of the zero tolerance assumes that a cumulative batcher is being used, the capacity of the aggregate scale is 30,000 lbs., and the capacity of the cement scale is 5,000 lbs.

Example 1

Assume one batch is composed of 1 CY of Grade A mix having 565 lb. of cement and 3,120 lb. aggregate total, 40% of which is fine aggregate (1,248 lb.) and 60% of which is coarse aggregate (1,872 lb.). The coarse aggregate is 40% No. 1 stone (750 lb.) and 60% No. 2 stone (1,122 lb.). Six batches (6 CY) are being individually and cumulatively weighed.

		Weight (lbs.)				Total Weight (lbs.)
Total aggregate	=	3,120	x	6	=	18,720
Fine aggregate	=	1,248	x	6	=	7,488
No. 1 stone	=	750	x	6	=	4,500
No. 2 stone	=	1,122	x	6	=	6,732
Cement	=	565	x	6	=	3,390

		lbs.					lbs.
Zero return tolerance (aggregate scale)	=	30,000	x	0.003	=	+/-	90
Total aggregate tolerance	=	18,720	x	0.015	=	+/-	281
Fine aggregate tolerance	=	7,488	x	0.015	=	+/-	112
No. 1 stone tolerance	=	4,500	x	0.015	=	+/-	68
No. 2 stone tolerance	=	6,732	x	0.015	=	+/-	101
Zero return tolerance (cement scale)	=	5,000	x	0.003	=	+/-	15
Cement tolerance	=	3,390	x	0.01	=	+/-	34

	Individual Batchers				Accumulative Batchers			
	Weight (lbs.)		Tolerance	Acceptable Range (lbs.)	Weight (lbs.)		Tolerance	Acceptable Range (lbs.)
Fine agg. (bin1)	7,488	+/-	112	7,376 - 7,600	7,488	+/-	112	7,376 - 7,600
No. 1 (bin 2)	4,500	+/-	68	4,432 - 4,568	11,988	+/-	180	11,808 - 12,168
No. 2. (bin 3)	6,732	+/-	101	6,631 - 6,833	18,720	+/-	281	18,439 - 19,001
Cement	3,390	+/-	34	3,356 - 3,424				

Before performing the initial tolerance check, the plant scales should be checked as provided in procedure CMM 813. The entire plant should be inspected and the operation of all interlocks, except interlocks having specified tolerances, should be checked.

Some plants provide for setting tolerances by dials; others may be computer programmed or use other methods. When plants do not have the capability to accept tolerance adjustments throughout the full range of batch sizes used, the tolerance for the smallest size batch being regularly produced should be used. Production of occasional fractional batches at the end of a pour may be visually inspected for compliance.

Automatic plants should be provided with controls to stop the cycle in the overweight check position and the underweight check position to allow tolerance checking. One common method of providing for checking of tolerances is by equipping the controls with Stop-over and Stop-under switches. The following checkout procedure assumes the plant is equipped in this manner and the tolerances are set using dials. Although each manufacturer and plant may have unique features, an acceptable tolerance check can generally be made using the following procedure.

1. The initial tolerance check is the test of the zero return or tolerance for the tare weight of the aggregate hopper. standard spec 501.3.4.5.4 provides that the batcher inlet must be interlocked against opening until the batcher is completely discharged and the scales balanced within 0.3% of the scale capacity. In the foregoing example, the allowable tolerance is computed as 68 lbs.

   Place both the Stop-over and Stop-under switches in the stop position and turn the plant to automatic. The plant should not batch out any material. Move the pointer (dial scale) or poise (beam scale) until the over-light on the panel comes on, the weight at which the light comes on is the actual zero tolerance, unless the weight indicated is greater than 68 lbs. If the indicated weight is greater than 68 lbs., hold the scale at 68 lbs. and turn the zero-tolerance dial until the light goes out. This should set the tolerance at exactly 68 lbs.
2. Turn the Stop-over switch to run, leaving the Stop-under switch in the stop position. This allows the plant to advance to the first weighing cycle (Bin 1). The underweight tolerance may now be checked by moving the scale pointer or poise until the underweight light for Bin 1 comes on. If the indicated weight is less than

7,387 lbs., the tolerance can be set by holding the scale at 7,387 lbs. (or more) and turning the Under tolerance dial for Bin 1 until the underweight light goes out.

3. Turn the Stop-over switch to stop and the Stop-under switch to run. Move the scale pointer or poise until the overweight light for Bin 1 comes on. If the weight at which the light comes on is greater than 7,613 lbs. the tolerance must be adjusted by holding the scale at 7,613 lbs. and turning the dial until the over light goes out.
4. Turn the Stop-over switch to run and the stop-under switch to stop thus cycling the plant to the next weighing cycle (Bin 2). Repeat the procedures outlined in Steps 2 and 3 for the remaining aggregate bins, using the applicable bin weights.
5. The procedures outlined in Steps 1, 2 and 3 should be repeated for the cement batcher using +/-1% as the over-under tolerance.

Standard spec 501.3.4.5.4 requires the audible signal to sound if a batch is discharged containing components outside the specified tolerances. Many plants, however, may have the audible signal device wired so that it is activated whenever any component outside the specified tolerance is discharged into the batcher. The operation of the horn for most plants wired in this manner can be checked during the tolerance check, since the horn should sound any time the over or under lights are on.

To test audible devices wired to the discharge of the batch, it will be necessary to simulate or produce a batch having components outside of the tolerances and discharge it manually and then check the horn operation when the batch is discharged.

The interlock requirements for cement batchers are similar to the interlock requirements for aggregate batchers for both automatic and semi-automatic plants specified in standard spec 501.3.4.5.4, except that the tolerance for the batcher discharge is reduced to 1%. Instructions for interlock and tolerance checks are as described above.

510.6.6 Cement, Fly Ash, and Slag Handling

Cement having a temperature in excess of 165 F when delivered to the mixer should not be used until it has cooled. Cement must be weighed in its own separate hoppers and scales. They may be either of the beam digital or dial type and are subject to the same general requirements for aggregate scales. Due to the sensitivity of cement to moisture and to losses sustained in strong winds, storage bins and hoppers for cement are completely enclosed, and reliance must be placed entirely on the scales to determine if the weigh hoppers are completely full or empty.

Standard spec 501.3.3.3 requires facilities for storing, handling, transporting, and conveying fly ash or slag to be equal to those used for the cement. Frequent balancing of the scales at zero reading for all types of plants is required as a check on whether cement is accumulating in the weigh hopper to add to the tare weight.

A check should be made on the adequacy of the venting system used in cement bins and hoppers to relieve the air pressure built up when cement is unloaded from truck transports by compressed air. Unless properly relieved, these pressures may build up to the point where a sudden surge of cement into the weigh hopper may trip the weighing mechanism prematurely or may cause false scale readings. This condition is usually accompanied by the erratic action of the weigh indicator on a beam scale or the needle of a dial scale. As a check, the cement should not be discharged from the weigh hopper until the air pressure has been relieved and the indicator or dial needle registers a constant weight. Where necessary, corrections should be made by equipping the hopper and the bin with larger vents, which should be checked periodically thereafter for accumulations of cement.

When fly ash or slag is batched together with the portland cement, the cement must be weighed into the batcher first and the fly ash or slag added to the cumulative weight. When separate batching equipment is used to add the fly ash or slag it must meet the same requirements as the cement batching equipment.

Refer to the procedure used to sample incoming shipments of cement. Fly ash is sampled and tested according to standard spec 501.2.6. Slag is sampled and tested according to standard spec 501.2.7.

510.7 Control of Concrete Mix

510.7.1 Water-Cement Ratio

510.7.1.1 Background

A concrete mix is designed to provide a workable mix with the maximum possible strength gain. Standard spec 501.3.2.2 provides a percentage range for each size of aggregate in order to allow adjustment within the specified limits when necessary to provide workability. Workability of the mix is especially necessary in concrete for pavements and bridge decks to produce a good riding surface.

No single factor affects the durability of concrete as much as the relationship between the quantity of water contained in the mix and its cement content. It is frequently referred to as the water-cement ratio.

Approximately 1 gallon of water per 30 pounds of cement is required to effect hydration. Concrete with this water-cement ratio is unworkable, and additional water is required to promote workability. Additional water, however, dilutes the cement paste that bonds the aggregate, and the concrete strength is decreased.

Only under extreme conditions is the maximum amount of mix water required. If the mix is harsh and difficult to finish, addition of water as a corrective measure is seldom the answer and may aggravate the condition. Many factors enter into the conditions affecting the workability of the mix. Lack of sufficient mortar to properly fill the voids and provide a slight excess to facilitate finishing is a condition frequently encountered.

510.7.1.2 Slump

The water-cement ratio is directly related to the consistency of the mixed concrete. For the purpose of providing a term that is convenient for the measurement, the consistency of the concrete is expressed as the slump of the concrete. Mixed concrete is composed of required proportions of aggregates, cement, minimum water content to produce a mix of a consistency that has workability suitable for its intended use, and an entrained air content within the specified range. The mix should have a slump within the slump range provided in the standard specifications for concrete for that particular use.

At the start of concrete production operations and until uniformity in desired consistency has been established, slump tests should be performed as frequently as necessary, in conjunction with operational adjustments, to establish uniformity of production well within the specification limits.

Generally, when uniform production prevails, except for very small pours a minimum of two slump tests per day should be made. However, observation should be maintained for indications of deviation from desired consistency. If deviation occurs, additional tests and necessary adjustments should be made to rectify the condition. Vigilance in this respect is especially required with reference to transit-mixed concrete where conditions may vary from unit to unit.

The slump ranges provided in the standard specifications relate to the consistency of the concrete as it is deposited in its approximate final location. When the site of the deposit is removed from the truck mixers, such as when the concrete is moved from the mixer to its final location by conveyor belt, slump tests may be run at the mixer for informational purposes to assist the contractor in determining what the slump of the concrete at the mixer should be in order for the slump to be within specification tolerances at the point of deposit.

Although the standard specifications, with engineer approval, allow incorporating measured quantities of wash water in batches, this approval may be withdrawn if uniformity in slump is not maintained.

510.7.2 Air-Entrainment

All concrete used in the work, except for pre-stressed concrete I-type girders, must be air-entrained.

Although specifications allow a range of air content, this does not mean that the air content for a given pour may fluctuate, among the various batches within the specified range limits, but that the specific air content selected for the concrete pour must be stable within that percentage range and preferably should be close to the center of the range. Once the air content for a given pour has been established, it should remain reasonably constant throughout the pour.

In some instances, it has been noted the added air-entraining agent does not increase the air content to that desired, even when relatively large quantities of it are added. This may be due to the incompatibility of the added admixture with that originally mixed with the cement, or to other factors. A complete record should be made of all such instances that occur, including name of additive, amount added, and results.

The air content of mixed concrete is measured by tests included in CMM 800. At the start of concrete production operations and until uniformity in desired air content has been established, tests for air content should be performed as frequently as necessary, in conjunction with adjustment of quantities of added air-entraining admixture, to establish the required air content uniformly in the produced concrete. Generally, when uniform production prevails and except for very small pours, a minimum of two tests per day should be made. However, observations should be maintained for indications of deviation from selected air content and, if this occurs, additional tests and adjustments of quantity of added admixture should be made.

Set retarding admixtures are capable of changing the air content. When it is proposed to use one with air-entraining cement, it is advisable to test a preliminary batch to determine whether there is a risk of producing concrete with air content above or below the specification limit.

510.7.3 Admixtures

510.7.3.1 Approved Admixtures

The admixtures on the approved list have been given conditional approval based on provided and derived information that indicates essential compliance with applicable specifications. Only air-entraining agents, water reducer-set retarding agents, and normal water reducing agents shown on the APL may be used in WisDOT work.

The set retarding and water reducing admixtures are capable of having a significant effect on the entrained air and slump of the mix. Care must be exercised to make sure the resulting entrained air and consistency are within the specified requirements.

The department assumes no responsibility for the performance of any admixture; the responsibility must be that of the contractor. The engineer reserves the right to rescind or restrict approval of any admixture, which in the engineer's judgment does not produce the desired results.

Care must be used to ensure each admixture's addition rate is carefully controlled, the admixture is properly added to the concrete mixtures, and when two admixtures are used, they are totally compatible. Admixtures are usually added with the water. If an admixture does not appear to be working, it may be added to the mix after the water is introduced, as a possible solution to the problem.

510.7.3.2 Air-Entraining Admixtures

The addition rates must be in accordance with the manufacturer's recommendations, adjusted as needed to produce specified and desired entrained air contents.

Many of the air-entraining admixtures are available in various strengths or concentrations. When there is a change in strength or concentration, it will be necessary to make an adjustment in the addition rate to compensate for the change.

510.7.3.3 Set Retarding Admixtures

Set retarders may be specified under certain circumstances. Any of the approved products listed on the approved products list APL as a Set Retarder, Type D, may be used. The addition rates must follow manufacturer recommendations. They may have to be adjusted, based upon the manufacturer's data and recommendations concerning relationships between mix and air temperature, amount of cement, setting time, results of field tests, and observations of preliminary batches of concrete.

510.7.3.4 Water-Reducing Admixtures

When concrete grades requiring a water-reducing admixture are used in the work, the required water-reducing admixture may be either an approved water-reducing admixture, Type A, or an approved set-retarding admixture, Type D, since both fulfill the requirements for water-reducing admixtures. When either is used as a water-reducer the addition rate must follow manufacturer recommendations.

Type A and Type D admixtures should never both be added to the same batch of concrete.

510.7.3.5 Storage

Containers for admixtures should be plainly identified, and the solutions should be protected from contamination, dilution, evaporation, and freezing. If need be, storage tanks should be agitated during batching to prevent settlement of the solutions.

510.7.3.6 Dispensing Equipment

Admixtures are commonly provided in liquid form and may be dispensed into the mixer by weight or volume. Dispensers should be large enough to measure a full batch of admixture for each batch of concrete. The volumetric container system is considered the most reliable and is the most common method. This type should have either a sight glass or a transparent container and be located so the plant operator and inspector can visually check to see the container fills to the desired volume and totally discharges for each batch.

Standard spec 501.3.4.7 requires admixture dispensing systems to be interlocked with the batching process for semi-automatic and automatic batching plants and for on-site mixers of 0.8 cubic yards or more.

Dispensing by means of a graduated jar or beaker, or a graduated glass tube filled and emptied by manually operated valves, should not be approved.

The dispensing equipment must be flushed with water occasionally to minimize the possibility of material accumulation, which will impair the equipment performance or dispense erroneous quantities.

510.8 Production

510.8.1 Computation of Batch Quantities

Standard spec 501.3.5.3 and standard spec 501.3.6.2 state the maximum allowable batch size in stationary mixers, truck mixers, and on-site batch mixers, respectively, and specify that the volume must be computed on the basis of the "nominal" cubic yard of concrete. The "nominal" cubic yard of concrete contains, in addition to the prescribed quantities of aggregates and cement, the "design" quantity of water and a 6.0% air content. The "nominal" cubic yard is based on field conditions, and generally the amount of air and water actually used will reasonably agree with those in the "nominal" cubic yard.

510.8.2 Batch Records and Cement Usage Check

It is important that the inspector keep an accurate record of the number of batches weighed out each day. It is of immediate value in the computation of the daily yield or spread, and later as a permanent record of the amount of material incorporated in the work.

The daily batch record also enables the calculation of the daily and accumulated cement used. As often as feasible in conjunction with the contractor's operations, the cement storage bins and hopper should be completely emptied. Checks on cement usage at the one-quarter point of production, one-half point, three-quarters point, and the end of concrete production are recommended.

On projects where a secondary storage bin or "pig" is used, a check may be made without emptying the silo or bin supplying the batcher by making the check when this silo or bin is full and the secondary storage bin is empty. To obtain this condition it will be necessary to unload the secondary bin at a rate that will ensure the supply silo is full at the time the secondary bin becomes empty. This allows a check to be made on the total amount received or the theoretical amount used. If this method is not feasible, it is permissible to allow a partial load in the overhead bin, provided this amount can be estimated with accuracy. The above record can be kept in a daily portland cement inventory, which can be found in the department's pantry software.

510.8.3 Batch Delivery

Batch delivery time is the elapsed time starting with addition of water to the cement or addition of cement to the aggregates and ending with the complete discharge of the concrete from the transporting vehicle. Delivery times for ready-mixed concrete are specified in standard spec 501.3.5.2.

The specifications allow the delivery of ready-mixed and central-mixed concrete in non-agitating, smooth, mortar-tight metal bodies. Trucks equipped with ordinary dump boxes are often used. End gates should be checked for tight fit to prevent mortar leakage and to ensure secure locking of the gate. Watertight covers are necessary when rainy conditions occur. The truck boxes must be cleaned of any retained concrete immediately after delivery to prevent build-up of hardened concrete. Delivery must be accomplished within 30 minutes of mixing. Free water should not be evident on the surface of the batch at the time of delivery. The concrete must be free from excessive segregation and slump tests taken from the batch cannot vary by more than 2 inches.

510.8.4 Ready-Mix Concrete Delivery and Inspection Tickets

510.8.4.1 Concrete from Noncommercial Plants

Standard spec 501.3.5.4 provides that ready-mixed concrete used in concrete pavement and associated items may be accepted without an inspection ticket when such concrete is mixed in plants erected specifically for such purpose. The inspection ticket requirement may also be waived for minor amounts of ready-mixed concrete used in other items.

Random checks of haul time of individual loads should be made. A record of departure times must be maintained at the plant by the contractor.

Information and facts relating to the waiver of ticket requirements for both concrete pavement and other items should be entered in the project records.

510.8.4.2 Concrete from Commercial Plants

When concrete is ordered from a commercial ready-mix plant, the plant inspector should have the following information, especially when inspecting more than one project:

- Project ID number
- Name of inspector
- Mix design number
- Slump required
- Location of pour
- Number of cubic yards required
- Time of pour

- Intended use of concrete
- Special instructions on temperature and admixtures

Inspection tickets furnished by the contractor containing the same information may be used instead of the form when signed or initiated by WisDOT or consultant personnel.

If any difficulty occurs on the job with the mix, such as undesirable air content, slump or temperature, the plant inspector should be notified immediately so the problem can be corrected. Observation of these properties at the plant in the case of transit mix is sometimes difficult.

510.9 Sampling and Testing Concrete

510.9.1 General

CMM 850 contains a listing of the frequency of sampling for different types of concrete construction.

510.9.2 Compressive Strength

510.9.2.1 Opening to Service

Cylinders may be made used to determine when concrete pavement may be opened to service. Standard spec 415.3.15 specifies opening criteria. The cylinders should be placed adjacent to the pavement and cured under conditions similar to those prevailing for the pavement they represent.

510.9.2.2 Removing Falsework

Cylinders should be cured under conditions that are not more favorable than the most unfavorable conditions for the portions of the concrete that the cylinders represent.

If job control cylinders for opening to traffic or for form or falsework removal are lost or damaged, the engineer may allow alternate non-destructive testing methods to evaluate the concrete and expedite the progress of the project. The Windsor Probe testing system or the Concrete Rebound Test Hammer (a.k.a. "swiss hammer") are acceptable methods for non-destructive strength evaluation for this purpose.

510.10 Inspection Summary

The following summary of major areas of inspection in concrete placement will ensure a high-quality product. Review of this information with the contractor is advised.

- The concrete plant must have the capacity to produce concrete to adequately keep the job site operation moving.
- Aggregate sampling and testing should be completed as stockpiles are produced to ensure uniformly graded stockpiles.
- Commercial ready-mix plants must designate an adequate number of trucks to ensure a regular hauling cycle.
- Quality truck mixers must be used and inspected for specification compliance, including condition of fins.
- Mix water at the plant should be adjusted so no water is required at the job site.
- Concrete delivery must be a continuous regular hauling cycle to avoid stops and starts in placing operations.
- When transit-mixed concrete is used, stationary mixing at mixing revolutions rated on truck must be inspected.
- Consistent uniform slump from load to load without excessive deviation is important. The contractor must hold slump to the standard spec range for the application.
- There should be strict control of slump and entrained-air by test at the work site.

SECTION 515 Concrete Structures

515.1 Preliminary Review

At the first opportunity, the engineer and inspector should make a thorough study of the plans, special provisions, and sections of the standard specifications relating to the work under the contract. The structure plan's general notes, bid items, quantities, dimensions, and elevations should also be reviewed. The most common error is in the number and length of reinforcing bars. The inspector should check for conformance between dimensions given and elevations shown for the various structure elements.

The structure site must be inspected to determine if conditions are as depicted on the plans or whether changes have taken place since the original survey was made. This investigation may indicate the structure should be shifted slightly from the exact stationing shown on the plans to better fit existing conditions. There may be no latitude for a shift in position in the case of a grade separation structure. However, there is sometimes opportunity to shift drainage structures. BOS should be consulted before making any changes from plan location, skew, elevation, grade, etc.

515.2 Structure Construction Survey

The centerline or reference line must be rerun and referenced at convenient locations beyond the limits of the structure where the references will be available throughout the construction operations. The location of each substructure unit should be staked in the manner described under CMM 740, and a stakeout diagram prepared, showing the location and relationship of all stakes set, and the checks made to verify their accuracy. When staking an abutment, it may be convenient to stake the centerline of bearing, or front or back face, depending on which line the unit is dimensioned from on the plans. In any case, the contractor must be informed which line has been staked. When applicable, the horizontal and vertical clearances should be checked.

The staking and layout of complex structures in complicated interchanges require special procedures adapted to the particular requirements. When grading operations are in progress, staking procedures demand close liaison with the contractor to maintain and preserve essential points.

The engineer is responsible for the setting and accuracy of stakes or reference points needed to establish the location and alignment of substructure units, and for establishing one or more convenient bench marks in the immediate vicinity of the work from which elevations can be determined. The contractor is responsible for all additional stakes, batter boards, markings, etc., needed to facilitate layout or construction of the work, and for the final conformance of the structure with the lines, grades and dimensions shown on the plans. The engineer can cooperate with the contractor in establishing the additional lines and elevations necessary for the proper prosecution of the work. However, it should be clearly understood that in so doing WisDOT is not relieving the contractor of any of the contractor's responsibility for the lines and grades.

515.3 Excavation for Structures

Excavation for structures includes all excavation, except roadway and drainage excavation and excavation relating to structure removal, necessary for placement of the structure such as excavation for foundations, girders, projections, timber backing, tie rods, dead-men seals, and sub-foundation courses.

Standard spec 206 provides that the item of excavation for structure will be measured as a unit and paid for as a lump sum and that the lump sum bid price applies to excavation removed to an elevation between planes lying one foot above and below the elevation of the bottom of footings or floor of culverts, or the invert of structural plate pipe or pipe arches as given on the plans for the specific units. Excavation ordered to be performed to another elevation either above or below the planes described above, in order to obtain acceptable foundation conditions, will be paid for as extra work as provided in standard spec 104.2.2.1.

Backfilling, including sub-foundation course, is incidental to the item of Structure Excavation. It is essential that an agreement be reached with the contractor as to the basis of payment for excavation to be paid as extra work. The actual quantity involved in the extra work may be more or less than the amount involved in the original lump sum price, depending on whether the footing was raised or lowered from the original plan elevation. A change order formalizing the agreement should be promptly executed.

All necessary clearing and grubbing will be measured and paid for separately. Structure backfill, when specified, will be measured and paid for separately.

Although the structure excavation is on a lump sum basis, it is recommended that adequate elevations or cross-sections of the site be obtained before excavation begins. Elevations or cross-sections will be of value should a change order need to be negotiated in connection with extra work.

The excavation should be carried to the elevation of the bottom of the footing shown on the plan. A possible exception would be when an acceptable foundation in rock can be secured at a higher elevation.

The material encountered at the plan elevation of the footing should be compared with that indicated by the boring information shown on the plans. If the foundation conditions are not equivalent to that indicated by the borings, it could be necessary to revise the footing elevation, increase the size of the footings, or extensively redesign the substructure unit.

Variations in foundation material are not as critical for foundations supported on piling as in the case of spread footing designs. Subsurface conditions are quite variable in most of Wisconsin and change so rapidly that boring results only a few feet away may be completely unreliable, so caution is advised when dealing with structure foundations. The region soils engineer should be consulted when soil conditions differ significantly from plan. Do not place concrete on frozen subgrade.

If acceptable material is not obtained at the plan elevation, the nature and extent of the material below that level should first be determined. This can usually be done by hand boring, rod sounding, or digging a test hole, but in extreme cases, arrangements can be made to have one of the department's boring rigs brought in. If acceptable foundation material is found at a reasonable depth below plan elevation, lowering the footings will probably be the best solution; if not, a redesign may be required. BOS, Structures Design section should authorize all but minor changes from plan elevations in advance.

When foundation piling is driven in a footing, the excavation must be completed to plan elevation or slightly below, to allow for swell of the material displaced by the piling, before driving of the piling begins. After pile driving has been completed, any displaced material must be removed to plan elevation of the footings. Pile driving is discussed in detail in CMM 540.

Structure excavation material may be disposed of in accordance with standard spec 206.3.14 as riprap, backfill, or embankment construction if requirements are met.

515.4 Forms and Falsework

515.4.1 Forms

Forms must be designed to withstand the fluid pressure of concrete that has not reached initial set, plus a live load allowance. This design depends upon the rate of pour and the temperature of the concrete and dictates the spacing of the form ties and braces. The formwork plan may be requested by the engineer for review, and must be revised by the contractor if so, ordered by the engineer. Review of the plans does not relieve the contractor of responsibility for obtaining acceptable results as specified in standard spec 502.3.3.1.

The contractor may perform prefabrication of formwork and reinforcing steel assemblies at their own yard or shop site for some components of the structure. This can result in improved quality of the structure because the fabrication occurs under more favorable controlled conditions at the shop. If the contractor intends to utilize formwork/rebar assemblies prefabricated off the project site, the engineer must be notified in advance of the start of the prefabrication work. This will allow the engineer the opportunity to provide whatever level of inspection appropriate for the off-site prefabrication work. The contractor must keep on file all required certifications for materials incorporated into the prefabricated assemblies, including heat number tags from the reinforcing steel.

If the contractor plans on storing prefabricated formwork/rebar assemblies for an extended period of time before incorporation into the work on the structure, it is recommended that the assemblies be protected from repeated rainfalls. This will avoid potential problems with:

- Distortion for the formwork assemblies.
- Excessive rusting or pitting of reinforcing steel.
- Washing out of the form oil from the assembly, which cannot be replaced because of tight clearance with reinforcing steel.

Regardless of whether the initial fabrication of these assemblies is inspected at the contractor's shop, the engineer reserves the right to final acceptance of these assemblies at the project site at the time of incorporation into the structure based upon the condition of the prefabricated assembly at that time.

The engineer must inspect the forms before the start of placing concrete for correct dimensions and alignment and require correction of any obvious inadequacy. Checking of the formwork should continue as the work proceeds. Forms should be observed throughout the progress of the pour to detect any excessive deflections or apparent weakness. Despite checks, the contractor assumes the full responsibility for the adequacy of the formwork plan, adequacy of form ties and braces, and for obtaining acceptable results that conform to the specified lines and dimensions.

Forms are to be built mortar tight. Wood forms are sometimes built in panels or sections as an early operation on the job, for assembly and use at a later date. Shrinkage of the lumber may cause objectionable openings of the joints between boards. A liberal application of form oil, and occasional wetting with water, will minimize shrinkage.

Steel forms used for pier columns should be carefully inspected to see those individual sections line up properly, present a smooth surface, and are mortar tight. Forms with open joints that will allow mortar to escape or that will result in fins or ridges in the finished work cannot be used.

When fiber pulpboard tubes are allowed as forms for cylindrical columns, it is customary for the contractor to order the forms to the lengths shown on the plans and have them delivered before the excavation is performed and the footings poured. If it becomes necessary in the course of the excavation to lower the footings, the column forms will be too short. Standard spec 206.3.2 provides that the elevation of footings shown on the plans are approximate only, and the engineer may order changes in dimensions and elevations of footings as may be necessary; so, strictly speaking, the contractor should be required to furnish another form of the revised length, since it is impractical to splice this type of material. In most cases, however, it will be acceptable to thicken the footing to restore the top to the original elevation or construct a square pedestal atop the regular depth footing, so the original length of form may be used. The volume of concrete required to construct the additional length of the cylindrical column corresponding to the amount the footing was lowered will be paid for as Concrete Masonry, but any additional volume required to thicken the footing outside the limits of the column will be the contractor's responsibility.

515.4.2 Falsework

Falsework consists of temporary supports required for the construction of the permanent structures. Falsework may be required for the support of structural steel during erection. This discussion will apply primarily to the support of concrete pier caps, slab span bridge floors, etc., while the concrete is being placed and cured.

As in the case of forms, the contractor is responsible for obtaining acceptable results with the falsework used. However, many instances may be cited where the design and construction of falsework was inadequate, and although there was no complete failure, excessive settlement or deflections resulted in the appearance or riding quality of the completed structure being somewhat less than acceptable. To avoid such deficiencies, one copy of the falsework plans is submitted by the contractor to the engineer for review. Up to two additional copies may be requested. The contractor must make changes required by the engineer. Submittal of the plan or concurrence in the plan by the engineer does not relieve the contractor of full responsibility of adequacy of the falsework. Review of the plans does not relieve the contractor of responsibility for obtaining acceptable results as specified in standard spec 502.3.2.

The contractor should submit only plans that are clear and legible. The plans should show:

1. A layout of the falsework location and spacing of falsework bents.
2. An elevation view of the falsework bents, showing spacing of piling or columns, caps, and sway bracing.
3. Minimum bearing for piling, which is usually in the range of 20 to 40 kip.
4. Presumed allowable soil pressure if mudsills are used.
5. Cross-section of deck forming.
6. Size and spacing of all lumber and timber. All lumber will be assumed to have four sides surfaced unless otherwise shown.
7. Continuity of members over two or more spans if continuity is considered in the analysis of the falsework.
8. The species of wood and its stress grade. In the absence of specific information, it will be assumed the material must be equal to or better than Pacific Coast Douglas Fir, No. 1.

   Allowable unit stresses that allow 25% overstress due to short-term loading in falsework are 1,870 psi in bending, 145 psi in horizontal shear and 1,490 psi in compression parallel to the grain and 490 psi in compression perpendicular to the grain. The modulus of elasticity is 1.76×10^6 psi.
9. Shim arrangement proposed to achieve the crown. Bearing surfaces should be at least 2" wide for proper support.
10. The plans must be signed and sealed by a registered professional engineer.

Falsework plans should not be sent to the BOS design section except for unusual situations.

A common cause of excessive settlement of falsework is yielding of the supporting foundations. Falsework for substructure elements, where a slight amount of settlement may not be critical, is often supported by posts and beams or scaffolding resting on the footings or on timber "mudsills" placed directly on the ground. Piling should generally support falsework for superstructures, unless the foundation material for the support of timber mudsills is extremely firm. Falsework columns should not be placed on spread footings unless the footings are supported on piling or founded on rock. The region should not accept falsework plans from the contractor if proposing timber mudsills, except under the best of conditions allowed under the specifications, and in addition, should be very cautious about allowing timber mudsills on embankment benches. Standard spec 502.3.2.3 allows falsework to be supported by timber mudsills placed on paved, well compacted slopes of berm fills; however, the falsework cannot be strutted to the pier columns unless the columns are founded on rock or supported by piling.

The structure plans usually contain a deflection diagram indicating the amount of camber that must be built into the bridge floor to compensate for the dead load deflection that takes place when the falsework is released, plus an allowance for future creep. The falsework and forms must be built to provide this required camber after the concrete is placed, which means that a further allowance must be made for the settlement that will take place in the falsework itself. The amount of settlement that will occur is not subject to precise determination and will depend on the character of the foundation support and the amount of compression occurring at the timber joints or interfaces in the falsework. The latter is sometimes estimated on the basis of from 0.03" to 0.06" per joint where the stress is perpendicular to the grain of the wood. Falsework plans must be designed for anticipated deflections of individual falsework members as well as for allowable unit stresses. Excessive deflections that are detrimental to the ride and appearance of the structure are a common deficiency of falsework designs.

When falsework is built over a stream or lake used for boating, adequate horizontal and vertical clearance should be provided for the passage of rowboats and small powerboats.

The minimum vertical clearance over a highway or street used by traffic is 13.5', and the minimum horizontal clearance is 22', unless otherwise provided by the plans or special provisions.

515.4.3 Failures

Frequently when forms or falsework fail to perform properly during the placing of the concrete, the cause may be one or more of the following:

1. Formwork design weakness is commonly in details rather than in the main structural members, unless the members are of poor quality, since designs similar to those involved in failures have been successfully used on other occasions.
2. Details that are difficult to perform will not be properly performed and may start a failure. These items should be eliminated in the planning stage.
3. High shoring becomes particularly susceptible to failure when not adequately braced diagonally.
4. Shock and vibration may result from using duckboard runways.
5. Power buggies, in synchronism at high speeds, impose a lateral force, which must be provided for in the design and details.
6. Forms are continuously supported structures and must be provided with uniform bearing at each support. Otherwise, settled mudsills or shrinkage at timber post splices will completely upset the computed reactions with possible overloading of some posts.
7. Wedging of posts to counteract compression under load must be done under proper supervision so a previously properly assembled form support is not disrupted.

515.5 Reinforcement

515.5.1 Sizes and Grades

Bar steel reinforcement is basically round in cross-section with the surface deformed (ridged) to improve the bond with the concrete. In the U.S. Standard System of Measurement, the size of the bar is designated by a number that indicates the diameter of the bar in eighths of an inch. Thus, a No. 4 bar is 4-eighths or 1/2-inch in diameter, and a No. 8 bar is 8-eighths or 1-inch in diameter. The exact correlation holds true in sizes up to No. 8, but deviates slightly in larger size bars.

Often, bars delivered to a project are stamped with the metric designation number. The metric number is the bar diameter rounded to the nearest millimeter. Table 515-1 shows the relationships between U.S. Standard and metric bar sizes.

TABLE 515-1 U.S. Standard and Metric Bar Sizes

U.S. Standard Bar No.	Diameter		Metric Designation Number
	in.	mm	
3	0.375	9.5	10
4	0.500	12.7	13
5	0.625	15.9	16
6	0.750	19.1	19
7	0.875	22.2	22
8	1.000	25.4	25
9	1.128	28.7	29
10	1.270	32.3	32
11	1.410	35.8	36
14	1.693	43.0	43
18	2.257	57.3	57

Reinforcing steel is also classified by grade. Grade 40 must achieve minimum yield strength of 40,000 psi. Grade 60 must achieve minimum yield strength of 60,000 psi. Grade 40 deformed bars have no specific grade identification marks on the bars. Grade 60 deformed bars may be identified by the number "60" or by the presence of a single continuous longitudinal line offset from the center of the bar side and extending through at least five deformation spaces.

515.5.2 Storage

Standard spec 505.3.1 states that reinforcement must be stored above the ground on platforms, skids, or other supports, and must be protected so far as practicable from mechanical injury and deterioration caused by exposure. When placed in the work, the reinforcement must be free from detrimental dirt, dust, paint, oil, or other foreign material.

Generally, new reinforcing steel can be stored on supports above the ground, without protective covering, for periods of from one to three months. When reinforcing steel is stored for longer periods, it should be protected from the weather with adequate covering. Refer to the Coated Bar Steel Reinforcement section for specific storage requirements for coated rebar.

The covering should be placed to allow air to circulate to the steel from beneath. Storage should be, whenever possible, in well-drained, stable areas not likely to become soft from rains, snowmelt, or freezing and thawing. If these conditions are likely to be encountered, extra blocking should be used to avoid shifting.

515.5.3 Rust

Test data has indicated that deformations, rather than surface conditions, are the principal parameter determining the bond characteristics of reinforcing bars. Therefore, tight light rust and thin powdery rust is not considered detrimental and need not be removed.

When reinforcement is rusted to the extent the effective cross-sectional area appears to be reduced, evidenced by an overall coating of thick rust or heavy scaling, tests should be made to determine if the reinforcement conforms to the required dimensions and mechanical properties. If the reinforcing steel meets these requirements, the rust should not be a cause for rejection.

When the condition of the steel is such that removal of rust is desirable, consideration should be given to the fact that, frequently, normal handling before installation is sufficient for the removal of loose rust and scale that might otherwise impair the bond of the steel with the concrete.

"White rust" frequently occurs on galvanized steel members closely stored or nested together. If it is merely a powder easily rubbed or scraped off, and if the underlying steel is not scaled or has not lost cross-sectional area, the members can be accepted and used. If there is significant loss of section, proceed as noted above for rust. Avoid "white rust" altogether by allowing sufficient air to flow through stored galvanized steel.

515.5.4 Coated Bar Steel Reinforcement

Present design practice calls for coated high-strength bar steel reinforcement used in all layers of reinforcement in bridge decks and parapets. The steel must be totally coated, including the ends. It is essential to handle coated reinforcement very carefully before and during installation. Standard spec 505.3.1 requires using padded or nonmetallic slings and padded straps when handling the reinforcement.

Before placement, damaged areas must be repaired with the manufacturer-supplied patching or repair material before the start of rusting or contamination. Before the pour the epoxy coated bars should be re-inspected for damage that may have occurred during placement. Ties must be an approved plastic or nonmetallic material, or be metal wire coated with nylon, epoxy, or plastic.

Coated bars should be stored on protective timbers with the supports spaced close enough to prevent sags in the bundles. If the storage of epoxy-coated bars is expected to last longer than two months, the bars must be protected from sunlight with opaque polyethylene sheeting or other suitable protective material. The contractor should ensure that the covering is adequately secured, while also providing for air circulation to minimize condensation. If epoxy-coated bars have been placed into a bridge deck mat and the deck pour is not to proceed for two months or more, the contractor must cover the rebar to protect from ultraviolet radiation.

Epoxy-coated reinforcement must not be welded, or flame cut.

515.5.5 Field Cutting of Reinforcing Bars

Uncoated bars can be cut with a saw or flame-cut (such as with an oxy-acetylene torch). Epoxy coated bars can be cut with a saw but cannot be flame-cut.

515.5.6 Testing and Acceptance

Before reinforcement is incorporated in the work, evidence of acceptance by test, or as otherwise allowed for small quantities, must be submitted to the engineer. Reinforcement that has been tested and certified according to ASTM A615 or ASTM A706 is equivalent to AASHTO M31. A certificate of compliance is required for coated high-strength bar steel reinforcement.

For each size of bar that exceeds 50,000 pounds on the project, a 5-foot cut sample piece must be provided to the engineer for testing. Refer to CMM 850 for details of the required samples. When replacing the cut sample piece, it's important that the contractor supplies the original 5' length plus additional lap length required for the splice. Splice lengths typically vary between 30 - 60 bar diameters. An old rule of thumb for splice lengths in uncoated rebar is to provide 38 times the rebar diameter. However, the WisDOT required splice length is a function of concrete strength, reinforcing yield strength, concrete cover over the bars, whether any horizontal bars have concrete below it more than 12", rebar diameter, and whether the bars are epoxy coated.

The WisDOT Bridge Manual provides information about development lengths for splices in section 9.3.1, and the splice lengths are provided in Table 9.9-1 and 9.9-2 of the bridge manual.

515.5.7 Placement and Fastening

Reinforcing bars must be placed and rigidly held in the correct position if they are to serve their intended purpose. The inspector should check on the size and spacing of the bars, as they are being set, the manner in which they are being supported, and the clear distance from the form or surface, as well as the correctness of any bends specified. Clear distance between forms and stirrups may vary by 1/2" due to the allowable tolerance in fabrication of stirrups. The inspector should also ensure the steel reinforcement when placed in the positions shown on the plan is firmly held in those positions to prevent movement during or after the placement of concrete surrounding the bar. Standard spec 505.3.4 provides for placing and fastening steel reinforcement. The wire used for the tying down of the steel must be of sufficient strength to prevent breaking or stretching of the wire during pouring operations. Standard galvanized 0.15" diameter wire is recommended for uncoated steel bars. A single loop of standard tie wire is not sufficient. Plastic coated wire or alternates listed in standard spec 505.3.4 must be used to tie down coated bar steel.

Standard spec 505.3.4 provides that bars must be securely tied at all intersections, except where spacing is less than one foot in each direction, in which case, alternate intersections must be tied. The correct application of this spec requires that bar spacing must be less than one foot in both directions before tying of alternate intersections is allowed. The inspector should record the quantity, size, and length of all bars placed in each unit of the structure.

The engineer should not measure and pay for the extra rebars used to accommodate for provided girders that have more or less camber than what the plans indicate. If the contractor can show evidence that a plan error has occurred related to the haunch height, the engineer should engage BOS for verification and potentially compensate the contractor for additional reinforcement required.

Spot welding of reinforcing bars to each other or to various devices used in holding forms in place will not be allowed. Bar mats or cages, when fabricated, should be tied. Welding or mechanical butt splicing of reinforcing steel should only be allowed when detailed on the plans or authorized by the engineer in writing. Should the contractor desire to hold curb face forms or similar forms with a tie rod welded to the bar steel mat for support, it should only be welded, when allowed, to a bar which is not a part of the structural stress steel, but which is an additional rod tie to the plan reinforcement.

515.5.8 Concrete Cover Over Steel

Although coated bar steel is used, the importance of maintaining proper cover for embedment of reinforcing bars cannot be overstressed. If the bars are placed too near the surface of the concrete, particularly in bridge floors, water and deicing chemicals will penetrate the concrete and may cause corrosion of the steel. The steel expands when corroding and soon causes spalling of the surface, which is both unsightly and a costly maintenance problem. Additionally, high steel may cause pop-outs of concrete or result in transverse cracking of decks over reinforcing.

Generally, the plans will show the minimum cover required for reinforcing bars in the bridge floor. If not shown, minimum cover of not less than 2.5" of concrete over the top bars is required. Screed grades should be computed and checked against the height of the bar supports, to determine the required cover that needs to be provided. Before placing the concrete, it is essential project personnel assure themselves the minimum embedment will be obtained. This can be most readily accomplished by attaching a piece of wood, equal in thickness to the minimum required cover, to the screed of the finishing machine and making a preliminary run over the deck. When the rails on which the finishing machine rides are placed on the overhang, the piece of wood should equal the minimum required cover plus the anticipated deflection of the overhang at the rail. The amount of deflection will vary with the width of the overhang, the mass of the load, and the type and spacing of the brackets. However, a general rule of thumb would be to provide for 0.01-foot deflection for each foot of overhang. This preliminary run must be done after the finishing rails have been adjusted for all anticipated deflections. Necessary adjustments should be made in the elevations of the bars.

Inadequate bar steel embedment has occurred on bridge decks most often in the negative moment area over the piers, particularly on prestressed girder structures. Another problem location is at the ends of the heavy longitudinal bars placed over the piers of concrete slab span structures.

The occasional problem with high steel in the vicinity of the piers may have resulted from using the wrong height of supporting chairs. Generally, heavier steel is called for over the pier than in mid-span and, therefore, shorter chairs are required over the piers.

Engineers have experienced tipping or twisting of exterior girders caused by deflection of the overhanging deck when placed. This tipping or twisting is most likely to occur on work with steel or prestressed girders 4 feet or less in depth.

An acceptable practice for stabilizing the exterior girder consists of tying or strapping the upper flanges of the exterior and adjacent girders together and bracing the lower flanges apart. Welding of ties to the upper flanges of steel girders is not an acceptable practice and will not be allowed. Some contractors have welded ties to the shear lugs and this operation must be closely supervised so that no welding occurs on the girder flanges. Even striking an arc on a girder may cause stress concentrations resulting in future fatigue cracking.

Any hardware (except for form ties) not required under the contract but incorporated into portions of the structure where all the reinforcement is corrosion resistant must be galvanized or epoxy-coated steel, stainless steel, or non-metallic materials. Welding is not allowed on epoxy-coated steel.

It is the contractor's responsibility to determine the need for any bracing or stabilization necessary to prevent girder rotation and overhang settlement.

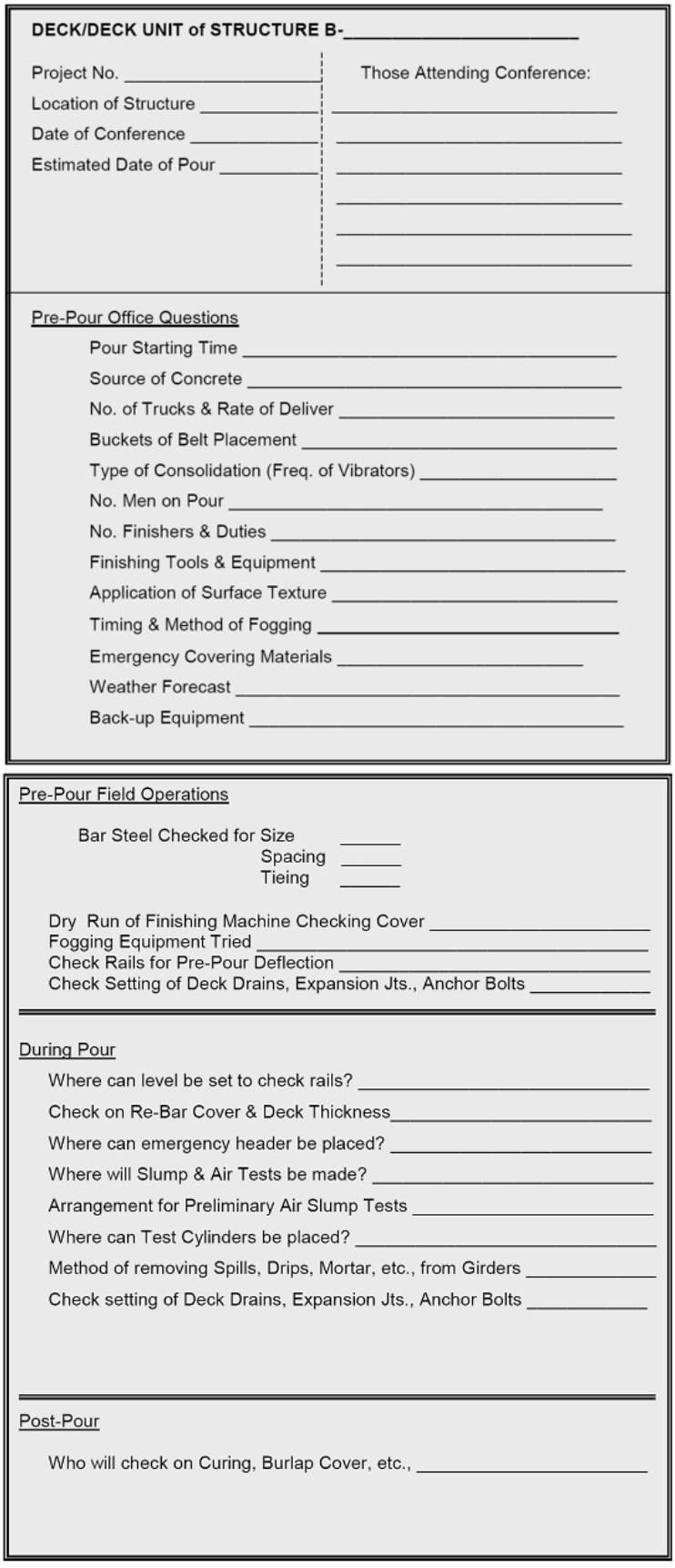
It is imperative that the potential for girder rotation be carefully evaluated before or at the pre-pour conference in order that any necessary stabilization can be done before deck placement begins.

515.6 Placing, Finishing, and Curing Concrete

515.6.1 Placing Concrete

Before concrete is mixed or ordered for any portion of the structure, the engineer should make sure the contractor has the necessary personnel available, including qualified finishers, and the required items of equipment, such as cranes, buckets, buggies, carts, hoppers, chutes, belts, strike-offs, floats, straightedges, etc., are on hand. The contractor should also ensure that adequate means are available to properly cure the concrete and to protect it from low temperatures. Refer to figure 515-1 for guidelines on what questions to get answered at the pre-pour meeting.

FIGURE 515-1 Concrete Bridge Deck Prepour Meeting Check List



DECK/DECK UNIT of STRUCTURE B-_____

Project No. _____ | Those Attending Conference:
Location of Structure _____ | _____
Date of Conference _____ | _____
Estimated Date of Pour _____ | _____
_____
_____
_____

Pre-Pour Office Questions

Pour Starting Time _____
Source of Concrete _____
No. of Trucks & Rate of Deliver _____
Buckets of Belt Placement _____
Type of Consolidation (Freq. of Vibrators) _____
No. Men on Pour _____
No. Finishers & Duties _____
Finishing Tools & Equipment _____
Application of Surface Texture _____
Timing & Method of Fogging _____
Emergency Covering Materials _____
Weather Forecast _____
Back-up Equipment _____

Pre-Pour Field Operations

Bar Steel Checked for Size _____
Spacing _____
Tieing _____

Dry Run of Finishing Machine Checking Cover _____
Fogging Equipment Tried _____
Check Rails for Pre-Pour Deflection _____
Check Setting of Deck Drains, Expansion Jts., Anchor Bolts _____

During Pour

Where can level be set to check rails? _____
Check on Re-Bar Cover & Deck Thickness_____
Where can emergency header be placed? _____
Where will Slump & Air Tests be made? _____
Arrangement for Preliminary Air Slump Tests _____
Where can Test Cylinders be placed? _____
Method of removing Spills, Drips, Mortar, etc., from Girders _____
Check setting of Deck Drains, Expansion Jts., Anchor Bolts _____

Post-Pour

Who will check on Curing, Burlap Cover, etc., _____

Bridge decks 100 ft and greater in length are cured with a double thickness of wetted burlap. The burlap is to remain in place and be kept thoroughly wet for at least seven days.

There have been several documented cases of spalling at the construction joint between bridge deck and parapet. The spalling appears to have resulted from insufficient vibration and consolidation of the plastic concrete. Consolidation should be complete and uniform to remove trapped air and to achieve full, uniform density. Special attention should also be paid that the vibrator is not used to move the concrete into this small area because segregation will result. The concrete should be placed as closely as possible to its final position before vibration. During a deck pour, it is recommended that vibrators be inserted at a spacing not to exceed a 2-foot by 2-foot. Vibrators never should be dragged laterally through the concrete.

An adequate number of vibrators should be available. Vibrators should be operating at a frequency of at least 7,000 impulses per minute. A quick and accurate field check can be made with a vibrating reed tachometer available through the region office. The tachometer reading shown in revolutions per minute is equivalent to impulses per minute.

For new prestressed concrete girder bridges, the engineer should not measure and pay for the additional concrete used to accommodate girders with more or less camber than the plans show; unless the contractor can show evidence that a plan error caused the issue. The engineer should engage BOS to help determine if there was a plan error.

515.6.2 Removal of Forms and Falsework

Except when forms are allowed to be left in place as provided in standard spec 502.3.4 for concrete placed during cold weather, standard spec 502.3.4.1 requires that forms, other than those forms directly supporting concrete, such as forms under slabs, beams, girders, etc., be removed in from 12 to 72 hours after casting the concrete. Early removal of the forms allows the application of the curing material directly to the concrete and allows the initial operations of the surface finish of the concrete such as filling holes, pits and other depressions with mortar before the concrete dries out. Better bond, less shrinkage, and greater durability of the patching will be achieved when finish work is performed on young concrete rather than an older concrete.

Early removal of forms during warm weather allows the escape from the concrete of the heat generated by the hydration of the cement. If restricted in its escape, the heat might result in the development of excessive internal temperatures. High internal temperature of the concrete during the hydration period not only produces concrete of lower ultimate strength, but also tends to produce shrinkage cracks.

Furthermore, when fiber pulpboard column forms are used, their removal is much easier at an early date than if left in place for the entire curing period. When forms are removed after the full curing period is completed, the form material tends to separate in layers and stick to the concrete, and the concrete surface does not have as good an appearance as when the forms are removed early.

Fiber pulpboard forms, by nature of their construction, provide an impervious barrier, which to an indefinite degree retains moisture in the concrete, and in some cases, may provide effective curing. Where appearance and durability of the concrete is a prime factor, as is the case with a concrete column, the forms should be removed early and the concrete cured by the membrane method or by a similar method, which provides acceptable curing and allows proper finishing operations.

Forms that are an integral part of the falsework should not be removed until the falsework can be removed as provided in standard spec 502.3.4.2. During hot weather water should be used, when necessary, to cool the concrete within the forms.

Recently poured concrete masonry when exposed to temperatures at or near freezing experiences little, if any, gain in strength. The spec relating to temperature was written to ensure that forms or falsework would adequately support concrete masonry until it had achieved sufficient strength obtained during favorable curing temperatures.

Removal of forms and falsework from under slabs, beams, girders, etc., which bear the mass of the placed concrete, should be made after the concrete has gained adequate strength to allow their removal. Determination of the time for removal of forms should be made in accordance with the requirements of standard spec 502.3.4.2.

Standard spec 502.3.4.2 provides that for cast in place slab or box girder spans, falsework may not be removed for a minimum period of seven days, regardless of test cylinder strengths and excluding days below 40 F.

515.6.3 Finishing Concrete

515.6.3.1 Bridge Seats and Anchor Bolts

Special care should be given to the finishing of bridge seats, pier caps, etc., so that full and uniform bearing with the masonry plates will be obtained, and the bearing areas are at the correct elevation. Also, the location of anchor bolts must be accurately laid out before the concrete is cast. If the anchor bolts are

to be cast into the pour, they must be rigidly held at the correct position, alignment, and depth of embedment. If the anchor bolts are to be drilled into the hardened concrete and anchored, the position of the bolts should be checked by with a template, and the reinforcing steel adjusted as necessary to avoid interference with the bolt locations.

Standard spec 506.3.30 allows anchor bolts to be set in an approved, premixed, non-shrink commercial grout except during freezing weather, or in an epoxy conforming to the standard specifications. These are found on the APL.

515.6.3.2 Superstructures

Under standard spec 502.3.6.4, sack-rubbed surface finish must be applied to all exposed formed surfaces of parapets, railings, posts, walks, and curbs and to all exposed side surfaces of superstructures, including the outer face of outside prestressed girders, unless otherwise provided in the special provisions. The prestressed girders must have the finish applied before shipment from the plant.

Rubbed surface finish will not be required for any formed surfaces of superstructures unless required by the plans or special provisions, except that when, in the judgment of the engineer, an acceptable sack-rubbed finish has not been secured, the contractor must apply a rubbed surface finish, conforming to the requirements of standard spec 502.3.8.3 to the affected exposed areas.

515.6.3.3 Substructures

Ordinary surface finish will be required for all formed faces of substructure units, except that parapets and curbs built integrally with the substructure should receive the finish specified for superstructures. Rubbed surface finish will not be required for any formed faces of substructure units unless required by the plans or special provisions or as provided in standard spec 502.3.7.2 for the application of a rubbed surface finish when the ordinary surface finish is defective.

515.6.3.4 Sack-rubbed Surface Finish

When so designated on the plans or in the specs, concrete surfaces must have a sack-rubbed finish. Before the application of the sack-rubbed finish, all tie rod holes, and large cavities must be filled, and all fins and irregularities removed or corrected.

Rubbing the concrete surface with a clean rubber float or fold of burlap and mortar will produce sack-rubbed surface finish. The mortar should consist of one-part portland cement and two parts, by volume, of sand passing a #16 sieve, mixed with sufficient water to provide a consistency of the mortar equivalent to that of a thick cream. The cement used in the mortar should be of the same type and brand used in the concrete. If necessary, to match the surrounding concrete surface, white cement should be blended with the cement.

The surface of the concrete to be finished should be thoroughly wetted and the sack-rubbing performed while the surface is damp but not wet. The mortar should be thoroughly rubbed over the area, filling all pits. While the mortar is still plastic in the pits, the surface should be rubbed using a dry mix of the above proportions, removing all excess plastic material and placing enough dry material in the pits to stiffen and solidify the mortar.

The completed surface should be free of surface voids and blemishes and should be uniform in appearance and texture except for the difference in texture between the filled voids and the remainder of the surface.

515.6.3.5 Rubbed Surface Finish

Areas specified to receive a rubbed surface finish require attention to the methods employed and timing of the work. Rubbing must be started as soon as possible after the forms are removed. The surface should be moistened with only enough water so that "lather" can be worked up, and the rubbing should continue until all small holes and depressions are filled. Using additional mortar should be limited to the filling of cavities produced by the removal of form ties or to pointing-up of honeycombed areas. Plastering of surface with mortar or cement base before or during the rubbing operations should not be allowed. After the rubbing is completed, the surface should not be allowed to dry out until curing is completed, to achieve a durable surface.

515.6.4 Curing Concrete

Curing procedures and times for substructures and superstructures are specified in standard spec 502.3.8 and are summarized as follows:

1. For substructures, excluding footings, use applied moisture, wetted burlap, or membrane curing compound.
2. For footings, cure by applied moisture, wetted burlap, membrane curing compound, submersion (if approved), or by leaving the forms in place and then backfilling after removal.

3. For floors, wearing surfaces, and sidewalks, use a fog or fine water spray until hardened, followed by a double layer of wetted burlap. For structures under 100 feet in length polyethylene-coated burlap or other approved coated covering may be used.
4. For inside faces of parapets and railings, use wetted burlap or polyethylene-coated burlap.
5. For outside faces of parapets, railings and exterior girders, use membrane curing compound, wetted burlap or polyethylene-coated burlap.

   One approved curing procedure for substructures, and for the outside faces of parapets, railings, and exterior girders is a clear or translucent membrane curing compound. It is emphasized that this method of curing must be discontinued when a non-uniform or a blotchy and streaked appearance results, and a wetted burlap or moisture cure should be substituted until the cause of the uneven appearance is corrected.

   Also, membrane curing compound should not be used before to application of the required surface finish. The other approved curing methods should be used before application of the surface finish.

   Membrane curing material should not be applied to construction joints or to surfaces to be bonded to other concrete, nor to surfaces to be waterproofed or sealed.

   Membrane curing compounds inhibit the penetration of protective surface sealers and should not be used on bridge decks.

515.6.5 Cold Weather Protection

The hardening or setting of concrete is accomplished through a process involving the hydration of the cement. The temperature of the concrete must be within reasonable limits, if normal strength gain is expected. Strength gain is very slow below about 40 F.

The standard specifications require certain minimum temperatures for fresh concrete placed under cold weather conditions. As the hydration process continues, heat is generated and the temperature of the concrete will increase, normally reaching a maximum within one to three days after placing, then gradually tapering off. The maximum temperature reached and the rate of cooling after passing the peak temperature will depend on the mass of the concrete. In the case of thick, massive sections, or when insulated forms or blankets are protecting the concrete, this build-up of temperature within the concrete may become critical. With elevated temperatures as the concrete is setting, later cooling to normal temperatures may cause shrinkage cracks to occur. Thus, it is important that the internal temperatures of the concrete protected by insulated forms or blankets be closely observed and controlled.

The standard specifications provide that structural concrete, placed when the air temperature is 35 F or less, or when an air temperature of 35 F or less can be expected within a period of 6 days following the placing of the concrete, must be protected by housing and heating or by using insulated forms or blankets. Unless otherwise provided, this protection is mandatory beginning December 1 and ending March 31. The contractor may delay the erection of housing during the period beginning April 1 and ending November 30 if the air temperature is not expected to fall to 35 F or below during the 24 hours immediately following placement of the concrete. The housing may be delayed until the temperature is expected to fall to 35 F or below during any 24 hours of the succeeding 5-day period, provided that an adequate supply of housing material is maintained at the site and sufficient workers and equipment are available to ensure suitable housing can be erected before the air temperature falls to 35 F.

Standard spec 502.3.7.6 provides that concrete in bridge decks, except railings, parapets, and similar pours, cannot be placed when housing is required unless specifically allowed or required by the engineer in writing.

Structural concrete should not be placed without the degree of protection contemplated in the specs unless or until the air temperature has remained above 35 F for a reasonable period and there is at least a short-range prediction of air temperatures to remain above 35 F. This, of course, is no assurance air temperatures will not fall below that level within the 6 days following, especially in the early spring and late fall, and the contractor should be required to have materials available to cover or otherwise protect the concrete from damage should this occur.

The engineer may remind the contractor that the contractor is responsible for the proper protection of all concrete exposed to cold weather during the required protection period, and may be required to remove and replace, at the contractor's expense, any concrete damaged by lack of proper protection.

Forms or insulation should be loosened as required and directed by the engineer to the extent that the interior temperature of the concrete not be allowed to exceed 120 F nor fall below 45 F during the protection period, and also that the temperature at the surface of the concrete not be allowed to exceed 100 F. Provision must be made when casting the concrete so internal temperatures can be readily obtained.

Specifications relative to gradual reduction of the temperature of the concrete at the close of the protection period are included in standard spec 501.3.9.

515.6.6 Hot Weather Concreting

Placement of high temperature concrete should be avoided. Concrete placed at high temperatures requires higher water content, has a lower ultimate strength, and is less durable. Standard spec 501.3.8 covers hot weather concreting for bridge, culvert, retaining wall, and permanent concrete barrier construction.

Methods for minimizing concrete temperature in hot weather include:

- Sprinkling aggregate stockpiles with water.
- Shading aggregate stockpiles.
- Insulating or shading water supply lines.
- Using refrigeration chilled water or ice in mix.
- Injecting liquid nitrogen into drum of ready-mix truck after batching.
- If above-ground surge tanks are used for storage of mix water and the stored water has warmed to ambient temperature, drain tanks and refill with cold well water if available.
- Use ready-mix trucks with white or light-colored drums to minimize heat gain in transit.
- Sprinkle drums of ready-mix trucks with water after batching and while waiting to discharge at project site.
- Schedule pours in evening, night, or early morning to minimize solar heat gain on aggregate stockpiles, truck drums, and in-place concrete.

Methods for minimizing the effective evaporation rate during deck placement include:

- Minimize the concrete temperature by any combination of the above methods.
- Schedule evening, night, or early morning pours when wind is light, air temperature is low and humidity is high.
- Erect windbreaks to minimize effective wind speed.
- Erect fixed fogging systems that will cover the entire pour area to decrease effective air temperature and increase effective humidity (activating individual nozzles after screed passes by).
- Delay pour until more favorable weather conditions resume.

Special action is required if concrete temperature at placement is 80 F degrees or more. Standard spec 501.3.8.2 requires the contractor to submit a temperature control plan enumerating actions they will take to control concrete temperature.

If the contractor's plan includes adding ice, the engineer should review the hot weather concreting plan as well as the contractor's construction schedule to assure the need for ice. The engineer should not delay pours on the critical path in order to avoid the payment for ice. The department will not pay for ice delivered and stored on site if it is not used.

The specifications allow the contractor to use concrete with a temperature up to, and including 90 F, only if both of the following conditions are met:

1. An approved temperature control plan has been submitted.
2. All actions contained in the plan have been followed when concrete temperatures exceed 80 F.

For bridge decks, the contractor also must submit an approved evaporation rate control plan and perform both the actions included in this plan and the actions included in the temperature control plan, while maintaining an evaporation rate of less than or equal to 0.2 lb/sq. ft./hr.

Standard spec 501.3.8 includes the following:

- If the contractor elects to use ice, as part of their plan to keep concrete temperatures below 85 F, the contractor provides the ice at their expense.
- If concrete temperatures exceed 85 F, the contractor may elect to use ice to control concrete temperatures. The department will pay $0.75 per pound for the ice used in the mix if the contractor has also performed all other actions contained in the temperature control plan.
- If the contractor provides ice solely based on the engineer's orders, the department will pay $0.75 per pound for ice used in the mix, regardless of the concrete temperatures.

While the engineer has the authority to order the contractor to use ice at any time, the engineer should talk to the contractor beforehand about the practicality of obtaining ice, as well as, any other options the contractor may have.

The department's goal is to build new structures with service lives of between 50 and 75 years in part by using concrete with cooler initial mix temperatures. Engineers are encouraged to approve using and paying for ice. When paying for ice, the department pays for the quantity required to reach a target concrete temperature of 80 F, rather than just paying to keep concrete temperatures below 90 F. The increased quality is worth the relatively small increase in project cost.

The cost of the contractor's temperature control plan and evaporation rate control plan are incidental to the concrete masonry bid items. The price of ice is fixed at $0.75 per pound and paid under the Hot Weather Concreting administrative item 804.6060.

515.7 Concrete Anchors

515.7.1 General

Concrete anchors are used to connect concrete elements with other structural or non-structural elements. Anchors can either be cast into concrete (cast in place anchors) or installed after concrete has hardened (post installed anchors). Post installed anchors can be subdivided into either adhesive or mechanical anchors.

Adhesive anchors are used mostly for structure rehabilitation work and pedestrian railing attachments. Rehabilitation work typically uses adhesive anchors to connect existing concrete with new concrete and rebar. The WisDOT Bridge Manual provides anchor rehabilitation information in section 40.16 of the bridge manual. Railing attachments are usually detailed with cast in place anchors and noted adhesive anchors may be used as an alternative.

Refer to standard spec 502 for other adhesive anchor requirements.

Standard spec 502.2.12 allows approved adhesive anchors when conforming to the standard specifications, contract plans, and manufacture requirements. The approved anchors are found on the approved products list APL.

BOS has placed a moratorium on mechanical anchors due to various concerns.

515.7.2 Concrete Anchor Testing Procedure

Tensile pullout loads (proof loads) are used to ensure anchors were installed correctly and satisfy load requirements. Proof loads are not required for cast in place anchors and may or may not be required for adhesive anchors. In most cases, when installed under the direct supervision of an ACI/CRSI certified installer proof loads are not expected. However, proof tests are recommended when field staff have concerns with anchor installation. Proof loads are required when the contractor does not use a certified installer for adhesive anchors. For these cases, anchors are subjected to tensile loads per the standard specification and plan requirements. Refer to standard spec 502 for anchor testing requirements.

Proof loads should be 80 percent of the bar yield load, unless otherwise provided by the contract. Anchor proof loads (ASTM A615) are given in table 515-2 for bar steel reinforcement and table 515-3 for typical anchor bolts. These values were determined by multiplying 0.80 times the nominal bar area times the bar steel yield strength. In some cases, ASTM minimum proof strengths were used instead of bar yield strengths.

Railing attachments are usually located near concrete edges, other anchors, and have shallow embedment. For these cases, it is recommended that the contractor install either cast in place anchors or install adhesive anchors by an ACI/CRSI certified installer. Damage may occur for this application when tested at 80 percent of the bar yield load.

TABLE 515-2 Adhesive Anchor Proof Loads for Bar Steel Reinforcement

Bar Size	ASTM 615 (1) GR 60
	Anchor Proof Load (kips)
#3	5.3
#4	9.6
#5	14.9
#6	21.1
#7	28.8
#8	38.0
#9	48.0
#10	61.0

(1 f_y = 60 ksi

TABLE 515-3 Adhesive Anchor Proof Loads for Anchor Bolts

Diameter (inches)	ASTM A325[1]	ASTM F593[2] (316 Stainless)
	Anchor Proof Load (Kips)	
1/2	13.4	10.2
5/8	20.9	16.0
3/4	30.0	15.9
7/8	40.9	21.6
1	53.4	28.3
1-1/8	58.8	35.8
1-1/4	72.6	44.2

[1] f_y = Based on 85 ksi (1/2" to 1" Diameter)
f_y = Based on 74 ksi (1-1/8" to 1-1/4" Diameter)
[2] f_y = 65 ksi (1/2" to 5/8" Diameter)
f_y = 45 ksi (3/4" to 1-1/4" Diameter)

SECTION 520 Steel Bridges

520.1 Shop Drawings

The fabricator's detailed shop drawings and steel erection drawings become a part of the project plans and are used in conjunction with the general plans. During steel erection, the engineer should make sure all members are placed in the proper position in the structure by checking match marks or identification marks on the members with the location shown on the erection drawing.

The department does not approve shop drawings. The department may perform a quality assurance review on selected submittals. BOS and project leaders/managers may provide comments on the shop drawings before acceptance by the department. The department's review does not relieve the contractor or fabricator of the responsibility for quality control of the work, for obtaining acceptable results, for the accuracy of dimension and details, or for conformity of these drawings with the contract.

Shop drawings for primary steel members and fabricated bridge components must be submitted to the department through the fabrication library. The fabrication library allows both BOS and project leader/managers to select review status and send notifications to the fabricator. Project leaders/managers must accept the shop drawings through the fabrication library by changing this status.

Project leaders/managers should review the fabrication library submission standards, which include electronic shop drawing review guides. This document can be downloaded from:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/fab-sharepoint.aspx

520.2 Shop Inspection

520.2.1 General

Based on the location of the shop and inspector availability, quality assurance (QA) inspection of the structural steel in the shop may be performed by a BOS representative. Shop inspection reports are submitted to the WisDOT fabrication library by quality assurance inspectors during fabrication, and are available for review at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/fab-sharepoint.aspx

In the event that shop inspection reports are not available, the engineer should contact the SFU to ensure that the structural steel has been shop inspected.

520.2.2 Primary Members

Primary members are critical members designed to carry load within the structure. Steel bridge primary members are listed in standard spec 506.3.1.1.

When structural steel members are delivered to a job site, if the region has concerns with the quality of the fabricated members provided, the region may arrange through BOS to have an on-site inspection made by an experienced shop inspector. This is not intended to be a complete inspection as to dimensions, etc., but rather to look for the type of defects that result from faulty fabrication and welding procedures.

The fabricator must submit certified mill test reports (CMTR) to the fabrication library. The project leader/manager must review these records before the start of fabrication. To avoid the incorporation of incorrect material into the structure, review of CMTRs for conformance to contract plans and specifications should be completed before assembly.

520.2.3 Fabricated Bridge Components

Fabricated bridge components are inspected in the field. The engineer or designer will make and document field inspections.

The fabricator must submit certified mill test reports (CMTR) to the fabrication library. The project leader/manager must review these records before the start of fabrication. To avoid the incorporation of incorrect material into the structure, review of CMTRs for conformance to contract plans and specifications should be completed before assembly.

520.3 Field Handling and Storage of Structural Steel

Standard spec 506.3.24 and standard spec 506.3.27, related to handling, storage, and erection of structural steel describes methods of storage and erection to avoid damage to steel members. Steel should be stored in areas adjacent to the work where it will not be subject to flooding or other hazards. Care should be exercised when storing steel on skids placed on frozen ground to select areas which, when thawed, will still provide a uniform support, without uneven settlement of the skids resulting in twisting of the members. Two or more pickup points must be used when handling girders 50 ft in length or longer. When picked up with a single crane, a suitable balance beam or spreader bar must be used when 2 or more pickup points are utilized. When epoxy-painted girders are moved, pads must be provided so paint is not damaged by cables or slings.

520.4 Bearings

520.4.1 General

Before erection of structural steel is started, the centerline of bearing should be laid out on all substructure units by precise methods, and the roadway centerline (or reference line) and centerline of bearings scratched or otherwise marked on the concrete. Bearing areas should be checked to see that a plane surface is provided at the correct elevation. If the concrete surface that will be in contact with the bearing pad is rough or irregular, it should be ground to provide full and uniform bearing. If a bearing area is low with respect to other areas on the unit or in relation to other units of the structure, shims of the same size as the masonry plate and of the required thickness should be ordered. Avoid using a number of thin shims if a single shim of the required thicknesses can be made from standard thicknesses of plates. The shims should be made from the same type of steel as specified for the bearings.

520.4.2 Bearing Pads

Bearing pads intended for use on bridge seats may consist of sheet lead or preformed fabric pads, or when so designated, may be of the elastomeric type. Only one type of bearing pad should be used throughout any one structure unless otherwise provided on the plans or in the contract. Preformed fabric pads must be Class A.

520.5 High Strength Bolts, Nuts, and Washers

520.5.1 Bolts

High strength bolts used on steel connections must conform to ASTM F3125 grade A325 or grade A490. ASTM A307 bolts, often referred to as "common" bolts, are not considered "high strength" bolts and should not be used unless otherwise provided on the plans or in the contract. High strength bolts must be of the heavy hexagon head style and either Type 1 (used on steels other than weathering steel) or Type 3 (used on weathering steel). Plain bolts are typically only allowed for Type 3 bolts. Coated bolts must be hot-dip galvanized.

A325 bolts are a medium carbon steel with a minimum yield of 120 ksi. A490 bolts are a heat-treated steel with a minimum yield of 150 ksi. A325 bolts may be galvanized, however A490 bolts are not to be galvanized due to hydrogen embrittlement. Since most bolts require a hot-dip galvanized coating A490 bolts are usually not allowed.

All bolts must be marked on the top of the bolt head (e.g. Type 1 bolts should be marked "A325" and Type 3 bolts should be marked "A325").

Note: A325 and A490 bolts are now covered by ASTM F3125 under grades A325 and A490 respectfully. Refer to ASTM F3125 for additional information.

520.5.2 Nuts

Nuts used on high strength bolts must conform to ASTM A563 and provide a similar protective coating as the bolt (e.g. a coated Type 1 bolt must use galvanized DH nuts and a plain Type 3 bolt must use plain C3 or DH3 nuts).

520.5.3 Washers

Washers used on high strength bolts must conform to ASTM F436 and provide a similar protective coating as the bolt (e.g. a coated Type 1 bolt must use galvanized Type 1 washers and a plain Type 3 bolt must use plain Type 3 washers). Flat washers are most commonly used. Tapered washers may be required for sloped bolting surfaces, such as attaching to sloped girder flanges.

520.6 Assembly

520.6.1 General

Bearing surfaces and all surfaces of metal that will be in contact must be free of rust, loose mill scale, dirt, oil, and grease. In addition, contact surfaces of beams and girder splices or main truss connections must be free of paint or lacquer, except that inorganic zinc rich primer is allowed on these surfaces. Currently, there are no other exceptions to the paint or lacquer-free requirement.

The steel should fit together with very little strain or distortion. If bolt holes are only slightly out of alignment, it is usually possible to bring the pieces into their proper position with drift pins. However, if the holes fail to line up properly, to the extent that forcing the drift pin through would result in damage to the metal surrounding the hole, the hole should be drilled or reamed instead. Any fabrication error that cannot be corrected by a small amount of drifting, drilling, or reaming is cause for rejection of the material. Heavy sledging of the parts to bring them into alignment or making any cuts or adjustments with a flame-cutting torch should not be allowed. The entire structure, or as a minimum for continuous spans, the span and immediately adjacent continuous spans, should be assembled, drift pinned, bolted and adjusted to the proper grade and alignment in accordance with the plan blocking diagrams or the top flange elevations

when shown on the plans, before permanent connections are made. If high strength bolts are used for the permanent connections, they may also be used for this "fitting up".

When deflections due to mass of steel are appreciable, the blocking diagrams should be adjusted to compensate for such deflection. Assembly and erection of continuous girders should be accomplished so the top flanges of the girders, as finally erected, are within 1/2 inch of the top flange or blocking diagram elevations, as shown on the plans or as adjusted in the field to compensate for appreciable dead load deflection.

Galvanized or coated bolts of any grades and A490 heavy hex bolts cannot be reused. Uncoated A325 bolts may be reused when approved by the engineer. Re-tightening, or “touching up” of previously tightened bolts during the snugging operation, or any re-tightening of adjacent bolts loosened during snugging operations is not considered “reuse”.

High strength bolts are used for either "slip-critical" or "bearing" type connections. All high strength bolted connections on bridges are designed as slip-critical, unless otherwise provided on the plans or in the contract. Slip-critical type connections are used on bridges since connections are subject to stress reversals and slippage must not occur between the joined parts at service load levels. To prevent slippage, high-strength bolts are installed to a specified initial tension, which causes an initial precompression (or clamping force) between the joining parts. The joining surfaces are referred to as the faying surfaces and require special surface preparations to ensure frictional resistances can be achieved. Steel connections are typically painted before assembly and will affect the slip resistance of the bolted connection. If the faying surface is painted, it will then require a blast cleaning and provide a Class A or B coating based on the design. Paints on the APL for Structure Painting Systems are qualified as Class A and B coatings.

Bearing type connections transfers loads by bearing the bolt shank against the side of the hole. This connection typically can be installed only to snug-tight condition since slippage is not critical. Bearing type connections may only be allowed when stated on the plans or in the contract, otherwise they are not allowed.

Connections must be made using 3/4" high strength bolts, unless otherwise specified, and the same type should be used throughout the structure.

High-strength bolts may be tensioned by the turn-of-nut method.

520.6.2 Turn-of-Nut Method

This bolt tensioning method produces additional rotation of the nut beyond "snug tight". Snug tight is defined as the point where the power wrench ceases to rotate freely and starts to impact and is also the approximate degree of tightness that can be obtained with an ordinary spud wrench. The entire connection should be snug tight, and the faying surfaces should be in intimate contact before additional rotation is applied.

The engineer should be present for the QC testing and may verify bolt installations using a calibrated torque wrench. Torque tension determination should be documented in the field by using DT2114 and kept in the permanent project file.

If no nut or bolt head is turned by this application of the inspection torque, the connection must be accepted as properly tightened. If any nut or bolt head is turned by the application of the inspection torque, this torque should be applied to all bolts in the connection. All bolts whose nut or head are turned by the inspection torque must be tightened and re-inspected or, optionally, the fabricator or erector may retighten all bolts in the connection and then resubmit the connection for the specified inspection.

520.6.3 Load-Indicator-Washer Method

This bolt tensioning method uses a specially designed washer with protrusions on one side. This load-indicator-washer is placed, in most conditions, under the head of the bolt with the protrusions facing away from the surface of the steel member being connected. The entire connection should be snug tight before final tightening. As the nut is turned, the protrusions are partially flattened and the gap between the load-indicator-washer and the bolt head is reduced to a gap specified by the manufacturer. Testing is done by measuring the gap with a metal feeler gauge.

The inspector should inspect 10% or a minimum of 2 bolts chosen randomly from each connection on the structure. If any of the gaps tested exceed the minimum gap spacing, all the bolts in that connection must be retightened by the fabricator or erector as needed and resubmitted for inspection.

520.6.4 Rotational Capacity Test

520.6.4.1 General

Rotational Capacity (RC) testing is required on all projects using A325 or A490 structural bolts in steel-to-steel connections unless the design engineer specifies otherwise.

On jobs requiring high strength bolts to have an RC test, those bolts should be received with the RC test performed at the supplier. RC lots need to be established with the lots and combination of lots on site that will be used in erection. Each RC lot includes the nut lot, bolt lot, and washer lot. Combinations that are not used in these lots should be segregated to eliminate the possibility of mixing untested lots for field use. Tension and rotational capacity testing should be documented on DT2113 and kept in the permanent project file.

520.6.4.2 Pre-Installation Verification

Pre-installation verification (PIV) tests are in addition to the Rotational Capacity test and are required to determine the effective installation of the bolt to an acceptable tension. DT2114 contains the procedure necessary to perform this test.

520.6.5 Welding

520.6.5.1 General

The standard specifications require welding of steel structures to conform to AASHTO/AWS D1.5, Bridge Welding Code. Welding pile splices should conform to American Welding Society (AWS) D1.1, Structural Welding Code - Steel. Clause 8, paragraph 8.5.1 of AASHTO/AWS D1.5 provides that unspecified welds are not to be added without the engineer's approval. Unspecified welding is welding not called for on the plans or in the specifications and is done by the contractor for the contractor's convenience in performing construction operations. An example is the welding to beams of fixtures such as form hangers, bar chairs, and screed holders used when placing deck concrete.

Due to the effect of residual stresses on the fatigue strength of steel, unspecified welding is not allowed in tension areas of beams or other main stress carrying members. Tension flanges shall be labeled in the contract plans. Contact BOS if the tension zone is not labeled.

All welding of steel bridges must be performed by qualified welders or qualified welder operators.

All welding of steel bridges must be performed according to written welding procedures (WPS), which must be approved by BOS. Procedure qualification records (PQR) may be required for non-standard base materials or filler metals. For shop welding the fabricator must submit all WPSs and PQRs for the project to the WisDOT fabrication library for BOS review and approval before the start of any welding.

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/fab-sharepoint.aspx

Equipment, weld joint preparation and fit up, welding procedures, and welder qualification must all be checked by a certified welding inspector before welding.

Welding electrodes and filler materials must be properly stored. Low-hydrogen E7018 and E7018-MR electrodes, once their sealed container is broken, should be stored in holding ovens if they will not be used within 4 hours and 9 hours, respectively. Refer to Table 520-1 for allowable atmospheric exposure times for other SMAW electrode specifications. Fluxes and flux-cored electrodes need protection from moisture, rain, and high humidity. Welding rods that have cracked from over-drying, or those that have been rained on or have been thoroughly wetted in any manner, should be discarded and not used. Electrode containers that have been opened or received in a non-hermetically sealed cans or boxes are considered wet and should not be used. Refer to Table 520-2 for matching filler metals.

Preparation for welding includes beveling ends of pieces to be butt welded, smoothing rough edges, and thoroughly cleaning all surfaces where a weld will be made, for a distance of not less than 1 inch beyond the edges of the weld on all sides. Surfaces should be perfectly clean and free from rust or oil. An approved weld-able primer may be used to maintain this condition. A thin coat of clean, pure linseed oil need not be removed.

The direction of general progression of welding on a member shall be from points where parts are relatively in fixed position with respect to each other towards points where they have greater freedom of movement.

Welding must not be done when the ambient temperature is lower than 0 F. When the base metal is below the required preheat temperature, it must be heated such that the surfaces of the parts on which weld metal is being deposited are at or above the specified minimum temperature for a distance equal to the thickness of the part being welded, but not less than 3 inches both laterally and in advance of the welding.

Preheat and interpass temperatures must be sufficient to remove any moisture from the base metal. WisDOT recommends a minimum preheat temperature of 150F, independent of thickness, to ensure complete moisture removal and prevent hydrogen crack formation. Minimum preheat must be the highest temperature between 150 F or the values listed on the WPS.

For ASTM A514, ASTM A517 and ASTM A709 Gr. HPS 100W steel, the maximum preheats and interpass temperature must not exceed 400 F for thicknesses up to 1 1/2 inch inclusive, and 450 F for greater thickness.

In joints involving combinations of base metals, preheat must be as specified for the higher strength steel being welded.

520.6.5.2 Inspection

A finished dependable weld of good workmanship has the following characteristics: A reasonably uniform cross-section with a flat or slightly convex face; reasonably straight edges merging almost imperceptibly into the base metal; a fairly smooth contour without overlap, undercutting or deficiency in section; and freedom from pits, oxides, slag conclusions and gas pockets. The weld metal should be bright and without color after cleaning with a wire brush.

When visually inspecting welds and the base metal parts for cracks or other defects, inspectors should use a strong light and a magnifying glass. A dye penetrant, if available, is a good inspection aid, but should only be used by SNT-TC-1a qualified technicians. The size and length of each fillet weld must be compared with the plan dimensions. The size or length may be slightly oversize or longer than specified but must not be less. A chart showing standard welding symbols is given in Figure 520-1.

If erection bolts are to be removed, the plans will indicate whether bolt holes should be filled and in what manner.

520.6.5.3 Correction of Defective Welds

Welds can be removed by chipping, grinding, oxygen cutting, oxygen gouging, or air arc gouging; but must be completed such that the remaining weld metal or base metal is not nicked or undercut. Caulking of welds is not allowed. Ensure that the contractor follows the applicable AWS welding code requirements and procedures for all repairs. Some AWS repair procedures require engineer approval. The engineer must not allow the contractor to start these repair procedures before contacting SFU, providing all required documentation for review, and receiving approval.

The engineer shall be notified if improperly fit and welded members are cut apart and should request inspection from SFU. Removal and repair procedures, including WPSs must be submitted to SFU for review and approval before cutting out the weld.

520.6.5.4 Field Welding

520.6.5.4.1 General

Field welding to primary members and fabricated bridge components must conform to standard spec 506.3.19. Field welding of piling must conform to standard spec 550.3.4.

Field welding at or below 32 F requires review and approval of the WPS by the SFU. No welding is allowed when the ambient temperature is lower than 0 F.

The contractor must have an approved DT2337 on file with BOS that covers the intended work before any welding can start. The engineer should confirm that the WPS, welder and inspector qualifications required for the work are listed in the DT2337 on file. If they are not or there is no form on file, request that the contractor update or submit their DT2337 to BOS for review.

Approved DT2337 forms can be viewed through the field welding library at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/fab-sharepoint.aspx

A spreadsheet listing all WPSs, welders and welder qualification is included in the Field Welding Library.

The contractor inspector should be submitting their completed DT2320 to the engineer on a daily basis for review. The contractor inspector and the welder must not be the same individual. At the beginning of field welding operations for the project, and intermittently for the remainder of welding, the engineer should verify that the welding parameters noted on DT2320 conform to the submitted WPS included in the DT2337. The engineer must review, sign, and submit DT2320, and any other inspection reports, to BOS through the WisDOT Field Welding Library at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/fab-sharepoint.aspx

The results of any non-destructive evaluation (NDE) tests must also be recorded and submitted to the engineer through the fabrication library as soon as they are available.

520.6.5.4.2 Field Welding to Primary Members

Field staff must notify BOS, Structural Metals Fabrication Quality Assurance Review Unit (SFU) in advance of any field welding on primary members. BOS must approve any welding on primary members with the exception of:

1. welding of shear studs when using a stud gun,

2. field welding bearing sole plates to the steel girder flange, and
3. welding threaded rods to the top flange of the girder to install new expansion joints.

520.6.5.4.3 Welding to Historic Steels

Strengthening and repair of existing structures often requires a determination of weldability of historic steels using conventional welding procedures and techniques. Any riveted structure likely contains historic steel that is no longer produced, and weldability may be compromised. If records of the original construction exist, they should be reviewed to determine base metal type and properties. Either or both mechanical and compositional tests may be necessary to identify the material, its composition and weldability. Older steels may require welding procedures that are more demanding than those used for new construction. Structures constructed by welding, regardless of age are suitable for welding repair. Materials shall always be identified to ensure chemical composition. AWS D1.7/D1.7M:2010-Guide for Strengthening and Repairing Existing Structures should be referenced during material identification and the determination of weldability along with input from the engineer.

520.6.5.5 Certifications

The AASHTO amendments to the AWS Code require the contractor to furnish certified copies of test reports for electrodes used on the project. The reports must also include the manufacturer's certification that the process and materials requirements were the same for the tested electrodes as for the furnished electrodes. The reports must include the results of applicable required tests of AWS A5.1 or A5.5. Certified test reports are also required for all combinations of gasses used with gas-metal arc and flux-cored arc welding. An example of electrode certification is shown on Figure 520-2.

520.6.6 Stud Shear Connectors

Stud shear connectors are end welded to the upper flanges of steel beams, girders or plates after such members have been erected and floor beams placed. Using stud shear connectors, rather than shop attached angular connectors, allows easier and safer erection and placement of forms and reinforcing steel; however, the studs are used only when and where designated on the plans. Requirements for welding and inspection of attached studs are covered in standard spec 506.3.20.

520.6.7 Intermediate Diaphragms for Prestressed Girders

For steel diaphragm to prestressed concrete girder web connections, the contractor must tighten connections to a snug-tight plus 1/4 turn condition at interior girders with through-bolts and to 80 foot-pounds at exterior connections when connecting to a ferrule loop insert with cap screws, unless the plan details show otherwise. Interior girder connections require bolt lengths that are typically not in stock for A325 bolts. Use of ASTM A449 bolts may be used instead of A325 bolts at interior girder bolted web connections.

For steel-to-steel connections within the diaphragms, the contractor must tighten according to standard specification 506.3.12.3 using 7/8" high strength bolts, unless the contract says otherwise. Tighten bolts by the turn-of-nut method outlined in CMM 520.6.2.

Field rotational capacity testing is not required for intermediate diaphragm bolts. The contractor must submit a certificate of compliance certifying that those bolts conform to the specifications.

520.7 Final Alignment of Bearings

Due to fabrication tolerances and inaccuracies in laying out the bearing locations, it is sometimes necessary to make slight adjustments in the position of the bearings, after the erection is complete, to allow the proper clearance between units or at abutments and to provide the correct opening at expansion devices. If the expansion bearings are of the rocker type, the rockers are adjusted by the erector according to the prevailing temperature, so they will be vertical at the standard temperature shown on the plans.

When the final position of the bearings has been established, and the steel has been fastened, holes for the anchor bolts are drilled and the bolts set in a premixed non-shrink commercial grout.

520.8 Miscellaneous

520.8.1 Masses of Structural Steel and Other Metals

Refer to standard spec 506.4.

520.8.2 Inventory Inspection

Refer to CMM 515.

520.8.3 Bridge Deck Removal, Partial and Complete

Significant damage to upper flanges of steel and reinforced concrete girders has occurred as a consequence of using excessive and sometimes careless efforts to remove structure decks. Using hydro-rams, whip hammers, heavy jackhammers, and cutting saws must be monitored by the inspector to

ensure that excessive vibrations or saw cuts are not imparted to already completed work or units that are to remain in place. The inspection and monitoring of deck removal is equally as important as the placement of new work. Contractor indifference towards protecting the integrity of the supporting members, whether stringers, floor beams, girders, or fracture-critical members, cannot be tolerated.

In the matter of partial deck removal, there have been instances where jackhammers have penetrated through the deck and shattered portions of the deck without any effort made to restore the integrity of the damaged area. Again, careful topside and bottom side monitoring and inspection must be exercised.

The requirements of standard spec 203.3.2 give the engineer full authority to order the contractor to discontinue or modify equipment or methods which damage parts of the structure to remain in place.

Obvious damage such as distortion of or damage to reinforcing steel and girders or the over breaking of concrete on work to remain should be cause for eliminating high energy removal equipment.

When damage will or might be imparted to any elements scheduled to remain, heavy hydraulic hammers should be confined to working outside an area 2 feet from any retained girder or from the line of neat removal. Additionally, using these hammers should be avoided on slab spans where the shock of impact might be detrimental to future performance of the remaining deck.

The contractor can be advised to avoid damage by bringing in lighter hammers or by utilizing hand-held pneumatic hammers. Proper use of equipment can minimize damage; however, the greater the energy capability of the hammer the more apt the operator is to work it to its maximum at the expense of the structural integrity of the structure.

A further ramification of partial removals is the increased dead load imparted to the first line of girders adjacent to a bay in which deck removal is taking place. The resultant cantilevered deck loads this girder with dead load that had originally been shared with the exterior or adjacent girder. If this dead load originally borne by the outside girder is not returned to the outside girder by shoring before placement of the additional deck, the load will remain on the interior girder. Furthermore, as the fresh concrete is placed, its mass may be assumed by the exterior or previously unloaded girder with little or no-load transfer to the interior girder.

Careful and continuing inspection of the removal operation is necessary to avoid damage or overloading of girders, and we believe that discussions with the contractor about equipment and removal methods before removal operations commence can eliminate many subsequent problems.

If you have any question about the possibility of damage occurring which is not discernable, contact the Geotechnical section. They will dispatch monitoring equipment to determine if intolerable wave energy is being imparted to adjoining members or newly completed work. Based on guides and charts at their disposal, they can provide guidance as to whether corrective measures are necessary.

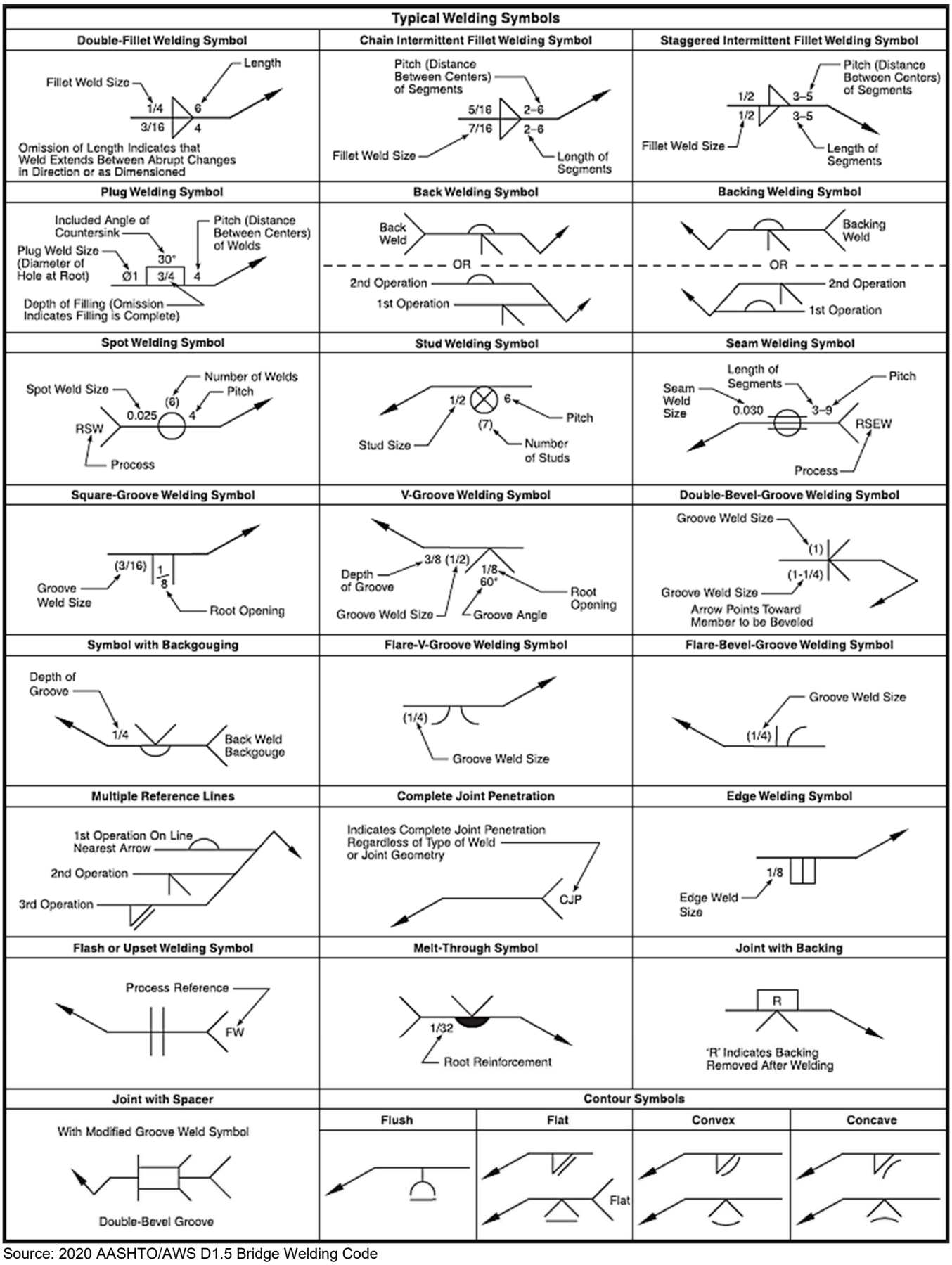
TABLE 520-1 Allowable Atmospheric Exposure of Low Hydrogen SMAW Electrodes

American Welding Society (AWS) Filler Metal Specification	Electrode	Hours
A5.1	E70XX	4 max
A5.5	E70XX-X	4 max
	E80XX-X	2 max
	E90XX-X	1 max
	E100XX-X	1/2 max
	E110XX-X	1/2 max

E70XX-X, E80XX-X, E90XX-X, E100XX-X, and E110XX-X electrodes with the AWS filler metal specifications optional supplemental moisture resistance designator “R” may be exposed to the atmosphere for up to nine hours when welding steels with a minimum specified yield strength of 50 ksi or less. Moisture-resistant electrodes shall be received in containers that bear the additional designator “R” as part of the AWS classification.

Source: 2020 AASHTO/AWS D1.5 Bridge Welding Code

FIGURE 520-1 American Welding Society Welding Symbols Chart



Source: 2020 AASHTO/AWS D1.5 Bridge Welding Code

TABLE 520-2 Matching Filler Metals for Written Welding Procedures (WPSs)

Welding Processes and AWS Electrode Specification and Classifications					
Base Metal AASHTO [ASTM] Designation	SMAW	SAW	FCAW-G	FCAW-S	GMAW
M270 Gr.250 [A709 Gr.36]	A5.1	A5.17	A5.20	A5.20	A5.18
	E6018	F6A0-EXXX	E7XT-1C	E7XT-6	ER70S-2
	E7015	F6A0-ECX	E7XT-5C	E7XT-8	ER70S-3
	E7016	F7A0-EXXX	E7XT-9C		ER70S-6
	E7018	F7A0-ECX	E7XT-12C		ER70S-7
	E7018-1				E70C-3C
	E7018M				E70C-6C
	E7028				
	A5.5	A5.23	A5.29	A5.29	A5.28
	E7015-X	F7A0-EXXX-XX	E6XTI -NiC, -NiM	E6XT8-X	ER70S-XXX
	E7016-X	F7A0-ECXXX-XX	E7XTI -XC, -XM	E7XT4-X	ER80S-XXX
	E7018-X	F8A0-EXXX-XX	E7XT5-XC, -XM	E7XT6-X	ER80S-NiX
	E7015, -16, -18, -C1L, -C2L	F8A0-ECXXX-XX	E8XTI -XC, -XM	E7XT7-X	E70C-XXX
	E701 8-C3L		E8XTI -Ni XC, -NiXM	E7XT8-X	E80C-NiX
	E7018-WI		E8XTI -W2C, -W2M	E8XT8-X	E80C-W2
	E8015-C1, C2, C3, C4		E8XT5-XC, -XM		
	E8016, -18-CI, -C2		E8XT5-Ni X, C -NiXM		
	E8016, -I 8-C3, -C4				
	E8018-W2				
M270 Gr.345 [A709 Gr.50]	A5.1	A5.17	A5.20	A5.20	A5.18
	E7015		E7XT- IC, - I M	E7XT-6 E7XT-8	ER70S-2, -3, -6, -7
	E7016	F7AO- EXXX F7AO-ECX	E7XT-5C, -SM		E70C-3C, E70C-3M
	E7018		E7XT-9C, -9M		E70C-6C, E70C-6M
	E7018- I		E7XT-12C, -12M		
M270 Gr.345S [A709 Gr.50S]	E7018M				
	E7028				
M270 Gr.345W [A709 Gr.50W]	A5.5	A5.23	A5.29	A5.29	A5.28
	E7015-X	F7AO- EXXX-XX	E7XTI-XC, -XM	E7XT-X	ER70S-XXX
	E7016-X	F7AO-ECXXX-XX	E7XT5-XC, -XM	E7XT6-X	ER80S-XXX
	E7018-X	F8AO- EXXX-XX	E8XTI-XC, -XM	E7XT7-X	ER80S-NiX
M270 Gr.HPS 345W [A709 Gr.HPS 50W]	E7015, -16-CIL, -C2L	F8AO-ECXXX-XX	E8XT1-NiXC, -NiXM	E7XT8-X	E70C-XXX
	E70I8 -C I L, -C2 L, -C3L		E8XTI-W2C, -W2M	E8XT8-X	E80C-NiX
	E7018-WI		E8XT5-XC, -XM		E80C-W2
	E8015-C I, C2, C3, C4		E8XT5-NiXC, -NiXM		E80C-XXX
	E8016, -18-C I, -C2				
	E8016, -18-C3, -C4				
	E8018-W2				

ASTM Designation	SMAW	SAW	GMAW	FMAW
A514 Over 2-1/2in	A5.5	A5.23	A5.28	A5.29
	E10015-X, 16-X, 18-X	F10XX-EXXX-XX	ER100S-XXX	E10XTX-XC
	E10018M	F10XX-ECXXX-XX	E100C-XXX	E10XTX-XM
			A5.36	A5.36
			E11TX-XAX-XXX	E11TX-XAX-XXX
A514 2-1/2in and under A517	A5.5	A5.23	A5.28	A5.29
	E11015-X, 16-X, 18-X	F11XX-EXXX-XX	ER110S-XXX	E11XTX-XC
	E11018M	F11XX-ECXXX-XX	E110C-XXX	E10XTX-XM
			A5.36	A5.36
			E11TX-XAX-XXX	E11TX-XAX-XXX

Source: 2015 AASHTO/AWS D1.5 Bridge Welding Code

TABLE 520-3 Minimum Preheats and Interpass Temperatures for Non-Fracture Critical Welds

	Minimum Preheat and Interpass Temperature F			
Welding Process Base Metal	Thickness of Thickest Part at Point of Welding, in			
	To 3/4in	Over 3/4in to 1-1/2in	Over 1-1/2in to 2-1/2in	Over 2-1/2in
SAW; GMAW; FCAW; SMAW A709 Gr. 50/50S/50W/HPS 50W	50	70	150	225
SAW; GMAW; FCAW; SMAW A709 Gr. HPS 70W/HPS 100W	50	125	175	225
Maximum preheat and interpass temperature is 450F For fracture critical welds use preheat and interpass temperature values in AASHTO/AWS D1.5 Tables 12.3/12.4/12.5				

Source: 2020 AASHTO/AWS D1.5 Bridge Welding Code

FIGURE 520-2 Typical Certificate of Conformance for Welding Electrodes

(Manufacturer's name and address)

CERTIFICATE OF CONFORMANCE TO REQUIREMENTS
FOR WELDING ELECTRODES

Supplied to:_____

Date Quantity Order No. Heat or Lot No.

This is to certify that (Trade name or No.) AWS classification (EXXXX), as supplied under the above order number, is of the same classification, manufacturing process, and material requirements, as the electrodes tested on _____ 19___.

All tests required by specification AWS A5.1 or AWS A5.5, were performed in conformance with the specification, and the above electrode met all of the requirements. The electrodes are marked in conformance with AWS A5.1 or AWS A5.5.

The chemistry and mechanical properties of the deposited weld metal were as follows:

	4mm		5mm		6mm	
	DC+	AC	DC+	AC	DC+	AC

Tensile Strength MPa _____

Yield Strength Mpa_____

Elongation % in 50mm_____

Charpy V Notch

Nm at C. _____

Manganese % _____

Silicon %_____

Nickel % _____

Chronium % _____

Molybdenum % _____

Vanadium % _____

Fillet Tests Position

as required_____

Radiographic test_____

Fillet Test, Radiograph, chemistry and mechanical properties are not required for the following size:

_____ _____ _____

Operations Supervised by Chief Engineer Director

SECTION 525 Bridge Decks

CMM provisions mobilized by the contract:

CMM 525.1.3 figure 525-1 ..... evaporation nomograph

525.1 Placing, Finishing, and Curing Bridge Decks

525.1.1 General

The placing, finishing, and curing of concrete bridge decks is the most critical aspect of bridge construction. Not only is it critical from the standpoint of the finished surface, since the traveling public judges a bridge by its riding qualities, but the quality and durability of the concrete are critical because bridge decks are probably subjected to more severe conditions conducive to scaling and deterioration than any other highway element. Since bridge decks are subject to becoming frosty and slippery, chemical de-icing and abrasive agents are frequently applied, which may remain in contact with portions of the bridge deck for extended periods.

Some of the measures necessary to obtain smooth riding bridge decks are setting of grades to allow for anticipated deflections, adequate falsework and supports, including banding and bracing of outside girders as needed, using adjustable screed guides, constant observation of actual deflections during the placement of the deck concrete, and the correction of any indicated deficiencies. Generally, it might be said that the same principles, methods, and skills are required to produce smooth bridge decks as are employed in constructing smooth pavements. The important difference in the two procedures is the technique of working in the limited space usually available on a bridge deck.

One of the essential ingredients of a smooth bridge deck, after the forms and screed guides are accurately set and firmly supported, is a properly proportioned, uniform concrete mix. It is impossible to get optimum results with concrete of varying consistency, since areas of stiffer concrete will finish a little higher than those placed with wetter concrete, and the wet concrete will shrink more when drying. However, a good mix is of little value unless it can be delivered to the bridge deck at an adequate and constant rate to allow uninterrupted placement and finishing of the deck surface. Another essential element is adequate equipment and manpower to place, strike-off, finish, and start curing the concrete.

525.1.2 Setting Grades

The structure plans will generally include a diagram showing the amount of deflection expected in any span due to the mass of the span itself (dead load). For non-prestressed cast in place structures, there will be an additional allowance for deflection due to future creep. Creep is the tendency for concrete under stress to deform, at a decreasing rate for a period of time, perhaps several years. The grade to which the forms, screed guides, or rails are set will depend on several considerations. As mentioned in the discussion of falsework, the grade to which the forms are built must provide sufficient camber to offset anticipated deflections due to dead load and future creep, plus an allowance for settlement or compression that will take place within the falsework.

Theoretical finished grades at the centerline and edge of slab at required intervals are supplied to the region by the structural design section. For spans utilizing steel beams or prestressed concrete members, WisDOT should determine a profile for each stringer after steel erection by taking elevations at frequent intervals. The theoretical deck grade, adjusted to allow for the anticipated dead load deflection, is then compared with the stringer profile and modified, if necessary, due to excessive camber in any stringer, to provide the minimum deck thickness and haunch as specified on the plans. After the forms, screed guides, or rails are set by the contractor to the grade established by WisDOT, they should be "sighted in" to remove any irregularities.

Attention must be paid to deflection allowances when screed rails are placed on overhangs. Falsework supports or placing of outer beams may be necessary to prevent settlement of the overhang or other areas of the deck forms.

The contractor should set the rails or tracks upon which the machine finisher operates to the required elevation. For all but the shortest spans, the screed guides or rails on which the strike-off apparatus rides should be readily adjustable, so that if excessive settlement or deflection takes place under load, appropriate adjustments can be made at once and the surface refinished to the correct grade.

Rails or tracks upon which heavy machine finishers operate should be rigid enough and supported at frequent intervals so that deflection of the rail will be minimized, and preferably the supports on one side of the bridge should not be directly opposite those on the other side.

The rails or tracks should be extended to allow the finishing machine to be run clear of the floor at both ends. Hand finishing at the ends of the bridge floor can be eliminated, and the quality of the ride improved under this procedure.

525.1.3 Prepour Preparations

1. Initial inspection

   Before placing the deck concrete, a thorough inspection of the falsework should be made, including the following:

   - Footings and the forms
   - Reinforcement
   - Finishing equipment
   - Guides or rails
   - Delivery system
   - Transit mix trucks or other mixers
   - Batch plant including admixtures, aggregates, and cement
   - Fogging and curing systems
   - Telltale devices

   Any deficiencies should be corrected before deck placement. Before scheduling the pour, a dry run of the finishing machine over the placed reinforcement bars must be made and periodic measurements of total deck thickness and clearance to the reinforcement taken and recorded. The fogging equipment must also be tried to see that it functions as intended and will not cause damage to the surface.

2. Prepour meeting.

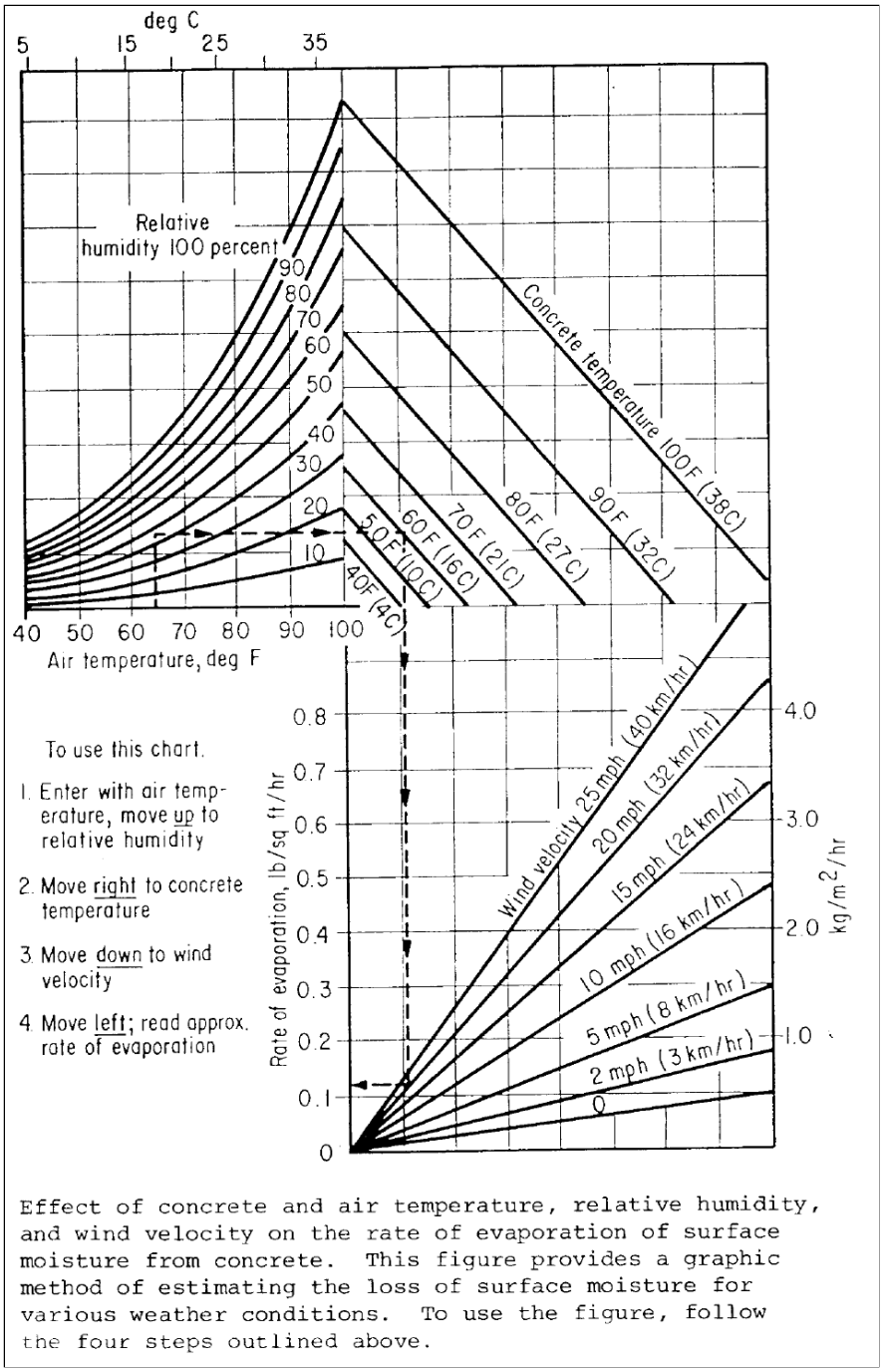
   Before every deck pour a pre-pour meeting should be held with the contractor at which time every aspect of the pour should be discussed, and any differences resolved. Items to be discussed should include:

   - Time of starting the pour
   - Anticipated weather conditions.
   - Rate of delivery of the concrete to ensure completion within a reasonable time.
   - An adequate number of approved delivery vehicles available exclusively for the pour.
   - Method of placement
   - Consolidation and finishing of the concrete
   - Number of finishers and their duties
   - Finishing tools and equipment available
   - Application of the surface texture
   - Timing of fogging and final curing
   - Emergency covering materials available in case of inclement weather.
   - Any other appropriate subjects

   Consideration should be given to delaying the pour if the rate of concrete surface moisture evaporation exceeds 0.2 lb/sq ft per hour as shown in figure 525-1 below.

The evaporation nomograph in figure 525-1 is mobilized into the contract by standard spec 501.3.8.2.2.

FIGURE 525-1 Rate of Evaporation of Surface Moisture from Concrete



Effect of concrete and air temperature, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This figure provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the figure, follow the four steps outlined above.

525.1.4 Placing Concrete

The concrete should be spread to approximate grade, then consolidated by vibration. The strike-off for the screeding equipment should be capable of striking-off low slump concrete to the desired grade and cross-section, moving forward at a uniform rate, and accomplishing its objective without requiring an excessive number of passes. It should be operated with a uniform amount of concrete ahead of the screed at all times, and for the full width of the screed. Walking in the concrete should be prohibited after the screeding operation.

Placement of concrete on the overhang should not be completed before placement of concrete on the adjacent bay or lane; otherwise the steel reinforcement on the overhang may deflect and raise the steel on the adjacent bay, reducing minimum clearance.

It is recommended that where feasible and practical, concrete placement proceeds from the lowest elevation to the highest elevation to minimize finishing problems caused by flow of rainwater or moisture from fogging into the area where finishing operations are proceeding. Also, concrete placed in longer

steel girder structures has a tendency to walk downgrade, especially if concrete placement is started at the highest elevations.

Field reviews have indicated that slump of vibrated concrete has frequently exceeded the maximum of 4 inches. Standard spec 105.3 requires that slump test results should fall substantially within the specified range and only occasionally be of borderline quality. Concrete having a uniform, proper slump is essential in obtaining a strong, durable deck, and the contractor should be required to regulate and control concrete production to ensure compliance with the slump requirements of standard spec 501.3.7.1.

Checks for deflections at form or rail supports need to be made during the deck pour. Depth of embedment and total slab depth must also be frequently checked during the placement operation, and any appropriate adjustments made in the rails or finisher screeds. The method used may be dictated to some extent by job conditions. A device for stabbing the deck for cover or thickness has been made available to each region for use in the field.

Decks that have turned out to be less than specified thickness could have easily been detected early enough by timely probing to make corrections. On the other hand, another deck pour that could have been a disaster was detected early by alert inspection and the paving rails were adjusted to make the necessary correction. It is not sufficient to assume everything will turn out all right because the dry run with the machine showed proper cover and thickness. We have numerous examples where these measurements have changed substantially without acceptable explanation. The only defense is to be constantly aware of what is happening and have a contingency plan for correcting it when something starts to go amiss. The inspector should also be constantly checking for settlement or deflection during a floor pour by sighting along the forms or rails, taking elevations of the same at frequent intervals, or by using telltale devices previously installed.

The standard specifications require that concrete in decks must be consolidated by mechanical vibration. Gang vibrators mounted on the paving machine are preferred. An adequate number of vibrators should be provided. Special care must be taken to ensure the entire deck pour is completely and uniformly vibrated to achieve thorough consolidation without over vibration of local areas. Vibration must not be applied through reinforcement to partially hardened areas of the deck. Vibrators must be capable of transmitting at least 4,500 impulses per minute to the fresh concrete. This frequency can be checked by means of a vibrating reed tachometer available through the region. The tachometer reading shown in revolutions per minute is equivalent to impulses per minute.

525.1.4.1 Evaporation Retarders

Commercial liquid evaporation retarders are only allowed with engineer approval in emergency situations such as equipment breakdowns during deck pours. If used, evaporation retarder must be applied in an even, fine mist by a hand-held pressurized sprayer. Application that results in puddling or runoff will not be allowed.

525.1.5 Finishing Concrete

Standard spec 502.3.7.8 provides that all concrete bridge floors must, unless otherwise specified, be finished by self-propelled machine finishers.

Placement of the concrete should never be allowed to progress faster than the hand finishers or machine finishers can acceptably complete the finishing of the concrete. The skill and experience of the contractor's crew will have a great effect on the final finishing operations. Where an acceptable finish has been obtained by the self-propelled finishing machine, float finishing will not be required. Float finishing, when required, should be closely observed by the inspector to detect and correct waves or dips due to faulty operation of the strike-off, failure to properly adjust screed guides, deflections of forms or screed guides, uneven consolidation of the concrete, or failure to properly meet expansion joints or construction joint headers. The screed or screeds should be so adjusted and operated as to finish the concrete to the required crown and grade and to produce a surface within specified tolerances.

Straight edging should be done while the concrete is still in a condition that corrections can be made but delayed as much as possible to take advantage of the final slumping of the concrete. The inspector should closely observe the straight edging operations by the contractor or may elect to independently check the surface with a testing straightedge. Any irregularities disclosed by the straight edging should be immediately corrected. Special attention should be paid to the finishing of gutter lines to maintain longitudinal drainage on the bridge floor. With structures on very flat grades or on the crest of vertical curves, it is sometimes necessary to warp the flow line of the gutter in order to maintain drainage to the ends of the structure or to the floor drains as the case may be. This warping can be accomplished in the outer three feet of the surface and need not be detrimental to the overall riding quality of the deck. A carpenter's or mason's level is helpful to the finishers working in these areas.

The final operation in finishing the bridge floor is the application of the surface texture. This is intended to give the floor a uniform, pleasing appearance and a skid-resistant surface. The timing of this operation must coincide with the proper degree of setting of the concrete if optimum results are to be obtained.

Decks having approach pavements with design speeds of 40 mph or greater must receive either an artificial turf drag finish or a broom finish, followed by a tined finish. The tined finish is similar to that used on rural pavements except that it is done transversely, and the depth is only about 1/8". The tining must not be applied within 1 foot of the gutters and may be applied manually. On bridge decks having skew angles of 20 degrees or greater, tining must be applied within 20 degrees of the centerline of bearing of the substructure units.

Decks having approach pavements with design speeds less than 40 mph must receive either an artificial turf drag finish or a broom finish, with no tining.

Brooms for a broomed surface should have fairly stiff, medium coarse bristles, and the pressure on the broom should be regulated to prevent tearing of the surface yet produce an acceptable skid resistant surface.

525.1.6 Curing Concrete

Curing of the concrete is extremely important in the production of strong, durable concrete. Included in the curing process is the protection of the concrete from either excessively high or low temperatures. It is very important that before the water sheen disappears from the surface of the bridge floor a fog or fine water spray be applied until the concrete is sufficiently hardened to support the curing procedure used for these surfaces. The object of fog curing is to provide the necessary concrete cure after the deck slab loses its surface moisture and before it is sufficiently hardened to allow placement of the burlap or fabric. The amount of mist and number of applications necessary may vary from bridge to bridge depending on weather, concrete consistency, and finishing methods. The engineer should review with the contractor the proposed method for applying the fog cure at the prepour meeting and before the day of the deck pour. Fogging should be accomplished by nozzle arrangements allowing the discharge of a constant uniform mist without washing of the fresh concrete. Fogging should be accomplished as a separate and distinct part of the deck curing operation.

After the concrete has sufficiently hardened the deck should be cured with a double thickness of wet burlap for not less than seven days. Keeping the deck continuously wet and covered is very important to maximize future strength and durability and minimize the potential for cracking. Decks on structures less than 100 feet in length may be cured for a period of seven days with polyethylene-coated burlap or other coated material meeting the requirements of the standard specifications. Curing with liquid membrane curing compound is not allowed on the bridge deck.

Refer to figure 525-1 above for rates of evaporation of moisture from concrete. Refer to standard spec 502.3.8 for detailed curing requirements.

525.1.7 Durability of Bridge Decks

Probably the most significant factor in the resistance of concrete to scaling is adequate air-entrainment. Many variables affect the percentage of air that a given concrete mixture will entrain. The inspector should make sufficient air tests on the concrete going into structures to ensure an air content well above the lower limit of the specification range. Later operations of placing and finishing the concrete should be closely controlled, since excessive manipulation and vibration of the concrete may decrease the air content. Research indicates a loss of 0.5% to 1.0% of air occurs at the surface of the concrete due to over vibration. Also, over vibration tends to bring the lighter, unsound aggregate particles to the surface where freeze-thaw action may cause deterioration, pop-outs, and scaling.

Another practice to be strenuously avoided in the finishing of concrete is the persisting tendency of some finishers to sprinkle water on the surface in an attempt to gain workability. The resulting high-water content in the surface mortar can result in a reduction of up to 25% in the strength of concrete at the surface and is an invitation to the development of surface scaling.

525.2 Miscellaneous

525.2.1 Set Retarding and Water Reducing Admixtures

Using retarding agents to delay the setting of concrete in bridge floors, especially in hot weather, offers the advantage of providing sufficient time for proper finishing of the concrete, including any corrections of high or low spots disclosed by the final straight edging, and generally allows using a lower water content, which is conducive to a stronger, more durable concrete.

525.2.2 Rust Stains

Rust stains may be removed from the concrete by mopping with a solution containing 1 lb of oxalic acid powder per gallon of water. After two to three hours, rinse with clear water and scrub with a stiff brush.

Rust staining of substructure concrete where reinforcing steel extends through a construction joint and will be exposed for some considerable time can be prevented by painting the steel with a thin coat of cement grout. The grout must be entirely removed before the remainder of the concrete is poured.

525.2.3 As-Built Plans

Refer to CMM 165 for requirements relating to the supplying of as-built structure detail sheets to the BOS structures development section.

525.2.4 Inventory Inspection

An inventory inspection is the inspection of a new bridge as it becomes a part of the bridge inventory. An inventory inspection could also apply where a substantial change has been made to the existing structure such as widenings, lengthenings, supplemental bents or piers, deck replacements, superstructure replacement, concrete or asphalt overlay, changing pin and hangers, or replacing or changing joints, bearings, etc. The inventory inspection required here may only have to include the changes made.

The inventory inspection is a fully documented investigation performed by persons meeting the required qualifications for inspection personnel. An analytical determination of load capacity may be required. An underwater or other specialized inspection may be part of the inventory inspection.

The purpose of this inspection is twofold:

- It will be used to determine all structure inventory and appraisal data required by the FHWA and other relevant information required by WisDOT to maintain an up-to-date bridge file.
- It will be used to determine baseline structural conditions and identify and list any existing problems or locations that may have potential problems. With this information recorded, these areas can be checked at the next inspection for a comparison to see what is developing. Aided by a prior detailed review of plans, it is during this inspection that any fracture critical members (or details) are noted for subsequent focus, and assessments are made of other conditions that may later warrant special attention.

On any new bridge or rehabilitated bridge where the construction inspection was accomplished with state funds by state forces or consultant forces, the engineer must notify the bridge maintenance supervisor and the maintaining authority that the structure is ready for an inventory inspection. This applies to either a state-maintained bridge or a local government-maintained bridge.

The inventory inspection should be accomplished after the bridgework is complete, but before the contractor leaves the job site.

All data required to update the bridge file must be submitted to the proper region. The region should submit the data to the BOS structural development section. This data should be submitted as soon as possible, preferably before the bridge is open to traffic.

Data to be submitted may include the inventory inspection, Bridge Inspection Report (form EM30), Bridge Inventory Report (short form EB575-186) and a set of bridge plans. The data required depends on the work done, plans available, if the state has a set of plans, etc.

525.2.5 Opening to Service

Refer to standard spec 502.3.10 for strength requirements for opening to service.

525.2.6 Applying Epoxy Pavement Markings to New Concrete Bridge Decks and Overlays

The question has arisen whether protective surface treatment should be removed from those areas on new concrete bridge decks and overlays where epoxy center-line and edge-line pavement markings are to be applied. The answer is yes, however the protective surface treatment must be re-applied to all areas where it has been removed in preparation for application of pavement marking. The protective surface treatment must be re-applied after the pavement marking is applied. Alternatively, the protective surface treatment can be applied to the entire surface after the pavement markings are in place.

No portion of an epoxy overlay on a bridge deck should be removed to apply pavement marking.

525.2.7 Grooving Preformed Plastic Tape on Bridge Decks

Preformed Plastic Tape placed in a grooved 120 mils slot on a bridge deck or concrete overlay will not cause structural problems, however, the protective surface treatment must be re-applied after the preformed plastic tape is applied. Alternatively, the protective surface treatment can be applied to the entire surface after the preformed plastic tape is in place.

No portion of an epoxy overlay on a bridge deck should be removed to apply preformed plastic tape.

525.3 Crack Survey and Sealing

Sealing cracks on bridge decks has great potential to extend service life of structures. Concentrated chloride solution can leach through cracks as a direct conduit all the way through decks within the first winter season. Defects in epoxy coating on embedded rebar in the vicinity of the cracks can allow

corrosion to begin immediately. To prevent chlorides from leaching into cracks, standard spec 502.3.13 requires application of low viscosity crack sealer to all cracks visible in dry weather conditions.

525.3.1 Crack Survey

The initial crack survey is performed within 7 days after the end of the required wet-cure period. The deck surface should be thoroughly dry at the time of the initial crack survey. The initial crack survey should be completed before opening the deck to public traffic. Falsework does not have to be released before the initial crack survey. Cracks to be sealed should be visible from a standing position. The initial crack survey must include the bridge deck surface only, not other items such as medians, sidewalks, or parapets.

When conducting the initial crack survey, identify the endpoints of each crack with a small, discreet mark. Use of a black felt-tip permanent marker is recommended. Please do not mark along the length of the cracks with fluorescent paint or any other marking that would prevent penetration or bond of the crack sealer or appear obnoxious to the public after the structure is open to traffic.

At the conclusion of the initial crack survey, determine the total linear footage of cracking that has been identified to be sealed. This is the upper limit of cracking for which the contractor will be responsible for sealing under the Concrete Masonry Bridges bid item.

525.3.2 Crack Sealing

The initial crack sealing should be completed at least 7 days following the end of the wet cure period at the earliest, but before opening the deck to public traffic. High pressure water-blasting should be used to clean the deck surface in the immediate vicinity of the cracks to be sealed. Do not sandblast, as this will deface the appearance of the deck.

The deck surface should be allowed to air dry for at least 48 hours before crack sealing. The sealer must be selected from the approved product list APL. It is acceptable for the sealer to be applied after only 7 days following the end of the wet cure period, which will take precedence over the longer dry curing periods recommended by the sealer manufacturers. The department recognizes the time pressure to construct and open projects quickly and is willing to forego the benefits of dry curing for 21 to 28 days as recommended by the sealer manufacturers.

Initial crack sealing is incidental to the concrete masonry bid item. However, it is recognized by the department that a majority of later cracking can be due to design and deflection influences that are beyond the control of the contractor. The department will be responsible for the cost (including traffic control) of sealing any additional cracking that develops later following the initial crack survey. The contractor should be paid for any additional crack sealing as additional work. To enhance the durability of the structure, it is recommended that wherever practicable, the department should pay for sealing any additional cracks that have developed just before final opening of the completed structure to public traffic.

In the event of a late season deck pour, when there is no opportunity to perform the crack sealing promptly due to cold or wet weather and improper curing conditions, the contractor may perform the crack sealing the following spring when weather conditions allow. Traffic control, if needed, will be paid for by the department.

525.3.3 Protective Surface Treatment

After deck crack sealing, new bridge decks must be sealed with protective surface treatment. Protective surface treatments significantly reduce the penetration of de-icing chemicals into the concrete, which reduces the rate of chemical attack on the concrete and chloride attack on the reinforcing steel and minimizes the effects of corrosion and freeze-thaw cycles.

The contractor must use products from the approved products list and apply the treatments according to manufacturer's recommendations. Application requirements can be found in standard spec 502.3.13.2.

525.4 Slab Span Bridges

Slab bridges are cambered (normally up) during construction to counteract creep of the concrete over the next several years. This camber is normally three times the dead load deflection. This camber will cause a temporary "bump" in the grade line until the creep deflection slowly takes place. This is an expected condition and part of the process in using concrete slabs. The finishing machine rails should be set to reflect this camber condition. Normally the high points will be at the mid span locations of the bridge. The bridge surface should not be ground after casting as the bump is expected and will disappear over time. If the bump is corrected when the bridge is opened there will be a depression at mid span a few years later. Any questions related to this issue should be directed to the BOS design section.

SECTION 528 Concrete Deck Removals, Overlays, and Structure Repairs

Standard spec 509 should be referred to in conjunction with this subsection.

528.1 Deck Removals

Contact BOS Structures Design at (608) 261-0261 if damage to steel or concrete girders occurs during deck removal.

The contractor is responsible for submitting a Damaged Girder Report to BOS prior to repairs to damaged girders commencing. The Damaged Girder Report can be found on the BOS Construction Resources website:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/construction-resources.aspx

Deck removal plans submitted for review by the contractor that include sawcutting that will damage or remove sections of the underlying girder flanges, shear stirrups projecting out of the top of the existing girder, or shear studs attached to the top flange of the existing girder shall be rejected by the engineer.

528.2 Cleaning and Preparation

The items of cleaning involve removal of rubber, oil, glaze, paint, salts, and other residue from structure decks and approaches scheduled to be overlaid. The items of preparation involve removing asphaltic patches and unsound concrete from bridge decks and approaches to be overlaid. Construction usually follows the following sequence:

1. The deck or approach is ground down by a mechanical scarifier. In areas where the scarifier cannot be maneuvered, the unsound concrete is removed by pneumatic air-hammers.

   Mechanical grinding should remove at least one inch of concrete or as shown on the plans. Grinding to this depth will remove top float, residue, and salt-contaminated concrete and allow minor grade correction. The grinder must be operated in a manner that avoids snagging or tearing of the reinforcing steel.

   Scarification should result in a clean, fresh concrete surface that will provide proper adhesion for the overlay, without loosening of aggregate.

   The faces of curbs should be cleaned of paint and residue by grinding or blasting from the surface of the deck up to the top elevation of the planned overlay. This operation will present a clean surface for proper adhesion, but it is one that is frequently overlooked.

2. The deck and portland cement concrete (PCC) approach is "sounded" by the engineer. Areas of unsound concrete are marked for removal.

   During the process of sounding, the entire deck and PCC approach must be tested, and the deteriorated areas marked for removal. There are several types of sounding equipment on the market for the detection of unsound or delaminated concrete. An adequate job can be done by sounding with a hammer or by dragging a chain or similar metal object. A dull, hollow sound indicates unsound concrete.

   Deep laminations can be detected by feeling vibrations in the concrete when it is struck with the hammer, or by seeing small particles of dust or dirt moving or bouncing when the concrete is struck. Thus, the limits of unsound and delaminated areas can be defined and marked by spray paint. Sounding in this manner is an onerous and time-consuming task, but it is extremely important that all unsound areas be detected.

   If the areas are few and widely separated, some time and effort may be saved using a chain drag to determine their general location, after which the exact limits are defined by the method described above. Sounding should be done during periods of quiet, when traffic is absent or minimal, and when machines are shut down.

3. Unsound concrete and remaining asphaltic patching is removed by air-hammer.

   Care must be taken not to damage sound concrete and reinforcing steel during removal of unsound concrete. Pneumatic hammers used for initial breakout should not exceed 35 lb. total weight except with the written approval of the engineer. The engineer should observe the use of each allowed hammer that is in excess of 35 lb. to determine if the benefit of increased performance is coming at the expense of increased damage.

   For removals below the top of reinforcing steel and within one inch of the steel, 16 lb. hammers are the maximum weight allowed.

   Before the sounding and marking operation, the contractor may voluntarily begin removal of areas of approach and deck where it is visually evident there is surface deterioration. This practice should be minimized and discouraged since over-break and loss of sound concrete can easily occur. Timely sounding by the engineer should avoid this problem.

4. Steps 2 and 3 must be repeated until the engineer is sure all unsound concrete has been removed.

   After the contractor has chipped and removed the deteriorated concrete in the marked areas, these areas must be sounded again. Often the surface exposed by the chipping operation will appear sound and durable but sounding will detect further laminations. These areas should be marked, and the entire process repeated until all unsound concrete has been removed. This is where the engineer must use good

judgment. Enough concrete must be removed to ensure the rehabilitated deck or approaches will provide adequate support.

5. The entire deck or approach surface to be overlaid, and all exposed reinforcing steel, is blast cleaned. Steel is spliced, realigned, and tied as needed. The steel should be free from layered rust and scale.
6. Debris, dust, blast material, and concrete remaining from the scarification and blast cleaning are removed. Final cleanup should be done by pressurized water, because water keeps down dust and removes small surface de-laminations that have escaped removal.

   Vehicles in adjacent traffic lanes must be protected from damage by flying debris and from obscured visibility by blowing dust. Water used in the cleanup operation should be prevented from flowing across live traffic lanes. The cleanup equipment should be inspected to ensure that oil from the compressor is not mixing with the pressurized air or water.

   The item of Full-depth Deck Repair is expensive, as it requires forming; therefore, the minimum thickness consistent with good construction practices should be placed. Any equipment that damages remaining portions of the deck, reinforcement, or girders must not be used. If an item scheduled for reuse in the new work is damaged, the contractor must replace it at the contractor's expense.

528.3 Mixing and Placing Concrete

528.3.1 Grades of Concrete

The grade of concrete used in the overlay or repair work is specified in the contract special provisions.

528.3.2 Pre-pour Meeting

A pre-pour conference should be held well in advance of the operation of placing overlay concrete. Refer to CMM 515 for details to be considered.

528.3.3 Mixing

Grade E concrete must be proportioned and mixed in a volumetric mixer at the site of the work. Requirements for volumetric plants are contained in standard spec 501.3.6.4.

528.3.4 Surface Preparation

Light films of surface rust appearing on the reinforcing steel between the blast cleaning and concrete pouring operations do not need to be removed, as light surface rust is not considered detrimental to obtaining a good bond to the concrete.

Areas receiving the items of Curb Repair, Concrete Surface Repair and Full-Depth Deck Repair are to be kept continuously wet for at least two hours before coating with neat cement and placing concrete.

When placing Grade E Concrete Masonry Overlay, ensure the surface of the existing deck is moist without having any standing water before coating with neat cement mixture. The reason for requiring the existing concrete to be moist is not necessarily for better adhesion, but to prevent moisture loss from the newly poured concrete.

For all overlay or repair work (except Concrete Surface Repair, for which using a neat cement can be approved as an option to concrete masonry) immediately before the concrete is placed, a neat cement mixture must be spread uniformly over the old concrete receiving the repair or overlay. The neat cement should have the consistency of a thick, smooth cream or smooth paste that can be spread effectively with a stiff bristle broom. The old concrete should be free of standing water. The admixture in the tank should be agitated at frequent intervals to maintain proper consistency. The area where the neat cement is applied should be kept to a minimum to prevent the slurry from drying out before new concrete can be placed. Accumulations of neat cement in low areas must be swept out.

Concrete for joint repair work made in preparation for a Grade E concrete overlay, and concrete for full-depth deck repair work must be placed, vibrated, and struck off at the old deck elevation before placing concrete for an overlay. Any powder or laitance on the surface of this prior work should be removed by blast cleaning before applying the neat cement.

528.3.5 Placement, Curing, and Finishing

The concrete mixtures specified for the repairs or overlays are high in cement content and consequently quite susceptible to high shrinkage and checking during the setting process. Therefore, it is desirable to keep the water content of the mix as low as is possible to minimize the amount of shrinkage, and to start the curing of the concrete as soon as possible, desirably just as soon as it is struck off and given the required surface texture.

Concrete masonry, overlay must not be placed when the surrounding air temperature will exceed 88 F. This specification will require the contractor to anticipate working conditions and plan ahead for the possibility of a night or early morning placement.

In contrast to the specifications for concrete bridges on skew, the specifications for overlays allow the finishing machine to operate with the screeds at right angles to the center line of the structure, even for

structures 20 degree or more on skew. This reduces overhang into the adjacent lane, providing a greater clear width for live traffic.

528.3.5.1 Grade E Concrete

Grade E concrete overlay must receive a tined finish. However, the turf drag or the alternative broom finish that is normally required before tining may be omitted.

The curing period for Grade E concrete overlay is 3 days.

Traffic may travel over a Grade E overlay or joint repair work 72 hours after completion unless the engineer extends the time period. Exception to this would be construction loadings on previously placed concrete overlay stages as indicated in standard spec 509.3.9.4(2). The intention is that all the concrete placed in previous overlay stages has cured a minimum of 12 hours (i.e., the last of the placed concrete on a previous pour has cured a minimum of 12 hours, and the remaining concrete has cured for longer). In addition to this curing requirement, the expectation is that the contractor maintains their curing process on all areas of the previously placed concrete overlay stages for the required 3 days; even throughout the set-up, placement, and finishing operations of an adjacent overlay.

528.4 Measurement and Payment

Concrete for the Concrete Masonry bid items is measured and paid for by the nominal cubic yard. The usual practice is for the engineer to ensure that the ready-mix plant or volumetric mixer is batching to the correct proportions and then to accept tickets from the ready-mix truck drivers upon delivery without further verification. Quantity determination for the mobile mixer is done by dividing the total counts on the mixer counter by the counts needed to produce one cubic yard. The engineer should verify the initial setting of the counter before production, plus the final count.

SECTION 530 Painting

530.1 Epoxy Paint System

The epoxy paint system consists of a prime coat of inorganic zinc-rich paint, an intermediate coat of high-build epoxy paint, and a protective coat of urethane paint. All three coats are applied in the shop. The approved proprietary coating systems will be shown in the contract special provisions; one must be selected by the contractor and ordered to be applied by the fabricator or associated painter.

In situations requiring field repair to the urethane topcoat, the contract special provisions will allow field application of a second urethane top coat to the exterior girder fascias and bottom exterior girder flange surfaces. All damaged areas must be repaired before applying the second urethane top coat. Adjoining concrete work including form removal must also have been completed before the recoating.

530.1.1 Preparation of Surfaces

Galvanized bolts, nuts, washers, and bearings must be painted conforming to epoxy coating system manufacturer recommendations. The procedure must include removing surface residue and applying a wash prime or tie coat before the applying the prime coat.

Non- galvanized bolts, nuts, washers, and sharp steel plate edges must be striped with inorganic zinc-rich primer by brush or sprayer before spraying the complete prime coat. Steel plate surfaces must be prepared with a Number 10 blast (near white metal) and the three-coat epoxy system must be applied conforming to the manufacturer's recommendations and standard spec 517.

530.1.2 Field Repair of Epoxy System

Specifications for field repair of the epoxy system are shown in standard spec 517.3.1.8.2 and in the contract special provisions. Field repair must include removing damaged paint down to base steel by blast cleaning with sand, grit, or shot, and applying the complete 3-coat system conforming to manufacturer's recommendations.

530.2 Sampling and Mixing Paints

Before samples are taken, ready-mixed paint must be thoroughly mixed. Thorough mixing is not only necessary before sampling but also before each time the paint is used. Good painting practice also requires mixing the paint periodically while the painting is being done. Failure to mix properly is one of the principal reasons for paint troubles and paint failures.

Under standard spec 517.2.3, the contractor is responsible for providing a representative sample by the thorough mixing of the paint; therefore, the contractor's personnel should do the mixing. For the size of sample and the frequency of sampling, refer to CMM 850.

Painting structural steel is not allowed until tests show that the paint complies with the specifications. Test results for field-applied paints must be for paints manufactured during the calendar year in which the paint is applied. If the contractor proposes to use paints manufactured in the previous calendar year, the batches must be re-sampled and tested and shown to comply with the specifications before application is allowed.

530.3 Handling of Coated Steel

Refer to standard spec 517.3.1.7.4.

530.4 Disposal of Lead-Based Paint

Refer to CMM 130.

SECTION 540 Piling

540.1 General

This document is being rewritten to reflect changes in standard spec 550 using the modified Gates formula to determine the required driving resistance. If you have questions, related to piling please contact David Staab (608) 246-7952 with the BTS Geotechnical unit.

SECTION 545 Railing

545.1 General

Bridge railings are of several types and materials. The railing provided for a structure must conform to the material requirements and details of construction shown on the plans for the type of railing designated in the contract. Some contracts may allow the contractor to furnish a designated type of railing in alternate materials. In this case, for adjacent structures on a dual highway, it is required that the railing furnished under contract for each structure be of the same kind of material.

Railings are not to be erected until the superstructure is free from falsework and the structure is completely supporting its dead load. Unless otherwise specified on the plans or in the contract, the railing should be erected with its posts at right angles to the grade of the structure. The inspector should ensure that shims are placed under each end base plate and railing post to provide true and uniform alignment of the rails. Refer to standard spec 513 for other requirements.

545.2 Inspection of Aluminum Railing

Aluminum railings may be assembled in the field if the component parts are provided by multiple fabricators or suppliers directly to the contractor at the bridge site without shop inspection. Therefore, a thorough field inspection must be completed by the engineer.

Before the railing is installed, the engineer should have received shop drawings accepted by BOS. The fabricator or suppliers are advised to keep certified mill test reports on file for quality assurance review by BOS.

SECTION 550 Pipe Culverts

550.1 Culvert Pipe List

Standard spec 520.3.1 provides that, unless otherwise authorized by the project engineer in writing, the contractor must not order and deliver the pipe culverts required for the project until a corrected list of sizes and lengths is furnished by the project engineer. This provides the project engineer an opportunity for checking the designated plan length in the field, making any necessary adjustment in length, and assuring the correct length of culvert pipe required at a designated location to satisfy field conditions is ordered.

At the earliest opportunity, the project engineer should prepare and furnish to the contractor the corrected list of sizes and lengths of culvert pipe, so the contractor may place the order with the supplier at an early date, avoiding a late delivery and delay in the progress of the work. This list should be in writing and a duplicate copy should be retained in the project engineer's files. The ordered length of a culvert should be in agreement with the length staked in the field and should be in accordance with the provisions below.

If the staking of culverts is not completed before the start of construction operations, the furnishing of the pipe lists should coincide with the contractor's plan of operations. Should the contractor have the pipe delivered at intervals, it will provide a more favorable opportunity to WisDOT for determining and furnishing the lists of required lengths. However, it is important the list be furnished as soon as practicable.

Section CMM 735 describes in detail the conditions necessary for restoration or construction of private entrances and the standards to which entrances must be restored or constructed. The sizes and lengths of culvert pipes required for private entrances, as determined in accordance with CMM 735, will be compiled by WisDOT and included with the corrected list of sizes and lengths of culvert pipe to be furnished to the contractor. The list of culvert pipe for private entrances will not include culvert pipe to be furnished and placed by the owner for those allowed entrances to be constructed at the owner's expense.

550.2 Ordered Lengths of Culvert Pipe

550.2.1 Corrugated Steel and Aluminum

It is standard industry practice to manufacture corrugated steel culvert pipe and corrugated aluminum culvert pipe in lengths of two-foot multiples in individual lengths from 16' to 30'. The maximum fabricated length normally shipped is 30'. Typically, the supplier will furnish the pipe for a culvert in a minimum number of fabricated lengths. In this respect, culverts from 32' to 60' total length would be furnished in 2 fabricated lengths and culverts from 62' to 90' total length would be furnished in 3 lengths. However, this is not a fixed criterion and suppliers may often furnish pipe for culverts in more than the minimum number of fabricated lengths.

550.2.2 Reinforced Concrete

Revise 550.2.2 (Reinforced Concrete) to update information.

Most reinforced concrete pipes supplied to WisDOT are manufactured in 8-foot lengths. Except in the case of pipes with skewed or beveled ends, the required length of culvert determined to satisfy site conditions should be adjusted to the nearest 8-foot multiple of barrel length or it will need to be field cut to length.

Where concrete apron endwalls are called for, the required culvert length as determined to satisfy site conditions should first be corrected to accommodate any barrel portions of the endwalls. In accordance with SDD 8F1 and SDD 8F2 concrete apron endwalls are manufactured with a part of the endwall in the form of a pipe barrel. The pipe-shaped barrel of the concrete endwall will vary from 19-3/4" to 48-7/8" in length, as shown in the referenced standard details for the various sizes of pipe. This may need to be confirmed with supplier shop drawings. Please note for larger diameter circular and horizontal ellipse pipes, in particular those sizes not shown in the standard detail tables, the manufacturer supplied endwalls may not match the proportions and appearance in the standard details and will not contain the pipe barrel section. Large diameter endwalls may be a precast headwall with wings similar to SDD 8F10. This is primarily for round pipes 96-inches and larger and horizontal ellipse pipes 68-inch x 106-inch and larger. This may vary by manufacturer and should be verified for large diameter pipe.

This adjusted length of culvert will be the ordered length. Adjustment in the required length of a pipe having skewed or beveled ends must take into account the method of measuring the end sections, as described below in this chapter.

550.2.3 Polyethylene and Polypropylene

Polyethylene and polypropylene culvert pipe is generally manufactured and supplied in 20-foot lengths. Individual manufacturers may offer one or more options for smaller lengths. Pipe is often field cut to match jobsite conditions. When apron endwalls are called for, standard steel apron endwalls or steel

endwalls sloped for cross or side drains conforming to standard spec 521.2 are required. Polyethylene and polypropylene endwalls are not allowed. Where corrosive conditions exist, aluminum endwalls conforming to standard spec 525 may be specified.

550.3 Inspection

Each load of delivered pipe must be accompanied by a loading document. The pipe must be installed only after the documentation is received. Pipe should also be inspected as soon as possible after delivery to the job. The inspection should cover dimensions, soundness, markings, damage incurred during shipment or unloading, and defects overlooked at the plant. Pertinent information concerning any rejected pipe should be recorded by the inspector in field notebooks. Refer to measurement of pipe culverts of this section for needed documentation. Refer to the Materials Testing and Acceptance Guide in CMM 850 for pipe acceptance conditions.

550.4 Storage and Handling of Pipe

Pipe delivered to the project site should be handled, and if not immediately installed, stored in a manner to prevent potential damage. Staging and storage areas should be flat, free of large rocks, rough surfaces, and debris. Storage areas should also be out of the way of construction traffic. Palletized pipe should remain on the pallet for jobsite storage. Consult manufacturer data for recommendations or prohibitions regarding stacking of loose pipe. Pipe gaskets, if provided should be protected from harmful substances such as dust and grit, solvents, and petroleum-based greases and oils. Some gaskets may need to be protected from sunlight (consult the manufacturer). Although often treated with black carbon and potentially other UV stabilizers, long term uncovered storage of polyethylene and polypropylene pipes on the jobsite may warrant reconsideration.

Polyethylene and polypropylene pipes should not be handled with chains. Individual lengths of pipe can typically be handled using a nylon sling or cushioned cable secured around the third points of the pipe.

Consult the manufacturer data for specific handling and storage requirements or additional information.

550.5 Preparing Foundation

Success in the construction of pipe culverts against detrimental settlement depends largely upon proper preparation of the foundation for support of the pipe. Embankments are required to be constructed to at least one foot above the top of the proposed pipe (see figure 550-1) before excavating the trench and laying the pipe, to provide a firmly and uniformly consolidated support for the superimposed embankment, and to ensure against an overload bearing on the pipe due to settlement of the embankment or its foundation. To ensure uniformity in compaction of the fill above the pipe, embankments should not be built to a height in excess of two feet above the pipe before the pipe is laid.

Preparation of the foundation for support of the culvert pipe is performed during the preparation of the embankment foundation. During preparation, inspections should be made to ensure the foundation at the pipe site and for a distance on each side of the pipe of at least the height of the proposed embankment is uniformly and thoroughly consolidated. Any foundation materials of poor supporting value should be removed and replaced with suitable materials. Where flowing water is a problem, it may often be carried in a ditch cut around the culvert site until the pipe is in place, or pumps may be used to maintain a dry foundation.

On occasion culvert foundations may be on compressible soils that are so deep that full excavation is impossible or impractical. Using a modest strength geotextile beneath foundation backfill is of considerable benefit in providing a stable base for construction, and to reduce abrupt changes in settlement.

Before embankment construction, the contractor should remove detrimental rock materials located near the natural ground surface that may interfere with later culvert foundation preparations. Backfill of these areas should consist of acceptable materials similar to the proposed embankment soils.

Loads acting upon a pipe increase with the width of the trench as well as with the height of fill above the top of the pipe. To ensure against the occurrence of a greater load upon the pipe than the design load for the pipe, trench width and trench wall limitations are necessary.

Trenches should be wide enough to provide free working space on each side of the pipe. Typically, this space must not exceed 1/2 the nominal diameter of the pipe, and never be less than 6 inches. The required working space depends upon the size of the pipe and the character of the material in the excavation. For steel or concrete pipe, the trench width should be enough to allow for preparing the foundation, laying the pipe, and placing and compacting backfill, but not exceed the pipe's outside diameter by more than 36 inches. For polyethylene and polypropylene pipe ensure minimum trench width is not less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter

times 1.25, plus 12 inches. ASTM D2321 and AASHTO LRFD Bridge Construction Specifications Section 30 provide additional guidance on the installation of polyethylene and polypropylene pipe.

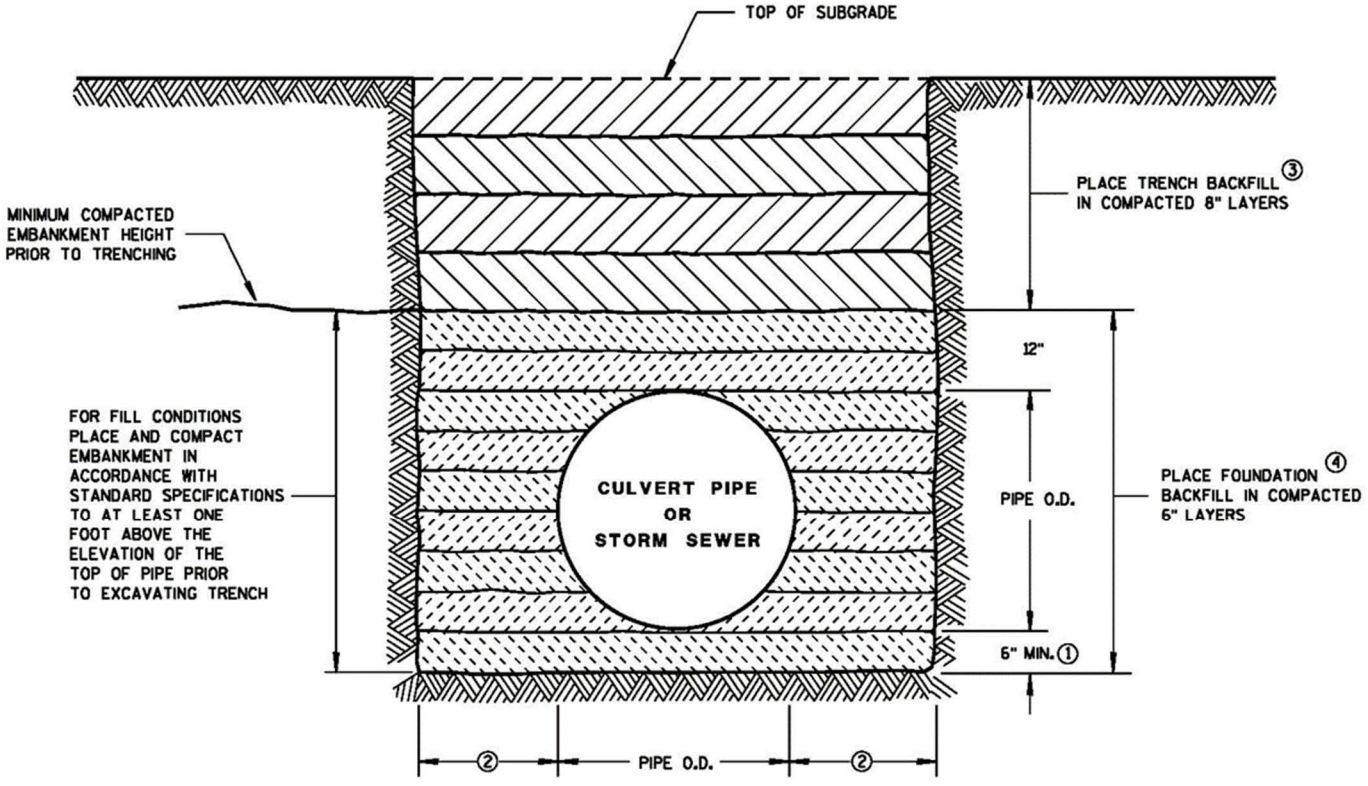
In addition to the trench width limitations stated above, the contractor should excavate the trench below the top of pipe as vertical as possible when the final height of the proposed fill above the top of the pipe will exceed 6 ft.

Pipe culverts placed under embankments support a greater load under the roadbed than at or near their ends and will settle more under the greater load. To compensate for this uneven anticipated settlement, a camber, may have been designated, to be built in the grade line of the culvert. When areas of unanticipated or unaddressed poor soils or a profile change creating higher fills, coordinate with the regional soils engineer, or the BTS Geotechnical Unit on the need for camber in areas of poor soils or high fills.

550.6 Excavating and Forming Bed for Pipe

Standard spec 520.3.2.1 specifies excavating and forming the foundation and bed for culvert pipes under public highways. Pipe foundation is the part of the terrain that supports the pipe and the forces of any loads superimposed upon the pipe. Pipe bedding or foundation backfill as depicted in figure 550-1, is the portion of the foundation in immediate contact with the pipe. The contractor must excavate for foundation backfill at least 6 inches below the elevation established for the bottom of the pipe unless the project engineer determines the existing foundation material for this depth conforms to standard spec 520.2.5.2. If rock, hardpan, or fragmented material exists, the trench is to be excavated the greater or 6 inches below the pipe or to a depth equal to 1/2 inch per foot of proposed embankment above the top of the pipe. Additional excavation may be needed for pipe bells. Figure 550-1 depicts trench width, foundation and backfill requirements for storm sewer and pipe culverts.

FIGURE 550-1 Trench, Foundation, and Backfill Details for Pipe Culverts and Storm Sewers



1. Excavate and place foundation backfill at least 6 inches below the bottom of the pipe. If rock, hardpan, or fragmented material exists, the depth is the greater or 6 inches below the pipe or to a depth equal to 1/2 inch per foot of proposed embankment above the top of the pipe.
2. 6 inches minimum. In general, this width not to exceed 1/2 the O.D. of the pipe.

   For CMP or concrete pipe, the trench width should not exceed the pipe's O.D. by more than 36 inches. For polyethylene and polypropylene pipe minimum trench width is not less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25, plus 12 inches.
3. For culvert pipe, trench backfill is to conform to standard spec 520.2.5.3. For storm sewer, trench backfill is to conform to standard spec 209.2 or standard spec 520.2.5.2.

4. For culvert pipe, foundation backfill is to conform to standard spec 520.2.5.2.

   For culvert pipe and storm sewer, foundation backfill is to conform to standard spec 608.2.2.2.

Major foundation problems should be brought to the attention of the project engineer and region soils engineer for resolution.

550.7 Backfilling Culvert Pipe

The backfill material should have a moisture content suitable for acceptable consolidation with the compaction tools used. A rough check for suitable moisture content may be made by squeezing the soil in the hand. A firm cast should result without wetting the hand.

550.7.1 Foundation Backfill

In order that a pipe may successfully support the loading to which it may be subjected without excessive distortion or rupture of the pipe, and to preclude settlement problems, it is essential that adequate lateral support be provided for the pipe by thorough consolidation of the backfill between the pipe and the walls of the trench. To facilitate this, culvert pipes are to be embedded in compacted foundation backfill as defined by standard spec 520.2.5.2 from a minimum 6 inches or more below the bottom of the pipe to 12 inches above the top of pipe. Foundation backfill is virgin material consisting of either sand-sized particles or sand-sized particles mixed with gravel, crushed gravel, or crushed stone. The contractor may use material from the work site only if it meets specification.

Before pipe placement, the foundation backfill is mechanically compacted. After pipe placement, mechanically compacted lifts, not measuring more than 6 inches after compaction, are to be placed to an elevation 12 inches above the top of pipe. To ensure against disturbance of the pipe alignment, each layer of backfill material must be placed, compacted, and brought up uniformly on each side of the pipe.

While compaction is essential and required by specification throughout the foundation backfill zone, special emphasis has been placed on compacting material under the lower portion of the pipe. Backfill material placed in the area under the lower half of the pipe must be thoroughly compacted. In narrow trenches where access and working conditions may be difficult, there may be a tendency to slight this work, particularly in the haunch areas directly under the pipe. Hand work may be required to fill voids under the pipe. Shovel slicing, rodding and hand tamping have been shown to be an effective means of achieving proper support in the haunch zone. Adequate compaction of foundation backfill in the haunch zone is important for all pipe materials, but it is particularly important for polyethylene, polypropylene and composite pipes where the pipe and bedding interaction is critical to developing the strength to support vertical loads applied to the pipe.

550.7.2 Trench Backfill

Starting 12 inches above the top of the pipe, the remaining trench, if any, must be backfilled with compacted trench backfill. Trench backfill is placed to the top of the subgrade in layers no more than 8 inches thick after compaction. Backfilling details are shown above in figure 550-1. Trench backfill can consist of material from the excavation for the typical roadway section that is free of large lumps, clods, rocks and other perishable and deleterious matter. Unless specified differently in plan documents, the trench backfill material for cross culverts starting 12 inches above the top of the pipe should be like the adjacent soil materials. This is to minimize differential frost heaves due to non-uniform materials and/or differential compaction efforts.

Pipe should be protected from construction traffic after placement. If 2 or more feet of cover is not provided by foundation and trench backfill, it may be necessary to temporarily place a "cushion" of compacted earth embankment over the pipe for at least the trench width. The purpose of this cushion is to protect the pipe from construction equipment during subsequent operations until such time the roadway pavements can be placed.

550.8 Joint Ties for Culvert Pipes

Reinforced concrete pipe culverts are required to be tied at the joints with joint ties to prevent separation of adjacent pipe sections. This is required at the last 3 sections on the upstream and downstream ends of concrete culvert and concrete cattle pass installations. When using apron endwalls, the endwall and the last 2 sections are tied. No ties are required on culverts with masonry endwalls unless the plans show otherwise.

Joint ties are not required for thermoplastic pipe where a full (+/- 20 foot) pipe section is utilized from the infall and outfall to the first joint. Where a partial pipe section must be used at the infall or outfall end, it should be restrained with a manufacturer supplied external mechanical coupling, a mastic impregnated geotextile wrap with mechanical fastening bands, or a concrete collar. Apron endwalls must be secured to the pipe. No ties are required on pipes with masonry endwalls unless the plans show otherwise.

550.9 Deflection Testing for Polyethylene and Polypropylene Pipe

Deflection testing is required for all polyethylene and polypropylene pipe culverts and storm sewers. Mandrels are used to test flexible pipes for variations in manufacturer tolerance, pipe roundness and deflection both from misaligned joints and backfill and construction loads.

Mandrels are typically manufactured from steel or aluminum and have nine legs (fins). Fins can be fixed or removable (figure 550-2). Mandrel kits with removable sets of fins can be used to test a variety of pipe sizes. Mandrels should be made available from the contractor, pipe supplier or manufacturer. The project engineer must approve the mandrel before testing. The mandrel must have nine fins or legs permanently marked to designate the nominal pipe diameter and mandrel diameter. Required mandrel size is shown in table 550-1.

FIGURE 550-2 Typical Fixed and Removable Fin Mandrels



The required mandrel is 92.5% of the nominal pipe diameter. This size mandrel accounts for 5% allowable deflection from installation plus allowable manufacturing tolerances. Unlike reinforced concrete pipe, polyethylene and polypropylene pipes are flexible and will deflect under load without compromising their integrity. The department required mandrel size accounts for these material specific conditions. Table 550-1 lists the minimum allowable mandrel size for testing polyethylene or polypropylene culvert or storm sewer. Mandrels labeled ASTM F679 or ASTM D3034 are intended for PVC gravity sewer and may be smaller than the minimum sizes in table 550-1 and, if so, should be rejected.

Acceptable mandrels should be permanently labeled, at a minimum, with the nominal pipe diameter and the mandrel diameter. As a spot check, or if the mandrel appears otherwise questionable, the size can be verified by measurement using the values in table 550-1 as a guide. Fixed fin mandrels could be verified by flexible tape or by proofing ring. Removable fin mandrels can be checked by measuring two removable fins laid adjacent to one another and adding a constant width representative of the fixed base. The mandrel manufacturer should be able to supply the fixed base constant width.

TABLE 550-1 Minimum Required Mandrel Size

Nominal Pipe Inside Diameter (inches)	Minimum Mandrel Outside Diameter (inches)[1]
12	11.10
15	13.88
18	16.65
21	19.43
24	22.20
27	24.98
30	27.75
36	33.30

[1] Values include both allowable manufacturing tolerances and allowable installed deflection.

The percentage of pipe that requires mandrel testing, based on size, is specified in standard spec 520.3.7 for culvert pipe and in standard spec 608.3.7 for storm sewer. Where less than 100% testing is required, the project engineer, not the contractor, designates where and how much pipe to test. The engineer should concentrate testing on larger diameter pipe, critical locations, areas of poor soils, and areas where contractor installation methods were questioned or not fully observed.

Pipe is tested after installation but before paving or finish grading. Waiting as long as practical, ideally 30 days when not in conflict with scheduled paving operations, to mandrel test is advised to allow deflection development in the pipe from embankment loading. The mandrel is pulled through the entire pipe section in one pass when pulled by hand without using excessive force. If the designated length of pipe fails, the project engineer may require additional testing in addition to the initial designation. Pipe that does not pass deflection testing needs to be re-laid or replaced and retested.

If deflection testing fails or significant construction issues occur with polyethylene and polypropylene pipe, the engineer should notify the statewide drainage engineer in the central office roadway standards development unit.

550.10 Measurement and Payment of Pipe Culverts

The standard specifications provide that the quantity measured for payment must be determined by measuring the linear foot acceptably completed, measured along the invert.

The corrected pipe list that was given to the contractor by the project engineer defines the lengths to be paid for, providing that the specified lengths are furnished and acceptably installed. Standard spec 520.5 provides that measurement will be made by the linear foot in place, which is interpreted as requiring that measurement for payment will be made only after the culvert pipe is in place and not upon delivery to the job site.

Joint ties or restraint use varies with pipe type and if endwalls are used, see standard spec 520.3.3. The ties or other restraints are incidental to item. If additional ties are required by the plans or the project engineer, they will have to be paid separately.

Foundation and trench backfill are incidental to the culvert or cattle pass items unless a special bedding or backfill material is called out in the plans or special provisions. The only other exceptions where foundation or trench backfill is paid are as follows

- For culvert installations where the where the project engineer determines that the material from the typical roadway section is not suitable for use as trench backfill. In that case the department will pay separately for additional trench backfill under other contract bid items.
- For pipe installations where the project engineer determines that proper bearing cannot be obtained 6 inches below the bottom of the pipe and directs additional excavation and subsequent backfill with foundation backfill. In this case the department will pay for excavating unsuitable material and backfilling as extra work.

SECTION 555 Noise Walls

555.1 Contractor Designed Noise Walls

Wall construction must not begin until the submitted drawing and calculations are accepted by the BOS, Structural Metals Fabrication Quality Assurance Review Unit (SFU).

The department accepts contractor designed noise walls after the award of the contract as follows:

- Contractor or fabricator/supplier submits shop drawings and calculations to the WisDOT fabrication library, conforming to the requirements of the fabrication library submission standards.

  https://wisconsindot.gov/dtsdManuals/strct/fabrication/sp-sub-std.pdf

- SFU is automatically notified that the submittal has taken place.
- SFU will select which shop drawings will be reviewed for quality assurance (QA). The selection will be based on a combination of structure type, fabricator/supplier, complexity of project, or other factors as determined by the SFU.
- If the structure is not selected for QA review, the SFU will stamp and change the status to 'Accepted' in the fabrication library within 1 week of receipt.
- If the structure is selected for QA review, the SFU will change the status to 'Selected for BOS Review' in the fabrication library. The QA review will be performed within 2 weeks of receipt.
  - If the submitted documentation is accepted, the reviewer will stamp the drawings as accepted and change the status to 'Accepted' in the fabrication library. Project field staff can set notifications within the fabrication library to be notified when changes occur to the documents. Upon acceptance of the documentation, construction may begin with the approval of the engineer.
  - If the submitted information is not acceptable, the reviewer will mark up the drawings and provide comments and change the status to 'Revise and Resubmit' in the fabrication library. The contractor and, if necessary, fabricator must work with the reviewer and, if necessary, project engineer in resolving the unacceptable items. After acceptable changes have been made and have been resubmitted to the fabrication library, the reviewer will stamp and change the to 'Accepted'. Upon acceptance of the documentation, construction may begin with the approval of the engineer.
- After completion of the project, and if significant changes were made in the field, the project engineer must submit a marked up copy of the accepted design drawing used in the field for construction to BOS for permanent storage. These drawings must contain all as built information or changes.

SECTION 560 Retaining Walls

560.1 Contractor Designed Retaining Walls

Wall construction must not begin until the submitted drawing and calculations are accepted by the BOS, Structural Metals and Fabrication Quality Assurance Inspection Unit (SFU).

The department accepts contractor designed retaining walls after the award of the contract as follows:

- Contractor or fabricator/supplier submits shop drawings and calculations to the WisDOT fabrication library, conforming to the requirements of the fabrication library submission standards.

  https://wisconsindot.gov/dtsdManuals/strct/fabrication/sp-sub-std.pdf

- SFU is automatically notified that the submittal has taken place.
- SFU will select which shop drawings will be reviewed for quality assurance (QA). The selection will be based on a combination of structure type, fabricator/supplier, complexity of project, or other factors as determined by the SFU.
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  - If the submitted information is not acceptable, the reviewer will mark up the drawings and provide comments and change the status to 'Revise and Resubmit' in the fabrication library. The contractor and, if necessary, fabricator must work with the reviewer and, if necessary, project engineer in resolving the unacceptable items. After acceptable changes have been made and have been resubmitted to the fabrication library, the reviewer will stamp and change the to 'Accepted'. Upon acceptance of the documentation, construction may begin with the approval of the engineer.
- After completion of the project, and if significant changes were made in the field, the project engineer must submit a marked up copy of the accepted design drawing used in the field for construction to BOS for permanent storage. These drawings must contain all as built information or changes.

SECTION 565 Temporary Structures

565.1 General

A temporary structure provides an alternate traffic route while an existing bridge is being rehabilitated or a new bridge is being built. Temporary structures are contractor designed, constructed, inspected, maintained, and removed. Refer to standard spec 526 for requirements.

565.1.1 Inspection of Temporary Structures

According to the National Bridge Inspection Standards (NBIS), any highway bridge open to public traffic must be inspected. The NBIS are available at:

http://www.fhwa.dot.gov/bridge/nbis.htm

Under the direction of the contractor, a department-certified Team Leader must perform an initial inspection conforming to NBIS and to the department's Structure Inspection Manual before opening the temporary structure to traffic. Additional inspections must be performed according to the Structure Inspection Manual based on the type of structure and the amount of time it is in service. For each inspection, the contractor submits DT2007 to the engineer for inclusion in the project files and submits an electronic copy to BOS.

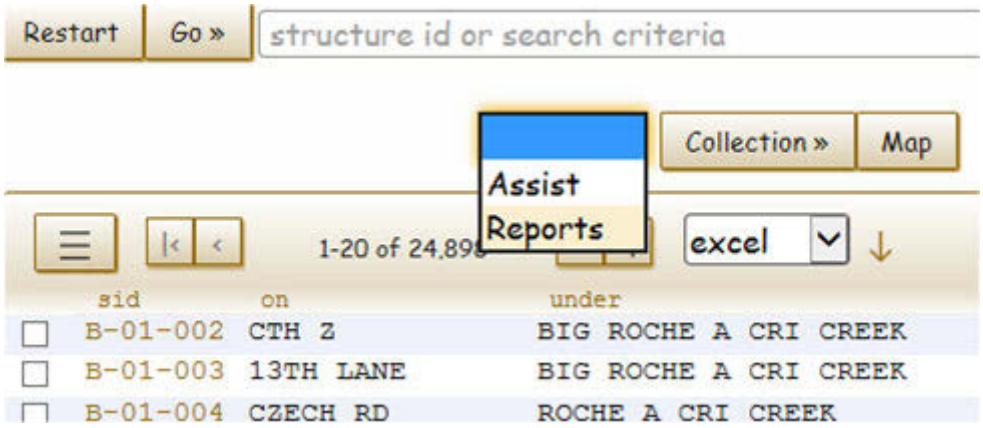
The Structure Inspection Manual is available from the BOS maintenance section:

https://wisconsindot.gov/dtsdManuals/strct/manuals/inspection/insp-manual.pdf

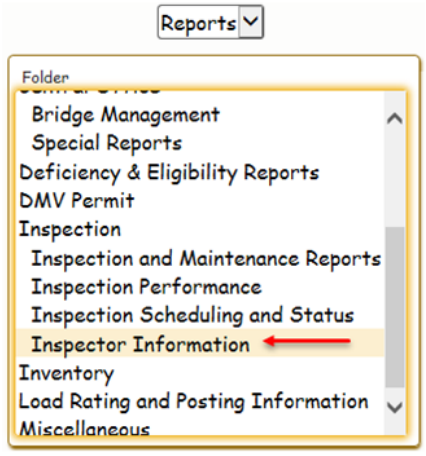
The list of department certified Team Leaders is available at:

https://trust.dot.state.wi.us/hsi/HSIController

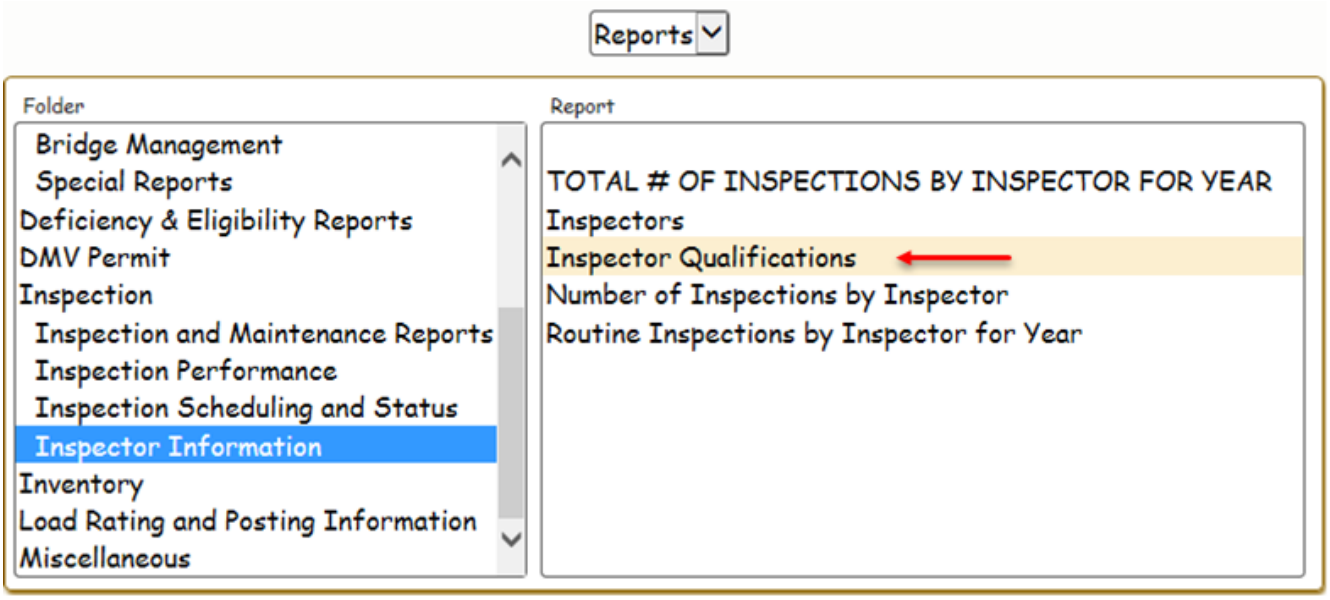
Step 1: Select Reports from the dropdown menu:



Step 2: Select Inspector Information from the Folder Menu:



Step 3:Select the Report titled Inspector Qualifications:



The column TEAM LEADER indicates the qualification for being a team leader in the State of Wisconsin. The column titled ACTV INSR indicates if an inspector is still active (Y), or inactive (N).

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Strc Insr Id	Strc Insr Fnm	Strc Insr Lnm	Actv Insr	Team Member	Team Leader	Wi Refresher
6514	Jeffrey	Durkee	Y	TMMR	TMLR	WI14
2515	Allen	Shook	Y	TMMR	TMLR	WI14
4501	Gaylord	Hansen	N	TMMR	TMLR	WI14
4502	Stephen	Lawrence	Y	TMMR	TMLR	WI14
4503	Dennis	Stiebs	Y	TMMR	TMLR	WI14
4504	Dean	Steingraber	Y	TMMR	TMLR	WI14
4505	Stan	Kobza	N	TMMR	TMLR	
9530	Terence	Browne	N	TMMR	TMLR	WI14
9531	Thomas	Collins	Y	TMMR	TMLR	WI14
9532	Paul	Wirth	N	TMMR	TMLR	WI14
9533	Todd	Demski	Y	TMMR	TMLR	WI14
9534	Roy	Forsyth	Y	TMMR	TMLR	WI14
8005	Bruce	Petersen	N	TMMR	TMLR	
8006	Gregory	Mattson	Y	TMMR	TMLR	WI14
7007	Bradford	Kimball	N	TMMR	TMLR	WI14
9535	Steve J	Miller	Y	TMMR	TMLR	WI14
4506	Dale	Petersen	Y	TMMR	TMLR	WI14
9536	Larry	Gotham	Y	TMMR	TMLR	WI14
2516	Mahmoud	Malas	Y	TMMR	TMLR	WI14
9537	Gerald	Dorscheid	N	TMMR	TMLR	

565.1.2 Construction Inspection of Temporary Structures

For "substantial" temporary structures, the department or its agent should perform some level of construction inspection (pile driving, etc.) to ensure that the structure is built according to the plans provided by the contractor.

SECTION 570 Ancillary Structures

570.1 General

Ancillary structures include overhead sign structures, traffic signal monotubes (pole types 9, 10, 12, and 13), and high mast lighting pole (HML) structures. All of these structures are now on the 8-tab of the let plans and should follow the guidance in the FDM and Bridge Manual.

The standard detail drawings for various traffic signal monotube/poles indicate which bolts need to conform to standard spec 657.3.3.2. Bolts for overhead sign structures need to conform to the details in the plans and to standard spec 532.3.6.3.

Field staff need to know bolting and anchor rod installation procedures used for erecting ancillary structures. Standard spec 532.3.6 requires contractor staff to complete the department's online ancillary bolting class presented by BOS. It is recommended that this course be taken annually. Department field personnel are strongly encouraged to view this training. This class provides current requirements and best practices.

Good quality assurance during ancillary structure installation and bolting is particularly important because:

- Ancillary structures generally have structural connections with a small number of bolts, as few as 4. Limited redundancy can lead to rapid and potentially catastrophic failures making each bolt connection more critical. Testing ensures proper installation, reducing the risk of a structure falling on the roadway.
- Ancillary structures see high cycle wind loads, subjecting bolts to high stress ranges if not installed properly. The combination of high cyclical loading and high stress ranges is a recipe for fatigue failure.
- Improper storage and installation practices can lead to lost lubrication due to thread contamination or corrosion. This can affect the ability to tension bolts and anchor rods thus affecting performance in the finished structure leading to failures.

Quality is a two-part process. This process involves quality control (QC) performed by the contractor and quality assurance (QA) performed by the department representative. The inspection checklist in CMM 570.4 provides QC checks the contractor needs to perform during construction; the department QA representative needs to double check to assure the contractor completed those steps. Ancillary structure installation and inspection should be discussed at the preconstruction conference. After installation, the structure needs an initial inspection performed in accordance with the WisDOT structures inspection manual (SIM).

A structural inspection by a department certified sign/signal structure inspector is required. See CMM 570.4 Part 7 for inspection requirements. Inspections should be scheduled to occur while the contractor is still on the job and use the contractors traffic control if possible. The inspection should be done after the structure and any attachments have been completed, but while the contractor erecting the structure is still on site. If the inspection reveals a nonconforming installation or material, the inspector will give a punch list of nonconforming work to both the project engineer and the contractor in the form of a draft (unsigned) inspection report printed from the highway structures information system (HSIS). It is the contractor's responsibility to correct problems and have the structural components (bolts, anchors, connections, etc.) re-inspected to verify that problems have been resolved. Punch list items including minor items that do not affect the structural components (such as ID plaques, rodent screen, vertical clearance, etc.) do not require a follow up inspection. Verification of these items can be in the form of a photo sent to the inspector to include in the inspection report. Once verified, the inspector signs the final HSIS report and submits it to the engineer. The project engineer should not make full payment for ancillary structures before structural inspections, and all required corrective actions are completed.

The department will perform QA inspections to ensure conformance to the SIM. If after a QA inspection, corrective action is required, the project engineer should contact the region's maintenance or traffic operations unit and BOS ancillary structures project manager to discuss. Serious findings will result in a contractor's inspector's loss of certification to perform inspections. The project engineer should consult with the BPD construction oversight engineer associated with your region and BOS to determine if the work should be replaced or if a deduct in the final payment for nonconforming work or the third-party re-inspection is applicable.

570.2 High Strength Bolts, Nuts, and Washers

High strength structural steel bolts and direct tension indicating (DTI) washers in ancillary structures need to conform to standard spec 532.2. Other bolts and fasteners used in ancillary structures should conform to manufacturer specifications as detailed in the shop drawings.

Follow the requirements specified in standard spec 532.3.6. Access to a calibrated Skidmore-Wilhelm device and torque wrench to establish torque/tension relationships is necessary. Federal requirements for rotational capacity testing must be followed. The contractor is responsible for supplying certification of the

RoCAP test from the supplier in addition to performing pre-installation tests following the procedures enumerated in DT2322.

The department requires the contractor to re-lubricate all high strength structural steel bolts and anchor rods. Re-lubrication makes it very unlikely that bolts will fail to develop their requisite tension at required torque levels. Proper lubrication also reduces the torque required to install bolts and promotes less strain on the bolt and equipment during installation.

Re-lubricating is relatively inexpensive because most ancillary structures contain a small number of high strength structural steel bolts. Lubricants must be waxed based and follow manufacturer's recommendations for application. Beeswax and toilet bowl ring waxes work well as lubricants. There are also commercially available products specifically designed for this purpose:

- MacDermid Torque'n Tension Control Fluid
- Castrol Iloform Stick Wax

If re-lubricated bolts fail to reach installation tensions above the tension and maximum torque relationship listed on Table 4 of DT2322, they must be rejected, and new bolts used. Bolts must not be incorporated into the work if their condition has deteriorated after testing and before installation.

570.3 Assembly

570.3.1 Anchor Rod Installation

Anchor rods on ancillary structures are important connections and installation requirements need to be strictly adhered to in order to reduce risk to the motoring public. Installation of anchor rods requires:

- Installing anchors at the correct elevation so the bottom of the leveling nut is no more than one rod diameter above the top of the concrete foundation. This allows for adequate adjustment for leveling the structure.
- Anchor rods should be spaced with templates as contract plans and shop drawings show. Anchor rods should be centered in the foundation and built plumb. If rods are out of plumb, contact BOS.
- Anchor rods should be galvanized as the contact specifies.
- Anchor rods should be color coded to indicate their grade:
    - Blue for F1554 Grade 36, not used on ancillary structures.
    - Yellow for F1554 Grade 55, common for signs, signals and HML structures.
    - Red for F1554 Grade 105, common for light poles.
- Base plate bolt holes of the structures should match the anchor pattern noted in the plans and shop drawings. If a hole does not line up, call the BOS, metals and fabrication inspection unit at (608) 266-8487 for further action that may be required. It is the contractor’s responsibility to ensure that anchors for contractor designed structures are designed to fit inside the rebar of the foundation noted on the plans. If it is not possible due to the design requirements of the structure, an RFI must be submitted and changes to the foundation may be required. The engineer should document and put in the permanent project file, any discrepancy of a misaligned bolt, bolt holes, or remedial action taken.
- Anchor rod threads above the top of the foundation level should be protected from concrete splash.

570.3.2 Anchor Rod Tensioning Procedures

Anchor rods should be tensioned by the contractor and documented according to the anchor rod tensioning DT2321. Lubrication with wax-based lubricants must be performed in all cases before tensioning. Installing any grade anchor rod other than grade 55 should be discussed with the BOS, metals and fabrication inspection unit before installation. A copy of the DT2321 must be kept in HSIS for "S" or "L" structures and in the permanent project file for structure types that are not included in HSIS, ensuring the following ancillary structures have been addressed:

- Each overhead sign (S) structure installed under standard spec 532.
- Each type 9, 10, 12, and 13 signal monotube (S) structure installed under standard spec 657.
- Each high mast light tower (L) structure installed under standard spec 532.
- Any moment or double nut type base plate connection (typically camera poles).

Once a structure is leveled the top and leveling nuts need to be snugged according to Table 1 of DT2321. The nuts are rotated as required, depending on the diameter and the corresponding rotation listed on the form. For large anchors, 2-inches and larger, special hydraulic or electric torque wrenches may be necessary to obtain the required rotation. With the potential of base plates being warped, the leveling nuts should be checked after tensioning. Any top or levelling nuts that are not in full contact may need to be re-tensioned or use a beveled washer. Leaving a nut that is not in full contact will cause performance issues with the structure, as the nut is likely to loosen over time. It is imperative that the department representative be present at this testing to witness the procedure. The department representative is required to sign the DT2321, certifying proper procedures were followed.

570.3.3 High Strength Bolts

Ancillary structures that require high strength A325 bolts must be fit up with the faying surfaces and free of rust, loose mill scale, dirt, oil, and grease. Connections should be reasonably flat so that when the bolts are tensioned, the bolts draw the faying surfaces together into intimate contact around each bolt. If intimate contact cannot be made, call the BOS, metals and fabrication inspection unit at (608) 266-8487 to determine the required course of action. Any connection alignment issues or unique problems with fasteners that remain in service on the structure should be documented on the as-builts and during the initial inspection and kept in the Highway Structures Information System (HSIS).

Connections that are made with bolts other than A325 bolts, such as U-bolts or stainless-steel bolts, must be installed following a written procedure from the manufacturer. The written procedure should be kept as part of the shop drawings or as-builts in HSIS. Hardware and other fasteners that are used on the structure must conform to the drawings and instruction from the manufacturer.

Contractors should organize and segregate different bolting assemblies. Check to see if:

- Did the supplier pre-assemble each bolt/nut/washer assembly before shipping to ensure parts are the same rotational capacity lot number? Having the nuts, bolts, and washers pre-assembled help ensure good fit and show the ability to run the nut down the bolt.
- Is there a certified report of test or analysis for each type of assembly showing the results of the supplier's rotational-capacity testing?
- Did the bolt/nut/washer assemblies get shipped in sealed and labeled containers? For example, the contractor could use sealed containers that are stored out of the weather that has permanent labeling showing size and rotational capacity lot number on the container.
- Has the contractor provided the required number of additional bolt/nut/washer assemblies for pre-installation and department testing?

High Strength bolts are to be tensioned using DTI's. Follow the installation procedure listed in the DT2322.

570.3.4 Rotational Capacity Testing

Rotational capacity (ROCAP) testing is performed by the supplier on high strength bolts used on ancillary structures. The contractor needs to provide documentation for each ROCAP lot before installation. Field ROCAP testing is not required unless the manufacturer is not able to provide testing certificates.

570.3.5 Pre-installation Test and Torque Testing

The pre-installation test and torque determination are required to determine the effective installation of the bolt to an acceptable tension. DT2322 contains the procedure necessary to perform these tests. It is imperative that the department representative witness the pre-installation procedure. The department representative is required to sign the DT2322, certifying proper testing was performed.

Complete contact of the indicators on the DTI is required to determine the torque applied to the assembly. Oversized washers, where the hole is greater than 1/16 inch larger than the bolt shaft, are not allowed in the assembly because the DTI may not have full contact with the washer face. Special washers may be required for diameters larger than 1-1/8".

If there is interference between the DTI washer and the base metal due to a weld, rotate the assembly so that the DTI is not on the weld or use an additional clipped and flat washer to raise the DTI above the weld so that the DTI washer lies flat when tensioned. The pre-installation tested will need to be repeated to ensure that the DTI will perform with the addition of the clipped washer. If the DTI does not lie flat, then it cannot be assumed to be tensioned properly.

If a contractor is working on multiple projects that require the same size and bolt configurations, pre-installation (PIV) testing for those projects may be observed by a single WisDOT representative, preferably one that has taken the Departments bolt training.

A single lot of bolts, nuts and washers may be used for multiple projects with signs, signals, or high mast lights if the following conditions are met:

1. A WisDOT representative observes the testing, and the contractor has coordinated with the various project managers to schedule the test.
2. Page 1 of the DT2322 form should include a note for all project IDs included in the test for each lot of bolts tested. This will be provided to each project after page 2 is completed after installation of the bolts on the specific structure.
3. Twelve (12) months has not passed since the test was done. If 12 months have lapsed a new test will be required, even if it is for the same project as the last test.
4. If the contractor has bolt assemblies left over from a previous order and an ancillary structure on a new project uses the same assembly, a new pre-installation test would be required to use the bolts.

570.4 Construction Inspection Checklists

BOS has developed a construction inspection checklist for ancillary structures providing standard specification references for field staff to review before both installation and inspection. The checklist also enumerates additional things to watch for when erecting ancillary structures.

Construction Inspection Checklist for Ancillary Structures

The check list below is a summary of many of the specified items for traffic signals and arms, sign structures, high strength bolts, anchor rods, concrete foundations, signals, signs, and sign blanks used on WisDOT projects. The following items should have been performed, submitted, detailed, conformed to, or checked by the contractor before review and approval by the department staff.

1. Traffic Signal Poles and Arms for Monotube Types 9, 10, 12 and 13

A. Department furnished materials (SE region and/or by special provision):

- Pole, arm, anchor rod assembly, mounting hardware including luminaire arm, connecting bolts, and tightening procedure.

B. Contractor furnished poles from department-approved manufacturer:

- Submitted material listing and certificate of compliance for design.
- Sent copy of certification and shop drawings to the project engineer

2. Overhead Sign Structures

- Contractor material certifications submitted to the project engineer.
- Contractor shop drawings, calculations for contractor-designed structures, and mill certs submitted to the fabrication library.
  - One structure per shop drawing.
  - DT2334 submitted and updated weekly to the fabrication library.
  - Submitted plans must be formatted according to 105.2.2 and be clearly legible. Poor scans on incorrect page sizes should be resubmitted.
- Project engineer-approved certifications and materials.

A. Department-Designed Standardized or Non-Standard Overhead Sign Structures

- Contractor-furnished trusses, columns, and steel accessories with galvanization.
- Inspected welds visually and performed other tests as required by the engineer under standard spec 532.3.5.
- Submitted certification of compliance for HS bolt shop installation for truss section and fitting match mark.
- Field assembled truss sections together as a single unit before attaching to the columns.
- Galvanized members are protected during transportation, storage and erection.
- Contractor repaired damages.

B. Contractor-Designed Overhead Sign Structures and High Mast Light Towers

- Shop drawings and calculations are sealed, signed and dated by a professional engineer registered in the state of Wisconsin.
- Provided certification of design conforms to AASHTO standards and the contract.
- Contractor to verify foundation dimensions and structure dimensions are compatible prior to installation.

3. Concrete Footing

A. Excavation:

- Located all existing underground utilities.
- Excavation completed conforming to standard spec 531.3.2.
- Checked for a firm and clean hole at the bottom.

B. Used casing for cave-in or seepage, engineer must coordinate with BOS for casing left in place.

C. Contractor may submit a proposal when encountering rock, boulder, or seepage that cannot be shut off with casing. The engineer will coordinate with BOS and the responsible individuals listed on the contract plans for review and approval.

D. Assembled bar cage with tie wires, properly positioned and supported before placing concrete.

E. Secured anchor assembly in proper alignment with adequate embedment before placing concrete. Anchor assemblies must be centered in foundation and plumb.

F. Protected exposed portion of anchor rods during and after concrete placement.

G. Used tremie to place concrete in drilled hole with standing water.

H. Backfilled by tamping tight against bare concrete base in layers of one foot or less.

I. Removed forms and casing unless plans show or engineer directs otherwise.

J. Erected structure when concrete base has attained 3,500 psi compressive strength or 7 equivalent days.

4. Anchor Rod Assembly

- Department furnished anchor rod assembly for concrete base type 10 and 13 (SE region and/or by special provision). Contractor furnished anchor rod assembly for all other structures.
- Verified anchor rod assembly: quantity, size, length, coating, and storage.
- Installed anchor rod assembly using turn of nut method specified in DT2321 and submitted completed form.
- Provided certificates of completion from the department's ancillary bolting online training with signed DT2321.
- Provided calibrated torque wrench to perform/verify torque.
- Project engineer was present during anchor rod installation and performed QA.

5. High Strength Bolt Assemblies

- Furnished high strength bolt assemblies (bolts, nuts, DTIs, and flat washers) except as noted in standard spec 532.2.1. A490 bolts are not allowed.
- Contractor furnished certificate of manufacturer/supplier test reports.
- Contractor furnished galvanized DTI washers.
- Contractor stored bolt assemblies and DTI washers in closed and labelled containers.
- Contractor provided calibrated torque wrench and load cell to perform pre-installation test.

A. Standard F3125 Grade A325 Bolts

- Performed pre-installation test and installed bolts as specified in DT2322.
- Provided certificates of completion from the department's ancillary bolting online training.
- Project engineer was present during pre-installation test and bolt installation and performed QA.

B. Tensioning procedures for nonstandard (proprietary) connections are detailed in shop drawings.

6. Signals, Signs, and Sign Blanks

A. Installed signs or sign blanks immediately after erecting structure and conformed to standard spec 637.3.3 and standard spec 532.3.7. Used hardware conforming to standard spec 532.2.1 and standard spec 637.2.4. Verify that hardware is properly sized for the connections and installed according to manufacturer recommendations.

B. Installed signals and other attachments immediately after erecting structure and conformed to standard spec 658.3. Used hardware conforming to the standard spec 658.2. Verify that hardware is properly sized for the connections and installed according to manufacturer recommendations. Verify that aluminum castings are not over tensioned or cracked, this includes the body of the connection bracket and the dished washer attached to the cables or band clamps.

C. Installed high mast light tower head assemblies, luminaires, and lowering devices immediately after erecting structure, and conformed to standard spec 532.3.7.2 and standard spec 660.

7. Initial Inspection after Structure Erection

A. For sign and high mast light structures, initial inspections are the responsibility of contractor. The contractor needs to:

1. Ensure a department certified inspector is scheduled to complete the initial inspection.
2. Notify the project engineer 5 business days before erecting and inspecting the structure to allow scheduling of project staff. The contractor should provide completed DT2321 and DT2322 along with bolt training certificates to the project engineer. The contractor should provide completed DT2321 and DT2322 to the team lead inspector for inclusion into HSIS inspection report.

3. Maintain appropriate traffic control during the inspection. The contractor's inspection team lead will inspect the structure and provide punch list items in the form of an HSIS inspection report to the project engineer. Provide punch list items as "Identified" maintenance items in the HSIS report. The signed report should be signed in HSIS and submitted to the project engineer within 1 business day of the inspection.
4. Ensure that the engineer and regional ancillary structures program manager are notified that the punch list items are complete. The contractor's inspector marks the maintenance items as "Complete" in HSIS and will add documentation to the final report showing that all items have been completed. The department should not make final payment before receiving verification of punch list completion. The region may request that BOS perform a QA inspection using a third-party contract if there are concerns regarding the accuracy of the contractor's inspection.
5. If a QA inspection is needed due to concerns with the contractor's inspection, the project engineer should contact the BOS ancillary structures project manager to schedule an inspection. This inspection needs to be completed within 2 weeks of the contractor's inspection and should use the project's traffic control, if possible. If errors in the report are found, BOS contacts the project engineer and the inspector, and follows the process in the Structures Inspection Manual for corrective action. If construction or material errors are found, BOS contacts the project engineer. The contractor must repair or replace defective elements.

B. For signal monotube inspections on type 9/10/12/13 structures, the Department will use master contracts to inspect new structures. The project manager will contact the state ancillary program manager, copying the region ancillary program manager to schedule the inspection. The following documents are required:
1. Intersection plan showing location of monotube structures including signal intersection number, signal base number and structure ID.
2. Completed inventory form for each signal structure. Forms can be found here: https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/inv-forms.aspx
3. Completed DT2321 and DT2333 forms.
4. A summary of existing traffic control at the structure location. The inspector will need to access each part of the structure, so it is critical for scheduling that they know if traffic control will meet their needs or if they need to schedule their own subcontractor.

The state ancillary PM will then schedule the inspection and the inspector will provide the inspection and punch list items to the project team and contractor as noted above. Structural component punch list items will need to be reinspected.

600 Miscellaneous Construction

CMM 610 Concrete Curb Ramps
CMM 615 Storm Sewer
CMM 620 Manholes and Inlets
CMM 625 Marker Posts, Cable Guard Fence, and Steel Plate Beam Guard
CMM 626 Energy Absorbing Terminals
CMM 627 Crash Cushions and Sand Barrel Arrays
CMM 630 Property Fence and Right of Way Fence
CMM 635 Maintenance and Repair of Haul Roads
CMM 640 Landscaping
CMM 645 Erosion Control
CMM 650 Pavement Marking and Delineation
CMM 655 Electrical Construction
CMM 660 Well Construction and Borehole Abandonment
CMM 670 Safety Edge

SECTION 610 Concrete Curb Ramps

610.1 General

Good quality, properly constructed concrete curb and gutter, true to line and grade, is essential to the overall functioning of any construction project of which this item is a part. Storm water runoff from the adjacent pavement as well as from side streets, alleys, entrances, and abutting properties is conveyed by the curb and gutter to inlets, storm sewers, or ditches where the drainage can be disposed of.

The curb serves as a means of traffic control at intersections and at traffic islands, delineating the limits of the traveled way and preventing encroachment of traffic onto sidewalks, medians, refuge areas, and the like. The curb also serves as an effective means of entrance control for both the width and location of the entrance. It lends a finishing touch to the pavement and enhances total appearance of the project.

The engineer and project staff are responsible for the construction layout, and staff should become totally familiar with the drainage layout, the curb and the gutter, the storm sewer system and appurtenances, and the curb ramp locations as shown on the plan. All aspects of surface drainage affecting the project should be carefully reviewed and inspected during the field staking, and necessary revisions should be made in grade to accommodate actual field drainage conditions. The correct and final location of inlets should also be determined during the staking.

Depressions in the curb to accommodate ramps for handicapped persons as required at street corner radii should also be located and referenced. Ramps must be at locations shown on the plan in accordance with plan details.

610.2 Setting Line and Grade

Generally, the procedures for running line and setting grade for concrete curb and gutter are like those for concrete pavement as covered in CMM 730. Survey hubs should be established at radius points where the points are accessible and the curves have small radii. These hubs allow for rapid establishment of line and for checking of forms at the returns. Where the radius point is inaccessible the curve can be staked by offsets from the chord.

Grade lines for curb and gutter should be established as far in advance of construction as possible to allow grade comparison and adjustment. Grade of the curb should be approximately parallel with grade on the highway centerline. When possible, top of curb should be lower than the adjacent sidewalk or adjacent ground.

Tilting or warping of the curb and gutter or of driveways, berms, and sidewalks may be necessary to maintain drainage. In urban areas, the curb and gutter should be checked to ensure drainage away from foundations and garages. Minimum desirable gutter grade is 0.5%, and absolute minimum gutter grade is 0.3%, as drainage is not guaranteed at a flatter grade due to tolerances in workmanship, settling, etc. While ensuring positive gutter drainage by meeting a minimum gutter grade, provide flatter gutter cross slope at curb ramps per plan and the standard detail drawings toward meeting ADA requirements.

610.3 Foundation

Maximum care should be used to secure a uniformly compacted subgrade for the work. Inadequate or nonuniform compaction may allow the curb or curb and gutter to settle when in service, resulting in a drainage problem, bad appearance, and maintenance expense.

610.4 Forms

Clean, straight forms in good condition are necessary for the work. Forms set true to line and grade, and adequately staked and braced to prevent movement when concrete is placed, will produce a product of uniform cross-section and good appearance. In order to obtain a smooth appearance in sharp radii curves of 100 feet or less, flexible radius forms must be used. The forms should be carefully inspected before and during concreting operations and realigned if necessary.

610.5 Placing and Finishing Concrete

Using a curb and gutter machine that extrudes curb or curb and gutter is subject to the approval of the engineer, based upon results achieved. It is essential for concrete used in these machines to have a very low slump and uniform consistency. Standard spec 601.3.4 requires the resulting curb or curb and gutter to meet or exceed the quality of that produced by formed method. All curb and gutter dimensions on the plans and details must be met.

When the contract contains a concrete pavement item, curb and gutter may be slip-formed integrally with the pavement unless prohibited by the special provisions. The operations of placing and consolidating the concrete must be coordinated with the finishing operations. In the event that proper finishing cannot be secured, placement operations should be suspended or curtailed until finishing operations have returned to normal. The flow line of the gutter should be checked with a straightedge and level, especially in areas of minimal grades, before the concrete has set. Any irregularities must be corrected. In areas of minimal

flow line fall, using curb and gutter poured separately from the pavement and with an independent grade line may handle runoff better than integral curb and gutter.

Cast-in-place tie bars must be used to connect new curb and gutter to new concrete pavement. Standard spec 601.3.4 requires driven tie bars to tie new curb and gutter to existing concrete pavement.

Standard spec 601.3.6 requires expansion joints to be placed in concrete curb or curb and gutter constructed adjacent to asphaltic pavement or surfacing.

Expansion joints must be placed in concrete curb or curb and gutter constructed adjacent to concrete pavement, to match the location of any expansion joints in the abutting pavement. The joints should be of the same type and width as joints in the abutting pavement.

SECTION 615 Storm Sewer

615.1 General

The design of a storm sewer system is based on information obtained from a survey conducted before preparation of plans for the project. Generally, time elapses between the initial surveys and the beginning of work. Changes in the surface drainage, existing sewers, underground utilities, and other features may occur during this time. Therefore, the project engineer upon arriving on a project should check the plan and profile sheets, drainage structure sheets, point of connection to existing sewer or point of discharge and all other drainage sheets for discrepancies and deviations from field conditions. Any discrepancies noted should be investigated. Existing field conditions should be provided with proper drainage.

To avoid damage or interference with local utilities or facilities of a municipality, a thorough check is to be made by the contractor of their locations before excavation. Utility location plans should be reviewed, and the utilities should be exposed. Pertinent elevations and other measurements should be taken before attempting any necessary adjustment or redesign of sewers or appurtenances. Check separation distances from existing or proposed watermains, especially if unexpectedly encountered during construction. State and local requirements require horizontal or vertical separation of storm and sanitary sewers from watermain unless protected by special material or joints.

It is very important to remember that any change in sewer grade will affect both flow velocity and capacity and may justify a change in pipe size. A change in horizontal or vertical alignment can affect the class of pipe used. Consult the fill height tables in FDM 13-1-25 to confirm maximum fill heights for the specified materials. Before changes are implemented, a check should be made with the region and the FDM.

The project engineer or inspector should inspect pipe as soon as possible after delivery to the job. The inspection should cover dimensions, soundness, and markings including class, damage incurred during shipment or unloading, or defects overlooked at the plant. Pertinent information concerning any rejected pipe should be recorded in field notebooks. Refer to the Materials Testing and Acceptance Guide in CMM 850 for pipe acceptance conditions.

Pipe delivered to the project site should be handled, and if not immediately installed, stored in a manner to prevent potential damage. Refer to CMM 550.4 for additional guidance regarding the storage and handling of pipe before installation.

The layout for the storm sewer is typically conducted by a staking contractor. The project engineer or inspector should confirm that the staking and storm sewer contractors are aware of any changes to the approved plans before any staking or computation of grades. Although the contractor is responsible for staking, the project engineer or inspector should still spot check grade stakes and verify cut sheets. In addition, a requirement of contractor staking is for the staking contractor to verify that the final elevations of storm sewer pipe outfalls and inlets match the existing field elevations and provide this information to the project engineer at a mutually agreed upon date or least 14 calendar days before ordering inlets, catch basins, manholes, endwalls, and storm sewer pipe. Further details on storm sewer construction staking, including requirements for contractor staking, can be found in CMM 720 and standard spec 650.

Before staking, the location of the stakes relative to the sewer structures should be determined in a conference with the contractor, recognizing the type of operation and construction procedures. A duplication of stake placement can often be eliminated by knowing where the pipe is to be stockpiled, whether the excavated material is to be loaded into trucks or placed along the roadway, and other details regarding the sewer installation procedure.

When laying out sewer structures, it should be noted that the center of the sewer is not necessarily the center of the top opening in the structure. Adjustments in the layout may have to be made to ensure proper location of the frame on the structure. Special care must be taken in the layout process to ensure location and elevation are correct.

615.2 Excavation

Trenches must be carefully examined to ensure bracing and sloping in the excavation are performed in accordance with the WisDOT standard specifications and OSHA regulations. Any trench considered unsafe by the project engineer or inspector should not be entered until necessary corrections have been made. Safety precautions in CMM 135 must be maintained to the highest degree during excavation due to the dangerous nature of this work.

Loads acting upon a pipe increase with the width of the trench as well as with the height of fill above the top of the pipe. To ensure against the occurrence of a greater load upon the pipe than the design load, trench width and trench wall limitations are necessary. Trenches should be wide enough to provide free working space on each side of the pipe. Generally, this space must not exceed 1/2 the nominal diameter of the pipe, and never be less than 6 inches. The required working space depends upon the size of the pipe and the character of the material in the excavation. For concrete pipe, the trench width should be

enough to allow for preparing the foundation, laying the pipe, and placing and compacting backfill, but not exceed the pipe's outside diameter by more than 36 inches. For composite, polyethylene and polypropylene pipe ensure minimum trench width is not less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25, plus 12 inches. ASTM D2321 and AASHTO LRFD Bridge Construction Specifications Section 30 provide additional guidance on the installation of polyethylene and polypropylene pipe.

In addition to the trench width limitations stated above, the contractor should excavate the trench below the top of pipe as vertical as possible when the final height of the proposed fill above the top of the pipe will exceed 6 ft. Sliding the trench box or shoring to a new location in the excavation, especially with polyethylene and polypropylene pipe, should be avoided unless special measures are taken to avoid disturbing the pipe and backfill or leaving voids as the shield is advanced. Such measures may include; using a subtrench, lifting the trench box during pipe installation to both conform with OSHA requirements and to properly backfill and compact the soil around the pipe, or other manufacturer approved methods. While following proper worker safety requirements, the trench box or shoring should be properly removed, and the resulting voids backfilled and compacted.

615.3 Forming Foundation

Standard spec 608.3.2 specifies excavating and forming the foundation and bed for storm sewer under public highways. Pipe foundation is the part of the terrain that supports the pipe and the forces of any loads superimposed upon the pipe. Pipe bedding, or foundation backfill as depicted in figure CMM 550-1 is the portion of the foundation in immediate contact with the pipe.

The contractor must excavate for foundation backfill at least 6 inches below the elevation established for the bottom of the pipe unless the project engineer determines that the existing foundation material for this depth conforms to standard spec 608.2.2.2. If rock, hardpan, or fragmented material exists, the trench is to be excavated the greater of 6 inches below the pipe or to a depth equal to 1/2 inch per foot of proposed embankment above the top of the pipe. Additional excavation may be needed for pipe bells. Figure CMM 550-1 depicts trench width, bedding and backfill requirements for storm sewer and pipe culverts.

If the pipe trench bottom is inadvertently over-excavated below intended grade, the over-excavation should be filled with mechanically compacted foundation backfill at no additional cost to the department. Major foundation problems should be brought to the attention of the project engineer and region soils engineer for resolution.

615.4 Laying Sewer

Pipe can be placed by various means, which are acceptable, if damage to the pipe or the foundation bed does not occur. Proper joints are essential in good sewer construction. As preferred installation methods may vary based on material, the contractor should comply with manufacturer's recommendations for assembly of joint components, lubrication, and making of joints. Polyethylene, polypropylene and composite pipe should be handled with great care to prevent damage during installation. These materials should not be handled with chains. Individual lengths of pipe can typically be handled using a nylon sling or cushioned cable secured around the third points of the pipe. Consult the manufacturer data for specific handling and storage requirements or additional information. The directions of the manufacturer should also be followed closely to ensure a tight joint. Standard spec 608.3.4 describes additional requirements for joints.

High grade on the pipe should not be corrected by alternately lifting and dropping the pipe. Care should be exercised to prevent the moving of a previously placed pipe when setting a new pipe. Line and grade should always be checked after the pipe is in final position. When pipe laying is interrupted, the contractor should secure piping against movement and seal open ends to water, mud, or foreign material from entering.

In areas where existing underground utility lines may interfere with proposed storm sewer work, grades for the storm sewer may have to be adjusted to not interfere with the existing utility lines. In these cases, it may be necessary to construct manholes after construction of the sewer line.

Reinforced concrete storm sewer pipes are required to be tied at the joints with joint ties to prevent separation of adjacent pipe sections. This is required at the last 3 sections of the system infalls and outfalls. When using apron endwalls, the endwall and the last 2 sections are tied. No ties are required on storm sewers infalls or outfalls with masonry endwalls unless the plans show otherwise.

Joint ties are not required for thermoplastic pipe where a full (+/- 20 foot) pipe section is utilized from the infall and outfall to the first joint. Where a partial pipe section must be used at the infall or outfall end, it should be restrained with a manufacturer supplied external mechanical coupling, a mastic impregnated geotextile wrap with mechanical fastening bands, or a concrete collar. Apron endwalls must be secured to the pipe. No ties are required on pipes with masonry endwalls unless the plans show otherwise.

Final sewer locations, elevations, and unusual ground conditions should be recorded by the inspector for future reference.

615.5 Backfilling

The backfill material should have a moisture content suitable for acceptable consolidation with the compaction tools used. The material provided should have a liquid limit less than or equal to 25 and a plasticity index less than or equal to 6.

615.5.1 Foundation Backfill

In order that a pipe may successfully support the loading to which it may be subjected without excessive distortion or rupture of the pipe, and to preclude settlement problems, it is essential that adequate lateral support be provided for the pipe by thorough consolidation of the backfill between the pipe and the walls of the trench. To facilitate this, pipes are to be embedded in compacted foundation backfill as defined by standard spec 608.2.2.2 from a minimum 6 inches or more below the bottom of the pipe to 12 inches above the top of pipe. Foundation backfill is virgin material consisting of either sand-sized particles or sand-sized particles mixed with gravel, crushed gravel, or crushed stone. For storm sewer only, the contractor may supply crushed stone chips conforming to standard spec 608.2.2.2. The contractor may use material from the work site only if it meets specifications.

Before pipe placement, the foundation backfill is to be mechanically compacted. After pipe placement, mechanically compacted lifts, not measuring more than 6 inches after compaction, are to be placed to an elevation 12 inches above the top of pipe. To ensure against disturbance of the pipe alignment, each layer of backfill material must be placed, compacted, and brought up uniformly on each side of the pipe.

While compaction is essential and required by specification throughout the foundation backfill zone, special emphasis has been placed on compacting material under the lower portion of the pipe. Backfill material placed in the area under the lower half of the pipe must be thoroughly compacted. In narrow trenches where access and working conditions may be difficult, there may be a tendency to slight this work, particularly in the haunch areas directly under the pipe. Hand work may be required to fill voids under the pipe. Shovel slicing, rodding and hand tamping are an effective means of achieving support in the haunch zone. Adequate compaction of foundation backfill in the haunch zone is important for all pipe materials, but is particularly important for polyethylene, polypropylene, and composite pipes where the pipe and bedding interaction is critical to developing the strength to support vertical loads applied to the pipe.

615.5.2 Trench Backfill

Starting 12 inches above the top of the pipe, the remaining trench, if any, must be backfilled with compacted trench backfill. Trench backfill is to be placed to the top of the subgrade in layers no more than 8 inches thick after compaction. Backfilling details are shown in figure CMM 550-1.

Allowable trench backfill materials for storm sewers are not the same as trench backfill for culvert pipes. Trench backfill material for storm sewer must be either granular backfill meeting standard spec 209.2 or material meeting the requirements for culvert foundation backfill under standard spec 520.2.5.2.

Pipe should be protected from construction traffic after placement. If 2 or more feet of cover is not provided by foundation and trench backfill, it may be necessary to temporarily place a "cushion" of compacted earth embankment over the pipe for at least the trench width. This cushion is to protect the pipe from construction equipment during subsequent operations until such time the roadway pavements can be placed.

Polyethylene, polypropylene and composite pipe can be easily punctured, so care must be used to prevent mechanical equipment from directly contacting the pipe during backfilling.

Foundation and trench backfill are incidental to Storm Sewer.

615.6 Clean Out

According to standard spec 608.3.6 all new or re-laid sewers must be cleaned of silt and debris, and flow-tested with water or other project engineer-approved means before acceptance. All existing sewers must be cleaned by the general contractor of silt and debris accumulated as a result of the contractor's operations. Clean out operations should be done very late in the progress of the project to collect and remove the maximum amount of silt and debris.

615.7 Deflection Testing for Polyethylene and Polypropylene Pipe

Mandrel Testing is required for all polyethylene and polypropylene pipe culverts and storm sewers. Standard spec 608.3.7 and CMM 550.9 describe the requirements for mandrel testing. If deflection testing fails or significant construction issues occur with polyethylene and polypropylene pipe, please notify the statewide drainage engineer in the Central Office Roadway Standards Development Unit.

SECTION 620 Manholes and Inlets

620.1 Layout

When laying out sewer structures, it should be noted that the center of the sewer is not necessarily the center of the top opening in the structure. Adjustments in the layout may have to be made to ensure proper location of the frame on the structure.

Special care must be taken in the layout process to ensure location and elevation are correct. The contractor and engineer should agree on the method of staking and marking drainage facilities before start-up of survey activity.

620.2 Materials

Mortar may be composed of three parts sand for mortar and one part 50% portland cement/50% masonry cement mixture, or three parts sand for mortar and one part 75% portland cement/25% hydrated lime mixture as specified in standard spec 519.2.3.

Sand for mortar must meet requirements of standard spec 518.2.2.

Concrete brick and block masonry units must conform to the requirements of standard spec 519.2.2. The maximum water absorption is not to exceed 6% by weight.

Some masonry plants add a color to differentiate brick or block meeting our requirements.

620.3 Construction

All masonry units should be wetted before use to allow the mortar to stick and to prevent quick setting of the mortar.

Observations of manhole, inlet, and catch basin structures of various ages have disclosed numerous cases where the covers have settled below the adjacent pavement or gutter, and investigation has revealed the materials used to support and adjust the cover have deteriorated to the extent the materials could either be removed by hand or had already fallen into the structure. This is typically the result of the improper methods used in setting or adjusting the covers when they were installed.

Covers are often observed temporarily supported on a variety of shims or wedges while the adjacent concrete is being placed. Later, a cosmetic layer of mortar is applied from the inside of the structure with little, if any, mortar getting under the flange of the casting. This practice of adjusting the masonry structure to near the final grade, supporting the covers on small wedges or whatever while placing the adjacent concrete, then later attempting to force mortar under the flange, has proven unacceptable and will not be allowed.

The practice of boxing out covers and then placing adjacent concrete promotes random cracking and will not be allowed.

The following construction practices are recommended:

- Whenever possible, the covers should be adjusted and set to grade on a full bed of mortar in advance of the paving operation or curb and gutter placement.
- In the case of inlet covers where slip-form methods of curb and gutter placement are utilized, the frames can be preset approximately one inch low, the curb box removed, and the slip-form operation run continuously through the inlet location. Later, the curb section can be shoveled out, the curb box replaced, and the concrete patched in by hand on either side. The gutter section can be worked down to the frame elevation within a short distance on either side of the inlet.
- In the case of a manhole cover in the pavement (slip-form operation), or any other case where the fixture cannot be set before the placement of the adjacent concrete, the structure should be covered with a temporary cover such as a steel plate, the location carefully noted, and the concrete placed over the structure. When the paving operation has passed, the concrete over the structure can be shoveled out, the plate removed, and the cover placed and supported on the structure in such a way that an opening exists between the top of the structure and the bottom of the flange. The subgrade around the fixture should be sloped down to the top of the structure on about a two-to-one slope so as to allow concrete to flow into the opening under the flange. A form must be placed inside the structure to retain the concrete. As the concrete is placed adjacent to the cover it should be carefully spaded and vibrated to force it under the flange. All remaining voids are to be pressure grouted with nonshrink grout before opening the highway to traffic.

Curing usually is not required for brick or concrete block masonry; however, the curing requirements are necessary when the manhole or inlet is constructed with concrete masonry.

620.4 Acceptance and Records

An inspection should be made of the interior of all manholes and inlets before final acceptance. Any voids between the flange and the top of the structure should be filled by the contractor.

Before final inspection and acceptance, all new, reconstructed or existing storm sewers, catch basins, manholes, inlets, or other drainage structures are to be cleaned by the general contractor of debris that has accumulated as a result of work operations under the contract.

Records of final locations, elevations, and unusual ground conditions should be inked on the as-built plan for future reference.

SECTION 625 Marker Posts, Cable Guard Fence, and Steel Plate Beam Guard

625.1 General

This section covers the construction of steel plate beam guard, cable guard fence, anchors, and marker posts. Construction details relating to post spacing and location, dimensions, and other pertinent information are shown on standard detail drawings included in the plans for the project. The locations and lengths of the installations are described on the plans also.

The engineer should check the proposed locations of the work as shown on the plans against the actual field conditions when staking out the work. Such installations should be made only when clearly justified. Where beam guard or barrier installations are indicated, the roadway should be examined to determine whether flattening an embankment slope or adjusting other site features might eliminate need for the installation. If, after consideration of all factors, doubt as to need for the installation exists, the proposed location should be examined by the team leader. Any subsequent required revisions in length and location should be noted and staked accordingly.

625.2 Marker Posts and Marker Posts for Right-of-Way

Right-of-way marker posts are erected during the early construction operations unless previously placed. Generally, they are placed at each right-of-way monument to mark its location. On most urban work, right-of-way marker posts are not erected.

Changes in right-of-way requirements may occur after the plans have been drawn; therefore, the right-of-way as shown on the field set of plans should be checked against that shown on the latest official right-of-way plat in the region office before staking is done.

Marker posts for right-of-way should be set so their outermost surface is on the property line. Refer to SDD 15A1. Upon completion of the work, all marker posts should be checked and all damaged or tipped posts should be replaced, repainted, or straightened.

Installing the metal right-of-way marker sign is not required on wooden right-of-way marker posts.

625.3 Steel Plate Beam Guard

625.3.1 General

Attention should be given to placement of posts for beam guard. The posts must be erected true to line. The posts must have a firm foundation to minimize future settlement and the backfill around the posts must be thoroughly compacted. After the posts have been erected on a firm foundation, a string line grade is established, inspected, and approved, after which the beam guard, offset blocks, and hardware must be attached to the post at the correct elevation and the tops of the posts cut off the proper grade. Before acceptance, all beam guard should be checked for line and grade and any nonconforming posts reset or straightened. The fill slopes should be constructed to provide adequate support for the posts and anchors when offset as shown on the standard detail drawing.

Care should be exercised when aligning and installing posts, and especially when driving, to preclude interference with and damage to underground facilities such as lighting and signal cables, under-drains, etc. These must be located and marked in advance of construction.

Posts are usually placed by driving with a machine. They must be driven to plumb, to the required depth and alignment, with adequate lateral stability, and without damage to the shoulders and adjacent slopes from the driving operations. Any post that fails to meet the above requirements or is damaged below cutoff during driving should be removed and replaced with a sound post. The contractor should be reviewing the driving equipment and technique if damage continues.

Cut wood surfaces are to be treated with two coats of the same type of preservative used originally to treat the posts, in accord with standard spec 614.3.3. Cutoff bolt ends and damaged galvanized areas on the beams must be painted with two coats of zinc-rich paint.

Details for installing reflectors are shown on SDD 14B15.

625.3.2 Timber Terms

Following are the definitions along with examples of lumber and timber terms to understand the surface characteristics of wood defects:

Check A separation of the wood along the direction of the fibers. Checks usually extend across the rings of annual growth and commonly result from stresses set up during seasoning.

Green wood Freshly sawed wood that has received no drying. Green wood is also said to be "unseasoned."

Knot Portion of a branch or limb that has been surrounded by subsequent growth of the wood of the tree. The size of the knot is its smallest measured diameter.

Seasoning The process of removing moisture from wood, or drying, to achieve moisture content appropriate for the performance expected of the final product. Dried wood is referred to as "seasoned."

Shake The longitudinal separation along the grain of the wood. Generally, two forms of shake are recognized: heart shake starts at or near the center of the log and extends radially 45 degrees; ring shake occurs along the annual growth rings.

Split A separation of the wood parallel to the fiber direction, due to the tearing apart of the wood cells. A split extends through the piece from one surface to another.

Wane Bark, or lack of wood from any cause, on an edge or corner of a piece.

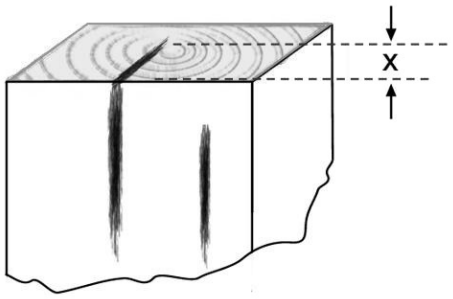
625.3.3 Measurement of Post Defects

The examples below illustrate various post defects, and how the engineer is to measure them. The measured defects should be checked against the specification requirements provided in standard spec 614.2.5.1, table 614-1.

625.3.3.1 Checks

Checks may or may not go to the faces of the piece. Checks go across the annual rings. The engineer should measure checks perpendicular to the face of the piece, as shown in figures 625-1a, 625-1b, and 625-1c. Both of the checks in figure 625-1a can be measured by inserting a device into the crack to measure penetration of the crack (depth), if the checks are perpendicular to the piece face.

FIGURE 625-1a Measuring Check Depth



Always measure perpendicular to the 8-inch face of the post if check is on the 6-inch face, not the actual length of the crack.

FIGURE 625-1b Measure Checks Perpendicular to Face

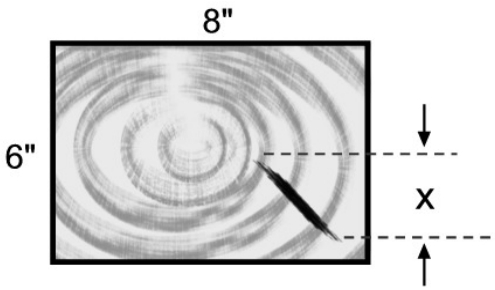
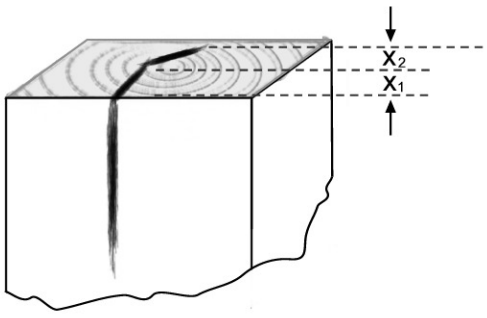


Figure 625-1c illustrates a form of a double check. In this case, add X_1 and X_2 together. Measure across the grain and perpendicular to the grain to the opposite face.

A split could appear the same but would just follow the grain or fiber path through the post (see split examples).

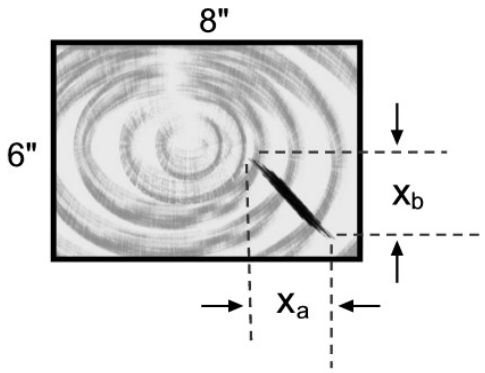
FIGURE 625-1c Double Check



625.3.3.2 Shakes

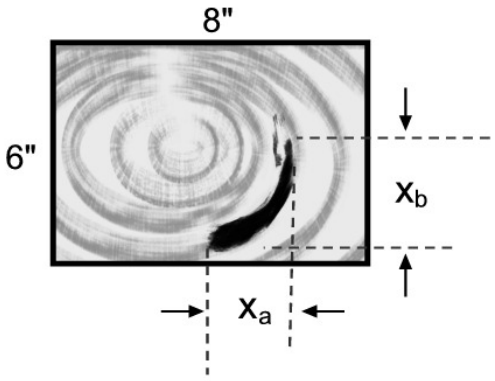
Measure heart shake on the end of the post with perpendicular lines to the face(s). The least dimension (X_a for the example) is to be compared with the specification maximum.

FIGURE 625-2a Heart Shake



Ring shake follows the growth ring. Measure as outlined in figure 625-2b with perpendicular lines to the face(s). The least dimension, X_b is to be compared with the specification maximum.

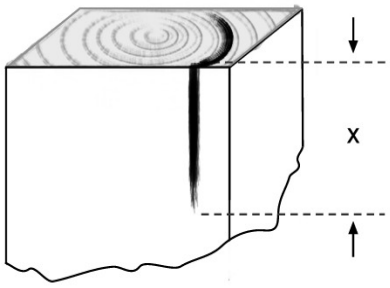
FIGURE 625-2b Ring Shake



625.3.3.3 Splits

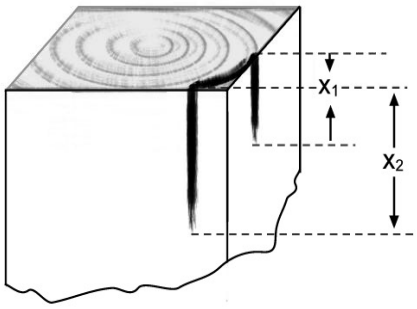
Notice in figure 625-3a that the split follows the grain of the wood through the post. Measure the split on the face as shown by the "X" in the diagram. Measure the length of the split on the back side too and compare the larger of the two measurements with the specification maximum.

FIGURE 625-3a Split through Post



Notice in figure 625-3b that the split follows the annual ring to an adjacent face of the post. Measure the lengths of both of the facial splits and compare the larger length (X_2 in this example) with the specification maximum.

FIGURE 625-3b Split to Adjacent Face



625.3.4 Replacement and Adjustment of Beam Guard

625.3.4.1 Posts and Blocks

Posts and blocks that are out of alignment are to be straightened. figures 625-4 and 625-5 show posts and blocks that are out of plumb and should be straightened. Damaged and rotten posts and blocks as shown in figures 625-6, 625-7, and 625-8 should be replaced.

FIGURE 625-4 Twisted Block



FIGURE 625-5 Post out of Plumb



FIGURE 625-6 Damaged Post



FIGURE 625-7 Rotten Block



FIGURE 625-8 Rotten Posts



625.3.4.2 Rail Damage

Figure 625-9 provide examples of flattened, kinked, and torn rails, which will require repair or replacement.

FIGURE 625-9 Rail Damage Examples

Flattened Rail





Torn Rail





Kinked and Flattened Rail



Twisted Rail



Kinked Rail



625.3.5 Project Acceptance Procedure

Steel plate beam guard manufacturer must be on the department Pre-Qualified Steel Plate Beam Guard Manufacturers List. Procedure for manufacturer prequalification is listed in a separate section below.

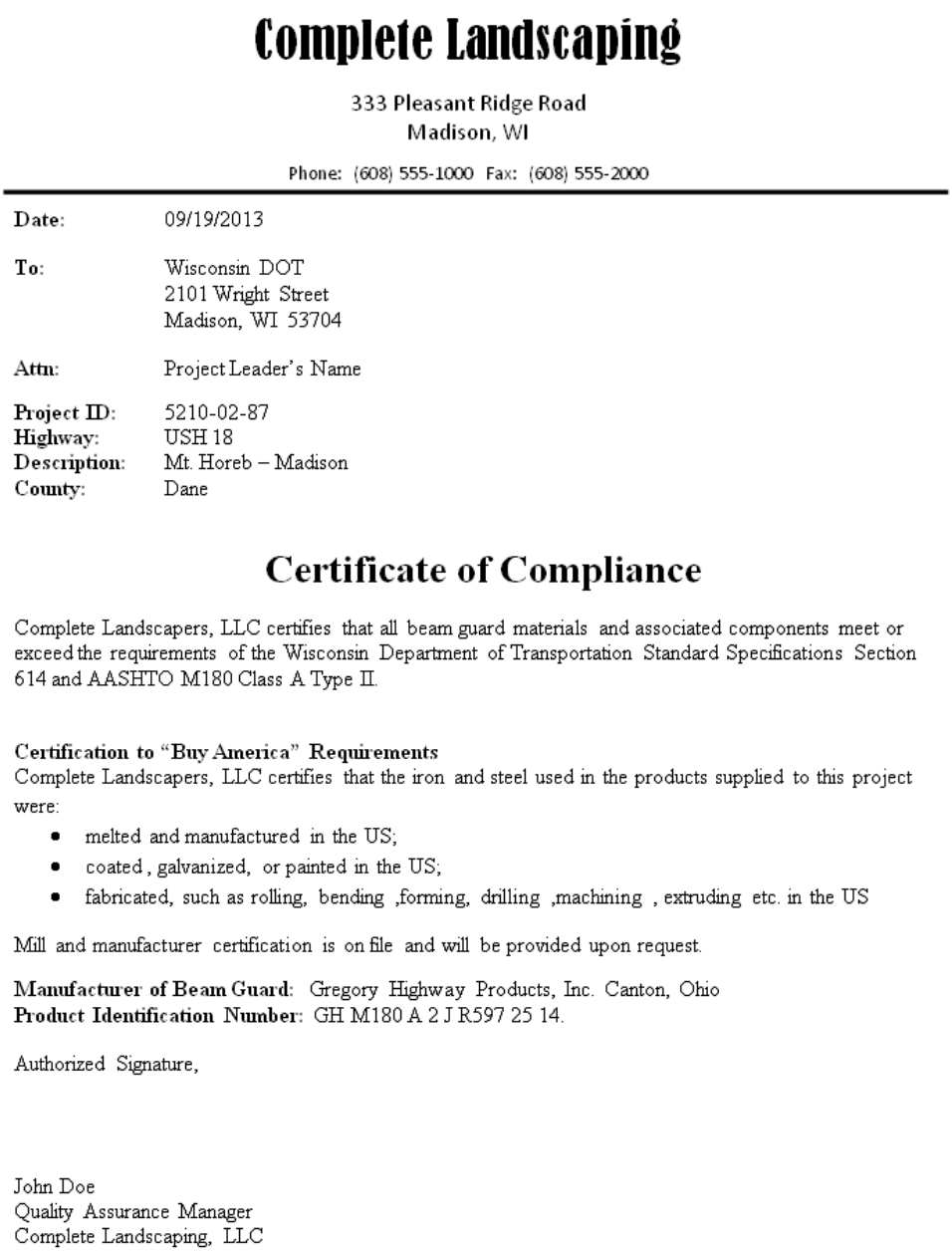
625.3.5.1 Certificate of Compliance

A certificate of compliance must be furnished (for each contract) by the guardrail installer for each manufacturer of beam guard for the contract. The certificate needs to be have the date, signature and title of the person certifying the product. Information on the certificate must include the following:

- State project ID
- Highway number
- Project description
- County
- Name or brand of manufacturer
- Product ID number (i.e.: AASHTO M180 Class A Type II)
- Signed "Buy America Certification Statement"*

*Certification statement needs to state where the steel/iron has been melted, molded, galvanized, epoxy coated etc. A signature is required on the Buy America certification. Also, mill and manufacturer certification is expected to be on file and provided upon request. Buy America is a mandate of the FHWA, enacted in 1983.

FIGURE 625-10 Example Certificate of Compliance



Complete Landscaping

333 Pleasant Ridge Road
Madison, WI

Phone: (608) 555-1000 Fax: (608) 555-2000

Date: 09/19/2013

To: Wisconsin DOT
2101 Wright Street
Madison, WI 53704

Attn: Project Leader's Name

Project ID: 5210-02-87
Highway: USH 18
Description: Mt. Horeb – Madison
County: Dane

Certificate of Compliance

Complete Landscapers, LLC certifies that all beam guard materials and associated components meet or exceed the requirements of the Wisconsin Department of Transportation Standard Specifications Section 614 and AASHTO M180 Class A Type II.

Certification to "Buy America" Requirements
Complete Landscapers, LLC certifies that the iron and steel used in the products supplied to this project were:

- melted and manufactured in the US;
- coated, galvanized, or painted in the US;
- fabricated, such as rolling, bending ,forming, drilling ,machining , extruding etc. in the US

Mill and manufacturer certification is on file and will be provided upon request.

Manufacturer of Beam Guard: Gregory Highway Products, Inc. Canton, Ohio
Product Identification Number: GH M180 A 2 J R597 25 14.

Authorized Signature,

John Doe
Quality Assurance Manager
Complete Landscaping, LLC

All guardrail materials and associated guardrail components are to meet the material requirements of standard spec 614 and AASHTO Specification M180. Any guardrail material not in conformance with specifications will be removed and replaced at no cost to WisDOT.

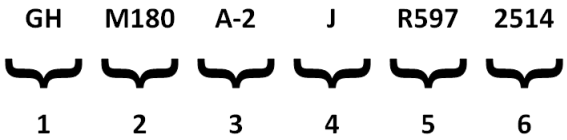
The engineer will verify that the certificate of compliance product ID number is on the shipment of beam guard delivered to the project site.

Figures 625-11a through 625-11f depict the typical stamped markings for each manufacturer on the steel beam.

FIGURE 625-11a Key for Gregory Highway Products, Inc. Guardrail Stamp

Gregory Highway Products, Inc.

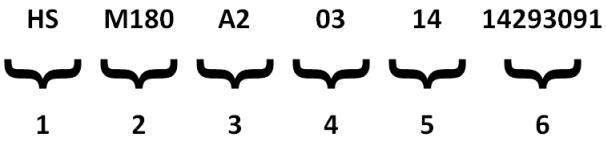
Gregory markings could be in a differing order than depicted here



Legend:
1 = Gregory Highway Products, Inc.
2 = AASHTO Specification
3 = Class-Type (Class A = 12 gauge, Base metal nominal thickness) –
(Type 2 = Zinc coated, 3.6 ounces per sq. ft., minimum single spot)
4 = Operator Identification / First letter of operator's last name
5 = Heat Number Code (4-digit, alpha-numeric)
6 = Coating Lot (Week: one of two digits between 1 thru 52, Year: two digits, e.g. 14 = 2014)

FIGURE 625-11b Key for Highway Safety Corp. Guardrail Stamp

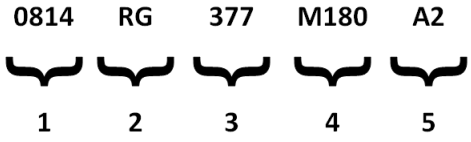
Highway Safety Corp.



Legend:
1 = Highway Safety Corp.
2 = AASHTO Specification
3 = Class-Type (Class A = 12 gauge, Base metal nominal thickness) –
(Type 2 = Zinc coated, 3.6 ounces per sq. ft., minimum single spot)
4 = Coating Lot (Week: one of two digits between 1 thru 52)
5 = Year (two digits, e.g. 14 = 2014)
6 = Heat Number (purchase order number)

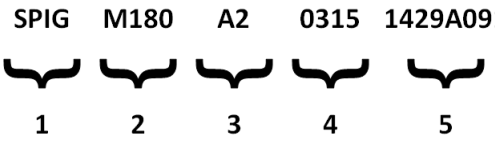
FIGURE 625-11c Key for R.G. Steel Corporation. Guardrail Stamp

R.G. Steel Corporation



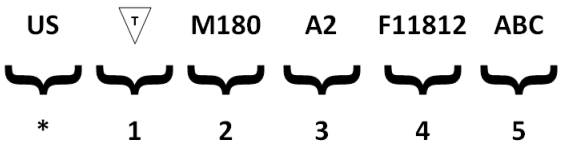
Legend:
1 = Week (one of two digits between 1 thru 52) and Year (two digits, e.g. 14 = 2014)
2 = R.G. Steel Corporation
3 = Heat Number
4 = AASHTO Specification
5 = Class-Type (Class A = 12 gauge, Base metal nominal thickness) –
(Type 2 = Zinc coated, 3.6 ounces per sq. ft., minimum single spot)

FIGURE 625-11d Key for SPIG Industries. Guardrail Stamp



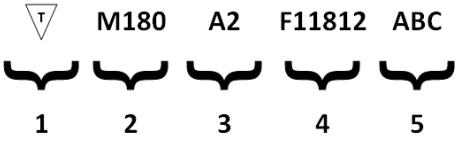
Legend:
1 = SPIG Industries, LLC
2 = AASHTO Specification
3 = Class-Type (Class A = 12 gauge, Base metal nominal thickness) –
(Type 2 = Zinc coated, 3.6 ounces per sq. ft., minimum single spot)
4 = Coating Lot (Week: one of two digits between 1 thru 52, Year: two digits, e.g. 14 = 2014)
5 = Heat Number (6-10 digits, alpha-numeric)

FIGURE 625-11e Key 1 for Trinity Highway Products, LLC Guardrail Stamp



Legend:
* = US Melted and Manufactured in the USA
1 = Trinity Brand Trademark
2 = AASHTO Specification
3 = Class & Type as per AASHTO M180
4 = Heat Code, the first letter defines which plant the beam is manufactured from.
(Trinity has both a Heat CODE and a Heat NUMBER. Trinity's Heat CODE = WisDOT Heat NUMBER.)
G = Girard, OH Plant
L = Lima, OH Plant
5 = Lot Identification

FIGURE 625-11f Key 2 for Trinity Highway Products, LLC Guardrail Stamp



Legend:
1 = Trinity Brand Trademark
2 = AASHTO Specification
3 = Class & Type as per AASHTO M180
4 = Heat Code, the first letter defines which plant the beam is manufactured from.
(Trinity has both a Heat CODE and a Heat NUMBER. Trinity's Heat CODE = WisDOT Heat NUMBER.)
F = Fort Worth, TX Plant
K = Kosciusko, MS Plant
O = Orangeburg, SC Plant
C = Centerville, UT Plant
5 = Lot Identification

625.3.5.2 Coating Thickness, Quality Verification

Annually, each WisDOT Regional Technical Services Section (TSS) visits projects where Beam Guard has been installed. Randomly select a rail and test using PosiTector Model 6000 F coating thickness gauge or equivalent to verify the minimum mean (average) for the rail is at least 80 microns (which has been tested in the Truax laboratory to be equivalent to the standard spec 614, coating thickness requirement of 3.6 ounces per square foot.) If the mean of the rail measurements is deficient, randomly select two additional rails from that heat/lot number and take a batch of measurements at each end of the two rails. The mean coating thickness for all four of the batches must meet or exceed the specification of

80 microns (3.6 oz/sf). If the rails do not meet the specification, have the vendor cut three standard two-foot samples from the original failing rail for Truax laboratory testing. Also, mark the two retest rails in the field for future reference. If the test at Truax laboratory confirms deficient coating thickness, all the beam guard provided for the contract will be removed and replaced at no cost to WisDOT.

Beam guard coating thickness verification may be waived if less than 500 linear feet is placed on a contract. Beam guard coating thickness quality verification testing must be performed for any contract that has 500 linear feet or more of beam guard installed, regardless of the number of beam guard manufacturers or the length of beam guard provided by each manufacturer. Test beam guard coating thickness for each manufacturer.

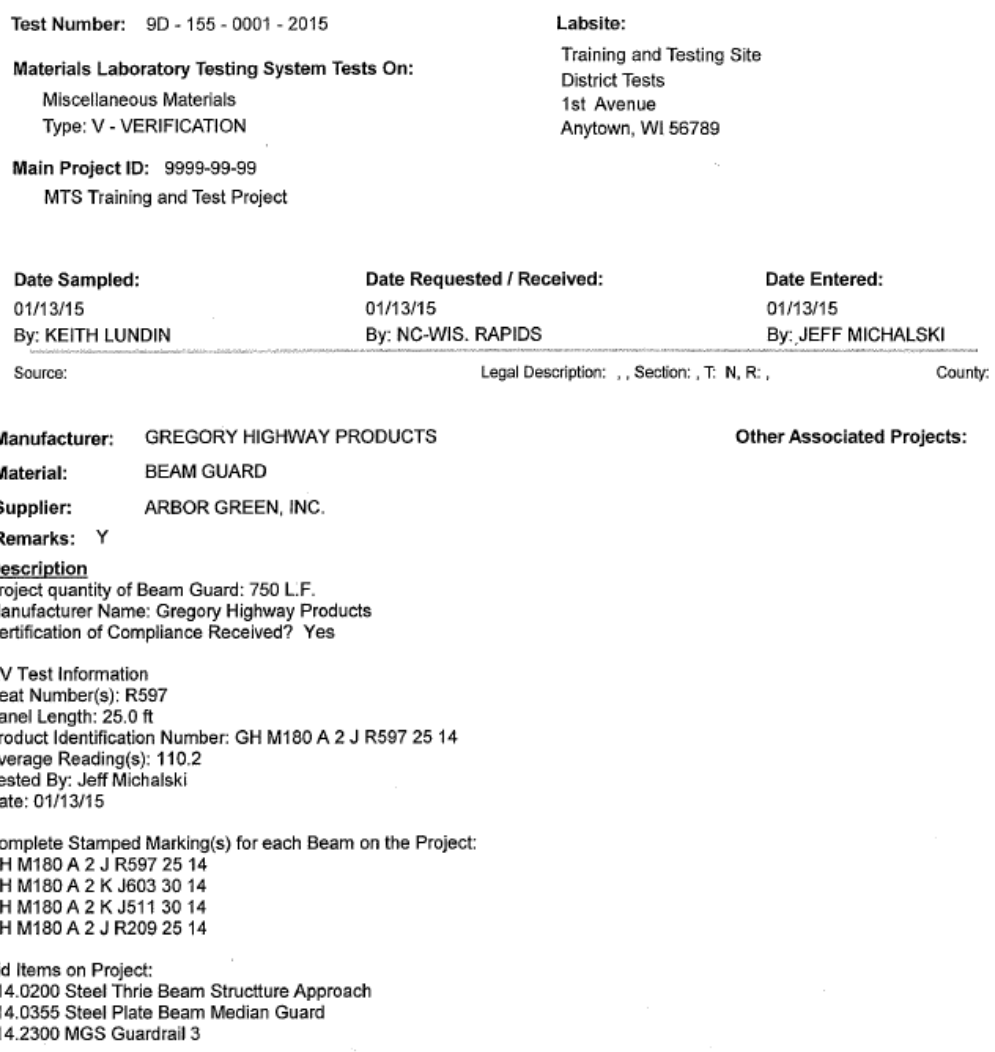
Annually WisDOT will complete Round Robin Verification Testing to validate Region's Positector calibration and consistency.

Positectors found to be outside of verification tolerances must be repaired or replaced. Replaced Positectors need to be tested on a verification panel before use.

625.3.5.3 Department Documentation

All beam guard Coating Thickness Quality Verification testing as described above must be reported on a material tracking/material information tracking (MTS/MIT) prefix 155 Miscellaneous Materials Report.

FIGURE 625-12 Example Beam Guard 155 Materials Report



Test Number: 9D - 155 - 0001 - 2015

Materials Laboratory Testing System Tests On:
Miscellaneous Materials
Type: V - VERIFICATION

Main Project ID: 9999-99-99
MTS Training and Test Project

Labsite:
Training and Testing Site
District Tests
1st Avenue
Anytown, WI 56789

Date Sampled:	Date Requested / Received:	Date Entered:
01/13/15	01/13/15	01/13/15
By: KEITH LUNDIN	By: NC-WIS. RAPIDS	By: JEFF MICHALSKI

Source: Legal Description: , , Section: , T: N, R: , County:

Manufacturer: GREGORY HIGHWAY PRODUCTS
Material: BEAM GUARD
Supplier: ARBOR GREEN, INC.
Remarks: Y

Other Associated Projects:

Description
Project quantity of Beam Guard: 750 L.F.
Manufacturer Name: Gregory Highway Products
Certification of Compliance Received? Yes

QV Test Information
Heat Number(s): R597
Panel Length: 25.0 ft
Product Identification Number: GH M180 A 2 J R597 25 14
Average Reading(s): 110.2
Tested By: Jeff Michalski
Date: 01/13/15

Complete Stamped Marking(s) for each Beam on the Project:
GH M180 A 2 J R597 25 14
GH M180 A 2 K J603 30 14
GH M180 A 2 K J511 30 14
GH M180 A 2 J R209 25 14

Bid Items on Project:
614.0200 Steel Thrie Beam Structture Approach
614.0355 Steel Plate Beam Median Guard
614.2300 MGS Guardrail 3

Certificates of compliance must be referenced on a MTS/MIT prefix 900 or 905 reference report. (Contact your region materials section for documentation preference.)

The complete marking stamped on the beam needs to be recorded in a MTS/MIT prefix 155 reference report. Create one MTS/MIT prefix 155 report for each manufacturer.

Figure 625-12 above shows a combined 155 report for Coating Thickness Verification and the complete stamped markings. A combined 155 report is acceptable provided the Coating Thickness Verification Test and the markings recorded are from the same manufacturer. If you have multiple manufacturers, create a separate prefix 155 reference report for the other manufacturer. A template of the prefix 155 Beam Guard reference report can be found in the statewide pantry.

625.3.5.4 Manufacturer Pre-Qualification Requirements

Only materials from the manufacturers listed on the APL Pre-Qualified Steel Plate Beam Guard Manufacturers List will be accepted for use on state projects.

Pre-qualification is based on Brand Registration and Guarantee in accordance with AASHTO M180. Submit Brand Registration and Guarantee annually to the BTS, Materials Management Section for approval.

SECTION 626 Energy Absorbing Terminals

626.1 Energy Absorbing Terminals

To function appropriately Energy Absorbing Terminals (EATs) must be designed, installed, and maintained properly. This section will concentrate on the proper installation of EATs. Guidance provided in this section will apply to EATs for non-MGS beam guard and for MGS beam guard. Both Non-MGS EATs and MGS EATs have the same manufacturers. Additional information about the design and operation of an EAT can be found at:

FDM 11-30-4.1

Designer notes for SDD 14b24

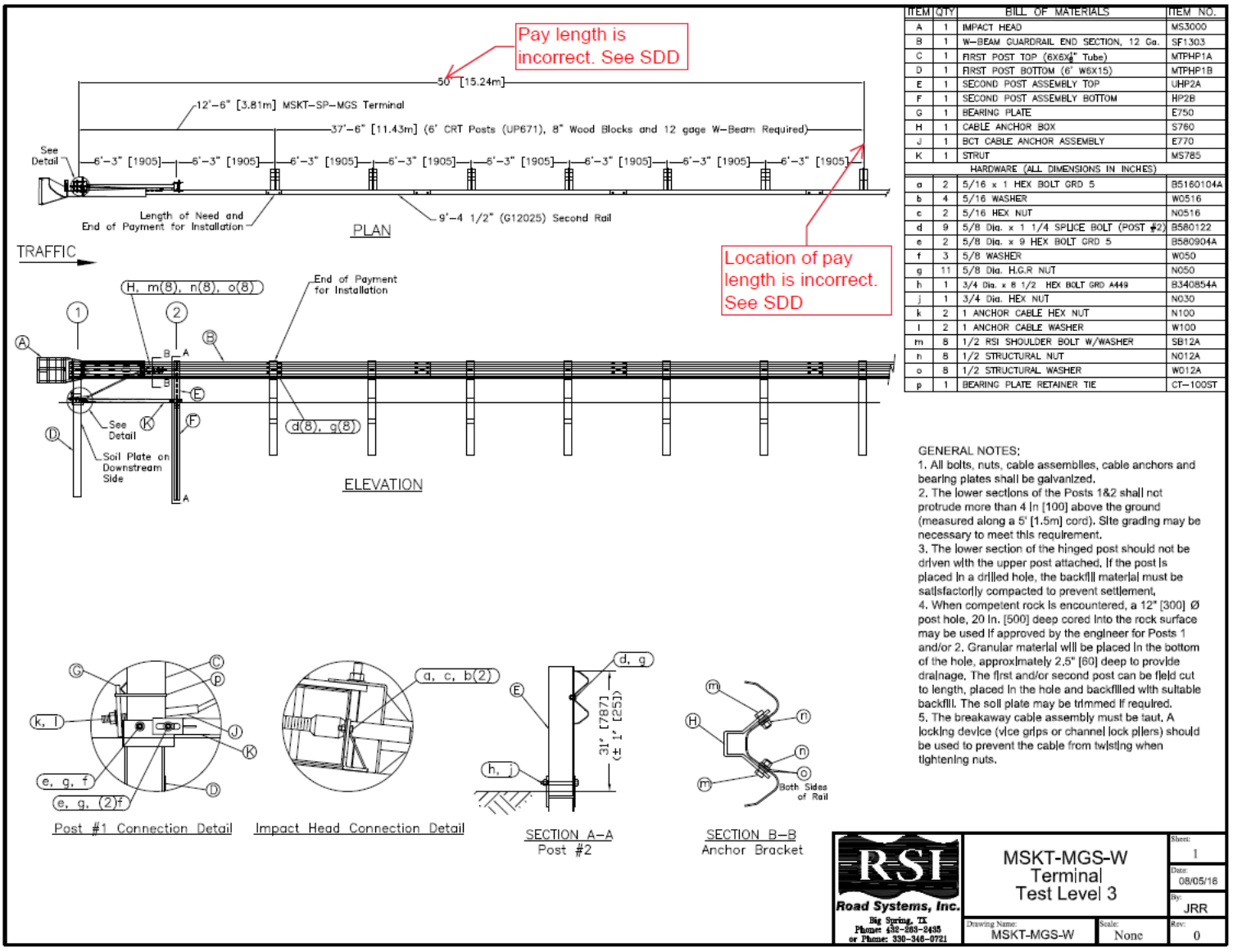
Designer notes for SDD 14b44

AASHTO Roadside Design Guide Chapter 8

626.1.1 Hardware

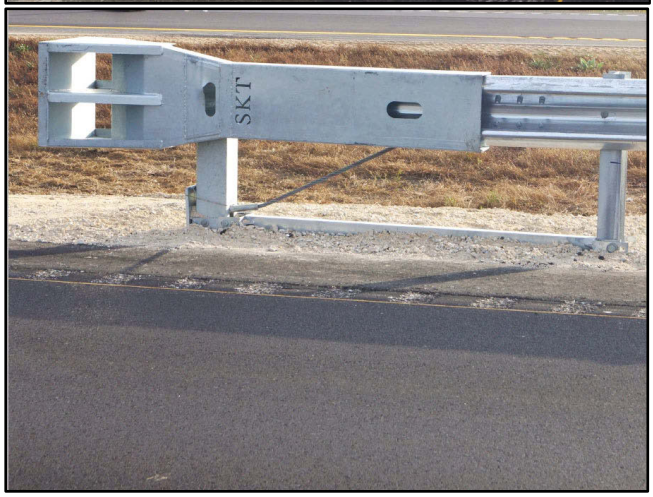
See the APL for approved manufactures of non-MGS and MGS EATs. Below are drawings and photos from the manufacturers of MGS EATs. These drawings and photos provide useful installation information:

Road Systems, Inc. - Drawing: MSKT-MGS-W Terminal

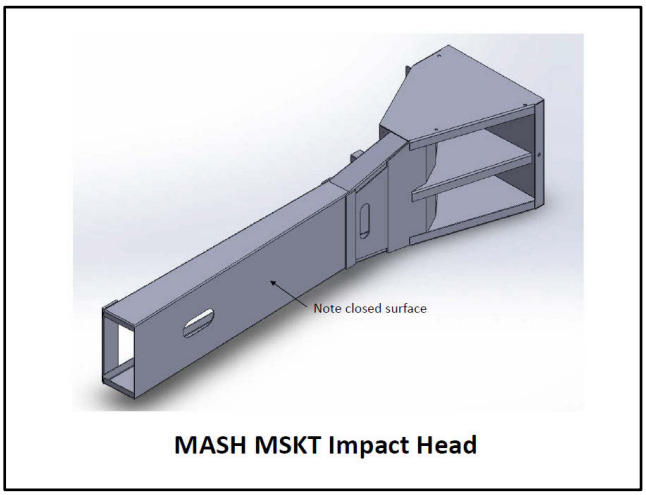


Road Systems, Inc. - Photos: MASH MSKT Components

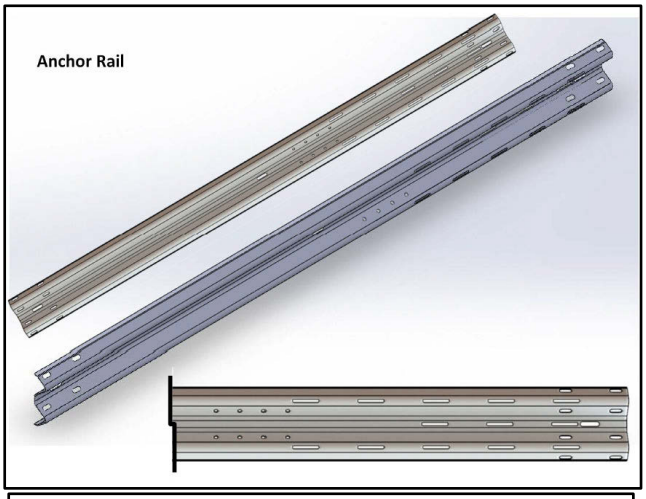


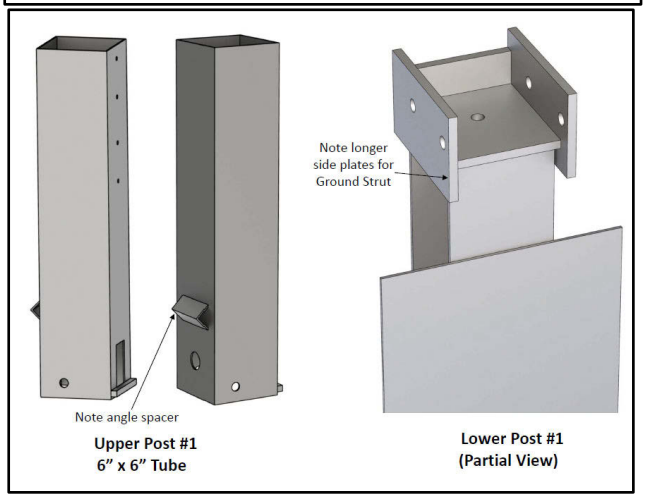






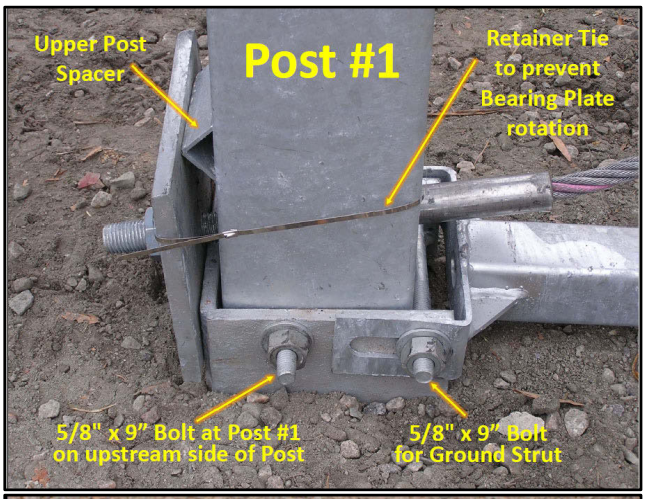
MASH MSKT Impact Head

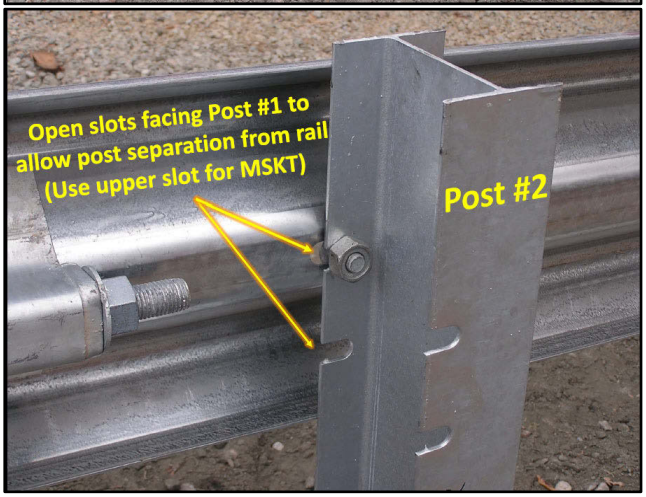


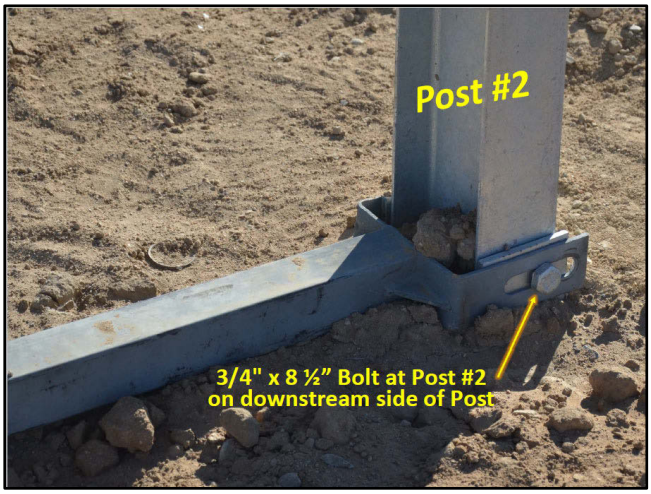


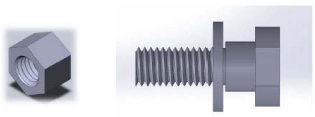
Upper Post #1
6" x 6" Tube

Lower Post #1
(Partial View)

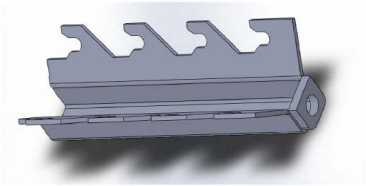

Post #1
Upper Post Spacer
Retainer Tie to prevent Bearing Plate rotation
5/8" x 9" Bolt at Post #1 on upstream side of Post
5/8" x 9" Bolt for Ground Strut


Open slots facing Post #1 to allow post separation from rail (Use upper slot for MSKT)
Post #2


Post #2
3/4" x 8 ½" Bolt at Post #2 on downstream side of Post



Shoulder Bolt



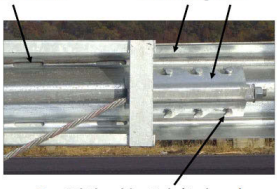
Cable Anchor Bracket

Cable Anchor Bracket

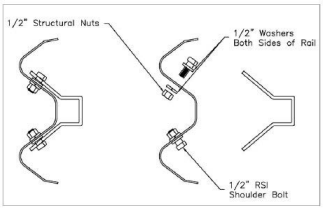


Universal Slotted Rail Section

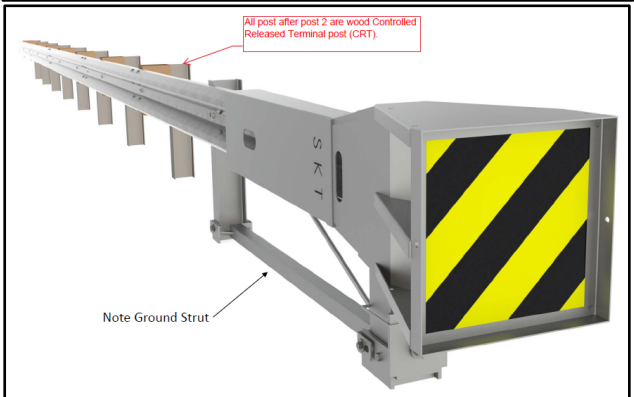
End Rail & Anchor Bracket Interchangeable



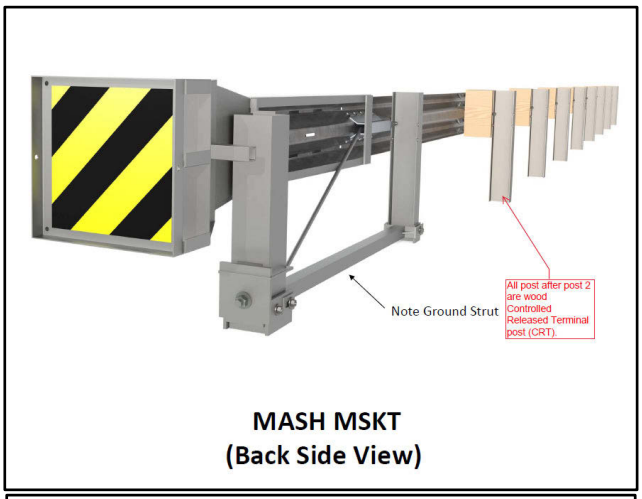
Special Shoulder Bolt (8 places)

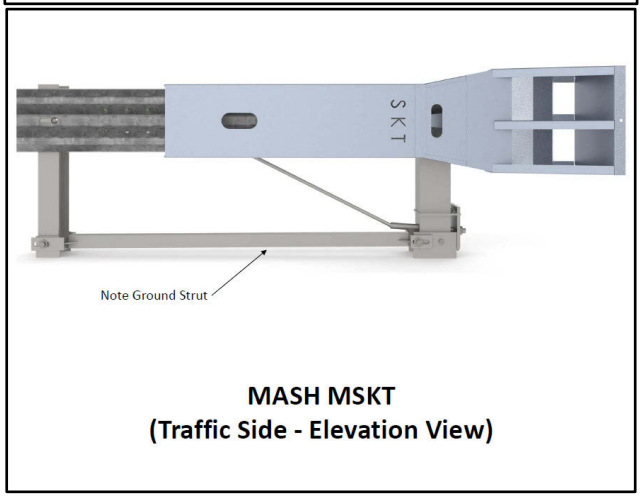






MASH MSKT
(Traffic Side View)





626.1.1.1 Installation Issues

This section will discuss typical hardware installation issues.

FIGURE 626-1 Breakaway Post



The breakaway holes in figure 626-1 are too high. During a head-on impact, the undercarriage of a vehicle could snag on a post.[1] Objects taller than 4 inches on a 5-foot chord are potential snag hazards. The second post from the left also appears to be out of plumb and may not absorb

enough impact energy or an errant vehicle may vault over the EAT. In either case, the errant vehicle may engage a roadside hazard that the EAT was installed to protect.

[1] Object taller than 4 inches on a 5 foot chord are considered to be potential snag hazards.

FIGURE 626-2 Close Up of EAT Post 1



The steel foundation tube in figure 626-2 is too high and may snag a vehicle during an impact with an EAT. Also, the cable has slack in it which can cause excessive deflection or rail failure for the whole installation of semi-rigid barrier. Finally, the bearing plate is not installed correctly.

FIGURE 626-3 Poor Compaction/Visible Gaps



Visual gaps, seen in figure 626-3, between foundation tubes and soils or improper compaction around the foundation tube can reduce the amount of force the whole semi-rigid barrier system can absorb.

FIGURE 626-4 Ground Strut and Bearing Plate Problems



In figure 626-4, the ground strut is too high and can spear into a vehicle cab or cause a vehicle to roll over during an impact. Also, the bearing plate is not installed correctly.

Other hardware issues and missing or damaged components are discussed in CMM 625. and FDM 11-45-30.5.

626.1.2 Grading Issues

Grading is critical to the function of the EAT and the entire semi-rigid barrier system. Grading around an EAT is broken down into three primary areas:

- Approach grading- Is grading leading to the EAT. This grading allows a vehicle to avoid impacting an EAT.
- Adjacent grading- Is grading next to the EAT. This grading allows for vehicle stability during impact and provides structural strength to the entire barrier installation.
- Runout grading- Is grading behind the EAT. This grading allows for a vehicle to traverse a slope and stop after impacting an EAT.

Desirable grading has:

- Compacted material
- Traversable slopes that blend into the surrounding
- A flat area between head of EAT and hinge slope
- Room for errant vehicle to traverse (see runout grading SDDs: SDD 14b24 and SDD 14b44).

Marginal grading has:

- Poorly compacted materials
- Slopes that do not blend into surroundings
- No flat area between EAT and hinge point
- Restricted room for an errant vehicle

Grading adjacent to the EAT is consider marginal if a vehicle can slowly drive around the terminal and park directly behind or adjacent to EAT end section. Runout grading is considered marginal If a vehicle can drive at slow speeds behind the terminal for a distance of 75 feet without running into fixed object or losing control.

Figures 626-5 to 626-10 show examples of desirable grading, marginal grading and EAT with little to no grading.

FIGURE 626-5 Desirable Grading



Side slopes match into other slopes - side slopes are relatively flat and well compacted.

FIGURE 626-6 Desirable Grading



Good distance from hinge point to EAT, good compaction of materials, slopes are relatively flat.

FIGURE 626-7 Marginal Grading



Side slopes don't match into existing slopes, side slopes are too steep, materials are not compacted.

FIGURE 626-8 Marginal Grading



Side slopes are not compacted; side slopes do not blend with surrounding slopes.

FIGURE 626-9 Little to No Grading



Minimum to no grading; no flat area behind the EAT; material not compacted near the foundation tube.

FIGURE 626-10 Little to No Grading



Minimum to no grading; ditch check is in the runout area.

626.1.3 Curb and Gutter Issues

Curb and gutter can degrade the performance of an EAT. Curbs can make it difficult for an errant vehicle to engage an EAT properly. Curbs could trip a vehicle into an EAT. Installations similar to figure 626-11 are problematic because of the curb.

Typically curb and gutter is installed before installing an EAT. Review FDM 11-45-30.4.1.6 for guidance on installing curb and gutter near an EAT.

FIGURE 626-11 Use of Curb Near EAT



626.1.4 Fixed Object Issues

Collisions into multiple fixed objects are more likely to have negative consequences, especially with EATs. A fixed object in front of and EAT may channel drivers into an EAT (figures 626-12 and 626-13). On the other hand, fixed objects installed within the adjacent or runout areas can be struck by an errant vehicle after it has impacted an EAT (figures 626-14 and 626-15).

FIGURE 626-12 Sign Could Funnel Vehicles into EAT FIGURE 626-13 Pole and EAT Will Likely be Hit

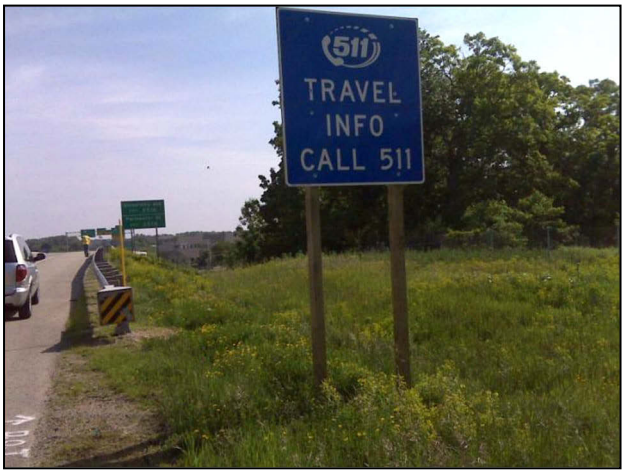




FIGURE 626-14 Rock Wall Can Still be Hit



FIGURE 626-15 ITS Pole Can Still be Hit



After post 3 an EAT reacts like other semi-rigid barriers. The working width is similar to the semi-rigid barrier system it is connected to. Placing fixed objects too close to an EAT may allow a vehicle to hit those objects. FDM 11-45-30.3.4.1.6 discusses working width and what can happen when working width is not provided.

626.1.5 Block Height Issues

If a contractor drives the post where the 3.5" hole of the universal post is flush to the ground, blocks of the EAT may need to be raised to get the rail to the required height. This problem is more likely to happen with the MGS EAT.

FIGURE 626-16 Block Height Adjustments





Based manufacturer's information, it is acceptable to modify the block height as show in figure 626-16. A note has been added to the SDD indicating that installing the block this way is acceptable.

SECTION 627 Crash Cushions and Sand Barrel Arrays

627.1 Crash Cushions

627.1.1 General

Guidance provided applies to permanent and temporary crash cushions using standard specifications. Review special provisions for permanent and temporary crash cushions to determine if the guidance provided is applicable.

Crash cushions are crash tested proprietary hardware and are to be from the APL. Look under the traffic barriers section of the approved product list.

The following should be provided by the manufacturer before the crash cushion is installed:

- P.E. Stamped Drawings*
- Installation Materials*
- Maintenance Manuals*

The project engineer should review these documents. Additional information is available in FDM 11-45-30.4.4 and AASHTO's Roadside Design Guide.

627.1.2 Parts of a Crash Cushion

WisDOT considers the following items to be part of the crash cushion:

1. Concrete or asphalt pad
2. Backup block (if needed)
3. Connections between the crash cushion and pad
4. Crash cushion
5. Transitions from the crash cushion to the object being shielded
6. Attaching transitions to object being shielded
7. Adjusting the object being shielded so crash cushion works correctly
8. Object marker on the nose of the crash cushion

These items are parts of the crash cushion because they:

1. Allow for proper performance during an impact
2. Allow for the proper installation of the crash cushion
3. Allow the crash cushion to comply with the guidance in the MUTCD

Although not part of the crash cushion bid item, grading near the crash cushion can have a significant influence on crash cushion performance. Grading should be 10:1 or flatter. Most new installation of a crash cushion should not have curb installed near them.

Crash cushion bid items do not include grading. Other bid items in the plan should address grading for crash cushion.

If there are issues with the grading or curb and gutter near a crash cushion, contact the designer and regional staff.

627.1.3 P.E. Stamped Drawings

Many of FHWA's eligibility or approval letters state the manufacturer of the proprietary hardware is to provide sufficient information on the design and installation of their hardware. WisDOT requires Wisconsin P.E. stamped drawings for crash cushion installations.

Many crash cushion installations can use a standard set of stamped drawings. Examples are (list is not all-inclusive):

1. Temporary Concrete Barrier (SDD 14B7 and SDD 14B8)
2. Permanent Safety Shaped Barrier
    2.1 Stem Reinforcement at Barrier End Section Drawing (SDD 14B11)
    2.2 Concrete Barrier Transitions to Thrie Beam (SDD 14B22 Sheet B)
3. Permanent Single Slope Barrier
    3.1 End Anchor Single Slope Concrete Barrier Drawing (SDD 14B32 Sheet A)
    3.2 Large and Small Fixed Object Protection (SDD 14B32 Sheet B)
    3.3 Thrie Beam Transitions for single slope barrier (SDD 14B33)

Occasionally, the contractor may need to provide unique site-specific drawings with a stamp. Examples are (list is not all-inclusive):

1. An extra wide object needs shielding.
2. An existing pole with temporary traffic near it, cannot have the transition connected to it.

The project engineer decides if standard or unique drawings with a P.E. stamp are required. Drawings provided to the project engineer are to be "Wisconsin specific". The definition of "Wisconsin specific" is:

> Information on the contactor's P.E. stamped drawing matches information provided in Wisconsin standard detail drawings (SDD), the project's plan, project's specifications or projects' special provisions. This includes dimensions, reinforcement and other information.

Providing generic drawings out of an installation manual are not acceptable. Contractor can find the SDDs in the contract documents or on the WisDOT's website. More project specific information should be in the plans.

Designers are to provide individual construction details and other information in the miscellaneous quantities for crash cushions. If the plan is missing individual construction details or information in the miscellaneous quantities, contact the designer.

627.1.3.1 Information on P.E. Stamped Drawings

The P.E. Stamped Drawings needs to provide, at a minimum, the following features:

1. Asphalt or Concrete Pad.
    - 1.1 Dimensions (length, width, depth).
    - 1.2 Material requirements.
2. Connection between pad and crash cushion.
    - 2.1 Adhesive or mechanical anchoring information.
    - 2.2 Strength of connection.
    - 2.3 Diameter of anchor.
    - 2.4 Adhesive strength.
3. Transitions.
    - 3.1 Connections on both sides of the object being shielded and crash cushion.
    - 3.2 Use of nested rails in connection between crash cushion and object being shielded.
    - 3.3 Transitions from narrow crash cushions to larger objects being shielded using, beam guard posts, beam guard or thrie beam needs to use a TL-3 crash tested design.
    - 3.4 Beam guard posts in the transition are not restrained in pavement.
    - 3.5 Beam guard posts in the transition are not interact with other posts.
    - 3.6 Flare or taper rates of beam guard or thrie beam elements should follow acceptable taper rates in AASHTO Roadside Design Guide.
4. Object being shielded.
    - 4.1 Sufficient reinforcement to absorb TL-3 impact loads transfer to it by transition or crash cushion.
    - 4.2 Adjustments to object to minimize snag.
    - 4.3 Anchoring temporary barrier by the crash cushion.

Other critical information may not be directly in the P.E. stamped drawings. However, the contractor is to provide this information. For example, P.E. stamp drawings may point to what adhesive or mechanical anchor is allowed. The contractor is to provide the anchor manufacturer's installation instructions.

WisDOT is basing its minimum requirements on its interpretation of the following:

1. FHWA memo from September 29, 1994 directing states, at a minimum, to have beam guardrails attached to rigid barrier.
2. Various crash tests between rigid barriers and transitions.
3. Various crash tests of beam guard.
4. Various crash tests of temporary barrier.

WisDOT has seen failed crash test for transitions to rigid barrier caused by:

1. Rail elements that could not transmit impact energy to object being shielded.
2. Rail elements had excessive movement and formed a pocket.
3. Failure of object being shielded.
4. Object being shielded snagging vehicle's tires.
5. Failure of beam guard because of restraining beam guard post from rotating.
6. Lack of nested rail elements have caused rail to fail.
7. Lack of posts to absorb impact load have caused rail to tear.

WisDOT requires the P.E. stamped drawings to address these issues. It is not possible for WisDOT to design for the various crash cushions that manufacturers can provide.

627.1.3.2 Request to Not Comply with WisDOT Requirements

Based on the Department's interpretation of FHWA's Memo issued on October 10, 2014, WisDOT makes the final determination of what is acceptable on its roadways. When a manufacturer, contractor, or the P.E. who stamps the drawings and indicates these conditions exist:

1. WisDOT's requirements are not necessary for their crash cushion or situation.
2. WisDOT's requirements degrades the performance of their crash cushion.
3. A location has issues that prevent proper installation of a crash cushion.

When conditions 1 and 2 exist, the manufacturer to provide written documentation to Bureau of Project Development. At a minimum, documentation is to include:

a. A detailed description of what requirement is not necessary or degrades the performance of a crash cushion.
b. Analysis of why the requirement is not applicable or degrades the performance of a crash cushion.

The analysis must be from a certified crash test facility or FHWA. WisDOT may require computer modeling and crash testing as part of the analysis.

Project engineer and regional staff should contact Bureau of Project Development before deciding if the provided documentation for condition 1 or 2 is acceptable.

When condition 3 exists, the project engineer should discuss with the designer, regional staff and construction oversight staff. Document in the project records and as-builts the decision-making process and what alternatives were reviewed.

Discussion about not complying with WisDOT requirements is to occur before the crash cushion is installed. Staff need enough time to review contractor's information.

627.1.4 Certified Installation

Contractor is to provide a certification for each crash cushion installation. Certification is to show: manufacturer's recommendations, P.E. stamped drawings, project plan, and WisDOT specifications were followed. A P.E. site visit of crash cushion installation is not required.

Place certification in the project records.

If a contractor states they will not certify an installation, treat this situation as a Condition 3 in 6.27.3.2.

627.1.5 Qualities of a Good Crash Cushion Installation

A good crash cushion has the following characteristics:

- Concrete or asphalt pad is the proper size, structurally sufficient, and in good condition.
- Anchors for the crash cushion and pad are properly installed and tensioned.
- Transitions from crash cushion to the object being shielded are in place and connected.
- Crash cushion, transition, and object being shielded are not likely to snag the vehicle.
- Install and secure the correct object marker.

Inspect before the opening or switching traffic. It may be more difficult to inspect or fix a crash cushion after a traffic switch.

627.1.6 Temporary Crash Cushion

Temporary crash cushions follow the same requirements as permanent crash cushions and includes the cost of removal. WisDOT's interpretation of removal includes:

- Removal of the crash cushion pad.
- Removal of transitions and temporary connections.

Connections that extend above pavement or beyond the object being shielded may cause snags or tire deflation. Leaving these features in place can complicate future maintenance, safety, and future projects. Make any remaining part of a connection flush to the surface. Contractor may need to grind down connections.

Remove temporary grading for crash cushion. Restore original grading. Grading items not included in the temporary crash cushion bid item.

627.1.7 Damaged During Construction

The contractor is responsible to maintain traffic control devices and the safety of the traveling public during construction. Standard spec 614.3.4 requires immediate replacement of a crash cushion damaged during construction.

In the majority of cases, the contractor is responsible for the costs of repair. The contractor is to be paid by the party that strikes the crash cushion or their insurer. It is the contractor's risk if there is damage to

their crash cushion and no party can be identified. If project engineer is not sure if they should pay for repairs they should contact project oversight staff.

If a contractor is not repairing a damaged crash cushion in a timely manner, the project engineer already has authority under the contract to take action. Contact regional staff or Bureau of Project Development construction oversight staff on what actions the contract allows project staff to take.

627.2 Sand Barrel Arrays

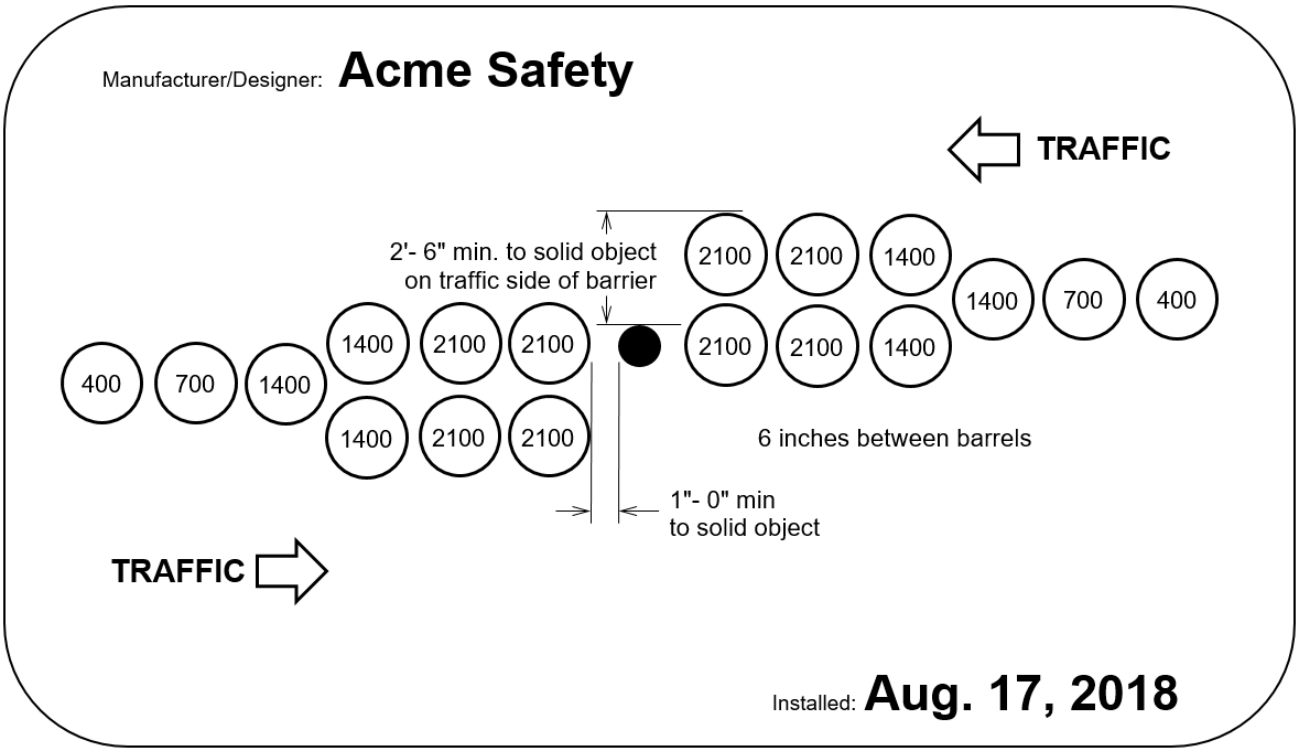
Sand barrel arrays are designed by the manufacturer for each specific location the plans show. The contractor must submit the manufacturer's PE stamped and sealed design details to the engineer for inclusion in the project records. The engineer should also see to it that the information is forwarded on to the agency, usually the county, that will be responsible for replacing barrels.

Because the sand barrel array design is site specific, the design must be readily available to maintenance staff to make sure that the array is maintained as designed after being hit. Good practice is to mark the pad with the location and weights of each drum. Over time, however, these markings can deteriorate. Under standard spec 614.3.3 the contractor is required to provide a plaque showing the array design information on site for permanent installations.

The engineer needs to approve the plaque and work with the contractor to determine where and how to mount it. Installations will vary depending on the nature of the object being shielded and specific site conditions. Factors to consider when approving plaque materials and installation are:

- Capable of withstanding the harsh roadside environment.
- Ideally attached to the object being protected. Some installations may require mounting on a post.
- Mounted above level of expected snow banks.
- Not present a safety hazard if struck.
- Not be readily visible to travelling public to avoid possible distraction.
- Include all the contract required information at a size that is easily readable at close range.

FIGURE 627-1 Example Sand Barrel Array Plaque



627.3 Records

Place copies of P.E. stamped drawings, manuals, certifications and other related materials for crash cushions and sand barrel arrays in the on-line material records. Indicate on as-built what records belong to each crash cushion. Give copies of the same information to regional maintenance.

SECTION 630 Property Fence and Right of Way Fence

630.1 Woven Wire Fence

Requirements for installation of woven wire fence are in standard spec 616.3.2. Fence location should be checked before installation. Locating the fence line by survey may be necessary.

Staples for woven wire fencing should be at least 2 inches long, galvanized, and resin coated. Shorter staples will not give the resistance required to prevent pull-out. Non-galvanized (bright or polished) staples will not produce the long life required. Resin coating is important to prevent future pull-out.

Staples are to be driven in a position rotated 20-30 degrees off vertical and away from the flat face to prevent pull-out and fence sag. They are not to be driven in a vertical position. Rotation increases pull-out resistance by 40%. Attention should be paid as to the position of the flat face and the staple then rotated accordingly. Staples on line posts should be driven only to within about 1/4" of the post surface so the fence is free to move longitudinally.

The fence needs be grounded as specified in standard spec 616.3.5.

630.2 Chain Link Fence

Only Type II, aluminum-coated steel, is allowed for fence fabric. Only Grade 1 steel posts, rails and gate frames are to be used. Specifications for installation are in standard spec 616.3.3.

Fence location should be checked before installation. Locating the fence line by survey may be necessary. The portions of aluminum-coated posts to be set in concrete are to be coated with asphaltic or other approved material before setting to prevent corrosion by galvanic action.

The tops of the concrete footings must be struck off 6 inches below the top of ground and sloped away from the post. After curing for 24 hours, the footing must be backfilled. The top and bottom tension wires cannot be placed until the footing concrete has cured 7 days.

Chain link fence of the type specified in standard spec 616 does not need to be grounded.

SECTION 635 Maintenance and Repair of Haul Roads

635.1 General

Section 84.20 of the Wisconsin Statutes requires the department to repair damages to county or local roads caused by use as a detour designated by the department or damages due to hauling materials used in the maintenance or construction of the state trunk highway system. The statutes require the department to maintain the roads while the hauling is in progress.

The department may arrange to have the necessary maintenance and repair work performed by county forces or as extra work under an existing contract or include it as part of the work to be performed under the contract for the improvement. As a matter of policy, when the volume of material to be hauled under a contract is large and local conditions and experience indicate that considerable haul road damage may result, the bid item Maintenance and Repair of Haul Roads will be included in the contract.

The department has no authority to designate which public roads may be used for hauling materials to a project, or to limit the hauling to a particular route. The contractor is free to haul on any route they choose, subject to restrictions imposed by the contract provisions on hauling on any roadway carrying traffic through the project.

If the haul road item was not in the contract, the contractor could potentially use one route until it was broken up or otherwise damaged, then switch to another route. The contractor would cause an unreasonable amount of damage to local roads that the department would be obligated to repair. This was often the situation before the repair of haul roads was made a part of the contract work, and it was the major factor in the department's decision to make the maintenance and repair of haul roads a bid item.

635.2 Administration

Before hauling begins the engineer should contact the local road authorities responsible for the roads anticipated to be used for hauling and explain the type, amount, frequency, and duration of the hauling, together with the routes tentatively chosen by the contractor. Standard spec 107.2 requires the contractor to notify the engineer 3 business days in advance of hauling over any road off the state trunk highway system. This will allow the engineer adequate time to notify the local road authorities of the haul route location.

Under standard spec 107.1, the contractor must comply with all local laws, ordinances, and regulations. If the engineer becomes aware that the contractor has violated a limitation or condition on using a local road, such as a load limit, during hauling, the engineer will inform the contractor of the violation and require future conformance with the limitation or condition under the terms of the contract. The engineer should also notify the local road authority of the violation.

Regardless of whether the contract contains the item of Maintenance and Repair of Haul Roads, the condition of any haul roads for which the department is obligated to maintain and repair must be determined before the hauling begins. At the time the contractor gives the engineer 3 business days written notice of intent to haul materials over local roads as required by standard spec 107.2, the engineer must make an inspection of the road, taking note of its pertinent features such as condition, width, and thickness of surfacing; condition of culverts and bridges; and similar information as necessary to subsequently determine the extent of the department's responsibility for damages. "Before" and "after" photographs and videos should be taken for the project records. The inspection should preferably be made in company with the local authority responsible for maintenance of the road and with a representative of the contractor.

Under the specifications, the contractor bids a price for the maintenance and repair of haul roads. The contractor knows the source of the material when they bid the job and can anticipate the amount of damage that might occur on the various haul routes available. The contractor may then elect to stabilize, reinforce, or strengthen existing facilities to prevent or minimize damage; they may elect to haul over an alternate route that may be less vulnerable to damage; or they may elect to haul possibly farther distances on a state trunk highway on which the contractor would not be responsible for damages.

Payment is contingent solely upon the condition of the road being equal to or better than the condition before work under the contract began. The contractor incurs cost for whatever they do, or do not do, to ensure the final condition of the haul road. The department pays the full contract amount regardless of how much maintenance or repair work was done, or even if the contractor did not haul on the designated road at all.

During hauling, the engineer has the authority to make periodic inspections of the haul roads. The engineer determines what maintenance and repair steps are necessary to prevent further damage or to restore the road to an acceptable state of serviceability for other users of the road.

No work must be undertaken to maintain, strengthen, repair, or restore haul roads at the direction of the engineer, or by the contractor on the contractor's initiative, without reasonable notice to local officials having jurisdiction. Concurrence of the local authority in the adequacy of the maintenance and repairs should be solicited but is not required. However, in the case of repair by a contractor under the bid item, it is the engineer solely who must decide the amount and quality of materials required and the type and amount of maintenance and repair work to be performed.

The engineer should not be influenced by the whims or desires of local officials in the determination of the nature and extent of the contractor's obligation under the contract item, or when it has been acceptably fulfilled. The contractor should not be required to obtain written acknowledgement of satisfaction, or "releases," from local officials as a prerequisite to acceptance of the contract.

At the end of hauling, the engineer must again inspect the road, along with a representative of the local authority in charge of maintaining the road, and determine what work is necessary to restore the road to a condition equivalent to that which would have prevailed had hauling not occurred. If repairs or restoration are needed, the engineer will order the repairs to be performed by the contractor. If the contract does not contain the Maintenance and Repair of Haul Roads bid item, the engineer should write a change order to have the contractor do the required repairs or request approval from the region to have the local authority perform the work by service and supply agreement.

The haul road location must be shown in the project records together with the detailed records. The Item Daily Record will be the official accounting record to substantiate usage and justify payment.

635.3 Alternatives to Restoration of Haul Roads by the Contractor

635.3.1 Waive Obligation Instead of Payment to Local Maintaining Authority

Under certain circumstances, when the contract contains the item of Maintenance and Repair of Haul Roads, and when considered advantageous, expedient, and agreeable to all concerned, the contractor may be relieved of the actual performance of haul road repairs. This arrangement would require a negotiated settlement between the contractor and the governing body in charge of the haul road, representing the contractor's obligation under the item.

The agreement must have the prior approval of the department and be formalized by change order. The change order must be accompanied by a resolution executed by the town board, county highway committee, or the appropriate governing body of a city or village acknowledging receipt of payment from the contractor and specifically agreeing that the department has fulfilled its obligation under Section 84.20 of the Statutes.

The change order would require the municipality's release of the department and would waive any further maintenance or repair of the haul road by the contractor in consideration of payment made to the municipality. The change order would provide no change in the amount to be paid to the contractor under the haul road item. It should be understood, and a definite statement to that effect should be made when requesting prior approval to enter into this arrangement, that the amount of the settlement between the contractor and the municipality, whether strictly monetary or in terms of materials or services, must be equitable and reasonably related to the cost which would otherwise be incurred by the contractor, and the amount bid for the haul road item is not a criterion or given any weight in this connection.

Conditions under which it may be expedient to relieve the contractor of repairs include the following:

- When the municipality is in a better position than the contractor to perform the specific work in a timely manner.
- When the responsibility for maintenance and repair or restoration of a road may be divided between two or more contractors.
- When immediate restoration would not be feasible because of the seasonal factors or because of anticipated further hauling under succeeding construction stages.
- When the municipality desires to provide a betterment associated with needed restoration work.

635.3.2 Service and Supply Basis from Maintaining Authority

The contractor can arrange for equipment or services or can purchase materials on a service and supply basis from the municipality responsible for normal maintenance of the road. This is the only type of work under a private contract that may be performed by public forces or with publicly owned equipment. This work would not be considered subcontracting, since it is on the basis of actual cost, but any labor furnished to the contractor in this connection would be subject to all of the wage and hour provisions of the contract.

635.3.3 Not Acceptable Alternative

Private negotiations between the contractor and local officials in which a "release" is obtained and presented in order to secure acceptance of the contract without performing haul road repairs, thereby shortcutting any of the steps outlined above, are not acceptable.

635.4 Non-STH System Projects

The specification does not limit the applicability to WisDOT-administered projects on the STH system or connecting routes. If the item is in the contract it is applicable.

If a contractor performing work on a local road uses another local road as a haul road, and the hauling damages the haul road, WisDOT as the project administrator has no responsibility to seek correction or restitution from the contractor on behalf of the local authority whose road has been damaged.

SECTION 640 Landscaping

640.1 Topsoil

Topsoils are those humus-bearing soils that can sustain plant life. After completing the finish grading, they are spread over the graded earth surfaces where seeds will be sown or sod will be placed, to provide a growing medium for the development of turf.

To motivate contractors to spread topsoil as early as possible, the engineer may at times want to consider allowing a contractor to spread topsoil on the side slopes before placement of "bluetop" grade stakes. This consideration assumes the rough grading is performed to reasonably close conformity with the slope stakes and reasonable care is taken to maintain an aesthetically pleasing, shoulder-to-topsoil transition at the bluetop location. Minor variations in the bluetop elevation or location will not materially affect either the function or appearance of the project for this purpose. This will allow the contractor to perform topsoiling operations to better fit the contractor's schedules and should expedite the other associated landscaping operations.

The topsoil is placed and uniformly spread over the areas to a uniform depth of 3 inches, unless otherwise specified. During spreading and shaping of the placed topsoil, all clods and lumps are to be broken down so the placed topsoil is of a fine, uniform texture. Where topsoil is placed on steep slopes, to preclude the formation of planes of slippage the surface of the underlying soil should be roughened to allow bonding with the topsoil. If slippage planes develop, sloughing of the placed topsoil may occur at any time during wet periods before sufficient root growth has developed to retain the mass in place. Also, where there is a significant difference in texture of topsoil and subsoil, such as clay over sand, it is better to blend the soils to obtain a more uniform growing medium.

Subbase areas of the inslope should be left bare unless the subbase material is highly susceptible to erosion by wind or rain. In this case, topsoil should be placed over the subbase material; however, precautions should be taken to apply no more than the designated quantity so drainage from the subbase will not be impeded or destroyed by blocking the drainage with impervious material. Materials from marsh disposal have a tendency to retain water and should not be used to cover subbase material at the inslope.

Standard spec 625.3.3 contains special requirements for urban areas where a lawn-type turf is desired. During finishing operations all loose or waste stones that will not pass a one-inch sieve must be removed. Topsoil for use over these areas must pass a one-inch sieve and at least 90% must pass a No. 10 sieve. Some topsoils containing large, hard clods may need to be pulverized or screened.

Table 640-1 defines the various soil classifications (sand, silt, clay) on the basis of particle size. Topsoil recently treated with herbicides to prevent plant growth may not allow seed germination or support plant growth. If herbicide contamination is suspected, the engineer should contact the Bureau of Highway Operations.

It may be possible to treat small amounts of topsoil to neutralize the effect of the herbicide. For large amounts, treatment may not be cost-effective, the topsoil will have to be rejected, and an alternative source of topsoil found.

Occasionally, such as where shallow (less than 6 feet) fills are being built, to ensure the stability of the fill, the contractor will have to excavate more topsoil than the amount necessary to cover the graded surfaces. This excess volume is regarded as EBS and is eligible for payment as common excavation. To minimize the amount of excess, the engineer may direct the contractor to remove the topsoil from the shallow fill sites before stripping other areas. The engineer is encouraged to discuss with the contractor early on in the project the amounts of topsoil necessary and available.

TABLE 640-1 Soil Classification Particle Sizes

Soil Class	Diameter Range (inch)
Clay	< 0.00008
Silt	0.00008 - 0.002
Very fine sand	0.002 - 0.004
Fine sand	0.004 - 0.01
Medium sand	0.01 - 0.02
Coarse sand	0.02 - 0.04
Very coarse sand	0.04 - 0.08

640.1.1 Topsoil Testing

Soil pH analysis and analysis of prior herbicide use should be performed. Topsoil and salvaged topsoil can be tested to determine if the pH range will sustain grass. In addition, soil that is suspected of prior herbicide use can also be tested.

When topsoil or salvaged topsoil is accepted from a wetland, low land, or conifer (evergreen trees) area, an analysis should be performed to find out if appropriate pH levels exist. Often the pH level is so low that the soil will not sustain plant growth without addition of lime.

An analysis for the presence of herbicides should be performed when topsoil or salvaged topsoil is accepted from areas which have been in agricultural crop production. Before performing any analysis, try to obtain field history data information from the land owner(s) about the crop production/herbicides use of the land to be used as a source for topsoil. The land owners are required to retain this information. This data should indicate which herbicides were used in the field.

If any of the herbicides listed below were used in the field's history information, it may cause problem in establishing grass. A soil analysis may have to be performed if history information is not available. This applies especially if the parcel had field corn, sweet corn, or soybeans the year before.

Table 640-2 indicates which type of crop is associated with what type of herbicide. The numbers in the table indicate the number of months the particular herbicide will have an impact on grass establishment.

The result of the soil analysis for trizine may also indicate presence of the majority of the herbicides as listed in the table.

Testing soils for the presence of herbicides is expensive, so testing requests must be limited. A complete outline of herbicide persistence (residue) in soil is available in Pest Management in Wisconsin Field Crops-1998 (A3646), Appendix Table (Page 184). It is authored by C.M. Boerboom, J.D. Doll, R.A. Flashinski, C.R. Grau, J.L. Wedberg.

This material is available from:

Wisconsin County Extension Office or Cooperative Extension Publication
Room 170
630 W. Mifflin Street, Madison, WI 53703
Phone # (608) 262-3346.

TABLE 640-2 Herbicide Effects on Grass Establishment

Herbicide	Effect on Grass Establishment (Months)		
	Field Corn	Sweet Corn	Soybean
Atrazine	24	24	
Bicep II/Bicep Lite II	24	24	
Bullet/Lariat	24	24	
Command 4EC/3ME	16		12
DoublePlay	24		
Guardsman	24	24	
Harness Xtra	24		
Lightning	12		
Marksman	24		
Princep	24	24	
Surpass 100	24		

640.1.2 Topsoil Sampling Guidelines

Topsoil may be sampled either from a stockpile, or in-place.

640.1.2.1 Sampling from a stockpile:

1. Do not obtain sample from the stockpile face. First remove the surface of the pile at the point of sample then obtain material from inside the stockpile. This will be more representative of the material in the stockpile.

2. Obtain material from at least three different locations from the stockpile. These samples will be combined into one sample that will be 3 to 4 times larger than the final sample size required.
3. Mix the large sample and remove from it enough material to be placed in one of the department's cement sample boxes. Ensure that the sample is bagged and sealed (twist tie) before placing it in the box.
4. Fill out DT1499, Sample Shipping Tag and enclose the form in the box. Make sure to write the word "Topsoil" on the outside of the box before submitting.

640.1.2.2 Sampling topsoil in-place:

1. The procedure for sampling topsoil in-place is the same as for sampling existing topsoil that is planned to be used, or sampling topsoil that has been placed.
2. Remove the surface of the topsoil so that the sample taken will not be from the surface and is representative of the material in place. For existing topsoil, ensure that the sample is as free as possible of plant material (grass, roots, etc.).
3. Obtain material from at least three different locations. These samples will be combined into one sample that will be 3 to 4 times larger than the final sample size required.
4. Mix the large sample and remove from it enough material to be placed in one of the department's cement sample boxes. Ensure that the sample is bagged and sealed (twist tie) before placing it in the box.
5. Fill out DT1499, Sample Shipping Tag and enclose the form in the box. Make sure to write the word "Topsoil" on the outside of the box before submitting.
6. Send topsoil samples to:

   Russell Frank
   3502 Kinsman Blvd.
   Madison, WI 53704
   Phone # (608) 246-7942

640.1.3 Topsoil Acceptance

The department encourages contractors to topsoil, seed, and install long-term erosion control measures as soon as practicable. Consequently, the department may entertain contractor requests for partial acceptance upon completion of significant portions of that work. If the contractor requests partial acceptance, the engineer needs to inspect the work and make sure it was completed correctly and all erosion control measures are installed properly. If partial acceptance is granted, the department assumes maintenance responsibility for the work under standard spec 105.11.1. If the topsoil is washed out or damaged due to erosion, the department pays for that restoration as specified in standard spec 625.5. The department does not reimburse the contractor for washouts or damage caused by contractor operations.

640.2 Fertilizer

640.2.1 General

Fertilizers Type A and Type B have been developed to ensure adequate fertilization of seed or sod located over most soil types in Wisconsin. Selection of Type A or Type B is made by the region design section based upon soil type and the mixture of seed to be sown. Refer to standard spec 629.

Where fertilizer is required, it should be spread upon the soil at the required rate and worked into the soil during the preparation of the seedbed, unless seeds are sown with a hydro-seeder, in which case, the fertilizer may be applied in the water along with the seed.

The rates of fertilizer application for Type A and Type B are 7 lbs. per 1,000 ft^2, as specified in standard specifications, when they are applied at the minimum percentage of components of nitrogen, phosphoric acid and soluble potash (N-P-K) required. However, the standard specifications allow the application of fertilizers containing percentages of components greater than the minimum specified. When fertilizers containing percentages of N-P-K components greater than minimum are to be paid for, the quantity to be measured can be obtained by multiplying the weight used by the ratio of the actual percentage of N-P-K components used to 32% for Type A, or to 50% for Type B.

Example 1

Type A fertilizer is supplied which contains 40% N-P-K, instead of the minimum 32% The adjusted application rate would be:

$$7 \times \frac{32}{40} = 5.6 \text{ lbs./1,000 } ft^2 \text{ applied}$$

Actual use =2,200 lbs. of a Type A fertilizer containing 40% N-P-K.

$$2{,}200 \text{ lbs.} \times \frac{40}{32} = 2{,}750 \text{ lbs.} = 27.5 \text{ CWT to be paid.}$$

Example 2

Type B fertilizer is supplied which contains 70% N-P-K, instead of the minimum 50%. The adjusted application rate would be:

$$7 \times \frac{50}{70} = 5 \text{ lbs. / } 1000 \text{ ft}^2 \text{ applied}$$

Actual use = 2,400 lbs. of a Type B fertilizer containing 70% N-P-K.

$$2{,}400 \text{ lbs. } \times \frac{70}{50} = 3{,}360 \text{ lbs. } = 33.6 \text{ CWT to be paid.}$$

In addition to the total N-P-K requirements for type A and B fertilizers, standard spec 629.2.1.2 contains specific minimum requirements for nitrogen, phosphoric acid, and potash as individual components.

640.2.2 Agricultural Limestone

Agricultural limestone treatment is applied at the rate specified in standard spec 629.3.2 for the particular index zone (neutralizing index). The index zone is a material property that varies with the material source location.

Agricultural limestone treatment is paid by the ton. To determine the quantity to be measured for payment, the base application rate of 100 lbs. per 1,000 ft^2 from Index Zone 60-69 is used. The actual weight of lime used is multiplied by 100 and divided by the application rate.

Example 3

Index Zone = 95

Application Rate = 70 lbs. per 1,000 ft2 from standard spec 629.3.2

Actual usage = 3,600 lbs.

Payment =

$$3{,}650 \text{ lbs. } \times \frac{100}{70} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 2.6 \text{ tons to be paid.}$$

640.3 Seeding

In the past, seeding and final finishing were usually delayed by the contractor until the entire project had been graded and substantially completed. The contract was accepted shortly thereafter, at which time the contractor was relieved of responsibility for maintenance. Generally, only minor amounts of reseeding were necessary, and contractors took care of the restoration at their cost.

In our continued efforts to minimize erosion and the associated negative environmental impacts, we now allow seeding to be done as shown in table 640-3.

TABLE 640-3 Seeding Guidelines

Seed Mixes	Can Be Sown	Mulch Required?[1]	Mgr. Approval Required?
10,20,30 & 40	Anytime, except midsummer and late fall	Yes	No
10,20,30 & 40	Midsummer or late fall	Yes	Yes
60	Anytime, except from 7-15 to 10-15		
60	From 7-15 to 10-15	Yes	Yes
70 & 70A	Anytime, except from 6-15 to 10-15	Yes	No
70 & 70A	From 6-15 to 10-15	Yes	Yes
Temporary seed	Anytime on temporary or permanent slopes	Yes on permanent slopes	No

[1] WisDOT guidelines recommend using mulch on all disturbed permanent slopes.

[2] WisDOT guidelines recommend using temporary seed at half the normal rate on all permanent slopes to promote quick re-vegetation. Use winter wheat or winter rye during the late fall (see No. 9 below).

The specification is broad and general in nature and subject to interpretation as to the calendar dates of midsummer. Midsummer could be regarded as falling between July 15 and August 15; however, the important point is that erosion needs to be controlled any time, mid-summer or otherwise, by the application of temporary or permanent measures.

Liberal use of temporary erosion control measures and emphasis on early completion of roadway finishing has led to substantially more reseeding either anticipated, as in the case of a temporary seeding bid item, or unanticipated, resulting from our emphasis and direction to complete early finishing. Because of our direct involvement in the prosecution of the fertilizing and seeding work, and the intermix of temporary and permanent seeding it has become very difficult to clearly distinguish the pay or no pay

status of areas of seeding or reseeding done by the contractor. Therefore, in the interest of sound erosion control practice and consistent contract administration, we will pay for all re-fertilizing and reseeding within the limits designated in the contract or ordered by the engineer, unless caused by the contractor's negligence.

640.3.1 Late Seeding

Use the following guidelines when determining how late to seed in the fall. While effective erosion control is important, it is also improper practice to jeopardize permanent seeding by placing it when it will almost surely die.

1. Seed germinates only when the soil temperature and moisture are adequate.
2. The seed plant is most vulnerable when it has just germinated. Drought or freezing can kill a newly germinated grass plant.
3. Determine when the area is prone to receive its first "killing" frost, then allow a safety factor.
4. Weigh the risk. Is it worth gambling? Are environmental or customer sensitive areas a factor?
5. "Dormant Seeding" is acceptable in some cases and is desirable with seed mixes 70 and 70A. Non-germinated seed will normally remain dormant and germinate in the spring.
6. If there is a "killing-freeze", it is likely that all new germinated seed plants will die, as they have not had enough time to establish themselves.
7. As a rule, it is risky if permanent seed is planted between September 30th and November 15th for the central part of the state. Adjust according to farther north or south project locations.
8. Late seeding can be helped by a heavier application of mulch. Instead of the normal 1/2" to 1-1/2", increase it to 2" to 2-1/2". This will allow for added protection of the grass plants during cold weather.
9. These guidelines DO NOT apply for temporary seed. WisDOT guidelines call for using temporary seed at half the normal rate on all permanent slopes, but using temporary seed as an erosion control measure, during late fall, is encouraged. Temporary seed is more likely to germinate in cold conditions and is so inexpensive that any risk is minimal.

640.3.2 Failing to Water

Perhaps as many as 90% of seeding disappointments are due to a failure to keep the seedlings moist after they germinate. Seed can lay dormant in the soil for months without water, but once germination begins the tender young seedlings will die without moisture. Best advice: water frequently and don't let the top inch of soil dry out until the grass is well established.

For this reason, the bid item of water should be considered for urban seeding where a lawn type turf is desired. Water should continue for a period of at least 30 days when rainfall is not adequate to maintain soil moisture.

640.3.3 Temporary Seeding

Temporary seeding is the establishment of a temporary vegetative cover on disturbed areas by seeding with an annual herbaceous plant, usually grass, which is quick to germinate.

Temporary seeding is used for both temporary and permanent stabilization measures to include:

1. Disturbed areas that will not be brought to final grade for more than 30 days.
2. Borrow pit and waste area sites.
3. Other disturbed areas such as sides of sediment basins, temporary road banks, intercepting embankments, etc.

Temporary seeding should be included on all projects where exposed soils are expected and re-vegetation is required. It is the least expensive of all erosion control measures, germinates quickly, and is highly effective.

Temporary seeding is an important tool to prevent erosion not only at the time of final seeding but it can also be used on sites that will stand idle over the winter months. Also remember that temporary seed may be used on sites that do not have topsoil placed yet. However, sandy soils tend to be too dry for good temporary cover to establish. When final seed-bed preparation occurs, disking or tilling may have to occur to allow for permanent vegetation growth. Past experience has indicated that annual oats and rye work best onsite with this application.

When erosion control is a crucial action item, permanent or temporary seed (or both) with mulch maybe placed in the late fall. But, WisDOT's normal application rate for mulch of 1/2" to 1-1/2" should be increased to 2" to 2-1/2". This will allow for added protection of the seed during the winter months.

640.3.4 Mixtures Containing Pure Live Seed

640.3.4.1 Background and Definitions

This is the method for determining sowing rate and method of measurement for seed mixes Nos. 60, 70, 70A, 75 and 80 containing seeds to be supplied and applied PLS (Pure Live Seed).

Purity The percentage of the specified species or variety that is contained in a given quantity of the seed.

Germination The percentage of the designated species or variety that will sprout.

Pure live seed (PLS) The percentage purity multiplied by the percentage germination equals the percentage of pure live seed.

The commonly used cool season grasses are specified as having a minimum purity and germination. Unless purity and germination of seed specified PLS are both 100%, the amount of seed required to be sown will always be greater than the amount specified and measured.

640.3.4.2 Determining the Sowing Rate for Seed Mix No. 60

Step1: Total the percentages of species or varieties in the mix with a specified minimum purity and germination. Convert to a decimal form.

Step 2: Divide the percentage of each species or variety designated PLS by the percentage PLS shown on the seed certificate for that species or variety.

Step 3: Total the numbers obtained in Step 2.

Step 4: Add the numbers from Steps 1 and 3.

Step 5: Multiply the result from Step 4 by the specified rate per thousand square feet of the mix to determine the actual pounds to sow per thousand square feet.

Step 6: Divide the total actual weight sown by the amount from Step 4. This will be the amount to be paid for as Seeding, Wetlands (mix No. 60).

Example for Seed Mix No. 60

Species	Purity	Germination	Percentage of Mix (Actual)	Percentage of Mix (PLS)
Timothy	98	90	12	
Canada Wild Rye	PLS			12.0%
Annual Ryegrass	97	90	35	
Alsike Clover	97	90	4	
Red Clover	98	90	4	--
Japanese Millet	97	85	8	
Annual Oats	98	90	25	___
TOTALS			88 %	12.0%

Step 1: Unadjusted %= 88% = 0.88

Step 2: The PLS used in this example is hypothetical. The actual PLS must be taken from the label of the seed supplied. For this example, the percentage PLS for Canada Wild Rye is 65%.

12.0 ÷ 65 = 0.185

Step 3: 0.185

Step 4: 0.88 + 0.185 = 1.065

Step 5: The application rate under standard spec 630.3.3.5 is 1.5 pounds per 1,000 square feet

1.5 x 1.065 = 1.60 pounds per 1,000 square feet actual sowing rate

Step 6: Say 113 pounds were sown

113 ÷ 1.065 = 106 pounds measured for payment.

640.3.4.3 Determining the Sowing Rate for Seed Mix No. 70 and 70A

Step 1: The actual pounds Pure Live Seed (PLS) may be listed on the seed package label. If so, proceed to Step 3.

Step 2: If, instead of the actual pounds PLS, the seed package lists gross weight and percent PLS, convert the percent PLS to decimal form and multiply the gross weight by the percent PLS to get pounds PLS in the package.

Step 3: Divide the gross weight of the package of each species by the pounds PLS in the respective

package.

Step 4: For each species, convert the percent PLS in the seed mix to decimal form and multiply the percent PLS of that species in the seed mix by the seeding rate per thousand square feet to find the PLS rate of that species.

Step 5: For each species, multiply the result from Step 3 by the result from Step 4 to find the gross weight of that species to apply per thousand square feet.

Step 6: Add the results for each species from Step 5 to determine the gross weight of the seed mix to apply per thousand square feet.

Example for Seed Mix No. 70 (The seed mix in this example is hypothetical.)

Species	Of Mix (PLS)	Gross Weight	Percent PLS
Yellow Coneflower	5	50 lb.	70
Wild Bergamot	5	50 lb.	70
Butterflyweed	5	60 lb.	60
Prairie Blazingstar	5	40 lb.	80
Little Bluestem	35	50 lb.	90
Sideoats Grama	35	50 lb.	90
Canada Wildrye	10	50 lb.	95

Step 1.
The actual pounds Pure Live Seed (PSL) may be listed on the seed package label. If so, proceed to Step 3.

Step 2	Gross Weight	X	% PLS	=	PLS Weight
Yellow Coneflower	50 lb.	X	0.7	=	35 lb.
Wild Bergamot	50 lb.	X	0.7	=	35 lb.
Butterflyweed	50 lb.	X	0.6	=	36 lb.
Prairie Blazingstar	50 lb.	X	0.8	=	32 lb.
Little Bluestem	50 lb.	X	0.9	=	45 lb.
Sideoats Grama	50 lb.	X	0.9	=	45 lb.
Canada Wildrye	50 lb.	X	0.95	=	47.5 lb.

Step 3	Gross Weight	÷	PLS Weight	=	Conversion Factor
Yellow Coneflower	50 lb.	÷	35 lb.	=	1.43
Wild Bergamot	50 lb.	÷	35 lb.	=	1.43
Butterflyweed	60 lb.	÷	36 lb.	=	1.67
Prairie Blazingstar	40 lb.	÷	32 lb.	=	1.25
Little Bluestem	50 lb.	÷	45 lb.	=	1.11
Sideoats Grama	50 lb.	÷	45 lb.	=	1.11
Canada Wildrye	50 lb.	÷	47.5 lb.	=	1.05

Step 4	% Species in Mix	X	Seeding Rate/1,000 Sq. Ft.	=	PLS Weight/1,000 Sq. Ft.
Yellow Coneflower	0.05	X	0.4	=	0.02 lb.
Wild Bergamot	0.05	X	0.4	=	0.02 lb.
Butterflyweed	0.05	X	0.4	=	0.02 lb.
Prairie Blazingstar	0.05	X	0.4	=	0.02 lb.
Little Bluestem	0.35	X	0.4	=	0.14 lb.
Sideoats Grama	0.35	X	0.4	=	0.14 lb.
Canada Wildrye	0.10	X	0.4	=	0.04 lb.

Step 5	Conversion Factor	X	PLS Weight/1,000 Sq. Ft.	=	Gross Weight/1,000 Sq. Ft.
Yellow Coneflower	1.43	X	0.02 lb	=	0.03 lb.
Wild Bergamot	1.43	X	0.02 lb	=	0.03 lb.
Butterflyweed	1.67	X	0.02 lb	=	0.03 lb.
Prairie Blazingstar	1.25	X	0.02 lb	=	0.03 lb.
Little Bluestem	1.11	X	0.14 lb	=	0.16 lb.
Sideoats Grama	1.11	X	0.14 lb	=	0.16 lb.
Canada Wildrye	1.05	X	0.04 lb	=	0.04 lb.

Step 6	Gross Weight/1,000 Sq. Ft.
Yellow Coneflower	0.03 lb.
Wild Bergamot	0.03 lb.
Butterflyweed	0.03 lb.
Prairie Blazingstar	0.03 lb.
Little Bluestem	0.16 lb.
Sideoats Grama	0.16 lb.
Canada Wildrye	0.04 lb.
TOTAL	0.48 lb.

Therefore, the actual gross weight of seed that needs to be applied per 1,000 square feet is 0.48 pounds in order to get the required PLS rate of 0.4 pounds per 1,000 square feet which will be measured for payment.

640.3.5 Testing Seed

WisDOT can test standard seed mixes for germination rates, seed type, and ratios if the engineer suspects a problem. This is an effort to continuously improve recommended seed mixes, and to determine the reason of failure on standard seeding projects. It will also provide the project manager with an opportunity to require some of the standard seed mixes to be tested. Contact Leif Hubbard at (608) 267-6884 with soil and seed related questions.

640.3.6 Seed Sampling Guidelines

Take seed samples from two locations representing seed that will be used on the specific project. Sample locations include sampling from the seed bags, or from the seeding equipment.

The seed used contains many species, and these may tend to stratify in the bag or seeding equipment. Care should be taken to ensure that the sample is representative of the seed overall. This may be accomplished by mixing the seed by hand before taking a sample, or by obtaining parts of the sample from different layers from within the bag or equipment.

Take a sample large enough to be placed in one of the department's cement sample boxes. Ensure that the sample is bagged and sealed (twist tie) before placing it in the box.

Fill out the "WisDOT Seed & Topsoil Testing Request Form" and enclose the form in the box. Include the information that is requested on the form, along with a copy of the seed ticket from the bag sampled. Also, please write "Seed" on the outside of the box before submitting.

Send seed samples to:

Russell Frank
3502 Kinsman Blvd.
Madison, WI 53704
Phone # (608) 246-7942

640.3.7 Native Seeding Mixtures

Seeding Mixtures 70 and 70A are primarily composed of native grasses and wildflowers. They are intended to be used in areas where it is desirable to re-establish native species on the project, either for aesthetic or environmental reasons. They are particularly appropriate in instances where the DNR liaison requests a native seed mix that is compatible with plant communities beyond the right-of-way. They were not, however, intended to be used primarily for erosion control or for other large-scale uses on highway rights-of-way for several reasons:

They are relatively expensive because of the wildflower component. It is not necessary that an erosion control seed mix contain wildflowers, especially when the areas are often not visible from the highway, so they cannot be enjoyed by travelers. If the seeding takes place on the inslopes, periodic mowing may preclude the wildflower plants from flowering anyway, depending on the timing of the mowing in relation to the phenology of the plant.

Wildflower seed germinates most effectively if it is dormant-seeded in the fall so that it goes through a cold stratification process over the winter to soften up the hard seed coat. This may require that temporary seed be used in the likely event that ground cover for erosion control needs to be established earlier in the season.

Diverse native grass/wildflower mixes like 70 and 70A require 2-3 years of management after seeding. These mixes should only be planted if Regional PDS staff are willing to commit the resources necessary

to do this management and SPO staff are willing to make the same commitment for any necessary follow-up management.

Seeding Mixture 75 is designed to be used for erosion control purposes and can be seeded at any time during the growing season. This mixture consists almost entirely of native grasses along with a couple of inexpensive, easy-to-grow wildflower species. It should be used in conjunction with the Seeding Nurse Crop item as described in standard spec 630.

Seeding Mixture No. 80 consists of a combination of relatively salt tolerant native and non-native species and is intended to be used on inslopes. The species in this mixture are non-invasive so it should be especially suitable for areas where the DNR liaison or others have concerns about adjacent natural areas. This mix should also be used in conjunction with the Seeding Nurse Crop item.

640.3.8 Seeding with a No-Till Rangeland Type Drill (Method C)

No-till rangeland type drills are typically equipped with 3 seed boxes: one for cool season seeds such as lawn-type grasses and nurse crop species, one for light fluffy seeds such as most native grass seeds, and one for small seeds such as most wildflower seeds. Each box is capable of being calibrated independently from the other boxes. A press wheel is mounted to the rear of each drop tube to firm the soil over the seed.

When seeding into existing vegetation or thatch, the drill should be equipped with a no-till attachment consisting of coulters which slice through the vegetation or thatch in front of the furrow openers and seed drop tubes. This no-till attachment is not necessary when seeding into bare soil.

As an alternative to using a drill with 3 separate seed boxes, each seed type (cool season, light fluffy and small) may be seeded separately with the drill being recalibrated for each seed type.

640.4 Sodding

Standard spec 631.2.1 requires that sod must be indigenous to the general locality in which it is used. In other words, the sod should grow naturally under the same general climatic and soil conditions as those at the site of the work. For example, sods grown on peaty soils would not be acceptable for use on sandy soils. Varieties of grasses that require a high degree of maintenance should not be planted either.

Sodding is the quickest method of securing a vegetative cover on graded areas of the roadway. However, due to the high cost of sodding it is generally used only on those areas where serious erosion might occur before turf could be established by seeding, or in urban areas.

The inspector will lay out the areas to be sodded and determine that the soil forming the bed upon which the sod will be placed is properly prepared. If erosion has taken place, the gullies are to be backfilled and compacted by the contractor. The finished bed should have a uniformly even surface and be shaped, especially for flumes and ditches, to the required dimensions. Before laying the sod, the soil surface should be loosened to a fine texture and to a depth of at least 1" in order to provide a condition suitable for the penetration of the grass roots. If the soil is dry, water should be applied to properly condition the bed.

During the laying of the sod, the inspector should check on the work to ensure the following:

- The sod is laid as tight as possible
- Joints are properly made
- Edges of the sod where water is apt to flow over it are properly embedded in the soil
- Laid sod is tamped or rolled to make continuous contact with the underlying soil
- The sod is properly held in place with stakes

Sod placed on slopes steeper than 1-unit vertical to 4 unit horizontal, and all sod placed on flumes, ditches, or other areas that may be subjected to a concentrated flow of water, regardless of the slope, is required to be staked. It is important that sufficient stakes are used to ensure retention of the sod in place until the grass roots have developed and entered the underlying soil, anchoring the sod in place. Only stakes made of wood can be used, and they must be driven to within 1/2" of the surface of the sod to avoid interference with subsequent mowing.

Sod may be anchored with a jute fabric (class II, Type A) of specified weight.

Refer to standard spec 631.3 for requirements for fertilizing, rolling, tamping, and watering the placed sod. Also refer to SDD 8E4 for details on sod and sod-masonry ditch checks and to SDD 8E5 for sodded flume details.

640.5 Mulching

640.5.1 Material

The purpose of mulch is to break up rainfall, prevent compaction of the soil surface, lessen the erosive effects of water and wind, moderate soil temperatures, supply shade for germinating seedlings, and prevent excessive evaporation of water from the soil.

Standard spec 627.2 allows straw, hay, wood chips, wood excelsior fiber, or other material that is suitable. All mulch must be substantially free of noxious weed seeds and objectionable foreign material. Rotten or partially decayed straw or hay is not acceptable. Short-stemmed straw is not acceptable for crimping purposes but should work well for tacking.

Standard spec 627.2 further provides that straw or hay used for mulch must be air-dry. As a guide, any straw or hay having 10% or less of moisture will be considered air-dry. It is important that the straw or hay be air-dry when weighed for payment by the ton. Generally, baled hay or straw coming from sheds, barns, under tarps, or even interiors of stacks will be air-dry unless exposed to rain before weighing. Should the engineer believe the straw or hay contains moisture greater than 10%, the moisture can be determined by randomly obtaining handfuls of hay or straw from bales and stuffing them into a soil sample bag. The sample should be weighed to obtain the net mass and then heated at moderate heat in an oven or suitable container to drive off the moisture. Moisture content is then determined by the following formula:

$$\text{Moisture Content (\%)} = \frac{\text{Wet Mass of Sample - Air Dry Mass of Sample}}{\text{Air - Dry Mass of Sample}} \text{ X } 100$$

640.5.2 Equipment

Equipment used in mulching operations should be specifically designed for applying, tacking, or crimping mulch. Equipment that is of inadequate capacity, jerrybuilt, poorly designed, badly worn, or malfunctioning is not acceptable.

640.5.3 Application

Mulch must be applied to seeded areas within two days after completion of the seeding in order to conserve the moisture necessary for germination of the seed within the soil.

The contractor has the option to use one of the following three methods, unless restricted to a specific method by the contract. Contracts with counties should specify the mulching method to be used if their standard county practices differ from ours. When mulching areas of slopes that are too steep for tilling or otherwise inaccessible to a tiller, the contractor must anchor the mulch, using method A or B.

640.5.3.1 Method A: Netting

This method allows spreading mulch in place to a loose, uniform depth of 1/2 to 1 1/2 inches, and then anchoring by means of approved netting or twine secured by pegs or staples. When using this method, begin mulching at the top of the slopes, and proceed downward. Usually, the contractor selects a lightweight plastic netting rather than twine. This lightweight netting ultimately degrades under action of sunlight.

The contractor may use department-approved erosion control mats, listed in the PAL, instead of separately applying mulch and netting.

640.5.3.2 Method B: Tackifier

With this method, mulch is blown by machine to a uniform depth of 1/2 to 1 inch, using 1/2 to 3 tons of mulch per acre. The mulch covering should be loose enough to allow some sunlight to penetrate and air to circulate, but thick enough to shade the ground, conserve soil moisture, and prevent or reduce erosion. Mulch material from compacted bales should be loosened or fluffed before or during the placing so that no matted lumps of the material are placed on a seeded area. A spray of non-asphaltic tack sufficient to hold the mulch in place achieves anchoring.

Straw or hay mulch is usually applied with a mulch blower. The mulch blower is equipped with one or more nozzles, a storage tank, and a pump. It allows for combined application of a non-asphaltic binder with the mulch. Experience indicates that the blower must be equipped with at least three operating nozzles when combined application of binder is allowed.

Hydro-seeders are used for spraying a non-asphaltic tackifier over mulch that has been previously placed. Positive agitation must be provided in the tanks during application to assure a homogeneous mixture of water, tackifier, dye, and mulch when applied simultaneously.

Tackifiers, if used, must be from the PAL.

Specifications, application rates, and general information on tackifiers are contained within the PAL.

The inspector must verify that the correct proportions of binder and water are mixed uniformly. Likewise, the rate of application of binder and tackifier must be checked and verified. Increased rates of application may be required based on inspection of the mulch after placing and tacking.

640.5.3.3 Method C: Crimping

This method involves spreading the mulch uniformly to a loose depth of 1/2 to 1 1/2 inches by blowing from a machine or other means. Anchoring will be by a mulch tiller specially designed for crimping mulch into the soil. Experience to date indicates that anchoring mulch by tilling is a superior method for most soils. For desirable results, especially in heavier soils such as clays, the mulch should be applied and tilled into the soil while the topsoil and seedbed are still in a loose and friable condition. Tiller ballast should be added or discarded to achieve the required penetration.

One pass of the tiller is usually sufficient, but short-strand straw or hay may require several passes. Several passes may also be needed to anchor the mulch next to shoulders, in medians or in areas exposed to frequent or high-velocity winds.

When wood excelsior fiber is used for mulch, the fiber need not be anchored as required for other mulch types. The wood fiber tends to swell and expand, and the many tiny fibers and barbs interact to secure the mulch in place.

Plastic nettings designed for use over mulches to secure the mulch in place can be used in areas where crimping is not feasible or where tacking agents cannot be applied or are ineffective.

A mulch tiller is used for crimping mulch. An agricultural disc is not a mulch tiller. A mulch tiller has flat, notched disks, whereas a farm disk has curved smooth disks and is designed to turn over soil. An agricultural disk should not be used for crimping mulch because it will bury the mulch rather than pressing it into the soil.

Random checks should subsequently be made as necessary to assure continued conformance. Areas that have been crimped may need additional passes of the tiller to secure the mulch depending on soil conditions and exposure to wind. Inspection of mulched areas must be made to assure that areas that have not been crimped have been secured by another method.

640.5.4 End Results

Mulch should remain on the seedbed until the grass has grown through the mulch. Mulch lost before acceptance is assumed to have been improperly placed and must be replaced by the contractor at the contractor's expense. Mulch properly placed and anchored but lost from exceptional or severe rain or wind must be replaced by the contractor and paid for by the department to encourage early landscaping and erosion control. Mulch replaced by the contractor must undergo inspection to assure the mulch is properly secured.

640.5.5 Mulch Inspection

An inspector must be present during initial applications to inspect straw and hay for moisture content, deterioration, and length of straw as well as to check equipment for suitability and operational capability.

640.5.6 Diary Entries

Appropriate information relating to mulching should be entered into the grading or erosion control diary. Entries relating to the following are suggested:

- Kind of mulch
- Condition of mulch, including air-dry context or moisture percent if 10% or more, average length and state of deterioration if any
- Kind and condition of equipment, number of nozzles, etc.
- Method of application
- Binding or tacking agent used, if any
- Actual rate of application of tacking agent
- Dates of initial and random inspections
- Condition of mulch after anchoring or tacking.
- Amounts lost to wind and replaced by contractor at the contractor's expense
- Items of interest, special problems, recommendations, etc.

640.6 Trees, Shrubs and Vines

WisDOT Bureau of Highway Operations has a staff of landscape architects who have expertise in all areas of vegetation management. They should be invited to participate in the preconstruction conference for projects that have a significant amount of planting involved. They are also available to answer

questions and assist with field checking of staking, inspections of plants and planting operations, advising on care requirements during the plant establishment period, determining plant survival, etc.

640.6.1 Materials

Planting of trees, shrubs, and vines under the contract will be made with plant stock grown by and furnished from nurseries, unless the contract provides for using collected or plantation-grown stock.

The plant material to be used in the planting project is perishable and therefore requires special care and handling. Acceptable plant material as described in standard spec 632 has been grown, dug, stored, packaged, and transported in a manner designed to keep it alive and in good condition. The intent of the specifications is that all reasonable means should be used during the term of the contract to keep the plant material in good condition.

Engineers should have the American Standards for Nursery Stock; a Plant Hardiness Zones map, published by the U. S. Department of Agriculture, and the latest AASHTO Inspection Guide for Landscape Planting. The AASHTO guide is not a contract document but provides helpful information. These standards, maps, and guides are available in the region and from the Bureau of Highway Operations landscape architects.

The contractor is to furnish a list of sources for all plant material at least 15 days before the delivery of the material. The addresses on this list should be checked against the Plant Hardiness Zone map to make sure that all plants come from within the specified acceptable area.

Nursery-grown, plantation-grown, or "collected" stock, are three levels of plant culture. Nursery-grown stock has generally been better managed, grown under more controlled conditions, and received more care than plantation or collected stock. Plantation-grown stock has been systematically planted in friable soils free of stones but has received only a minimum of aftercare. The most common examples of plantation-grown stock are evergreens grown for Christmas trees. Collected stock has been taken from wild or native stands and generally is subject to greater shock when transplanted than the same kind when nursery-grown.

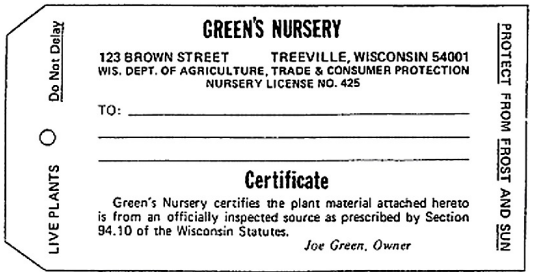
640.6.2 Certification for Nursery Stock

A certificate of compliance should accompany each shipment of nursery-grown planting material received on the project and is filed with the engineer.

Wisconsin Statutes Section 94.10(5) sets out the requirements for labeling nursery stock. Shipments of nursery stock must be labeled with the name and address of the person selling or distributing the shipment. Nursery stock sold at retail must bear a tag or label giving the common or botanical name of the plants.

Each nursery or dealer is responsible for obtaining their own tags.

FIGURE 640-1 Example Certification for Nursery Stock



640.6.3 Inspection

Usually, a general inspection of the plant stock is made at the nursery or source of supply or a central collection area by a plant specialist. If the specialist has not inspected the project plant stock, the engineer or inspector may use the checklist shown in figure 640-2 as a guide to acceptance or rejection. When inspection is made at the source, approved stock is usually tagged. An approval tag may be attached to each large size tree. Small size trees and shrubs may have only representative samples of each species and size tagged.

Regardless of any prior approval, the inspector will examine each shipment of plant stock upon its arrival at the job site, noting the condition of plants and compliance with contract requirements, and obtaining accompanying certificates of inspection relative to injurious insects and diseases. Plants that are not acceptable upon arrival should be rejected.

FIGURE 640-2 Checklist for Inspection of Trees, Shrubs and Vines

If a plant specialist has not inspected the stock before its delivery to the project site, the engineer or inspector should check each plant at the time of delivery for the following desirable characteristics:

___1. Size and quantity meet contract requirements for the species

___2. Natural, uniform leaf or needle color.

___3. Well-developed, firm, moist buds uniformly spaced out to the end of branches on dormant stock. The cambium layer just under the bark should be green and moist.

___4. No visible decay in the roots, trunk, or branches.

___5. No sun scald, as shown by lighter-colored areas of bark. The cambium layer just under the light-colored bark will be dry and brown if the plant has been sun scalded.

___6. A good root system. Roots should not be on or close to the surface, crowded, twisted, or encircling the plant.

___7. No frost cracks. These are long, vertical splits in the bark that will allow insects and fungi to enter the plant.

___8. No signs of injury; such as abrasions, cuts, or breaks.

___9. Correct pruning, with no protruding stubs, cutting of the bark, or decay at the cut.

___10. No diseases. These may appear as discharges of sap; discolored leaves, needles, or bark; abnormal growth of branches, etc.

___11. No insects. Evidence of insects may be clusters of eggs, feeding patterns on bark and leaves, and holes drilled into the bark.

___12. Proper habit of growth.

a. Shade trees and flowering trees should be balanced, symmetrical, with a single leader. Side branches should be well developed.

b. Evergreens should have full foliage with uniform density.

c. Shrubs should have at least the minimum number of branches for the species and be uniformly branched.

___13. Trees with wrapped trunks should be unwrapped at time of delivery and immediately checked for defects under the wrap. If unwrapping is not allowed, the trees should be rejected.

___14. A firm, intact ball on balled and burlapped stock. The trunk should not be free to move inside the ball.

___15. Necessary certificates should accompany the shipment.

Failure of plant stock to pass this checklist is cause for rejection. Rejected plant stock should be immediately reloaded onto the delivery vehicle and not allowed to remain on the project.

The following items and procedures should be considered or employed when accepting plant material on arrival:

- A nursery inspection tag should accompany each shipment.
- The stock should be protected from the wind, sun, and other detrimental climatic effects during transit. According to standard spec 632.2.2.9, all stock must be dug, handled, packed, transported, and planted in the appropriate manner as applicable to BR, B&B, B&P, CG, or MT stock. These acronyms are defined below:

BR Bare root stock
B&B Balled and burlapped stock
B&P Balled and potted stock
CG Container grown stock
MT Machine transplanted stock

- The earth ball of B&B material should be firm and unbroken. Remove burlap from a random plant. If cut ends of several large fleshy roots appear on the surface of the earth ball, break the ball and examine the root system. If there are very few fibrous roots, chances of plant survival are reduced, especially in evergreens.
- B&B plant material should always be handled by the ball with no exceptions.
- Dormant deciduous plant material should have green tissue just under bark on all parts of the plant top. Check by cutting a small secondary branch and laying back a small piece of bark.
- Roots of bare root material should be of an average minimum spread as described in the American Standards for Nursery Stock.
- Permission to substitute plants should be extended only after consultation with the landscape architect to ensure the substituted plants are suitable for the purpose intended.

640.6.4 Measurement

The information in table 640-4 is derived from the American Standard for Nursery Stock.

TABLE 640-4 Method of Measurement for Various Tree Types

Tree Type	Method of Measurement
Shade and flowering trees (caliper measurement)	Take caliper measurement of trunk at 6 in above ground level [1] if diameter is 4 in or less. If greater than 4 in, take trunk caliper measurement at 12 in above ground level.
Shade and flowering trees (height measurement)	Measure height vertically from ground level to top of tallest trunk.
Deciduous shrubs	Measure height vertically from ground level to top of tallest branch.
Coniferous evergreens (upright growth)	Measure height vertically from top of ball to top middle of leader.
Coniferous evergreens (creeping or low spreading growth)	Measure horizontally the widest spread of the branches from one side to the other, measure the least spread, and average the results.
Vines	Measure from top of root to end of stem.

[1] Ground level refers to the top of the ball for B&B plants or the plant root collar for bare root and containerized plants.

640.6.5 Storage

All plant stock not planted on the day of delivery to the job site is required to be properly stored and protected from the sun and wind in the manner specified for temporary storage in standard spec 632.3.2. Special care should be taken so that roots of bare root plants are covered at all times except at planting time when brief exposure is necessary. Do not allow several bare-root plants to be distributed to their individual planting locations and left with their roots unprotected before they are planted. The fine hair roots will dry out very quickly when exposed to sun and wind.

Earth balls of B&B stock should be completely covered with approved moist mulch material. Evergreens being stored for more than a week should be spaced and have tops untied to prevent yellowing which occurs when they are stored too close together. Potted plants should be spaced to provide air circulation, have the top spread, be protected from the wind if possible, and watered when necessary. It is important that stored plants receive proper care until all are planted.

640.6.6 Location Staking

The location of trees and shrubs shown on the plans will be staked or otherwise indicated in the field by the engineer, and the contractor's planting will be inspected for compliance. The plan location should be accurately staked in the field using a base line or other methods for large areas.

Trees should not be planted at locations that would be hazardous to occupants of vehicles leaving the roadway. Generally, newly planted trees with an ultimate trunk diameter of more than 4 in should have a minimum setback of 36 ft from the edge of the traffic lane - 50 to 60 ft is desirable. If the trees are located behind walls, abutments, or other obstructions that separate the roadway from the trees, they may be planted closer.

The staking of plant locations should be done early so that staking is completed or nearly so before planting operations begin. The plant locations should be scaled off the plan. A full-size plan rather than a "D" size plan will work better for this. If plant locations conflict with some existing feature such as power lines or if the plant would be in an undesirable location, for example, in a ditch that did not appear on the plan, or would be located within the minimum setback, the necessary adjustment in location should be made. These adjustments should be noted on the plan and brought to the attention of the engineer before planting begins.

640.6.7 Planting

During planting operations, the inspector should determine that the performance of the work complies with the specified requirements. Specific attention should be paid to the following:

- Proper size of excavated plant holes
- Correct placing of plants
- Backfill of plant holes with specified materials
- Correct manner of placing backfill material around plants
- Proper application of fertilizer
- Adequate watering
- Any required pruning, mulching, wrapping, staking, or guying of plants

As a general rule, planting should be done in a manner that storage time is reduced to a minimum. Where many plants are involved, and the planting time is drawn out, it is usually best to concentrate on getting the material planted, leaving guying, wrapping, and mulching for later. An exception to this may be evergreens, which offer much wind resistance, and which should be braced or guyed as required at or soon after planting time. Constant wind action usually breaks small roots, keeping the tree from becoming established, defeating the purpose of the earth ball.

Usually, machine transplanting should be done as early in the spring as possible.

Evergreens desirably should be planted either in the spring before the buds open, or in September. Deciduous trees desirably should be planted before the buds have opened in the spring or after the leaves have dropped naturally in the fall. Project conditions may require adjustments to these ideal planting times.

Potted plants are usually planted last because an adequate root system is contained in the pot, and with proper care they can be held for some time without ill effect. In some cases, potted shrubs have been potted by the contractor and should be held for a specified period to ensure a live, healthy plant at the time of planting.

Care should be taken to set the plant at its proper elevation. This should be as close as possible to that at which it was previously growing. If the hole is too deep, backfill it until the plant will rest at its proper height. The depth of the hole should be carefully measured for large B&B stock to eliminate unnecessary handling that loosens the roots from the ball. It is better for a plant, especially a tree, to be planted slightly too high than for it to be planted too low. Soil under large balled and burlapped trees should be firm; otherwise, loose soil will turn to mud after watering and the tree will settle into the hole.

Backfilling of bare root plants should be done carefully so that the soil fills in between small roots. The plant should be worked around slightly to cause soil to filter down between the roots. Firming by stamping with a boot should be avoided because this breaks many small roots. The required watering will also compact the soil and assist in eliminating air pockets.

Standard spec 632.3.7 requires that backfill material for plant holes must be a combination of six parts native topsoil and one part compost. Holes for MT plants must be filled half-full with a slurry of one part water and one part compost just before placing the tree.

In planting potted plants, the elevation should be based on the plant root crown rather than the pot. Plantable fiber pots should be planted intact, with several gashes made in the pot to speed up deterioration. If the top of the pot will not be covered by the mulch material, the top portion should be cut off after planting, but before mulching. If plastic or metal pots, which do not readily decompose, are used, the pot should be removed from each plant as it is planted.

The contractor, upon completion of the planting, must remove and dispose of all excess excavation, waste materials, or other debris resulting from the planting.

640.6.8 Pruning

The philosophy for pruning at planting time has changed dramatically in recent years. It is now not acceptable to prune up to half of the growth from a plant to compensate for root loss incurred during the digging operation at the nursery. Research has shown that leaving as much leaf surface as possible on the newly planted plant increases its photosynthesis capability that allows it to overcome the shock of transplanting much more quickly. The only recommended pruning operation at planting time is the removal of broken, dead or rubbing branches.

Pruning to improve the structure of the plant should wait at least one growing season or to the end of the final year of a multi-year plant establishment period. Plants should be pruned so that after pruning the plant still retains the character and appearance typical of the species. The thinning of small branches of some species of low growing trees may be warranted at this time. For instance, lower branches of crab apple trees may need to be removed to accommodate rodent control material, and the interior branches of hawthorns may need to be thinned to allow air and light to penetrate.

The following procedures should be employed when pruning:

- Evergreens normally should not be pruned; however, all dead or broken branches and all leaders, except one, should be removed.
- All broken, dead, or rubbing limbs of deciduous trees should be removed.
- Cuts should be made as close as possible to the branch collar at the base of the limb without injuring the collar.
- Painting of pruning cuts is no longer required, except on oaks to prevent oak wilt.
- Pruning tools should be suitable for the purpose and sharp enough to make a clean, smooth cut.

640.6.9 Anti-Desiccant

If specified, an emulsion formulated to reduce water loss by transpiration should be sprayed on the needles of evergreens at or before the time of planting, on the roots of BR stock before shipment, and on MT stock before transplanting unless deciduous trees are dormant. When dry, the anti-desiccant will leave an odorless, colorless, thin film of wax on the roots, needles, and branches. Comparison with unsprayed plants and experience with the process are the best ways the inspector has to detect if anti-desiccant has been applied.

640.6.10 Landscape Planting Surveillance and Care

The contractor is obligated to care for plantings and must be made aware of the responsibilities as described in standard spec 632, especially standard spec 632.3.19. This subsection pertains to watering, weeding, spraying, etc., after the initial planting. This work is an important part of the planting project that ensures the survival of the plants and protects the taxpayer's investment.

Mulching, watering, wrapping, guying, bracing, and application of rodent protection and anti-desiccant materials, when required, are a definite part of the bid item for which the contractor is remunerated. The contractor's obligation to perform this work is as clear cut and binding as that of furnishing and planting the plant material.

Ties used to secure wrappings should not be of nylon, plastic, or other materials that do not degrade rapidly.

Payment for the care of the plant material after planting is not included in the bid price for the plants. It is paid for under a separate bid item entitled Landscape Planting Surveillance and Care (see standard spec 632.3.19). The care cycles described should occur every 10 to 14 days. For estimating purposes, the number of cycles is typically figured on the basis of 1 cycle in late May, 2 cycles each month from June through September and 1 cycle in early October. The actual number of cycles may vary depending on whether adequate rainfall or drought occurs.

If the contractor fails to adequately perform landscape surveillance and care as described in standard spec 632.3.19, the engineer should assess daily damages using the administrative item 806.0632 Failing to Perform Landscape Surveillance. The daily damages are intended to offset the cost of hiring an outside source to perform the work. The dollar value to be used is provided in the contract special provisions. Daily damages specified in the special provision should be dependent upon the value of planting items in the contract, as shown in FDM 27-25-10.

Replacement of dead plants during the appropriate planting season is still incidental to the bid item for furnishing and planting that species and size.

640.6.11 Establishment Period and Payment

The contractor will be responsible for care of plants and necessary replacements for a 2-year establishment period, unless a 1-year period is specified in the contract.

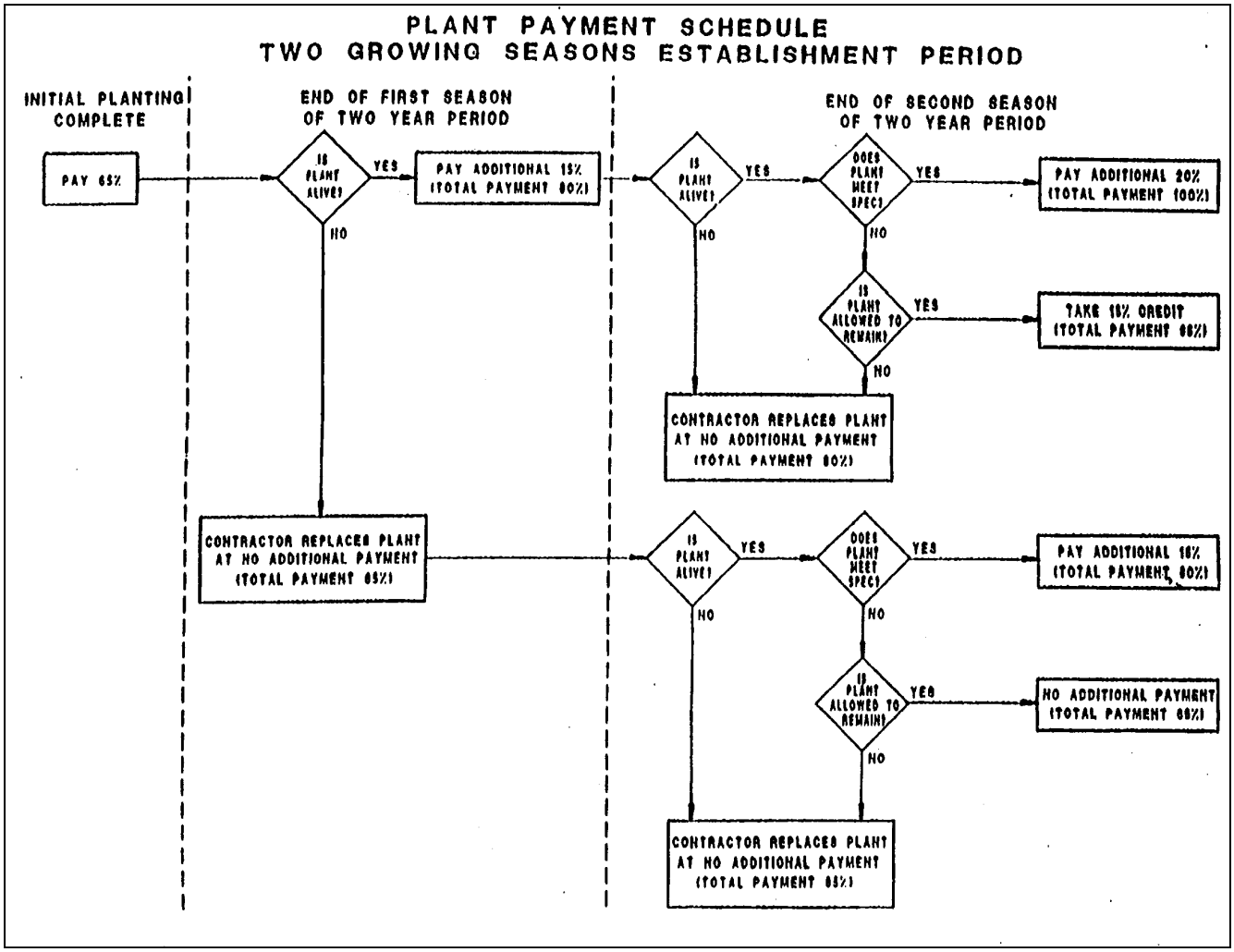
The 2-year establishment period must extend until October 15 of the second full growing season. The 1-year establishment period must extend until October 15 of the first growing season, if planting is done in the spring; the period must extend until October 15 of the succeeding year, if the planting is done in the fall.

When a 2-year plant establishment period has been specified, care and general condition of plantings should be monitored at least every month from the time the plants leaf out in the spring, until they lose their leaves in the fall. A comprehensive inspection should be conducted in late August or early September following the first growing season. Any dead plants should be tagged or marked. These are to be replaced by the contractor during that fall planting season. Another inspection should be conducted the following spring in case any plants die during the winter, with replacements again being made at that time.

The contractor must complete all replacements by June 1 of the year the final inspection is made so that all plants are top quality and in prime condition as of the inspection date. The final inspection is normally conducted late in August or early in September of the final year of the plant establishment period using the criteria specified in standard spec 632.3.20 for determining plant acceptability and qualification for payment. Partial and final payments will be in accord with standard spec 632.5.

A diagrammatic flow chart in figure 640-3 shows the payment schedule for plants installed under a two-year growing season establishment period. Future payments made under the plant payment schedule in the standard specifications for a two-growing season establishment period should follow this chart.

FIGURE 640-3 Plant Payment Schedule



SECTION 645 Erosion Control

CMM provisions mobilized by the contract:
CMM 645.2.....Erosion Control and Implementation (ECIP) preparation and submittal

The department emphasizes practical roadside erosion control to reduce water pollution, soil erosion, and siltation of watercourses and adjacent lands. Environmental concerns necessitate planning, increased use of erosion control materials, and installation concurrently with grading operations, rather than as a final operation before acceptance of the work.

The department is committed to lessening adverse environmental impacts resulting from our projects. WisDOT policy is to construct projects according to standards that will minimize or negate erosion and sediment damage to the highway and adjacent properties, prevent surface water pollution, and prevent ground water contamination.

Standard spec 107.20 requires that continuous erosion control be practiced during and after construction using temporary or permanent measures such as seeding and mulching as shown on the plans or determined by the engineer. Temporary and permanent erosion control will be measured and paid as provided for the contract or as extra work, unless the need for temporary erosion measures stems from the contractor's negligence. The specification is designed to prevent damage to the environment caused by the construction or reconstruction of a publicly owned transportation facility.

645.1 Measures Taken Before Construction

According to Chapter Trans. 401 of the Wisconsin Administrative Code and standard spec 107.20 the contractor is required to prepare and submit a detailed ECIP for the project, including borrow sites and material disposal sites. The contract may also require removal plans and clean-up contingency plans for removals over waterways.

Temporary and permanent erosion control measures proposed in the contractor's ECIP and schedule are discussed at the preconstruction conference. Refer to CMM 226.

Before the preconstruction conference, the engineer reviews the project plan, ECIP, and schedule, plus the environmental documents, to become fully aware of areas of environmental sensitivity and concern. Environmental commitments and permit requirements should be noted for compliance and implementation by WisDOT and the contractor.

Before construction begins, the engineer should discuss contract-required erosion control measures with the prime contractor. The prime contractor should be aware of the requirements of any erosion control items performed by the subcontractors, and the prime contractor's ultimate responsibility for all subcontractor actions. The prime contractor should also be made aware that the department will pay for all reseeding and refertilizing made necessary by factors beyond the contractor's control.

The Wisconsin Department of Natural Resources (DNR) must receive a copy of the ECIP developed by the contractor 14 days before the preconstruction conference. The DNR should be consulted on the erosion control needs and the measures proposed to be taken.

Requirements for preparation and submittal of the ECIP as prescribed in 645.2 are mobilized into the contract by standard spec 107.20.

645.2 Erosion Control Implementation Plan (ECIP)

Standard spec 107.20 and Chapter TRANS 401.08 Wisconsin Administrative Code require the prime contractor to prepare and submit an ECIP for a project. The prime contractor must submit the ECIP to the appropriate region office of the department and to the region liaison at the appropriate region office of the DNR. The ECIP must be submitted at least 14 days before the preconstruction conference, or at a time otherwise agreed upon by the DOT, DNR and prime contractor. It is to contain project implementation details that indicate the timing of project activities related to erosion control, such as staging and the placement of erosion control practices.

An ECIP is required for any WisDOT-administered project that contains an erosion control bid item, a removing structure over waterway bid item, or a debris containment over a waterway bid item. However, the details and contents of the ECIP depend on the project type. WisDOT- administered projects that do not contain erosion control bid items do not require the submittal of an ECIP, unless specified otherwise by the department. The ECIP may be completed in stages, if approved by the department. For example, if borrow and material disposal sites are not known at the time of the ECIP submittal, a staged ECIP will likely be approved. The initial ECIP for the project should indicate that other stages would be submitted later. The engineer must consult with DNR before approving staged ECIP submittals.

The region reviews the ECIP for conformity with TRANS 401 requirements. The DNR also reviews the ECIP and sends comments to the region before the date scheduled for the preconstruction conference. If the DNR has not sent comments by that date, assume that the DNR concurs and construction can

proceed. The ECIP must receive region approval before the contractor can start construction. Keep a copy of the approved ECIP in the field office. The engineer must monitor compliance with the approved ECIP during construction.

The contractor should consider the erosive effects of its planned operations and provide an ECIP that will mitigate and control erosive action. Permanent erosion control required in the contract plans can be used as a guide and basis in planning complementary interim erosion control measures. Measures necessary to control erosion based on the contractor's particular schedule or sequence of operations should be addressed. Items that should be provided for in the ECIP include but are not limited to the following:

1. Provide a schedule of grading operations showing the grading segments and sequences necessary to conform to or satisfy the intent of the number of erosion control mobilizations provided in the contract plans. A variation in the number of mobilizations can be submitted for the engineer's approval.
2. Show on the erosion control or plan and profile sheets the specific erosion control measures that must be in place before grading operations begin, if they are not indicated in the contract.
3. Show interim treatment between sequences or operation, noting specific erosion control device type and location using plan sheets. In particular, address protection for sensitive areas, including streams, lakes, uplands, and woodlands. Include provisions for topsoil storage locations and dewatering sites when applicable. Address stream diversion methods in detail.
4. For borrow and material disposal sites (selected sites), provide a complete erosion control plan and an ECIP, including the appropriate calculations to demonstrate that the proper erosion control measures are being used.
5. Designate the person on the contractor's staff responsible for erosion control administration, and include mobile telephone numbers. Responsibilities include consideration and mitigation of soil erosion in planning grading activities, mobilization of materials and work force to meet erosion control needs, monitoring of the project site for necessary revisions to the erosion control effort, and monitoring and maintenance of the in-place erosion control devices.
6. Hydrologic and hydraulic calculations for selected sites that would be severely impacted by off-site erosion because of the proposed excavation as fill.
7. Give details of a structure removal and clean-up plan describing various strategies the contractor might employ to protect the waterway.

Other items to be considered in the plan may include:

1. Access to site (causeway, temporary roads)
2. Topsoil (removal, storage, and placement)
3. Special ditches and intercepting embankments
4. Embankment (cuts and fills)
5. New structures over waterways (abutment fills, excavation, temporary crossings)

In development of the plan and during prosecution of the erosion control measures, the contractor should:

1. Use innovative ideas and techniques. Be specific in schedule and detail.
2. Maintain flexibility. Be ready for adjustments and alterations.
3. Rethink past practices.
4. Have necessary materials on the job site for timely installation. Preplan implementation of erosion control measures.
5. Be prepared to correct, augment or add measures during and after periods of runoff.
6. Revise ECIP should planned operations significantly change.

During review of the plan and during the work operations, the engineer or responsible WisDOT agent should:

1. Thoroughly review the plan, analyze measures in detail for shortcomings, and discuss details.
2. Be generous in application without extravagance.
3. Adjust methods and limits as needed.
4. Maintain continuing inspection and surveillance to assure adequacy and performance. Suggest corrective measures where and when needed. Inspections are required weekly, after each 0.5-inch rainfall, at the beginning and ending of each stage, and at the completion of the project. The inspector must use DT1072, Construction Erosion and Sediment Inspection.

   The inspection documentation should be maintained in project files with the approved ECIP.
5. Require amendments to the ECIP from the contractor when construction practices no longer conform to those described in the ECIP.
6. Review and approve the ECIP amendments.
7. Inform DNR of significant changes to the initial ECIP.

Adjustments and alterations may be necessary after plan review and during construction. The contract should provide quantities for the common erosion control items encountered on a project. A list of approved erosion mats is available in the PAL.

The approved mats are designed for specific applications and should be used accordingly. Follow the procedures of the WisDOT FDM Chapter 10 for the proper design of erosion mat application. It is helpful to discuss changes with the design engineer for their input on the original design intent.

For the detailed ECIP requirements refer to TRANS 401.08 Wisconsin Administrative Code. Copies of Chapter TRANS 401 Wisconsin Administrative Code are available for reviewing at transportation region offices. As part of the awarded contract package the department provides the prime contractor DT1073, Erosion Control Implementation Plan Worksheet.

The worksheet also describes what is required for selected (borrow and material disposal) sites. The contractor must fill out Section B - Erosion Control Implementation Plan - Selected Sites for each selected site for the project.

645.3 Measures Taken During Construction

645.3.1 General

The planned location of erosion control installations should be reviewed and the final location adjusted to fit field conditions. Substitution of materials may be necessary. As an example, vegetation may not always be adequate to prevent erosion and formation of gullies on areas subject to concentrated flow of water at a relatively high velocity, and in such cases erosion control may require using pipe down drains, riprap, or other appropriate means.

Sound erosion control practices include reasonable restrictions on grading; maintaining drainage and consolidating and trimming the subgrade daily to aid drainage and protect against erosion; vehicle access and parking; materials delivery and storage sites; constructing and maintaining temporary silt fences; stabilizing bare soil as soon as possible by seeding, sodding, mulching, using soil stabilizer or erosion mats; and installing plant materials at the earliest opportunity. The best way to ensure the success of these endeavors is through engineer-contractor cooperation during the entire life of the contract. It is essential that along with the requirements the contractor must strive to minimize erosion on the project. WisDOT provides the assurance the contractor will be paid for the restoration of damaged areas to the extent previously mentioned in background above.

The contractor is expected to ensure the work does not encroach on or directly affect wetlands, streams, or other waters of the state abutting highway right of way. The engineer should be alert to such situations, and if they occur, order the contractor to cease the work operation, remove all encroachments, and restore the area to its prior condition as nearly as practicable. Work must not be performed in waters of the state without prior concurrence of DNR and the U.S. Army Corps of Engineers, except in an emergency.

Temporary and permanent erosion control measures specified in the contract should be installed in a timely fashion. The engineer should be alert for situations requiring further erosion control measures not foreseen in the plan and schedule, and order the proper erosion control devices to be installed where needed to prevent degradation of the highway and surrounding lands.

The best solution to erosion-related damage is anticipating or identifying possible problems and taking preventive measures. Early erosion control practices are far less expensive than damage repair when all impacts are considered. Timely installation is essential. The prime contractor or the subcontractor charged with erosion control must take all necessary steps to install the erosion control measures at or before the time they are needed. Being busy on another project or another work operation is not an acceptable reason for late installation or no installation. A wide range of relatively simple practices are available. Early protective measures can include detention basins and sediment traps to trap runoff and sediments, proper procedures and locations for removing and storing topsoil, and measures to protect nearby lakes, streams, and wetlands. Other acceptable, proven measures are intercepting embankments, berms, dikes, dams, settling basins, ditch checks, riprap, mulching, erosion mats, silt fences, seeding, sodding, plantings, and special control installation as called for on the plans or ordered by the engineer.

Erosion control items that have proven effective when correctly installed at suitable sites include:

1. Rock check-dams, clean concrete ditch checks, and mortar rubble masonry ditch checks in ditches with step slopes
2. Rock lining of ditches, with a geotextile underlayer
3. Riprap in ditches at the toe of new slopes and along shorelines

Temporary erosion control measures should be coordinated with the permanent measures to secure continuous erosion control as economically as possible. However, temporary measures should not be

constructed instead of permanent measures specified in the contract, since it is the permanent measures that provide the ultimate control.

Permanent and temporary erosion control items that are damaged or lost, or found to be defective should be replaced as soon as possible. Replacement necessitated by damage or loss resulting from conditions beyond the contractor's control will be paid for under the standard bid item. Defective materials or installation must be replaced at the expense of the contractor.

Standard spec 107.20 limits the amount of erosive land that can be opened up. The area is not defined in square yards but rather is the area that the engineer can approve based on specific conditions affecting the area. Contractors must pursue operations in a timely and diligent manner, continuing all construction operations methodically, expeditiously, and with adequate forces from the initial topsoil stripping operation through subsequent grading operations and ultimate re-topsoiling, seeding, and other associated landscaping operations. Standard specification 107.20 extends full authority to the engineer to suspend or limit the contractor's grading operations.

Occasionally, job conditions may require disturbance of the ground surface beyond the right of way line, such as might occur from the storage of topsoil or from grubbing or finishing of the adjacent slopes, especially where right of way widths are restricted. Fertilizing, seeding, and mulching of such areas will be measured and paid for under the appropriate item, provided such areas are contiguous to the right of way, of a reasonable size, and justified by the job conditions. These areas need environmental review through the ECIP process before disturbance.

The basic work items involved in erosion control are topsoiling, fertilizing, seeding, ditch checks, sodding, mulching, erosion mats, sedimentation basins, and silt fence.

645.3.2 Erosion Control Order Form

The engineer is responsible for inspections on WisDOT administered projects, as detailed under TRANS 401, to ensure project compliance with the ECIP. If corrective action of erosion control items is identified, written notification must be given to the contractor on DT1074, Erosion Control Order.

This would be for the following cases:

1. When an Erosion Control Corrective Action is required. The contractor must mobilize within 24 hours of receiving the order. Corrective action is limited to situations where:
    1.1. The order is to perform corrective action, such as correcting items not properly installed, installing items not installed as previously ordered, or repairing damaged items
    1.2. The work is required because the contractor is out of compliance with the project erosion control plan or ECIP per Trans 401.
    1.3. The work is part of normal maintenance covered and paid under a previously installed bid item.
2. When an Erosion Control Mobilization is required, see CMM 645.4. The contractor must mobilize within 72 hours of receiving the order.
3. When an Emergency Erosion Control Mobilization is required, see CMM 645.5. The contractor must mobilize within 8 hours of receiving the order.

See standard spec 628.5.11.1, Erosion Control Orders for deductions for the contractor's failure to promptly install required corrective action following an engineer written order.

645.4 Mobilization of Erosion Control

The bid item of Mobilizations, Erosion Control has been established for providing payment to the contractor for efforts required to marshal labor, equipment, and materials to complete seeding, mulching, sodding, and other erosion control measures at planned increments or stages during the life of the project. It is intended for use in situations where erosion control mobilization is required per the ECIP or ECIP amendments. The contractor is required to mobilize within 72 hours unless otherwise agreed to in writing by the project manager, such as for planned future work or work that carries little environmental risk. Payment under this bid item will be made for erosion control activity only if all of the following conditions are met:

1. The erosion control has been preplanned.
    1.1. In the original contract plan, or
    1.2. In the approved contractor's ECIP, modifying the contract plan, or
    1.3. Ordered in writing by the engineer subsequent to (a) or (b) to respond to changed site conditions, unusually severe weather, or enough area is ready for erosion control that would require substantial move-in of labor, equipment, and materials but not requiring emergency response of eight hours.
2. The erosion control requires a substantial move-in of personnel, equipment, and materials. Use of on-site personnel, equipment, and materials is minimal to none.

3. The erosion control does not constitute normal maintenance of erosion control item installations.
4. The erosion control does not constitute incomplete installation of erosion control items covered by a previous mobilization or planned stages, unless required by changed site conditions or unusually severe weather and approved by the engineer.

Amendments to the ECIP not necessitated by the contractor being out of compliance with Trans 401, or associated with contractor-selected waste or borrow sites, which result in the landscaper needing to mobilize to the project with additional equipment or manpower, will result in one additional mobilization granted per ECIP amendment.

Thus, the contractor and the engineer must plan ahead to ensure that all erosion control measures are performed for a completed stage and are provided as required for a following stage. This requires an ongoing evaluation of both the permanent and temporary measures required as work progresses. Attention by the engineer, prime contractor, and appropriate subcontractors will minimize the potential for "call back" and its inherent costs.

See standard spec 628.5.11.2, Mobilizations Erosion Control, for payment information and deductions for the contractor's failure to promptly mobilize and install required erosion control following an engineer written order.

645.5 Emergency Mobilization of Erosion Control

The Mobilizations Emergency Erosion Control bid item has been established to provide payment to the contractor for efforts required to marshal labor, equipment, and materials to complete seeding, mulching, sodding, and other erosion control measures that may be required for emergency situations during the life of the project. It is intended for use in emergency situations where erosion control mobilization is required within eight hours. Orders issued under this bid item will be made for emergency erosion control activity only if all of the following conditions are met:

1. The erosion control has not been preplanned, such as mobilization included in the ECIP.
2. The erosion control has been ordered in writing by the engineer.
3. The erosion control requires a substantial move-in of personnel, equipment and materials beyond those already available on-site.
4. The erosion control does not constitute interim installation of erosion control items between planned stages, unless required by changed site conditions or unusually severe weather and has been approved by the engineer.
5. The erosion control work is deemed urgent and necessary to minimize risk of offsite sediment discharges. The risk of release may be due to forecasted weather conditions, flooding, change in site conditions (such as discovered a spring or breach in adjacent construction), etc.
6. The required work cannot be installed within 72 hours requirement of "Mobilizations of Erosion Control" without substantial environmental risk.

See standard spec 628.5.11.3, Mobilizations Emergency Erosion Control, for payment information and deductions for the contractor's failure to promptly mobilize and immediately install required erosion control following an engineer written order.

645.6 Structure Removals Over Waterways

645.6.1 Background

During the design process, the project design team consults with the DNR Transportation Liaison (TL), WisDOT Regional Stormwater & Erosion Control Engineer (SWECE), WisDOT Regional Environmental Coordinator (REC) and Bureau of Structures (BOS) to determine the appropriate type of structure removal standard specification and any project specific special provisions based on the type of structure to be removed, waterway or wetland under the structure and other site constraints. In some cases, the design team will consult with the contracting industry to verify feasible removal methods.

Once the contract is awarded, the contractor will prepare and submit a Removing Structures Over Waterways or Wetland Plan as part of the ECIP. The project staff, WisDOT Regional SWECE and DNR TL review this submittal to ensure the contractor’s proposed removal methods are consistent with the standard specifications, project specific special provisions, and any other details included in the contract. The review shall also include specific attention to other waterway related specifications listed in standard spec 107.18, standard spec 107.19, and standard spec 107.20. Ensure allowable construction windows are addressed in the removal plan. Verify that the waterway and wetlands are protected by appropriate erosion control methods placed downstream of the equipment and operations for performing the excavation and demolition. The demolition may require multiple erosion control methods and set-ups.

When the project staff, SWECE and DNR TL are satisfied with the contractor’s removal plan, the project engineer will provide written authorization to the contractor to proceed with the removal.

Prior to allowing the removal to begin, the project staff need to verify that the contractor has provided the appropriate equipment, apparatus, materials and personnel to match the methods stated in the approved removal plan. Ensure that there are no gaps in erosion control methods, especially in the transition areas

between in-water and land methods and that the methods go far enough landward to adequately protect the waterway and/or wetlands.

During the removal operation, the project staff will need to carefully monitor the demolition techniques and methods of debris capture and be ready to halt the contractor's operations if they deviate from the approved removal plan and/or damage to the waterway starts to occur. If the department, with DNR TL consultation, determine that alternative removal operations are necessary to avoid damage to the waterway, the contractor may be required to develop an alternative written removal operation and re-submit for approval.

Refer to FDM 19-15-55 and WisDOT Bridge Manual 6.3.3.8 for more information.

645.6.2 Reviewing the Structure Removal, Debris Containment, and Clean-up Plans

Department staff should make sure that the contractor's required removal, debris containment, and clean-up plans are appropriate for the level of care required in the special provisions. The following are strategies or techniques that the contractor might employ. This is by no means an exhaustive list of appropriate measures, nor is it a set of minimum requirements. The contractor is encouraged to develop new and innovative approaches to protect the waterway during removal operations. This toolbox is provided to help the contractor put together an effective plan that can be customized to the individual project as well as the contractor's available resources. Likewise, the toolbox should help department evaluate the contractor's plan.

- Provide decking attached to the structure.
- Provide barges beneath the structure.
- Build false decks or other temporary structures.
- Provide a crane suspended platform beneath the removal area.
- Provide blasting mats for abutments.
- Provide fencing in the waterway to prevent material from washing downstream.
- Wet-saw the structure into large, manageable sized pieces.
- Use "slab grab" equipment to remove large pieces.
- Provide fencing or side panels on debris collection devices.
- Use fabric or fencing material slung under demolition areas.
- Choose equipment that will minimize the creation of dust and small debris.
- Remove saw slurry, chips, and other potential small debris at the end of each work-day.
- Use vacuum equipment during demolition operations.
- Load and haul away debris immediately as it is created.
- Build temporary work roads.
- Cover accumulated on-site debris to assure containment during windy or rainy conditions.
- Provide boomed equipment with grabber attachments to remove debris from the waterway.
- Remove debris from the waterway by hand.

645.6.3 Example Removal and Clean-up Plans

Removing Structure Over Waterway Remove Debris (structure), Item 203.0250

Structure B-XX-XX will be removed in the following manner.

1) *A crane mounted wrecking ball will be used to break apart the existing structure.*
2) *All rebar will be removed from the waterway.*
3) *All large pieces of concrete will be removed from the waterway using a clam bucket.*
4) *The existing waterway bottom will be restored to approximately original depth. The smaller pieces of concrete remaining will be used to repair the streambed according to the plan. This work will be done by hand.*

Alternate Removing Old Structure Over Waterway
Item 203.0500.S

1) *The existing concrete deck will be saw cut into 7'x10' slabs and then removed by a crawler crane.*
2) *Once the slabs are removed the truss will be lightened to a point at which it can be tipped into the stream and then removed in as large sections as the crane can handle.*
3) *The existing pier will be removed by use of a hydraulic breaker to a point 2 feet below existing ground.*
4) *The existing abutments will be excavated to the landward side and removed in that direction by a hydraulic breaker.*
5) *All reinforcing steel and concrete rubble greater than 5" diameter will be removed from the river by use of a clam bucket then trucked off the project site.*

Removing Structure over Waterway Minimal Debris (structure), Item 203.0260

Structure B-XX-XX will be removed in the following manner.

1) *A longitudinal saw cut will be made on the "limits of removal" line between Stage I and Stage II. The median side of the bridge deck will be removed in Stage I. Traffic will be operating on the right side of the bridge.*
2) *Transverse saw cuts will extend between the longitudinal saw cut and the curb line.*
3) *A Backhoe mounted breaker will be used to break vertical slot through the parapet and curb parapet at these locations to minimize pieces of broken concrete during removal.*
4) *A backhoe with a "slab grab" attachment will be used to remove and carry the large precut sections of concrete deck to the end of the bridge.*
5) *Removing the bridge deck in large sections in this manner will significantly reduce the amount of small pieces that fall to the ground. Any large pieces of concrete in dimension, all reinforcing steel, and other debris that fall in the water will be picked up using a bucket clam and disposed of at the XYZ quarry.*
6) *Removal operations at the abutments will be completed by excavating behind the abutment and then removing in that direction.*

Bridge Pier Removal

1) *Turbidity barrier or sheet piling will be installed around piers as defined in the contract.*
2) *The bridge piers will be removed using a wrecking ball.*
3) *Any large pieces of concrete in dimension, all reinforcing steel, and other debris that fall in the water will be picked up using a crane and clam bucket.*

Alternate Bridge Pier Removal Plan:

1) *Sheet piling will be installed around the piers.*
2) *Water will be pumped to a settling basin at the location indicated in attachment.*
3) *A hole will be drilled in the old footing to house a localized charge, the charge will be localized enough to prevent widespread projectile debris.*
4) *The debris from the blast will be removed with a clam bucket.*
5) *Sheet piling will be removed after the new piers are poured.*

Removing Structure Over Waterway Debris Capture (structure), Item 203.0270

Structure B-XX-XX will be removed in the following manner.

1) *A backhoe mounted hydraulic breaker will be used to cut the concrete deck into approximately 6 foot x 15 foot sections.*
2) *A backhoe will be used to remove the deck sections.*
3) *For areas of the deck that are over water, a barge will be floated under to catch all debris, or if a barge is not possible, plywood decking will be placed between the existing bridge beams under the areas where the cuts are to be made.*
4) *As the cuts are made to divide the deck into sections, concrete chips will be caught on the barge or the plywood decking.*
5) *After the deck sections are removed, the concrete chips will be removed and taken to the disposal area.*

6) *The girders will then be removed using a crane.*
7) *The bridge abutments will be removed by excavation behind and then removing in that direction.*
8) *The concrete debris from the removal operations will be disposed of in the fill areas of the new roadway as directed by the engineer.*
9) *A flocculent approved by DNR for use in the water and silt screen will be on-site for use incase of a failure to the system.*

645.6.4 Monitoring Compliance

One of the goals in developing these removal and debris containment specifications is to improve the department's ability to administer this work and determine if the contractor is removing the structure according to the contract. The basic strategy of these specifications is:

- The contractor develops a removal plan meeting the requirements of the special provision.
- The department and DNR approve the contractor's removal plan.
- The department uses the approved removal plan as the key focus for contract administration. The department determines contract compliance by holding the contractor accountable to diligently follow the prevention, mitigation, and clean-up measures they identified in the approved plan.

The specifications provide requirements for removal of certain sized items that may fall into the waterway, depending on the specification provided in the contract. Projects staff should be aware that under some instances, the removal of these items may cause more damage to the waterway than leaving it in place. These situations should be reviewed with the DNR TL and DOT SWECE for concurrence to leave in place. When allowed to remain in place, document in the project diary what items may remain and any specific conditions for doing so.

For removals over navigable waterways, project staff need to be familiar with the requirements of permits and authorizations issued by other agencies. These may include, but not limited to: US Army Corps of Engineers Section 404 Permit, WisDNR Waterway Markers, and US Coast Guard requirements.

It is especially important to ensure the safety of waterway users located underneath and in the vicinity of removal operations. Verify that proper waterway markers are in place and in the correct locations. The contractor may need to make modifications to these markers as the removal process progresses. In situations where debris capture or containment systems may reduce navigational clearances underneath the structure, verify that all necessary agencies have been notified and such reductions in clearance have been properly posted before starting the work.

645.7 Erosion Control Items

645.7.1 Erosion Mat

Erosion mat is placed on seeded areas of the graded roadway to prevent erosion while turf is forming. It is important that the mat be placed immediately following completion of the seeding and before a rain occurs.

All erosion mat products must be pre-qualified by the department before use. Erosion mat products must be selected from the PAL. The PAL identifies pre-qualified erosion mat products by class and type.

The specifications for the different classes of erosion mats, and for the biodegradable anchoring devices to be used with Class I Type urban mats, are contained within the PAL.

The required class and type of erosion mat will be shown on the plan or will be specified by the engineer. The contractor may furnish any pre-qualified erosion mat product of the class and type shown on the plans or specified by the engineer.

Substitutions within class should not be made without verification being made with the designer. For example, some of these mats are commonly requested by the DNR liaison or may be needed to meet a certain shear stress requirement. Products not listed on the PAL should not be accepted.

Before installation, the contractor must provide the engineer with one full set of the manufacturer's literature and the recommended installation procedure for each selected product. Installation must be in accordance with the procedure recommended by the manufacturer unless otherwise specified in the contract or directed by the engineer.

Class III Type B, Type C, and Type D erosion mats must be covered by a soil stabilizer or erosion control revegetative mat as required by standard spec 628.2.1. When a soil stabilizer is used, application must be at the rate recommended by the manufacturer of the soil stabilizer, unless otherwise specified by the engineer or special provisions.

The inspector is responsible for determining that the area to be covered is in a suitable condition. The surface of the seeded area should be reasonably even, and all stones, clods, sticks, or other objects that

would interfere with the mat laying completely on the soil should be removed. The inspector should ensure that the following procedures are followed:

- The mat is placed in a natural smooth position without stretching.
- The mat is completely on the soil.
- Proper overlaps are made.
- Installation of anchor and check slots, when required, are properly made.
- The mat is correctly anchored in place.

Erosion mat placed in channels (ditches) should be placed at a width that will ensure that the outer ends are approximately one foot higher than the elevation of the channel bottom.

Areas of seeding disturbed in making the anchor and check slots should have more seed scattered on them. After the fabric is in place, water must be sprayed on the area to moisten the seedbed to a depth of 2" to expedite germination.

Erosion mat designed for lesser flows is typically placed in the upper reaches of a ditch or waterway. Subsequent sections through the middle and lower reaches will require mat designed for greater flows, or perhaps sod or reinforced sod, dependent upon conditions of runoff.

645.7.2 Erosion Bales

Erosion bales consist of straw, hay, or other suitable material of the size shown on the plan placed as dikes or dams to control runoff from ditches or slopes. These bales are effective in controlling the deposition of sediments on adjacent properties, as well as reducing the formation of rivulets and gullies, when placed and staked in accordance with plan details.

Erosion bales should be placed across the full ditch bottom and up the ditch sides to allow water to flow over the center bale. This will prevent flow around the ends of the bales. Refer to SDD 8E8.

The locations shown on the plan for installation should be considered a guide. Additional bales should be placed when and where warranted by field conditions. Also, the locations shown on the plans may require adjustment to fit field conditions. After several rains, the bales may be filled with sediment and no longer will allow water to pass. They should be replaced when effectiveness is lost. Generally, they are to be removed by the contractor after slopes are established and turf has developed, unless the engineer determines leaving them in place to rot would be beneficial.

645.7.3 Sedimentation Basins

Sedimentation basins are artificial collection ponds excavated to contain and control sediment-laden surface runoff. The basin should be of a size sufficient to retain the inflow for the required number of hours or days. The resultant clear water then seeps into the ground, evaporates, or is released via a spillway or overflow pipe, leaving sediment as a precipitate on the bottom of the basin. Direct flow-through of the basin should not be allowed.

Sedimentation basins must be inspected regularly, cleaned out as needed, and maintained in accordance with plan details if they are to be effective. Ultimate disposition of the sedimentation basins must be as shown on the plans or special provisions.

645.7.4 Silt Fence

Silt fences are erected to trap sediment-laden surface water flowing off a slope in a sheet flow or along a shallow, low-velocity, low-flow ditch. They are constructed by stretching a geotextile fabric between vertical posts, attaching it to the posts and to support wires strung between the posts, and trenching in the foot of the fabric. The fabric allows clear water to eventually pass through while leaving the sediment as a precipitate up slope from the fabric. Construction should be in accordance with the plan details, including post diameter, length and embedment, fence height, fabric type, fabric overlap, wire gage, and depth of trench. Refer to SDD 8E9 for installation details.

Do not place silt fence across channels unless it is heavily reinforced. Acceptable reinforcement would be steel fence posts with a steel mesh or woven wire fence used behind (downstream of) the silt fence fabric.

Silt fence installations need to be inspected regularly, cleaned out as needed, and maintained. Additional bracing or guying may be needed to provide full support of the fabric under heavy water flows.

Silt fence should be removed after slopes and turf are established. This may require allowing the silt fence to remain until the next year or at least for several weeks. If the contract has not been closed at the time of removal, the contractor is required to perform the removal and disposal. If the contract is closed, the maintenance forces of the authority controlling the highway must do the removal and disposal.

645.7.5 Silt Screen

Silt screen is a floating geotextile material used to minimize sediment transport within a body of water. Unlike turbidity barriers they do not touch the bottom of the watercourse. Instead they float from the surface of the water to approximately two feet above the waterbed.

Silt screen works by deflecting sediment that then settles out and deposits at the bottom of the screen. It is important that silt screen not touch the bottom of the waterbed, as sediment build up could then "sink" the floats allowing sediment-laden water to enter the waterway.

Silt Screens generally work best where the sediment particle size is larger or where water flow prevents using a turbidity barrier. Selection is normally based on coordination with the DNR/DOT liaison.

Consideration should also be given to standard spec 107.19, Construction Over or Adjacent to Navigable Waters. The designer must have established, and noted in the special provisions, if the waterway is so designated.

645.7.6 Turbidity Barrier

Turbidity barriers are fence-like structures and are placed within a body of water to barricade sediment from being transported. A geotextile material is stretched on posts from the bottom of the waterbed to an elevation two feet above the anticipated high-water mark for the time of the year the barrier will be placed.

Turbidity barrier works by totally enclosing a work area and separating it from a body of clean water. It is not intended as a device where de-watering may be done behind it, such as with sheet piling, nor is it intended to be used where currents exceed 5 feet/second. If currents exceed these limits, other measures should be considered to divert water away from the area being worked on or disturbed. This may be accomplished by using other devices such as sheet piling, cofferdams, or just reinforcing the turbidity barrier.

In moving water conditions, provisions must be made to allow the volume of water contained within the barrier to change. Since the bottom of the barrier is weighted, the volume of water contained within the curtain will be much greater at high water levels. Therefore, measures need to be taken to prevent the barrier from collapsing and to allow water to be equalized on each side of the barrier. This may be achieved by constructing part of the curtain from a heavy filter fabric. The fabric allows the water to pass through the barrier yet retain the sediment. Consideration should be given to the volume of water that must pass through the fabric and sediment particle size when specifying fabric permeability.

Barriers are one of the last lines of defense, and should be used as part of an overall erosion and sediment control plan. Other on-land measures should be utilized to minimize sediment in the turbidity barrier enclosed area.

Turbidity barriers generally work best in locations having finer particle sizes. Selection is normally based on coordination with the DNR/DOT liaison.

Consideration should also be given to standard spec 107.19, Construction Over or Adjacent to Navigable Waters. The designer must have established, and noted in the special provisions, if the water way is so designated.

The bid item provides for payment of turbidity barrier by the square yard. It is WisDOT's intent to pay for whatever height of barrier is needed to meet the two-foot requirement above the anticipated high water mark for the time of year the barrier will be placed. This requires the contractor to adjust the height based on anticipated seasonal flows. Work being done in the early spring would normally require a higher barrier than work being done in midsummer.

Another consideration would be how long the barrier is to remain in place, or in other words what is the chance of a peak event during the time it will be in place. High water elevations indicated on plans, contacts with local officials, contracts with area residents, and discussions with region maintenance representatives are all sources of information for obtaining this data. Barriers that are placed unreasonably high for the time of year that the work will be done, only create an eyesore and have been criticized by the public.

Consideration should be given to the placement of riprap or other permanent erosion control measures as soon as possible in order to minimize the duration that the barrier is in place.

Care should be taken when removing barrier due to the possible release of sediment. When possible, barrier should be released when the flow rates are low. Consultation with the DNR/DOT liaison is recommended.

645.7.7 Riprap

645.7.7.1 Compliance with the Specification

There are several problems that the DOT typically has with riprap: stone sizes may be too small, stone size may be poorly distributed, or too many fines may be included. Riprap specifications describe riprap dimensionally so that the engineer can, in the field, measure the stone supplied for the project to determine if it meets specifications. The spec requires engineers to determine the average dimensional range for the stone and the required fraction of gross in-place volume occupied by riprap.

To determine if the supplied stone meets the larger dimension ranges for a project, first mark out a 20 square feet area of in-place riprap with paint. Measure the largest stones in the 20-square foot area, marking and numbering each stone as it is measured. Measure each stone in three perpendicular dimensions and calculate the average of these measurements to get the average dimension. If there are few or no stones that fall within the two highest dimension ranges, then the supplied stone does not meet the specification.

Another way to determine if the stone is within specification is to count the number of stones that fall within the size gradations for a type of riprap. Table 645-1 describes number of stones required within each average dimension size range for each 10 cubic yards of in-place riprap. This method is labor-intensive and requires either lifting heavy stones or counting large numbers of stones.

TABLE 645-1 Riprap Gradation Averages

	Average Dimension (inches)	Number of stones per 10 cu. yd. of riprap
Light Riprap	>16 11 - 13 9 - 11 4 - 9 <4	0 35 - 48 92 - 130 445 - 620 1850 - 2700
Medium Riprap	>20 14 - 16 11 - 14 5 - 11 <5	0 10 - 27 45 - 65 240 - 340 1080 - 1620
Heavy Riprap	>25 18 - 20 14 - 18 6.5 - 14 <6.5	0 9 - 13 22 - 32 112 - 160 580 - 810
Extra Heavy Riprap	>30 22 - 25 18 - 22 8 - 18 <8	0 5 - 7 12 - 16 56 - 78 240 - 345

645.7.7.2 Conversion to Weight

If you need to convert in-place riprap volume to total riprap weight, multiply the in-place volume in ft^3 by (1 - 0.40), where 0.40 is the assumed void ratio of the riprap, and then multiply the resulting number by the specific weight of water (62.4 lbs/ ft^3) and by the specific gravity of the stone (SG=2.65). To convert an individual stone from stone volume to stone weight, multiply the stone volume (ft^3) by the specific weight of water (62.4 lbs/ft^3) and by the specific gravity of the stone (SG=2.65).

645.7.7.3 Fine Particles in Riprap

The requirement that no more than 2% of the in-place riprap be less than 1 inch in size was included to prevent the contractor from placing large amount of fines with the riprap. From a volumetric point of view, this requirement translates into a maximum allowable thickness of fines in the riprap, as described in table 645-2. The acceptable thickness is calculated by multiplying the minimum depth of the riprap volume, as described in the specification, by 2%.

Since the riprap specification is an in-place spec, and since riprap is usually placed on top of geotextile fabric Type R or HR, measure the depth of the fine material on the riprap apron in six random locations on a 20 ft^2 area, taking care to include both the bottom and sides of a channel. If the average depth of the

sediment significantly exceeds the acceptable average thickness listed in table 645-2, then the riprap supplied by the contractor does not meet the DOT's specification.

However, in applying this method, good judgment should be used. It should be kept in mind that fines may collect on the fabric in the spaces between the riprap stones. This could give the appearance of more fines than are actually present. This procedure should be done before it rains, because sediment transport from a rainfall will alter the quantity of fines in the riprap. Observing the amount of soil attached to the stones at time of delivery would provide a means to judge if excessive fines may be a problem.

TABLE 645-2 Acceptable Thickness of Fines for Riprap

Riprap Gradation	Minimum Riprap Thickness (inches)	Acceptable Average Thickness of Fines Covering Geotextile Fabric Type R or HR (inches)
Light Riprap	12	1/4
Medium Riprap	18	3/8
Heavy Riprap	24	1/2
Extra-Heavy Riprap	30	2/3

645.7.8 Tracking Pads

645.7.8.1 General

The best approach to preventing off-site tracking is to restrict vehicles to stabilized areas. It is always preferable to prevent sediment from being deposited upon the road than cleaning the road later. Sediment on a road can create a safety hazard as well as a pollution problem. Any sediment tracked onto a public or private road should be removed by street cleaning or sweeping, not flushing, or as directed by the engineer.

Tracking pads reduce off-site sedimentation by eliminating the tracking of sediment from construction sites. The contractor must install a tracking pad wherever traffic will leave a construction site. This practice applies where construction traffic is likely to transport sediment off site onto private or public roadways.

Stone tracking pads remove sediment from the tires of vehicles by allowing the tires to sink into the stone base slightly. This action, combined with the rolling motion of the tires, acts to knock loose the majority of sediment from a vehicle's tires before it leaves the site. Manufactured tracking pads should produce similar results.

645.7.8.2 Construction

The tracking pad must be installed before any traffic leaves the site. The aggregate must meet the gradation requirements of select crushed material specified in standard spec 312.2, with the exception that material passing the No. 10 sieve should be negligible by visual inspection. The aggregate layer must be constructed to a minimum depth of 18 inches.

Stone tracking pads must be underlain with a Type R geotextile fabric to prevent migration of underlying soil into the stone. The tracking pad must be the full width of the egress point or 12-foot minimum. The tracking pad must be at a minimum 50 feet long. Surface water must be prevented from passing through the tracking pad. Flows must be diverted away from tracking pads or conveyed under or around them by using culverts, trenches, or diversion dikes that divert surface water runoff into a dispersion area, or other similar practices. There is no additional compensation for practices used to divert water.

645.7.8.3 Proper Use and Maintenance

Tracking pads only perform when maintained properly. Vehicles traveling across the tracking pad should maintain a slow constant speed. Rocks lodged between the tires of dual wheel vehicles must be removed before the vehicle leaves the construction site.

Maintenance is needed when existing stone becomes buried in sediment or tracking onto roadways creates a safety issue. The tracking pad performance must be maintained by scraping or top-dressing with additional aggregate. A minimum 18-inch thick pad must be maintained.

645.7.8.4 Removal

Once the project site has been stabilized and the tracking pad is no longer needed, the materials must be removed and the area restored.

645.7.8.5 Alternatives

Alternative methods, i.e. manufactured products, wash racks, or tire washing stations may be used. If proposing an alternative method, the contractor must provide, at a minimum, the following in the ECIP:

1. Schedule for installation and removal
2. Standard drawings and installation details
3. Stabilization after removal

645.7.9 Polyethylene Sheeting

645.7.9.1 General

Polyethylene sheeting is a sediment control device that can be used to convey waterways during culvert or box-culvert construction, to convey clean off-site water through a work zone, and to protect steep embankment areas. The objective with this device is to protect sensitive areas by completely covering and minimizing exposure of the bare soils to erosive forces, especially in locations where temporary seeding is not suitable or practical. Suggested locations for use are outlined in FDM 10-10-26.3.

645.7.9.2 Construction

When preparing areas for polyethylene sheeting use, it is important to shape the underlying earth bed to ensure good contact with the bare soils. This will provide the best form of contact and help minimize displacement of the sheeting throughout construction, during storm events, during high winds, and from other natural forces (refer to Figure 645-1). Items that can puncture the sheeting (ex: stones, sticks, roots) need to be removed prior to placement.

FIGURE 645-1 Polyethylene Sheeting Placement



When more than one piece of sheeting is used, the sections shall be overlapped by 3 feet and sealed using a waterproof tape. The contractor may propose other methods to seal the edges, which can be approved by the engineer on a case-by-case basis. The goal is to ensure that sheet flow of water from on top of the sheeting does not have an access point to get underneath and create erosion.

The polyethylene sheeting needs to be secured properly to be effective. This includes both the initial upstream edge of the sheeting, as well as throughout the area of the sheeting.

The initial upstream edge shall be entrenched a minimum of 6 inches for both slope and channel applications. In locations where trenching is not suitable, such as rock or paved areas, the use of other methods may be proposed by the contractor and approved by the engineer on a case-by-case basis. The use of a continuous line of sandbags or rock bags may be a suitable alternative. In locations where the top edge of sheeting is at the high point and there is no opportunity for runoff to get underneath the sheeting, the engineer may waive the trenching requirement.

FIGURE 645-2 Securing Polyethylene Sheeting with Sand Bags



Securing the entire area of the sheeting is up to the contractor's means and methods. This should be discussed with the contractor prior to use and documented in the contractor's ECIP to ensure compliance. Figure 645-2 is an example of a securing method using stakes, ropes, and sand/rock bags.

Erosion control inspections shall document the condition of the sheeting. An erosion control order shall be used to direct the contractor to make any adjustments or maintenance needs during construction.

Upon completion of the polyethylene sheeting use, all materials (including all securing materials) are to be removed and properly disposed of by the contractor. Since the polyethylene sheeting will likely be landfilled, it is encouraged to not over-use.

SECTION 650 Pavement Marking and Delineation

650.1 Materials

The current list of acceptable pavement marking products is located on the APL. The contractor needs to choose specific materials based on field conditions and conform to manufacture's installation requirements.

650.2 Equipment

Marking equipment should be able to heat liquid markings to the temperature the marking manufacturer specifies. For wet reflective/recoverable markings, a double drop system is required. The equipment should be able to report all information needed to complete a DT2130 and/or DT2131.

650.3 Locating Pavement Markings

650.3.1 General

The project engineer should review the proposed locations before markings are applied. Questions may be directed through the project engineer to the region traffic engineer.

On resurfacing contracts where there is no change in either horizontal or vertical alignment, and which do not contain a separate Locating No Passing Zones bid item, the contractor is responsible for referencing the beginning and end of all existing no passing zones. This must be done before the start of construction operations that will destroy existing markings.

On contracts that contain changes in horizontal or vertical alignment the contractor is responsible for establishing the beginning and end of no passing zones under the Locating No Passing Zones bid item. The contractor should reference the beginning and end of newly located no passing zones on intermediate layers, so these locations only have to be established once. Locating no passing zones for the final surface must be done when paving is complete.

For roadways with speed limit changes, maintain the proper no passing zone sight distance.

- For locations where the posted speed limit is increasing: When the lead vehicle reaches the speed limit sign, the trail vehicle would back up to the appropriate no passing zone sight distance.
- For locations where the speed limit is decreasing: When the trail vehicle reaches the speed limit sign, the lead vehicle would back up to the appropriate no passing zone sight distance.

650.3.2 Locating No Passing Zones Checklist

Locating No Passing Zone Checklist based on standard spec 648.

1. Project personnel responsible for inspecting marking should contact the Regional Pavement Marking Coordinator for special zones at least one month before locating no passing zone work takes place.
    - Are there any special zones and have they been placed according to the project special provision?
2. Have contractor personnel checked with the project engineer before beginning work?
3. Is equipment required under standard spec 648.3.2 on the spotting vehicle?
4. Are the marks locating the ends of the no passing zones legible and durable (white marks on asphalt and black marks on concrete)? Is the backup lath placed away from any construction activity?
5. Are barrier lines located as specified in standard spec 648.3.2, the department's traffic engineering, operations & safety manual policy 3-2-2 and the plans?
6. Are the no-passing zones leading into and out of the project limits correct, according to standard spec 648.3.2 and the department's traffic engineering, operations & safety manual policy 3-2-2?
7. Is the line of sight within the shoulder, avoiding future vegetation growth or obstructions?
8. Is the minimum distance between the zones available or do the zones need to be closed?
9. Did the No-Passing Zone log (DT2124) include the following?
    - Date of Survey.
    - Cardinal direction of travel.
    - Sight distance used and posted speed for each zone.
    - Entries logged from west to east on east-west roads and entries logged from south to north on north-south roads.
    - Location of geographical features such as side roads, county and regional boundary lines, and starts and ends of bridges.
    - Locating features to the 1/100 of a mile for each road surveyed.
    - The beginning and ending of each no-passing barrier line in both directions.
10. Did the contractor provide an electronic copy of the No-Passing Zone log to the Regional Pavement Marking Coordinator and the BTO Marking inbox (DOTBTOMarking@dot.wi.gov)?

650.3.3 Locating Curves

- Horizontal curves: Do not extend the line of sight outside the grass/gravel shoulder. Locate no passing zones on the inside radius of horizontal curves and record the no passing zones in the cardinal direction.
- Crest vertical curve: When the target light on the lead vehicle goes out of sight, the trail vehicle parks at the base of the hill, back the lead vehicle up to reveal a full silhouette of the car (from the bottom of the bumper up). Once the trail vehicle sees the full silhouette of the lead vehicle, establish the appropriate sight distance between the 2 vehicles before continuing spotting.
- Sag vertical curves: When the target on the lead vehicle goes out of sight, stop the lead vehicle at the base of the hill or in the sag, pull the trail vehicle forward until the full silhouette of the lead vehicle is visible. Once the trail vehicle sees the full silhouette of the lead vehicle, establish the appropriate sight distance between the 2 vehicles before continuing spotting.

650.4 Application

Temporary traffic control and flagging requirements are discussed in CMM 145. Personal safety requirements are in CMM 135.

The contractor is responsible for locating required temporary and permanent pavement marking, including the beginning and end of no passing zones, unless the contract specifies otherwise.

650.4.1 Temporary Markings

Standard spec 646.3.2.5 requires same-day temporary longline pavement markings on pavements or surfaces open to traffic the same day the pavement layer is placed, or the surface is milled, except when adverse weather conditions preclude marking.

The traffic control contractor must coordinate with the permanent pavement marking contractor to ensure complete removal of lines that are not in the same locations as the permanent marking.

Temporary markings should be installed on any temporary surface or where the marking will be removed before the permanent marking is installed.

650.4.2 Same Day Pavement Marking

Standard spec 646.3.2.5 allows the contractor to use temporary pavement marking to meet the permanent same-day requirement on upper layers. If the contractor chooses this option, temporary marking must be completely removed before placing permanent pavement marking. Costs associated with this option are incidental to the associated Marking Line Same Day bid item.

Under the Marking Same Day bid item, standard spec 646 requires same day long-line permanent pavement markings on pavements open to traffic on the same day the upper layer is placed, unless adverse weather conditions preclude marking.

Same day pavement markings are only for necessary longline markings typically used on the upper surface layer placed on conventional two-lane highways that are open to traffic and that have surfaces capable of retaining markings.

Any temporary pavement marking material which meets standard spec 646.3.2.5 may be used on the surface course to temporarily mark centerline when the permanent markings are delayed.

650.4.3 Permanent Markings

Pavement markings designated in the contract for removal and any other pavement markings not appropriate to the travel path must be removed. Pavement cleaning may be done by any method that will not damage the pavement, leave a residue or cause discoloration and has a dust control system. The contractor should avoid damage to parked or passing vehicles.

Marking limits should be laid out well in advance of the actual application operation to avoid delay to the marking contractor. Standard notations for delineating the limits should be used and should be coordinated with the marking crews before application. The marking limits and the positioning of special markings are to be checked by the engineer before application.

An initial check of the marking equipment is ideally made at the contractor or municipality's shop on a paint test area. If this is not possible, the initial checks must be made on the project at the start of operations. Placing a nonabsorbent plate on the marked line and applying material without glass beads over it is a good way to check the thickness of the material. Wet thickness may be checked with a depth gauge available through the region. Dry thickness may be checked by a caliper available through the region.

Permanent pavement marking on pavements open to traffic must be applied to the upper layer within 7 days of completing mainline surfacing, unless the contract requires otherwise, or weather conditions preclude such application.

Permanent markings on roads that were closed to traffic during construction must be applied before opening to traffic, unless the engineer allows otherwise.

Markings may be omitted:

- On roadways closed to through traffic, marking is not critical, if barricades and road closed signing are present prior to the road opening.
- On roadways open to traffic, if markings will not be in place for 24 hours or less, install No Center Line and Do Not Pass signs at the beginning of the project and every 2 miles or after county and state intersections. If markings are absent for longer than 24 hours and up to 72 hours, channelizing devices must be placed along with No Center Line and Do Not Pass signs.
- On multilane divided highways, do not open more lanes than are marked. If on a four-lane freeway and two of the lanes are not marked, then only a single lane 12 ft. may be opened. If on a six-lane freeway, and two of the lanes are marked and the third is not, then the third lane must be closed.

650.4.4 Grooving Pavement

Revise 650.4.4 (Grooving Pavement) title and add information when grooving pavements open to traffic.

Pavements have very good water retention. Expect water in the grooves if it has rained in the last 48 hours. If water is encountered during grooving, the contractor must allow the groove to completely dry before placing markings. When grooving pavements open to traffic follow SDDs for flagging, lane closures or moving operations.

650.4.5 Grooving on Bridge Decks

A grooved slot on a bridge deck or concrete overlay will not cause structural problems or affect the service life of the concrete.

650.4.6 Placing Epoxy Marking on Polymer Overlay Bridge Decks

Polymer overlay warranties do not allow any mechanical removal of temporary markings. Only surface applied standard epoxy marking is allowed.

650.4.7 Resealing Protective Surface Treatment on Concrete Bridge Decks

The contractor can place this treatment in any feasible way. Rolling and spraying are two options. The contractor can use other methods as long as sealant does not cover the marking. Any sealer from the APL is acceptable. Standard spec 646.3.1.1(5) requires the contractor to protect markings when resealing to ensure the markings retain their reflectivity, color, and presence.

650.4.8 Cold Weather Pavement Marking

Standard spec 646.3.1.3 restricts placement of permanent pavement marking at low temperatures since pavement marking adherence is most effective when the markings are placed above 35 F for epoxy and 50 F for tape. This specification may require the marking contractor to place temporary marking over the winter. A higher failure rate of 25 percent is allowed for cold weather pavement marking. Since conditions outside of manufactures specifications do not promote a good bond, the contract requires removal and replacement once weather allows.

650.4.9 Pavement Markings Inspection

Project personnel are responsible for inspecting the pavement marking and should contact the Region Pavement Marking Coordinator if any items on the Pavement Marking Checklist are not satisfactory. Standard spec 646.3.1.5 has initial retroreflectivity inspection criteria to be completed 15 to 60 days after installation or before the first snow fall. Do not perform inspections before day 15 since excess beads may still be present and affect the retroreflectivity readings.

Pavement Marking Checklist:

1. Pavement marking coverage
   - Is it uniform throughout the line within the specified mil thickness?
   - Is there a sharp cut off on both sides and ends of the line?
2. Bead coverage
   - Is it uniform throughout the line within the specified pounds per gallon?
   - Viewing the line with the sun behind you makes an initial check of the effective application of glass beads dropped onto the surface. The full width of the line should be covered. There should not be an excessive amount of non-embedded beads.
3. Are the products on the approved products list APL?
4. Are long-line markings placed according to specifications for width, color, lengths, and cycles?
5. Are special markings placed according to specifications for spacing and layout?
6. Have the temporary lines been removed without leaving a noticeable scar?
7. Grooving

- Did the contractor provide a copy of the manufacturer recommendations before grooving?
- Has the contractor ensured that the asphalt can handle the grooving operation?
- Is the groove edge sharp in appearance? If not, the grooving equipment may need to be changed or in the case of asphalt, the 5-day waiting period isn't long enough.
- Is the groove clean from fine particles and dry before placement of the permanent marking?
- Is the groove depth 175 mils for tape and 90 mils for wet reflective epoxy from the pavement surface or from the high point of the tined surface?
- Is the groove width no more than one inch wider or longer than the permanent marking?
- Does the groove operation follow the joint curve?
- Is the groove edge a minimum of 3 inches away from the joint edge according to contract standard detail sheets, typically SDD 15C8-a?
- Was the groove dry before markings were placed?

8. Proving Period
    - Are the markings following the minimum criteria listed?
    - Contact Regional Pavement Marking Coordinator as soon as possible if there are any questions of pavement marking performance issues. The Region Pavement Marking Coordinator will take retroreflectivity readings upon request. Send a copy of any retroreflectivity data captured by the Regional Pavement Marking Coordinator or contractor to the BTO Marking inbox (DOTBTOMarking@dot.wi.gov).
    - Pay attention to marking placed on High Early Concrete since the hydrostatic pressure may cause a premature marking failure.

650.5 Protection of Fresh Markings

The approximate times for approved marking materials to dry to a no-tracking condition under optimum conditions of air temperature, pavement temperature and humidity, can be found in the manufacturer's specifications.

It is necessary to protect slower drying materials, including epoxy, from tracking by vehicles. One or more of the following methods may be used, depending on traffic volume, crossing movements and drying time:

1. Traffic cones at 100' spacing.
2. A convoy of moving vehicles.

650.6 Delineator Posts

Delineator checklist based on standard spec 633.

1. The project personnel responsible for inspecting the delineators should contact the Regional Pavement Marking Coordinator at least one month before placement.
2. Are the steel delineators placed according to specification for reflector color, quantity of reflectors, and spacing and layout of the posts?
3. Are the flexible delineator posts placed according to specification for color of sheeting, and spacing and layout?

650.7 Measurement and Payment

Payment may be required for marking that fall within the project scope but is beyond the project limits. There are times when center line remarking is needed beyond the project limits to ensure the project and adjoining roadway works together within the current standards for locating no-passing zones. This may occur when:

- The project alignment has changed.
- No-passing zone standards are modified, thereby closing a previously marked carry over zone.
- Or when 500' barrier lines were added to a project thereby closing a carryover zone.

These changes could require the closing of passing zones on one or both ends of the project. When this occurs, measure and pay for Locating No-Passing Zones and for the center line 6" marking required beyond project limits. The quantity required outside of the project limits will never exceed four times the minimum distance between zones.

SECTION 655 Electrical Construction

655.1 General

Electrical construction, in connection with a highway improvement contract, may include all or part of the installation of roadway lighting, illuminated signs, traffic counters, traffic signals, traffic signal detectors, rest areas, truck weighing stations, and other miscellaneous electrical systems.

Electrical work may be performed as a separate electrical contract, or it may be a part of another highway contract often performed by a subcontractor specializing in that line of work. The prime contractor, whether the electrical work is performed by the prime contractor's forces or by a subcontractor, is held responsible for the work, and the engineer is responsible to ensure the work is performed according to the requirements of the contract.

Highway electrical systems, National Electrical Code, Material Specifications, and standard detail drawings (SDDs) are all subject to frequent changes. Revisions in materials and specification requirements may occur on successive jobs. Both the contractor and the engineer should be alert to the fact that the way work was performed on a previous contract may not be applicable under the present contract. It is necessary to thoroughly read and understand the present contract and forget about previous contracts.

At the preconstruction conference, the contractor must supply the engineer with a list of names and qualifications of journey workers and electrical apprentices who will or may be working on this contract.

The contractor should be advised that electrical apprentices must work under the terms of their indentures, which require that an apprentice be under the direct supervision of a journey worker at all times with the exception of an apprentice in the final year as an apprentice. Any violation or suspected violation of these terms will be reported to the Bureau of Apprenticeship Standards.

Engineers should coordinate with and solicit input from utility representatives and municipal engineers who have interest in electrical work done on our projects. Occasionally, electrical utilities have requested inspection by local building or electrical inspectors of work performed by department personnel, or by the department's contractor. Those inspections often involve a permit fee. It is the position of the department that the engineer is responsible for the inspection of the work, and inspection by local units will not be allowed. Legal opinions have held that the state of Wisconsin and its agencies are not subject to local ordinances, such as building or electrical codes.

Electrical utilities making service connections require an affidavit stating that the work conforms to the Wisconsin State Electrical Code, National Electrical Code, and the requirements of the local utility. This affidavit must be on file with the local utility before an electrical power hookup will be done.

Questions and problems not able to be resolved at the project site or in the region office may be directed to DTSD-electrical unit in Madison.

655.1.1 Preliminary Inspection

Before the start of electrical work operations, the engineer and any inspector assigned to the work should carefully study the plans, specifications, and special provisions. Layout of plan requirements should be checked early in the field to determine if any omissions or necessary changes might require change orders. It should be determined before work starts that no surface, underground, or aerial obstructions exist, or will be erected, which will preclude the installation of a pole or standard, or which will interfere with the view of a sign or signal or inhibit its proper operation.

Lists of material to be used in the work should be pre-checked to avoid omissions or irregularities. When appropriate for the identity of a material item, the manufacturer's name and catalog number should be provided in the material list to allow proper checking.

State furnished materials such as poles, mast arms, luminaries, signal controllers, fixtures, or other specified equipment, should be ordered from the supplying region in sufficient time for pickup and delivery to the project by the contractor for his timely installation of those materials.

If a signal controller is being provided or being tested by the state electrical shop in Madison, its delivery time should be investigated for availability at the projected time of installation.

655.1.2 Materials

Generally, the inspection, sampling, and acceptance of materials for electrical work must conform to CMM 850, the department's materials testing and acceptance guide. Materials and construction methods for electrical work must conform to requirements of standard spec 659, the plan details, and applicable contract special provisions. Standard spec 651.3 requires that the work be performed in accordance with the requirements of the Wisconsin State Electrical Code, as found in the Administrative Code of the Department of Commerce.

Some materials, such as electrical conduit, nipples, elbows, etc., that are required by the specifications to have the Underwriters Laboratories, Inc., label firmly attached, are generally accepted without sampling and testing (see standard spec 651.2). Field inspection should be made for condition on arrival and compliance with plan requirements. Suspected inferior material and possible counterfeit U.L. labels should be referred to the DTSD-electrical unit in Madison for evaluation.

Many electrical devices may have the same general external appearance and are manufactured to various standards of quality. Those items should be carefully checked to ensure compliance with the specified brand, grade, or model number. To aid and facilitate positive identification, the special provisions often may require wiring devices be delivered to the job in original cartons.

Some materials may be field-accepted without sampling when accompanied by the manufacturer's certificate of compliance with specification requirements, or when the product of a particular manufacturer is on the APL.

Should a question arise in regard to acceptability of a material, the engineer should refer the matter to DTSD-electrical unit in Madison, if necessary.

Substitution of an alternate electrical item for the specified item will not be allowed unless specifically authorized in writing. A list of contractor-proposed alternate items should be sent to the DTSD-electrical unit in Madison for review and possible approval. The list should include all pertinent data that would justify equal status of the alternate with the original item.

655.1.3 Inspection Checklists

Check lists to guide the inspector during installation of conduit, lighting, traffic signals, and loop detectors are included in figures 655-1, 655-2, 655-3, and 655-4, respectively.

655.1.4 Final Inspection and Acceptance

A representative of the authority which will be maintaining the electrical installation should be invited to review the project with the engineer before construction begins, during construction, and during development of a contractor's punch list of work to be completed and should be invited to suggest input into the list. The representative should also be invited to be present at final acceptance and be a participant. A representative of the WisDOT region electric unit or the DTSD-electrical unit in Madison, who would be knowledgeable in electrical construction, should also be present at final acceptance.

655.2 Conduit

Conduits provide secure raceways for the wires and cables of an electrical system. Metal and PVC conduits are used for raceways in traffic signal and street lighting installations. Materials furnished for and methods of constructing conduits are to be in accordance with the requirements of standard spec 652, plan details, and applicable contract special provisions.

Before allowing the work to start, the inspector should ascertain that the materials to be used have been approved. All conduit runs are required to be installed (sloped) in a manner providing for drainage of the conduit.

Conduit on or in above ground structures must be drained at low spots by one of the following methods:

- Drain T's in metallic conduit.
- Drain to a junction box or underground pull box.
- Cut out a 1" section of gasket at the bottom of the junction box cover.

Where conduit is installed below ground, drainage is accomplished in accordance with Standard Detail Drawing SDD 9B2.

The specifications require that the contractor, upon completion of the work and in the presence of the engineer or the inspector, make an inspection of all installed conduit to determine that the bore is fully open for its entire length and the conduit is acceptable.

655.2.1 Underground Installations

Where conduit is installed underground, it should be determined that the trench is at the required location at proper depth and grade, unsuitable materials encountered are removed and properly replaced with suitable material, and any required drain tees and gravel-filled drainage sumps are provided as explained above. See standard spec 651.3 for proper trenching methods and for the handling of unsuitable material during the trenching operation. Close attention should be given to proper compaction of backfill material in trenches to preclude later detrimental settlement of the roadbed.

Where the contract does not include installation of wiring cable or conductors, it is required that the ends of the installed conduit are tightly plugged or capped to preclude the infiltration of water and soil, and a 12 AWG XLP insulated stranded copper pull wire must be installed in the conduit. The ends of the conduit should be suitably referenced to aid in future identification and retrieval.

Auguring, boring, or drilling operations to install conduit must not disturb the existing pavement under which it will pass. The conduit must be installed in accord with SDD 9B2, unless otherwise provided in the contract.

655.2.2 Conduit on Structures

When conduit is installed on structures, it is attached to the structure or embedded in the concrete, as required by the plans. In either case, inspection should be made during the placing to determine that it is in acceptable condition and properly installed. Conduit risers should be located to preclude interference with other facilities. Conduit embedded in concrete should normally have a minimum cover of 2 inches and should be pitched to drain, preferably to a junction or pull box.

Where the conduit crosses an expansion joint in the structure, an expansion fitting (sized as shown in the plans) is required in the conduit. Expansion fittings must also be installed in the number(s) required by the manufactures and in the method as recommended by the manufacturer. Install expansion/deflection coupling per manufacturers recommendations.

Expansion fittings are required to be provided with a bonding jumper. Some expansion fittings are designed and furnished with an internal bonding jumper as an integral part of the fitting, while other types require an external bonding jumper. It should be determined that the external bonding jumper is accordion-pleated and placed for free movement of the conduit.

655.2.3 Metal Conduits

Metal conduits are installed both underground and on structures. Inspection should be made during installation operations to determine that the work conforms to specified requirements. Field-made bends in the conduit should be made only with proper bending tools that produce a smooth, uniform bend without reducing the effective diameter of the conduit. The radius of the curve of the inner edge of any field bend should be not less than six times the nominal diameter of the conduit.

Not more than 4 one-quarter bends (360 degrees) or equivalent, are allowed between pull boxes and junction boxes. Bends should be sufficiently away from a threaded end to preclude fracture at the threads introduced by the bending stress. Pull box to pull box location of conduit must not have any bends. Runs must be straight.

During the placing of the conduit, it should be determined that the couplings are properly installed. The ends of each section length of the conduit should be square cut, threaded, reamed free of burrs and screwed tightly together within the coupling so that the coupling covers all the threads. All installed conduits designated to receive future conductors must be examined to ascertain that properly installed pull wires/rope have been installed.

Conduit terminating in junction boxes should extend into the box to provide maximum clearance for connections and bushings. Use Erickson or no-thread couplings. Do not use running threads.

655.2.4 Nonmetallic Conduit

Make sure nonmetallic conduit is installed according to the plan details. Nonmetallic conduit is easily damaged by construction operations; precautions should be taken to protect it. Nonmetallic conduit should not be installed until immediately before paving to avoid damage from trucking or other construction operations. After completion of other contract work in the vicinity of installed conduits, an inspection must be made to determine that the conduit is still in acceptable condition.

655.2.5 Pull Boxes and Junction Boxes

Pull boxes and junction boxes are used with conduit installed both underground and on structures. They provide access to conduit runs and facilitate placing wires in long conduit runs.

On structures, junction boxes are generally galvanized cast iron boxes with accessible covers and are of the size and type specified. They are installed at the locations and in the manner the plans show. They may be used to house fuses and fuse holders as well as for splicing of wire and cable.

Pull boxes for underground conduit are made of corrugated metal culvert pipe with cast iron frames and covers. When installed in shoulder areas, they must be set 2" - 3" below the shoulder surface. See SDD 9B4 and standard spec 653. Bearing should be provided under the box to prevent settlement under axle loads. Make sure drainage is provided according to SDD 9B4 and SDD 9B2.

FIGURE 655-1 Conduit Installation Checklist

1. MATERIALS

___ a. Does conduit have the U.L. label on each pipe and fitting?

2. RUNS

___ a. Is a conduit run the same pipe size from one end to the other?

___ b. Does the conduit extend a maximum of 3" into the pull boxes?

___ c. Does the conduit extend 24" beyond the edge of the pavement?

3. BENDS

___ a. Are proper tools used to bend conduit?
___ b. Are radius curves bent with proper diameters?
___ c. Do bends total no more than 360 degrees per run between junction boxes and pull boxes?
___ d. Are bends made far enough from metallic conduit threaded ends so the threaded ends won't fracture?

4. JOINTS

___ a. Are expansion fittings or flexible conduit used at expansion joints? Are they installed properly?
___ b. Are bonding jumpers used at expansion joints? Are they installed properly?

5. PULL WIRES AND BOXES

___ a. Is a pull wire installed where required?
___ b. If installed, is the pull wire 12 AWG?
___ d. Is the pull wire doubled back 24" at each end of the run?
___ e. Does the pull box have proper support and is it 2"- 3" below grade or in accord with SDD 9B4?
___ f. Are holes cut into the pull boxes sufficiently large and in accordance with SDD 9B4 to accept the conduit but not so large to admit dirt?

6. BURIAL

___ a. Is conduit under the traveled way buried at least 24" but not more than 36"? If outside the traveled way, is it buried at least 18" but not more than 36"?
___ b. Is unsuitable fill material removed and replaced by acceptable fill? Is the fill material compacted properly below and above the conduit? Where cinder fill is encountered, is the conduit encased in at least 2" of concrete, or as an alternative, is 12" removed below the conduit trench and replaced with suitable fill?

7. DRAINAGE

___ a. If holes are drilled to drain PVC conduit, are the holes ¼" in diameter?
___ b. Are all conduits laid so they drain and have no pockets of trapped water in long runs? If encased or embedded in concrete, is the conduit properly drained?
___ c. Are drain sumps installed where needed? Are they built according to SDD 9B2?
___ d. Is at least 0.5 cubic feet of No. 2 coarse aggregate placed under each drainage tee?

8. END TREATMENT

___ a. Are plugs or caps in place on all conduits in which wire or cable has not been installed? Have they been cleaned for easier removal when wire or cable is installed in the future?
___ b. Are metal conduit ends square-cut, threaded, and reamed? Has all metal conduit received bushings, caps, or plugs? Has all PVC conduit received end bells?
___ c. Are couplings properly installed?
___ d. Are exposed new threads or damaged places on rigid conduit coated with a suitable zinc rich material?
___ e. Are conduit ends 1" above the top of signal and lighting concrete bases? Has a 1" diameter conduit been installed for grounding as required on pertinent SDD's?

9. AFTER INSTALLATION

___ a. Is the bore open all the way through?
___ b. Is PVC conduit checked after backfilling its trench to make sure it is not damaged or crushed?
___ c. If attached to a structure, is the conduit attachment secure?
___ d. Are conduit location "arrow" marks cut in the pavement (or curb) over conduit lines at each pavement edge?
___ e. Are pull boxes accessible?

655.3 Lighting Units

A lighting unit consists of a pole, concrete base, luminaire arm, luminaires, ballast, lamp, cable, fuse, hardware, fixtures, fittings, and attachments necessary to integrate the components into a single unit connected to the branch circuit.

Before erection, each lighting unit should be checked with the approved shop drawing to determine the required luminaire arm and pole are furnished. Luminaire arms do not carry size markings, so length determination must be made from plan details.

Concrete bases are to be constructed in accordance with plan details and location as shown on the plans. The base should be positioned to allow erecting the pole with the vertical plane of the bracket arm at right angles to the center line of the roadway on tangents and on the radial line of the curvature of the roadway on curves. At ramp connections where the pole is set back of the ramp, the pole must be squared to the mainline while other poles along the ramp are squared to the ramp alignment. Poles along the mainline and at ramp connections are designated by the mainline stationing and the other poles along the ramp carry the stationing of the ramp. Other special arrangements, if required, will be detailed on the plans.

A pole should be erected to avoid the appearance of leaning towards the roadway. This is accomplished by having the back side of a tapered pole truly vertical. Median lighting poles having twin bracket arms should have the center line of the poles vertical.

It should be determined that the cable is not pinched when the arm is bolted to the pole, that the handholes are at the designated locations, and that the pole is properly grounded. To preclude interaction between the stainless-steel screws in the handhole cover and the aluminum column, the screws should be lubricated with an anti-seize compound. When unit identification numbers are required by the plans, aluminum plaques bearing the numbers will be per contract requirements.

Luminaires are typical of producing a wide range of light distribution patterns on the roadway through adjustment of internal components. The engineer must verify the correct luminaire settings before installation on the pole, by a review of the project requirements and the manufacturer's instructions to verify the distribution required on the plans.

After the pole has been erected to its true and required position, the luminaires must be set to a level position. Luminaires are required to be equipped with an integral level indicator.

Refer to figure 655-2 for a checklist on lighting installation and related construction.

655.3.1 Cable

Cable-in-duct maybe installed as the electrical branch circuit from the distribution center, or other source of power, to lighting units, illuminated signs or lighted sign bridges. Cable-in-duct must be installed at a depth of at least 30" and backfilled in layers not exceeding 12" in depth.

The cable is required to be laid continuously without splices from terminal to terminal. For its protection, it should be delivered and remain on reels until uncoiled for placing in the trench. To preclude injury to the cable (or wire), it should never be dragged along the roadway, over stones, or on the ground and should always be free from sharp bends or kinks. It should be placed without tension in the conduit.

At each entrance to an underground conduit or at other cable entrances, 36" of cable slack should be provided. At the base of a standard or sign bridge, this slack cable should be provided in the column.

655.3.2 Splices, Connections, Fuses, and Fuse Holders

It should be determined that all conductor connections and splices are made electrically and mechanically secure. Approved pressure- or compression-type fittings are required on all electrical connections. Those made by Burndy and Thomas and Betts or equal are usually accepted. Each splice must be protected and insulated with an approved vinyl tape that will provide insulation and mechanical protection equal to that of the conductor. Vinyl tape equal in quality to Scotch #33+ may be accepted.

Irregular-shaped splices and connectors are required to be built up with insulating putty to eliminate sharp corners before applying the tape. All insulating materials used on a connection or splice should be of the same brand to preclude possible adverse chemical reaction between them. The entire completed, taped splice should be liberally coated with an approved insulating varnish.

When installing the secondary in-line fuse assembly in the phase wire at the handhole, a sufficient length of No. 12 AWG pole and bracket wire is required to be installed in the pole to allow removal of the fuse holder through the handhole.

FIGURE 655-2 Lighting Installation Checklist

1. BASES
__ a. Are concrete bases in their proper location as shown on the plans? Are they round?
__ b. Are entrance conduits properly installed in the bases?
__ c. Is the top of the base level, trowelled smooth and free of holes?
__ d. Does the bolt circle template fit the pole base?
__ e. Are anchor bolts straight (misalignment less than 1:40 from vertical) and of proper height and diameter?
__ f. Is the base and bolt circle oriented according to the plans and specifications?
__ g. Is a rust prohibitor, corrosion-resistant, anti-seize compound used on all bolts?
__ h. Is a 5/8" x 8' grounding electrode installed at each Type 2 and Type 5 base? Is the grounding rod electrode exothermically welded properly to the ground wire, (sized as called for in the plans), and connected to the pole grounding lug as shown on the plans? Is the wire continuous and without splices?
__I. Are junction boxes mounted in the structure grounded and the cover screws stainless steel hex headed.

2. CONDUIT AND CABLE
__ a. Are all rigid metallic conduits, when required, cut, reamed, and threaded properly?
__ b. Are bushings placed on all metal conduit? Are bell ends placed on all non-metallic conduit?
__ c. Is the cable delivered and stored on reels until placed in the trench?
__ d. Are electrical cables buried at the specified depth?
__ e. Are trenches for cable-in-duct provided with curves rather than sharp bends?
__ f. Are stones, boulders and debris are they removed and replaced by suitable backfill?
__ g. Is the cable, when not in duct, handled carefully and not damaged?
__ h. Is cable laid in the trench without tension?
__ I. Is slack left at conduit entrances?
__ j. Is the cable continuous, without splices, from base to base?
__ k. Is the backfill tamped?
__ l. Are disturbed areas restored to the condition existing before burial operations?

3. POLES AND ARMS
__ a. Do all the delivered poles and arms match the shop drawings?
__ b. When installed, are the poles plumbed and oriented according to the specifications?
__ c. Are unit pole plaques mounted as specified?

4. INTERNAL WIRING
__ a. When cable is pulled up the pole and into the arm, is the cable free at the hole in the pole where the wire enters the arm, and not pinched after the arm is bolted down? Where "J" hooks are installed in a pole, is the wire looped (attached/hung) from the hook?
__ b. Is the specified type of fuse (voltage, amperage) being used?
__ c. Is enough wire left in the base of the pole to allow the fuse holder to be taken out of the pole for service?
__ d. Are the proper wires connected to the "load" and "line" side on in-line fuse assemblies?
__ e. Does the wire improperly protrude into the fuse cavity of the connector?
__ f. Was a proper crimping tool used if ferrule-type connections were made?
__ g. Are all connections and splices both mechanically and electrically secure?
__ h. Are only approved compression-type connectors used for splicing?
__ I. Is an approved insulating tape or putty used to build up connections so sharp edges are eliminated?
__ j. Is approved tape used to cover the connection?
__ k. Have all circuits been tested as required by the specifications?

5. LUMINAIRE AND PHOTOELECTRIC CONTROL
__ a. Is the luminaire of the specified voltage?
__ b. Is the luminaire lamp of the specified wattage and type?
__ c. Is the luminaire socket set for the proper distribution of light according to the plans and in accordance with the manufacturer's instructions?
__ d. Are luminaires leveled properly?
__ e. Is the photoelectric control placed in a position where best possible function of the unit occurs?

When attaching a ferrule to a conductor, a crimping tool must be used to properly indent the ferrule and the conductor. Using long-nose pliers for this purpose is unacceptable and could result in poor mechanical contact or injury to the wire and could contribute to a premature failure.

It should be determined the manner of terminating the No. 12 AWG wire in the ferrule of the fuse holder will avoid the conductor protruding into the cavity of the fuse holder. A check should be made on the fuses to determine that the types and sizes as required in the contract are installed.

655.3.3 Testing Completed Circuits

Under standard spec 651, the contractor is required to perform tests and demonstrate to the engineer that a completed lighting circuit is acceptable.

Testing of a completed lighting circuit will include tests for continuity, ground, insulation resistance, and operation of the circuit. With all fuses removed in all poles on a circuit, the resistance to ground of non-grounded circuits between any two adjacent terminals must be not less than infinity as determined with an insulation tester (megger) on wire or cable having a rating of 600 VAC or higher.

A copy of test results must be given to engineer. The engineer should give a copy of the results to the municipality or agency having jurisdiction.

655.3.4 Photo Electric Control

Where photo electric controls are installed, the "eye" should be positioned to the north or, if this is not practical, in another position where other light sources do not operate the control. The on and off calibration of the control is preset at the factory and will not need adjustment.

655.4 Traffic Signals and Loop Detectors

Figure 655-3 contains a checklist for traffic signal construction inspection, and figure 655-4 contains a checklist for inspection of loop detector construction.

FIGURE 655-3 Traffic Signal Installation Checklist

1. GENERAL
__ a. Are all materials delivered to the job site in accordance with the specifications
2. CONDUIT AND CABLE
__ a. Is any conduit used underground of a thin wall type? If so, it is unacceptable. Only PVC of Schedule 40 or heavier, or rigid metallic conduit is acceptable for underground use.
__ b. Is the specified underground multi-conductor cable used?
__ c. Is the traffic signal cable routed per plan?
__ d. Is a loop of approximately 24" of multi-conductor cable left in the base of signal columns for splice purposes?
__ e. Is an unused wire in the underground cable stripped back to be used for the equipment grounding conductor?
__ f. Are bushings used on all rigid metallic conduit and end bells on non-metallic conduit?
__ g Are all pipe and bolt threads coated with a heavy coating of an approved rust-prohibitor, anti-corrosion, anti-seize compound?
3. BASES AND PEDESTALS
__ a. Are all concrete bases of a proper depth?
__ b. Are pole caps installed to keep water and snow out of the poles and standards?
__ c. Is the signal pedestal leveled on the concrete base?
__ d. Are the shims used for leveling under all four corners of the base? (If so, start over leveling. At most, shims may be used under three corners).
__ e. When finished leveling bases, are all shims tight enough to remain in place?
__ f. If a transformer base is used under the mast arm pole, is it mounted level before the pole is set?
__ g. Are the mounting nuts tight, and leveling shims firmly in place after poles are mounted?
4. POLES AND ARMS
__ a. If signal standards and bases are delivered in two parts, are the standards tightened in the bases with chain wrenches, and tight enough so they will not work loose?
__ b. Is the pole which holds the trombone mast arm, of a proper length?
__ c. Is the trombone mast arm of the proper length?
__ d. Is the pole holding the trombone mast arm, plumb?
__ e. Is the pole cap installed?
5. SIGNAL HEADS
__ a. Is the signal face lens configuration in accordance with the Uniform Manual of Traffic Control Devices?
__ b. Is the signal face mounted in the trombone mast arm tight enough so it doesn't tilt after it is mounted?
__ c. Is the overhead signal face aimed for the most effective sight line to the head?
__ d. Are all ground-mounted signal faces aimed properly?
__ e. Are signal faces mounted in a plumb or level manner as required?
__ f. Are signal and walk light faces mounted with proper clearance above ground level?
__ g. Are overhead signal faces mounted at the proper height?
__ h. Are side-mount brackets tight and plumb?
__ i. If slipfitters are used, are they bolted down tight?
__ j. Are the signal face lenses mounted in their signal face bodies in accordance with manufacturers specifications?

6. WIRING

__ a. Is the electrical service in accordance with the contract specifications?

__ b. Is the wire being handled with care to protect the insulation?

__ c. Is a grommet or bushing provided to protect the wires at points where wires exit from standards to enter a side-mounted head?

__ d. Is a grommet or bushing installed in the pole where the hole for cable leads into the trombone mast arm?

__ e. Are cables free to move from the standard or pole onto the side mounting signal faces or trombone mast arm, and not pinched?

__ f. Are the furnished circuit breakers rated according to specs?

__ g. Are the cable from the signal base to the signal faces of a proper color, as specified?

7. GROUNDS

__ a. Are equipment grounding electrodes driven for the electrical service in accordance with the National Electrical Code and the local utility requirements?

__ b. Are grounding electrodes connected by a grounding electrode conductor without any breaks or splices?

__ c. Does the single, unbroken wire or cable from the grounding electrode(s) connect to the grounding lug provided in the breaker enclosure?

8. CABINETS

__ a. Is the controller post mounted cabinet fitted to the bolt circle provided by the manufacturer?

__ b. Is a 1" duct installed in each cabinet base for the equipment grounding conductor entrance?

__ c. Is the door closed and locked except when being serviced?

9. LED Modules

__ a. Are the LED Modules installed correctly in the signal head housing?.

10. ACCEPTANCE AND OPERATION

__ a. Are scratched or damaged pieces of equipment repaired before the job is accepted?

__ b. Has the signal been turned on and operated for some time before the job is accepted? See standard spec 651.4.

FIGURE 655-4 Loop Detector Installation Checklist

1. CONDUIT
__ a. Are PVC conduits pitched for drainage the pull box?
__ b. Are joints in PVC conduit properly glued?
__ c. Is the PVC conduit properly buried and backfilled?
__ d. Are PVC conduits sealed into the side of the junction box so they are watertight?
__ e. Does the loop ground resistance read "infinity"?
2. SAW SLOTS
__ a. Are adjacent loop sides or corners the minimum distance apart?
__ b. Are pavement slots the proper width?
__ c. Are the slots sawed to the proper depth?
__ d. Are the bottom and sides of the slot clean?
__ e. Is the saw slot depth maintained around or across corners?
3. WIRE LOOPS
__ a. Is the loop wire of the type specified?
__ b. Has the loop wire been damaged in any way? If so, don't use.
__ c. If any loops in duct are buried in the base course, is the duct protected from traffic to prevent crushing and subsequent damage before paving?
__ d. Are the proper number of turns of wire placed in the slots?
__ e. Are the loop wires twisted from under the pavement to the splice?
__ f. Is the polyethylene pipe top (in pavement) stuffed with a rag to prevent tar from running into the pull box? Are the loop wires twisted from under the pavement to the splice?
4. SPLICES
__ a. Are extra loops of wire left at a splice connection rather than cutting off wires to an "only needed" length?
__ b. Before the splice is made and after the loop sealant has been poured, was the loop tested for ground resistance?
__ c. Are splice kits of an approved type?
__ d. Are wires soldered at the splice?
__ e. Are spliced wires insulated from each other in the splice kit?
__ f. Are the ends of the splice kit taped or blocked so the sealant does not run out?
__ g. Is the sealant in the splice kit poured into the tipped or lower end to force out all air?
5. PULL BOX
__ a. Are pull boxes installed per SDD 9B4?
6. PULL WIRE
__ a. If the loop wire is not installed when building the PVC loop, is a pull wire installed?
7. LEAD-IN WIRES
__ a. Are loop wires twisted at least three turns per 12"?
__ b. Is the type "T" access fitting marked with the ease of future retrieval in mind?
__ c. Is the hole drilled in the pavement of a size sufficient to hold the PVC Conduit tight?
__ d. Is the PVC conduit pitched to drain into a pull box, if a pull box is used?
8. AS-BUILT PLAN
__ a. Has an as-built loop layout been filed?
__ b. Are loop lead wires identified in relation to the loops they are tied to?

655.5 Detectable Warning Fields

655.5.1 General

The department conforms to the Americans with Disabilities Act requirements that mandate detectable warning fields for all curb ramps that are newly constructed or modified under the oversight of the department.

The department does not allow stamped concrete installations for curb ramp detectable warning fields. Under standard spec 602.2, contractors must provide a detectable warning field from the APL.

655.5.2 Construction Method

Curb ramp detectable warning fields should be installed 6 to 8 inches from the flow line of the curb. In installations where the orientation of the ramp and the radius of the curb skews the detectable warning field, the closest edge of the curb ramp detectable warning field should maintain the 6 to 8-inch offset from the flow line of the curb.

The rectangular warning fields are 2' deep and vary in length from 1' to 3'. The length of the rectangular warning field should be perpendicular to the down-slope direction. This will align the grid pattern with the direction of travel of the ramp to provide unimpeded access to the pedestrian walkway for wheel chair

users. This is independent of the direction of the crosswalk, although efforts should be made to keep the orientation of the crosswalk to the ramp similar to provide directional cues for handicapped users.

Curb ramp detectable warning fields are to be installed with the floor of the product equal in elevation to the surrounding curb ramp.

The cross slope of the sidewalk, curb ramp, and warning field should not exceed 2%. Additionally, landing areas should not exceed 2% in either direction as specified in the contract detail drawings.

- SDD 8D5-10a Curb Ramps Types 1, 1-A
- SDD 8D5-10b Curb Ramps Type 2 and 3
- SDD 8D5-10c Curb Ramps Type 4A
- SDD 8D5-10d Curb Ramps Type 4B
- SDD 8D5-10e Curb Ramps Type 5, 6, 7A, 7B, & 8

Inset product installations should be finished with a concrete edging tool to provide a clean rounded edge. When applying the broom finish to the curb ramp care should be taken to pull the broom away from the warning field. Excess concrete broomed onto the curb ramp detectable warning field will cause uncontrolled cracking and subsequent spalling at the inset product interface.

SECTION 660 Well Construction and Borehole Abandonment

The inspector should ensure well construction does not deviate from the procedure specified in the contract, as any deviations may be contrary to the requirements of the state code. The contract will indicate the diameter of the drill holes, the diameter of the casing to be installed, the type of material expected to be encountered, and the anticipated depth of the well. The construction methods specified are established by a review of the known geological features of the area and the records of any previous wells in the vicinity that may be on file with the DNR. The size of drill holes and casing, the depth of the casing, and the method of sealing the annular space between the upper drill hole and the casing, or between the casing and the liner pipe are established in accordance with the requirements of Chapter NR 812, Wisconsin Administrative Code of the DNR.

Strict adherence to the contract provisions does not ensure an adequate supply of potable water will be obtained. Many unforeseen difficulties may be encountered, requiring changes in the planned construction procedures. However, no changes in methods or work outside the scope of the original contract must be undertaken until a change order has been authorized.

Refer to figure 660-1 for steel casing pipe requirements established by the Wisconsin DNR. Recognized national standards for public water supplies recommend a maximum iron content of about 0.3 parts per million. However, for wells of the type in our waysides and rest areas, several parts per million of iron can be tolerated. Also, water that is slightly corrosive (with PH deviating considerably from the norm of 7.0) has been utilized. Hardness has not been a major consideration in evaluating the suitability of these wells.

660.1 Construction Details

One source of difficulty occasionally encountered is caving strata below the casing. In these instances, the casing has probably been terminated by driving to a firm seat in a hard layer or stratum, and the drill hole continued through rock into a less firm layer. This layer may or may not be water-bearing. If the material continues to cave and slough into the hole an unacceptable well will result.

It also happens occasionally that water from a less firm layer may be unacceptable due to high turbidity, iron content, sulphide taste or smell, bacteriological content or other reasons. In either situation, the solution may be to place a liner pipe inside the drill hole and grout the annular space around the pipe to seal off the unacceptable formation. A smaller drill hole is then extended downward from the bottom of the liner pipe to find an acceptable source of water. The diameter of the well is usually large enough that one liner pipe can be placed. When the well diameter is decreased by use of a liner pipe, the designer should be contacted to discuss the effect on the water supply system. The outer temporary well casing of the upper drill hole must be removed during grouting operations, unless the engineer allows it to remain in place.

FIGURE 660-1 Steel Well Casing Pipe Weights and Dimensions

TABLE B
MINIMUM STEEL WELL CASING PIPE AND COUPLING WEIGHTS AND DIMENSIONS

WELL CASING PIPE								REAMED & DRIFTED COUPLINGS	
Size	Weight in Pounds per Foot				Thickness in Inches		Diameter in Inches		Diameter & Length	
Diameter in Inches	Threaded & Coupled		Plain End		Low Caps	Potable High Cap, School & WWTP	External	Internal	External Diameter in Inches	Length in Inches
	Low Caps	Potable High Cap, School & WWTP	Low Caps	Potable High Cap, School & WWTP						
1	1.7		1.68		0.133		1.315	1.049	1.576	2–5/8
1–1/4	2.3		2.27		0.140		1.660	1.380	1.900	2–3/4
1–1/2	2.75		2.72		0.145		1.900	1.610	2.200	2–3/4
2	3.75		3.65		0.154		2.375	2.067	2.750	2–3/4
2–1/2	5.90		5.79		0.203		2.875	2.469	3.250	2–7/8
3	7.70		7.58		0.216		3.500	3.068	4.000	3–15/16
3–1/2	9.25		9.11		0.226		4.000	3.548	4.625	4–1/16
4	11.00		10.79		0.237		4.500	4.026	5.200	4–3/16
5	15.00		14.62		0.258		5.563	5.047	6.296	4–5/16
6	19.45		18.97		0.280		6.625	6.065	7.390	4–1/2
6–5/8 OD	20.00		19.49		0.288		6.625	6.049	7.390	4–11/16
7 OD	23.00		22.63		0.317		7.000	6.366	7.657	4–11/16
8	25.55	29.35	24.70	28.55	0.277	0.322	8.625	8.071	9.625	4–11/16
10	35.75	41.85	34.25	40.48	0.307	0.365	10.750	10.136	11.750	5–1/16
12	45.45	51.15	43.77	49.56	0.330	0.375	12.750	12.090	14.000	5–9/16
14 OD	57.00		54.57		0.375		14.000	13.250	15.000	5–15/16
16 OD	65.30		62.58		0.375		16.000	15.250	17.000	6–3/8
18 OD	73.00		70.59		0.375		18.000	17.250	19.000	6–3/4
20 OD	81.00		78.60		0.375		20.000	19.250	21.000	7–1/8
22 OD			114.81		0.500		22.000	21.000		7–5/8
24 OD			125.49		0.500		24.000	23.000		

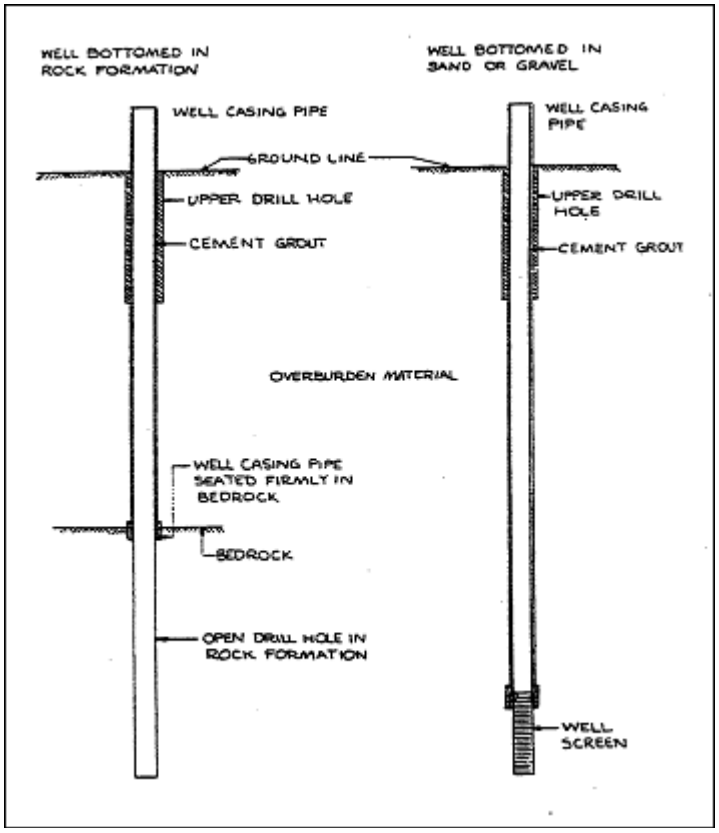
Note: The weight of threaded and coupled well casing pipe includes the weight of the coupling.

Wells that are not expected to bottom in bedrock, but where an acceptable water supply is expected in an unconsolidated and gravel formation, will be required to have the casing fitted at the lower end with a screen. The screen length and size of openings should be as recommended by the manufacturer on the basis of a mechanical analysis of a sample of the material from the water-bearing formation and the specified yield capacity of the well.

Usually the minimum specified screen length of 36" is ample for the capacity required in the department's wayside wells with a hand pump. Generally, the screen is placed by either the pullback or bail-down methods. In the pullback method, the screen is lowered to the bottom of the casing and the hole. The casing is then pulled back or retracted and the screen exposed to the aquifer. A special tool is then lowered inside the casing and a formable washer at the top of the screen is swaged outward to form a tight sand seal with the casing.

In the bail-down method, the screen fitted with a special bail-down shoe is lowered to the bottom of the casing and the hole. The sand ahead of the screen is then bailed out through the special shoe and the screen settled to its exposed position in the water-bearing strata. The special nipple in the bail-down shoe at the end of the screen is then plugged and the formable washer at the top swaged to the casing. Instead of using a formable washer, the contractor can opt to drill an oversize drill hole and then weld or screw on the well screen at the bottom of the casing pipe. Details and cross-sections of two typical well installations, one with a screen, are shown in figure 660-2.

FIGURE 660-2 Cross-Sections of Typical Well Installations



660.2 Test Pumping

When it is thought an acceptable supply of water has been reached, the well should be test pumped. The purpose of test pumping is to determine the yield capacity of the well or to prove it complies with the minimum specified in the contract. The inspector should record the static water level in the well before starting pumping, the pumping rate, which should be held constant until a stable water level is reached in the well, and the corresponding water level, together with the time each observation was taken. It is desirable to make these observations at various pumping rates. If the minimum specified capacity has not been obtained, and the nature of the material encountered makes it improbable that an increased supply can be reached without considerable additional drilling and expense, the well discharge during test pumping should be checked for solids being pumped out of the well.

The operation of disinfecting the well is incidental to the bid item of Well Casing Pipe. The completed system (water column, pump and discharge piping) must be disinfected with a chlorine solution of 100 mg/L (minimum strength) or stronger, which must remain in the system at least 8 hours. The system must be thoroughly flushed before sampling or using the water supply.

660.3 Sampling

A two-sample procedure is recommended. The first water sample should be obtained during the test pumping procedure, and the second sample taken after the pump is installed and disinfected. Results of the tests can indicate whether both well and pump are safe or whether the source of contamination is in the well or the pump.

The driller must also file a report with the DNR showing the details of the well construction and is required by the code to furnish a copy of the report to the owner. A copy of this report should be submitted to the region. The work should not be accepted until copies of the Construction Report have been received.

The driller is required by the Wisconsin Administrative Code NR 812.46 to obtain a water sample from each new well for transmission to the State Laboratory of Hygiene. The sample may be sent to a private laboratory of the well driller's choosing provided the private laboratory agrees to send a water sample to DNR and provided the laboratory is certified by the Department of Health and Social Services. The test must be for bacteriological analysis.

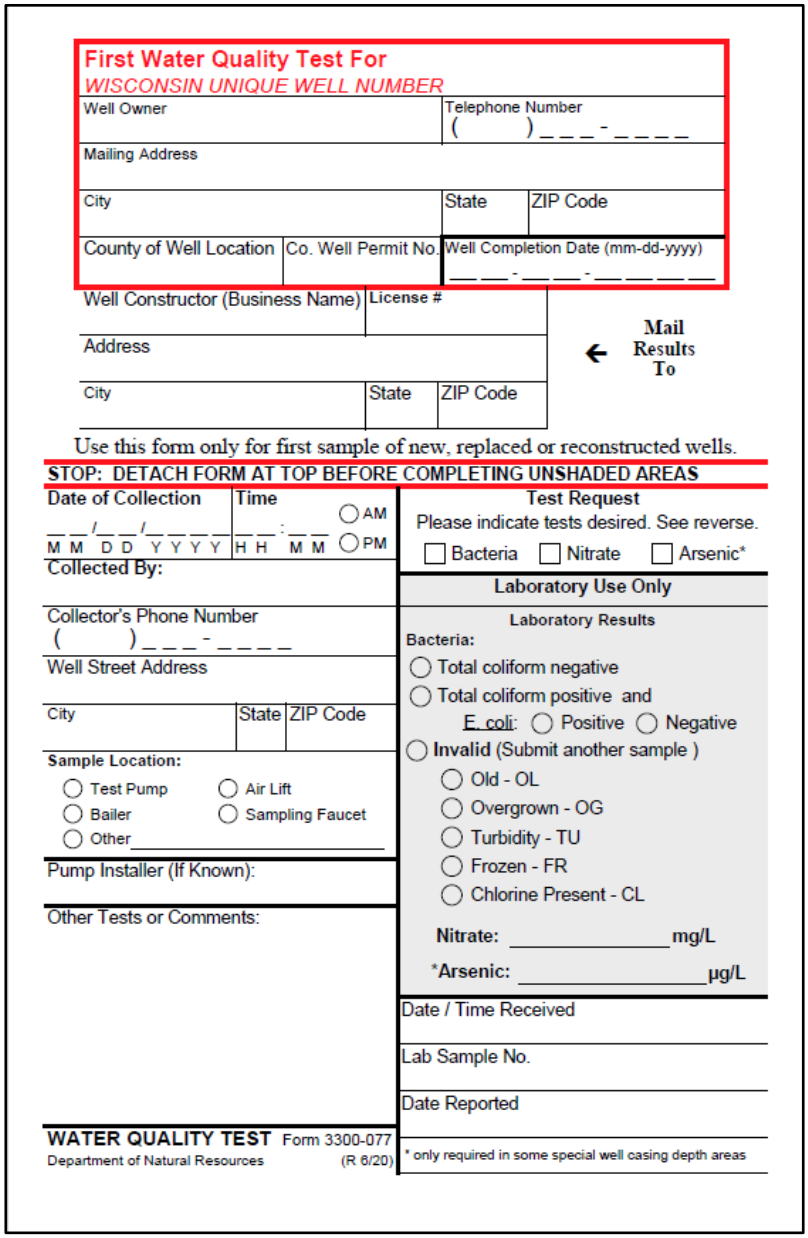
The required water sample should be taken by the driller in the presence of the engineer and sent by the engineer, together with a completed Water Bacteriology form requesting analysis of the sample, to the

State Laboratory of Hygiene, 2601 Agriculture Drive, Madison, Wisconsin, 54718, or to the address of the certified private laboratory selected by the driller. If the pump and piping system installer is different than the driller, each must submit a water sample, upon completion of the work done by each, for bacteriological analysis.

For each water well drilled, the engineer should complete DNR Form 3300-77, Water Quality Test and send it, together with water samples, to the State Laboratory for Hygiene. The region chief construction engineer should receive a copy of the results of testing from the State Laboratory of Hygiene. Copies of Water Quality and Well Construction Reports need to be filed with region maintenance section and Bureau of Highway Operations. DNR Form 3300-77 is available at:

https://dnr.wi.gov/files/pdf/forms/3300/3300-077.pdf

FIGURE 660-3 Example Water Quality Test, DNR Form 3300-77



First Water Quality Test For
WISCONSIN UNIQUE WELL NUMBER

Well Owner | Telephone Number ( ) _ _ _ - _ _ _ _

Mailing Address

City | State | ZIP Code

County of Well Location | Co. Well Permit No. | Well Completion Date (mm-dd-yyyy) __ __ - __ __ - __ __ __ __

Well Constructor (Business Name) | License #

Address

City | State | ZIP Code

Mail Results To

Use this form only for first sample of new, replaced or reconstructed wells.

STOP: DETACH FORM AT TOP BEFORE COMPLETING UNSHADED AREAS

Date of Collection __ __ / __ __ / __ __ __ __ (M M D D Y Y Y Y) | Time __ __ : __ __ (H H M M) ○ AM ○ PM

Collected By:

Collector's Phone Number ( ) _ _ _ - _ _ _ _

Well Street Address

City | State | ZIP Code

Sample Location:
○ Test Pump ○ Air Lift
○ Bailer ○ Sampling Faucet
○ Other _____

Pump Installer (If Known):

Other Tests or Comments:

Test Request
Please indicate tests desired. See reverse.
☐ Bacteria ☐ Nitrate ☐ Arsenic*

Laboratory Use Only

Laboratory Results

Bacteria:
○ Total coliform negative
○ Total coliform positive and
E. coli: ○ Positive ○ Negative
○ Invalid (Submit another sample)
○ Old - OL
○ Overgrown - OG
○ Turbidity - TU
○ Frozen - FR
○ Chlorine Present - CL

Nitrate: _____ mg/L

*Arsenic: _____ µg/L

Date / Time Received

Lab Sample No.

Date Reported

* only required in some special well casing depth areas

WATER QUALITY TEST Form 3300-077
Department of Natural Resources (R 6/20)

In accord with standard spec 639.3.3, samples also are to be taken by the driller for nitrate, iron, manganese, turbidity, and hardness tests. A combined sample for bacteria/nitrate test can be sent in but must be separate from the samples for the other tests.

Frequently, the samples are inadvertently contaminated during the sampling process or may receive contamination from inadequately sterilized components of the pump assembly and piping. It is not uncommon for several samples to test 'unsafe' before one is secured which tests 'safe.' Samples should be taken early in the week and promptly submitted to the laboratory for analysis. In the event the samples

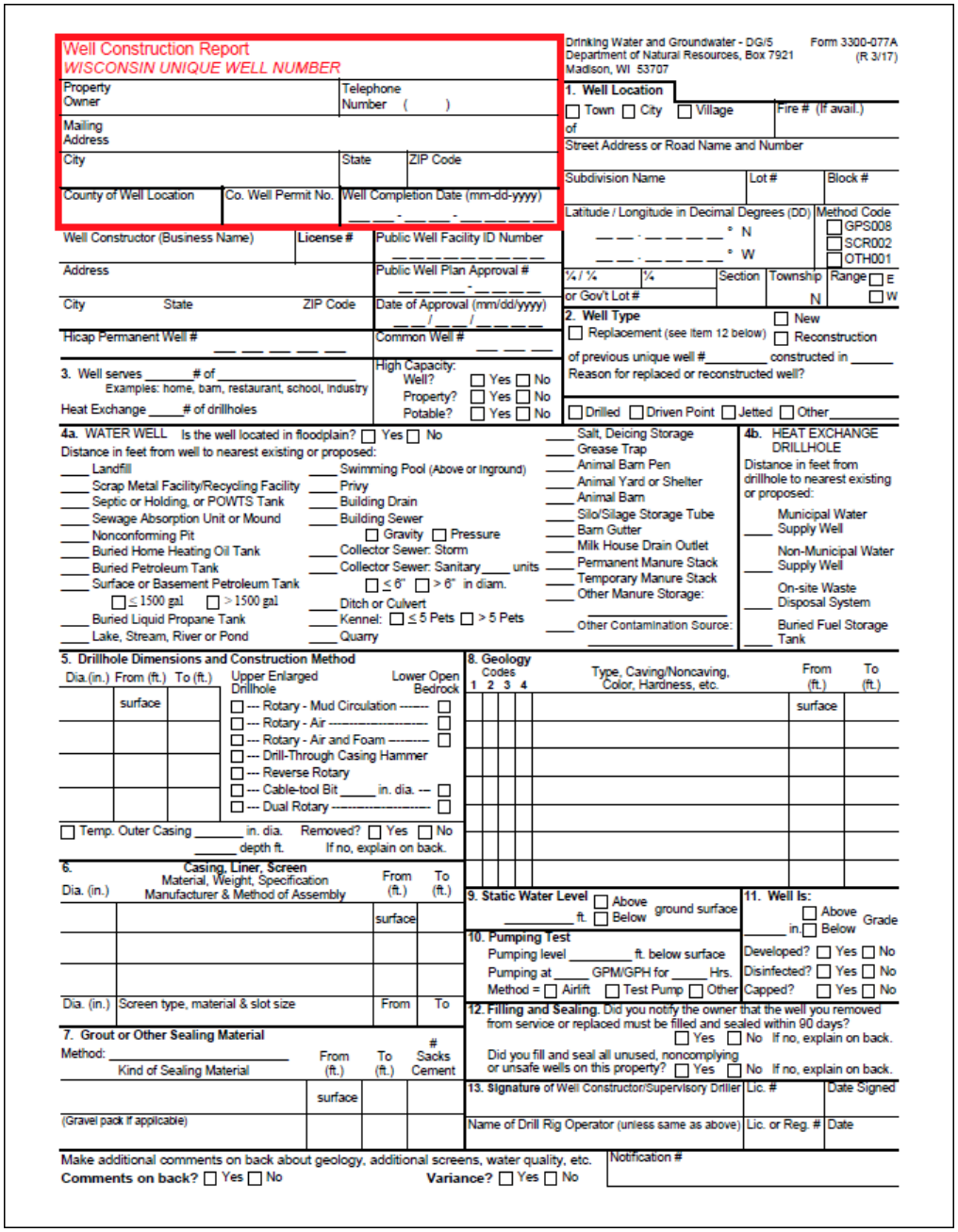
are 48 hours old or more when received, the laboratory will not perform the requested analysis and it will be necessary to submit another sample.

In addition to submitting water samples to the State Laboratory of Hygiene for testing, the driller must also file a report with the State DNR showing the details of the well construction and is required by the Wisconsin Administrative Code to furnish a copy of the report to the owner. A copy of this report should be submitted to the region chief construction engineer.

The well should not be accepted until the engineer receives and evaluates DNR Form 3300-77A, Well Construction Report. A copy of the results of the analysis should be sent to the region. DNR Form 3300-77A is available at:

https://dnr.wi.gov/files/PDF/forms/3300/3300-077A.pdf

FIGURE 660-4 Example Well Construction Report, DNR Form 3300-77A



Well Construction Report
WISCONSIN UNIQUE WELL NUMBER

Drinking Water and Groundwater - DG/5
Department of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-077A
(R 3/17)

Property Owner | Telephone Number ( )

Mailing Address

City | State | ZIP Code

County of Well Location | Co. Well Permit No. | Well Completion Date (mm-dd-yyyy)

Well Constructor (Business Name) | License # | Public Well Facility ID Number

Address | Public Well Plan Approval #

City State ZIP Code | Date of Approval (mm/dd/yyyy)

Hicap Permanent Well # | Common Well #

3. Well serves _____ # of _____
Examples: home, barn, restaurant, school, industry
Heat Exchange _____ # of drillholes

High Capacity:
Well? ☐ Yes ☐ No
Property? ☐ Yes ☐ No
Potable? ☐ Yes ☐ No

1. Well Location
☐ Town ☐ City ☐ Village | Fire # (If avail.)
of
Street Address or Road Name and Number

Subdivision Name | Lot # | Block #

Latitude / Longitude in Decimal Degrees (DD) | Method Code
° N
° W
☐ GPS008 ☐ SCR002 ☐ OTH001

¼ / ¼ | ¼ | Section | Township | Range ☐ E ☐ W
or Gov't Lot #

2. Well Type ☐ New
☐ Replacement (see item 12 below) ☐ Reconstruction
of previous unique well # _____ constructed in _____
Reason for replaced or reconstructed well?

☐ Drilled ☐ Driven Point ☐ Jetted ☐ Other _____

4a. WATER WELL Is the well located in floodplain? ☐ Yes ☐ No
Distance in feet from well to nearest existing or proposed:
___ Landfill
___ Scrap Metal Facility/Recycling Facility
___ Septic or Holding, or POWTS Tank
___ Sewage Absorption Unit or Mound
___ Nonconforming Pit
___ Buried Home Heating Oil Tank
___ Buried Petroleum Tank
___ Surface or Basement Petroleum Tank
☐ ≤ 1500 gal ☐ > 1500 gal
___ Buried Liquid Propane Tank
___ Lake, Stream, River or Pond
___ Swimming Pool (Above or Inground)
___ Privy
___ Building Drain
___ Building Sewer
☐ Gravity ☐ Pressure
___ Collector Sewer: Storm
___ Collector Sewer: Sanitary ___ units
☐ ≤ 6" ☐ > 6" in diam.
___ Ditch or Culvert
___ Kennel: ☐ ≤ 5 Pets ☐ > 5 Pets
___ Quarry
___ Salt, Deicing Storage
___ Grease Trap
___ Animal Barn Pen
___ Animal Yard or Shelter
___ Animal Barn
___ Silo/Silage Storage Tube
___ Barn Gutter
___ Milk House Drain Outlet
___ Permanent Manure Stack
___ Temporary Manure Stack
___ Other Manure Storage:
___ Other Contamination Source:

4b. HEAT EXCHANGE DRILLHOLE
Distance in feet from drillhole to nearest existing or proposed:
___ Municipal Water Supply Well
___ Non-Municipal Water Supply Well
___ On-site Waste Disposal System
___ Buried Fuel Storage Tank

5. Drillhole Dimensions and Construction Method
Dia.(in.) | From (ft.) | To (ft.) | Upper Enlarged Drillhole | Lower Open Bedrock
surface
☐ --- Rotary - Mud Circulation ------ ☐
☐ --- Rotary - Air ---------- ☐
☐ --- Rotary - Air and Foam --------- ☐
☐ --- Drill-Through Casing Hammer
☐ --- Reverse Rotary
☐ --- Cable-tool Bit _____ in. dia. --- ☐
☐ --- Dual Rotary ---------- ☐
☐ Temp. Outer Casing _____ in. dia. Removed? ☐ Yes ☐ No
_____ depth ft. If no, explain on back.

8. Geology
Codes 1 2 3 4 | Type, Caving/Noncaving, Color, Hardness, etc. | From (ft.) | To (ft.)
surface

6. Casing, Liner, Screen
Dia. (in.) | Material, Weight, Specification Manufacturer & Method of Assembly | From (ft.) | To (ft.)
surface
Dia. (in.) | Screen type, material & slot size | From | To

9. Static Water Level ☐ Above ☐ Below ground surface
_____ ft.

10. Pumping Test
Pumping level _____ ft. below surface
Pumping at _____ GPM/GPH for _____ Hrs.
Method = ☐ Airlift ☐ Test Pump ☐ Other

11. Well Is: ☐ Above ☐ Below Grade
_____ in.
Developed? ☐ Yes ☐ No
Disinfected? ☐ Yes ☐ No
Capped? ☐ Yes ☐ No

7. Grout or Other Sealing Material
Method: _____
Kind of Sealing Material | From (ft.) | To (ft.) | # Sacks Cement
surface
(Gravel pack if applicable)

12. Filling and Sealing. Did you notify the owner that the well you removed from service or replaced must be filled and sealed within 90 days? ☐ Yes ☐ No If no, explain on back.
Did you fill and seal all unused, noncomplying or unsafe wells on this property? ☐ Yes ☐ No If no, explain on back.

13. Signature of Well Constructor/Supervisory Driller | Lic. # | Date Signed
Name of Drill Rig Operator (unless same as above) | Lic. or Reg. # | Date

Make additional comments on back about geology, additional screens, water quality, etc.
Comments on back? ☐ Yes ☐ No Variance? ☐ Yes ☐ No
Notification #

660.4 Abandoning Drilled Boreholes and Wells

There is an increased emphasis by the DNR on proper abandonment of drilled holes. The engineer must complete report for each well abandoned under the contract and submit the completed form to the DNR. It should be completed and submitted promptly after the well has been abandoned. Information on the

depth of the well and the geologic features should be included only if the information is reliable. Distribution is shown at the bottom of each form sheet and explained on the reverse side.

The greatest concern is in Situations 3, 4 and 6 below, where the hole provides ready access to ground water. Following are the steps to be taken by WisDOT and consultant drill crews:

1. Boreholes 10' and less in depth will be filled by shoveling in and tamping the drill cuttings. Tamp from bottom to the top.
2. Auger holes greater than 10' in depth will be filled by pouring in 3/4" or 3/8" DNR-approved, bentonite chips. Pour over a coarse screen, at the rate of one minute per bag, to remove dust and prevent bridging. Then activate by pouring in clean water.
3. Bentonite (mud) rotary drilling holes will be filled with a filler. Pump grout from bottom of bore hole to the surface. Pull casing. Top off with at least 6' of DNR-approved bentonite chips and water. Acceptable filler materials are neat cement grout, sand-cement grout, concrete mixture, bentonite-sand slurry, or bentonite-cement grout.
4. Holes drilled from a barge will be filled by cement grouting from the bottom to the barge deck. Then pull casing.
5. Barnyard, pasture, cultivated farm fields and related area-type borings will be cement grouted from the bottom of 2' below surface. Complete with tamped topsoil.
6. Monitoring well abandonment:
    - Drop in drill rod with bit and pump cement grout from the bottom to the surface.
    - Pull the drill rod and auger out the top 6' of PVC pipe and annular space seal.
    - Complete with bentonite chips and water.
7. Additional notes:
    - Neat cement grout: 80# bag of portland cement to 5-6 gal of water.
    - Sand-cement grout: 80# bag of portland cement, one cubic yard of sand and 5-6 gal of water.
    - Concrete: 80# bag of portland cement, equal volumes of sand and gravel (recommend to use max size 100% passing 3/4" screen 100% retained on 3/8' screen) and 5-6 gal of water. The ratio of volumes of sand and gravel to cement must not exceed 3 to 1 (use only in drill holes 4" or larger.)
    - Bentonite-sand slurry: 55# of bentonite to 100 gal of water, and 10-25% sand by volume. The mud density must be a minimum of 12#/gal.
    - Bentonite-cement grout: 5# of bentonite to 80# of cement and 5-6 gal of water.
    - Asphalt paved areas at airports will be topped off with 6" of asphaltic mixture. All other asphalt and concrete paved areas, including highways, will be topped off with 6" of portland cement concrete.

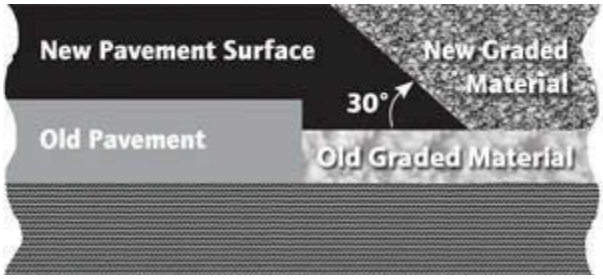
Additional information relative to abandoning wells is contained in standard spec 204.3.3.

SECTION 670 Safety Edge

670.1 General

Safety edge is an approximately 30-degree sloped wedge of pavement added to the outside edge of a lane with no shoulder or the outside edge of a paved shoulder.

FIGURE 670-1 Typical Cross Section



Background information and guidance on safety edge is available on the FHWA safety edge website at:

http://www.fhwa.dot.gov/everydaycounts/technology/safetyedge/intro.cfm

Safety edge is used to mitigate run-off-the-road crashes due to edge drop. Edge drops as little as 2.5 inches can cause a driver to over steer in an attempt to reenter the pavement. At some point the vehicle's tires suddenly climb the edge drop and the vehicle abruptly shoots across its' lane into oncoming traffic or leaves the roadway.

Besides the safety benefit of the safety edge, many states are reporting better pavement performance near the safety edge. Some of the benefits are: reduced edge line cracking, better compaction, less damage to pavement edge due to construction traffic.

Safety edge can be installed on HMA and concrete pavements. Currently WisDOT is only using safety edge on HMA.

Safety edges are created by adding a wedge maker to the paver. Different manufactures have different types of wedge makers that attach to pavers in different locations. Typically, on HMA pavers wedge makers are attached to the end plate or the screed of the paver.

FIGURE 670-2 HMA Wedge Maker



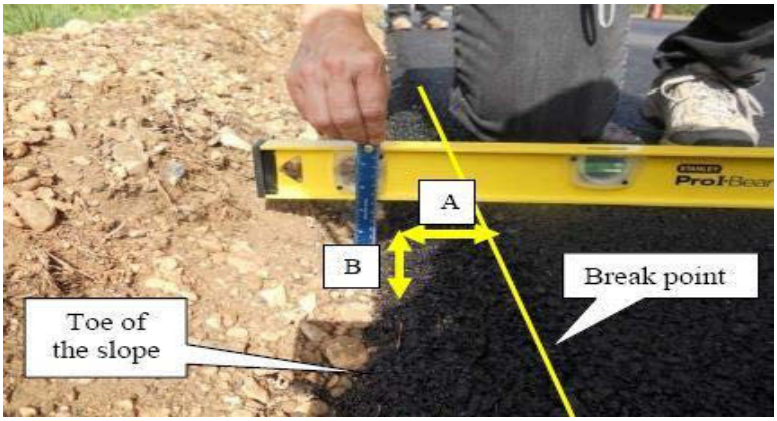
Material trapped between wedge maker and end plate can affect the slope of the finished edge.

670.2 Measuring Safety Edge Angle

The contract standard detail describes the required angle in terms of the horizontal run to the vertical rise of the sloped portion of the safety edge. The target angle of 30 degrees is equivalent to about 1.7:1. The contract limits of 1.8:1 and 1.2:1 are equivalent to an allowable range of about 29 degrees to about 40 degrees.

Figure 670-3, borrowed from the FHWA's Safety Edge$_{SM}$ Design and Construction Guide, shows how to measure the required angle in the field. Distance A divided by distance B needs to be within the range the contract specifies.

FIGURE 670-3 Field Check of the Required Angle



B is the vertical distance from the toe to an extension of the pavement surface cross slope. The toe is where the sloped surface contacts the ground or intersects a vertical edge. It may be useful to use a straightedge to better define the plane of the sloped surface otherwise single aggregate particle can have a meaningful effect on the resultant measurement.

A is the distance from the point where a straight edge laid on the pavement surface deviates from the surface, the break point, to a vertical projection from the toe or edge of the sloped portion.

670.2.1 When to Measure Safety Edge Angle

To get an accurate angle measurement at a given location at least two angle measurements are needed. The first measurement should be made as soon as practicable behind the paver. Angle measurements taken near the paver are likely to be near the 30-degree angle or flatter. This measurement helps the contractor to quickly adjust the safety edge to the correct angle.

The second angle measurement is made after the finished roller. In some situations, the rolling process can steepen the angle of the safety edge. The second measurement is for final acceptance of the safety edge.

During the initial start of pavement operations, or if there is a change in pavement operations, a contractor may wish to measure the angle of the safety edge during each stage of the rolling process. This will help determine how the rolling pattern is influencing the angle of the safety edge.

Each layer with safety edge needs to have the angle of the safety edge measured.

670.2.2 How Often to Measure Safety Edge Angle

At a minimum, safety edge angle should be measured at the following locations:

- Within 200 feet of the start of the paving the safety edge.
- At the start/end of a curve's superelevation.
- Approximately midway between PC/PT and start/end of a curve's superelevation.
- PI of a horizontal curve.
- Once every 1000 feet on a tangent section.

If a final acceptance angle is steeper than the acceptable range of angles, more frequent measurement is required.

670.3 Acceptable Angles

For final acceptance safety edge angles may range from about 29 to 40 degrees (inclusive). Angles flatter than 29 degrees are safe but may require more material or can be difficult to match into later. Angles of 40-degrees or steeper require corrective action by the contractor.

Corrective action includes but is not limited to the following:

- Adjust the angle of wedge maker.

- Adjust the amount of material reaching the wedge maker.
- Remove material trapped between the wedge maker and the end plate (see figure 670-2 above).
- Increase or decrease the amount of downward force being applied to the wedge maker.
- Remove objects that can snag on the wedge maker.
- Review firmness or grade of the shoulder below the safety edge.
- Change the rolling pattern.

670.4 Where Not to Install Safety Edge

Safety edge is not intended for the following applications:

- Centerline pavement joint.
- Joint between paved side road and mainline.
- Bridge decks.
- Adjacent to concrete barrier.
- Adjacent to curb and gutter.
- Edges between adjoining pavements.
- Centerline pavement joint.
- Mainline and taper joint.
- Mainline and turning joints.

Depending on the project, if a driveway is paved a safety edge may or may not be installed. Some examples:

- On a mill and overlay project, the mainline pavement adjacent to a paved driveway would not get a safety edge.
- On a mill and overlay project, the mainline pavement adjacent to a gravel driveway would get a safety edge.

Depending on contractor's equipment it may be difficult to install safety edge near beam guard.

670.5 Lessons Learned

The following lessons have been learned:

1. For proper performance the wedge maker needs to be adjusted periodically.
    - Too much pressure on the wedge maker can cause the wedge maker to snag on material below it.
    - Too much pressure can damage wedge maker or wedge maker's adjustment mechanisms.
    - Too little pressure on the wedge maker can prevent the wedge maker from forming proper edge or reduces the compaction provided by the wedge maker.
    - Too little pressure on the wedge maker can allow too much of a gap between the base and the wedge maker. This may allow material to spill out from the wedge maker. Depending on the amount of vertical adjustment a wedge maker has, a contractor may have to install safety edge with multiple layers to prevent material from spilling out from under the wedge maker. It may not be possible to place a 5-inch tall safety edge in one layer with a Carlson Paving Products wedge maker.
2. Insure base aggregate foundation is proper graded and compacted when placing safety edge.
    - If the wedge maker loses contact with foundation material, HMA can spill out under the wedge maker and allow a crack to form later during the paving process (see figure 670-4).
    - If placing safety edge on a final layer, the wedge maker may need more adjustment than 5 inches to compensate for variations in mat thickness and gravel profile. The contractor may have to use multiple layers to install the safety edge properly. It may not be possible to place a 5-inch tall safety edge in one layer with a Carlson Paving Products wedge maker.

FIGURE 670-4 Cracked Edge



Safety edge cracked because wedge maker lost contact with base aggregate.

3. Too little HMA by the wedge maker can:
    - Prevent the proper angle from being extruded.
    - Prevent the safety edge from forming a smooth surface texture.
    - Allow the material to get between the wedge maker and the end plate. Material in this location can cause the wedge maker to pivot. If the wedge maker pivots, the angle of safety edge can become too steep.
    - Make it difficult to get a smooth face to the safety edge.
4. Variations in mix design and ambient temperatures can have an impact on the construction of the safety edge.
    - Tender mixes have a tendency to move more during rolling causing the angle to steepen.
    - The angle of the wedge maker must be reduced to compensate for HMA movement.
5. On multiple layer applications of safety edge, it is not necessary to get a perfect match between layers. A stair step look is acceptable. However, these variations will impact the roadway width. Added width to lower layers may be needed to allow for proper location of edge of pavement.
6. The top of the safety edge is at the edge of the lane line if no paved shoulder is present or at the edge of paved shoulder. Properly locate the top edge of safety edge. Add width to lower layers to allow for proper location of edge of pavement.
7. Safety edge typically adds less than 1 to 2 percent of the overall tonnage of HMA being paved. For most construction projects, the quantities have been adjusted by the designer. If construction staff is unsure if the quantities have been adjusted for the safety edge, contact the designer.
8. Discuss construction of the safety edge during the preconstruction or prepaving meeting. Discuss the following:
    - What wedge maker will be used.
    - Amount of vertical adjustment a wedge maker will have.
    - Number of layers and layer thicknesses used to construct safety edge.
    - Quality of grade.
        - Compaction.
        - Profile.
        - Offsets.
    - Rolling patterns used.

700 Construction Surveying

CMM 710 Construction Surveying - General
CMM 715 Highway Staking
CMM 718 Automated Machine Guidance
CMM 719 Automated Machine Guidance - Concrete Paving
CMM 720 Staking Storm Sewer System
CMM 725 Staking Subgrade and Base
CMM 730 Staking Curb, Gutter, Curb and Gutter, and Concrete Barrier
CMM 735 Staking Pipe Culverts
CMM 740 Staking Structure Layout
CMM 745 Staking Concrete Pavement
CMM 750 Staking Re-Surfacing Reference
CMM 755 Staking Electrical Installations
CMM 760 Staking Supplemental Control
CMM 762 Slope Staking
CMM 765 Staking Right of Way
CMM 770 Cross Sections and Digital Terrain Models
CMM 775 Staking Borrow Pits
CMM 780 Constructing and Restoring Access Points
CMM 785 Survey Monuments

SECTION 710 Construction Surveying - General

CMM provisions mobilized by the contract:

CMM 710.3 ..... construction data packet

710.1 Responsibility for Surveys

Generally, construction survey work will consist of setting the construction stakes necessary for field control and layout. It will include setting stakes or marks to establish alignment, grade, and slopes for grading the roadway, ditches, and channels; to designate limits of right-of-way; to establish alignment and grade for base and surface courses; and to establish location, grade, and alignment of structures. Construction survey work will also consist of taking measurements, such as cross sections or a digital terrain model (DTM), for determining quantities of work.

The engineer is directly responsible for the construction survey work. Regardless of how the survey crew is organized administratively, the engineer must have full knowledge of methods used and results accomplished.

The engineer, by means of the survey crew, will furnish and set the initial stakes for establishment; however, standard spec 105.6 provides that the contractor will furnish such other facilities and labor the engineer may deem necessary for setting stakes or points after work has begun. The contractor is required to furnish all stakes and other material necessary to preserve and protect stakes or points. The contractor must furnish and set all additional stakes or markings necessary to transfer alignment or grades from the controlling stakes or points established by the engineer.

If any survey monuments stakes set by the department are carelessly or willfully destroyed or disturbed by the contractor, the cost of replacement by the department may be charged against the contractor and deducted from the next payment.

Attention should be directed to safety of the survey crew when performing survey work, especially where work is subject to public traffic or construction machinery movements. The crew chief is responsible for implementing and maintaining safe procedures on survey work and for ensuring proper use of safety measures such as hard hats, safety vests, warning signs, flags, paddles, etc.

Construction survey work done by the contractor, or by a consultant engineering firm retained by the State or by the contractor, must adhere to and meet the same standards under which department personnel operate. It will be the responsibility of the engineer or designated inspector to randomly check the survey work of the contractor or consultant to ensure that qualified personnel have been retained and are performing competently.

710.2 Coordination with Contractor's Operations

The survey work must be planned and accomplished with due regard for the expediency and accuracy of the work under the contract. To avoid delaying the contractor's operations due to lack of staking, complete as much of the survey work and staking as is practicable before actual start of construction activities. Where staking is delayed or is required subsequent to start of contract operations, setting of stakes should be in accordance with the sequence of the contractor's plan of operations.

The engineer and members of the engineer's staff responsible for staking should confer with the contractor's superintendent concerning the method of staking to be used, how stakes will be marked and guarded, offsets, spacing, etc. Information to be placed on stakes, abbreviations to be used, location of message on stakes, etc., should be carefully established so no misunderstanding or misinterpretation will result.

Staking may be one of the items discussed at the preconstruction conference. A construction data packet will be made available at the preconstruction conference to facilitate staking operations.

Requirements for documentation of supplemental control as prescribed in 710.3, table 710-1 are called into the contract by standard spec 650.3.12.

710.3 Construction Data Packet

The construction data packet consists of digital files prepared by the project designer. The packet contains survey information and existing and proposed design files based on the project type. The data in the construction data packet is only provided for the contractor’s general knowledge and is not a part of the construction project contract. The department assumes no responsibility for discrepancies between the data provided and the contract documents. Table 710-1 provides a list of data types, submittal requirements, data formats, the person responsible for survey data and links to FDM procedures and WisDOT forms to used.

TABLE 710-1 Existing and Proposed Design Data Files

Item	Format	Responsible party	Comments
Provide a copy of all digital data to contractor	Digital	Design engineer	Refer to FDM 19-10-43 attachment 43.1 for the list of files to be provided and acceptable formats.
Complete DT1291 U.S. Public Land Survey Monument Record	Digital & paper	Contractor (RLS required)	The form must be completed by a registered land surveyor (RLS) under contract to perpetuate landmarks on the project.
Complete Contractor Staking Data Record	Digital & paper	Contractor	-
AMG Construction model	Digital	Contractor	Refer to standard specification 650.3.1.2 Automated Machine Guidance for delivery guidelines

Survey information on paper will be placed in a folder labeled with "Project name, Project ID, "Survey Information - Keep in Field Office when not in use of - DO NOT LOSE!".

Not all projects will require all categories of data. Refer to FDM 19-10-43 for details regarding the categories of data and the recommended electronic project data by project type.

710.4 Accuracy and Tolerance

It is essential that work procedures in staking a project be conducted in a manner to avoid making mistakes and errors. Errors in staking may lead to additional expense for the project. It is necessary when staking structures, right-of-way, or other work requiring high precision, that the work be carefully done and rechecked before being released as final. It is assumed the crew chief is familiar with methods and procedures in staking; however, concurrence as to method and procedure must be obtained from the engineer before the start of staking operations. To promote efficiency and accuracy in the work, each member of the survey crew and especially new members should be explicitly instructed in the proper manner and method of taking measurements and setting stakes. The engineer must make periodic observations and checks on the work to ensure the survey work proceeds properly and conforms to the accuracy required.

Basic horizontal and vertical controls are to conform to recognized accuracy. Refer to FDM 9-35-5, and FDM 9-40-5 for orders of accuracy. Other construction stakes should be set to an accuracy corresponding with their use.

It is generally accepted the error of closure in establishing or checking an intermediate benchmark be not more than 0.02 ft (6 mm), while for other level work such as taking cross sections or setting grade and slope stakes and similar work, an error of closure on a benchmark of 0.05 ft (15 mm) is allowable. Under circumstances where it is not considered to be critical to the work, a greater error of closure may be allowed.

Generally, level rod readings should be taken to the nearest 0.01 ft (3 mm) in setting grade for forms, structures, and pavements; to at least the nearest 0.05 ft (15 mm) in setting sub-grade and base stakes; and to the nearest 0.1 ft (30 mm) when reading ground elevations for cross sections and setting slope stakes.

710.5 Care of Equipment

The global positioning system (GPS) equipment, total stations, theodolites, transits, and levels used on construction survey are precise instruments and are expensive. The retention of their value and the results of the work depend to a large degree upon proper care and functioning of these instruments. Proper care must be exercised when handling and transporting surveying instruments to protect from possible damage. Survey equipment should never be left unattended when in use. When not in use, equipment should be stored in a secure and locked location.

Instruments should be cleaned, checked and adjusted for accuracy frequently to ensure proper working order. Procedures for checking instruments and making the necessary adjustments may be found in most surveying manuals. Pamphlets containing methods and procedures for proper adjustment of instruments may be obtained from manufacturers of surveying equipment through the region office.

710.6 Survey Notes and Records

710.6.1 Data Records

In general, all measurements and calculations of contract quantities must be accurate. Both hard copy and electronic records of contract quantities must be complete and detailed enough to sustain an audit, and records of all activities pertaining to the contract must contain sufficient detail and must be clear enough to be read and understood by any one unfamiliar with the contract. Refer to the section of this chapter, which includes a list of forms and digital data to be completed by the contractor.

All construction survey notes covering alignment, bench levels, cross sections, grade stakes, slope stakes, stakes set for structures of all types, and any other survey work related to the construction of the project should be recorded in standard notebooks (as well as electronically, when possible in the AASHTO Survey Data Management System (SDMS) or CAiCE archive format) at the time of performing such survey work and should become part of the Contractor Staking Data Packet. Cross section notes to be processed electronically may be recorded, as the sections are taken, on forms provided for that purpose and slope stake notes may be entered on appropriate computer tabulation sheets, but preferably this will be recorded electronically as the data is collected.

Survey notes should be accurate and legible and should be recorded in a neat, orderly manner. Information should be provided to show a complete record of the survey work. Each notebook should bear the identification of the project, the date, and the survey crew personnel. Large projects will require separate books for alignment, level work, slope staking, grade staking, staking of structures, etc.; while for small projects, two or more phases of the survey work may be recorded in separate sections of a book, depending on the space required.

The alignment book should show complete information for the construction centerline or other lines run, including any errors found in angles or distances and corrections made and reference ties to control points. The level book should show level checks run on existing benchmarks and should include any errors found and corrections made. It should also show descriptions of new benchmarks established at structures, or to replace those that will be disturbed during construction. A record should be made of all grade stakes set, showing the level runs, established grade, and rod readings on the stakes.

710.6.2 Data Submittal

Upon completion of the project, all survey notebooks and disks of project information/data should be assembled in an orderly manner and sent to the engineer at the region office with the other project records. Raw data should be archived before making any changes or edits and should be included in the package.

Information and instructions for recording and submitting notes for electronic data processing are contained CMM 165. Requirements for submittal of survey data may also be found in the contract special provisions.

Refer questions concerning data recording and submittal to the region survey coordinator.

SECTION 715 Highway Staking

Construction staking encompasses those items included in the contract for a given transportation improvement project. The staking contractor is responsible to know the standards and specifications for each item staked.

A large portion of engineering cost is represented by construction staking. If errors occur in staking, the cost can be considerable to WisDOT and the contractor. The survey crew is to stake according to the standards stated in each section and must build in independent checks to eliminate errors. For example: an operation involving a level should never be terminated without checking into a known elevation. Alignment operations, such a bridge layout or sewer staking, are not to be left before checking into known control points and benchmarks.

715.1 Staking Contractor Duties

715.1.1 Preliminary Research and Data Gathering

The staking contractor should:

- Obtain, from the prime contractor, the approved plans, special provisions, and specifications for the project. Plan revisions may occur, so check with engineer throughout project for changes to the approved plan.
- Obtain material from the department necessary for the interpretation of the approved plan. This includes the standard specifications and other relevant publications.
- Obtain supplemental existing project information from the engineer (digital, previously computed, etc.).

715.1.2 Field Investigation

The staking contractor should:

- Field locate controlling plan survey data for the project.
- When necessary, establish horizontal and vertical control that is in compliance with Third Order Class II accuracy in relation to the existing project control.
- Record all information in field books and make them available to the engineer. This includes a description of control and all related notes for this control.
- Immediately bring to the attention of the engineer any discrepancies or errors.
- Do not set out anything without first field verifying for accuracy.

715.1.3 Computations

The staking contractor should:

- Check with the engineer to ensure that alignment, profiles, and grades have not changed from what is shown on the approved plan.
- Compute grades/alignment from approved plans and contact with engineer on the availability of information.
- Keep neat and accurate field notes of work being performed.

715.1.4 Field Notes

Construction survey notes generated by hand are to be recorded in bound field books. If data has been developed by computer, three-ring binders are acceptable.

On the cover of all field books/binders:

- WisDOT project identification (ID) number
- Subject (alignment, slope stake, bench marks, etc.)
- Each book numbered for cross-referencing

In the front section of all field books/binders:

- Engineer's name, address and phone number
- An index of book contents
- Pages are to be numbered

Each day's notes should include:

- Date
- Weather
- Crew
- Location
- Instrument type
- Crew chief's signature

Errors should have a line drawn through them or the word "void" printed across a page, and a note referring to the location where the correct notes are to be found. Erasers are not to be used.

All computations and field notes are to be included in the files at the end of the project and are a matter of record. Various examples of field notes are included throughout this manual. Computations, such as grade sheets and bridge notes are to be included. All notes are to be neat, clean, legible, and complete so another crew can continue the work.

Field notes must be made available to the engineer upon request. It may be desirable to leave the original or a copy in the field office.

715.2 Equipment

It will be up to the discretion of the staking contractor to use the appropriate equipment to ensure required accuracies are met for each item. The staking contractor must decide what equipment to use.

All equipment should be maintained and calibrated before fieldwork. These calibration results should be recorded in the field books as a matter of record.

715.3 Control

715.3.1 Horizontal

Accuracy must be met. The tool to get the job done does not matter, whether it is transit and tape, total station, or GPS. The control on the plan controls the project. GPS equipment must be calibrated to the plan control unless sufficient checks have been completed to insure coordinate systems match.

715.3.2 Vertical

If using a conventional automatic level, the proper rod should be used for the accuracy desired. Longer rods with multiple sections provide for greater changes in elevation but tend to wear faster and require more maintenance that will decrease the accuracy. Heights out of GPS equipment are often ellipsoidal not orthometric. Elevations on a plan are orthometric.

715.4 Monumentation

Construction layout monuments should be a solid material, a type consistent with the terrain, and set to provide a degree of permanence for the intended use. Sufficient monuments and offset information should be provided to enable the user to check the accuracy of any point or line established.

Monuments should be witnessed in a manner that allows them to be easily found by the user in a reasonable period of time. Any witness stakes or laths that show offsets and cut/fill data should also show sufficient information to identify horizontal position of the point being referenced.

715.5 Diggers Hot Line

Digger's Hot Line should be called when any monuments are being driven deeper than approximately two feet. The plan may show a gas line 10 feet right of the centerline but the utilities may have since been relocated.

In Wisconsin, call Diggers Hot Line at (800) 242-8511.

715.6 Stakes

Stakes must have sufficient stiffness, section modulus and length to remain stable during normal grading operations. Stakes suggested in each procedure may need to be modified to fit field conditions. Stakes should have a smooth surface to allow for marking legibly.

The following are suggested stake types and uses:

- 1" x 2" x 18" flats - centerline, offset lines, slope stakes, fence line, information, etc.
- 2" x 2" x 12" hubs or 20 penny nails or spikes - curb and gutter, pipe grades, blue tops, miscellaneous grade and line references, etc.
- 1" x 2" x (12", 24", 36", or 48") guards - easements, clearing limits, guard stakes, etc.
- Wood lath - visual protection for stakes and hubs, and extreme cuts and fills.

Also note the following points regarding construction stakes:

- For centerline control points or reference points, PK nails or 6" - 8" spikes will be allowed instead of hubs and tacks.
- Permanent marking pen may be used in some situations instead of a tack.
- Length of stake will vary depending on terrain, vegetation, and soil type.
- The above recommended stakes may vary due to regional preference and availability.
- A flag may be an appropriate guard stake.
- Different abbreviations are used throughout the manual to show options, for example: (s) or O/S both depict "offset."

SECTION 718 Automated Machine Guidance

718.1 General

Standard spec 650.3.1.2 allows the contractor to substitute automated machine guidance (AMG) for all or part of the work under the individual contract staking bid items. The extents of each AMG segment and work performed using AMG need to be described in the contractor's AMG work plan. It is the contractor's option whether they will use AMG or conventional methods.

Not all projects are suitable for GPS use. Projects with a dense tree canopy, large vertical cuts, or limited survey control may not prove suitable. On these projects, other AMG methods may be suitable.

718.2 Initial Coordination

The contractor needs to provide the AMG work plan as described in the specification to the engineer before the preconstruction conference, so the engineer can evaluate the proposed plan. Figure 718-1 shows an example AMG work plan. The design engineer, construction engineer, region survey staff, appropriate management, and contractor survey personnel should be present at the preconstruction meeting to discuss the following points regarding grading with machine guidance:

- AMG work plan.
- Project and survey schedules.
- Key personnel, roles, and responsibilities.
- Methods for handling changes in the model and related matters.
- Handling of survey data and support.
- 3-D models and their formats.

The project engineer should be in close contact with the region survey staff throughout the course of the project.

718.3 3D Model Development and Exchange

The contractor must develop and maintain the construction model for use with the automated machine guidance equipment, based on the initial survey information provided in the construction data packet, as discussed in CMM 710. The department recognizes that the contractor will need time to develop the model.

The contractor is responsible for ensuring that the construction model agrees with the contract plans. If a plan error is discovered, the contractor must notify the engineer. The department determines what revisions may be required. The department revises the contract plans and design model, if necessary, to address errors or discrepancies the contractor identifies. The contractor is still responsible for updating the construction model and sending the revised version back to the department in LandXML or another engineer-approved format.

The engineer should review the contractor's proposed model and perform spot checks by projecting known points generated from the plan cross sections onto the proposed model and generate an error report. The engineer is responsible for maintaining an archive of DTM revisions and dates. The archive should include the DTM files and the time period for which each was active on the project.

718.4 GPS Site Control and Calibration

The department is responsible for providing control from the initial survey. The contractor is responsible for verifying, supplementing, and maintaining the project control. Site calibration, sometimes referred to as "localization", for AMG using GPS is a process that results in computation of parameters for transforming measured GPS coordinates into the coordinate system of the project control points. Good site calibration and checking are vital to the success of AMG operations.

On continuous mainline projects, it is recommended that a minimum of 6 control points or 2 points per mile be used for site calibration and that the site calibration be checked daily at control points not used in the calibration. The horizontal and vertical coordinates of all control points must be documented and presented to the engineer. These points should be constructed or located outside the anticipated construction footprint, and they should be available 2 weeks before the preconstruction conference.

The control points used for site calibration should envelop the project and be well distributed around its perimeter. Control points in close proximity to one another should be avoided. Long, narrow configurations of control points should be avoided. There should be control points near the corners of the project and approximately midway along its boundaries.

The number of site calibrations performed by the contractor should be limited. It is preferred that a single site calibration be used for the duration of the project, but there might be circumstances under which follow-up site calibrations are necessary. In these cases, independent construction checks should be made after each site calibration.

718.4.1 GPS Daily Site Calibration Checks

Site calibration checks are the responsibility of the contractor but should be reviewed with the region survey staff to verify they are within specified tolerances.

Horizontal and vertical tolerances are specified for site calibration checks but not for site calibration itself. Once the site calibration measurement process is complete, the RTK GPS software will report estimates for horizontal and vertical errors at each of the site calibration control points. The tolerances are 0.10 feet horizontal and 0.05 vertical for the site calibration checks. If any site calibration check exceeds specified tolerances, follow these steps:

1. The check should be re-measured at the same independent control point to ensure there is no problem with the check measurement.
2. A second and, perhaps, a third independent control point should be used to check the site calibration. If tolerances are met at these additional independent control points, then a problem is indicated with the first check control point.
3. If check tolerances are not met at two or more independent control points, then a problem is indicated with the site calibration, and the site calibration measurement and computation procedure should be repeated to ensure that there is no problem with the initial site calibration measurements. If site calibration problems persist, vendor-supplied manuals or guidance might also need to be consulted.
4. If the repeated site calibration measurements are in close agreement with the initial site calibration measurements, then a problem is indicated with one or more of the site calibration control points. The site calibration should then be performed while excluding the control point with the largest horizontal and / or vertical error estimate.
5. If a problem with a site calibration control point is identified in step 4, that control point should be replaced by another and the site calibration procedure and checking should be repeated. The above control point configuration guidelines should be followed in selecting replacement control points.

718.4.2 Construction Checks

The engineer should work with the region survey staff to develop a plan to perform construction checks. It is essential to provide some independent checks at project start-up to ensure contractor methods are meeting necessary tolerances. These checks should be performed using independent GPS equipment or conventional survey methods (e.g., total station or level), and should meet specified tolerances. The department reserves the right to do added checks as needed.

718.4.3 Final Subgrade Checks

On completion of the subgrade the contractor must perform 20 or more randomly selected subgrade checks per stage, per project, or per mainline roadway mile, whichever results in the most tests, against plan elevations. These points should be located at stations evenly divisible by 100 so it's easy to check against the plan. According to the definition of roadway in standard spec 101.3, a divided highway has two or more roadways.

Before conducting the final random checks, the engineer may want to direct the contractor to make additional non-random checks in out-of-tolerance areas or areas that otherwise raise concern. Sideroads may warrant additional checks. The engineer should also be aware of critical points, and have the contractor perform additional checks at these locations. Critical points include the following:

- Beginning and end of the project.
- Bridge clearances.
- Ramp gore areas.
- Above and below ground utility crossings.
- Bridge approaches.
- Intersections and side road matches.
- Clearances over pipes.

It is very important for the engineer to be present during the subgrade checks, and to make note of each check in the field diary.

If more than 1 of any 5 consecutively tested random subgrade points differs by more than 0.10 feet from the plan elevation, the grade is not suitable, and the contractor must make corrections to the grade. Random subgrade checks should then be performed again until 4 out of 5 consecutively tested points are within 0.10 feet of plan elevation.

FIGURE 718-1 Sample AMG Work Plan



234 CTH S
Green Bay, WI
Phone: (920) 799-4404 Fax: (920) 799-4410

GPS Machine Guidance Work Plan
End Zone Road to Super Bowl Way
STH 92; Playoff Road
Door County

Equipment

Design:

Trimble Terramodel v. 10.43

Staking:

Base Station: Trimble SPS750
Rover: Trimble SPS780
Data Collector: Trimble TSC2
Staking Software: Trimble SCS900 v. 2.11

Machine Control:

Caterpillar D6R Dozer
Caterpillar 14 H Motor Grader
System on Machines: Trimble GCS900 v. 6.0

People

Bart Starr - Packer Country Construction

Six years of grade staking and data preparation using robot total stations, GPS instruments, and design/survey software.
Six years of teaching grade staking classes using total stations and GPS instruments at Local 139 Union School in Coloma.
Role in Specification: Primary contact for GPS Pilot Spec. He will be on-site daily, and will be handling data flow and field operations for the pilot.

Lynn Dickey - Packer Country Construction

Twelve years of construction layout, data preparation, and property surveying using total stations, GPS instruments, design/survey software, and cad software.
Role in Specification: Oversight and support to field and data operations.

Brent Favre - Packer Country Construction

Two years of grading using Trimble GPS machine control motor graders.
Role in Specification: Operator of Caterpillar 14H Motor Grader equipped with Trimble GCS900.

Reggie White - Packer Country Construction

Two years of grading using Trimble GPS machine control D6R Dozer.
Role in Specification: Operator of Caterpillar D6R Dozer equipped with Trimble GCS900.

Leroy Butler - AMC Staking

Construction Staking Contractor for the project.
Role in Specification: Create and maintain on-site control points

Project Control

For this project, the department has provided a list of control (Attachment A) that was established by Central Engineering. This control shall be used as the primary control for this project. Packer Country Construction will us these points in the site calibration. Some points will not be used in the site calibration; these points will be reserved to be used as daily checks throughout the duration of the project.

Site Calibration

Site calibration will be performed using the calibration function in Trimble SCS900. The points used in the site calibration will envelope the site. The entire project will be included in one site calibration. Each point in the calibration will be observed statically for 15 seconds. The resulting precision of the site calibration shall fall within 0.01 ft. horizontally and 0.05 ft. vertically. A hard copy of the resulting site calibration data from SCS900 will be given to the engineer.

Packer County Construction will perform control check daily. Packer County Construction's typical workweek will be 5 days per week, 50 hours per week. Packer County Construction will perform two control checks per workday. One will be done at the start of work, and the other will be done during the last half of the workday. Those checks shall fall within 0.10 ft. horizontally and 0.05 ft. vertically. Those control checks will be recorded using SCS900. A hard copy of that record will be reported weekly to the engineer.

A list of points used in the site calibration and used as checks, and their location can be found in Attachment B.

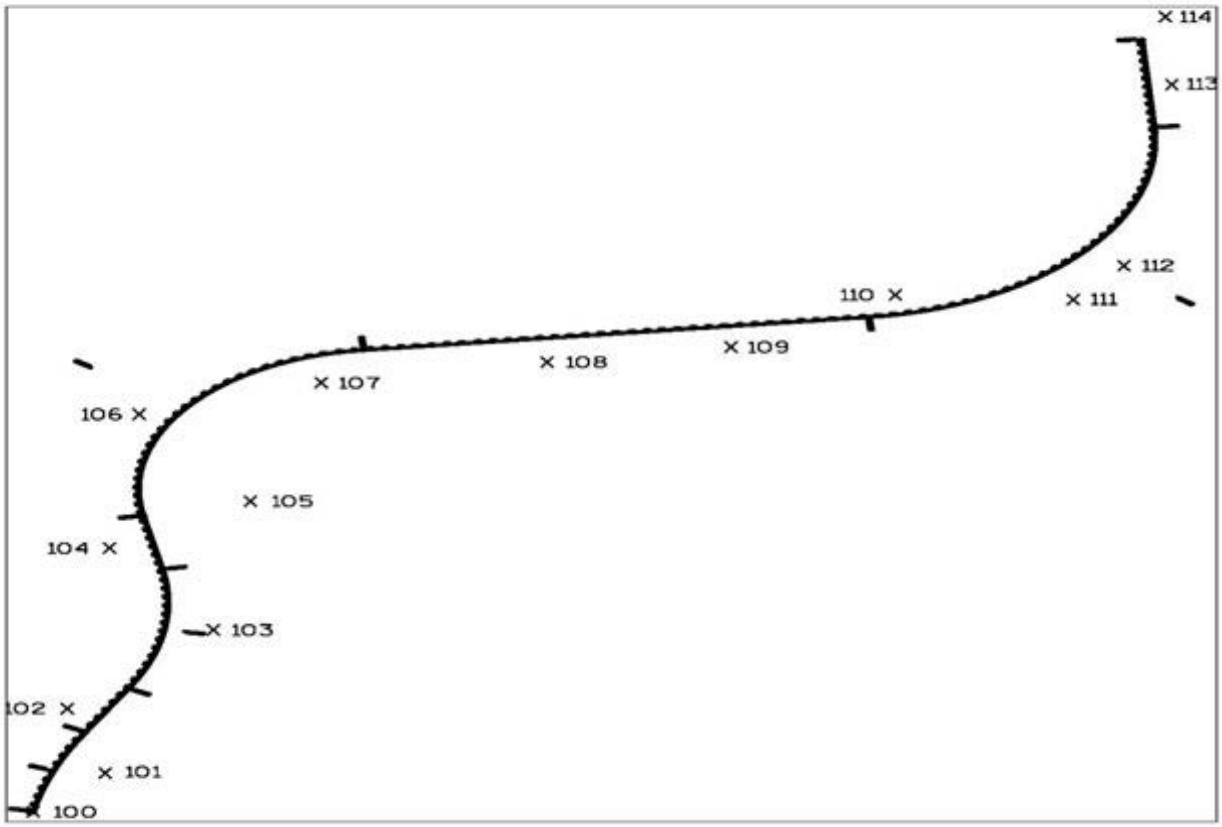
(Attachment A)

Packer Country Construction

Control point coordinates on local coordinate system

POINT	x	y	ELEVATION
100	854985.57	449051.20	741.26
101	855450.87	449505.32	680.52
102	855204.92	450256.54	699.62
103	856147.58	451179.49	701.59
104	855477.05	452135.51	656.23
105	855668.36	453699.63	745.58
106	856386.71	452681.75	722.89
107	856843.19	454068.23	717.92
108	858298.36	454307.89	678.04
109	859487.01	454484.22	729.85
110	860545.98	455092.65	714.33
111	861693.56	455038.91	786.52
112	862021.06	455434.10	801.00
113	862328.88	457551.17	823.64
114	862287.51	458344.47	805.49

(Attachment B)



SECTION 719 Automated Machine Guidance - Concrete Paving

719.1 General

Standard spec 650.3.1.2 allows the contractor to substitute automated machine guidance (AMG) for all or part of the concrete paving staking work under the contract. The extents of each AMG segment need to be described in the contractor's work plan. It is the contractor's option whether they will use AMG machine guidance or conventional methods.

Not all projects are suitable for AMG use. The AMG system for WisDOT projects should use Total Station technology to control paving operations. Projects can be challenged with a dense tree canopy, fog, sun light, large vertical cuts, or limited survey control which prove AMG is not suitable. On these projects, contractors would use conventional methods.

719.2 Initial Coordination

The contractor needs to provide the AMG work plan, as described in the specifications, to the project engineer before the preconstruction conference so the project engineer can evaluate the proposed plan.

An AMG work plan must document the items below:

- Portions proposed for AMG Concrete Paving
  - The plan should detail stationing or coordinates of paving sections that will be built using AMG technologies.
- Equipment and software of AMG equipment
  - Contractor should identify how many and types of robotic total stations to be used for guiding the paver when moving and the device to be used to perform quality control checks. Note: to achieve the best product possible, robotic total station with a 1" angular accuracy is required to for guiding the movement of paver. For static checks of the grade and top of pavement can be done with a robotic total station of 3" angular accuracy or lower.
  - The specifications for AMG equipment used on the paver.
- Key personnel, roles and responsibilities
  - Identify technical experts and who is responsible for monitoring paving operations. Who will responsible for running AMG equipment on the paver. The plan should identify any consultants that will be on-site to assist the contractor to do AMG paving. Identify who is responsible to run the survey equipment for paving operations. Who is responsible for developing and revising contractor models used for AMG paving.
- Process for establishing project survey control and a map of the control points with their coordinates installed by the contractor.
- Contractor quality control for AMG, including the trimmed base and concrete final grade and position.

The design engineer, project engineer, region survey staff, appropriate management, and contractor survey personnel should be present at the pre-pour or a separate meeting before trimming/paving to discuss the AMG work plan. The project engineer should be in close contact with the region survey staff throughout the course of the project to assure the surveying aspects of the paving process are working properly.

719.3 3D Model Development and Exchange

The contractor must develop and maintain the construction model for use with the AMG equipment, based on the initial survey information provided in the construction data packet, as discussed in CMM 710.3. The department recognizes that the contractor will need time to develop the model.

The contractor is responsible for ensuring that the construction model agrees with the contract plans. If a plan error is discovered, the contractor must notify the project engineer. The project engineer will notify the designer of the errors so necessary plan revisions and updates to the existing surface can be made to the DTM. The contractor is still responsible for updating the construction model and sending the revised version back to the department in LandXML or another project engineer-approved format.

The project engineer and, if necessary the methods group in Bureau of Project Development should review the contractor's proposed model and perform spot checks by projecting known points generated from the plan cross sections onto the proposed model and generate an error report.

719.4 Site Control

The department is responsible for providing control from the initial survey. The contractor is responsible for verifying, supplementing, and maintaining the project control.

The project engineer should work with the region survey staff to develop a plan to perform construction checks. It is essential to provide some independent checks of the project control points before paving to assure the pavement is installed in the required location and elevation. These checks should be

performed using independent equipment and must meet the tolerances specified in the AMG work plan requirements of the contract special provision.

The project staff should do spot checks of pavement installed. Compare the x, y, and z coordinates of the pavement installed with the accepted cross section elevations.

Project staff should review paving plans with the contractor at adjacent pavement and bridges at centerline, edge of pavement, and other locations necessary to characterize existing profile and cross slope. The contractor must provide their plans in how the AMG paving is going to match into tapers and turn lanes before paving so locations of dowel joints are coordinated. The contractor must adjust design profile grade and cross slope to provide a smooth transition from the new pavement to the existing pavement or bridge. The contractor must notify the project engineer when a smooth profile cannot be provided. The contractor must submit final adjusted plan elevations to the project engineer.

The department reserves the right to do added checks as needed.

719.5 Training for AMG

An overview of AMG concrete paving uses and best practices, called "Proper Use of Stringless Paving Technology", is available from industry.

http://www.wisconcrete.org/

719.6 Best Practices for AMG for concrete paving

Best Practices:

1. The contractor should employ the services of a professional engineer or professional surveyor, licensed by the state of Wisconsin to provide the contractor the model used by the paver and operation of total station or GPS control equipment.
2. The model being used has been verified by the department and error checking was performed on the model. Error checking should include a comparison between the design and model to be used by the paver. Check model alignments and elevations to assure the contractor's model meets the design.
3. Control points used meet the 250' spacing requirements and are located where they will not be disturbed, instruments and paver should have line of site to three points.
4. Contractor is using approved AMG work plan.
5. Line of sight to instrument must be maintained, care must be taken in foggy situations and interferences with the exhaust from the paving equipment.
6. Control instruments should have line of site with at least 3 control points to maintain accuracy.
7. Radios should be checked periodically.
8. There should be a constant head of concrete in front of paver. Maintain a uniform delivery schedule. Consistent batch to batch properties is important. Operate paver vibrators per recommended machine specifications, typically 5000-8000 rpm and the paver speed should be constant without stops.

719.7 Checklist for AMG for concrete paving

Stringless Paving Checklist

Date Prepared:_____ By:_____

Project Name/No:_____ Location:_____

Check if the statement is true.

DATA CHECK AND MODELLING

___ The CAD data is checked against plan sheets for errors in alignment, elevations, and cross- sections.

___ Any discrepancies in the CAD data are confirmed with the owner/engineer.

___ Surface mapping is conducted for use in 3-D modeling.

___ The 3-D model is checked for segment to segment alignment.

___ The profile is completed to characterize the surface on at least 25-foot intervals.

___ For modeling the profile of an existing pavement: data was taken at lane edges, wheel paths, lane quarters, and centerline positions.

___ The 3-D model is checked for constructability & compatibility with the equipment for paving tight turning radii.

SURVEYING

___ The survey control network has been established and is tied into known benchmark(s).

___ Control point locations are identified and are assessable throughout the project length.

___ A plan for total station locations (or other instruments) is completed.

___ Instruments are positioned adequately on both sides of pavement (if possible) and within recommended range of the instruments.

___ Sandbags or anchors are in place to secure tripods in windy conditions.

EQUIPMENT CONFIGURATIONS

___ Appropriate instrument types are selected for the application (total stations, GPS with total stations, GPS augmented with Lasers).

___ The instruments selected with tolerances compatible with paving specifications and smoothness requirements.

___ The placement of instruments is correct for the type of paving, tolerances, and specifications.

___ The software, sensors, instruments and other components are compatible with paver and checked for proper operation before the start of production paving.

___ Spare sensors, instruments and other components are available on the job site. Radios are properly powered, connected and signals are verified on the paving machine.

___ Antennae are positioned vertically and checked for signal interference with metal components of the paving machine.

___ Antenna positioned away from other metal (or object that may interfere with signal).

___ Antenna for each radio is spaced at 1 1/2 feet or more.

___ Batteries (including spares) are charged for all instruments and radios.

___ The four corners of profile pan and mast elevations checked. (These should be checked after setting up machine for a new project, moving to a new location on site, after changing paver width, or if mast heights, prism swaps, or other instruments have been changed.)

___ A plan is in place to configure the equipment for paving against existing pavement sections.

PERSONNEL

___ Personnel assigned to project are trained and dedicated to the stringless equipment.

___ Personnel assigned to project are capable to create, interpret and correct 3D data.

___ Personnel assigned to project are familiar with using and maintaining the equipment/components of the stringless paver.

DAILY CHECKS AND SPECIAL CONSIDERATIONS DURING PAVING

___ Battery life is assessed for weather conditions (particularly cool weather) and charged spare batteries are available for all equipment.

___ Prisms are checked and cleaned of dust and moisture (dew) before starting paving.

___ A plan is in place for receiving GPS signals (if GPS is used) when paving in wooded terrain, in urban environment, or under bridges where signals may be lost temporarily.

___ A rover is assigned to check results behind paver or other equipment and to communicate results to the paver operator or ground crew foreman.

___ The paver operator or ground crew foreman is trained to make compensating manual adjustments to the on-board computer to meet project specifications and tolerances.

SECTION 720 Staking Storm Sewer System

720.1 Construction Staking Storm Sewer System

Storm sewer system information may be found throughout the plan. Every plan is different. A schedule of the storm sewer will be found in the miscellaneous quantities. The schedules should contain the proposed locations of structures, types of structures, size, length, class of pipes, flow line of pipe elevations, percent of grade for pipe between structures, and grate or rim elevations. Other locations for data may include the plan and profile sheets, the storm sewer plan sheets, typical sections, and construction details.

Construction stakes for storm sewer system must be set and maintained as necessary to achieve the required accuracy and to satisfy the storm sewer contractor's method of operations. The staking contractor must determine that storm sewer pipe outfalls and inlets match existing field elevations and must provide this information to the engineer 14 calendar days before the contractor orders inlets, catch basins, manholes, end-walls, and storm sewer pipes.

FIGURE 720-1 Example Plan View of Storm Sewer System

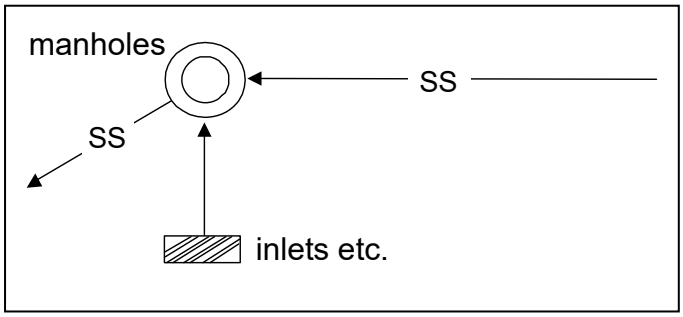
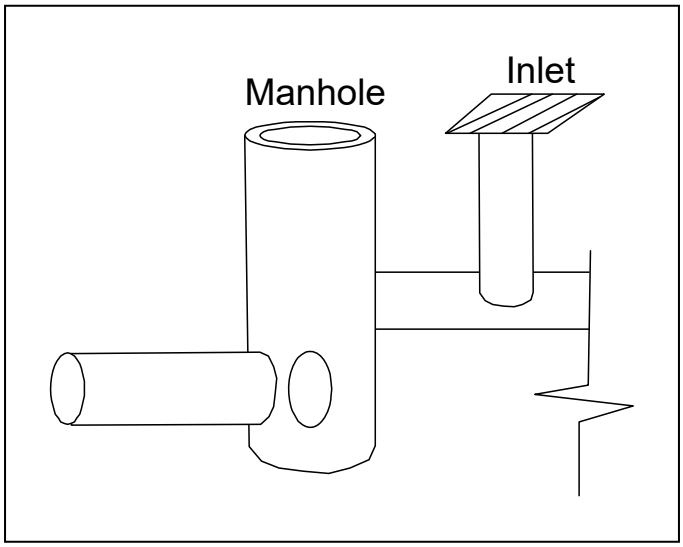


FIGURE 720-2 Example Elevation View of Storm Sewer System



720.1.1 Suggested Procedure

The staking contractor must always consult with the storm sewer contractor and check with the engineer for changes to the approved plans before doing any staking or grade computations.

The steps to take when staking storm sewer systems are outlined below:

1. Locate information in the approved plan.
   - Miscellaneous quantities
   - Plan and profile sheets
   - Storm sewer plan sheets
   - Typical sections
   - Construction details
   - Other

2. Prepare the storm sewer field book. Include the general information as shown in CMM 715 and:
   - A layout sketch of the structures as staked
   - Stake locations
   - Distances from stakes to item
   - Benchmarks
   - Grade elevations
   - Other pertinent information
3. Re-establish centerline, if necessary, from control points.
4. Field-locate the structure and the offset distance

   Check that these units are correct in relation to the lane widths and radius locations (radii should already be staked)
5. Set out stakes with respect to centerline. Ensure stakes are stable and visible to other people on the project
6. Grade the stake to approved plan elevations and mark accordingly. Mark with:
   - Structure number
   - Cut or fill to grate flow line (GFL)
   - Cut or fill to discharge (DIS)
   - Station and offset of structure
   - Hub elevation
   - Offset distance and direction from proposed structure to hub
   - Percent (%) of grade from one structure to the next if applicable

720.1.2 Examples and Figures

Examples of storm sewer quantities (figure 720-3 and figure 720-4), plans (figure 720-5), stakes (figure 720-6), and field notes (figure 720-7) are provided.

FIGURE 720-3 Example Miscellaneous Quantities of Storm Sewer

Reinforced Concrete Pipe, Storm Sewer Class III					
Station	Structure		Dia (in.)	Length (Lin. Ft.)	Pipe Joint Ties
	From No.	To No.			
281+00	64.3	64.0	18	60	-
281+24	64.0	63.0	42	36	-
9+11 STH 73	63.2	63.1	12	22	-
9+15 STH 73	63.3	63.1	12	48	-
9+26 STH 73	63.1	63.0	15	46	-
10+64.5 MILL	63.5	63.4	12	32	-
10+64.5 MILL	63.4	63.0	15	90	-
284+70	63.0	62.0	36	376	-
288+50	62.1	62.0	15	58	-
288+50	62.2	62.0	15	4	-
288+50	62.0	61.0	36	346	-

FIGURE 720-4 Example Miscellaneous Quantities of Manholes, Inlets, and Inlet Covers

Manholes, Inlets and Covers						
Station	Structure Number	Location	Inlet Type	Manhole Type	Cover Type	Depth (Ft.)
281+00	64.3	35' RT	3	-	BS	3.2
284+70	63.0	27' LT	-	3	J	9.4
9+11 STH 73	63.2	41'+ RT	3	-	H LT	2.3
9+11 STH 73	63.3	25.5' LT	3	-	H RT	2.3
9+26 STH 73	63.1	23' RT	-	1	H RT	3.3
10+64.5 Mill Ave	63.4	17.5' RT	3	-	H RT	2.9
10+64.5 Mill Ave	63.5	17.5' LT	3	-	H LT	2.3
288+50	62.0	27' LT	-	3	J	7.0
288+50	62.1	34.5' RT	3	-	H LT	2.6
288+50	62.2	34.5' LT	3	-	H RT	2.6
291+90	61.2	34.5' LT	3	-	H RT	2.3
291+90	61.4	34.5' RT	3	-	H LT	2.3
292+00	61.0	27' LT	-	3	J	5.0
292+00	61.1	34.5' LT	3	-	H LT	3.6

FIGURE 720-5 Example Storm Sewer Plan

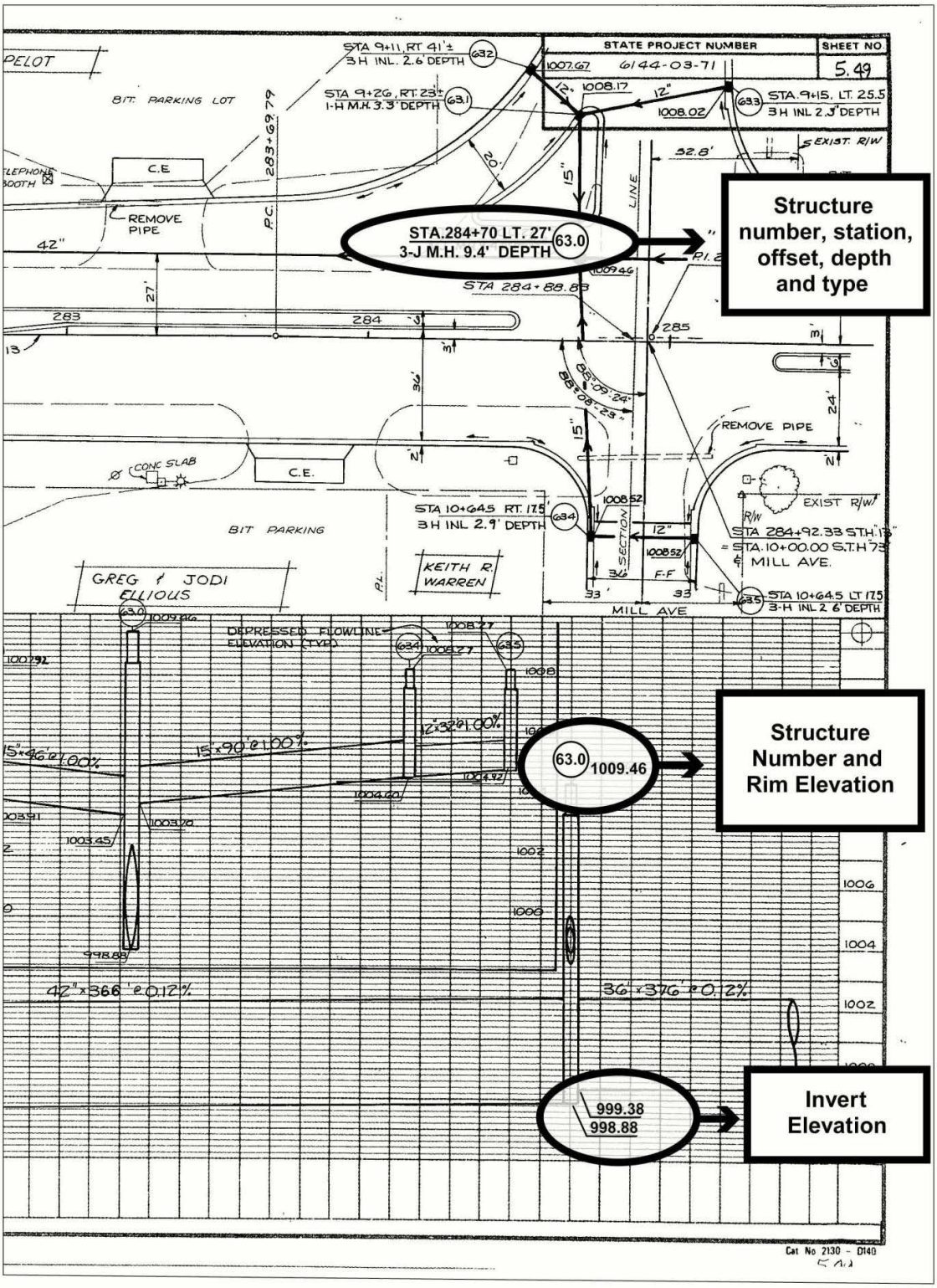


FIGURE 720-6 Storm Sewer Stakes

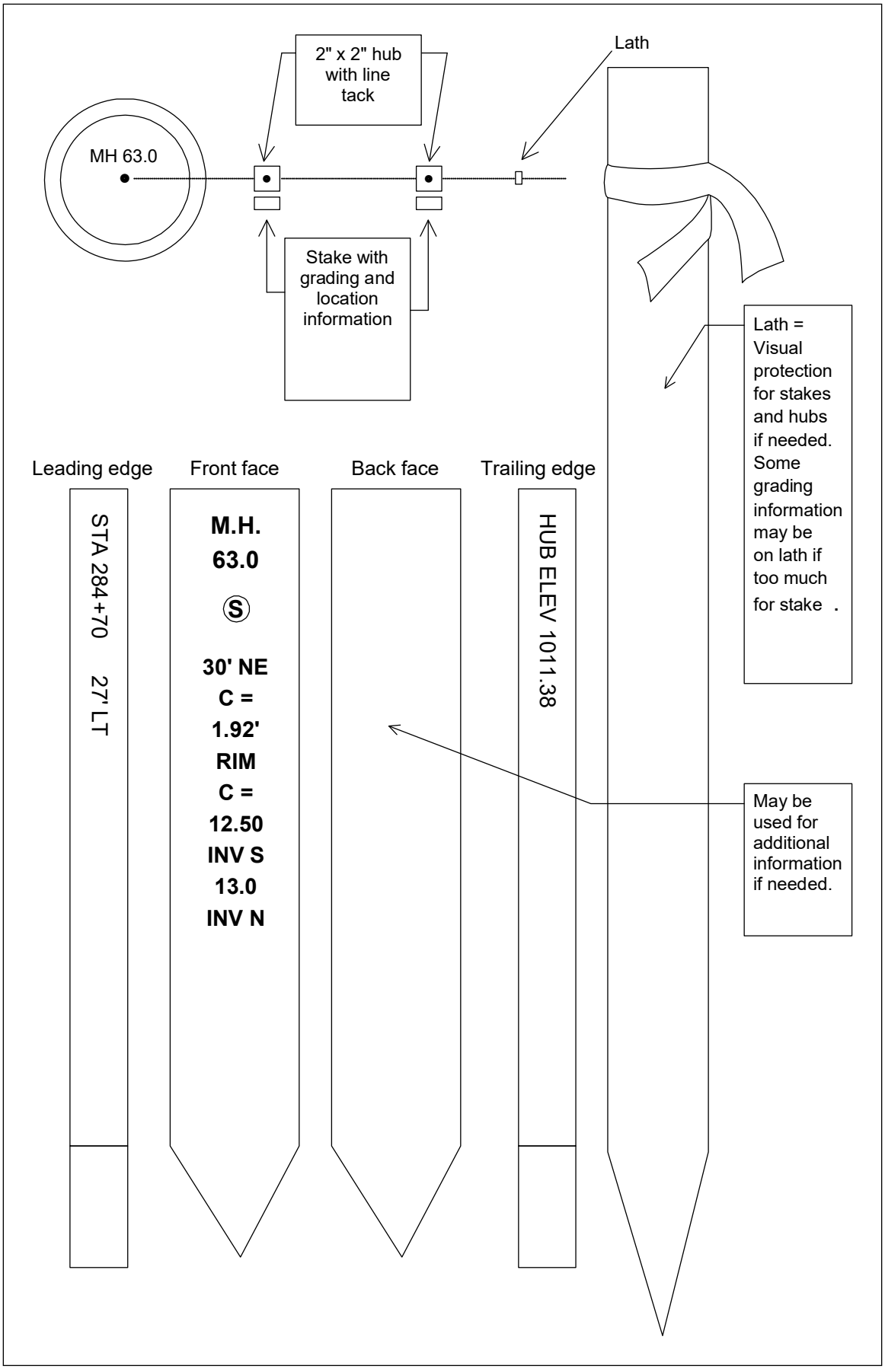
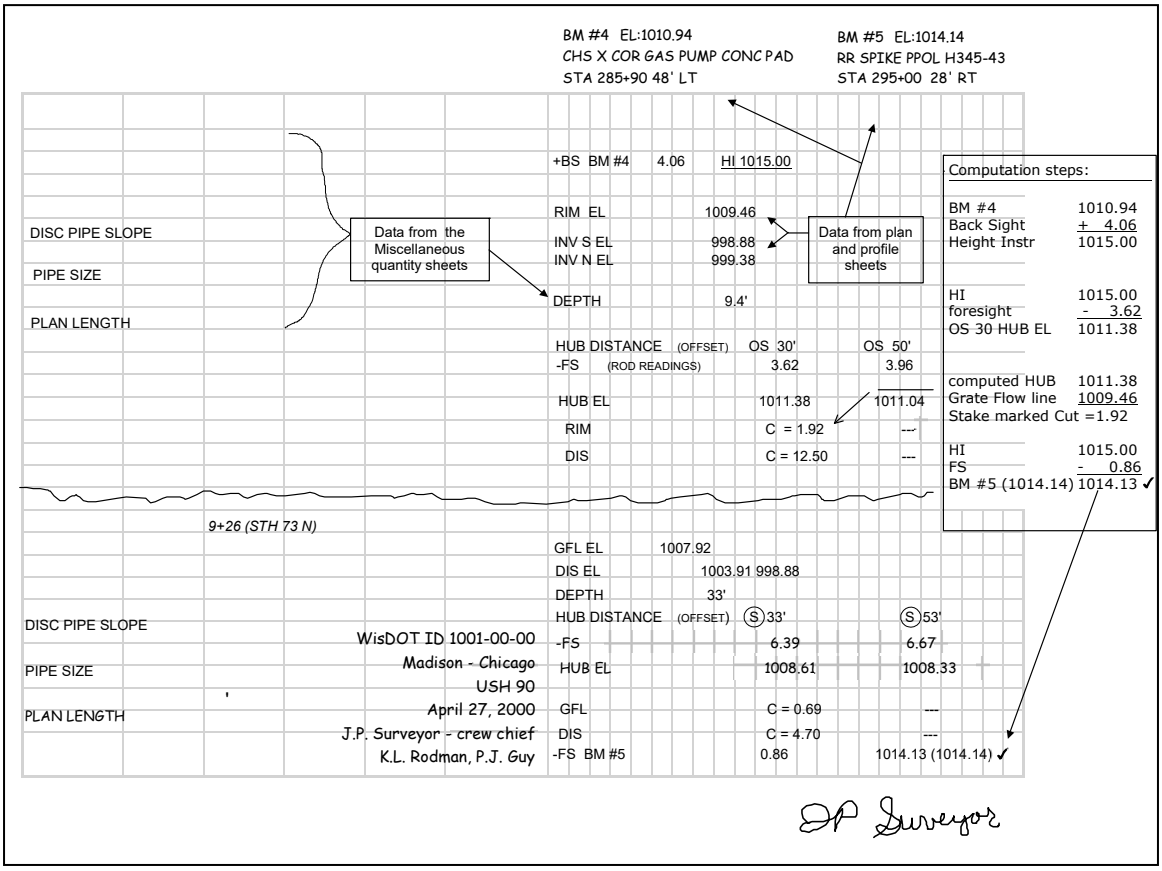


FIGURE 720-7 Example Storm Sewer Staking Field Notes

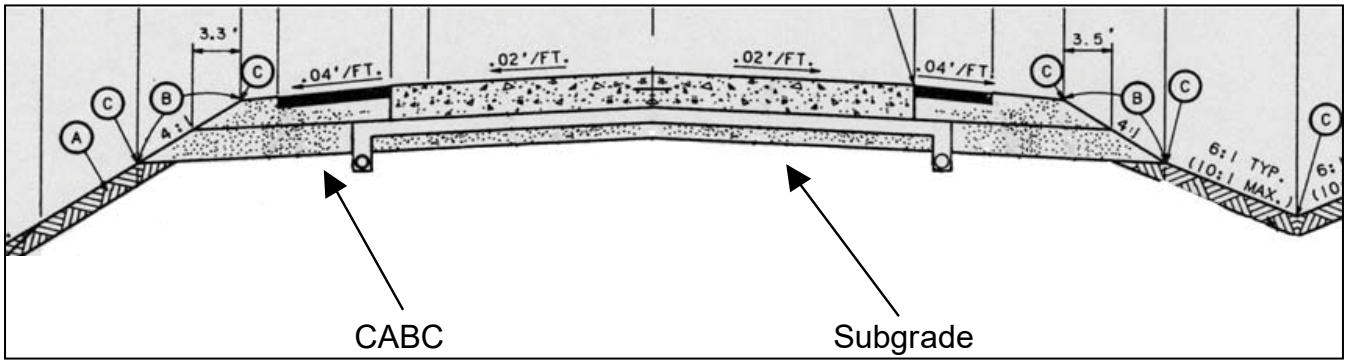


SECTION 725 Staking Subgrade and Base

725.1 Construction Staking Subgrade and Construction Staking Base

The field procedures for construction staking for subgrade and crushed aggregate base course are similar. Subgrade stakes (blue tops) are set to guide the grading contractor in trimming and finishing the earth subgrade after the rough grading has been completed. Base course stakes (red tops) are included on base course and asphalt projects. This item should not be included when concrete pavement is being constructed in the same contract. Concrete pavement staking covers dense base and open-graded base course.

FIGURE 725-1 Example Highway Cross-Section



Normally, construction stakes for subgrade and crushed aggregate base course are placed at intervals of 100 feet for rural sections and 50 feet for urban sections. Refer to plans and specifications for project intervals. Commonly, urban sections refer to areas that include curb, gutter, or curb and gutter, and rural sections refer to areas with pavement and shoulders. An example rural cross section is provided in figure 725-1. Contact the engineer for specific project rural/urban determination.

A minimum of three stakes is required per cross section. The stakes may be set at the above interval on the centerline and at varying lateral distances from the centerline, depending on the needs of the grading contractor. Additional stakes should be set and maintained as necessary to establish location and grade along intersecting road radii and for auxiliary lanes, vertical curves, horizontal curves, and curve transitions in accordance with the plan. Urban projects with rolling profiles should have subgrade and base course grade stakes set at all high and low-profile points in addition to stakes set at stations or other regular intervals. The grading contractor must determine additional stakes needed to achieve the required accuracy and to satisfy the grading contractor's method of operations.

725.2 Suggested Procedure

The staking contractor should always consult with the grading contractor for staking preferences and check with engineer for changes to the approved plans before doing any staking or grade computations.

Steps to take when staking subgrade or crushed aggregate base course:

1. Locate grades, compute grades, or get them from the engineer or grading contractor. Refer to table 725-1 for an example of plan grades.

   Subgrade

   - The staking contractor must locate subgrade shoulder point information. Normally, the shoulder point stakes are moved in a specific width due to depth of the salvaged topsoil (this depth is shown on the typical section or is calculated using the depth and slope shown on cross sections).
   - Normally, cross sections show sub-grade elevations:
     - At the reference line.
     - At breaks in the section where there is a cross slope change.
     - At the shoulder points which include the topsoil.
   - Additional grade computations may be needed if subgrade stake locations desired by the contractor differ from the grades shown on the cross sections.
   - If desired grades are not shown on the cross sections:
     - Find typical section/s relating to the stations required.
     - Identify all cross slopes and change of slope locations and depth of salvage topsoil on the typical section.
     - Obtain the project profile from the plan and profile sheets.

        - Use profile to compute remaining grades.
    - Compare to grades shown on cross sections.

Base course

- Offset distances for base course staking are determined by the typical section and the grading contractor's operation. Grades for these locations need to be computed based on the plan and profile reference line elevations, from a depth below finish grade and cross slope from the typical sections and cross sections.
- Top of base course grades should be:
    - At the reference line.
    - At breaks in the section where there is a cross slope change.
    - At a distance several feet beyond the finished pavement edge.
- This last location allows for sufficient additional room to construct the pavement on a well-prepared uniform base.

2. Re-establish the reference line from control points, if necessary.
3. Set out hubs for the grade point with respect to the reference line at approved project intervals and offsets.
4. Grade the hubs according to plan elevations or separate grade run computations.
    - Grade is established by driving a hub until the top is at subgrade/base course elevation. Hub should be stable.
    - Should the subgrade be either too high or too low, the side of a stake or lath may be marked with a value and either cut (C) or a fill (F).
    - Hubs at grade are marked with flag, pink crayon, paint, or whiskers (tufts of fibers that are attached to the top of stakes driven flush with the subgrade/base course surface that makes the stake location visible).
5. Maintain neat and accurate field notes of the work being performed.
    - Refer to CMM 715 for general field note information.
    - Staking field notes should include the following:
        - Date, time, crew, location.
        - Control used (horizontal and vertical).
        - If conventional instruments are used, include instrument heights and back sights, foresights, etc.

TABLE 725-1 Example Plan Information for Subgrade and Base Staking

Grades/Gravel Westbound Lanes STH 29 Station	17 FT LT	C/L	15 FT RT
229+50	1253.12	1253.46	1253.16
230+00	1252.01	1252.35	1252.05
230+50	1251.04	1251.38	1251.08
231+00	1250.21	1250.55	1250.25
231+50	1249.51	1249.85	1249.55
232+00	1248.95	1249.29	1248.99
232+50	1248.53	1248.87	1248.57

SECTION 730 Staking Curb, Gutter, Curb and Gutter, and Concrete Barrier

As a general practice, the surveyor should check with the curb, gutter, curb and gutter, or concrete barrier wall contractor for paver limitations or requirements and for the preferred offset before beginning to stake. Offsets may be either to the center of barrier, back of curb, face of curb, or flange. Note most radii are to face or flange of curb and must be taken into account for offsets. Grades may be referenced to either to the top of barrier, top of curb, flange/flag, or string line with special attention given to point of curvature (PC), mid-point of curves, point of tangency (PT), high points, low points, and flumes. Grades and offsets must be used consistently throughout the project and the contractor must be informed accordingly.

Stakes for the construction of these items are usually set out two or three feet from the form line, unless the curb, gutter, curb and gutter or concrete barrier wall contractor prefers otherwise. This distance depends on the equipment and methods used. Normally, stakes are set at 50-foot intervals for rural sections. However, urban sections and short radius curves may require stakes at 25-foot intervals. Refer to plans and specifications for project intervals. Grade for these items is shown by driving a hub and marking the side of the guard stake. Accuracy in these stakes, grade and line, is critical for drainage.

Concrete barrier staking is a similar operation to curb, gutter, and curb and gutter staking. The same staking procedures are followed. This section does not include retaining wall staking.

730.1 Suggested Procedure

The staking contractor must always consult with the curb, gutter, curb and gutter or concrete barrier wall contractor and check with engineer for changes to the approved plans before doing any staking or grade computations.

The surveyor should follow these steps when staking curb, gutter, curb and gutter, or barrier wall:

1. Re-establish the centerline from control points, if necessary.
2. Determine curb, gutter, curb and gutter, or concrete barrier wall offset.

   Check with the curb, gutter, curb and gutter, or concrete barrier wall contractor for desired stake offset and for barrier wall, the actual desired stake location. This should remain consistent throughout the project.
3. Locate or compute curb, gutter, curb and gutter, or concrete barrier wall grades from the plan.

   For curb, gutter, or curb and gutter refer to:
   - Construction details for item (type, width, etc.).
   - Computed grades for elevations on plan or matching into existing pavement.
   - Typical sections for plan location.

   For barrier wall:
   - Construction details for wall dimensions.
   - Pavement grades for elevations.
   - Typical sections for plan locations.
4. Set tacked hub at predetermined interval and offset. Permanent marker may be used instead of tack.
5. Establish elevation on the top of the tacked hubs.
6. Compute fill or cut to required elevation.
7. Mark guard stake accordingly, as shown in figure 730-1.
   - Station and offset of stake.
   - Offset from stake to item and identify location referenced, for example back of curb.
   - Cut or fill to referenced elevation.
8. Be sure to keep neat and accurate field notes of work being performed, as shown in figure 730-2.

   Refer to CMM 715 for general field note information.

FIGURE 730-1 Labeling of Curb Stakes

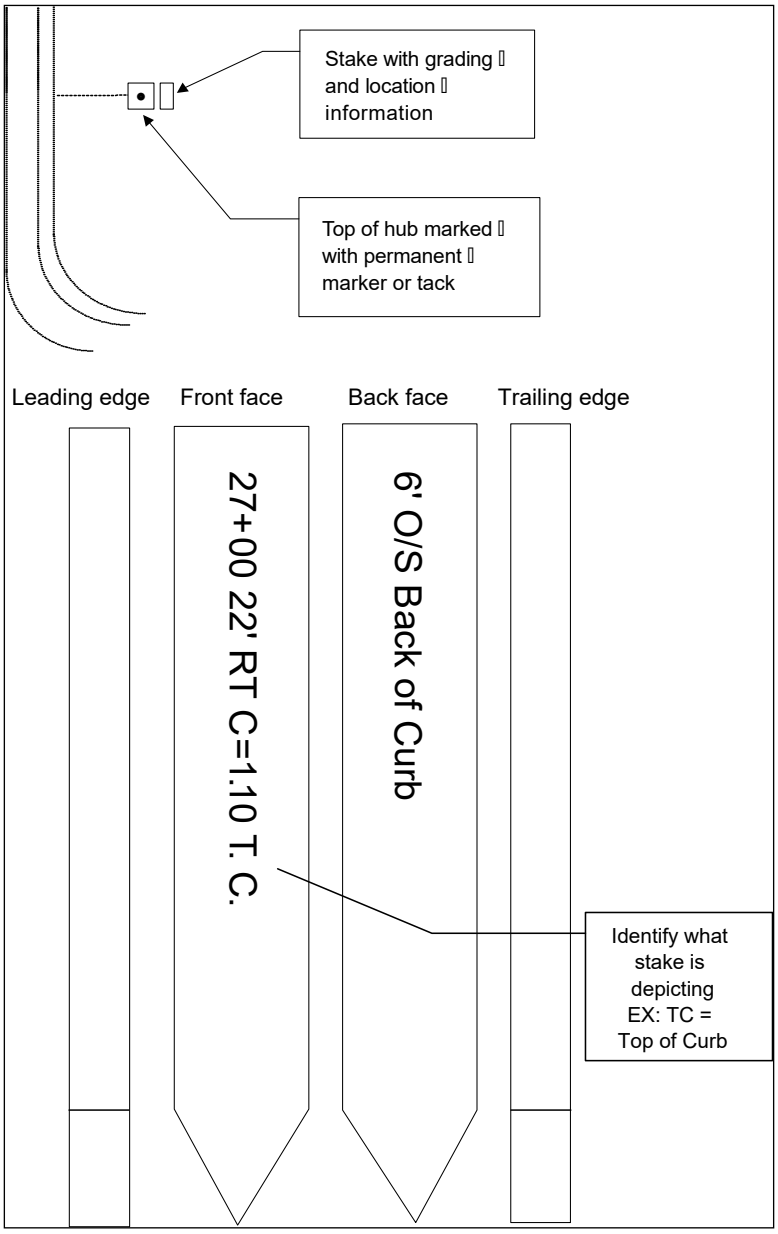
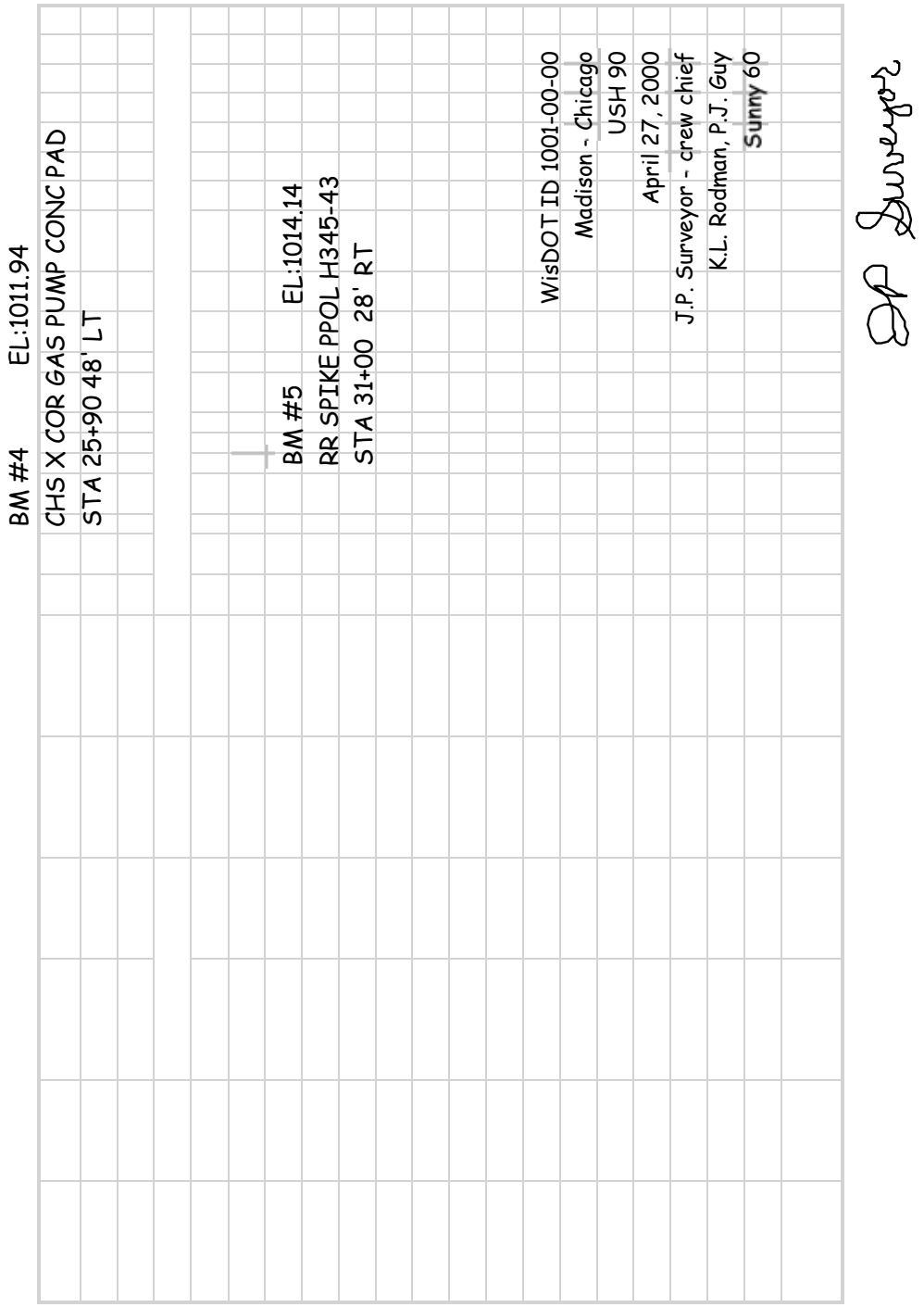


FIGURE 730-2 Example Curb, Gutter, or Curb and Gutter Field Notes



SECTION 735 Staking Pipe Culverts

Pipe culverts should be located to fit field conditions. After the preliminary section is taken by the staking contractor and turned in to the engineer, hydrological changes may be necessary. The staking contractor must provide drainage ditch information to the engineer a minimum of 14 calendar days before the contractor orders pipe culverts.

735.1 Checks Before Staking

The location, alignment, elevation, grade, and cover information are shown on the plans or obtained from the engineer. Before staking, all conditions affecting these requirements should be checked by the staking contractor:

735.1.1 Location

Is the location proper for efficient operation of the structure? Careful examination of the site may indicate that another line and grade would provide better performance.

735.1.2 Alignment

Skew and length must be checked against the plan. The best fit that can be developed by the engineer without being economically unsound must be used. Check for fit to roadway section. For the greatest hydraulic efficiency, culverts should be placed so the stream or ditch will have as straight an entrance and outlet as possible.

735.1.3 Elevation

Do the plan elevations fit existing features?

735.1.4 Grade

Do the grades for the inlet and outlet provide the proper gradient? The plan flow line should be checked against the existing flow line and adjusted as necessary. If the culvert is installed on a steep slope, there is a danger of water undercutting the outlet. Headwalls, end sections, or some type of energy dissipation device may be required.

735.1.5 Cover

Does there appear to be adequate cover over the culvert?

Should the staking contractor find any of the preceding items to differ significantly from the plan, it must be immediately brought to the attention of the engineer since it may affect the hydraulic design. When authorized by the engineer, pipe culverts may be shifted from the plan location to better fit field conditions.

735.2 Staking Procedure

All pipes require at least one reference line at each end of the pipe marked by hubs. Pipes more than 100 feet in length will require additional ties at a regular interval along the pipe with a grade to the invert relative to the position along the pipe.

Care should be exercised when staking parallel pipe culverts. The pipe culverts should be staked sufficiently far apart to provide the specified minimum distance of one-half of the pipe diameter or a minimum of 18 inches. Parallel pipe culverts with individual apron endwalls are to be staked to provide a minimum clear distance of six inches between apron endwalls.

This item does not include private, commercial, or field entrances. For box culverts and other structures see CMM 740.

The staking contractor must always consult with the culvert pipe contractor and check with the engineer for changes to the approved plans before doing any staking or grade computations.

The staking contractor should follow the following steps when staking pipe culverts:

1. Locate all required information from the approved plan.
2. Re-establish the roadway reference line from control points when needed.
3. Field-locate the proposed ends of culvert left and right of reference line.
4. Verify that inlet and discharge elevations fit field conditions.
5. Determine and document existing ditch location and elevations (see figure 735-1).
    - 5.1 Profile drainage ditch flow line for a minimum of 150 ft. from pipe ends.
    - 5.2 Record station, offset and elevation for each shot.
    - 5.3 Include a layout sketch of the existing field conditions the field notes, including benchmarks and other pertinent information.
    - 5.4 Submit field notes to engineer.

6. The engineer will generate a culvert pipe order list and, if necessary, provide revised pipe layout information to the survey crew that will perform the stakeout.
7. Stake out pipe using the information provided or approved by the engineer using line ties, straddle ties, or additional ties. Any combination of these ties may be used - one end of the pipe may be a line tie and the other end a straddle tie, etc. Refer to figure 735-2 for illustrations of line ties, straddle ties, and additional ties.

   Line ties

   Line ties are on the centerline of the culvert a short distance on line from each end of the pipe, but sufficiently far from the construction operations to be safe from being disturbed. Extra space for the pipe end section may be necessary.

   1. Set two tacked hubs on line at each end of a pipe.
   2. Establish elevations to the top of the tacked hubs.
   3. Set and mark a guard stake for each hub with the following:
      - Stationing of pipe.
      - Distance to the end of the pipe or end section.

        Distance to specified alignment of roadway.
      - Cut or fill from tack to flow line at end of pipe.
      - Information relative to camber, length, size, and type of pipe may also be placed on the stake.

   Straddle ties

   Offset stakes, also known as straddle ties, may be required if water is currently flowing in the stakeout area. These are perpendicular to the pipe directly at the end of the pipe without end sections.

   1. Set two-tacked hubs perpendicular to the end of the pipe.
   2. Establish elevations on the top of the tacked hubs.
   3. Set and mark a guard stake for each hub as shown for line tie.

   Additional ties

   Additional centerline offset stakes may be required for long culverts (greater than 100 ft).

   1. Establish elevations on the offset stakes.
   2. Compute grade at current location from plan data.
   3. Compute the amount of cut or fill.
   4. Compute the slope.
   5. Mark the stakes accordingly (see figure 735-3).
8. Record all the data in field notes and provide them to the engineer. An example of culvert staking field notes is provided in figure 735-4. The engineer may prefer sample computation sheet rather than field notes. This varies from region to region.

   Field notes should include the following:

   - Date, time, crew, location.
   - Control used (horizontal and vertical).
   - If conventional instruments are used, include instrument heights, back sights, foresights, etc.
   - A layout sketch of the culvert as staked.
   - Overall dimensions.
   - Hub and stake locations.
   - Distance to specified alignment of roadway.
   - Grade elevations, skew, fall.
   - All other pertinent information.

FIGURE 735-1 Example Pipe Culvert Existing Ditch Location and Elevation Field Notes

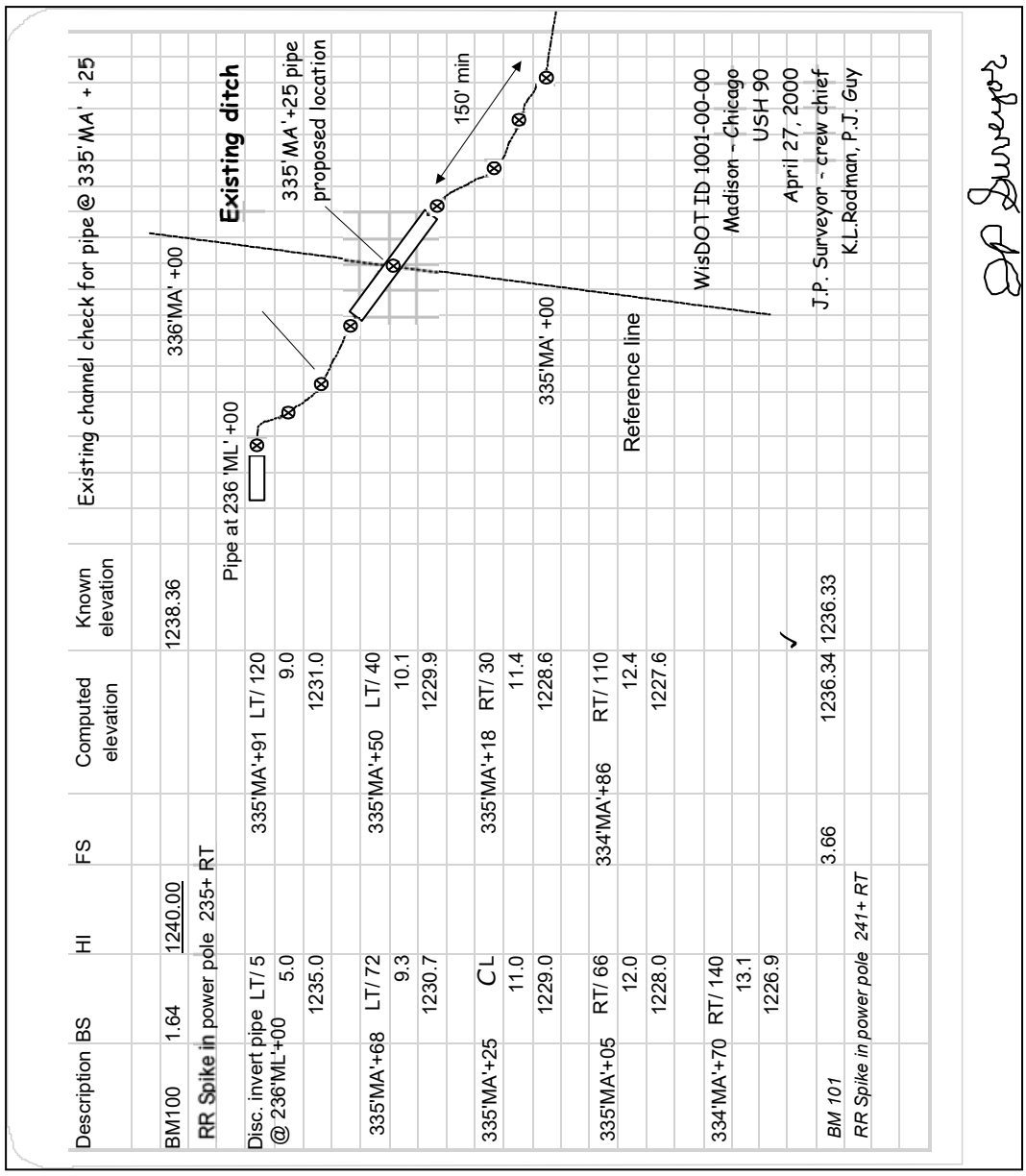


FIGURE 735-2 Line Ties, Straddle Ties, and Additional Ties

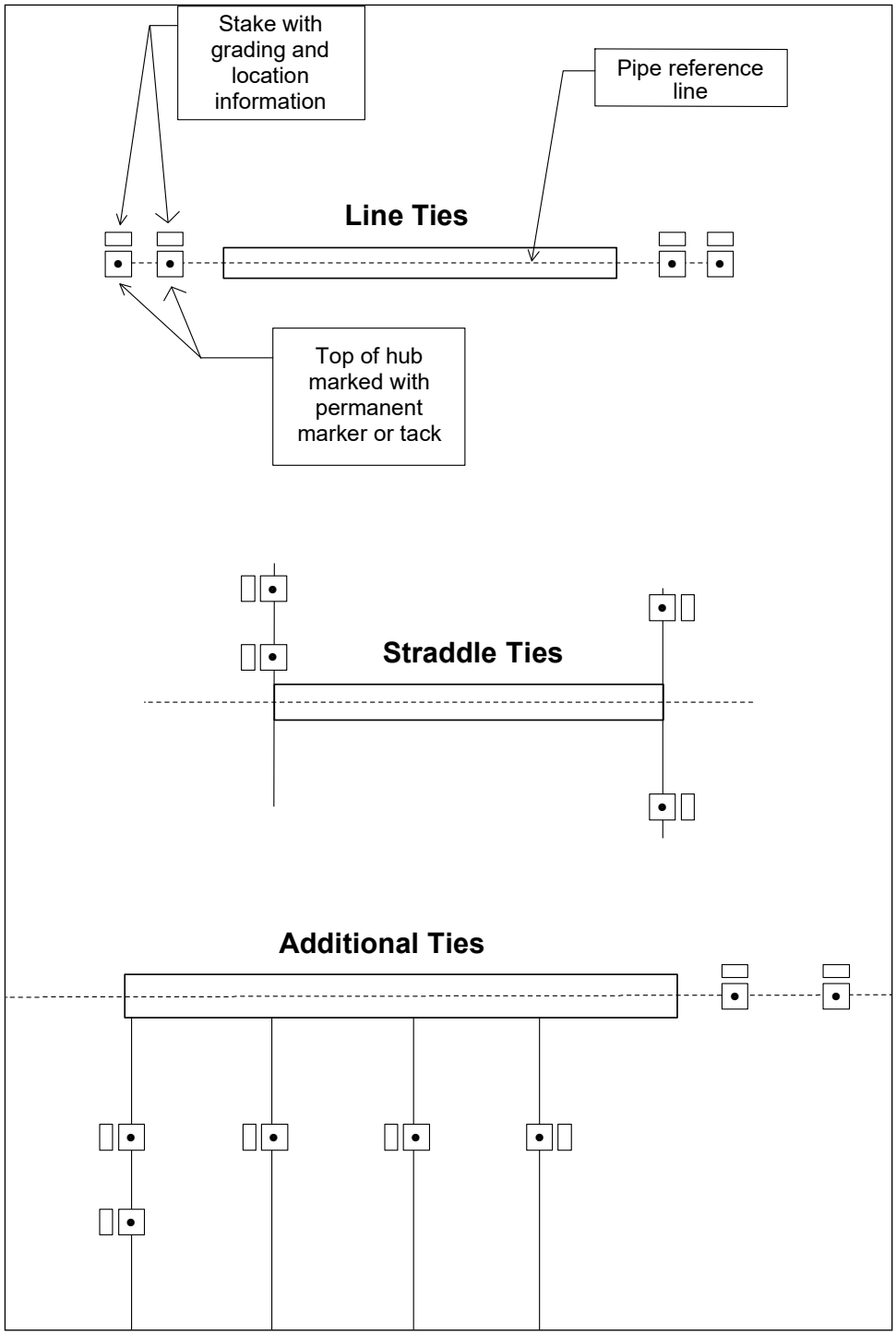


FIGURE 735-3 Labeling Pipe Stakes

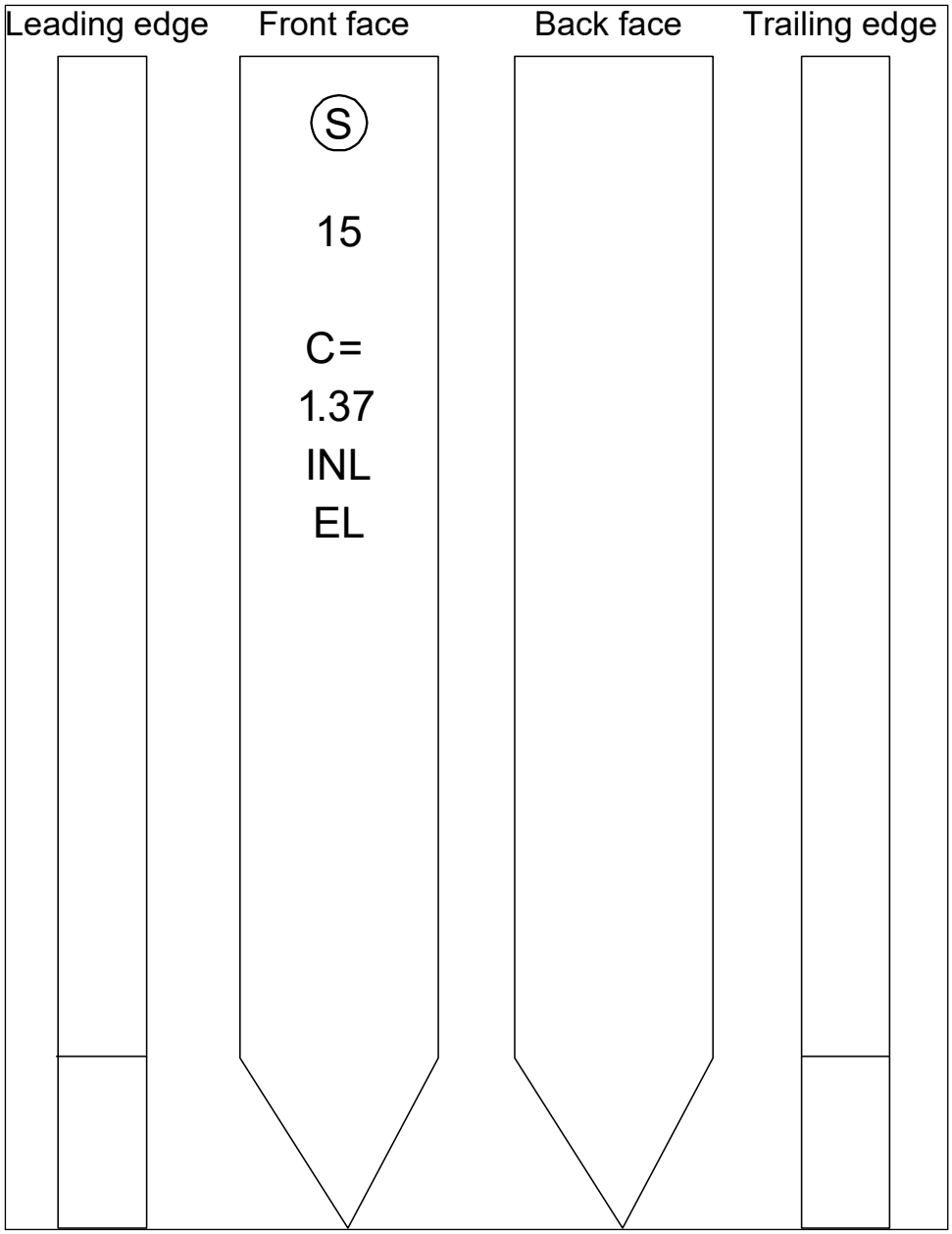


FIGURE 735-4 Example Pipe Culvert Staking Field Notes

Description	BS	HI	FS	Computed elevation	Known elevation
BM100	6.92	1245.28			1238.36
Hub 1					
Line Tie Hub shot 20' LT		12.91			
		1232.37			1232.70
inlet elev		1231.00			1229.00
		C= 1.37			C= 3.70
Hub 2					
Line Tie Hub shot 40' LT					
		12.25			17.08
		1233.03			1228.20
		1231.00			1229.00
		C= 2.03			**F= 0.8**
BM 101			8.95	1236.34	1236.33
RR Spike in power pole 241+ RT					

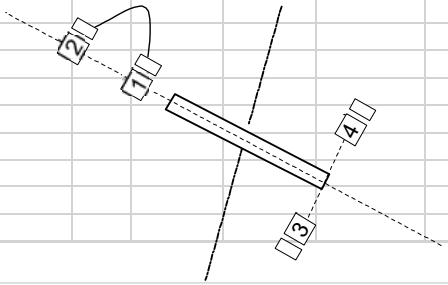
Hub 4

Offset +10' Hub shot 20'RT 12.58

Hub 3

Offset -10' Hub shot 20'RT

Marked guard stake



Final Pipe Staking Information @ 335'MA' + 25

Sta 335'MA' +35
Size 48" x 142' RCCP CL IV
Distance LT = 74' Distance RT = 68'
Total Fall = 2.0' Camber = 0.3'
Fall LT inl to R/L = 0.7'
Fall R/L to RT Discharge = 1.3'
total fall 2.0'

Skew = 25° LHF (left hand forward)
Inlet elevation = 1231.00
Discharge elevation = 1229.00

Note- plan sta 335+25 skew 21° LHF
plan length = 130'

Concrete masonry endwalls
Riprap
Geotex Fabric Type R
Geotex Fabric Type DF
Joint Ties

WisDOT ID 1001-00-00
Madison - Chicago
USH 90
April 29, 2000
J.P. Surveyor - crew chief
K.L. Rodman, P.J. Guy
Sunny 65

JP Surveyor

SECTION 740 Staking Structure Layout

Construction staking structure layout includes stakeout of bridges, box culverts, noise barriers and retaining walls. The staking contractor should consult with the structure contractor and engineer before proceeding with structure stakeout. Method of operation and construction project staging may impact staking operation.

The alignment, riding surface, and appearance of a structure are the result of quality plans and specifications, accurate staking, and construction according to the plan and specifications. The staking contractor must have full knowledge of the plans and methods and is responsible for the geometric layout of the structure. Systematic checks must be developed on each structure to ensure the accuracy of all points and stakes set. Stakes that are out of tolerance must be reset within the specified tolerance. Errors in staking or in replacing points for major structures can be very costly. Extra time and care is warranted in staking and checking to prevent errors.

Before staking, horizontal and vertical dimensions and elevations must be checked by the staking contractor. Structure grades must be checked for match with existing and proposed improvements grades. Alignment and stationing of abutments, piers, wing walls, and other bridge components must be checked in the field to ensure the structure fulfills the purpose for which it was designed. Any conditions found in the field by the staking contractor that may require adjustments, line or grade, should immediately be brought to the attention of the engineer.

Field notes should include any sketches and computations necessary to stake the structure. This information includes stationing of abutments and piers, span distances, skew angles, wing wall angles, lengths and offset distances, as-staked field location, and control points used. Several sketches may be required for clarity and neatness. All points referred to in the notes must be clearly described to allow rapid recovery in the field. Remember, the staking contractor may not be there when the structure is built, so the notes must be self-explanatory. The meaning of all stakes and markings must be understood completely by the structure contractor and engineer. Field notes must be kept at the project field office for use at all times.

Vertical control must be maintained by a minimum of 2 independent benchmarks (usually each end of structure).

740.1 Preparing for Layout

Preparing for layout is an indispensable part of the bridge layout procedure. When preparing to layout a structure, the staking contractor should take note of the following considerations:

740.1.1 General

- The layout should be done before the structure contractor starts to take down the existing bridge.
- Before staking, identify with the structure contractor equipment location, storage areas, and obstacles.
- Transfer benchmarks. All elevations on the plan may be referenced to one benchmark. Should the plan benchmark be destroyed there may be no other bench marks available.
- Use different color ribbon to mark the lath. Don't make offset tie points look like all the other points staked out on the job - make the points different so they stand out from other stakes.
- Notify the structure foreman of the location and markings of offset points. Are the points in the contractor's way?

740.1.2 Reviewing Structure Layout - Longitudinal Reference Line

- Does it require major preliminary work to reestablish?
- Is it straight or on a curve?
- Is it currently on a structure or roadway that will be removed or excavated?
- What is the terrain (water, woods, hills, etc.)?

740.1.3 Reviewing Substructure Layout - Transverse Reference Lines

- Are all the abutments, piers, and wing walls skewed at the same angles?
- Check individual units - are all angles the same as plan sheet?
- Are all intersecting points of reference lines and center lines of bearings the same points as shown on the plan sheet?
- Is the stationing on intersecting points consistent with distances as shown for span lengths?
- Are intersecting points accessible in field (could be in water, middle of heavily traveled roadway, building, tree, etc.)?
- Will points be visible after vegetation grows (can see easily in winter & spring until foliage grows out)?
- Field conditions determine where you can set the points. Set points out far enough so that the equipment does not destroy them.

- When staking, lay out both sides of the bridge at the same time.
- If there is a river or other obstacle, stake on both sides of obstacle. The user may not be able to cross.
- If the existing ground on both sides of the reference line is going to be disturbed, establish ties outside of the disturbed area.
- After staking out a structure on tangent, check the span lengths between offset points and the skew angle.

740.2 Suggested Procedure

The staking contractor must always consult with the structure contractor and check with the engineer for changes to the approved plans before doing any staking or grade computations. The staking contractor should follow these steps when staking structures:

1. Locate all required information from the approved plan:
   - Longitudinal lines and stationing.
   - Centerline of bearing of abutments, centerline of piers, abutments, walls, barriers, or other pertinent structures (transverse reference lines). The centerline of bearing of the abutment and reference line of abutment are not always the same line.
2. Re-establish the roadway reference line from control points when needed.
3. Before construction begins, transfer the existing benchmark elevation to at least two other benchmarks on opposite ends of the structure.
4. Establish and clearly identify the longitudinal reference line from control points.
   - Line may be off to one side of the bridge, may be the roadway reference line, or a line tangent to the roadway curve or on curve.
   - Set line ties beyond structure's construction limits but close enough for the structure contractor's use.
   - Line tie points may be a stake and tacked hub, chiseled cross, PK nail, or other stable marker.
   - Locate tie points so that construction operations will not destroy them.
   - Document all information in the field book.
5. Field-locate the proposed points for the centerline of substructure units on the longitudinal reference line at the proper station.
6. Set and clearly identify points to establish the transverse reference lines.
   - 'Close' points should be approximately 90 to 100 feet from structure to stay out of the path of all the equipment.
   - 'Far' points are for line of sight only.
7. The staking contractor must systematically verify angles, span lengths, plan distances, and stationing of staked points.
8. Record all the data in field notes and make them available to the engineer within 24 hours as work progresses.

   Refer to CMM 715 for general field note information.

   Field notes should include:
   - Date, time, crew, location.
   - Control used (horizontal and vertical).
   - If conventional: Instrument heights and other back sights, foresights, etc.
   - A layout sketch of the structure as staked.
   - A layout diagram of staked point locations.
   - Distances from stakes to centerline.
   - All other pertinent information.

Examples of staking layouts are provided in figures 740-1, 740-2, 740-3, and 740-4. It's important to note that each contractor may have preferences that differ with the examples. The staking contractor should always verify staking procedures with the engineer and structure contractor.

Refer to figure 740-5 for example stake markings.

FIGURE 740-1 Example Stake Layout for Span Structure with No Obstacles

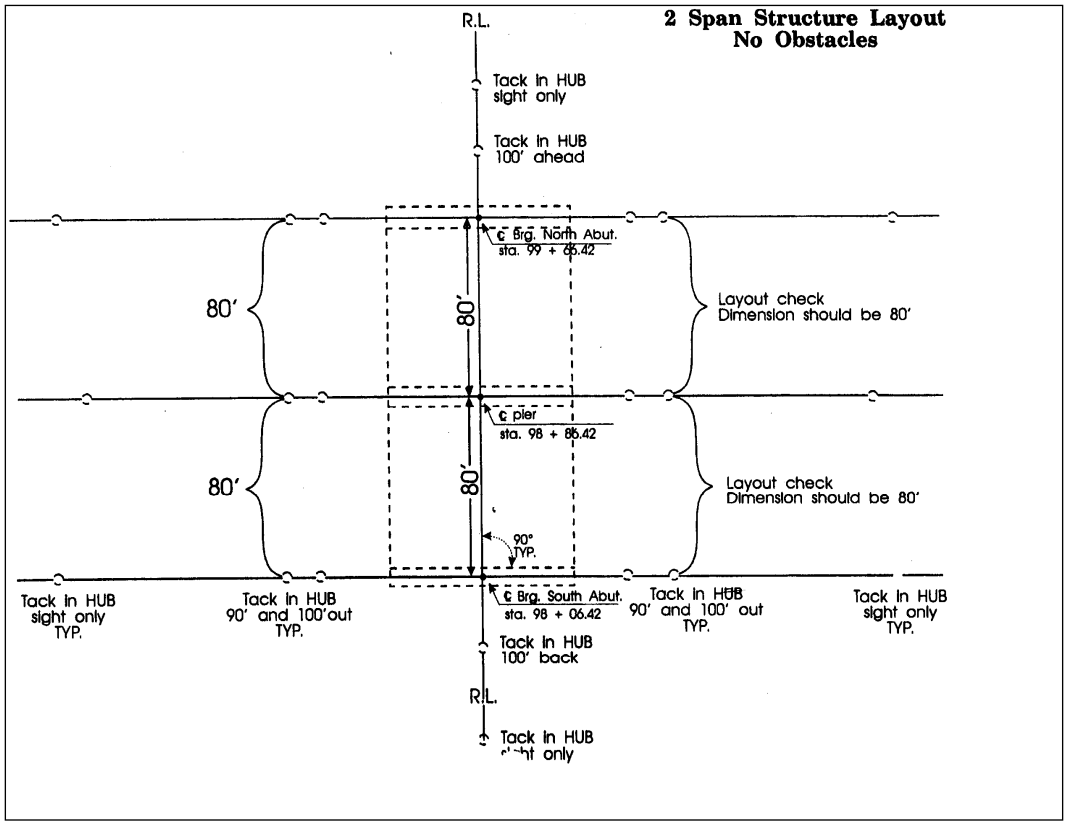


FIGURE 740-2 Example Stake Layout for Span Structure with River

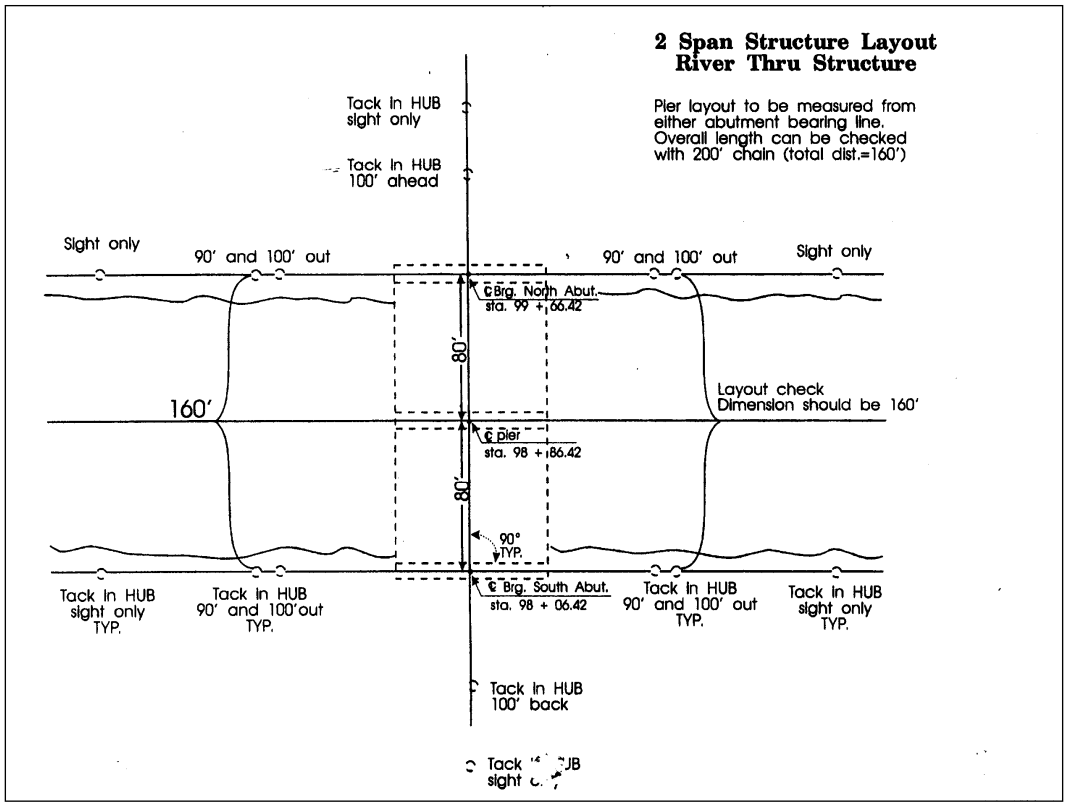


FIGURE 740-3 Example Stake Layout for Span Structure with Obstacles on One Side

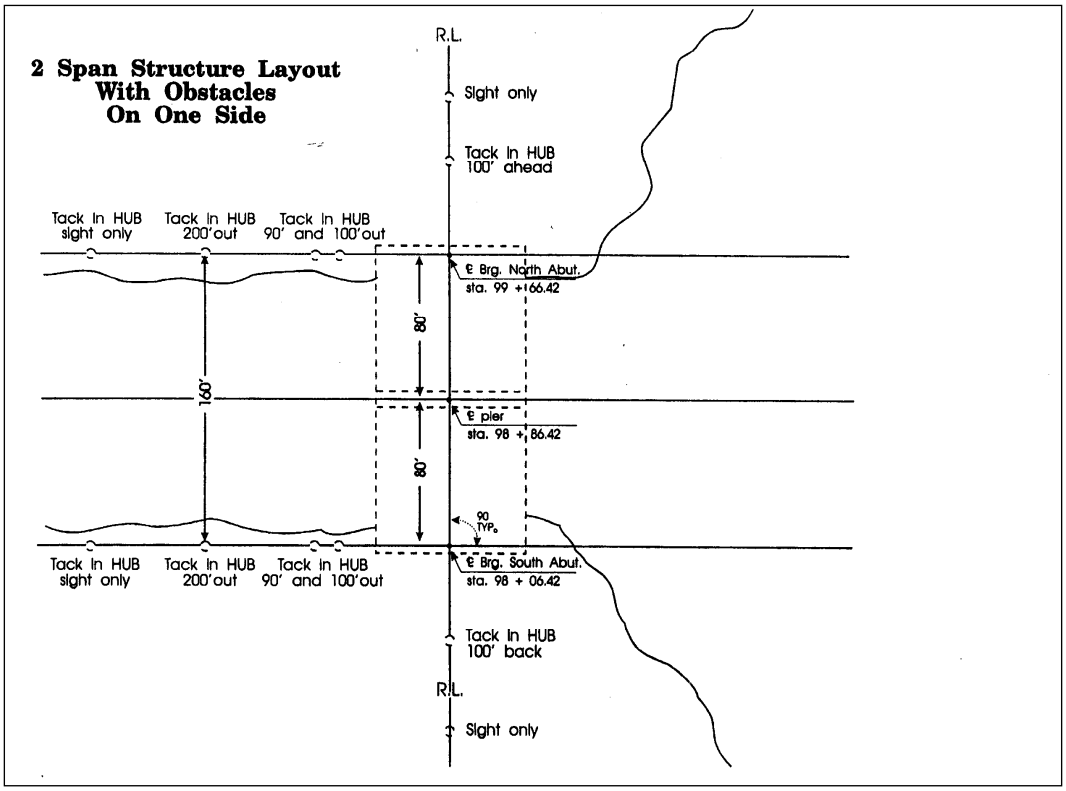


FIGURE 740-4 Example Stake Layout for Skewed Span Structure with No Obstacles

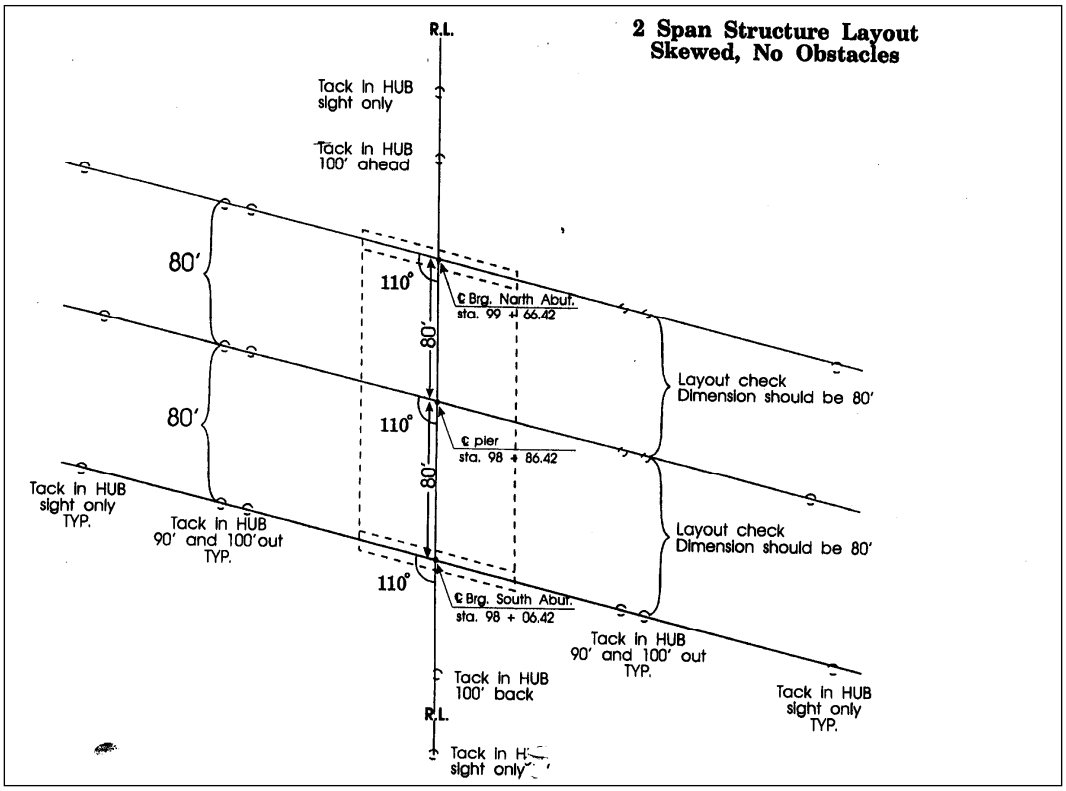
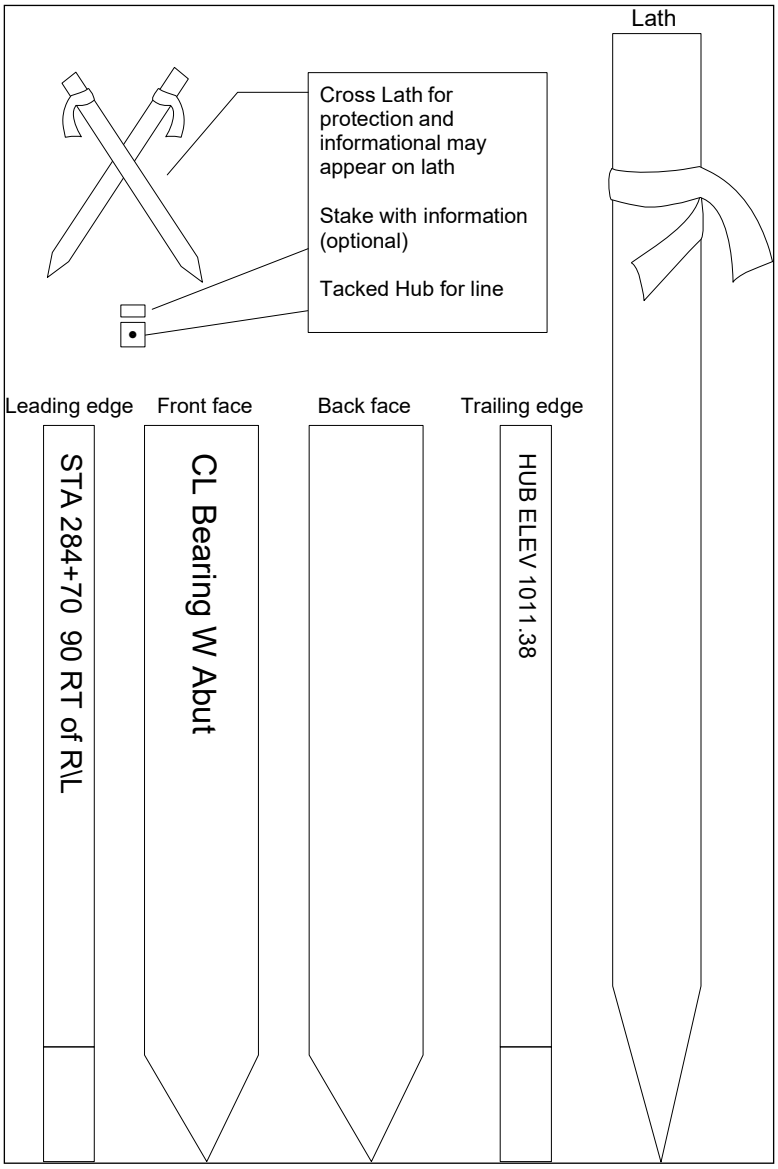


FIGURE 740-5 Labeling Structure Layout Stakes



SECTION 745 Staking Concrete Pavement

745.1 General

Concrete pavement stakes are set for either formed or slip-formed pavement operations. This item includes the staking of dense and open graded base course. Staking for subgrade is a separate item.

Construction stakes for concrete pavement must be placed at a maximum interval of 25 feet. Urban projects with rolling profiles should have paving stakes set at all high and low-profile points in addition to stakes set at stations and other regular intervals. Additional stakes must be set and maintained as necessary to establish location and grade along intersecting road radii, auxiliary lanes, vertical curves, horizontal curves, and curve transitions in accordance with the plan.

The number of construction stakes required per cross section should be determined by the concrete pavement contractor to achieve the required accuracy and satisfy the concrete pavement contractor's method of operations.

The process of setting paving stakes involves making horizontal and vertical measurements. Accuracy in the grades is critical to obtaining a smooth pavement surface, particularly in transition sections and in super-elevated sections.

Grade stakes may be used for more than one course if undisturbed between operations. If used for more than one course, the grade stakes must be checked and may be used again if found to be within acceptable tolerance. The checks must be documented in the survey notes.

The method of operation (formed concrete pavement or slip-form concrete pavement) used in the field will determine the staking requirements.

745.2 Suggested Procedure

The staking contractor should always consult with the concrete paving contractor and check with the engineer for changes to the approved plans before doing any staking or grade computations.

The staking contractor should follow these steps when staking concrete pavement:

1. Re-establish reference line from control points when needed.
2. Obtain and compute paving profile line information from the plan or, if available, obtain from the engineer.
    - Typical sections identify point referred to on the profile and the cross slopes for grade computations for typical and super-elevated sections.
    - The plan and profile sheet lists the finish profile grade elevations and super-elevation information.
    - Grade computations should include the profile line elevation from the plan and computed edge of pavement elevations.
        - Additional elevations for the offset location should also be shown. These elevations (and distance offset) are dependent on the concrete paving contractor's operation.
        - This elevation may be based on the pavement cross slope extended or some other method.
        - It is essential that grades be determined in consultation with the concrete paving contractor. It is also essential that super-elevation transitions be computed accurately. Do not interpolate slopes shown in the cross sections.
3. Set out tacked hubs and stakes and flags.

    Stakes are generally a tacked hub with guard stake but steel pins or rods may also be used.

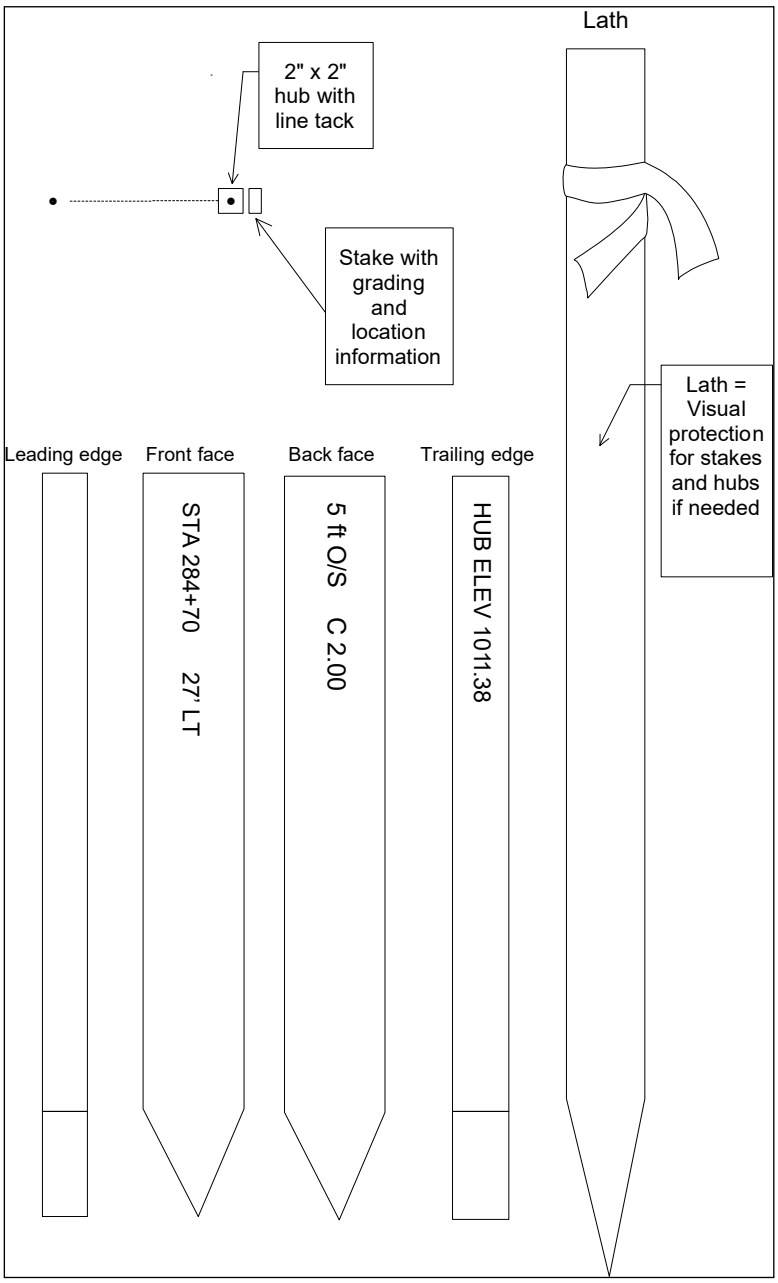
    Formed Concrete Pavement
    - Paving stakes for the construction of formed concrete pavement reference the elevation on the top of the concrete form.
    - The offset distance from the form line should be discussed with the concrete paving contractor but is generally set at two to three feet outside the form line. Check with the contractor's superintendent for paver limitations or requirements and for the preferred offset before beginning to stake. Once defined, offset should be consistent throughout project.

    Slip-form Concrete Pavement
    - Stake grades for slip-form paving are used as references to set one or two string lines that guide the auto grading of the base course or open graded base course and the concrete paver.
    - Slip-form concrete pavement grade stakes are generally set from three to ten feet from the edge of pavement, depending on the equipment and methods used for slip-form.
4. Establish elevation of tacked hubs or stake.
    - Record computations in field book.
5. Mark guard stakes or flag accordingly (see figure 745-1).
    - Grade should be shown by marking or taping the top or side of the stake.

- Grade shown appears as the value of the cut (C) or fill (F) from the top of tacked hub as marked on the guard stake or accompanying flag.
- Guard stake or flag should include:
    - Station
    - Offset from item
    - Grade cut (C) or fill (F)

6. Maintain neat and accurate field notes of the work being performed. Survey notes and computations must be made available to the engineer within 24 hours upon request as the work progresses.
    - Refer to CMM 715 for general field note information.

FIGURE 745-1: Labeling Concrete Pavement Stakes



SECTION 750 Staking Re-Surfacing Reference

750.1 General

Resurfacing reference construction stakes are set to guide the contractor by establishing and offsetting the horizontal roadway alignment before resurfacing pavement, milling, pulverizing, and relaying base. The work also includes establishing super-elevation transitions and reestablishing the alignment for trimming and asphaltic pavement operations.

Construction stakes used for offsetting the roadway reference line for pulverizing and relaying base normally are placed at a minimum of 100-foot intervals or as directed by the engineer. All other types of work normally are placed at a minimum of 300-foot intervals or as directed by the engineer.

Lath marked with rate of cross slope change from normal crown to full super-elevation are placed in the transition areas of all horizontal curves. Lath are usually marked in even increments of 1% in the transverse slope of each lane of travel, except those with normal crowns and as approved by the engineer. The super-elevation rate and transition locations must be adjusted as necessary where the existing asphalt pavement surface is retained to best fit the existing field conditions as approved by the engineer. Lath slope markings should be legible from the roadway centerline and recorded in field book.

Other methods of offsetting the roadway centerline may be used, but first consult engineer. Construction stakes for resurfacing reference must be set and maintained as necessary to achieve the required accuracy and to satisfy the paving contractor's method of operations.

750.2 Suggested Procedure

The staking contractor must always check with the paving contractor and check with engineer for changes to the approved plans before doing any staking or grade computations.

The staking contractor should follow these steps to take when staking resurfacing reference:

1. Obtain super-elevation and run out data from plan sheets. Review typical sections for cross slopes.
2. Compute super-elevation transition locations at defined increments.
3. Offset the existing pavement centerline before resurfacing, milling, pulverizing, and relaying base operations.

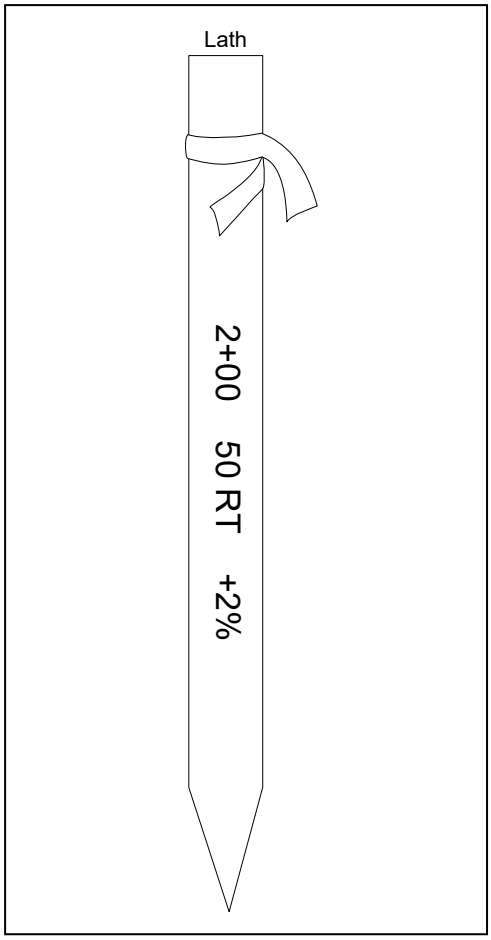
   Set lath marked with station and offset at:

   - Defined interval
   - Horizontal curve locations including PC and PT
   - Auxiliary lanes
   - Intersection road radii

   For resurfacing projects only, the staking contractor must determine if computed curve transitions (super-elevations) match existing pavement cross slope conditions. Any problem area should be brought to the attention of the engineer.
4. Place lath at computed horizontal curve locations where the rate of cross slope changes from normal crown to full super-elevation.

   Lath are placed in even increments of 1% in the transverse slope of each lane of travel, except those with normal crowns and as approved by the engineer. Mark lath as shown in figure 750-1.
5. Adjust the super-elevation rate and transition locations, as necessary, where the existing asphalt pavement surface is retained to best fit the existing field conditions as approved by the engineer.
6. After pavement is removed, re-establish the pavement centerline as needed for trimming and asphalt paving operations.
7. Keep neat and accurate field notes of work being performed.
   - Refer to CMM 715 for general field note information.

FIGURE 750-1 Labeling Resurfacing Reference Stakes



SECTION 755 Staking Electrical Installations

755.1 General

Construction staking for electrical installations includes, but is not limited to, the stakeout of:

- Conduit.
- Pull boxes.
- Junction boxes.
- Bases (various types).
- Meter pedestals.
- Loop detectors.
- Wiring.
- Service poles.
- Standards.
- Signals.
- Lighting.

Construction details for pavement joints and grades, traffic signals, and lighting are usually found in the plan. These should be referenced as to the location of conduit runs, concrete bases, pull boxes, and junction boxes. Some plans may have detail sheets or miscellaneous quantity sheets giving station and offset or coordinates to curb and gutter radii and island and median radii. If not contained in the plan, station and offset or coordinates will have to be computed, and the locations should be verified by the engineer.

Conduit runs, bases, pull boxes, and junction boxes all must be coordinated with the locations of curb ramps, sidewalk, signing, and pavement markings (stop blocks, etc.) for them all to function properly and not conflict. Ideally, items should be staked following installation of adjacent pavement or curb and gutter to ensure proper elevations.

Bases must not be located within curb ramps or sidewalk in islands. Loop detectors must be installed the correct distance from stop blocks and the correct distance from adjacent lanes.

Elevations for bases and pull boxes can be computed from the pavement grade detail sheets, typical section sheets, plan and profile sheets, and standard detail drawings for curb and gutter, etc. Incorrect elevations set during electrical staking can result in pull boxes set too low in island locations or signal boxes set too low or high. Units set too low result in "icing up problems" in winter. Ideally, designers should show a top of unit elevation on the plan.

The sequence of new construction operations usually is such that one operation closely follows another. As soon as the base course is completed, underground conduit can usually be installed.

Loop detectors installed in new concrete pavement usually must be located and installed just before paving operations so as not to interfere with other construction operations. The trimming of the base for concrete paving or the fine grading of the base for asphalt paving is also occurring at this time. Finish base course elevations can be used for determining depth of underground conduit. Paving grade stakes can be used to determine conduit end locations.

New construction is often done in stages, so all the required electrical staking will not be able to be done at one time, but also must occur in stages. It is important that the same crew and the same method of location (station and offset or coordinates) are used. A conduit run may be only partially staked for installation in one stage. The buried end must be relocated to extend in a later stage.

Construction stakes for electrical construction must be set and maintained as necessary to achieve the required accuracy and to satisfy the contractor's method of operations.

755.2 Suggested Procedure

The staking contractor must always consult with the electrical contractor before doing any staking or grade computations. The staking contractor must check with the engineer to ensure that alignment profiles and grades have not changed from what is shown in the approved plan.

The following shows the steps to take when staking electrical and electrical projects:

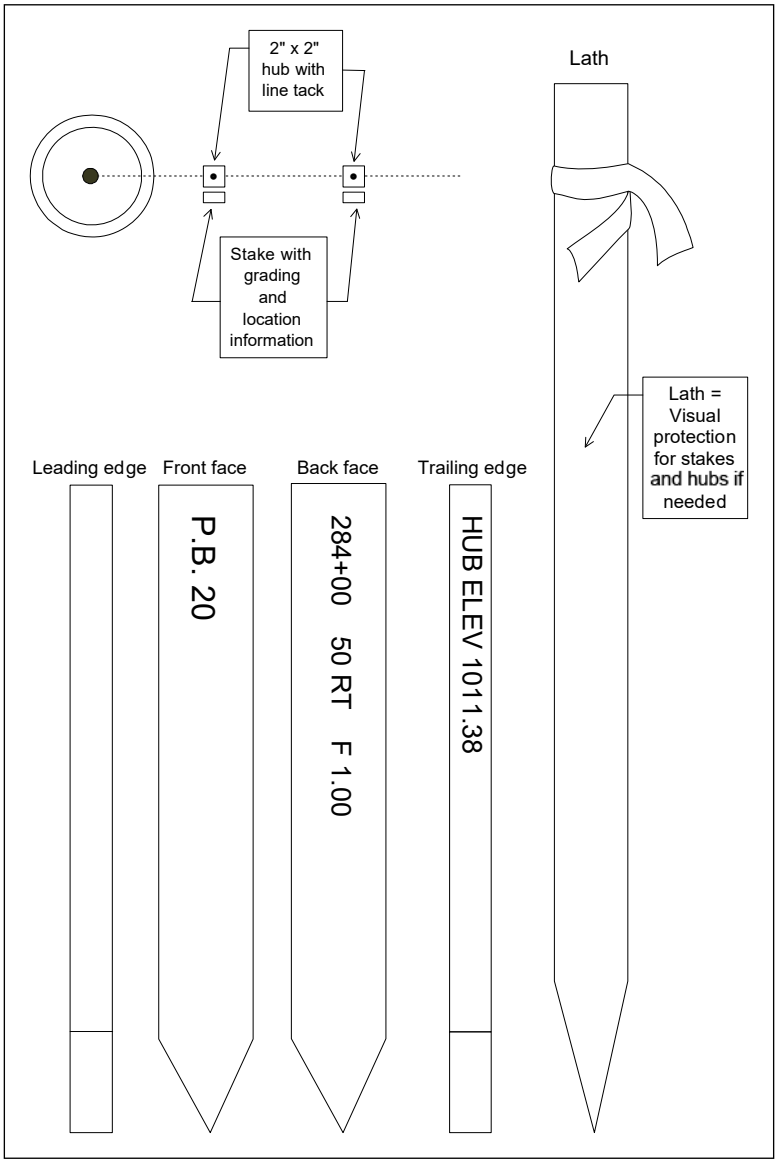
1. Review the plan construction detail sheets.
    - Pavement joint detail.
    - Grades.
    - Coordinates or station and offset sheets.
    - Lighting sheets.
    - Signal sheets.

- Pavement markings sheets.

Review the typical section sheets, miscellaneous quantities sheets, and applicable standard detail drawings sheets.

2. Compute unit locations and elevations to be staked from the above:
   - Determine finished pavement elevation and finished island or curb and gutter location.
   - Top elevation is governed by adjacent elevation, and the standard detail drawing shows depth needed to compute unit elevation.
3. Re-establish the reference line(s) from control points, if needed.
4. Field establishment of new islands, medians sidewalk, etc. may be required to assist field verification of item staking location.
5. Locate the unit and offset distance.
6. Set stakes out with respect to reference line(s).
7. Set grade stakes according to plan or computed elevations, and mark appropriately (see figure 755-1).
8. Check stakes and grade locations for match with new and existing constructed items - sidewalk, islands, etc.
9. Repeating these steps for some units may be necessary as construction progresses to subsequent stages.
10. Be sure to keep neat and accurate field notes of work being performed.
    - Refer to CMM 715 for general field note information.

FIGURE 755-1 Labeling Electrical Installation Stakes



SECTION 760 Staking Supplemental Control

760.1 General

Staking Supplemental Control includes furnishing and setting construction stakes necessary to establish the vertical and horizontal control for the construction project, including the following:

- Vertical control and bench level circuits (benchmarks)
- Horizontal control (control points)
- Horizontal and vertical alignments
- Radius points
- Clearing and grubbing
- Marsh excavation limits

Most WisDOT projects have existing horizontal and vertical project control that was established during the preliminary phases of the project. The staking contractor will perform the work using these points as their field control.

It is the responsibility of the staking contractor to locate, verify, and document the accuracy of all existing control points before using them for construction staking control work. The staking contractor must notify the engineer in writing of any discrepancies before using those points.

The elevations, dimensions, and horizontal alignment of structures, earthwork, and roadways must be checked for plan errors, compatibility, and consistency with existing field conditions. If any discrepancy is discovered, the engineer must immediately be informed. New grades must be established from the approved plan with adjustments to match existing roadway features as approved by the engineer.

The staking contractor will always consult with the engineer before doing any staking or computations. Data availability, project staging, or plan changes are all considerations that should be discussed before starting initial layout.

All field adjustments must be approved by the engineer. The staking contractor should always check with the engineer for changes to the approved plans before doing any staking or grade computations.

760.2 Vertical Control and Bench Level Circuits (Benchmarks)

This activity consists of locating the existing benchmarks set during the preliminary phases of the project, verifying their accuracy, correcting errors if necessary, transferring benchmarks to new locations to prevent conflict with construction, and establishing new benchmarks as needed.

Additional benchmarks must be set so as not to conflict with the construction operations. They should be set with a spacing not to exceed 500 ft or other spacing required by the engineer and contractor. Additional benchmarks must be of suitable material to endure the duration of construction.

Additional benchmarks should be set in locations that will be convenient for future work. It is also beneficial to alternate on left and right sides of the roadway, particularly when work is done under traffic. Benchmark number and elevation should be written on the guard stake or directly on the benchmark. All additional benchmarks set must be recorded (number or name, description, location and elevation) in the field book kept in the field office when not in use.

Good guidelines for locating benchmarks are:

- At each end of large structures.
- At points of change from cut to fill.
- At high and low points.
- Locations that are handy for cross sectioning of side hills.
- Any time there is a difference of 25 ft. in elevation in rolling terrain.

Before starting a bench level circuit (bench loop), the level must be checked for accuracy. A peg test is a standard level (instrument) test, but also check the tripod head and shoes and level rod tape and shoes for wear. If using a total station for setting benchmarks, ensure that the instrument is calibrated. This information should be recorded in the field notes.

In order to verify or establish elevations for benchmarks, they must be looped with a minimum of three benchmarks in the loop (two known).

Minor errors in benchmark elevations should be corrected in a manner that will not materially affect the work and brought to the attention of the engineer.

Major errors or apparent discrepancies found affecting other bench marks, existing plan information, and future work must be immediately brought to the attention of the engineer for correction or interpretation before preceding with the work.

All field notes will be required for verification. Refer to CMM 160 for general field note information.

760.3 Horizontal Control

Horizontal control begins with field-locating the control points, traverse points, section corners, etc., set by the original survey. These points will be noted on the plans along with field ties or can be obtained from the engineer. From these control points, the horizontal alignment for construction is established.

Additional control usually needs to be set outside the construction limits and there are special requirements for machine control grading projects as noted in CMM 718. Consideration must be given to future use of these control points to prevent loss during the life of the project, provide for easy access, recovery, and inter-visibility. Care should be taken when establishing these reference points to assure their accuracy. When a control point is disturbed or destroyed, new monumentation for the point must be set and new coordinates established before any staking is accomplished in the area controlled by the disturbed or destroyed point. A new point number should be used and the field notes should be updated to note the disturbed or destroyed point, the new point, and their locations.

When the project is staked using coordinates, the staking must be performed using the project control coordinates found in the plan or provided by the engineer. Verify that the coordinates provided are correct by checking the units, datum, and coordinate system used on the project. Field verify coordinates by performing independent checks made from different control point set -ups. Consult with engineer regarding the frequency and areas of the project that horizontal control needs to be maintained.

All additional control points established are to be documented in the field book with the point description, location, coordinates (ground values), and station/offset for use during the life of the construction project. They will be marked in the field for easy recovery. Crossed lath with fluorescent pink ribbon and the control point number legibly written is a standard practice.

760.4 Horizontal and Vertical Alignment

After horizontal and vertical control has been verified and established the alignment should be staked. The staking contractor should establish, on the ground, the reference line of the roadway from which measurements are taken for laying out the work and setting the stakes required for control of the work. Since it is obvious any stakes set on the centerline, base line, or reference line will be destroyed during construction operations, this line only needs to be temporarily marked (for example, painted on hard surface or lath in ground).

All horizontal and vertical alignments used on the project need to be checked. Bearings, curve data, coordinates, distances, and elevations need to be verified mathematically and in the field. If coordinates have not been included on the plans, they are generally available from the engineer.

On projects where GPS machine control grading has been performed, horizontal reference lines should be staked or marked. These marks would aid in the quality control of grading work and provide alignment for remaining contract operations.

Warning: during the design process, a number of survey lines may have been established. Assume a point or line is of no consequence until checked out by verification of field ties and other control points. Also, the proposed alignment should be checked for its fit with existing entrances and side roads. If the proposed alignment does not fit field conditions, the alignment may have to be adjusted. Notify the engineer immediately so that adjustments may be made.

760.5 Radius Points

Most plans will have side road radius points located from stationing and offsets with respect to the mainline and the side road. It is a necessary check when staking the radius in the field to confirm the station from the mainline and the station from sideroad are actually one point (see example below).

It is important to know what the radius is referenced to (back of curb, face of curb, flange, edge of pavement, islands, medians, etc.). Once the point of reference has been identified, it is necessary to review the offsets and radius length (for example, checking the offset and radius lengths agree with the roadway width). Lane widths and curb dimensions can be found in either the typical sections or paving detail sheets in the plan.

If matching to existing curb or structures, check that the radius fits with existing conditions. A good practice is to set the radius point and do a final check with a tape to ensure the location fits in the field.

Figure 760-1 shows a common mistake that can be avoided by properly field-checking the radius point. The station and offset on the plan do not actually identify the same point. The staking contractor should verify from both alignments, and then swing a tape to check for field fit.

FIGURE 760-1 Field Check of Radius Point

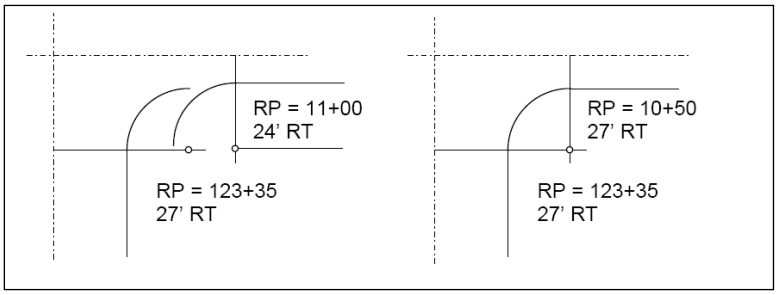
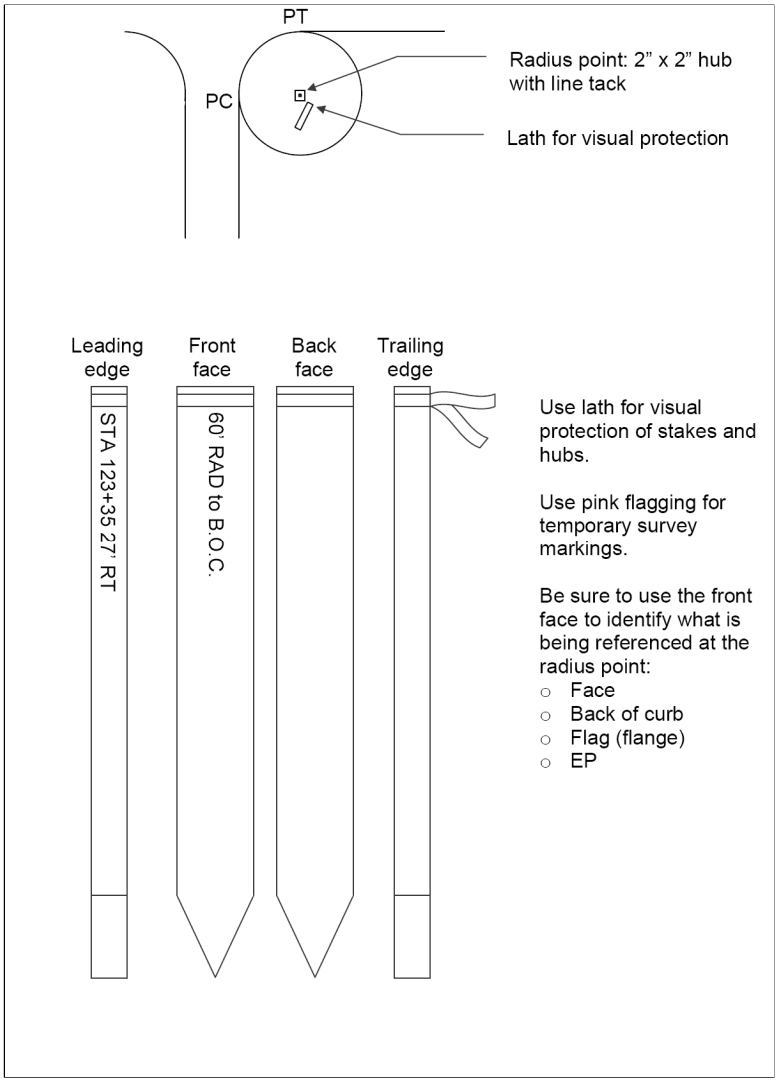


Figure 760-2 shows the proper marking and placement of radius point stakes.

FIGURE 760-2 Stake Radius Points and Mark Lath



760.6 Clearing and Grubbing/Marsh Excavation Limits

Staking for clearing and grubbing or marsh excavation is a similar procedure to slope staking. Limits may be shown on the cross section or in the right-of-way (R/W) plan.

An effort to save trees when possible while still meeting safety requirements may be done by the engineer. The engineer may wish to be present or contacted for input when this staking is being performed.

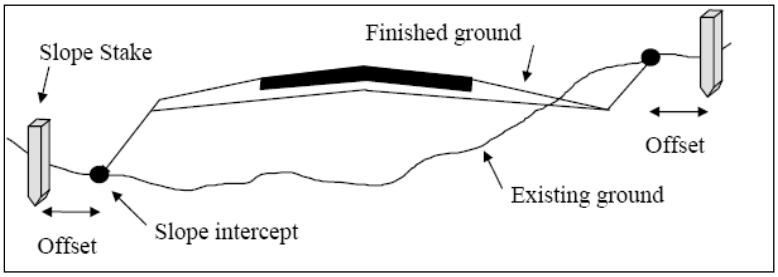
Additional stakes may be required in heavily wooded areas to insure inter-visibility for the contractor. Always check with the grading contractor, clearing and grubbing contractor and engineer for requirements and stake markings. Some contractors may want just centerline stations marked, pulling the offset distances themselves. Caution must be used to stay within the R/W limits.

Discuss the desired format of field notes with the engineer before setting stakes and check with engineer for changes to the approved plans.

SECTION 762 Slope Staking

Slope stakes mark the outer limits of grading on a construction project. Slope stakes mark, using a standard offset, the point where the proposed back slope of a cut or fill intercept with the existing ground. This intercept with existing ground is known as the slope intercept. Slope stakes must be set and maintained on each side of the road at each cross-section location shown in the plan. Slope stakes mark the outer limits of the grading and are set to indicate the point where the back slope or the fill slope intersects the natural ground or are offset from that point.

FIGURE 762-1 Slope Stakes



Slope stakes are the control points from which the contractor takes horizontal and vertical measurements for use in constructing the rough grade of the earth. Contractors using GPS machine guidance generally do not use slope stakes to construct the grade and ditches. However, the slope stakes provide important reference for the engineer and subcontractors, so they should continue to be provided at all cross-section locations.

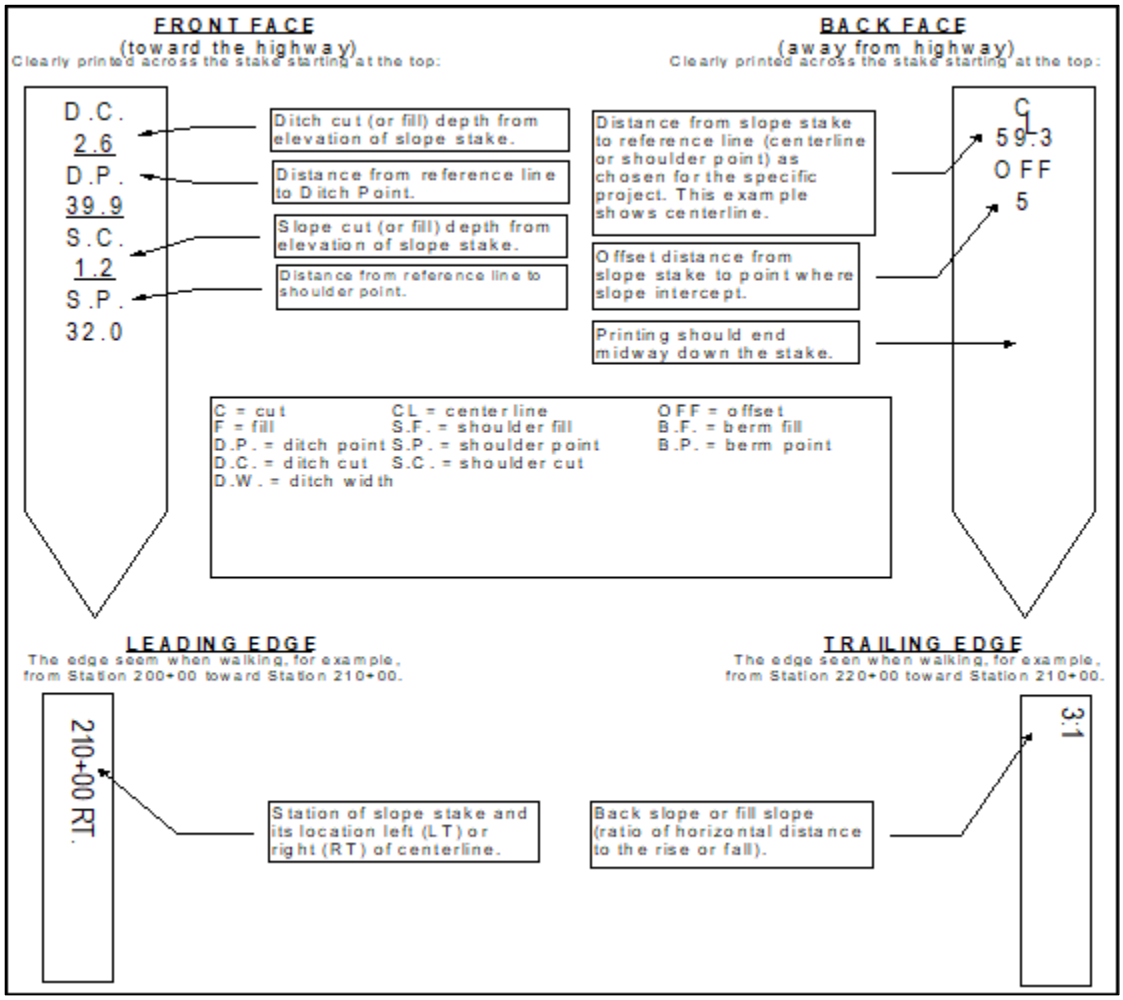
Stakes show the cut or fill from the ground elevation at the stake to the elevation of the finished subgrade at the road centerline or at the shoulder or other predefined point. A "cut" marking on the stake designates the vertical distance the ground at the stake is above the finished subgrade. Elevations are generally marked to the nearest tenth of a foot. A "fill" marking designates the vertical distance the ground at the stake is below the finished subgrade. Either the shoulder subgrade or the centerline subgrade may be referenced in setting the stakes. Whichever is chosen must be used consistently throughout the project and the grading contractor and engineer must be informed accordingly.

TABLE 762-1 Slope Staking Process

Slope Staking Process	
1.	Locate information in the approved plan. - Plan and profile sheets - Typical sections - Cross section details
2.	Prepare slope stake field book. Include items shown in the general section of this manual and: Refer to CMM 160 of this manual for general field note information. - Station of stake - Slope intercept elevation from cross sections - Offset distance slope stake to actual slope intercept - Offset slope stake to centerline from cross sections - Benchmarks - Other pertinent information should be included in the field notes
3.	Re-establish centerline, if necessary, from control points.
4.	Verify benchmarks used for staking before use. Document these checks in the field book.
5.	Establish slope intercept location in field from slope stake field book. Record actual elevation of ground at this point in slope stake field book.
6.	Compare ground elevations at slope intercept and slope stake to plan elevations recorded in the slope stake field book. The project may warrant additional existing ground elevation, obtained from plan cross-section sheets, to verify project plan (existing section) to actual field conditions. Always discuss with the project engineer and grading contractor any additional elevation verification they may foresee to the specific project. Elevation must be within 0.4 foot of the plan elevation to be considered acceptable. If acceptable: continue to step 7 If not acceptable: The true slope point needs to be located. - Do not set out a slope stake. - Set a stake or mark on the reference line at the bad station. - This station may need to be re-cross sectioned again. - The staking contractor needs to inform the engineer of the questionable sections in order to determine appropriate action to be taken. The engineer should consider going back to the designer to determine if a greater problem exists, and to help with corrective action. The engineer determines who will perform the re-cross section work. Any re-cross section work can be performed by the department, the staking contractor, or by a consultant under a surveying master contract with the department, using WisDOT digital data standards. If the work is performed by the staking contractor it should be considered as extra work. - The engineer will plot the correct original ground line to determine the true slope intercept location. If a plot is off for a significant number of stations, a recheck of the benchmarks and their adjustment may be necessary to preserve integrity of the plan. Any benchmark and grade adjustment must be brought to the attention of the engineer and documented in the field notes.
7.	Set out slope stake at the project offset distance beyond the intercept location.
8.	Establish elevation on the ground at the offset stake.
9.	Record elevation of ground at this point in field notes.
10.	Mark stakes Stake may include: - Station of stake - Elevation on ground at slope stake - Slope stake distance to centerline - Offset distance to actual slope intercept - Cut or fill to predefined location (ditch cut, etc.) - Rate of slope - Ditch cut and shoulder width may also be included when appropriate - Other pertinent data
11.	Keep neat and accurate field notes and give to engineer when not in use. - Include all elevations, distances and calculations used to determine cuts and fills in the field book.

To ensure against disturbance during the construction operations, the stake is offset or set back a short distance from the actual point where the constructed slope intercepts existing ground, usually 5 feet. It is desirable that all slope stakes for a given project be offset the same distance. The cut or fill is computed from the elevation of the ground at the offset stake. The surveyor should establish the offset distance and stake marking in consultation with the grading contractor and the engineer.

FIGURE 762-2 Example of Marking Stakes and Lath for Slope Staking

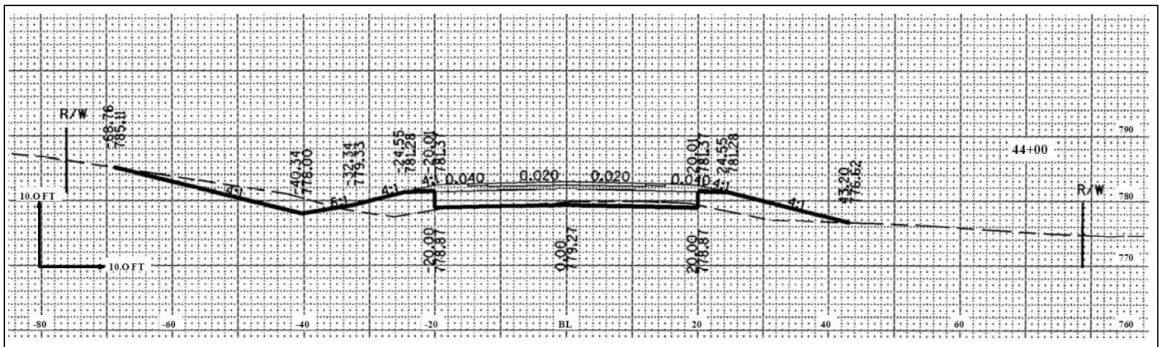


In certain situations, a standard offset or baseline may be the format the grading contractor wants. These stakes provide cuts and fills but are a uniform distance from the reference line. They are more commonly used in urban projects.

762.1 Slope Staking Notes

Staking notes, referred to as a "slope stake field book", should be prepared by the staking contractor before the time the staking crew sets the slope stakes. Notes may be in the form of digital file for data collectors, computer printout, or set up in a field book. The surveyor should discuss the desired format with the engineer and the grading contractor before setting stakes.

FIGURE 762-3 Example Slope Staking Field Notes



	STA	S/S	S/A	DITCH		SHLDR	CL	SHLDR	DITCH	S/A	S/S	
Distance from CL	44+00	73.8	68.8	40.3	32.3	24.5	0	24.5	--	43.2	48.2	
Proposed (Plan) Elevation		786.0	785.1	778.0	779.3	781.3	779.3	781.3		776.6	776.5	
Rod Reading		2.0	3.1				8.6			11.5	11.5	
Field Elevation		786.1	785.0				779.5			776.6	776.6	
HI	788.1					Existing (Plan) Elevation	779.7					
				C=8.1	C=6.8	C=4.8	C=6.8					
							F=2.7	F=4.7				

The slope stake book should contain plan and field elevations, slopes, and distances. The slope intercept distance from the centerline must be determined. There are two methods to find this distance.

1. The first is to use the approved plan cross sections. The distance from the centerline and the elevation of the slope intercept can be "picked" off the cross sections.
2. The second is to have a computer program generate the report including all points needed. This report should be cross-referenced to the approved plan.

The engineer may be able to provide a digital file or computer printout for the staking contractor's use. The slope stake book must be made available to the engineer and grading contractor for the duration of the project.

762.1.1 Requirements

Slope staking for each phase of construction must be 100% complete and acceptable to the engineer and grading contractor before earthwork for the particular phase is started. If slope staking is not completed, construction must be stopped until the staking is complete. This will ensure the earthwork quantities will be calculated and any required earthwork changes are made in a timely manner.

After stakes have been set, it is useful to sight along the slope stakes to check for major breaks in staking. Unless the terrain has sharp breaks in elevation, transitions between stakes should be smooth and in harmony with the rise and fall of the land. Stakes which do not follow this pattern should be checked to the corresponding plan cross-section for an elevation or offset error.

The staking contractor should contact the grading contractor for the preferred offset distance from actual slope intercept to slope stake and grade line to be referenced (ditch line, centerline etc.) before beginning to stake. This offset and grade references should be consistent throughout the project. Also discuss what information should be included on stakes.

The staking contractor should check with the engineer for changes to the approved plans before doing any staking or grade computations.

762.1.2 Slope Stake Report

The slope stake report is used by the surveyor to help set the slope stakes. It is used to verify existing field conditions and compare plan to field elevations. The report is also a useful tool to help calculate yardage quantities for contractor payment.

FIGURE 762-4 Caice Slope Stake Report

CAiCE Slope Stake Report
Alignment Used for Station and Offset: SICL1

STATION	OFFSET	PLAN ELEV	FIELD ELEV	C/F	POINT TYPE	SLOPE
44+00.00	-73.76	786.00			SS	
	-68.76	785.11			SI	
				C		1: 4
	-40.34	778			DPLT	
						1: 6
	-32.34	779.33				
						1: 4
	-24.55	781.28			SHLD	
						0.02 ft/ft
	-20.01	781.37				
						VERTICAL
	-20	778.87				
						0.02 ft/ft
	-12	779.03				
						0.02 ft/ft
	0	779.27				
						-0.02 ft/ft
	12	779.03				
						-0.02 ft/ft
	20	778.87				
						VERTICAL
	20.01	781.37				
						-0.02 ft/ft
	24.55	781.28				
						1: 4
	43.2	776.62				
				F		
	48.2	776.50			SS	

Note: Slope Stake (S/S), Slope Intercept (SI), and Center Line (CL) elevations need to be within 0.40 foot when comparing plan to field elevations. If the elevation at the slope intercept is off by more than 0.40 foot, notify the engineer. Contractor may also want % of slopes, subgrade elevations, etc. Discuss with the contractor and agree on content before making slope stake book.

SECTION 765 Staking Right of Way

Department policy on right-of-way survey accuracy and monumentation is contained in FDM Chapter 9.

After the project control and construction centerline or other base line or reference line has been established, stakes marking the right-of-way should be set. If right-of-way has previously been staked or marked on the ground, the staking should be reviewed to make certain the right-of-way as staked coincides with plan requirements. Occasionally, the right-of-way requirements may be revised after plans have been prepared. To ensure the correct right-of-way is staked, the engineer should check the right-of-way as shown on the field sets of plans against that shown on the official copy of the latest right-of-way plat, which is located at the region office.

Right-of-way will be staked at each and every break in its alignment and may be staked at each P.C. and P.T. at the pre-defined station interval on curves and at such other intermediate points on tangent as may be necessary to readily delineate it. Where marker posts for right-of-way are required to be set by the contractor, stakes are to be set to show the location of marker posts in accordance with requirements of the plans before construction.

Where the contract provides for constructing property or right-of-way fence, stakes are to be set to show the correct location of the fence with respect to the right-of-way line and plan requirements. Fencing is constructed 3 feet inside the right-of-way line unless the plan designates otherwise.

SECTION 770 Cross Sections and Digital Terrain Models

Since roadway excavation is measured by volume in cubic yards in its original position and computed by the method of average end areas, it is necessary to take cross sections or derive cross sections from a digital terrain model, both before and after the grading. Preconstruction cross sections are required, before the ground is disturbed, for all areas of the roadway where acceptable preliminary or location survey cross sections have not been taken. Original cross sections or the cross sections taken before disturbance of the ground are to be determined at each predefined station interval and at intermediate points as necessary to show a true average of the original ground.

Occasionally, during the process of setting and marking slope stakes, a cross section will be found to be in error by 0.4 feet or more and not representative of the actual ground. In this event, the original ground line should be re-sectioned for accurate measurement of earthwork as well as for setting the slope stake. Remember to first check the accuracy of the staking procedure before doing any re-sectioning.

Each section will be taken on a line that is at right angles to the construction centerline (or base line or reference line) and should extend from the centerline to beyond the limits of construction on each side of the roadway. Each cross section will consist of taking and recording a measurement (and feature code, if applicable) on the ground at the roadway or construction centerline and at each significant break in the slope of the ground along the line of the section. The station and offset are recorded with the measurement. Readings should be taken in ditches and channels to establish existing drainage patterns and for future reference. If cross sections will be computed from a Digital Terrain Model (DTM) collected in the field, readings should be taken along break-lines (centerline, shoulder, ditch, etc.), at high points, at low points and at a predetermined grid interval, to best model the ground.

Upon completion of the grading, final cross sections or a DTM must be taken on the finished grade. A section will be taken at the pre-defined station interval and the same intermediate points on centerline, base line, or reference line at which the original sections were taken. Final sections will show the shape of the work by taking shots at the centerline and from the left and right sub-grade shoulder points to the outer lateral limits of the grading, or by collecting a DTM.

Aerial photogrammetry to obtain original and final cross sections from DTM may be used in place of ground surveys. The only involvement of the survey crew may be to establish and mark the location and elevation of points on the ground for control of the photography.

Although software available may use DTM data to compute volumes between surfaces, the end area method is preferred due to the availability of data to verify results.

Unless other methods of measurement are used, areas of the roadbed undercut for removal of unsuitable material should be cross-sectioned before the back-fill is placed to show the quantity of material removed.

SECTION 775 Staking Borrow Pits

A digital terrain model (DTM) or cross-sections are required to be taken on borrow pits before and after excavation for determining the quantity of material removed. Original or preconstruction measurements should not be taken until any required clearing and grubbing has been completed and unsuitable materials have been removed from the pit area. Measurements may be taken either before or after topsoil is removed, as deemed necessary by the engineer.

If cross sections are taken, they should be taken from a base line established along the side of or through the borrow pit. If practicable, the base line should be at right angles to the general slope of the ground or parallel to the major axis of the pit. One or more hub and tack stakes should be set at each end of the base line, well away from the area to be excavated, where they will not be disturbed. These hubs should be so referenced that they can be located, and the base line accurately re-established upon completion of pit excavation.

The base line definition should be recorded along with the cross-section data for comparison of computations. When practical, the sections should be taken using the same horizontal datum as used for the project. The cross sections should be taken at intervals not exceeding 50 ft and at closer intervals as required to accurately show the contour of the entire area. With the approval of the engineer, cross sections may be taken at 100 ft intervals when the original ground and the finished borrow pit do not show sharp breaks in elevation. When practical, levels should be run using the same vertical datum as used for the project; otherwise, two bench marks should be set with reference to an assumed vertical datum.

If the borrow pit volumes will be computed from a DTM collected in the field, readings should be taken along discontinuities (top of ridges, around the base or top of mound, etc.), at high points, at low points and at a predetermined grid interval, to best model the surface.

A sketch of the original pit layout should be entered in the field notebook. The sketch should show topographical features such as trees and buildings and should indicate the magnetic bearing of the base line, the limits of the sections, and all hubs and ties necessary for re-establishing the base line and control points.

If original measurements were taken before to the removal of topsoil, the final measurements cannot be taken until the topsoil has been replaced.

SECTION 780 Constructing and Restoring Access Points

780.1 General

The engineer, cognizant of any access controls, Trans 233 land divisions, or more restrictive local or municipal ordinances and regulations should, in conjunction with initial layout and staking operations on the project, check and review requirements and locations for access points to be constructed under the contract, as shown on the plans, against actual field requirements. The plan will provide a driveway intersection detail and a schematic of required right-of-way and allowed access points along the project. The plan should also provide the engineer with a list of all new and to-be-restored access points to be staked by station and offset.

The engineer should be notified of any conflicts between the plan and field requirements as to the number and type of access points and the resolution to the conflict.

The engineer should consult with all property owners regarding the location of each entrance to ensure that it will be built, if practical, where the owner desires it, thus avoiding any future question concerning location. The width should be as the owner wants, within the staked limits. The original grade should not be exceeded where possible.

The location and width of entrances determined to be restored or constructed should be staked or laid out in the field, and all pertinent information given to the contractor to avoid errors and the necessity of removing and reconstructing entrances constructed at the wrong location.

Requests by property owners for entrances in addition to those required to be restored or constructed under the terms of the contract in accordance with the requirements of the Wisconsin Statutes, and as discussed herein, should be referred to the region office for review and issuance of the necessary permit, if approved. Additional permitted entrances must be constructed at the property owner's expense and must incorporate all necessary approved drainage facilities.

The restoration and construction of entrances in urban sections and curb and gutter sections may present special problems beyond the scope of this section. These problems should be resolved with the region. The mere omission of the curb section does not constitute restoration; therefore, the omission of curb in anticipation of a permitted entrance to be constructed at the owner's expense does not constitute restoration even though little additional work remains behind the curb for the owner to perform to secure an acceptable entrance. The contractor must be held to the obligation under the contract to fully restore the entrance.

The locating of a new entrance or the change in location of an existing entrance is controlled in an urban area under the permit authority of the municipality. No curb opening can be provided without permission of the local unit of government.

Generally, driveways and entrances are restored with the same type of surfacing material as previously used, provided it is consistent with plan requirements and municipal ordinances. In some instances, the property owner may request a type different from that allowed or previously used, and it will be necessary for the engineer to check with the region and local officials to determine its acceptability and any need for landowner monetary contribution to absorb increased costs. Also, the type requested may not be feasible to construct if it is made of a material not readily procurable by the contractor at a reasonable price. For example, a solitary concrete driveway on an asphaltic-surfaced urban street with asphaltic driveways may not be feasible.

Every effort should be made to minimize inconvenience to abutting businesses and residences. Driveways and entrances should be resurfaced concurrent with surfacing operations on the street or highway, or as soon thereafter as practicable.

780.2 Statutory Basis for Construction and Restoration

Section 86.05 of the Wisconsin Statutes, provides in part: "Whenever it is necessary, in making any highway improvement to cut or fill or otherwise grade the highway in front of any entrance to abutting premises, a suitable entrance to the premises must be constructed as a part of the improvements; and if the premises are divided by the highway, then one such entrance shall be constructed on each side of the highway."

An interpretation of this statute relative to the word "premises" was given in an opinion of the attorney general, dated July 25, 1957. A question had arisen relative to the number of entrances required to be restored to a property or contiguous properties of the same ownership whereon were located a number of "premises", some of which were occupied by tenants and some by the owner. In essence, the opinion held that independence of use of a property or portions of a property rather than its ownership should be the deciding factor.

Section 86.05 is construed to require the restoration of a maximum of one entrance per economically separate premise or property of separate ownership on each side of the highway, except that when adjoining portions of the premises are divided by a natural barrier such as a stream, a second entrance may be restored. Where highways are relocated, an entrance is normally provided as part of the construction on each side of the highway to restore access for the divided premises.

The restoration or construction of private entrances may not be in accordance with the foregoing policy or Section 86.05 of the Wisconsin Statutes when access controls exist along the highway, or when a local or municipal ordinance or zoning is more restrictive. Section 84.25 of the Wisconsin Statutes, relating to controlled-access highways, restricts an abutting property owner's access to a controlled-access highway. Section 84.295(5) of the Wisconsin Statutes, relating to Freeways and Expressways, states that for any highway on relocation, that is designated as a freeway or expressway, no right of access shall accrue to any abutting property owner.

Section 84.09 and Chapter 32, Eminent Domain, of the Wisconsin Statutes provide for the acquisition and purchase of access rights. Wisconsin Administrative Code, Chapter Trans. 233, based on Chapter 236 of the Wisconsin Statutes, provides that no direct vehicular access may be had between a state trunk highway and the individual lots of a land division without the express consent of the department. In addition to these state statutes access covenants have been recorded against many properties adjacent to state trunk highways. These covenants restrict access to the highway.

The engineer should contact the region access coordinator before constructing or modifying any driveway or private street that is not shown on the plan sheets. The region access coordinator will determine if there are existing access controls that affect the property.

780.3 Construction Standards - Trans 231

Pursuant to and under authority of Section 86.07(2) of the Wisconsin Statutes, the Wisconsin Administrative Code Chapter Trans 231 prescribes the placing, constructing, altering, and maintaining of private driveways connecting with state trunk highways under permits. It is applicable generally to restoration and construction of all entrances on the state trunk system, except where local ordinances or regulations impose more restrictive requirements.

The following applicable sections of Chapter Trans 231 are excerpted and presented as a guide to construction standards.

780.3.1 Trans 231.03 Location, Design, and Construction Requirements - General

"The location, design, and construction of a driveway shall conform to the following:

1. A driveway shall be located and restricted as to width as necessary so that the entire driveway roadway and its appurtenances are contained within the frontage along the highway of the property served. At public highway intersections a driveway shall not provide direct ingress or egress to or from the public highway intersection area and shall not encroach on or occupy areas of the roadway or right of way deemed necessary for effective traffic control or for highway signs or signals. A driveway shall be so located and constructed that vehicles approaching or using it will have adequate sight distance in both directions along the highway.
2. The number of driveways permitted serving a single property frontage along a state trunk highway shall be the minimum deemed necessary by the engineer for reasonable service to the property without undue impairment of safety, convenience, and utility of the highway.
3. The island area on the right of way between successive driveways or adjoining a driveway and between the highway shoulder and right-of-way line shall remain unimproved for vehicular travel or parking. Such area shall be considered as restricted and may be filled in or graded down only as hereinafter provided in sub. (7).
4. The surface of the driveway connecting with rural-type highway sections shall slope down and away from the highway shoulder a sufficient amount and distances to preclude ordinary surface water drainage from the driveway area flowing onto the highway roadbed.
5. The driveway shall not obstruct or impair drainage in highway side ditches or roadside areas. Driveway culverts, where necessary, shall be adequate for surface water drainage along the highway and in no case less than the equivalent of 15 in diameter pipe. The distance between culverts under successive driveways shall not be less than 10 ft, except as such restricted area is permitted to be filled-in under the provisions of sub. (7).
6. When curb or gutter is removed for constructing a driveway, the new connections shall be of equivalent acceptable material and curb returns provided or restored in a neat, workmanlike manner. The driveway surface shall connect with the highway pavement and the sidewalk, if any, in a neat, workmanlike manner. The driveway construction shall include replacement of sidewalk areas that are inadequate or become damaged by reason of vehicular travel across the sidewalk.
7. The restricted area between successive driveways may be filled in or graded down only when the following requirements are fully complied with:

7.1 The filling in or grading down shall be to grades approved by the engineer and, except where highway drainage is by means of curb and gutter, water drainage of the area shall be directed away from the highway roadbed in a suitable manner.

7.2 Culvert extension under the restricted area shall be of like size and equivalent acceptable material of the driveway culvert, and intermediate manholes adequate for clean-out purposes may be required where the total culvert length exceeds 100 ft.

7.3 Where no highway side ditch separates the restricted area from the highway roadbed, permanent provision may be required to separate the area from the highway roadbed, to prevent its use for driveway or parking purposes, by construction of a border, curb, rail, or posts deemed adequate by the engineer."

780.3.2 Trans 231.04 Commercial - Rural Driveways

"On rural type highway cross section, driveways serving commercial or industrial establishments shall conform to the following:

1. Width of Drive:

   No driveway except as hereinafter provided shall have a width greater than 35 feet measured at right angles to the centerline of the driveway, except as increased by permissible radii. In no instance shall a driveway have a width greater than 62 feet (including flare of return radii) measured along line 10 feet from and parallel to the edge of the pavement on which the entrance will be constructed.

2. Return Radii:

   No return radius projected between the edge of highway pavement and the driveway shall be greater than 40 feet. Usually, these radii will be determined by the restrictions given in subs. (1), (3), and (4).

3. Angular Placement of Drive:

   The angle between the centerline of a driveway serving two-way traffic and the edge of the pavement shall not be less than 45°. Where suitable precautions are taken, or one-way operation along divided highways permit only one-way operation of the driveways, the angle of the entrance drive to grantee's property may be decreased. The angle of the exit drive with the highway pavement shall be not less than 45°.

4. Island Areas:

   4.1 An island of a minimum length of 10 feet shall be maintained between driveways serving the same premises. (The measurement is along a line 10 feet from and parallel to edge of pavement.) The permit specifies that the island area, if less than 20 feet in length or 10 feet in width, is defined by curbs, posts, boulders, masonry walls, guardrail, etc. Materials used to define the island, except concrete curbs, shall be painted white. The side of the island next to the highway shall be not less than 10 feet from the pavement edge. The side of the island farthest from the highway shall be at the right-of-way line.

   4.2 The area within 5 feet of a property line shall be a restricted area over which no driveway may be developed. The 5-foot restriction shall be measured parallel to the pavement edge and shall be effective between the right-of-way line and line 10 feet from and parallel to the pavement edge. This is to serve as an island area should the adjoining property owner request a permit for a driveway."

780.3.3 Trans 231.05 Noncommercial - Rural Driveways

On rural type highway cross section, driveways serving farm or residence property shall conform to the following:

1. Width of Drive:

   No noncommercial driveway or combination of driveways shall have width less than 16 feet nor greater than 24 feet measured at right angles to the centerline of the driveway except as increased by permissible radii.

2. Return Radii:

   No return radius projected between the edge of highway pavement and the driveway shall be greater than 30 feet.

3. Angular Placement:

   The centerline of that part of the driveway lying on the State right of way shall be at approximately right angles to the pavement, except as topography may make certain angular placement necessary."

780.3.4 Trans 231.06 Commercial - Urban Driveways

"On urban type highway cross section, driveways serving commercial or industrial establishments shall conform to the following:

1. Width of Drive:

   No driveway shall have a width greater than 35 feet measured at right angles to the centerline of the driveway, except as increased by permissible radii.

2. Return Radii:

The return radii projected between the line of face of curb of the highway and the driveway shall be determined by the engineer, basing his decision on the type of traffic and the restrictions given in subs. (1) and (4). In all cases, the entire flare shall fall within the right of way.

3. Angular Placement of Drive:

   The angle between the centerline of the driveway and the curb line shall be not less than 45°.

4. Island Areas:

   4.1 When sidewalk is adjacent to curb, an island of a minimum length of 6 feet, measured along the curb line, shall be placed between each entrance to a state highway. The curb shall be left intact for this length.

   4.2 When sidewalk is remote from curb, an island of a minimum length of 10 feet measured along the right-of-way line shall be maintained between each entrance to a state highway. All flares shall be tangent to the curb line.

   4.3 A curb length of not less than 3 feet shall be left undisturbed adjacent to each property line to serve as an island area should the adjoining property owner request a permit for an entrance."

780.3.5 Trans 231.07 Noncommercial - Urban Driveways

"On urban type highway cross section, driveways serving residence property shall conform to the following:

1. Width of Drive:

   No noncommercial driveway or combination of driveways shall have a width greater than 24 feet measured at right angles to the centerline of the driveway, except as increased by permissible radii.

2. Return Radii:

   The radius of the return connecting the line of face of curb of the highway and the edge of driveway shall not exceed 10 feet. In all cases, the entire flare shall fall within the right of way.

3. Angular Placement:

   The centerline of the driveway may be either parallel to the property line of the lot for which access is requested, or at right angles to the curb line."

SECTION 785 Survey Monuments

785.1 General

WisDOT policy, FDM 9-5-1.1, the contractor is to take all reasonable measures to assure that no survey monuments will be destroyed, disturbed, removed or buried to the degree that they are no longer usable. If survey monuments are discovered by the contractor, contact the WisDOT Geodetic Surveys Unit (GSU), Surveying and Mapping Section; toll free number 866-568-2852 or via email geodetic@dot.wi.gov for specific disposition instructions.

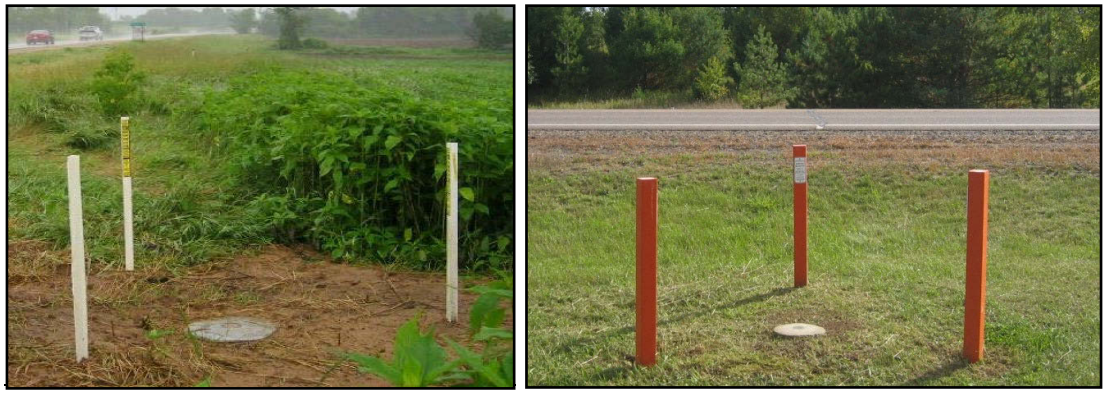
785.2 Geodetic Control Station Monuments

The U.S. Coast & Geodetic Survey, U.S. Geological Survey (USC&GS), National Geodetic Survey, WisDOT, and various county and local agencies have established thousands of geodetic survey control stations throughout Wisconsin.

Every reasonable effort should be put forth to protect geodetic control station monuments. Geodetic control station monuments are expensive to replace (as much as $25,000 each) and use of the station is lost until it is replaced. When one of these geodetic survey control station monuments will be disturbed (moved more than 1/16th of an inch) or destroyed during construction, the department and the contractor must notify the agency that established the monument. Notification of endangered Wisconsin Height Modernization Program (HMP) stations must be made to GSU as stated above.

If it is not certain whether the station is an HMP station, assume it is and call the toll-free number. The GSU will provide instructions for establishing a replacement monument and for submitting the disk of the destroyed station. Contact the GSU at least one year before planned construction activities in the area of a HMP geodetic survey control station so that planning can be made for the protection or destruction of the station(s). If a HMP geodetic survey control station is located on a construction project but was not noted on the construction plans, notify the GSU immediately. Changes to the contract may be required if a station was discovered that was not identified in original contract documents. GSU will work with design and construction personnel to identify the HMP geodetic survey control station and if the geodetic survey control station will be disturbed by construction activities. Figures 785-1 and 785-2 show examples of HMP geodetic survey control stations in the field.

FIGURE 785-1 HMP Monument Marking



A geodetic survey control station surrounded by three white posts (left) indicates the mark is a vertical control point with a high ordered leveled elevation. A geodetic survey control station surrounded by three orange 4" x 4" guard posts (right) indicates the mark is a 3-Dimensional control point with a precise horizontal position and elevation.

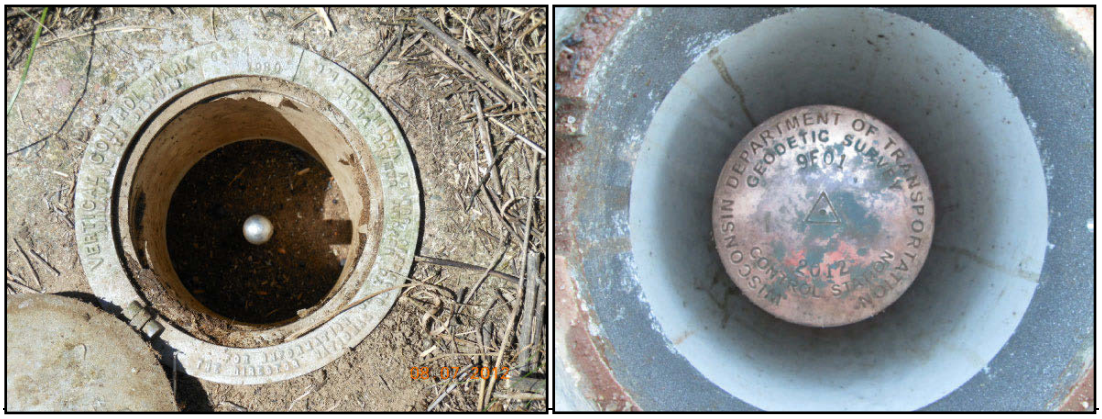
FIGURE 785-2 Bronze Survey Disks



A bronze survey disk embedded in the top of a 16-inch diameter concrete post (left) along with a view above the concrete geodetic survey control station (right). The concrete extends 8 feet below grade to maximize stability.



A bronze survey disk set in the top of a bridge abutment (left) and a bronze survey disk set in the top of a box culvert wing wall (right). The location of the bronze survey disk is identified by a pink spray paint can. Whenever possible, a bronze survey disk set in a concrete structure is marked with a single white witness post (vertical control point).



A stainless steel rod driven to refusal monument may be capped by grinding the top of the steel rod to a smooth domed finish (left) or by fastening a bronze survey disk to the top of the rod (right). A stainless steel rod geodetic survey control station is either surrounded by white witness posts (vertical only) or orange 4" x 4" guard posts (horizontal and vertical) depending on the survey accuracy.

785.2.1 Geodetic Survey Control Station Replacement Procedure

When a geodetic survey control station will be disturbed or destroyed during construction, it must be replaced-and reestablished as specified in the Geodetic Survey Control Station Replacement Procedure The Geodetic Survey Control Station Replacement Procedure describes the roles, responsibilities, and funding necessary to ensure the replacement and reestablishment of a geodetic survey control station is performed to the same specification and survey accuracy of the station it is replacing.

The Geodetic Survey Control Station Replacement Procedure can be found here:

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/wiscors/geodetic-control-replacement-procedure.pdf

For Geodetic Survey Control Stations that are to be destroyed due to Transportation Improvement Project(s): Steps are outlined in the Geodetic Survey Control Station Replacement Procedure regarding the retrieval of the survey disk and other necessary steps to ensure that the station is properly removed and accounted for.

For Geodetic Survey Control Stations that are not to be destroyed due to Transportation Improvement Project(s): Before construction activities, the GSU will verify that the necessary orange or white protective guard posts are installed around the geodetic survey control station in question.

The project manager, project engineer or inspector must notify the GSU by phone 866-568-2852 or email geodetic@dot.wi.gov two weeks before construction activities if any of these posts are missing. The GSU will replace any reported missing posts.

The GSU will install orange snow fence around the geodetic survey control station guard posts as a protective measure during construction operations. An opening may be available around the geodetic survey control station to allow individuals access to continue to utilize the geodetic survey control station while construction activities are ongoing.

When the project has been completed and the geodetic survey control station is no longer in danger of being disturbed or destroyed by construction activities, the GSU must be notified by phone 866-568-2852 or email geodetic@dot.wi.gov. The GSU will remove the orange snow fence upon notification of project completion or when punch list items are being completed on site.

785.2.2 Other Geodetic Survey Control Station Monuments

Other government and private entities can create their own geodetic networks with geodetic survey control station monuments (i.e. NGS, USGS, etc.). Many counties have established a county User Densification Network (UDN) as an extension of the Wisconsin HMP. Some county or other local geodetic survey control network stations have been incorporated into the HMP. Whenever any type of geodetic survey control station is or will be endangered, contact the GSU by phone 866-568-2852 or email geodetic@dot.wi.gov. The GSU will contact the appropriate agency if the monument is not an HMP monument. The procedure for replacing a non-HMP station will be provided by the affected agency.

785.3 Boundary Monuments

Wisconsin Statutes 59.74 states in part, "no landmark, monument, corner post of the government survey or survey made by the county surveyor or survey of public record may be destroyed, removed, or covered by any material that will make the landmark, monument, or corner post inaccessible for use, without first having erected witness or reference monuments and making a certified copy of the field notes of the survey setting forth all the particulars of the location of the landmark with relation to the reference or witness monuments..."

The statutes also state in part, "Whenever it becomes necessary to destroy, remove or cover up any landmark, monument of survey, or corner post. The person including employees of government agencies who intend to commit such act shall serve written notice at least 30 days prior to the act upon the county surveyor, or the city or village engineer..." WisDOT policy, FDM 9-5-1.5, states that the written notice must be served at least 60 days before the act.

785.3.1 Locating Landmarks

Survey crews need to locate all survey monuments on or near the proposed right-of-way. When a landmark is found that will be disturbed by construction operations, the construction contract should include provisions for the proper referencing of the landmark by the contractor under a Landmark Reference Monument bid item. The location of the landmark will generally be shown on both the right-of-way plat and the plan sheet. Even though the plan may not indicate any existing landmark, the engineer should be aware of the possibility that one may exist, and if discovered during construction, it must be preserved until the statutory referencing has been accomplished. The reference monuments can be erected by the contractor as extra work under an appropriate change order. Contact the WisDOT region survey coordinator for further guidance if additional monuments are found along a project.

Questions may arise as to the definition or identification of landmarks, and the nature or category of stakes, monuments, corners, etc., that require perpetuation under the law. Generally, landmarks established by governmental agencies, county surveyors, city or village engineers, land surveyors, etc., including but not limited to section corners, fractional section corners, platted subdivision corners, monuments established by public or private surveyors from which property descriptions have been written, and any other points considered to be in the public interest within the construction limits must be

perpetuated provided they are physically evidenced by a monument. It is not necessary to attempt to perpetuate vague or indeterminate locations like the ones frequently referred to in metes and bounds descriptions, such as "the edge of a stream," or "the center of the road," which may be difficult to establish or be subject to personal judgment.

FDM 9-5-5 and FDM 9-25-1 state that although the position of every lot corner monument will not normally be perpetuated by a monument provided by the department, the position of every monument which is found must be recorded in the department's files so that it may readily be reestablished. In some instances, it has been necessary to engage the services of county surveyors or private surveyors to locate or restore lost corners from which right-of-way descriptions and plats can be developed. As stated above, WisDOT or other agents will preserve by referencing only those landmarks that are presently monumented.

Property owners should be given every reasonable opportunity to relocate their land parcel corner monuments within the newly acquired right-of-way. To avoid property owner ill will, contact each owner before construction. Have them show the location of property corners affected by construction, and then reference the property corners even though they fall inside our new right-of-way.

785.3.2 Placing Monuments

Landmarks that will be disturbed or destroyed by construction must be perpetuated by the contractor in accordance with the following described procedure. For each landmark, four or more reference monuments must be constructed at locations outside the construction limits. It should be noted that the law requires the contractor to erect the reference monuments before the landmark is covered or destroyed. Specifics on the requirements for the monuments are detailed in s. 59.74 and in FDM 9-5-1 and FDM 9-25-1.

785.3.3 Type of Monuments

SDD 16A1, FDM 9-25-6, and FDM 9-25-10 detail requirements for Landmark Reference Monuments and Covers, and types of monuments.

785.3.4 Documentation of U.S. Public Land Survey System Corners

U.S. Public Land Survey Monuments that will be disturbed or destroyed must be referenced to nearby monuments and landmarks by a professional land surveyor before being disturbed or destroyed. Documentation relating to the establishing of witness monuments for landmarks must be filed by the surveyor in accordance with s. 59.74 and s. 59.45.

Information should include a description of the landmark, the material and size of witness monuments or location of offset marks, distances, and courses in terms of the true meridian the reference monument bears from the landmark and from each witness monument to at least one other witness monument. The notes may include ties to other objects, natural or manufactured, to aid in re-establishing the landmark location.

Documentation of government corners should also include department form DT1291, U.S. Public Land Survey Monument Record, or an equivalent form as requested by the county surveyor. A sample completed form is shown in figure 785-3.

FIGURE 785-3 Example U.S. Public Land Survey Monument Record, DT1291

*** * * * EXAMPLE ONLY * * * ***

U.S. PUBLIC LAND SURVEY MONUMENT RECORD

Wisconsin Department of Transportation

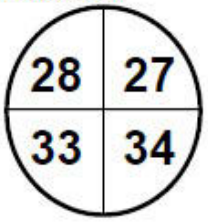
in accordance with Wisconsin Administrative Code, Chapter A-E 7.08 (3)(a-i))

DT1291 10/2024

Location: (a) The identity of the corner, as referenced to the U.S. Public Land Survey System.

County Name Eau Claire		**Name of ☒ Township, ☐ City, ☐ Village** Washington	
Name of Surveyor and Firm Shawn Meyer – Wisconsin Department of Transportation			
Address, City, State, ZIP Code 1701 N. 4th St., Superior, WI 54880			
Y (Northing) 269296.78	**X (Easting)** 378845.76	**Latitude (D-M-S.SSS)** N 44° 47' 08.98018"	**Longitude D-M-S.SSS)** W 91° 20' 50.10701"
Corner-Section-Township and Range SE Corner – Section 28 T27N R8W		**PLSS ID Number:** 22708280000	**WisDOT Project ID** 7080-01-73
Horizontal Datum NAD 83 (2011)	**Units** US SURVEY FEET	**Coordinate System** WISCRS	

T. 27 N.—R. 8 W.
4th Principal Meridian
Corner: SE 28





Plan View: (c) Reference to at least 4 witness monuments. Witness monuments shall be concrete, natural stone, iron, bearing trees or other equally durable material, except wood other than bearing trees; (d) A plan view drawing depicting the relevant monuments and reference ties which is sufficient in detail to enable accurate relocation of the corner monument if the corner monument is disturbed; (e) A description of any material discrepancy between the location of the corner as restored or reestablished and the location of that corner as previously restored or re-established;

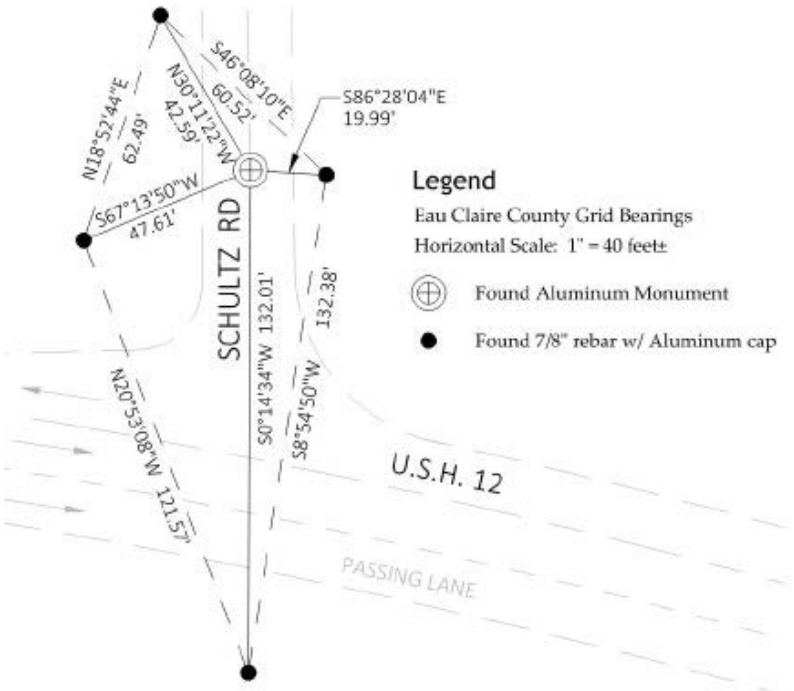


FIGURE 785-3 Example U.S. Public Land Survey Monument Record, DT1291 (cont'd)

*** * * * EXAMPLE ONLY * * * ***

Recovery Procedures: (b) A description of any record evidence, monument evidence, occupational evidence, testimonial evidence or any other material evidence considered by the surveyor, and whether the monument was found or placed; (f) Whether the corner was restored through acceptance of an obliterated evidence location or a found perpetuated location; (g) Whether the corner was reestablished through lost-corner-proportionate methods; (h) The directions and distances to other public land survey corners which were used as evidence or used for proportioning in determining the corner location.

Original Notes, Henry Maddin, Deputy Surveyor, September, 1849:
North on line between Sections 33 & 34, Var. 8°45' East
80.00 Set a pat at the corner to Sections 27, 28, 33, and 34
Jack Oak 6" in Diameter bears South 61°30' East, 170 Links
Jack Oak 8" in Diameter bears North 38°00' West, 250 Links

Floyd M. Loken; October, 1971
Set Harrison Cast-Iron Monument

Anthony B. Kiedrowski; July, 1983
Found Monument in place, set new ties

Eau Claire County Surveyor's Office (Sam Wenz); May December, 2011:
Found Harrison Cast-Iron Monument in place and set four ties

Wisconsin Department of Transportation (Shawn Meyer); October, 2024:
Found Harrison Cast-Iron Monument in place and along with four ties. Concurred with the position as established by Loken in 1971 and accepted the perpetuated location.

Surveyor Certificate
I, the undersigned, certify that the corner location shown on this record was determined by me or under my direction and control and that this U.S. Public Land Survey Monument Record is correct and complete to the best of my knowledge and belief, in accordance with Chapter A-E 7.08 of the Wisconsin Administrative Code.

This survey monument record will be filed in the County Surveyor's office within 60 days of the corner being reestablished. A-E 7.08 (1)

Field Date	Project ID	PLSS ID Number
10/10/2024	7080-01-73	22708280000

Affix Land Surveyor Seal



x _____ WI 3089 (Professional Land Surveyor Signature and Number)

10/15/2024 (Date)

10/10/2024 SE Corner – Section 28 T27N R8W Page 2 of 2

800 Materials Testing, Sampling, and Acceptance

CMM 810 Materials - General
CMM 813 Weighed Materials
CMM 815 Density Testing
CMM 820 Independent Assurance Program
CMM 830 QMP - General
CMM 832 QMP - Subgrade
CMM 834 QMP - Aggregate
CMM 835 QMP - Concrete
CMM 836 QMP - HMA
CMM 838 Ride Quality
CMM 840 Materials Sampling
CMM 845 Materials Testing and Acceptance - General
CMM 846 Materials Data Collection and Reporting Software System
CMM 850 Materials Testing and Acceptance Guide
CMM 855 Materials Testing and Acceptance - Earthwork
CMM 860 Materials Testing and Acceptance - Aggregates
CMM 865 Asphaltic Binder Materials
CMM 866 Asphalt Mixture Design
CMM 870 Materials Testing and Acceptance - Concrete
CMM 871 Concrete Mixture Design
CMM 875 Materials Testing and Acceptance - Structures

SECTION 810 Materials - General

810.1 Control of Materials

810.1.1 Approval of Materials Used in Work

The service life of a highway is dependent upon the quality of the materials used in its construction, as well as the method of construction. Control of materials is discussed in standard spec 106.1. The spec provides that only materials conforming to the requirements of the contract must be used, and the contractor is responsible for furnishing materials meeting specified requirements. Only with permission of the project engineer can the contractor provide materials that have not been approved, as long as the contractor can provide evidence that the material will be approved later. The department's intention is to hold payment of items until the required materials information is provided by the contractor.

The standard specifications encourage recovered and recycled materials to be incorporated into the work to the maximum extent possible, consistent with standard engineering practice. Standard spec 106.2.2 and Wisconsin statute 16.754 require using American made materials to the extent possible. On federally funded projects, all steel products must be produced in the United States, and manufacturing and coating processes must be performed in the U.S. Construction materials must also comply with Buy America requirements. “Buy America” requirements are discussed in CMM 228.

810.1.2 Contractor and Department Designated Materials Persons

Standard spec 106.1.2 requires the contractor to designate a contractor project materials coordinator (CPMC) who will be responsible for submitting all contractor materials information to the department. The department should also designate a WisDOT project materials coordinator (WPMC) who will be in direct contact with the contractor's designee.

Standard spec 106.1.2 requires the CPMC to communicate with all subcontractors to ensure that sampling, testing, and associated documentation conforms to the contract. The contract also makes the CPMC responsible for submitting materials information from the prime contractor and subcontractors to the WPMC, promptly reporting out-of-specification test results, collecting and maintaining all required materials certifications, and regularly communicating with the WPMC regarding materials issues on the contract.

The WPMC should provide a project-specific sampling and testing guide (EGuide) to the contractor at the preconstruction conference. Select eGuide from the Log In tab on the Atwood Systems website located at:

http://www.atwoodsystems.com/

Both the CPMC and WPMC should review and supplement the E-guide before work operations begin to ensure that testing methods, frequencies, and documentation requirements conform to the contract.

The CPMC and WPMC are charged with working together throughout the life of the contract to ensure that contract materials requirements are met and any issues that might arise related to either non-conformance or non-performance are dealt with promptly. The ultimate goal is to make sure that problems with materials are brought to light and timely corrective action taken before those materials problems compromise the quality or acceptability of the completed work.

The CPMC should coordinate contractor materials related activities and do the following:

- Establish methods and work expectations with the WPMC.
- Provide all QMP test data and control charts from the prime contractor and subcontractors.
- Deal with all materials-related concerns from the WPMC.

The WPMC is responsible for administration of the contract with regards to contract materials requirements and should do the following:

- Communicate or meet weekly with the CPMC to discuss outstanding materials issues on the contract.
- Monitor the submittals from the CPMC to ensure timeliness and completeness.
- Review contractor submittals to verify materials requirements are met.
- Inform the Project Leader of nonconforming materials issues and discuss actions to be taken.
- Prepare materials documentation for inclusion into the project files.

810.1.3 Materials Coordinator Training

All contractor and department personnel serving in the role of project materials coordinators must be HTCP-certified by successfully completing the online Materials Coordinator Training course and exam. This course is also available and recommended for all other personnel who work with materials on WisDOT projects. The training provides details about the department's materials acceptance process as well as the roles and responsibilities of project materials coordinators. Materials Coordinator Training can be accessed at:

http://www.uwplatt.edu/htcp/materials-coordinators-training

810.2 Approval of Materials

All materials used in a project are subject to the project engineer's approval before incorporation into the work. Approval of materials is discussed in standard spec 106.3. Material approval is generally based on material tests and analysis and is implemented by using approved product lists, certification, or sampling and testing. Unless the contract specifies otherwise, the contractor must follow manufacturer's recommended procedures for products incorporated into the work. Refer to CMM 845 for details of acceptance types.

Under the standard specifications, material testing is performed by the department on samples obtained by the department, samples obtained by the contractor under observation of the department, or on samples shipped to the central office laboratory. Sampling, testing, and documentation is performed according to WisDOT Manual of Test Procedures (MOTP), https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/qmp/motp.pdf) and within CMM chapter 800.

810.3 Quality Management Program

Projects that include QMP specifications are sampled, tested, and documented according to CMM 830 and following CMM sections to meet the requirements of the QMP provisions.

810.3.1 Quality Control (QC)

Under QMP specifications, the contractor provides a quality control (QC) program that includes all contractor/vendor activities performed in relation to production and placement of materials, including mix designs, process control, inspections, adjustments, operational techniques, sampling and testing, and documentation thereof. The contractor performs QC sampling and testing to meet the contract requirements and additional process control testing as needed.

810.3.2 Quality Verification (QV)

Quality verification (QV) sampling and testing is performed by department representatives, independent of QC sampling and testing, to validate the quality of the material. While the department performs all QV testing, some materials require contractor sampling under department observation.

810.3.3 Independent Assurance Program

The Independent Assurance Program (IAP) is an element of the QMP intended to ensure that test data from project acceptance testing is reliable. This is accomplished through annual, unbiased reviews of all QC and QV personnel to ensure sampling and testing is performed according to standards by certified personnel using appropriate equipment that is properly calibrated. Additional independent assurance (IA) testing may be performed on split samples for comparison purposes. Further information about the IAP can be found in CMM 820.

810.4 Nonconforming Materials

810.4.1 General

The department does not want materials that do not meet contract specifications incorporated into the work. Standard spec 106.5 gives the project engineer the authority to either reject nonconforming materials or to allow the nonconforming materials to remain in place. If materials are found to be unacceptable before or after placement into the work, the project engineer may reject the materials, and the contractor must remove the materials from the site at no cost to the department. Materials that have been tested and approved at their source or otherwise previously approved but have become damaged or contaminated before use in the work, are also subject to rejection by the project engineer.

To ensure consistency in the decisions made for acceptance of nonconforming material or workmanship, the project engineer should involve the region oversight engineer before finalizing any decision. This will help keep central office informed about contractor or material problems that may require action with a change in specifications or discipline of a contractor. If any technical questions remain about the acceptance or rejection of nonconforming materials refer to the appropriate technical expert in BTS.

810.4.2 Nonconforming Materials Allowed to Remain in Place

810.4.2.1 Deciding Whether or not to Allow Material to Stay in Place

Good engineering judgment is required when making decisions on nonconforming materials. The project engineer may choose to approve nonconforming materials, allow them to remain in place, and adjust the contract price. When making the decision to direct the contractor to remove and replace the materials versus leave the materials in place, it's important to consider the following:

- Long-term consequences on quality and durability.
- Implications on the project's life cycle costs, service life, serviceability, and maintenance.
- Socioeconomic, environmental, and aesthetic considerations.

- Impacts on traffic, staging, and construction timeframes.

810.4.2.2 Deciding Whether or Not to Apply Price Reduction

After the project engineer has decided to allow nonconforming materials to remain in place, he or she must carefully evaluate each situation in deciding whether to take a price reduction. The goal is to achieve consistency statewide in administering price reductions for nonconforming materials that are allowed to remain in place. Results of retests and related quality tests should be considered. The following list includes some examples of the types of factors the project engineer must consider when deciding if a price reduction is warranted and how much it should be:

- Has the contractor been conscientious to provide quality by carefully controlling materials and construction operations?
- Has the contractor been proactive and made good use of QC data to maintain and improve quality?
- Did the project engineer provide the contractor with nonconforming test results within the contractual timeframe, if specified?
- If timeframes are not specified, did the project engineer provide nonconforming test results in time for the contractor to make process or materials corrections?
- Upon becoming aware of a materials quality problem, has the contractor responded quickly to correct it?
- Is the nonconforming test an isolated incident or a recurring situation?
- How does the nonconforming test compare to the rest of the project data:
  - Have material test results been well within specification requirements or consistently at the very limit of what is acceptable?
  - How many tests are nonconforming vs. how many tests have passed?
  - How far out of spec is the nonconforming test?

810.4.3 Price Reductions Specified in the Contract with Administrative Items

If price reductions are included in the specifications or special provisions for certain nonconforming items, the price reductions should be administered using the appropriate 800 series administrative items. Since the price reductions are included in the contract language, the project engineer can add the 800 series items to the contract without going through the complete change order process. Approval by a DOT representative and contractor representative are not necessary, though it's good practice to communicate the changes to all parties. Further guidance on the 800 series administrative items is provided in CMM 238. Instructions on entering change orders in AASHTOWare Project Construction™ are found at: https://awpkb.dot.wi.gov/Content/constr/LETContract/ContractProgress/ChangeOrders.htm.

For payment of nonconforming items with associated administrative items, pay for the installed quantity and bid price of the work item under the original bid item. The pay reduction will be accounted for using the administrative item. Compute the price reduction by multiplying the quantity of nonconforming material by the original unit price and the percent price reduction. The pay units of all administrative items are DOL. Document all calculations and use the total calculated price reduction as the quantity, with negative one dollar as the unit price. See Example 1 for calculating price reductions.

Example 1

- Contractor placed total of 19,000 SY of Concrete Pavement 9 inch
- 670 SY is 1/8" - 1/2" under plan thickness
- Standard spec 415.5.2 directs to pay 80% contract price for this range (20% reduction)
- Bid unit price is $35/SY

Using original bid item, pay 19,000 SY at $35/SY = $655,000
Compute price reduction = 670 SY x $35 x -0.20 = -$4,690
Add the administrative item 804.6005 Nonconforming Thickness Pavement to the contract,
Unit Price = -$1.00
Quantity = 4,690
Net pay = $655,000 - $4,690 = $650,310

Paying for nonconforming items this way allows for clean tracking of as-built quantities. Administrative items can easily be tracked to monitor specific items that are frequently the target of price reductions. This can help the department develop improved specifications and construction methods.

810.4.4 Price Reductions Not Specified in the Contract

If specific price reductions are not outlined in the contract specifications or special provisions, standard spec 106.5 gives the project engineer the option to take a price reduction on nonconforming materials

allowed to remain in place. The project engineer has latitude to decide whether a price reduction is appropriate, and what amount the price reduction should be.

For payment of nonconforming items, use full quantity and bid price of the original work item. Apply the price reduction by submitting a change order that creates a new item with the same bid item number but with the supplemental description "price reduction - nonconforming material - (reason)". In Example 2 below, the supplemental description for the new item is "price reduction - nonconforming material – gradation". Use the quantity of the nonconforming material. The unit price is the negative price reduction percentage multiplied by the original item's unit price.

Example 2

- Contractor placed total quantity of 4,600 tons of base aggregate dense 1 1/4-inch
- Unit price = $9.00/TON
- 450 TON out of gradation on a particular sieve
- The project engineer allowed the material to remain in place and apply a 20% price reduction.

Using the original bid item, pay the full 4,600 TON at $9.00/TON = $41,400

Submit a change order creating item 305.0120 with supplemental description "price reduction - nonconforming material - gradation"

Unit Price = -$1.80 or (0.20 x $9.00)

Quantity = 450 TON

Resultant price reduction = -$810 or (450 TON x -$1.80)

Net pay = $40,590

Price reduction guidelines for noncontractual items are provided in the following section. Instructions on entering change orders in AASHTOWare Project Construction are found at: https://awpkb.dot.wi.gov/Content/constr/LETContract/ContractProgress/ChangeOrders.htm.

810.5 Noncontractual Price Reduction Guidelines

The guidelines below do not provide guidance on the project engineer's initial decision to either reject the nonconforming material or allow it to remain in place. After that initial decision has been made, these guidelines are intended aid the project engineer in deciding whether a price reduction is appropriate, and what price reductions to consider.

Except for HMA, the guidelines themselves are not contractual, but they are intended to aid the project engineer in administering standard spec 106.5 on nonconforming materials.

810.5.1 Nonconforming Concrete (Masonry, Pavement, or Ancillary)

Revise 810.5.1 (Nonconforming Concrete (Masonry, Pavement, or Ancillary)) to remove subsection for temperature (for concrete masonry only), revise subsection titles, and renumber remaining subsections.

The project engineer must justify and document the incorporation of any nonconforming materials into the project. The project engineer must determine the quantity of nonconforming material. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction.

810.5.1.1 Slump

0.0" to 3/8" out of spec..... 0% price reduction

>3/8" to 1 7/8" out of spec.....% reduction = 16 x difference between measured slump and spec limit

>1 7/8" or more out of spec ..... remove & replace or 50% price reduction

These price reductions assume concrete meets strength requirements. If strength has not been met, the project engineer may apply a greater price reduction or require remove and replace of concrete.

If the project engineer elects to take a slump test for slipform pavement, do not take a price reduction if both of the following are met:

1. Result of slump test is less than 4-inches.
2. Pavement meets edge slump spec as defined in standard spec 415.3.11.8.4.

810.5.1.2 Air Content (for Ancillary only)

0.5 % or more above spec.....10% price reduction[1]

0.1% to 0.4% above spec .....5% price reduction[1]

0.1% to 0.5% below spec ..... 20% price reduction

0.6% to 1.0% below spec ..... 30% price reduction

More than 1.0% below spec ..... remove & replace or 50% price reduction

[1] On QMP projects, evaluate strength data. If strengths are acceptable, do not take a price reduction for high air content. Contractor is responsible to provide additional strength data, if necessary.

810.5.1.3 Time Limit (for Ancillary only)

Use of concrete after time limit exceeded ..... 25% price reduction

810.5.1.4 Aggregate Gradation

The corrective action process must be completed for QC and QV aggregate gradations that are nonconforming. Any cost of additional sampling and testing done by the department due to nonconforming aggregate gradation should be paid by the contractor, to include the time of testing as determined by the department. Do not administer a credit if the corrective action is followed and adhered to.

Credits should be considered only if the corrective action is not followed or if the corrective action results in a nonconforming material or the corrective action is not possible. The credits should be applied based on the department's test results to represent the quantity within the lot. The department will calculate the pay reductions as follows:

1. Non-conforming Aggregate Gradation (exceeds gradation limits by <= 5% combining all sieves)
   - 10% price reduction on the invoice CY cost of the delivered concrete.
   - 5% price reduction on the bid item unit price, if the concrete base, pavement or structure invoice price is not available.
2. Significantly Out of Spec Aggregate Gradation (exceeds gradation limits > 5% combining all sieves)
   - 20% price reduction on the invoice CY cost of the delivered concrete.
   - 10% price reduction on the bid item unit price, if the concrete base, pavement or structure invoice price is not available.

810.5.2 Nonconforming Granular Materials

810.5.2.1 General

All conditions of CMM 845 must be met. The project engineer must justify and document the incorporation of any nonconforming materials into the project. The project engineer must determine the quantity of nonconforming material. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction.

Pay adjustments for Base Aggregate Open Graded and Base Aggregate Dense bid items are specified in standard spec 730.5. For other granular materials, the project engineer follows the guidance here in 810.5.2.2 and 810.5.2.3.

810.5.2.2 Gradation

Apply to Backfill Granular, Backfill Structure, & Subbase.

≤ 3% out on any sieve ..... 5% to 10% price reduction

> 3% to ≤ 5% out on any sieve ..... 10% to 20% price reduction

> 5% out on any sieve ..... remove & replace or 20% to 40% price reduction

810.5.2.3 Wear, Soundness, Freeze-Thaw, or Plasticity

Apply to Backfill Granular, Subbase, & Select Crushed Material.

Non-conformance identified before placement ..... nonconforming material must not be used

Non-conformance identified after placement ..... remove & replace or 50% price reduction

810.5.3 Nonconforming Prestressed Girders

The project engineer must justify and document the incorporation of any nonconforming materials into the project. The project engineer must determine the quantity of nonconforming material. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction.

Any girder judged to be structurally or otherwise unacceptable by WisDOT staff or agent thereof due to low strength, cracking, breakage, honeycombing or other deficiency will be rejected and replaced. (Note that honeycombing with exposed strand automatically falls in this category.)

Any girder judged to be acceptable but deficient by WisDOT staff or agent thereof due to any of the following problems will be subject to the pay deductions listed below. These guidelines for standard deductions are intended to be applied to typical problem severity in the majority of cases. In occasional cases where problem severity is lower or higher than typical, the pay deduction may be decreased or increased, respectively. Depending on the nature of the problem, repairs may or may not be required as a

condition of acceptance. Standard deductions shown represent a percentage of bid price for the prestressed girder item.

810.5.3.1 Nonconforming Compressive Strength

Compressive strength below required level at required test age - standard spec 503.5(3). Standard spec 503.5(4) also provides a method for coring girders with nonconforming compressive strength cylinder test results to determine girder acceptability.

810.5.3.2 Nonconforming Fabrication Defects

Pay deductions for the following fabrication defects will be recommended by the QV inspection firm, approved by the quality assurance supervisor in BTS, and implemented by the project engineer. (For questions, contact Tirupan Mandal at 608-246-5320 or tirupan.mandal@dot.wi.gov) The following deductions will be applied to infrequent occurrences of the stated defects. For repeated occurrences of the same defect, these deduction rates will be doubled. Pay deductions may be waived for minor defects judged to be inconsequential.

- Misalignment of form and soffit joints - 1/8 inch or greater on flat surface - 5% deduction
- Inadequately sealed joints with significant mortar washout - 5% deduction
- Cracking/spalling caused by fabrication and curing - 5% deduction
- Dimensional Tolerances - deviation outside values specified in 503.3.2.1.1 - 5% deduction
- Honeycombing - judged to be repairable - 10% deduction
- Curing temperature - violation of any specified criteria in 503.3.2.2.1 - 10% deduction
- Broken/cracked flanges judged to be acceptable/repairable - 10% deduction
- Shipping girder before achieving required strength without permission of project engineer - 20% deduction

810.5.3.3 Nonconforming Shipping or Erection Damage

Pay deductions for the following defects due to shipping damage or erection damage at the job site will be made by the project engineer in consultation with BOS and BTS. (BOS contact: Aaron Bonk at 608-261-0261 or aaron.bonk@dot.wi.gov; BTS contact: Tirupan Mandal at 608-246-5320 or tirupan.mandal@dot.wi.gov). Please do not assess deductions for cracking without consulting the above contacts - certain fine cracking patterns are expected in our girders due to current girder designs.

- Cracking/spalling caused by shipping or erection damage - 5% deduction
- Broken/cracked flanges judged to be acceptable/repairable - 10% deduction
- Dimensional tolerances - sweep or differential camber - 5% deduction
    - Field measurement of sweep or camber is only necessary if an erection or forming problem occurs that cannot be corrected by the contractor. Routine field measurement of sweep and camber on all girders is not necessary or recommended. Note that deduction for sweep should not be assessed if the contractor can successfully correct the problem at the time of diaphragm installation.
    - If it becomes necessary to measure sweep for a girder that cannot be properly installed by the contractor, the only acceptable field location for measuring sweep is when the girder is sitting on the beam seats, in a laterally plumb position without any lateral restraint on the girder at any point between the bearing surfaces. Never measure sweep of a girder sitting on a truck bed, as one or both ends can be laterally out of plumb, causing torsion or lateral bowing that can result in erroneous measurements.
    - Sweep can be measured with a very taut stringline along the edge of the top flange of the girder. Be sure that wind does not influence the position of the stringline. If initial sweep is acceptable on the casting bed following strand release, then most later age sweep issues at the point of erection are typically temporary and reversible, related to environmental conditions.
    - Warm sun on the south side of a girder and/or cold wind along the north side can cause significant temporary sweep. Allowing the girder to sit overnight and reach a better equilibrium condition can ease the installation of steel diaphragms.
    - Problems with differential camber within a span are very rare, as currently the girder fabricators are required to cast all girders for a span within a short time, and stressing operations are very closely controlled and inspected at the plant. As with sweep, camber should only be measured in the field when the girder is sitting on the beam seats in a laterally plumb position. The camber should be measured with a survey rod and level at the ends and center point of a girder, either on top of the girder, or taking inverted measurements along the bottom flange from below.

810.5.4 Nonconforming Miscellaneous Items

The project engineer must determine the quantity of nonconforming material. Only one price adjustment will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction.

810.5.4.1 Items Requiring Special Guidance

If any of these items are nonconforming, consult personnel in the area of BTS that specializes in the item for guidance.

Examples of items in which it may be unacceptable to leave the nonconforming item in place, even at a reduced cost, include the following:

- Bar steel reinforcement (except for bend test requirements)
- Anchor bolts
- High strength bolts
- Geotextile fabric type MS
- Piling and pile coating

After consultation with BOS, bar steel reinforcement that conforms in all other respects, but fails the bend test requirements according to AASHTO M31, may be allowed to remain in place with a 20% price reduction on the bid item price.

810.5.4.2 Minor Nonconformance

If the material does not conform to the requirements of the contract, but is expected to substantially fulfill the needs of the project, apply one of the following two price reductions:

1. 20% price reduction on the bid item unit price
2. 50% price reduction on the material (invoice) cost

810.5.4.3 Major Nonconformance

When the material does not conform to the requirements of the contract and is insufficient to fulfill the needs of the project, but will be allowed to remain in place, the project engineer should not pay for the item.

Example:

Test results for riprap fabric are returned after the riprap has been placed, and fabric is significantly outside of the specifications. The project engineer may allow the fabric to remain in place but will not pay for it.

SECTION 813 Weighed Materials

813.1 General

WisDOT personnel are responsible for checking the accuracy of all scales used on projects under their supervision, both at the time of installation and during use. The following are the current recommended procedures relative to the administration of scale testing and inspection.

The expressions "testing" and "checking" of scales as used here do not imply that the physical work involved in making necessary adjustments or adding or removing standard weights will be done by WisDOT personnel. WisDOT personnel will only observe the procedure and work of the contractor's personnel to ensure it is being done in such a way as to provide valid data, take necessary dial or calibration readings, make appropriate notebook notations, and issue the required instructions or orders to obtain the condition for approval. Suggestions or recommendations of technical nature that may be helpful to the contractor in accomplishing the test are considered proper in this function.

Contract items such as asphaltic mixtures, subbase, and base course materials, when measured by the ton, are generally weighed in the delivery vehicle over truck scales; however, asphaltic mixtures also may be weighed over plant or storage hopper scales, and subbase and base course materials also may be weighed over conveyor scales. Each load of asphaltic mixtures must be weighted to the nearest 0.02 ton. Each load of subbase and base course materials must be weighed to the nearest 0.04 ton, except when automatic scales are used which record weight to closer tolerances, or except when conveyor scales are used.

The contactor must provide a load ticket for each load, showing, at the minimum:

- Net weight of the load
- Material type
- Date
- Project I.D

Tickets used for automatic digital recordation for asphaltic mixtures delivered over truck scales or weighed on plant or storage hopper scales must conform to the requirements of standard spec 450.3.1.1.4 or standard spec 450.3.1.1.3.

Standard spec 109.1.4 requires that all aggregates and asphaltic mixtures furnished by the ton measurement be weighed on approved scales furnished by and at the expense of the contractor. It is further provided that the scales must be acceptable to the engineer and must be tested by the engineer or by a testing firm or agency as often as the engineer may deem necessary to ensure their accuracy. Similar requirements are designated in other sections of the standard specs when materials for specific items of work are measured or proportioned by weight.

The engineer must not allow the contractor to use any scale for measuring materials for the work until the scale has been properly checked, inspected, and approved for use.

The Wisconsin Department of Agriculture Trade and Consumer Protection (DATCP) is responsible for checking the accuracy of commercial scales, and so may make random checks during the life of the project if the contractor weighs over commercial scales. DATCP responsibility does not include scales used exclusively for highway construction purposes if the scales are supervised by WisDOT. DATCP follows the specifications and tolerances of Handbook 44 published by the National Institute of Standards and Technology.

813.2 Truck Scales

813.2.1 General

The scale inspector must maintain, as part of the permanent project records, a list of the tare weight of each vehicle and the period for which the list was used. Tare weight must be determined at least once each day and the time of day at which the trucks are tared may vary from day to day. Trucks should be tared at a time when the average conditions for the period prevail, especially regarding fuel levels. The time and frequency of obtaining tare weight will be determined by the engineer, considering the location of the scale with respect to the job or source of material, length of haul, fueling schedules, or other relative circumstances and any apparent changes in the truck.

The scale inspector should observe the tare weighing of the trucks regardless of whether the gross weighing is continuously observed, randomly observed and checked, or printed by truck scale recorders, except that when recorders are used that record tare weight the tare weighing doesn't need to be directly observed.

Increment weighing of trucks will not be allowed. Truck scales must be sufficient size to weigh the entire truck in one weighing. In the case of a truck and trailer, unless the scales are large enough to completely

support both units, the truck and the trailer must be weighed separately. During weighing, the truck and the trailer must be physically disconnected and free from each other, except as follows: Truck and trailer units consisting of a truck and four-wheel trailer equipped with a special jointed tongue need not be disconnected during weighing, provided that test weighing of units on the same scale having the same approach conditions as used in the work indicates no appreciable difference in weights of the units connected or disconnected.

Scales that have had any of their beam extended beyond the scale capacity by filing marks or otherwise can be used to weigh loads only to the rated capacity of the scale. The extension should be reported to the Weights and Measures Technical Section, Wisconsin Department of Agriculture, Trade and Consumer Protection, Madison, WI.

Truck weights can be validated through either continuously observed weighing or randomly checked weighing, which are discussed below.

Normally, testing of truck scales will be accomplished by the engineer. When a truck scale does not check out acceptably, proper facilities are not made available for checking, scale performance is erratic, or source of difficulty cannot be determined, the contractor can be required under the specifications to obtain the services of a scale testing firm or agency. The costs of this service are the obligation of the contractor. A report from such an agency indicating conformance will be considered an acceptable check on the installation of a scale.

When checking truck scales, project personnel are to complete DT1931, Inspection and Test Report -- Portable Vehicle Scale, and retain it with project records. An example of a completed DT1931 is shown in figure 813-1.

If a commercial scale is not within reasonable distance from the project to make a comparison test or the contractor refuses to provide the test, the scale must be checked out by a testing agency or firm.

Using stable concrete foundations and the securing scales to the foundation to prevent shifting or movement is required for department approval.

813.2.2 Continuously Observed Weighing

An inspector will observe the weighing and will check the indicated gross or net weight of the load, the tare weight of the vehicle, and the settings of the tare weight or counterbalance on scales equipped with a separate tare beam or counterbalance.

The load ticket must indicate the identification of the hauling vehicle. The scale inspector will sign or initial each load ticket after checking that the information on the ticket is accurate and complete.

FIGURE 813-1 Inspection and Tests Report for Portable Vehicle Scale

INSPECTION AND TEST REPORT - PORTABLE VEHICLE SCALE Wisconsin Department of Transportation
DT1931 2002 (Replaces EC255)

Project ID: 1691-1-70	Contractor: Ed Kraemer & Sons, Inc.	Date: June 10, 2003
Make: Winslow	Number: 362036 Type: ☑ Beam ☐ Dial Capacity: 6000 LBS	Heaviest Load Weighed: 46000 lbs. approx.
Scale Location: Jenkins Pit	Scale Owner: Ed Kraemer & Sons	Project Engineer: T. E. Smith

MINIMUM INSTALLATION REQUIREMENTS

CHECK AS COMPLETED

☑ 1. One piece concrete abutments according to drawings.

☑ 2. Scale bolted to abutments.

☑ 3. Scale bench mounted on concrete or steel.

☑ 4. Approaches: Compacted and level (i.e., same plane), with scale platform on each end for a distance equal to the wheelbase of the longest truck weighed.

☑ 5. Horizontal parts of scale are level; vertical parts are plumb.

TEST

☑ 1. Zero balance.

☑ 2. Sensitivity with no load (beam scale only). Move smallest poise two graduations or 40 lbs whichever is greater. This must move beam from center of trig loop to bottom and hold it there. This must move the balance indicator when attached to a beam approximately 3/8".

☑ 3. End test. Place a loaded truck on scale, the weight of which will represent loads to be weighed, keeping rear axle at extreme end of platform.
Record:
45640 lbs. weight

Reverse position of truck on scale, keeping rear axle at extreme end.
Record:
45700 lbs. weight

Weight with load centered on platform.
Record:
45710 lbs. weight

The difference between these weights must not be greater than 2 pounds per thousand pounds of loaded truck weight.

☑ 4. Sensitivity (beam scale only). With the loaded truck on scale, balance beam in center of trig loop; move smallest poise out two graduations. This must move beam to bottom of trig loop; this must move the balance indicator when attached to a beam approximately 3/8".

TEST (Continued)

☐ 5. * DIAL SCALE: Using loaded truck.

_____ lbs. when splitting dial only; OR
_____ lbs. on dial to its capacity.
_____ lbs. remaining on beam.
_____ TOTAL
_____ lbs. when using tare beam only; OR
_____ lbs. on beam to its capacity AND
_____ lbs. remaining on dial.
_____ TOTAL
_____ lbs. represented by drop weights(s)
_____ lbs. remaining on dial
_____ TOTAL

* The difference in total weight using any possible combination of reading elements shall not be greater than 2 lbs. per thousand pounds of test load.

☑ 6. Comparison Test. This is extremely important and valuable and should be performed whenever possible.

48700 lbs. weight of loaded truck on project scale.
48620 lbs. weight of loaded truck on reference scale.

J. C. Jones Operator
Lodi, WI Location

Reported by
x J. A. Johnson

813.2.3 Randomly Checked Weighing

The engineer should select loaded trucks at random for reweighing. Standard spec 109.1.4 provides that vehicle gross and tare weight may be checked as often as the engineer deems necessary. Validation of the weigh ticket is not required by a scale inspector. Loads of asphaltic mixtures, subbase or base materials that, upon reweighing, fall within a tolerance of 0.05 ton plus or minus of the original weight are acceptable without any need for correction of the original weigh ticket. Sufficient random checks should be made to assure the engineer the contactor's weighing procedures are accurate; at least two of these checks should be performed for each full day of production, if possible.

Should random checking disclose more errors than might occasionally occur, the engineer should review the weighing procedures used by the contractor and require that the scales be tested. Should errors continue to be discovered, it would be necessary to continuously observe the weighing.

813.2.4 Minimum Requirements for Approval

The minimum requirements for approval of a truck scale installation are:

1. The scale must be supported on concrete abutments or foundations constructed to the minimum dimensions indicated on figures 813-2, 813-3, and 813-4. The abutments, whether cast-in-place or pre-cast, must be in one piece and founded and laterally supported to prevent settling or shifting. If the abutments are covered with gravel, enough must be removed to reveal clearly whether they are monolithic.

2. Scale pedestals must be bolted or otherwise securely held in place to prevent shifting or wobbling on the abutments.
3. The scale bench (support for the recording dial or the poise beam mechanism) must be mounted on and bolted to a concrete slab or steel beams to offer unyielding support. Wood sleepers may be anchored to the concrete or steel beams to allow lateral adjustment of the scale bench and attachment by means of lag screws.
4. Horizontal scale parts and levers must be level; vertical parts must be plumb. Fulcrums, knife-edges, and clevises must be clean and free.
5. Poise beams, poises, pivots, pivot seats, etc., must be kept clean and free from accumulations of dust. The beams must not be extended beyond scale capacity.
6. Approaches to the scale must be level (in the plane of the scale platform) and firm (no excessive rutting, shoving, and chuck-holing) on either end of the platform for a minimum distance equal to the wheelbase of the longest truck weighed or to the distance between the pintle or hitch of the truck and the rear wheel of the four-wheel trailer when weighing of the units is allowed while connected.

813.2.5 Scale Check Tests

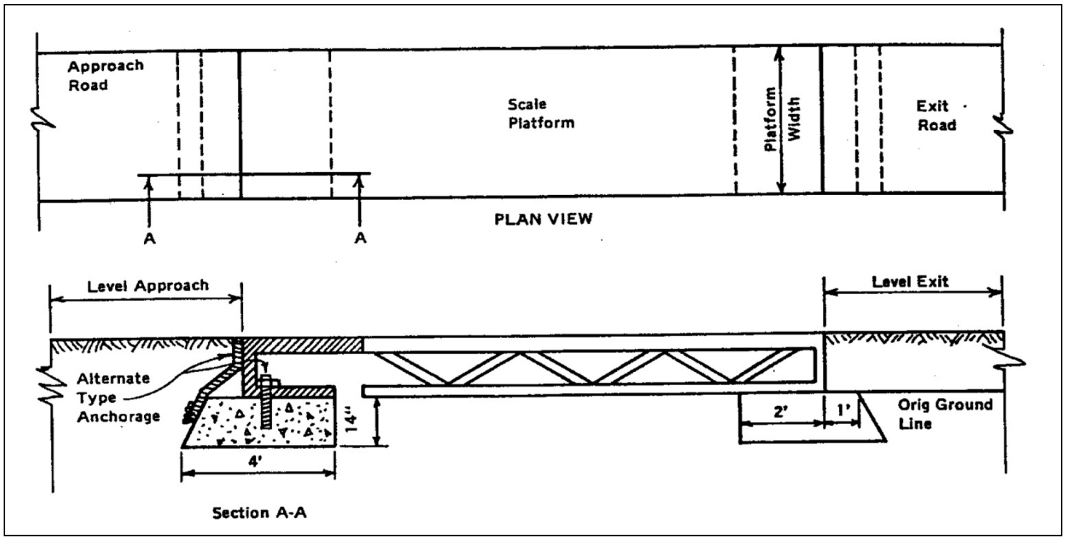
813.2.5.1 Zero Balance

The poise must center in the trig loop at no load for beam scales and must indicate zero for dial scales.

813.2.5.2 Sensitivity (Beam Scales Only)

At both "no load" and scale loaded situations, when the smallest poise is moved out two graduations or an amount not to exceed 40 pounds on the balanced beam, the beam end must drop from the center of the trip loop to the bottom and tend to rest there. When a balance indicator is attached to the beam, moving the smallest poise out the above amount should cause the indicator to move from the center approximately 3/8-inch.

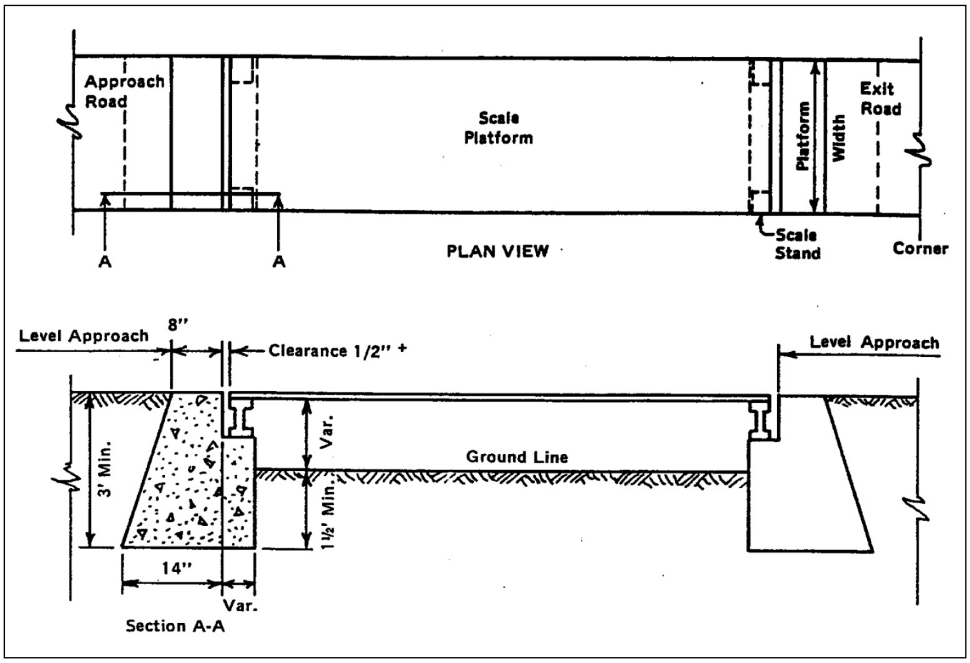
FIGURE 813-2 Truck Scale Installation Minimum Requirements, Full Width Bearing Type



Note: Scale box frame must be anchored to concrete foundation by anchor bolts or other means to preclude longitudinal shifting of scales on foundations.

- All indicated dimensions are minimum and may require increase for some scales.
- Abutments and support must be constructed of portland cement concrete of adequate strength to preclude failure in service.

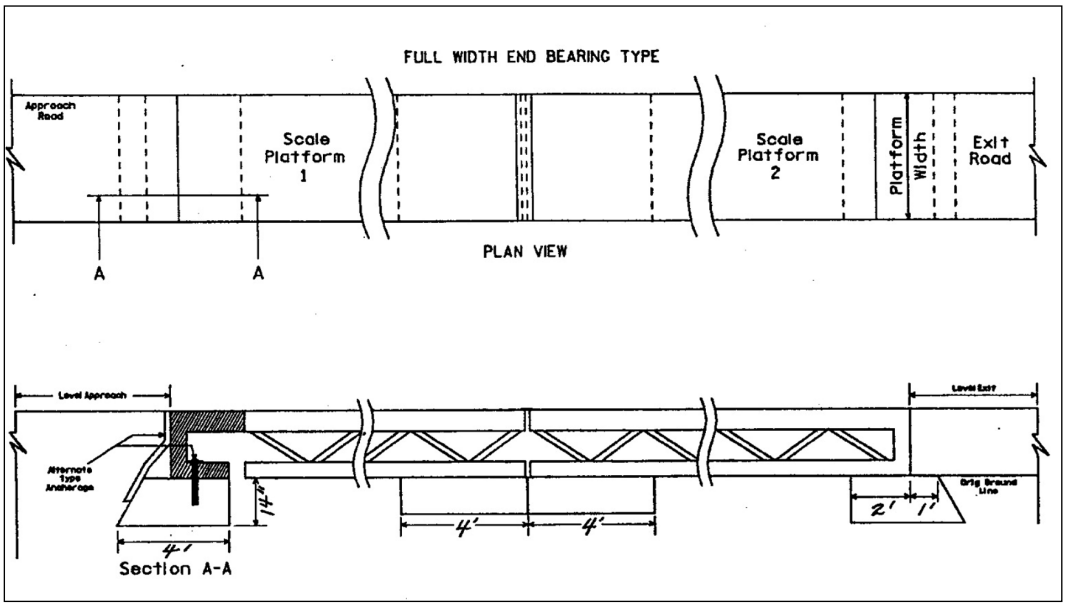
FIGURE 813-3 Truck Scale Installation Minimum Requirements, Corner Pedestal Bearing Type



Note: All indicated dimensions are minimum and may require increase for some scales.

- "Variable" dimensions are dependent upon specific scale requirements for bearing areas and level arrangements.
- Abutments and supports for scale corner stands must be constructed of portland cement concrete of adequate strength to preclude failure in service.

FIGURE 813-4 Dual Truck Scale Installation Minimum Requirements



813.2.5.3 End and Center Test

1. Place a loaded truck, representative of the loads to be weighed, on the scale with the rear wheels at the extreme end of the platform. For a scale having dual platforms, the "extreme ends" must be the approach end of scale platform #1 and the exit end of scale platform #2.
2. Weigh and record the weight.
3. Reverse the position of the truck by placing the rear wheels at the extreme opposite end of the platform.
4. Weigh and record the weight.
5. Place the loaded truck centered on the platform. For a scale having dual platforms, the load when centered must be supported one-half on scale platform #1 and one-half on scale platform #2.

6. Weigh and record the weight.

The difference between any of these weights must not exceed two pounds per thousand pounds of the loaded truck weight.

813.2.5.4 Dial Scale Test

The purpose of this test is to check the indicated load using all possible combinations of dial, poise beam, and drop counterweights, which are independently adjustable reading elements.

1. Place a loaded truck, representative of the loads to be weighed, on the scale platform.
2. Record the total indicated weight, based on using the dial to its maximum capacity, and the remaining weight on the beam.
3. Record the total indicated weight, based on using the beam to its maximum capacity, and the remaining weight on the dial.
4. Record the total indicated weight, based on using drop counterweights as required, and the remaining weight on the dial.

The difference in indicated total load when using any possible combination of reading elements must not exceed two pounds per thousand pounds.

813.2.5.5 Comparison Test

The contractor's scale must be finally checked for accuracy under a representative truckload against a permanent truck scale. The difference between readings on the two scales (making due allowance for fuel consumed during the trip) must not exceed two pounds per thousand pounds of the loaded truck weight.

813.2.6 Frequency of Scale Check Tests

During use, the end and center test and comparison test should be made at least once per week; the zero-balance test and sensitivity test (for beam scales only) should be performed several times daily. When scales are being subjected to unusually heavy use or appear to depreciate rapidly in accuracy or sensitivity, more frequent testing may be necessary to ensure adequate control. With record of acceptable performance, the frequency of check tests may e reduced to two per month for permanent commercial scales; however, at least one comparison test should be made at the beginning of the weighing operations on the project.

The frequency of comparison tests may be reduced to twice per month at the discretion of the engineer on work where 10,000 tons or less of material is weighed over the scale weekly.

813.3 Conveyor Scales

813.3.1 Background

Subbase and base course may be weighed over approved conveyor scales and the weight used for pay purposes. Conveyor scales cannot be approved for sporadic or intermittent production, or for commercial sources supplying private and highway needs concurrently, or for similar applications where alternating deliveries could result in unacceptable errors.

If the approved conveyor scales are equipped with an approved printer system, continuous observation by a scale inspector of the weighing will not be required. Validation of the weigh tickets will not be required either.

Conveyor scales may also be used for proportioning purposes, such as for asphaltic and concrete mixtures.

813.3.2 Inspection and Approval

Requirements for approval, accuracy, inspection, and testing of conveyor scales must conform to the code for belt conveyor scales in Handbook 44, published by the National Institute of Standards and Technology.

The contractor must furnish all necessary equipment, data, labor, and personnel to accomplish the required testing, unless the contractor prefers to have the testing performed by a scale testing agency. If the conveyor scales do not check out acceptably, do not retain their accuracy, or are erratic, and the source of difficulty cannot be determined, the contractor should obtain the services of a scale testing agency familiar with conveyor scales.

The conveyor frame must be equipped with leveling bubbles. The unit must be level when set up for operation. The stability and rigidity of the conveyor in which the scale is installed is of prime importance in all conveyor scale installations, but especially so for portable conveyor scales, since portable conveyor scales are frequently moved from job to job, and from one location to another in a pit.

Truck scales for comparison purposes are not always handy and material tests using truck scales are time consuming. It is, therefore, essential that all portable conveyor scales approved for use must be

capable of calibration with simulated tests using a test chain, test weights, or calibrated plates. The unit must be sufficiently stable and rigid to allow for recalibration after movement of the scale from one location to another without resort to comparison testing with a truck scale.

813.3.2.1 Testing for Acceptance

Unless waived by the engineer, all conveyor scales must be tested initially for acceptance as follows:

1. The conveyor scale must be calibrated with an accurate truck scale by a material comparison test.
2. The leveling jack must be removed, and the unit towed about in a typical move, after which the unit should be jacked up and leveled in a different location than that in which it was first calibrated.
3. A zero-load test must be run and the scale calibrated by a test chain, test weights, or calibrated plates, and any necessary span adjustments made.
4. A material comparison test must be performed using the truck scale with which the conveyor scale was originally calibrated. No span or zero adjustment must be made during the comparison test.
5. The weights as measured by the conveyor scale must agree with the weights as measured on the truck scale to within 0.5% of the test load.

813.3.2.2 Frequency of Testing

Conveyor scales must be tested and calibrated after each relocation of the scale at the work site as well as after each movement between work sites. Conveyor scales must be tested at least once for each week of continuous use and at any time when accident, settlement, or other causes may have affected their accuracy.

The zero-load test must be performed at least once daily. The contractor may test the scale by either a material test or simulated test, but the contractor should not be required to calibrate or make comparison tests with truck scales when simulated tests provide acceptable results and when the scale was approved as provided above.

813.3.2.3 Records

Several different types of conveyor scales are on the market and these are mounted in conveyors manufactured by a number of companies. The type and manufacturer of the scale and the manufacturer of the conveyor, together with any new or interesting aspects of design should be entered in a field notebook.

All data relative to tests made for acceptance as well as data relative to routine calibration tests should be entered in a field notebook for incorporation in the permanent job records, together with appropriate comments relating to repair, adjustments, problems, and any item of interest relative to the operation of these scales.

813.3.3 Scales Used for Proportioning Purposes

Each conveyor scale must be calibrated and checked for accuracy in accordance with the manufacturer's instructions. A material comparison test with a truck scale of known accuracy should be made before beginning production. The size of material test should be at least the size recommended in the manufacturer's manual. The purpose of the material test is to establish a calibration point to allow routine checking of the scale using its own weights.

Weights as recorded by the conveyor scale must agree with the weights as measured on the truck scale to within 1.0% of the test load. Should the conveyors be moved and re-erected, another material test should be performed.

The conveyor's scale must be calibrated and checked for accuracy using its static weights at least once for each week of continuous use and more frequently as necessary or desirable. High-production plants may warrant scale checks more frequently than once a week. Frequency of checks should be determined by the engineer on the basis of the specific plant operation. The zero-load test must be performed at least once daily.

813.4 Storage Hopper Scales

Storage hopper scales must be checked for inspection and testing of batching scales, or by the comparison test. Rather than compare the gross load of the truck at the plant site with the gross load when weighed on a permanent scale, while making due allowance for fuel consumption, a comparison will be made between the net load at the plant site and the net load when weighed on a permanent truck scale. The difference between the two weights must not exceed 0.5% of the net load when weighed by storage hopper scale at the plant site.

The storage hopper should be substantially loaded for at least five hours so that most of the probable settlement will have occurred. An example of the calculations is shown below.

Example 1

Truck tare at plant = 27,700 lbs
Fuel consumption; estimated 10 gal. @ 6 lbs./gal. = 60 lbs
Recorded weight of mix on storage hopper scale = 21,000 lbs
Gross weight on permanent scale = 48,620 lbs
27,700 - 60 = 27,640#
48,620 - 27,640 = 20,980#
21,000 - 20,980 = 20#
Allowable difference = 21,000 x 0.005 = 105 lbs
Actual difference = 20 lbs, so the storage hopper scale passes the check.

813.5 Plant Scales

Standard spec 450.4 allows weighing minor quantities of asphaltic mixtures over plant scales instead of truck scales when the engineer approves. This provision applies to asphaltic plants not equipped with printer systems. The size of minor quantities is left to the discretion of the engineer; however, the provision should not be construed to eliminate the need for installation of a truck scale on small tonnage contracts. Plant scales might be used for minor quantities when truck scales are out of order, when automatic printers are malfunctioning and are awaiting repair, and when other similar situations occur. Standard spec 450.4 also allows the measurement of intermittent or minor amounts of asphaltic mixtures by weighing over the plant scale when the measurement of amounts based on net weight would be impractical.

Initial inspection of the scales and subsequent checks by random weighing by a scale inspector will be required. A comparison test should be made in accordance with the frequency. Asphaltic mixtures weighed over automatic plant scales equipped with an approved printer system will not require continuous observation of the weighing or validation of the weigh ticket by a scale inspector.

Requirements for approval, accuracy, inspection, and tests of plant scales used for weighing asphaltic mixtures and materials for pay purposes, including scales used in connection with automatic printer, mixing, and batching systems are in this section.

813.5.1 Storage Hopper Scales

Asphaltic mixtures may be weighed with storage hopper scales. If the approved storage hopper scales are equipped with an approved printer system, continuous observation by a scale inspector of the weighing will not be required. Validation of the weigh tickets will not be required either.

813.5.2 Commercial Batching Scales

Permanent commercial ready-mixed concrete or asphaltic batch plants serving the general public must have on hand a report of annual testing of each scale by a scale testing agency. This report should be checked to determine if the scale accuracy meets specification requirements. In general, a report dated before the calendar year in which the scales are used will not be accepted. If a current report indicating acceptable accuracy is available, the engineer need not make any initial check on the sales but should make periodic checks of proper functioning and sensitivity during the course of normal batching operations.

If acceptable evidence of scale check by a testing agency is not available, the installation must be checked out by a testing agency before it is approved for use. It is not necessary for WisDOT personnel to observe testing when performed by a testing agency.

The requirements for approval and use of batching scales are covered in standard spec 450.3.1.1.2 (hot mix asphaltic mixtures) and standard spec 501.3.4.5 and standard spec 501.3.4.6 (portland cement concrete).

813.5.3 Inspection

Before approval of a scale for use, the installation must be inspected and tested for compliance with the requirements of standard spec 450.3.1.1.2, standard spec 501.3.4.5, and standard spec 501.3.4.6 as applicable.

The required number of standard 50-pound testing weights should be available, not only for the initial test, but for rechecking as required to ensure continuously correct weighing. The weights must be kept clean and free from accretions of foreign material. They should be checked for accuracy before initial use and thereafter whenever there is reason to suspect a change in their weight.

Inspections and tests must be made in accordance with the following recommended practices. The inspections and tests should be made preliminary to approval and during routine plant inspection.

813.5.4 Requirements for Accuracy

All scales at asphaltic batching plants should be accurate to 0.5% of the maximum load that may be required. Scales at concrete batching plants should be accurate to within a tolerance of 0.4% of the net load in the weigh hopper.

813.5.5 Suspended Hopper Scales

Scales must be checked only after the bins have been fully loaded for at least five hours so that most of the probable settlement will have taken place. Horizontal scale parts and levers must be level and vertical parts plumb.

Scales used in weighing aggregates may be checked for accuracy at 500-pound increments of load until near the required net load, when 100-pound increments should be used. The contractor may have, in addition to the required minimum of 10 standard 50-pound weights, standard weights of greater size such as weights of 500 pounds each, accurate to within 0.1%.

When these larger weights are available, increments of up to 2,000 pounds may be used until near the required net load, when 100-pound increments should be used. Cement and asphalt scales must be checked at not more than 500-pound increments of load until the last 500 pounds of required net load, when 50-pound increments should be used. The sensitivity of beam-type scales must be checked at each increment within 200 pounds of the required load.

813.5.5.1 Load Tests

The poise beam must be balanced to center in the trig loop with the pointer of the indicator dial (if attached) centered at no load for beam scales or to indicate zero for dial scales. The standard weights must then be placed on the scale in a manner to approximate as closely as possible the conditions of normal load application. When the last weight has been applied for the increment, the actual test load and its comparable indicated load should be recorded on DT1378. An example of a completed form DT1378 is shown in figure 813-5.

Without changing the scale setting, the standard weights are removed, and the beam again brought to accurate balance by placing material into the weigh hopper. The standard weights are applied as before to the new load and the process repeated until the required net load for each beam, dial, or combination of beams and dial is reached. Scales should be checked against standard weights at the start of weighing operations, at least once a week during continuous use and more frequently as necessary or desirable, or at any time that accident or settlement may have affected them. High production plants may warrant scale checks more frequently than once a week. Frequency of checks should be determined by the engineer on the basis of the specific plant operation. Commercial batching scales having a current report indicating acceptable accuracy need not be checked against standard weights unless deemed necessary by the engineer.

813.5.5.2 Sensitivity

A beam scale is acceptably sensitive if, when the smallest poise is moved two graduations, the beam moves at least 1/4 inch from the position of equilibrium in the middle of the trig loop towards the top or bottom of the loop and tends to rest there. Scales not accurate to within specification limits or not sufficiently sensitive must not be used until adjusted or repaired.

The scales should be inspected frequently to detect signs of sluggishness, inaccuracy, or damage. They should be checked for zero balance at no load several times daily and for accuracy and sensitivity at least once a day by applying one standard 50-pound weight to the full load and observing the difference in weight and the sensitivity.

If the scales have long, exposed levers that cause instability in the telltale dial on windy days, the contractor should be required to provide the scales with suitable protection from the wind. When oil is used on scale parts such as knife-edges, pivots, fulcrums, clevises, etc., it tends to collect dust and cause sluggishness. Less trouble will result if brushes and highly volatile cleaners are used instead of oil.

Telltale devices, or over or under indicators, must be checked for compliance with specification requirements whenever the scales are checked for accuracy.

813.5.6 Records

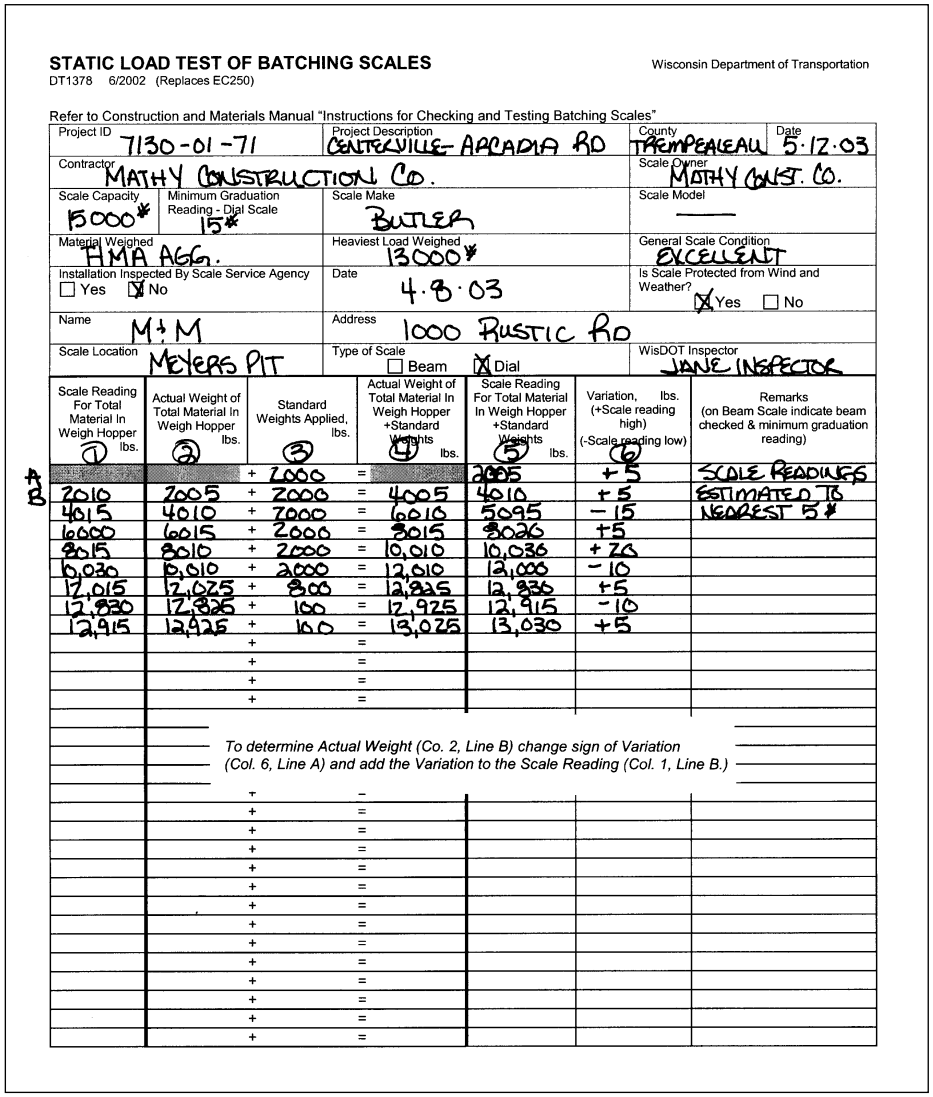
A tabulation of data of scale readings versus increments of standard weight must be recorded on DT1378, with appropriate comments relating to corrections, repair, approvals, etc., entered on the back of the form.

813.5.7 Recordation

The standard specs require that on projects involving 10,000 tons or more of asphaltic mixtures, the contractor must employ recordation of weights. If the contractor does not use recordation on batch plant

scales, the contractor must use recordation on a truck or storage hopper scale. Truck and storage hopper scale recordation must comply with standard spec 450.3.1.1.4. Batch plant scale recordation must comply with standard spec 450.3.1.1.4. Weighing of materials, including base and subbase materials, will require random checks of the weigh ticket by an inspector. Under this weighing procedure, a comparison test should be made.

FIGURE 813-5 Static Load Test of Batching



STATIC LOAD TEST OF BATCHING SCALES
DT1378 6/2002 (Replaces EC250)
Wisconsin Department of Transportation

Refer to Construction and Materials Manual "Instructions for Checking and Testing Batching Scales"

Project ID: 7130-01-71	Project Description: CENTERVILLE-ARCADIA RD	County: TREMPEALEAU	Date: 5·12·03
Contractor: MATHY CONSTRUCTION CO.			Scale Owner: MATHY CONST. CO.
Scale Capacity: 15000#	Minimum Graduation Reading - Dial Scale: 15#	Scale Make: BUTLER	Scale Model: —
Material Weighed: HMA AGG.		Heaviest Load Weighed: 13000#	General Scale Condition: EXCELLENT
Installation Inspected By Scale Service Agency: ☐ Yes ☒ No		Date: 4·8·03	Is Scale Protected from Wind and Weather? ☒ Yes ☐ No
Name: M & M		Address: 1000 RUSTIC RD	
Scale Location: MEYERS PIT		Type of Scale: ☐ Beam ☒ Dial	WisDOT Inspector: JANE INSPECTOR

	Scale Reading For Total Material In Weigh Hopper lbs. (1)	Actual Weight of Total Material In Weigh Hopper lbs. (2)	Standard Weights Applied, lbs. (3)	Actual Weight of Total Material In Weigh Hopper +Standard Weights lbs. (4)	Scale Reading For Total Material In Weigh Hopper +Standard Weights lbs. (5)	Variation, lbs. (+Scale reading high) (-Scale reading low) (6)	Remarks (on Beam Scale indicate beam checked & minimum graduation reading)
			+ 7000 =		2005	+5	SCALE READINGS
A B	2010	2005	+ 2000 =	4005	4010	+5	ESTIMATED TO
	4015	4010	+ 2000 =	6010	5095	−15	NEAREST 5#
	6000	6015	+ 2000 =	8015	8026	+5	
	8015	8010	+ 2000 =	10,010	10,036	+26	
	10,030	10,010	+ 2000 =	12,010	12,000	−10	
	12,015	12,025	+ 800 =	12,825	12,830	+5	
	12,830	12,826	+ 100 =	12,925	12,915	−10	
	12,915	12,925	+ 100 =	13,025	13,030	+5	
			+ =				
			+ =				
			+ =				
			+ =				

To determine Actual Weight (Co. 2, Line B) change sign of Variation (Col. 6, Line A) and add the Variation to the Scale Reading (Col. 1, Line B.)

		+ =	
		+ =	
		+ =	
		+ =	
		+ =	
		+ =	
		+ =	
		+ =	
		+ =	
		+ =	
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		+ =	
		+ =	

813.6 Loader Scales

Under standard spec 109.1.4 the engineer can approve alternate scales. The department expects materials coming from off site to be weighed on a platform scale. For on-site recycling and other on-site operations, the engineer can allow the contractor to use loader scales. The engineer should not allow loader scales that can't provide a printed record of each bucket of material. The contractor must also provide a way to identify each bucket load in a specific truck load and submit the sum of bucket load weights in that truck load.

Before approving a loader scale the engineer needs to ensure its accuracy. The engineer can have the contractor perform an initial check by using a tested and currently approved platform scale to establish a truck tare weight, load a truck with the loader, determine the loaded truck weight on the platform scale, and compare the calculated load weight to that indicated by the loader scale. The difference cannot exceed 0.5% of the load weight determined using the platform scale.

The contractor must perform regular checks at least once per 2000 tons. The engineer can direct spot checks anytime. The engineer should suspend use of a loader scale if the difference exceeds 0.5%.

The engineer should periodically monitor the contractor's load out operations to ensure that weights used to determine payment are being determined correctly.

SECTION 815 Density Testing

815.1 General

Field densities are taken by nuclear methods in accordance with established procedures as required by the contract. If the contract contains QMP density testing provisions, the contractor performs quality control density testing and the department performs quality verification density testing. If the contract doesn't include QMP density testing provisions, the department will perform all density testing conforming to standard spec 460.3.3.2. Once a method has been selected for determining mat density, that method should be used throughout the project.

815.2 Nuclear Gauges

Sampling and testing certifications are an FHWA requirement in the CFR 23 part 637. The NUCDENSITYTEC-I class is offered only by the University of Wisconsin Platteville as part of the HTCP.

For certification class schedules contact the director of the HTCP at (608) 342-1545 or at:

https://www.uwplatt.edu/department/highway-technician-certification-program

Testing of some soils, fly ash, and coarse materials requires special testing procedures, for which the operator will need additional training. Contact the WisDOT RSO for further information regarding special testing procedures.

815.3 Vacant

815.4 Annual BTS Gauge Block Calibration Procedures

Run the block and procedure for each gauge as described below:

1. BTS block procedure
    - Maintain 30' or greater spacing between gauges.
    - Sweep off yellow and green blocks.
    - Perform manufacturer recommended warm up time if applicable. Gauges should only be used when they stabilize to ambient room temperature.
    - Place the manufactures supplied poly standard block on the yellow concrete block and perform the Standard Count, and record data on department supplied block forms.
    - Remove the poly standard block and align the front of the gauge that it touches the front line on the yellow block, and center the gauge.
    - Take a four minute back-scatter (BS) test for CPN, Troxler, Humboldt and InstroTek gauges, or a two-minute test for both Contact and Air gap for Seaman nuclear gauges.
    - Without moving the handle for CPN, Troxler, Humboldt, or InstroTek, record required data Wet pounds per cubic foot (pcf), # Moisture, Density counts, and Moisture counts and then perform the next test.
    - For Seaman gauges record the required data Wet pcf, # Moisture, Density counts, Moisture counts. Re-center the gauge and perform the next test.
    - Take three tests for each concrete test block and record the data for each test. DO NOT perform a new standard for each block.

Record the Block results on the WisDOT Block Calibration form and submit to the RSO.

815.5 Nuclear Density Testing HMA

Gauges must be in the shielded position and locked when not in use. Gauges should never be left unattended when in use.

Gauges must be warmed up and checked following the manufacturer's guidelines.

815.6 Vacant

815.7 QMP QC and QV Nuclear Density Gauge Comparison

If calibration factors need to be adjusted in the field, contact the RSO beforehand for guidance and documentation.

Use the last two test sites from the final comparison process and proceed with your moisture basis calculations as explained in CMM 815.12.1. If the difference in moisture content between a gauge and the corresponding sample exceeds 1.0 pcf, then a moisture bias needs to be calculated for that gauge for the specific soil classification. The bias needs to be checked during placement or if the material classification changes. If testing in DT mode, operators need to be cautious to ensure that the pilot holes do not collapse. Provide one of the QC or QV gauges that passed the comparison process, within allowable tolerances, to perform density testing on the project.

815.8 Vacant

815.9 Vacant

815.10 Use of Nuclear Moisture/Density Gauges on HMA

The designated materials persons (standard spec 106.1.2) will determine how the documentation will be communicated at the preconstruction meeting. A new standard is also required if testing different materials on the same day (e.g., testing aggregate base and then switching to HMA testing). Changing the HMA mix type, or base course material sources does not require a new standard.

815.10.1 Vacant

815.10.2 Vacant

815.10.2.1 Vacant

815.10.2.2 Vacant

815.10.3 Vacant

815.10.4 Duration of Test and Gauge Placement

All moisture/density gauges have different shapes, so the operator must outline the gauge. For CPN, Troxler, Humboldt and InstroTek gauges, mark an arrow in the direction the source rod is facing. For a Seaman C-75 gauge, the arrow should be marked forward if facing the display, and to the left facing the display for C-200 & C-300 gauges. Always align the gauges to the front of the footprint marked out on the pavement.

815.11 Procedure for Determining Limits of Unacceptable Material

Standard spec 460.3.3.1 requires the engineer to investigate a single nuclear density test result, greater than 3.0% below specified minimums. The engineer needs to access acceptability of that material by performing the following:

1. Test at 50-foot increments both ahead and behind the unacceptable site, using the same offsets as the original test.
2. Continue 50-foot incremental testing until the test value indicates conforming material (i.e., within 3.0% less than minimum required density).
3. Materials within the incremental testing indicating more than 3.0% below minimum required density are defined as unacceptable, and will be handled as follows:
    3.1. Remove and replace unacceptable materials with the same mix type, unless otherwise approved by the project engineer, and meeting the required specified density. This will be done to the full lane width as defined by the density requirements. The shoulder may be considered separately from the mainline. Unacceptable materials replaced are at contractor cost.
    3.2. If unacceptable materials are allowed by the project engineer to remain in place, tonnages will be paid at 50%.

Note: If the 50' testing extends into a previously accepted lot, removal of the unacceptable material may be required or allowed to stay in place at a 50% payment deduct; however, the results of these tests must not be used to recalculate the previous accepted lot density.

815.12 Vacant

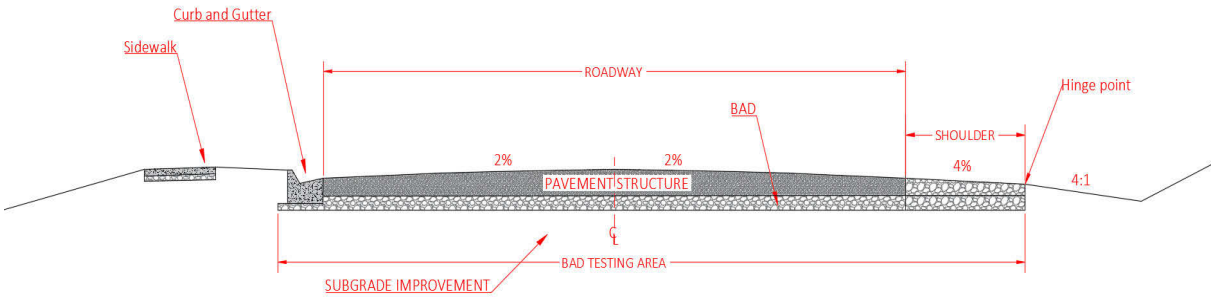
815.12.1 Use of Nuclear Moisture / Density Gauges on Soils, Base Course, etc.

During testing, the gauge must be set on a flat surface with no more than 1/16" void between the gauge's surface and the material being tested. If any small air voids need to be filled, use only native material as filler.

If the gauge needs to have a moisture bias for a specific soil, the gauge operator needs to conduct tests at 2 random locations with that soil type. After each moisture / density gauge test is completed, the material directly below the gauge will be retained and a 1-point Proctor test must be run at its natural moisture level. Then use part of the sample and perform a natural dry-back. Compare the average moisture content of the natural soil to the average moisture reading of the gauge. If the difference between the two averages exceeds 1.0 pcf, then a moisture bias is needed for that gauge for that specific material.

For density testing of 1-1/4” base aggregate, the defined area for testing should be between shoulder hinge points or the edge of subgrade improvement. A hinge point is defined as the location where the shoulder steepens in the clear zone. The edge of subgrade improvement is defined as the horizontal extent of where the subgrade has been compacted. Hinge points are typically found in rural settings, and the edge of subgrade improvement areas are typically located near curb and gutter installations in urban settings. An example of a typical roadway section is shown in Figure 815-1 to provide guidance in locating the base aggregate dense (BAD) testing area.

FIGURE 815-1 Base Aggregate Dense (BAD) Testing Area



815.12.2 Establishing a Moisture Density Gauge Bias for Soils

All Proctor tests must have a minimum of 5 points, 2 ascending and 2 descending, with 1 point at or near the optimum moisture.

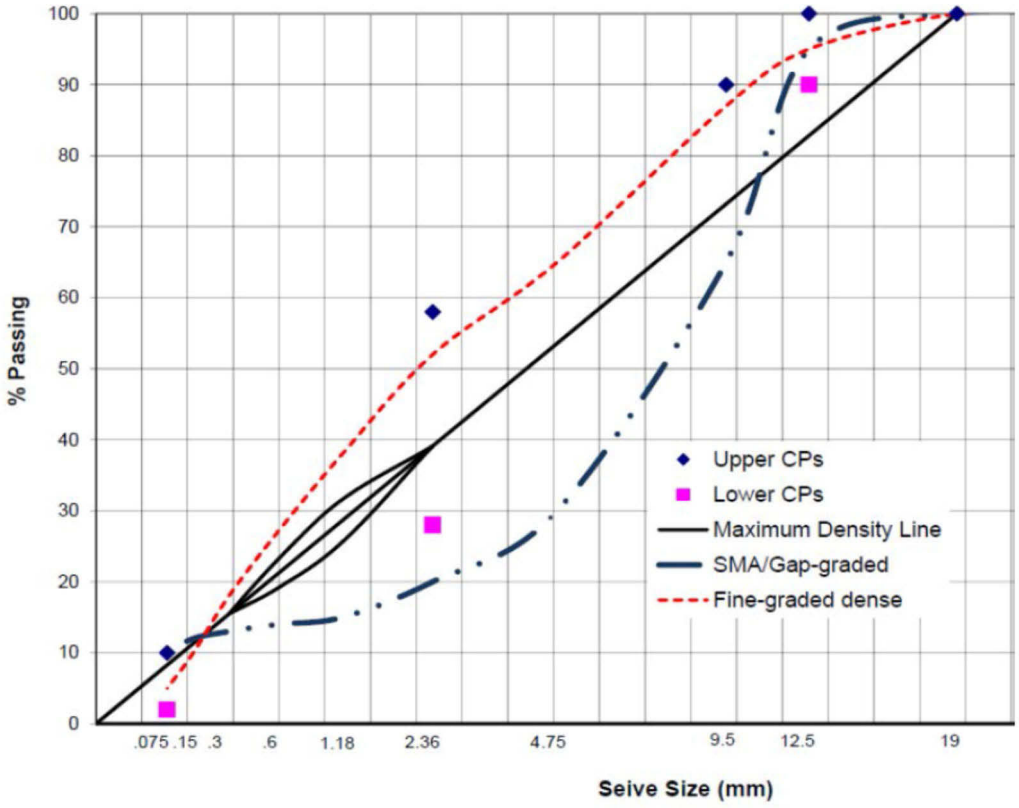
815.13 Test Strip Requirements for Stone Matrix Asphalt (SMA) and Coarse (Gap-graded) mixes

The procedure for correlating gauges to pavement cores using as test strip for SMA and gap graded mixes prescribed in 815.13.1 is mobilized into the contract in standard spec 460.3.3.2.

815.13.1 Test Strip Description

Density determination procedures and requirements must be used to correlate nuclear gauges to pavement cores for SMA and gap graded mixes. Since SMA is a type of gap-graded mixture, only the term SMA will be used to describe both SMA and gap-graded mixtures.

FIGURE 815-2 SMA(Gap Graded) Gradations



Correlate nuclear gauges to pavement cores for SMA pavement using a WisDOT test strip according to WTM T355 Appendix X1. Construct one approved test strip for each mix design of SMA for each contract. Ensure the test strip is acceptably compacted and meets all requirements specified in the contract special provisions for SMA pavements. The test strip is to remain in place and becomes part of the completed pavement. The following describes the SMA density and volumetric testing tolerances required for an SMA test strip.

Notify the department at least 48 hours in advance of construction of the test strip. At the beginning of the first shift of production requiring a test strip, produce approximately 500 ton of SMA and cease production until the required testing is completed. Test strips must be located in a section of the roadway to allow a representative (i.e. not a ramp or shoulder, etc.) rolling pattern.

815.13.1.1 Sampling and Testing Intervals

Laboratory testing will be conducted from three split samples, with portions designated for QC, QV, and retained. Required field tests include contractor quality control (QC) and department quality verification (QV) nuclear density gauge tests and pavement coring.

During production for the test strip, HMA mixture samples are obtained from trucks before departure from the plant. Two split samples are collected during the production of test strip material. Sampling and splitting are in accordance with section CMM 815.13.1.3 and as further detailed in CMM 836. These two samples will be randomly selected from each half of the test strip tonnage (T), excluding the first 50 tons, and will be identified by the project engineer:

TABLE 815-1: Interval Windows for Test Strip Volumetric Samples

Sample Number	Production Interval (tons)
1	50 to T/2
2	T/2 to T

All test reports are submitted to the department upon completion and approved before paving resumes.

815.13.1.2 Field Tests

Daily standardization of gauges on reference blocks and a reference site is performed in accordance with WTM T355. A gauge comparison according to WTM T355 must be completed before the day of test strip construction. Nuclear gauge readings and pavement cores are used to determine nuclear gauge correlation in accordance with WTM T355 Appendix X1. The target maximum density used to determine core density is the average of the two QC volumetric/mix Gmm values from the test strip multiplied by 62.24 pcf. Each team must have at least two gauges correlated at the time of the test strip. Any data collected by a team without an acceptable gauge (i.e., correlated during test strip) will not be accepted. Two gauges per team are not required to be onsite daily after completion of the test strip.

Each core, 150 mm (6 inches) in diameter must be taken at locations identified in WTM T355 Appendix X1. Each random core must be full thickness of the layer being placed. This may require cutting/separation of core from underlying layers at the pavement layer interface to ensure that subsequent testing is performed only on the most recently placed layer/mix.

Coring and filling of core holes must be approved by the project engineer and performed according to WTM R67.

815.13.1.3 Laboratory Tests

QC and QV samples are tested for Gmm, Gmb, and AC. Air voids and VMA are then calculated using these test results. QC samples are also tested for aggregate gradation. Material is collected from trucks at the plant according to the frequency described in CMM 815.13.1.1 above. Sample sizes must be consistent with the minimums for a three-part split as described in WTM R47.

Bulk specific gravities for cores and gyratory compacted specimens are determined according to WTM T166. Two QC volumetric tests are conducted during the test strip, and the department representative randomly selects one of the two splits for QV testing. The Gmm is determined according to AASHTO T209 as modified in WTM 209.

The bulk specific gravity values determined from field cores are used to calculate a correction factor (i.e., offset) for the QC and QV nuclear density gauges to be used throughout the remainder of the project for that mix and layer. QC and QV teams may wish to scan with additional gauges at the locations detailed in WTM T355 Appendix X1, as only gauges used during the test strip correlation phase will be allowed on the remainder of the project.

For additional information on sample size, splitting, and laboratory testing, refer to WTM R97 and WTM R47.

The 12 density tests required for determining the control strip density and rolling pattern for asphalt base, prescribed in 815.13.2 is mobilized into the contract in standard spec 460.3.3.2.

815.13.2 Density Testing Asphaltic Base Mixtures

The control strip consists of 1000 feet of the asphaltic base mixture that contains a minimum of one QC mixture test and twelve sites for nuclear density testing. Within the control strip, the department, using random numbers for sample determination, will identify twelve locations for density testing. Upon

completion of the desired compaction for the control strip, nuclear density tests will be performed by the contractor at the twelve locations. Do not use additional materials to aid in seating the gauge.

The Control Strip accepted density will be determined by calculating the median value of the random twelve nuclear density locations. Within (4) hours, the contractor will provide the department with test results for the QC sample and Control Strip acceptance density. The QC sample is taken randomly within the first 300 tons of production not to include the first 50 tons. The Control Strip will validate the rolling pattern to be used for the remainder of the contract if the air voids from the initial QC sample taken during the control strip construction falls between 2.5% to 4.0%. If the test results do not meet these minimum requirements during the first control strip, an investigation will result, and a new control test strip and new QC sample will be required. Once the contractor has proven in the control strip that he can maintain a minimum density of 91.0% density, the rolling pattern will be accepted and used for the remainder of the project. The department maintains the right to verify that the rolling pattern is maintaining a minimum density of 91.0% at any time. If the department's test is less than 91.0%, a new control strip may be required, at the department's discretion. QMP nuclear density testing does not apply to asphaltic base. Mixture production will be stopped, and an investigation initiated if any of the following conditions occur:

1. The previous day's maximum specific gravity average from QC testing varies by ≥ 0.020 from the value of the initial QC test;
2. If a new mix design is required (i.e, 250 number), a new test strip will be required.
3. Any other condition occurs which in the judgment of the project engineer would warrant the establishment of a new control strip density.

Submit the results to the project engineer. The Materials Reporting System is not designed to accept nuclear density test results for Asphaltic Base. Asphaltic Base is not subject to density incentive/disincentive bid items. Also note that the control strip is not to be used for gauge comparison. That procedure is done as described in WTM T355 and will be completed before density testing in the control strip.

815.14 Reports Forms

A Daily Nuclear Reference Check Record form must be completed each day that a gauge is used. All data fields must be recorded.

The operator must choose the form relevant to the gauge manufacturer and fill in all columns. This form may also be used for recording data when determining the value for a field reference location.

A copy of the appropriate form will be left with the project engineer, unless mutually agreed upon.

Nuclear density forms are on the AASHTOWare Project Knowledge Base (AWPKB) website at:

https://awpkb.dot.wi.gov/Content/constr/Pantry/StatewideForms.htm

815.15 Acceptance and Incentive/Disincentive

For nuclear density testing data that indicate densities of less than the specified minimums, appropriate steps should be taken to identify and resolve the problem. Review all test procedures and derived data to ensure the test data is correct. Problems relating to the nuclear test equipment should be referred immediately to the RSO.

Additional tests taken for information purposes must not be averaged with the initial test or used to reduce payment when the tests are non-complying.

815.15.1 Disincentive for HMA Pavement Density

The determination is based on five factors:

1. Type of HMA Pavement, location, and layer.
2. Amount of deficiency in attained density in terms of percent below minimum required density. See standard spec 460.5.2.2 for percent of contract unit price allowed.
3. Contract unit price per ton of HMA pavement.
4. Number of tons of asphaltic mixture in the deficient lot. This may be determined by any available means, such as by plant or load records, delivery tickets, theoretical yield quantity, etc.
5. A non-compared gauge was used to conduct testing.

815.15.2 Incentive for HMA Pavement Density

Note: This section and the contained examples do not apply to stone matrix asphalt (SMA) pavements

If the lot density is greater than the minimum specified in standard spec 460.3.3.1, table 460-3 and all air void test results for that mixture placed during the same day are within 2.5% to 4.0%, the pay should be adjusted for the lot as specified in standard spec 460.5.2.3 or the special provisions.

Examples of Computing Incentive/Disincentive for QMP Nuclear Density

Project Information for Examples 2 and 3:

A project begins at station 56+78 and ends at station 234+25. It is a 2-lane roadway with a shoulder on each side. The traffic lanes are 12 feet wide and the shoulders are 3 feet wide. Shown in figure 815-11 is the eastbound traffic lane and shoulder for the length of the project. The contractor will be paving the shoulder integrally with the traffic lane. The pavement is a 2-inch overlay and the same HMA mix type is used on the entire project. The bid price for the HMA pavement item is $41.75 per ton. The specified target density for the traffic lane is 93.0%. The target density for the shoulder is 92.0%.

Day One:

The contractor begins paving at station 56+78 and ends the day at station 102+97, a total length of 4,619 feet. A quantity of 677 tons was placed on the eastbound traffic lane, and 169 tons was placed on the integral shoulder.

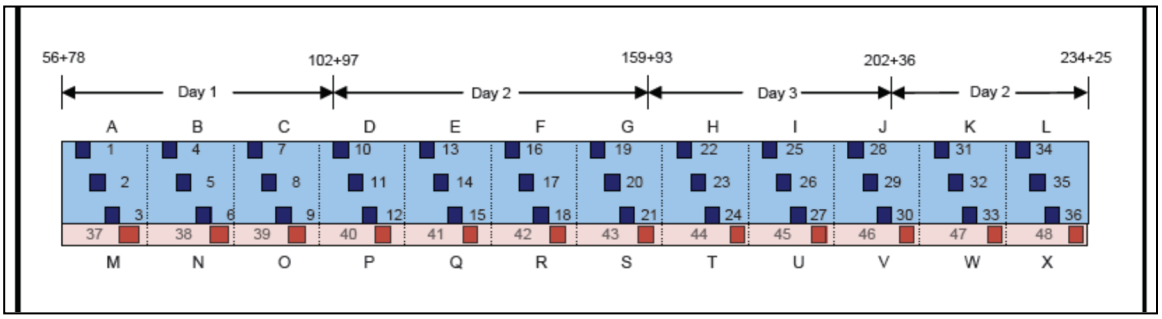
Day Two:

The contractor begins paving at station 102+97. Due to traffic staging requirements, the contractor stops paving at station 159+93, 5,696 feet, and begins paving again at station 202+36. They end the day at the end of the project, station 234+25, 3,189 additional feet. A quantity of 1303 tons was paved on the eastbound traffic lane, and 326 tons was placed on the integral shoulder.

Day Three:

The contractor begins paving at station 159+93 and ends the day at station 202+36, 4,243 feet. A total of 622 tons was placed on the eastbound traffic lane, and 156 tons was placed on the integral shoulder.

FIGURE 815-11 Linear Sublot Example Project



Example 2:

Use the example project information and the following test results from Day One. All of the day's air voids tests were acceptable (Density Calculated off the pcf value, sublot is the average of the density %)

Sublot ID	Test ID	% Density	Sublot Avg % Density
A 56+78 to 71+78	1	93.8	94.1
	2	94.2	
	3	94.4	
B 71+78 to 86+78	4	94.1	94.5
	5	94.7	
	6	94.6	
C 86+78 to 101+78	7	93.6	94.1
	8	94.5	
	9	94.3	

Sublot ID	Test ID	% Density	Sublot Avg % Density
M	37	93.2	93.2
N	38	94.2	94.2
O	39	93.0	93.0

1. Compute the average density for each traffic lane sublot and each shoulder sublot.
   SOLUTION: See the results in the table above.
2. Compute the density incentive or disincentive for the day's paving.
   SOLUTION:
   -Traffic Lane:
   The specified target density for the traffic lane is 93.0%. All of the sublot averages were no more than one percent below the target density, so all of the day's traffic lane test results are used to compute the daily lot density and the lot incentive pay.
   - Lot density = (93.8 + 94.2 + 94.4 + 94.1 + 94.7 + 94.6 + 93.6 + 94.5 + 94.3) / 9 tests = 94.2%

   According to standard spec 460.5.2.3, this lot density is eligible for incentive pay of $0.40 per ton. 677 tons of HMA was placed on the traffic lane on day 1, therefore the contractor receives $270.80 density incentive for the day 1 traffic lane lot. This is for all of sublot A, B & C and the 119' in sublot D that did not reach the random number.
   - Shoulder:

   The minimum required density is 92.0%. All of the sublot averages were acceptable, so all of the day's shoulder tests are used to compute the shoulder lot density. The average of all the shoulder tests is 93.5%. According to the specification, this lot density is eligible for incentive pay of $0.40 per ton. 169 tons of HMA was placed on the shoulder on day 1, therefore the contractor receives $67.60 density incentive for the day 1 shoulder lot.

Example 3:

Use the example project information and the following test results from day three. All of the day's air voids tests were acceptable.

Sublot ID	Test ID	% Density	Sublot Avg % Density
H 161+78 to 176+78	22	91.8	91.8
	23	91.9	
	24	91.7	
I 176+78 to 191+78	25	95.1	94.9
	26	94.8	
	27	94.9	
J 191+78 to 202+36	28	92.0	91.9
	29	91.8	
	30	91.9	
T	44	91.9	91.9
U	45	94.4	94.4
V	46	92.1	92.1

Compute the density incentive or disincentive for the day's paving.

SOLUTION:

1. Traffic Lane:

   According to the specification, a minimum density of 93% is required for the traffic lane. When verifying whether or not the sublot densities meet the requirements, it is found that sublot H and sublot J have average densities that are more than one percent below the required minimum. According to the specification, the quantities of HMA pavement and asphaltic material items placed this day in each of these sublots is subject to disincentive, and the day's test results within these sublots are not included when computing the incentive for the remainder of the lot.

2. Sublot H:

   Day 3 began inside the limits of sublot G, at station 159+93, but beyond its random test location. The tests for sublot G represent material placed on day 2. The tests in sublot H represent the day 3 material from station 159+93 to 176+78, total length of 1685 feet long (185' from sublot G, paved on day 3, and 1500' in sublot H) by 12 feet wide.

   Quantity represented by tests in sublot H =

   $$\frac{1685\ ft\ \times 12\ ft}{9\ ft^2/yd} \times \frac{2\ in\ \times 112\ lb/yd^2/in}{2000\ lb/ton} = 252\ tons$$

   According to the disincentive pay table in the specification, the quantities are subject to a pay factor equal to 95 percent of the contract price. This is equivalent to a 5 percent pay reduction.

   Disincentive Density HMA Pavement = 252 tons x ($41.75/ton x 0.05) = -$526.05

3. Sublot I:

   Quantity represented by tests in sublot I =

   $$\frac{1500\ ft\ \times 12\ ft}{9\ ft^2/yd} \times \frac{2\ in\ \times 112\ lb/yd^2/in}{2000\ lb/ton} = 224\ tons$$

   According to the incentive pay table, 224 tons of the HMA pavement item are eligible for an incentive of $0.80 per ton, or a total of $179.20.

4. Sublot J:

   Day 3 ended within the limits of sublot J, beyond its random test location. The day 3 quantity placed within sublot J, from station 191+78 to 202+36, at length of 1,058 feet, is represented by its tests. The day 2 quantity placed toward the end of sublot J is represented by the tests taken on day 2 within sublot K.

   Quantity represented by tests in sublot J =

   $$\frac{1058\ ft\ \times 12\ ft}{9\ ft^2/yd} \times \frac{2\ in\ \times 112\ lb/yd^2/in}{2000\ lb/ton} = 158\ tons$$

   According to the disincentive pay table in the specification, the quantities are subject to a pay factor equal to 95 percent of the contract price. This is equivalent to a 5 percent pay reduction.

   Disincentive Density HMA Pavement = 158 tons x ($41.75/ton x 0.05) = -$329.83

5. Shoulder:

   All of the day 3 shoulder sublots have acceptable density values, so we use all of the results to compute the day's shoulder lot density.

   Day 3 shoulder lot density = (91.9 + 94.4 + 92.1) / 3 tests = 92.8%

   The lot density of 92.8% is not more than 1.0% above the required minimum of 92.0%, therefore the day 3 shoulder pavement does not receive any density incentive.

Note: For shoulders paved integrally with the traffic lane see standard spec 460.5.2.3(3).

Day 3 Incentive/Disincentive Summary:

Incentive Density HMA Pavement (Lot I) = $179.20

Disincentive Density HMA Pavement (Lot H) = -$526.05

Disincentive Density HMA Pavement (Lot J) = -$329.83

815.16 Density Data Submittal

After verifying the contractor's data, the department calculates pay adjustments using the department's MRS software. The contractor must submit the required density test information electronically using the MRS software. The contractor should contact Atwood Systems to have the necessary software installed. Call toll free phone: (877) 518-1920 or email at: support@atwoodsystems.com

Note: Asphaltic Base test results are recorded and submitted on DOT forms, and not submitted to the MRS system.

SECTION 820 Independent Assurance Program

820.1 Scope

The Independent Assurance Program (IAP) is an important aspect of WisDOT's Quality Assurance Program. The goal of the IAP is to ensure that test data derived from project acceptance testing is reliable; this is accomplished by evaluating all active samplers and testers performing acceptance testing on WisDOT projects. Independent Assurance (IA) evaluations may include one or more of the following:

1. Split sample testing.
2. Proficiency sample testing.
3. Witnessing sampling and testing.
4. Test equipment calibration checks.
5. Reviewing contract-required data and available contractor process control information.
6. Requesting that testing personnel perform additional sampling and testing.

820.2 Federal Requirements

The department's IAP is federally mandated by FHWA via the Code of Federal Regulations (CFR), as per §637.207(a) from the 23 CFR 637:

> "Each STD's quality assurance program shall provide for an acceptance program and an independent assurance program…"

The IAP evaluations are to be handled without conflict or bias. 23 CFR 637 defines the IAP evaluations as follows:

> "Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program"

The IAP is mandated by the FHWA. The purpose is to confirm the reliability of the test results obtained in the acceptance sampling and testing program. This is accomplished by observing sampling and testing procedures, as well as obtaining split portions of acceptance samples. Split samples are tested using equipment and operators different from those used for acceptance testing. The test results are then compared to the acceptance test results. If these test results do not compare favorably, follow-up actions are taken to discover and correct the deficiencies.

IAP personnel will evaluate the sampling and testing personnel and equipment of both the contractor and the department. The program covers sampling procedures, testing procedures, and testing equipment. The testing equipment will be evaluated by calibration checks, split samples, or proficiency samples. Testing personnel will be evaluated by observation, review of the control charts and documentation, and split samples or proficiency samples.

FHWA requires states to have an independent assurance program for federal aid projects. The states develop their own program content using FHWA prescribed guidelines. FHWA concurrence with the IAP is necessary before implementation by the state. It is department policy to apply the program to all state funded projects except those specifically exempted.

Management of this program at the region level is the responsibility of the Independent Assurance Engineering specialist. In this function, the specialist is considered a representative of the Central Laboratory responsible to the BTS, Materials Management program engineer.

It is important that all IAP activities are completely independent of project management activities, though close cooperation between the two is essential. It is also particularly important that project personnel appreciate the importance of the IAP and cooperate fully to accomplish its intended purpose.

Specific detailed instruction and guides relative to the samples and tests undertaken in this program are not described here, since the instructions and guides are of primary concern to the Independent Assurance engineering specialist and have little value to project personnel. The region Independent Assurance specialist may be contacted to obtain copies of the WisDOT IAP.

SECTION 830 QMP - General

Standard spec references to concrete testing and sampling methods contained in this chapter:

Standard spec 701.2.5 .....equipment calibration

Standard spec 701.3 ..... random sampling

830.1 Scope

This section provides guidance to the contractor's quality control personnel and engineer's quality assurance and/or verification personnel for performing quality management functions required under the various WisDOT QMP provisions. The section provides references, procedures, and examples for inspection, sampling, testing, and documentation.

830.2 Quality Management Program

The primary goals of the QMP are to provide consistent construction quality, ensure effective use of personnel, and maintain cooperation throughout all phases of the work. The foundation of the concept is to develop partnerships so that the exchange of information becomes commonplace. Working together will be enhanced if all participants communicate openly, honestly, and with respect for each other.

Before construction, the contract parties (contractor and engineer) should discuss the work included under the QMP provisions. Questions regarding QMP work should either be resolved, or the mechanisms should be in place to resolve issues before the work begins.

830.3 Highway Technician Certification Program (HTCP)

The Highway Technician Certification Program (HTCP) is offered through the University of Wisconsin-Platteville, in association with the WisDOT. The QMP provisions require sampling and testing of material to be performed by a HTCP certified person. The HTCP, in consultation with WisDOT and industry, provides instruction and certifies that individuals have demonstrated the ability to perform quality management activities required for highway work contracted by WisDOT.

Some of the QMP provisions allow for an Assistant Certified Technician (ACT) to help conduct sampling, testing, and documentation. An ACT must successfully complete the ACT course and be registered by the department as an ACT before performing QMP sampling and testing. The ACT course and registration is administered through the HTCP. The director of the HTCP is responsible for the activities of the program. To receive information about the program, contact Jodi Pluemer, HTCP Director, at the following address:

University of Wisconsin - Platteville
49 Ottensman Hall
Platteville, WI, 53818-3099
phone: (608) 342-1545

or check out the website at:

https://www.uwplatt.edu/department/highway-technician-certification-program

830.4 Verification and Quality Assurance

Quality verification (QV) and/or quality assurance (QA) will be provided by the department. The engineer has responsibility for contract administration, including final record keeping and acceptance of the materials provided by the contractor.

The department QV and/or QA testing and data analysis will be performed by a certified technician or an assistant certified technician (ACT) under the direct supervision of a certified technician. Certification will be by HTCP, see CMM 830.3.

Verification sampling and testing will be performed by a department representative to validate the quality of the product. Verification testing will be performed on samples that are taken independently of the quality control samples. These samples will be collected in accordance with the QMP provision. The verification personnel will also monitor the contractor control charts.

Quality assurance will be performed by a department representative. Quality assurance will be performed by testing quality control split samples, by observing sampling and testing performed by the contractor, by monitoring required contractor control charts, and by directing the contractor to take additional samples for quality assurance testing. Quality assurance data will supersede contractor tests when the contractor data has been proven to be incorrect.

830.5 Contractor Quality Control

The contractor will provide quality control (QC) personnel for the project to ensure production of quality products. As specified, personnel must be provided for process control inspection, sampling, testing, documentation, and adjustments of the production and/or placement of the associated material. An

appropriate number of persons must be provided to perform the work in a timely manner. The personnel must be certified at the level required by the contract. Certification of all technicians must be by the department's Highway Technician Certification Program. The contractor is responsible for the recognition of obvious defects and timely correction. The contractor should have skilled personnel able to make corrective action decisions when materials deviate from specification requirements.

830.5.1 Contractor Quality Control Plan

A quality control plan is required with some of the WisDOT QMP provisions. The purpose of the QC Plan is to explain how the contractor intends to control the equipment, materials, and processes to ensure the product is consistently within the specification limits. The plan should be flexible enough to allow for innovation and improvements during the course of the work.

The plan should outline the contractor's material and construction control processes. It provides the engineer with assurance that the contractor has the ability to properly control and monitor the quality of the product.

830.5.2 Contractor Quality Control Plan - Aggregates

A quality control plan is required by this provision. The plan should outline the contractor's material and construction control processes. It provides the engineer with assurance that the contractor has the ability to properly control and monitor the quality of the product. Items that should be considered for inclusion in the quality control plan are:

1. A list of QC personnel including certification status. The list must include names and phone numbers of all individuals responsible for QC work and an organization chart showing lines of authority. Alternates should be identified.
2. A list of sources for all aggregate materials that will be used for the project that requires QC sampling and testing. This does not replace the Source of Materials report normally submitted to the engineer by the contractor; however, the information reported here may be taken from the Source of Materials report.
3. The pertinent Aggregate Quality Test results for the aggregate that will be included in the project that requires QC sampling and testing. This must include wear, soundness, specific gravity, absorption, liquid limit, and plasticity index.
4. A description of the plant location(s) and provisions for stockpiling and/or hauling the material.
5. The location of the QC laboratory. Include the location(s) and a description of where any retained samples are to be stored.
6. Evidence of inspection or certification, and calibration records of all test equipment used for QC purposes. All equipment must be in proper condition for use according to specifications before the work begins.
7. The posting location of control charts and other documentation (test records).
8. An outline of process control inspection activities for the plant(s) (include weighing, batching, mixing equipment), various materials handling processes, material supplies and laboratory (equipment for sampling and testing).
    1. A list of proposed inspection to be conducted.
    2. The frequencies of inspection including changes for certain operations (start-up, process changes, adjustments, material changes).
    3. A description of the documentation that will be generated and where it will be filed.
9. An outline of process control sampling and testing activities to be conducted according to requirements of the specifications. Include:
    - A list of the tests the contractor proposes to conduct including any not in the specifications.
    - The sampling and testing frequencies and any specifics regarding sampling associated with the work if different from the specifications.
    - A description of the documentation process. Include where documentation will be filed and how often documents will be presented to the engineer.
10. An outline of the process adjustments that may be made to control quality.
    - A list of some typical adjustments in the process and general description of the conditions needed to cause the adjustments to be made.
    - A description of the documentation process including the items to be recorded.
11. An outline of the processes of communication by which QC information will be disseminated to the appropriate persons. The outline should include a list of recipients, the means of communication that will be used, and action time.
12. An outline of the mechanism to be followed in resolving a process control problem. Include:
    - Identification of the problem (i.e., observation of obviously defective material, observation of obviously defective work, equipment malfunction, test data in the warning band, test data outside the control limits, etc.).

- An outline of typical steps to be taken to resolve the identified process problems and identification of who will perform each step. Present example(s).

830.6 Quality Control Laboratory and Equipment

830.6.1 Laboratory

The contractor must furnish and maintain a department-qualified laboratory as specified in the QMP provision. A qualified laboratory is required for all testing performed for acceptance of a product. Information on the Wisconsin Laboratory Qualification Program may be obtained from:

Wisconsin Department of Transportation
Truax Center, 3502 Kinsman Blvd.
Madison, Wisconsin 53704
telephone: (608) 246-5388

or on the internet at:

https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/appr-prod/qual-labs.aspx

The laboratory should be set-up before the work starts. Set-up includes checking the adequacy of the water supply, connecting electrical power and telephones, and checking and calibrating laboratory equipment.

830.6.2 Equipment

Sampling and testing technicians must have the necessary equipment and supplies available to perform quality control testing under the contract. Equipment should be properly maintained. If any equipment becomes defective during the course of the work, the contractor needs to repair or replace it.

The contractor must maintain a record of calibration results at the laboratory or with the equipment. Equipment calibration must be performed according to the calibration requirements of the AASHTO or WisDOT test procedures for which the equipment is used. Questions regarding calibration requirements should be resolved with the engineer before the start of production.

830.7 Quality Control Start Up Activities

The QC personnel should meet with the WisDOT QA and/or QV personnel before the start of project sampling and testing. Plans should be made to review sampling and testing processes, and the schedules for production. General information should be exchanged to establish proper communications on the project.

Before the start of production, the QC personnel should perform preliminary inspections of the materials and storage; set-up, check operation, and calibrate laboratory equipment; and set-up the required QC charts needed for the project.

830.8 Inspection

The contractor should inspect key construction processes on a regular schedule to ensure that all required equipment and materials are available on the job and the equipment is adequately maintained. The contractor is encouraged to develop check sheets for the routine inspections that will be performed. These sheets should be dated and initialed by the individual(s) performing the inspection(s).

Suggested inspections should include, but are not limited to, the following:

- Aggregate stockpiles
- Materials storage
- Plant(s)
- Hauling trucks
- Laboratory sampling and testing equipment and tools

830.9 Sampling and Testing

830.9.1 General

The contractor QC personnel must conduct sampling and testing at the frequencies outlined in the contract. The specified sampling and testing frequencies are the minimum required for the project. The contractor may conduct increased sampling and testing at any time to supplement the specified work.

The QC test results are used to ensure material compliance with the specifications. One sampling method should be adhered to throughout the work to facilitate data comparisons for the project. The contractor must respond to failing tests by modifying production operations to achieve specification conformance.

830.9.2 Random Sampling

The QMP special provisions often require the contractor to test randomly selected samples. The intention of random sampling is to eliminate bias in the sample selection process. The standard method

recommended for selecting random sample locations is ASTM D3665, Standard Practice for Random Sampling of Construction Materials. Random numbers may be selected by following the instructions of the ASTM, using a calculator with a random number generator, or another common method of selecting random numbers acceptable to the engineer.

Random sample locations are required to be selected by a certified technician. To fully ensure the selection of samples is random, the information should only be shared with those who need it. At a minimum, the contractor must provide the random numbers and sample locations to the engineer before placing material. Operator(s) must not be advised in advance as to when samples are to be taken. Collusion between the QC personnel and production or placement operator(s), in this regard, will be cause for removal of the QC technician from the project.

For sample location selection, the QC technician should develop, in advance, the sampling schedule for the work. At the beginning of each day the contractor should inform the QC technician of the intended material production or placement for the day. Based on this estimate, the technician can determine the required number of sublots according to the contract sampling frequencies and determine a random sample location for each sublot. Sample locations may be defined in terms of quantity, position on the grade, or another appropriate transformation of the sampling frequencies the contract defines.

For placement sampling, the sample locations based on quantity can be converted to correspond to project stationing. Then, if samples are being collected of an in-place material, a random number should be used to determine a baseline offset or transverse location at the chosen station.

The following examples further describe the random sampling methods during production and placement.

Example 1: Base Course Production Sampling

At the initial production of a base aggregate, a contractor plans to produce 3900 tons of base course in an 8 hour day.

From the QMP Base special provision, during initial production, a minimum of 1 sample per 1500 tons is required.

The QC technician would first determine the number of sublots required for the day by dividing the estimate of the daily production by the maximum sublot quantity.

3900 tons/ 1500 tons = 2.6 sublots, round to 3 sublots

The sample location of each in each sublot must be determined by selecting a random number for the sublot. The random number is then multiplied by the quantity of material in each sublot. This quantity must then be added to the final quantity of the previous sublot to yield the approximate total quantity of when the samples are to be taken. These quantity sample locations can be divided by the anticipated rate of production to determine the approximate time after start up of when these samples might be collected. Collection, however, should be based on the actual tonnage produced, not on the production rate estimate. The calculations for this process follow:

Sample	Quantity Range (tons)	Random Number	Sublot Sample Point	+ Tons in Prior Sublot	Sampling Point	Production Rate	Approximate Time
1	0-1500	X 0.569	= 854	+ 0	= 854	/ 490	1 hr. 45 min.
2	1501-3000	X 0.335	= 503	+ 1500	= 2003	/ 490	4 hr. 05 min.
3	3001-3900	X 0.802	= 722	+ 3000	= 3722	/ 490	7 hr. 36 min.

This procedure is used for any number of samples selected randomly per day. Field staff can calculate and record the random sample site locations on form WS3011, Production Sample Locations. An example is provided in figure 830-1.

FIGURE 830-1 Example Production Sample Locations, Form WS3011

PRODUCTION SAMPLE LOCATIONS		
PROJECT DESCRIPTION		GENERAL INFORMATION
Project ID.	Contract	Matrerial Source
Highway	County	Material (Type, Grade, Etc.)
Description		Tester:
Contractor		

Date/ Start Time/ Est. Prod. (tons)	Sample Number	Sublot Size (tons)	Random Number	Sublot Sample Point (tons)	Sublot Prior Sublots (tons)	Sublot Sample Point (tons)	Estimated Production Rate (tons/hr)	Approx. Time Interval (hours)	Approx. Sample Time (hour:minute)	Actual Production Rate (tons/hr)	Comments
3/3/99	33P-1	1500	0.596	894	0	894	450	1.99	9:00 AM	480	
7:00 AM	33P-2	1500	0.491	737	1500	2237	480	4.66	11:00 AM	475	
4500	33P-3	1500	0.93	1395	3000	4395	475				Crusher breakdown 2pm, no
											sample taken.
3/4/99	34P-4	1200	0.262	314	0	314	480	0.65	7:40 AM	480	
7:00 AM	34P-5	1200	0.135	162	1200	1362	480	2.84	9:50 AM	470	
4800	34P-6	1200	0.383	460	2400	2860	470	6.09	1:05 PM	470	
	34P-7	1200	0.943	1131	3600	3731	470	7.94	2:55 PM		
3/5/99	35P-8	1200	0.37	444	0	444	470	0.94	7:55 AM	475	
7:00 AM	35P-9	1200	0.367	441	1200	1641	475	3.45	10:27 AM		3 consecutive 4 pt. ave. in WL;
4700	35P-10	1200	0.619	743	2400	3143					therefore, move to 1 test/day
	35P-11	1200	0.334	401	3600	4001					

Example 2: Base Course Placement Sampling

Form WS3013, or a similar sheet, should be used to calculate and record the random sample locations for base course placement. Figure 830-2 illustrates use of this sheet.

FIGURE 830-2 Example Placement Sample Locations, Form WS3013

WS3013 PLACEMENT TEST SITE SAMPLE LOCATIONS

PROJECT DESCRIPTION		GENERAL INFORMATION	
Project ID.	Contract	Material Source:	Placement Width:
Highway	County	Material (Type, Grade, Etc.):	Material Density:
Description		Tester:	Placement thickness:
Contractor		Project Length:	Placement (ton/sta):

Date/ Est. Placement	Sample Number	Sublot Size (tons)	Beginning Sublot Station	Sublot Length	Random Number	Sublot Sample Point	Sublot Sample Station	Random Number	Sample Offset	Comments
5/1/1998	51S-1	2000	100+00	50+00	0.256	1280	112+80	0.966	34.8	2 tests required for > 3000 T placed, ets. Placement
4000 T	51S-2	2000	150+00	50+00	0.148	740	157+40	0.346	12.5	is 4000 T; therefore 2 samples at 2000 T sublots.
5/2/1998	52S-3	2500	200+00	62+00	0.613	4766	247+66	0.715	25.7	2 tests required for > 3000 T placed, ets. Placement
5000 T	52S-4	2500	262+50	62+00	0.763	4769	310+19	0.297	10.7	is 5000 T; therefore 2 samples at 2500 T sublots.

Quantity / Length = (Density)x(Width)x(Thickness)

Example 3: Placement with Baseline Offset Sampling

For determining a station/offset sample location for sampling in-place base course, a random sample station is first chosen as defined in the previous section. Next a random offset distance, from a field alignment base line, is determined. For this example, assume the width is 36 feet. The random number 0.683 is chosen. The offset from the base line (either side, but stay constant throughout the contract) is 36 X 0.683 = 25 feet rounded to nearest foot.

If the base course layer is too thick for placement in one lift, then separate sampling is required of each lift. Base course samples should be taken from full depth areas of the base course layer (shoulder point to shoulder point).

830.9.3 Retained Samples

QC personnel may need to retain split or companion samples of material for quality assurance, independent assurance testing, or dispute resolution as specified in the contract. As soon as samples have been portioned for QC and department testing, the samples are required to be identified properly with a suitable identification tag. Tags should include the following:

- WisDOT project I.D. number
- Highway designation
- County
- Highway project limits
- Contractor
- Sample number
- Date and time sampled
- Material source, type & grade
- Sample location (Tonnage at point of sampling, station number, offset & layer, etc.)
- Name of sampler

- Other pertinent test results

The identification tag must stay with the sample until the sample is discarded. Markings on the tags should be permanent. Samples are to be stored in a protected location for the time period required by the contract.

830.9.4 Additional Samples

The QMP provisions provide for the engineer to direct the contractor (QC personnel) to take additional samples. The additional sampling may be requested to observe the QC technician's sampling and/or testing technique or to evaluate questionable materials identified by the engineer. The test results from additional samples should be plotted on the control chart as a non-random test and not included in the running average (except for QMP, Asphaltic Mixture tests conducted by the contractor are included in the running average).

Specified sampling and testing frequencies are minimums. The contractor may increase frequencies, but must communicate those increases to the engineer.

830.9.5 Process Control Adjustments

The contractor is responsible for making process adjustments to control or to improve the quality of the product. Some adjustments are made out of necessity, such as when a problem exists and an immediate reaction by the contractor is necessary. Other adjustments may be made to fine-tune the process. In all cases, the contractor should advise the engineer of adjustments along with pertinent information concerning the changes made.

830.9.6 Documentation

The contractor is required by the QMP provision to document all quality control work for the project by providing and maintaining written records and control charts. The full name (first and last) of the qualified sampler and/or tester and the qualified lab location must be on the individual sample test property worksheets.

When the project is complete, the contractor records for the work must be furnished to the engineer in a neat and organized manner. These records will become part of the final project records. It should be assumed by those preparing them that the records must withstand any review or analysis in future years.

The contractor is encouraged to use computer programs to handle recording and analysis of the process control data. In addition to saving a great deal of time, concern about errors through data transfer will be eliminated. WisDOT will work with the contractor to accomplish computer uses. Use of portable personal computers will allow technicians to input sampling and testing data directly in the field. Data may then be submitted electronically instead of paper copies. However, the original "source" documents should be maintained in the project records. If the data is entered directly into an electronic document, then that is acceptable as the source document. If the original document is handwritten and then transferred to an electronic document, the original handwritten document should be maintained as the "source" document.

When supplying the original "source" document, a scanned copy is acceptable.

830.9.6.1 Records

The contractor must record observations, inspections, adjustments, and test results according to the QMP provision. Recording should be done in a timely manner, preferably upon occurrence of the activity. The information should be reported in a permanent field record book.

The records should contain sufficient detail to sustain an audit and be clear enough to be read and understood by persons not associated with the project. Emphasis should be placed on neatness. Computation records should be clear, precise, accurate, and complete. Computations should be initialed and checked. The records should also include documentation of significant conversations of project personnel, meetings, disputes, and subsequent decisions.

830.9.6.2 Control Charts

Control charts are graphs that depict the variation of a measured characteristic with time. Standardized control charts should be maintained by the contractor QC staff at a location agreed upon by the contractor and engineer, typically the field office. If quality control testing is being performed at more than one site for the material, the QMP provisions require separate control charts for each site.

Control charts include both upper and lower control limits and upper and lower warning limits as appropriate. The area between the control limit and warning limit is the warning band.

Individual test results obtained by the contractor are required to be recorded on the control charts as soon as possible on the same day the tests are run. The department results should be posted as soon as the data is available.

Control charts should contain pertinent identification information as well as the plotted data. In addition to the individual contractor QC and engineer QA or QV & IAP test points a running average of the four latest QC data points must be plotted.

The following control chart legend is used throughout the control chart examples in this manual:

Upper control limit (JMF limit) = UCL

Upper warning limit = UWL

Upper warning band = UWB

Lower control limit (JMF limit) = LCL

Lower warning limit = LWL

Lower warning band = LWB

QC Individual Test Result ..... λ

QC Running Average of 4 ..... Δ

QC Non-Random Test ..... O

QA or Verification Individual Test Result X

Independent Assurance Test Result..... Φ

This example illustrates a typical method for computing the 4-point running average values and plotting the individual and 4 point running average test results. The example utilizes aggregate gradation data for the 3/8-inch sieve fraction.

TABLE 830-1 Aggregate Gradation Control Chart, 3/8" Sieve

Test Number	Test % Pass 3/8"	Sum of Last 4 Values	Average of Last 4 Values, % Pass 3/8"
1	60	--	--
2	62	--	--
3	61	--	--
4	64	247	62
5	62	249	62
6	58	245	61
7	57	241	60
8	60	237	59
9	62	237	59
10	65	244	61

The control limits (specification limits) are 40 and 75%. The upper and lower warning limits (two percentage point warning band inside the control limits) are 42 and 73% respectively as defined by the QMP provision.

Ideally, test results should be near the specification mid-points. This will best ensure that the contractor will avoid exceeding the specified limits. Operating near the limits represents an insecure situation for the contractor.

830.10 Corrective Action

Control charts provide a means for the contractor to identify when corrections should be made in the process. Process trends can be more easily recognized by plotting the test result data. The test result plots, particularly those for the running average values, show trends as they develop. As the running average approaches the limits, the contractor should assess his/her options and correct the process.

The data plots will not identify the source of the process variability. When a contractor investigates an undesirable trend, it may be determined that something (an assignable cause) happened in the process that caused the trend. For example, when a hole develops in a sieve and increases in size with use, the sieve should be found and replaced with a suitable sieve before the process advanced to a point where test results would be out of specification.

Control charts can provide an early detection system for identifying potential trouble spots for the contractor. The contractor should review control charts regularly to stay on top of the production process. The prudent contractor and QC staff will watch the data trend and take corrective action as soon as test data confirms something is not right in the process.

Corrective actions are required to always be documented. The corrective action undertaken may be to inspect laboratory equipment, inspect plant or placement equipment, adjust in the process, change materials or equipment, or a combination of these actions. When adjustments are made, an increase in the frequency of sampling and testing may be required to ensure the adjustments were adequate. In addition to documenting corrective actions, resulting effects of the corrective actions should be recorded.

The QMP provisions suggest the contractor consider corrective action when the running average is towards a warning limit. Corrective action is required when two consecutive running average points exceed a warning limit. In addition, most of the QMP provisions require action when an individual test result exceeds a control limit. The specific provision that is being used should be reviewed to determine when and what action is required for situations when test results exceed a specification limit and to assess the effectiveness of corrective action.

830.11 Testing Precision

The QMP provisions specify allowable differences between engineer and contractor test results. The contractor should be aware of these differences and the importance that QC test results be comparable to the department test results. Furthermore, the contractor should be aware that if test comparisons exceed allowable differences, the engineer will investigate the reason immediately. The contractor should want to make every effort to ensure his/her operations, equipment, and procedures are correct.

830.12 Dispute Resolution

The QMP provisions present methods for resolution of disputes through referee laboratory testing if the contractor and engineer cannot resolve a test result and/or procedure difference.

830.13 Contractor Non-Performance of QMP Sampling & Testing

It is the contractor's responsibility to perform the quality control work according to the specification. With the QMP specifications, the contractor's quality control (QC) test results and documentation serve as the primary means for determining if materials conform to the specifications, and for calculating pay adjustments.

It is the project engineering team's responsibility to monitor the contractor's quality control program (QC). As the work is being performed, the engineer should monitor the contractor's sampling, testing, and documentation. To monitor test results, the engineer should request that the QC technician post documentation (control charts and or test summary reports) in a location easily accessible to the engineer. Electronic transfer or faxing of information is an option. With fax transfers, the engineer should keep in mind the amount of time and paper that this requires. The engineer should routinely monitor the test documentation to ensure that the contractor is properly performing under the specification.

The primary objective of both the contractor and engineer is to work together to ensure compliance with QMP sampling and testing requirements.

For contractor QMP non-performance, the engineer should notify the contractor early to address the problem. If the contractor responds immediately and is able to correct the non-performance issue, no further action may be necessary. If non-performance continues, the engineer should consider one or more of the following options, but may use other alternatives:

1. Suspend or delay contract operations as provided in standard spec 105.
2. Withhold payment of the material bid item not properly sampled and/or tested until the contractor supplies adequate pre-placement or in-place test results or demonstrates material compliance in a manner acceptable to the engineer. The engineer must document the approved acceptance or require removal and replacement of the material. The engineer's acceptance may lead to a price adjustment for the improperly tested or untested material. If the contractor demonstrates material compliance in a manner acceptable to the engineer, a price adjustment for the material is not necessary.
3. Administer a pay reduction using the Non-performance of QMP administrative item.

Table 830-2 presents guidelines to address QMP non-performance problems. The engineer should carefully evaluate each problem situation encountered in order to determine the applicability of these guidelines.

TABLE 830-2 General QMP - QC Testing Problems Encountered

Problem Encountered	Action Taken
Non-random tests. Moving of test location.	Administer a pay reduction using the Non-performance of QMP administrative item, based on historical costs of QMP sampling and testing or the contractor's documented costs. Require resampling and testing of the material in a random location. If random sampling cannot be done, deduct 10% of the material bid item price for the amount of material represented and allowed to remain in-place.
Improper: Sampling, testing, or documentation methods. Testing equipment.	Require resampling and testing using proper methods. If retesting cannot be done, administer a pay reduction equal to 10-100% of testing costs using the Non-performance of QMP administrative item, based on historical costs of QMP sampling and testing or the contractor's documented costs. Also, deduct 10 -50% of the material bid item price for the amount of material represented and allowed to remain in-place.
Calculation error.	Correct the calculation. Address nonconforming material separately.
Tester not certified. ACT certified w/o direct supervision. Laboratory not qualified. Too few tests. Tester not present.	Administer a pay reduction using the Non-performance of QMP administrative item, based on historical costs of QMP sampling and testing or the contractor's documented costs. Require resampling and testing using a certified tester and a qualified laboratory. If retesting cannot be done, deduct 10 -50% of the material bid item price for the amount of material represented and allowed to remain in-place.
No tests.	Administer a pay reduction using the Non-performance of QMP administrative item, based on historical costs of QMP sampling and testing or the contractor's documented costs. Require removal and replacement of the material unless the contractor can demonstrate, in a manner acceptable to the engineer, that the material complies with the specification. If compliance cannot be demonstrated and the engineer allows the material to remain in-place, deduct 50% of the represented material bid item.

Note: Where a price deduction range is given in the preceding guidelines, the engineer should take into account the severity of the non-conformance when choosing the deduction.

- The upper limit of the materials cost deduction is shown at 50% of the item price, since the materials cost can often be about 50% of the bid item cost. For some bid items the materials costs can be significantly less. For the more severe cases, the engineer should consider deducting the total cost of the materials for the bid item.

  For re-sampling and testing, the contractor must demonstrate the material compliance using a method acceptable to the engineer.

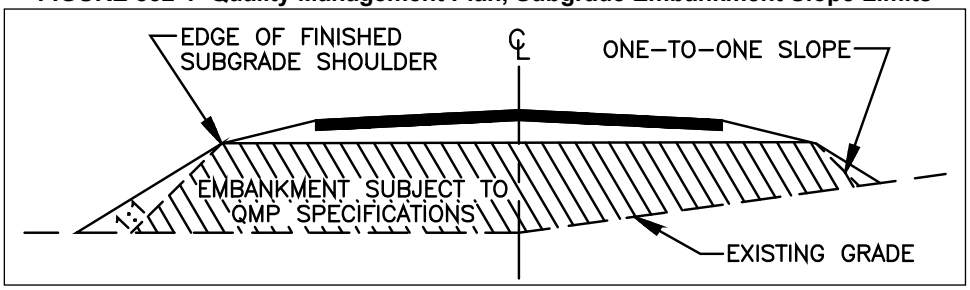
SECTION 832 QMP - Subgrade

832.1 Quality Management Plan Description

Quality Control (QC) includes all activities in the subgrade construction including process control inspection, sampling, testing, recording, and adjustments in the process. QC for the project will be understood to cover all subgrade construction on the mainline within the limits of the assumed one-to-one slopes extending outward and downward from the outer limits of the finished subgrade shoulder lines (see figure 832-1). This will include all embankment fills, backfill of excavations below subgrade (EBS), structure or utility backfill, and the recompaction of the subgrade in cut areas.

The individual performing all the QC activities must be certified by HTCP and have the Grading Technician I certification. An individual holding a Nuclear Density Gauge Operator certification will perform all moisture density testing. Fill materials placed outside the assumed slopes of the mainline project including side roads, frontage roads, and driveways will not apply to the Quality Management Plan (QMP). Fills outside the mainline will be placed in accordance with standard spec 207.3.6.1.

FIGURE 832-1 Quality Management Plan, Subgrade Embankment Slope Limits



The contract parties (contractor and engineer) will agree on the portions of subgrade work on the project to be included under the QMP. This agreement should be reached and documented at the project preconstruction conference. Questions regarding QMP work on the project should be either resolved at this conference, or the mechanics will be in-place to resolve issues before the work begins.

832.2 Contract Quality Control Plan

The contractor is required by the QMP subgrade special provision to provide the engineer with a written QC plan. The plan is to explain how the contractor proposes to control the equipment, materials, and processes to ensure the specified product is obtained. The contractor will be expected to respond to failing tests through increased testing, modification of the operation, or other appropriate action. All pertinent items in standard spec 205 and standard spec 207 will be covered in the plan but tailored to meet specific needs of the project. Construction of subgrade will not begin until the engineer accepts the plan.

The contractor will agree to consider appropriate changes to the QC plan as requested by the engineer to ensure proper quality. Mutually agreed subsequent amendments then become part of the plan.

832.3 Soil Source Study

The contractor will conduct a soil source study before the beginning of grading operations. The soil source study will identify and test the significant soil types that will be used as fill material on the project. The maximum density and corresponding optimum moisture level will be determined for each soil type. A site-specific family of Proctor curves will be developed from the completed soil source study to be used in determining the compaction compliance on the project.

To perform the soil source study, the contractor will review the soil borings and geotechnical report prepared by the department for the project. The contractor's QC personnel will determine, based on the project's soil borings and any additional soil explorations performed by the contractor, which significant soil types from the cut areas or borrow sources should be sampled for laboratory testing. Consultation with the department's geotechnical section and the region material section in determining which soils to include in the soil source study is recommended.

The contractor will perform test pit excavations to obtain representative samples of the soil types for laboratory testing, using the geotechnical report as a guide in locating the significant soil types. An expanded exploration plan of test pit excavations by the contractor is encouraged to identify any soil types that were not encountered in the department's soil borings.

Due to the limitations of the backhoe excavation equipment, the contractor is only required to perform the initial soil source study in the top 15' of the deep cut and borrow areas. The initial soil source study must be completed and approved by the engineer before any site grading. The contractor is required to expand

the soil source study in those deep cut and borrow areas (greater than 15') as those areas become accessible during the site grading. The laboratory testing for any additional soil types encountered during site grading must be completed and approved by the engineer before placement of that fill material. The contractor is encouraged to closely monitor the cut and borrow areas for changes in soil types, to prevent any delays due to laboratory testing.

The contractor will obtain a sufficient amount of material for each specified soil type to split into two laboratory samples of approximately 50 lbs. each. The material will be split by quartering or with a riffle splitter similar to the method described in WTM R76 and CMM 860. Each sample will be labeled by the contractor with the contract number, date sampled, sample number, and location.

The department's samples must be promptly delivered to the department at:

Mr. Tirupan Mandal
3502 Kinsman Blvd
Madison, Wisconsin 53704

or to other locations as directed by the engineer for possible quality assurance testing.

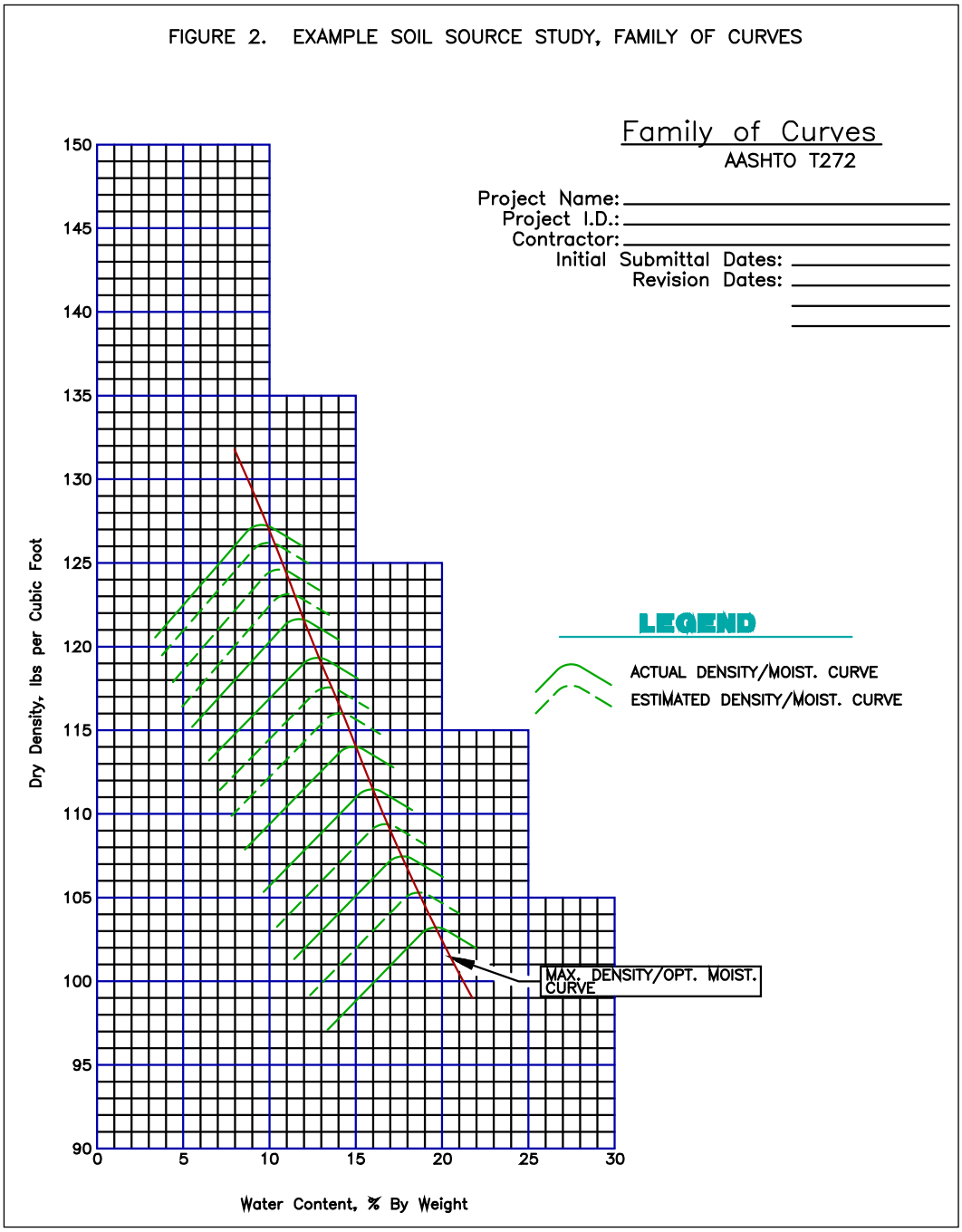
If the samples are sent to 3502 Kinsman Blvd. in Madison, it's recommended to you contact Mr. Tirupan Mandal at phone (608) 246-5320 in advance to assist in scheduling priorities. The department will complete the quality assurance comparison tests on the soil source study samples within seven working days after the department has received the samples.

The contractor will also retain a sealed, jar size sample (8 oz minimum) of each soil type selected, at its natural moisture content, for use in identifying the soil types during the site grading.

The contractor will perform a moisture-density (Proctor) curve and characterization tests as listed in the special provision for each soil type. A site-specific family of Proctor curves will be developed from the completed soil source study and be submitted to the engineer for review and approval. An example of a family of Proctor curves is illustrated in figure 832-2. The soil source study submittal will also include the natural moisture content of each soil type selected for the study. Those natural water contents that exceed the moisture control limit for the project will be identified as materials that will likely require drying during placement.

Determine the moisture-density relation of soil according to WTP T99.

FIGURE 832-2 Example Soil Source Study, Family of Curves



832.4 Excavations Below Subgrade

832.4.1 General

Excavations below subgrade (EBS) due to poor soil conditions will be determined by the engineer, with assistance from the contractor's QC personnel. The contractor will notify the engineer for direction if unstable subgrade soil conditions are encountered.

With the soils evaluation associated with the soil source study and the monitoring of the grading operations, the contractor's QC personnel will have an intimate knowledge of the site's soil conditions. This specific site soil knowledge should be a benefit in predicting and identifying areas of the site that may require EBS. The contractor's QC personnel should work closely with the engineer in identifying potential subgrade problems so as to expedite any correction of the subgrade soils that may be required.

Excavations below subgrade will be backfilled in accordance with the special provision unless otherwise directed by the engineer.

832.4.2 Guidelines Predicting EBS Areas

EBS should be anticipated if one or more of the following conditions are present:

- Normal groundwater levels are 3 feet or less from the surface.
- Soils have a silty "B" horizon (layer below the topsoil).
- Normal topsoil depths exceed 12 inches.
- Natural soil moisture levels are above the plastic limit and are approaching the liquid limit.
- Soils are of relatively recent alluvial origin.
- The existing roadway was constructed before 1940.
- Extensive filling has occurred in the general area (urban areas).
- The existing roadway shows signs of distress such as patches, cracks, alligatored surface, localized rutting, or subsidence.
- Pedological soils descriptions or on-site investigations indicate the presence of silt pockets or layers, wet sand layers, or highly variable soil conditions.
- The finished subgrade is within 2 feet of the original ground surface.

832.5 Field Density/Moisture Control Testing

The contractor's QC personnel must perform subgrade construction monitoring, testing, and field sampling to ensure contract compliance. The QC personnel must be on site during all grading operations performed under the QMP grading plan. The QC personnel must test for density and moisture of subgrade fill construction, where specified, within the established limits of the QMP. Monitoring of the subgrade construction should include documentation of the contractor's procedures for subgrade preparation and embankment fills. Testing and sampling of the subgrade materials must be performed in accordance with the procedures and at the frequencies stated in the special provisions.

832.5.1 Field Density/Moisture Testing

Fill placed during subgrade construction must be tested for density and moisture, where specified, using a nuclear density/moisture gauge in accordance with WTM T310.

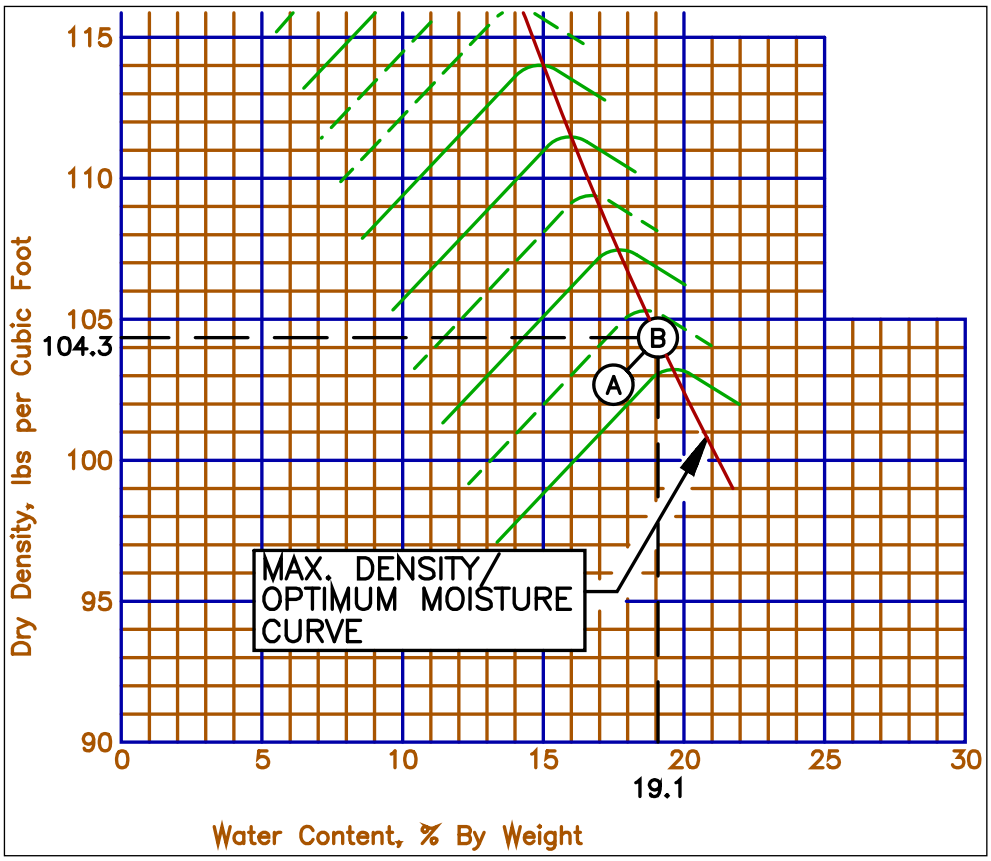
To determine the percent compaction and the percent of optimum moisture, the fill material from each field density/moisture test should be related to one of the specific soil types identified in the soil source study. Textural identification of the specific fill material for each test will be the primary method of estimating which maximum density curve from the soil source study to use in determining the percent compaction and percent of optimum moisture. A detailed description of the textural identification procedure is presented in ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

To aid in the visual and textural identification, a sample must be retained, at its natural moisture content, of each of the soil types included in the soil source study. The QC personnel can then refer to this library of soil samples when selecting the appropriate maximum density-optimum moisture curve.

As a check in determining the correct soil type, the QC personnel is required to obtain a representative sample of the fill material at every third randomly selected field density test location. This sample must be tested in accordance with WTM T99 and AASHTO T-272, Family of Curves - One-Point Method, Method A or C (one-point Proctor test). The one-point Proctor test result will be compared to the curves developed in the soils source study to determine the maximum density and optimum moisture applicable to the field density test. The appendix for AASHTO T-272 will be used as a guide in this determination.

Figure 832-3 illustrates how to select the maximum density and optimum moisture using the family of curves and the one-point Proctor value. The one-point Proctor test results will be recorded on the Nuclear Soil Testing Record (see example on figure 832-4). The results of the one-point Proctor test should be used to determine the percent compaction and percent of optimum moisture for the field test from which the one-point Proctor sample was retained. The contractor should retain a split sample of the material selected for the one-point Proctor test for 14 days for quality assurance comparison testing, unless released sooner by the engineer.

FIGURE 832-3 Plotting the One-Point Test Result



Example 1

Point A is a plot of the One-Point Proctor test results (102.7 lb./cf. dry density at 17.5% moisture). A line is drawn parallel to the nearest Proctor curve from point A to the Maximum Density/Optimum Moisture curve (Point B). The coordinates of point B (104.3 lb./cf. dry density and 19.1% moisture content) are the maximum dry density and the optimum moisture used for determining the percent compaction of the field density test represented by the One-Point Proctor test.

The contractor may conduct additional testing at any time to supplement the specified work. The specific frequencies represent the minimum testing for the project. However, only test results from randomly selected locations can be used for computing running average values for control charts. Therefore, test results generated by testing at the discretion of the contractor, while recommended and considered meaningful, will be for the contractor's information and process control use only.

The QC personnel should document the test data and locations for all randomly selected tests. The documentation will include the nuclear density/moisture meter test readings, test locations, and test elevations. Elevations are to be accurate to + 0.5 feet based on hand level readings taken from grade stakes.

WS4601, Nuclear Soil Testing Record, can be downloaded and used for the test documentation and may be reproduced, as needed. Figure 832-4 is an example of the field density/moisture test data documentation.

FIGURE 832-4 Example Field Density/Moisture Test Documentation

NUCLEAR SOILS DENSITY TESTING RECORDS — Wisconsin Department of Transportation

WS4601

Project ID.		Road Name			Project Engineer	
7091-06-72		Oregon - Evansville			B. Smith	
Contractor		County			Region	Hwy. No.
Excavators, Inc.		Dane			1	
Operator		Set No.	Density Standard	Moisture Standard		Date
J. Doe						07/02/08
Test No.	1	2	3	4	5	
Grading Area	2	2	2	2	2	
Station	359 + 32	360 + 21	360+93	359 + 10	360 + 72	
Offset	25' LT	20' LT	6' LT	38' LT	31' LT	
Depth Below Subgrade	3.5'	3.0'	1.0'	2.0'	∅	
Test Position **B.S. or D.T. Depth ,4",6"or 8"**						
Required % of Maxium Density						
Contact Reading **Density Count**	3463	3386	3457	3361	3301	
Air Gap Reading	5062	5078	5069	5071	5063	
Wet Density (P.C.F.) **Total Density**	121.8	123.7	114.8	119.1	120.4	
Moisture Count	127.0	200.5	185.5	250.0	263.5	
Moisture (P.C.F.) **(b) Total Water**	17.6	16.9	15.5	19.5	20.1	
Bulk Dry **(c) Dry Density**	104.2	106.8	99.3	99.6	100.3	
% Moisture 100 x b / c	16.9	15.8	18.6	19.6	20.0	
% Maxium Density 100 x c / d	93.5	95.8	94.2	95.5	95.2	
Soils Classification	BR. Silty Clay	BR. Silty Clay	BR Silty Clay	BR. Silty Clay	BR Silty Clay	
Proctor Number Pit Number						
Maximum Density (d) of Proctor	111.5	111.5	105.4	104.3	105.4	
Proctor Optium Moisture	16.0	16.0	18.7	19.1	18.7	
% R-4 Material						
Test Remarks						

832.5.2 Random Testing Selection

The QC plan special provision specification requires the contractor to perform "randomly selected tests" on subgrade fill soils for field density and moisture.

Random sampling is specified to eliminate bias. Greater reliability is assigned to test results from this process and the "strength of data" is improved for statistical purposes.

The method to be used for selecting random test locations is ASTM D3665, Standard Practice for Random Sampling of Construction Materials. Random numbers may be selected by following the instruction of Section 5 of ASTM D3665 or by using a calculator with a random number generator.

The contractor QC personnel should do the selection of random testing locations. In order to fully ensure that the selection of test locations is random, only those who need the information, such as QC personnel, should be notified. The operator will not be advised in advance as to when tests are to be taken. The effectiveness of process control sampling is completely reliant on unbiased testing. Collusion between the QC personnel or QA personnel and compactor operator, in this regard, may be cause for decertification of technicians.

The QC personnel should discuss the anticipated fill placement schedule with the contractor's grading foreman on a daily basis. The QC personnel and QA personnel need to know the general grading area(s) in which the contractor intends to fill, and the anticipated rate of fill placement based on the number of scraper or trucks hauling and the length of the haul. Based on the anticipated rate of fill placement the QC personnel will determine at what approximate time periods during the day random field density/moisture

tests will be required. The QC personnel may have to make adjustments to the testing schedule during the day if the contractor's production rate changes. Therefore, the QC personnel should document the load counts during the mid-day lunch break and at the end of the day to determine if the production rate is as anticipated. If the load counts indicate a significant change in the production rate the QC personnel must adjust the testing frequency accordingly.

Example 2

Based on the number of scrapers and the length of the haul the contractor anticipates placing approximately 1000 CY per hour with a total of 10,000 CY for the day. With the test frequency set at one test per every 3000 CY the QC personnel will be required to perform a test approximately every three hours during the day with a total of three tests for the day. The additional yardage could be included in the following day's production or handled by conducting a fourth test for the day.

To determine the specific test location the QC personnel will determine the general location of the active fill area at the time the test is being performed. Depending on the filling operations at that time the active fill area may only be a portion of the general grading area.

Example 3

The individual segment area in which the contractor has been placing fill for the day extends from approximately station 347+50 to station 356+30. However, for the previous several hours of grading the fill placement and compaction has been concentrated in only a portion of the general fill area because the contractor is allowing the fill in the remaining portion to dry.

When the QC personnel selects the test location only the active fill portion of the grading area should be used in determining the random location. The active portion of the grading at this time is from Sta. 353+75 to Sta. 356+30 and the width of the fill from finished shoulder slope to shoulder slope is 74 feet.

Total fill length = 255' (Sta. 353+75 to Sta. 356+30)

Total fill width = 74' (shoulder slope to shoulder slope)

Dimension/Fill Area		Random Number		Random Location Measurements
' (length)	x 0.272	=	69' (length)	
74' (width)	x 0.519	=	38' (width)	

Therefore, the dimensions for the location of the random test are 69' from the fill area's starting station (Sta. 353+75 plus 69') or Sta. 354+44 and 38' left from the right shoulder slope line.

The QC personnel may use some discretion in determining the exact location to place the nuclear meter for the test, due to surface conditions at the test location. However, the test will be performed within a three-foot radius of the calculated random location.

832.5.3 Grading Areas

Grading areas are defined as portions of the project in which fill placement and compaction procedures are unique and independent of another. Therefore, due to their isolation or unique procedures the quality control documentation for these areas should also be evaluated independent for each area.

Example 4

The contractor decides to split the grading crew and place and compact fill in two isolated portions of the site. The two grading operations are independent of each other. The quality control documentation for these two grading areas should also be independent of each other.

If the QC documentation is not separated a potential exists in which poor compaction procedures and low test results in one of the grading areas can be offset by exceptional test results in the other area.

The designation of a grading area is determined by the QC personnel but will be subject to review and acceptance by the engineer. As grading areas are designated, the QC personnel will assign an identification number to the grading area and document the approximate location of the area. The grading area identification number will be used for all test documentation.

832.5.4 Control Chart

Control charts are defined as graphs to reflect variability of a characteristic over a period of time on individual segments. Standardized control charts must be maintained by the contractor QC staff at the field laboratory.

If the contractor is placing fill in separate distinct grading areas for the project, he/she must provide separate control charts for each grading area for the project work. Individual test results obtained by the contractor must be recorded on the control charts as soon as possible on the same day as the tests are run. The engineer (QA staff) will post results of assurance tests on the same QC charts as soon as data is available.

Control charts must be maintained and kept current for the following items:

- Field density tests.
- Field moisture tests.

Control charts contain pertinent identification information as well as the plotted data. In addition to the individual test points of the contractor and engineer, a moving average of the last four (4) QC data points must be plotted.

Control charts include both control and warning limits. The areas between the control and warning limits are the warning bands.

Two different parameters will be plotted on the control charts for subgrade testing, each having different control criteria. The control chart for field density will have a lower warning limit and a lower control limit for the moving average values, plus a second lower control limit for individual test points. However, there is no upper warning or upper control limits for the field density tests.

The criteria for field density control limits may be different for each project, depending on where in the embankment the tests were performed. Density tests for the fill placed in the top six feet of a fill will be based on criteria established for upper zone fills unless otherwise specified. Density tests performed at depths greater than six feet will be based on the criteria established for lower zone fills unless otherwise specified. Refer to the special provisions for the specific criteria and zone definitions. The test data must be recorded on separate control charts for fill placed in upper-zones and lower-zones if there is a change in criteria.

The control chart for field moisture will have both upper and lower control limits with no warning limits. Refer to the special provisions for the specific moisture criteria.

The following color-coding will be used to draw control charts and plot data as outlined in the special provision specifications.

- Contractor individual data (QC): Black
- Contractor moving average of four: Red
- Engineer individual assurance data (QA): Blue
- Warning limits: Dash green
- Control limits: Dash Red

Other legends may be used, with approval of the engineer, but one legend system will be adhered to for a contract. If an alternate legend is used the system should be defined on the control chart sheets.

832.6 Documentation

The contractor must record observations, inspections, adjustments, and test results. Recording should be done in a timely manner, preferably upon occurrence of the activity. The records should be reported in a permanent field record book.

The records prepared by the QC personnel will be submitted to the project engineer on a daily basis and include the following:

- Nuclear soil testing records WS4601
- Field logbook for documentation of daily observations, inspections, and corrective action adjustments.

The records must be accurate and complete for all the work of the contract. The records should contain sufficient detail to sustain an audit, and clear enough to be read and understood. Emphasis should be placed on neatness. Computation records should be clear, precise, accurate, and complete. Computations should be initialed and checked. The records should also include all significant conversations with various project personnel, meeting notes, and accounts of all disputes and subsequent decisions.

Records of adjustments, if required, should be provided to the engineer on a daily basis. When the project is complete, the total records of the contractor for the work need to be furnished to the engineer in a neat and organized manner. These records will become part of the final project records and it's to be assumed by those preparing them that they must withstand any review or analysis in future years.

832.7 Corrective Action

When the moving average trend for any of the control chart values is towards the warning limits for density or toward the control limit for moisture the contractor will consider corrective action (refer to figure 832-5, example A). Corrective action must always be documented. The corrective action undertaken may be to increase the testing rate, change compaction procedures or equipment, inspect field or laboratory equipment, dry or water the fill material, increase compaction effort, change materials, or combinations of these actions. In addition to documenting corrective actions, resulting effects of the corrective actions should be recorded.

When the field density moving average for the control chart value exceeds the warning limits the contractor must notify the engineer (refer to figure 832-5, example B). This should be done immediately, as soon as the value is determined. When a second consecutive moving average value for density exceeds the warning limits (refer to figure 832-5, example C) the contractor and engineer need to discuss a course of corrective action. The contractor will perform the corrective measures.

Figure 832-5 demonstrates the three density control chart patterns presented in the preceding two paragraphs. The appropriate action to be taken by the contractor is indicated on each chart.

In the foregoing examples illustrated in figure 832-5 the data trends from the start are toward the warning limit. The prudent contractor and QC staff will be watching the data trend and making decisions to alter the trend, hopefully before the conditions in either example B or C occur. The contractor will want to take action as soon as the data confirms something is not right.

Process quality control is the responsibility of the contractor. It is important that the contractor attend to controlling the process when warranted, or it could result in excessive delays due to repeated corrective actions.

In the previous figure 832-5, Example C, there are a number of conditions that can result. One condition is that following the corrective action the field density may improve as evidenced by a new moving average point, after four random tests, which is not in the warning band. In this case, the contractor may continue production since the problem appears to be corrected (refer to figure 832-6, example A).

The second condition that can exist for figure 832-5, example C is that the corrective action does not improve the field density and the new moving average is still within the warning band (figure 832-6, example B). The continuation of fill placed within the warning band may have a cumulative effect on the stability and density of subsequent fill. Therefore, the fill represented by the third consecutive moving average point within the warning band is considered unacceptable. The contractor must perform corrective action to bring the unacceptable subgrade fill material, after four additional re-tests, above the warning limit.

Two other scenarios would result in fill material being considered unacceptable:

1. If a moving average point falls outside the control limit.
2. If an individual test result falls below the individual control limit for density.

With regard to the moisture control chart, fill material would be considered unacceptable if the moving average point falls outside the control limits. Therefore, the contractor will perform corrective action to bring the unacceptable fill material, after four additional retests, within the moisture control limits.

Regardless of the corrective action selected for the unacceptable fill, re-tests of the unacceptable fill is required. The fill in this area will not be considered acceptable until the new moving average, calculated with the re-test, is no longer within the warning band or is within the control limits (figure 832-6, example C).

Should the contractor encounter a situation that he/she is unable to get fill material within control limits in a timely manner, consideration should be given to various alternatives. If the subgrade is obviously defective and inferior, the contractor should divert the material to other destinations, if possible. If the contractor is repeatedly reworking the material and performing numerous tests off the record (non-random samples) in an effort to bring the material within the control limits with no favorable results, the engineer should be advised of this condition and a proposal should be offered to the engineer for corrective action. In all cases, obviously defective subgrade (example: subgrade soil with a moisture content exceeding the control limit) must not be incorporated into the work. The engineer may refer to standard spec 106.5 for unacceptable material.

832.8 Quality Assurance Aspects for the Contractor

While the contractor and QC staff is not responsible for QA on the project, they should be aware of how QA operations affect them.

832.8.1 Testing

The engineer QA staff must conduct testing on the split samples of the material selected for the soil source study. Testing will be at a minimum of ten percent of tests required of the contractor with a minimum of one sample to include each test listed in the Soil Source Study. The engineer may test as many of the samples as he/she determines necessary for the QA work. The engineer will be encouraged to select the most recent sample first and then select others, if needed to supplement QA information. Results should be provided to the contractor for comparison to the QC results as soon as possible after selecting the sample for test.

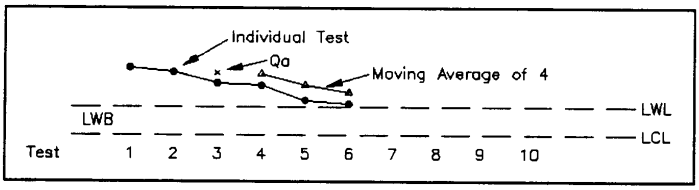
QA tests for field density/moisture must be from the exact location (nuclear source position) as the contractor and the one-point-proctor split samples will be tested at a minimum of ten percent of the tests required of the contractor.

The engineer will be allowed access to all areas of the project work including the QC laboratory. This is necessary for the engineer to conduct inspections and observations of operations as outlined in the specifications. If the engineer finds deficiencies in the contractor's process control he/she will notify the contractor verbally and in writing. The contractor should correct the deficiencies in a manner suitable to the engineer.

832.8.2 Testing Precision

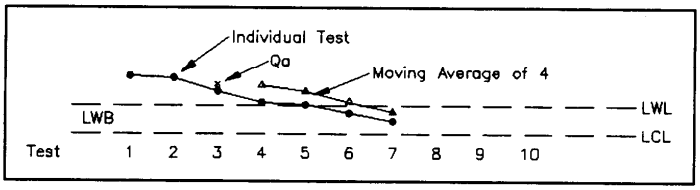
The special provision outlines allowable differences between engineer and contractor test results for the laboratory and field tests. The contractor should be aware of these differences and the importance that QC test results be comparable to QA data. Furthermore, the contractor should be aware that if testing differences exceed the allowable figures, the engineer must investigate the reason immediately. The contractor should want to make every effort to ensure their operations, equipment, and procedures are correct.

FIGURE 832-5 Density Control Chart Trends and Corrective Actions



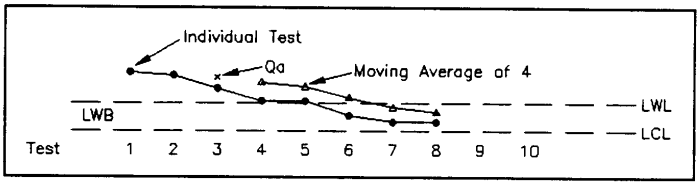
EXAMPLE A: Moving average trend is towards lower warning limit.

ACTION: The Contractor shall consider corrective action. This should happen as early as the 4th individual point and definitely by the 5th. Document action, if any taken.



EXAMPLE B: Moving average value exceeds the lower warning limit.

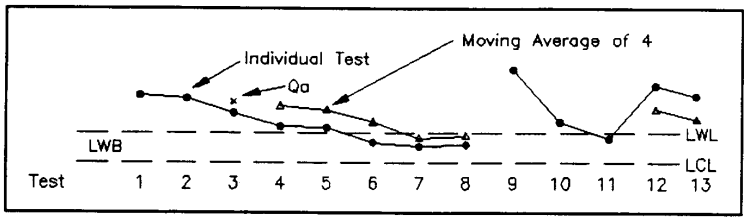
ACTION: The Contractor shall notify the Engineer when the first moving average point is obtained which exceeds the LWL (point 7). Document correction action, if any taken.



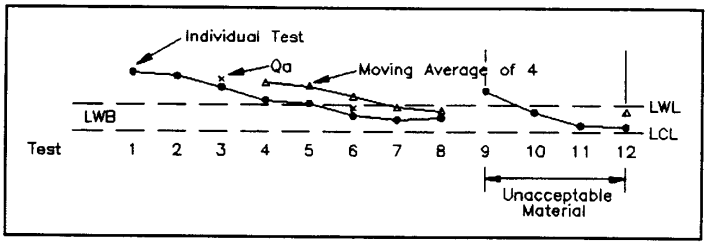
EXAMPLE C: A second consecutive moving average value exceeds the lower warning limit.

ACTION: The Contractor and Engineer shall discuss a course of corrective action when the 2nd consecutive moving average point (point 8) exceeds the lower warning limit. Document the corrective action taken.

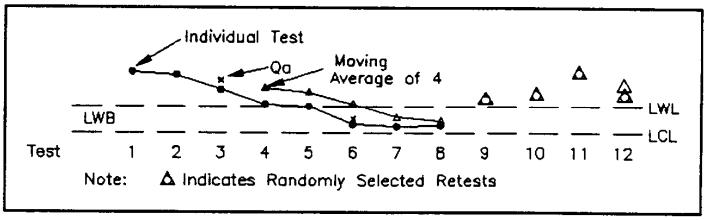
FIGURE 832-6 Conditions Resulting from FIGURE 8, Example C



EXAMPLE A: The Contractor notifies the Engineer at test 7. At test 8 the Contractor and Engineer discuss an action to take. At test 9 the new moving average of 4 random tests begins. At test 12 a new moving average is established, if this moving average is above the warning limit and the Contractor continues fill placement with the problem, seemingly, resolved.



EXAMPLE B: The Contractor notified the Engineer at test 7. At test 8, the Contractor and Engineer discuss an action to take. At test 12 the new moving average is still within the warning band and the material represented is unacceptable and will require correction before subsequent fill placement.



EXAMPLE C: The Contractor performs additional corrective actions on the unacceptable material (test 9-12). A re-test of the corrected material is used in calculating the new moving average for point 12. The new moving average is now above the warning limit and the Contractor continues fill placement.

SECTION 834 QMP - Aggregate

834.1 Sampling and Testing

Aggregate sampling techniques and minimum sample sizes must be in accordance with the appropriate sample method. Use of larger samples should be considered by the QC staff to increase the probability of obtaining a representative sample. When split samples are required, the field sample size shown in CMM 850 needs to be doubled.

834.1.1 Sampling During Production or Before Placement

For contract-required production or before-placement sampling, the contractor can obtain samples from the finished product conveyor belt or stockpile. Obtaining samples from the belt discharge is acceptable if the full production stream can be obtained with sufficient rapidity and safety.

Production samples are taken during aggregate crushing and stockpile operations and can only be conducted or witnessed by HTCP certified QC personal. Individual QMP provisions may allow for optional production testing as an alternative to in-place, stockpile or loadout samples before the beginning of a project. If production test results are submitted, documentation of random sampling must be provided.

Stockpile samples are taken after the contract is awarded, before placement and test results can be used for multiple projects within the QMP provision's specified timeframe. After aggregate placement begins, no additional stockpile samples are required for that project. Taking additional stockpile tests may be advisable depending on project circumstances. If a project is suspended and the aggregate source continues to be used on other non WisDOT projects or new material is added to the stockpile, taking a stockpile sample is advisable before resuming placement. If a project is suspended for over six months, taking an additional stockpile sample is advisable before resuming placement. Multiple stockpile tests for the same project and source are not required.

All sampling of aggregate used for acceptance testing must be random. If, for any reason, a random location will not be reached, a new random location within the partial lot may be required. Refer to standard spec 700 for partial lot sampling requirements. To prevent missing any quality control tests, the engineer should establish clear instructions for quality control sampling of partial lots as early as possible in the project; ideally at the preconstruction meeting. Instructions should be agreed upon by the engineer and contractor before any partial sublot sampling occurs.

834.1.2 Sampling During Placement

Sampling must take place after blading and shaping but before beginning compaction. The intent is to obtain samples as near to the final placement location of the material as possible so as to truly represent the aggregate placed. Sampling from roadbed windrows should only be used when the subgrade is granular, and it would not be possible to differentiate the change in material between the crushed aggregate base course and the granular subgrade.

The engineer should consider directing or conducting an additional placement test for the following scenarios:

- Material is added to an existing stockpile.
- A depleted stockpile is replaced.
- Material is suspected to be nonconforming.

The quantity of materials for roadbed field sampling should be doubled since samples are needed for both quality control and department testing according to special provision requirements of the contract.

834.1.3 Sieve Analysis

Sieve analysis testing must follow procedure outlined in WTM T11 and WTM T27. The sample weights derived from this procedure are minimums. As has been pointed out for field sample sizes, using larger samples should be given careful consideration by the QC staff to increase the probability of obtaining a representative sample.

Test data and calculation results should be recorded on a copy of DT1348, Sieve Analysis for Mixture of Fine and Coarse Aggregates. For consistency throughout the testing operations, it is preferred the test mass be made in units of grams. Figure 834-1 is an example of a completed test data sheet for a typical sample of aggregate base course material.

FIGURE 834-1 Example Sieve Analysis for Mixture of Fine and Coarse Aggregates, DT1348

SIEVE ANALYSIS FOR MIXTURE OF FINE AND COARSE AGGREGATES

Wisconsin Department of Transportation

DT1348 2/2006

Project Information	Project: 1001-01-00	Contract: ____ H ____	County: Rock
Deposit Identification	Contractor and/or Producer: Brewers Stone		Sample No.: 10T
☒ Crushed Stone ☐ Crushed Gravel ☐ Blend; ☒ Base Course ☐ Other; ☐ 3/4 inch ☒ 1 – 1/4 inches ☐ 3 inches ☐ Open Graded ☐ Other	Sampled at: 120 + 00, Top, 9' RT		Date: 5/28/09
	Materials Accepted at:		Time: 3:20 pm

MOISTURE CONTENT

Weight of Sample (moist)	6788G
Weight of Sample (dry)	6513G
Moisture Loss	275G
% Moisture	4.2%

Weight of Total Sample (dry, unwashed) 6513

Weight of R4.75 mm (No. 4) dry, unwashed 3879 = 0. 596 (A)

Weight of P4.75 mm (No. 4) dry, unwashed 2634 = 0. 404 (B)

	R-4.75 mm (R-4) MATERIAL			P-4.75 mm (P-4) MATERIAL Wt. = 674 (Min. 500 g)			TOTAL MATERIALS (% Passing)					
Sieve	Weight Retained	% Retained	% Pass (C)	Weight Retained	% Retained	% Pass (D)	4.75 mm (R-4) (A)(C)	4.75 mm (P-4) (B)(D)	Washed Results			Spec
75mm (3")	0	0	100	0	0	100	59.6	40.4	100			
37.5mm (1-1/2")	0	0	100	0	0	100	59.6	40.4	100			
32.5mm (1 1/4")	98	2.5	97.5	0	0	100	58.1	40.4	98.5			95-100
25 mm (1")	153	3.9	96.1	0	0	100	57.2	40.4	97.6			
19 mm (3/4")	1101	28.3	71.7	0	0	100	42.7	40.4	83.1			70-93
12.5 mm (1/2")	1798	46.3	53.7	0	0	100	32.0	40.4	72.6			
9.5 mm (3/8")	2471	64.2	35.8	0	0	100	21.3	40.4	61.7			42-80
4.75 mm (No. 4)	3738	96.4	3.6	0	0	100	2.1	40.4	42.5			25-63
2 mm (No. 10)	3796	97.9	2.1	233	34.6	65.4	1.3	26.4	27.7			16-48
425 µm (No. 40)	3800	98.0	2.0	415	61.6	38.4	1.2	15.5	16.7			8-28
75 µm (No. 200)	3813	98.3	1.7	531	78.8	21.2	1.0	8.6	9.6			2-12
In pan	19											

R-4.75 mm (R-4) FRACTURE COUNT

Fracture Particles	30.2
Questionable Particles	
Total particles	413
% Fracture	73

PLASTICITY CHECK

Can 425 µm (P-40) be rolled into 3.2 mm (1/8") thread when moist? ☐ Yes ☐ No

Mass/m^3 (Weight/c.y.) = _____

NOTE: If test does not meet contract requirement notify Project Engineer and indicate the action taken.

Sampled by	Date	Tested by	Date
Gormon Thomas	5/28/09	Paul Molitor	6/1/09

Gradation of aggregate should be expressed in percent passing sieve sizes. Separate charts must be kept for 2", 1-1/2", 1", 3/4", 1/2", 3/8", #4, #8, #10, #16, #30, #40 #50, #100 and #200 (50mm, 37.5mm, 25mm, 19mm, 12.5mm, 9.5mm, 4.75mm, 2.36mm, 2.00mm, 1.18mm, 600µm, 425µm, 300µm, 150µm and 75µm). Control charts for only the sieve sizes specified by the applicable specification need to be produced.

834.1.4 Atterberg Limits

Record Atterberg Limits test results.

834.1.5 Fractured Particle Count

Fractured particle testing must be according to WTM D5821. The QC tester should make the required calculation. Fractured particle test results must be plotted on a control chart.

834.2 Department Testing

Verification and independent assurance sampling and testing will be performed by the department or a department representative.

834.2.1 Verification Testing

Verification testing will be performed by an HTCP certified department representative on random samples collected independently of the contractor's samples. Testing of the material will be conducted in a separate laboratory and with separate equipment from the contractor's tests.

Transport base aggregate samples to the department’s regional laboratory the same day as the samples were collected. The regional laboratory requires at least one business day to complete the tests (two business days for material classified with recycled asphalt). If samples cannot be transported the same day, ensure samples arrive the following morning during normal business hours. Results will be reported on the material tracking system.

Ideal sampling and transportation examples include:

- Aggregate sampled on a Friday. Sample was transported to the laboratory by mid-Friday. Test procedures were conducted in the laboratory and results were posted on the Material Tracking System by close of business on Monday. The engineer reported results to the contractor by the close of business on Tuesday.
- Aggregate sampled on Monday. Aggregates were transported to the laboratory on Tuesday morning. Test procedures were conducted in the laboratory and results were posted on the Materials Tracking System on Wednesday. The engineer reported results to the contractor by the close of business on Wednesday.
- Aggregate sampled on Tuesday morning. Sample was transported to laboratory on Tuesday. Test procedures were conducted in the laboratory and results were posted on the Materials Tracking System on Wednesday. The engineer reported results to the contractor by the close of business on Thursday.
- Aggregate Sampled on Saturday. Sample was transported to the laboratory over the weekend. Test procedures were conducted in the laboratory and results were posted on Material Tracking System on Tuesday. The engineer reported results to the contractor by the close of business on Tuesday.

It is the project staff’s responsibility to make sure samples are transported to regional labs in a timely manner. Region staff can assist with transporting the sample. However, people affiliated with the project’s contractor(s) cannot transport verification samples.

Consider a regional laboratory’s workload throughout the construction season. High sample volumes can cause reporting delays if samples are not transported on the same day as sampling.

834.2.2 Independent Assurance Review

Independent assurance reviews will be conducted by a department representative. These reviews will be made of the contractor's quality control and the department's verification sampling and testing equipment and personnel.

834.3 Dispute Resolution

Split samples of the material collected for QC testing can be used to help resolve conflicts. Using these samples will be as agreed to by the contractor and the department.

SECTION 835 QMP – Concrete

835.1 Overview

This section addresses the standard specification for QMP Concrete Pavement, Cast-in-Place Barrier and Structures and the standard specification for QMP Ancillary Concrete.

The QMP for Class I concrete is detailed in standard spec 715.

The QMP for Class II and Class III concrete is detailed in standard spec 716.

835.1.1 Definitions

All personnel performing acceptance testing (QC and QV) must be certified through the WisDOT Highway Technician Certification Program (HTCP) administered by the University of Wisconsin – Platteville.

Certification requirements for each type of test are listed in standard spec table 701-1.

835.1.2 Concrete Grades

There are various types of concrete mixtures. By changing the proportions of the main ingredients, concrete mixtures are devised for specific applications. WisDOT defines these mixtures by concrete grade.

Grade A

- General use mix incorporated in paving, structures, and ancillary concrete. This is considered a standard concrete, which means it has a traditional unit weight of 145-160 pcf and traditional strength of 3,000-5,800 psi. Grade A concrete is the only grade of concrete that is allowed to reduce the cementitious content when using an optimized aggregate gradation (OAG). Admixture and supplementary cementitious material (SCM) requirements for this grade are found within the standard spec.

Grade B

- Concrete base mix that is specified when the concrete will be overlaid with either asphalt or concrete. This concrete is a structural component of the pavement and is not intended to be a wear surface for traffic. This grade has a lower cementitious content requirement than standard concrete and its ultimate strength will also be lower than a standard concrete. General strength for this mix will range between 2,000 psi and 4,000 psi.

Grade C

- General repair mixture for pavements and structures. It has a higher cement content for a rapid strength gain. This mixture is required in the contract when opening strength is needed sooner than a general use concrete.

Grade E

- Bridge deck overlay mixture that has a very high cementitious content. This mixture uses only No. 1 (AASHTO No. 67) coarse aggregates. These overlays are typically thin and are required to be open to traffic quickly due the nature of needing to construct the overlays on half of the bridge at a time. These mixes have a maximum w/cm ratio of 0.36. Specialized consolidation equipment is needed for this mixture grade.

In addition, listed below are some additional mixture types that are called out for specific purposes in the contract documents.

High Early Strength (HES) Concrete

- HES mixes are created by adding 94-282 lbs/cy of cement to an established mixture design. This modification can be applied to any concrete grade. The total amount of cement added to the mixture is dependent on a project's constraints. These constraints include, but are not limited to, project scheduling, opening to traffic or accelerated construction. When a concrete mix becomes HES, the HES is added after the grade. For example: Grade B mix design is submitted, when the additional cement is added, it becomes Grade B HES.

High Performance Concrete (HPC)

- HPC mixes are required to meet a higher performance standard for the constituent materials than a general use concrete. This mix generally has a higher durability than general concrete. These mixes are intended for use on high-capacity roadways and structures on the interstates. Designers consult with BTS/BOS when HPC concrete should be incorporated into a contract.

Modified High Performance Concrete (HPC)

- Modified HPC mixes are required to meet a higher standard for the constituent materials than a general use concrete. These mixes are intended for use on interstates. The modified HPC spec does not have as rigid delivery and discharge constraints as the HPC spec. Designers consult with BTS when the modified HPC concrete spec should be incorporated into a contract.

Lightweight Concrete

- This mixture has a concrete density less than 120 pcf and is made with lightweight aggregates or a combination of lightweight and normal weight aggregates. Lightweight concrete will require a longer drying

time than normal weight concrete due to the porous aggregates. Some typical applications for lightweight concrete include lift structure grid decks and extremely long span bridge decks.

Special High Early Strength (SHES) Concrete

- SHES mixes are used when opening strength is needed within hours of being placed. These mixes contain very high cement contents. Typically, calcium chloride is added in either liquid or flake form on site to accelerate the hydration process to give faster strength gain. Rapid strength gaining cements like Portland cement Type III may also be used.

Self-Consolidating Concrete (SCC)

- SCC mixes flow easily and are compacted by their own weight. No vibration is applied to this mixture. These mixtures use chemical admixtures, called superplasticizers, to achieve the self-compacting property. Mixture designs containing superplasticizers need BTS approval prior to use. It is important to ensure that segregation of aggregates does not occur when placing SCC mixes. Typically, SCC is used in areas of extremely congested reinforcement where vibration methods cannot get in between the steel, deep placement of concrete where vibration cannot reach the bottom (i.e.: drilled shafts) and underwater pours where the seal cannot be broken.

Shotcrete

- This concrete mixture is placed using a pneumatic gun that sprays the concrete at a high velocity. Shotcrete may be required in areas that are difficult to reach, and require a thin, large surface area coverage. Typical applications of shotcrete are in overhead and vertical structure surface repair.

835.2 Quality Control (QC) Plan

The quality control plan must be produced and submitted according to standard spec 701.1.2.

The department is responsible for reviewing the QC plan and provide comments back to the contractor. Once the contractor receives the departments comments, the contractor will need to review, revise, and resubmit the QC plan to project staff.

835.2.1 Contractor Concrete Mix Designs

The contractor is responsible for providing the design of the concrete mixture for use on the project and for any necessary adjustments during production. Each mix design must have the appropriate DT2220 or DT2221 form and all supporting documentation. Mix designs must conform to standard spec 710, 715, and 716. CMM 871 provides additional information regarding contractor concrete mix designs.

835.2.1.1 Class I Mix Designs

A PCC Technician II, hired or employed by the contractor, is required to develop and submit the mix design report to the engineer before the production of concrete for the project. The mix design must meet the conditions specified in standard spec 710.4 and 715.2.

A mix design may be used on multiple contracts. All supporting documentation is to be provided to each contract. Each project staff will review the documentation for the mix designs provided to the corresponding contract.

A copy of the mix design must be made available to all the interested project parties (i.e. engineer, contractor, QC technician, QA technician, and Independent Assurance technician) in the timeline defined in the standard spec. At a minimum, all parties should have a copy of the mix design packet prior to attending a pre-pour meeting.

835.2.1.2 Class II Mix Designs

The mix design for class II concrete must meet the conditions specified in standard spec 710.4 and 716.1.1.2.

A mix design may be used on multiple contracts. All supporting documentation is to be provided to each contract. Each project staff will review the documentation for the mix designs provided to the contract.

A copy of the mix design must be made available to all the interested project parties (i.e. engineer, contractor, QC technician, QA technician, and Independent Assurance technician) in the timeline defined in the standard specifications.

835.2.1.3 Department Review of Concrete Mix Design

The engineer's signature is required on the certification page of the appropriate DT2220 or DT2221 form. The engineer should review the following prior to signing the certification page and confirm that the submitted mix design meets the specification requirements:

- Cement is on the APL? If not, see the CMM 870 Attachment 870-1 for project level approval requirements or use the cement already on the APL.
- SCM's have appropriate certified report of tests?
- Correct SCM amount?

- Admixtures are on the APL? ,or, Certified report of tests provided? Does the admixture need BTS approval according to standard spec 501.2.5?
- Water source approved?
- Class I mix designs have trial batching? SAM number? Cylinder and beam break printouts? Box tests for optimized aggregate, slip-formed pavement?
- Aggregate sources are on the APL? Is it possible that the APL has not been published by BTS? Do the sources meet the specification requirements for intended usage? Are the sources tested satisfactory and not expired?

835.3 Concrete Plants

Plant start up includes calibration of the plant and testing equipment. Before production, the contractor should inspect the plant and test equipment. The engineer may choose to waive his inspection based on the results of the contractor's report.

In addition, the concrete producer is required to record the quantity of the materials used in each batch. The contractor is required to measure, monitor, and record the addition of materials to the mix after discharge from the plant.

835.4 Aggregate System

Aggregate gradation sampling and testing must be performed according to standard spec 710.5.

Mix designs will use one of two ways to evaluate aggregates. Either optimized gradation or combined gradation.

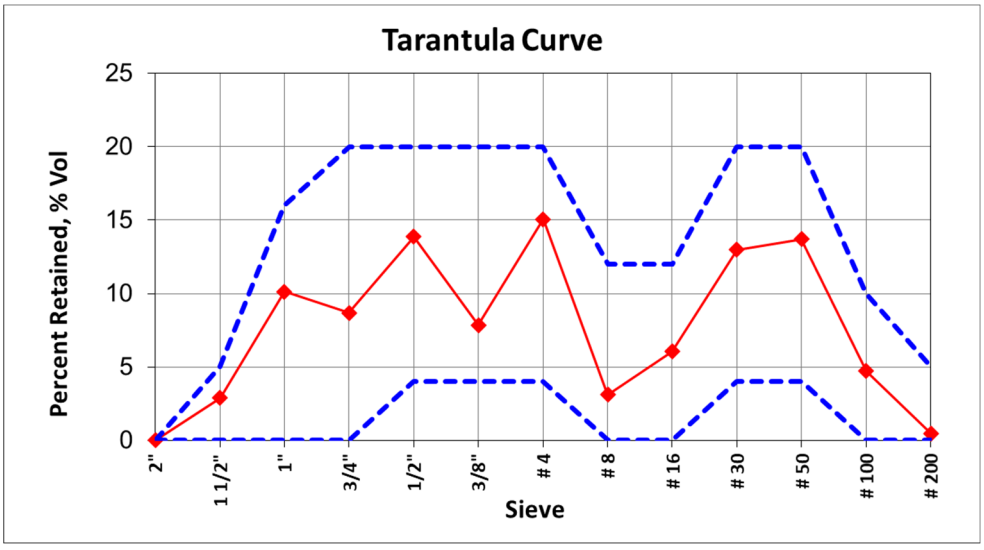
835.4.1 Optimized Aggregate Gradation

Optimized aggregate gradation (OAG) is required on pavement mix designs over the threshold stated in standard spec 501.2.7.4.2.1. OAG is encouraged on all projects, including Class II concrete.

OAG is taking the individual components of an aggregate sample and blending the individual sizes into a gradation that fits within the tarantula curve, refer Figure 835-1. Advantages of using the OAG include:

1. Contractor is allowed to reduce the cementitious content when using an OAG because the aggregate system of being in the tarantula curve has been tested and proven to increase workability and less paste is needed to achieve that property.
2. The durability of the concrete increases with this type of aggregate system provided the cement content is reduced. The amount of cement is directly related to the durability performance of the concrete.
3. Sustainability is increased provided the cement content is reduced.
4. Carbon footprint of concrete is decreased provided the cement content is reduced.

FIGURE 835-1 The Tarantula Curve



835.4.2 Combined Gradation

Aggregate systems are evaluated by using Combined Gradation for all mixtures not utilizing OAG.

The aggregates are blended together in the final product of the concrete and therefore are accepted per the blended combined gradation. Not all aggregates are conducive to optimization due to how they are produced. The combined gradation provides the state with a quality concrete that also accommodates the producer's products.

835.4.3 Structure Aggregate Moisture

During concrete production for class I structures, moisture content tests are required. Use department worksheet WS3010 "Worksheet for Calculating: Aggregate Moisture Content, Combined % Passing #200 Sieve, and Water/Cementitious Ratio" to calculate moisture content and combined P200. The quantities used must reflect a specific as-batched concrete moisture (not mix design quantities); therefore, as aggregate samples are collected the technician must also obtain current batch quantities.

Moisture of fine and coarse aggregates are tested when placing structure concrete as a measure to monitor the w/cm ratio. As the w/cm ratio increases, the strength of concrete decreases. Minimum structure strength is imperative to serviceability and safety.

For small quantities:

1. Quality control moisture testing and aggregate gradation testing including P200 should be tested at the frequency specified for small quantities which includes providing the engineer with documented previous testing dated within 120 calendar days or non-random start-up gradation testing.
2. As a process control, the contractor or the concrete supplier should test aggregate moistures during production and adjust batch weights accordingly.
3. The department should test aggregate gradations including P200 and moisture content on the first day of placement.

835.5 Concrete Testing

835.5.1 Materials Reporting System

The contractor submits mix information and test results for concrete pavement, cast-in place barrier and concrete structures using the department's Materials Reporting System (MRS) software available on the department's web site at:

http://www.atwoodsystems.com/

835.5.2 Water Cementitious Ratio

Water to cementitious ratio (w/cm) is an indicator of concrete quality. High water contents result in lower strength and decreased durability.

The w/cm is calculated according to the formula below. Quantities used must reflect target batch weights (mix design) for production concrete; therefore, when an individual aggregate moisture content changes significantly, the technician must also obtain current target batch quantities and adjust the target batch weights to maintain the design w/cm. If using mobile transit mixer trucks, be sure that the technician includes the water added on-site to the mix drum.

$$\text{Water to Cementitious Ratio (w/cm)} = \frac{\text{Weight of Net Water}}{\text{Weight of Total Cementitious Material}}$$

$$\text{w/cm} = \frac{MW + \sum AFM}{C + \sum SCM}$$

Where:

w/cm = ratio of water to cementitious material

MW = the weight of mix water added to the batch (lbs)

$\sum$ AFM = $AFM_1 + AFM_2 + AFM_3 + ... + AFM_n$

AFM_n = the weight of free moisture contributed by each aggregate (lbs)

C = weight of cement (lbs)

Σ SCM = $SCM_1 + SCM_2 + SCM_3 + ... + SCM_n$ (lbs)

SCM_n = weight of supplementary cementitious materials (lbs)

Conversion Factor for Water: 1 gallon = 8.34 lbs.

Free moisture contributed by each aggregate, AFM:

$$AFM = W_{Batch}\frac{TM - AC}{1 + TM}$$

Where:

W_{Batch} = the batch weight of the aggregate at field moisture.

TM = percent of total moisture of the aggregate expressed as a decimal fraction based on oven dry weight.

AC = percent absorption of the aggregate expressed as a decimal fraction based on oven dry weight.

In order to make this information useful to the batch operator, timely results are necessary. Work should begin immediately after the samples are collected and results should be shared as soon as they are available.

835.5.3 Concrete Lots and Sublots

835.5.3.1 Class I Pavement

The contractor must define lot and sublot locations before placing any concrete. Lots and sublots may contain concrete placed on more than one day of paving.

835.5.3.1.1 Lots by Lane Feet

A mainline sublot by lane feet is intended to be the length of a single paved lane. The sublot length can be divided in half if two lanes are paved simultaneously. For example: If the mainline sublot is 1000 lane feet in size, the sublot will be 500 linear feet for 2 lanes being paved simultaneously, or 1000 linear feet if the paving operation is one lane wide.

Lots will consist of a standard number of sublots and contain material from a single mix design. If a lot contains less than 3 sublots, there is not enough information to establish a meaningful percent within limits (PWL) statistic.

Create lots that logically correspond to construction operations. In order to transition into a new sublot, the previous sublot increment is required to be met. The only sublot that may have a different quantity is the last sublot of the mix design.

835.5.3.1.2 Lots by Cubic Yard

Lots and sublots by cubic yard are tested according to the amount of concrete placed. Sizes of lots and sublots are defined in the standard specification. Lots will consist of a standard number of sublots and contain material from a single mix design. If a lot contains less than 3 sublots, there is not enough information to establish a meaningful Percent Within Limits (PWL).

Create lots that logically correspond to construction operations. In order to transition into a new sublot, the previous sublot increment is required to be met. The only sublot that may have a different quantity is the last sublot of the mix design.

835.5.3.2 Class I Cast-In-Place Barrier

The contractor must define all lots on the project before placing any concrete. Lots and sublots may contain concrete placed on more than one day of placement.

Lots and sublots by cubic yard for barrier are tested according to the amount of concrete placed. Sizes of the lots and sublots are defined in the standard specifications. Lots will consist of a standard number of sublots and contain material from a single mix design. If a lot contains less than 3 sublots, there is not enough information to establish a meaningful PWL.

Create lots that logically correspond to construction operations. In order to transition into a new sublot, the previous sublot increment is required to be met. The only sublot that may have a different quantity is the last sublot of the mix design.

835.5.3.3 Class I Structures

The contractor must define all lots on the project before placing any concrete. Lots and sublots may contain concrete placed on more than one day of placement.

Lots and sublots by cubic yard for structure are tested according to the amount of concrete placed. Sizes of the lots and sublots are defined in the standard specification. Lots will consist of a standard number of sublots and contain material from a single mix design. If a lot contains less than 3 sublots, there is not enough information to establish a meaningful PWL statistic.

Create lots that logically correspond to construction operations. In order to transition into a new sublot, the previous sublot increment is required to be met. The only sublot that may have a different quantity is the last sublot of the mix design.

835.5.3.4 Class II Ancillary

Class II ancillary concrete testing frequencies are found in standard spec 716.

835.5.3.5 Class III Ancillary

Revise 835.5.3.5 (Class III Ancillary) to add DT2221 form and update information.

Class III concrete is accepted based on submission of a completed DT2220 or DT2221 certification page from the contractor. An example DT2221 certification page is shown in Figure 835-2. A 132 report entry in MRS is optional and not required for class III mixes.

FIGURE 835-2 Example Certification Page of DT2221 Form for Ancillary Concrete

ONCRETE MIXTURE DESIGN - OPTIMIZED AGGREGATE GRADATION				Wisconsin Department of Transportatio	
T2221 08/2022					
ECTION A - Project Information					
nstruction Project ID(s)	Contract ID	Highway		County	
100-20-70/71	20241008006	IH 41		Milwaukee	
oject Title		Project Limits			
41 Zoo Freeway		Burleigh St to Capitol Dr / Capitol Dr to Silver Spring Dr			
me Contractor		Project Engineer / Company			
ud Mover Contractors		Matthew Overton / WisDOT			
ECTION B - Concrete Contractor Information					
ncrete Paving Company				Telephone Number	
olid Gray Paving, Inc.				608.258.6500	
ain Address		City		State	Zip Code
498 Main Street		Madison		WI	54713
ECTION C - Concrete Supplier Information					
ncrete Supplier Company				Telephone Number	
olid Gray Paving, Inc.				608.258.6501	
ain Address		City		State	Zip Code
598 STH 100		West Allis		WI	53227
ECTION D - Concrete Mix Information					
ntractor Mix ID	Mix Grade	MRS Mix # (132 Prefix)		Design Date (mm/dd/yyyy)	
TH100-GrA-01	A - OAG	0-132-0001-2024		9/5/2024	
ix to be used on following bid items:					
d Item No.	Description				
15.0060	Concrete Pavement 6-Inch				
15.0080	Concrete Pavement 8-Inch				
15.0090	Concrete Pavement 9-Inch				
15.0100	Concrete Pavement 10-Inch				
01.0555	Concrete Curb & Gutter 6-Inch Sloped 36-Inch Type A				
ncrete Plant Name / Location				Plant Type	
oldi Gray Paving, Inc. - Portland Batch Plant				Batch	
dress		City		State	Zip Code
598 STH 100		West Allis		WI	53227
ECTION E - High Early Strength (HES) Mix Modification *(Fill Out As Needed)*					
ES Contractor Mix ID	HES MRS Mix # (132 Prefix)	HES Modification *(Select One)*	Additional Cement (lbs./cy)	Placement Method	HES Check
TH100-GrA-01-HES	0-132-0002-2024	☐ Type III Cement ☑ Additional Cement	175	Non-slip-formed	PASS
ECTION F - Mix Design Certification					
ertify that this mix design meets WisDOT specification requirements. The design is based on the documented material sources, types and proportions documented during the trial batching ocess and is only valid for these constituents and proportions. Any change in a constituent type or source will require reevaluation of the mix design by a certified mix designer. *Disclaimer: This mix design is to be used by the parties indicated on this certification for construction purposes. This mix design does not guarantee the results in the field due to the riability of construction operations.					
ix Designer Name (Print)	Signature (Wet or Digital)			HTCP #	Date (mm/dd/yyyy)
dam Paver	Adam Paver			605325	11/5/2024
mpany Name	Email			Telephone Number	
olid Gray Paving, Inc.	adam.paver@solidgray.com			608.258.6527	
dress	City			State	Zip Code
498 Main Street	Madison			WI	54713
ECTION G - Project Staff Review					
ertify that I have reviewed the mix design. All the sources listed in this mix design are approved per WisDOT specifications or written approval of the department. I have confirmed the urces in this mix design are accurate with the Contractor's submitted Quality Control Plan. I acknowledge that any source change from this mix design requires reevaluation by a certified ix designer.					
oject Engineer Name (Print)	Signature (Wet or Digital)			Date (mm/dd/yyyy)	
atthew Overton	Matthew Overton			11/11/2024	
mpany Name	Email			Telephone Number	
I Department of Transportation	matthew.overton@dot.wi.gov			262.548.5902	
dress	City			State	Zip Code
41 NW Barstow Street	Waukesha			WI	53188

835.5.4 Slump

Slump test results must be documented with appropriate sample identification information. QC records slump test results in MRS. QV records slump test results in the strength report and report for the mix.

835.5.5 Temperature

High concrete temperatures result in fast hydration of the concrete which result in shrinkage cracking and low strengths.

Placing concrete in temperatures below 40 F impacts workability and set time of the concrete. In addition, it will slow the rate of strength gain. If the fresh concrete freezes before hardening, the ultimate strength is significantly reduced.

Temperatures need to be monitored as the time required before sawing will be altered in extreme temperature conditions. Hot weather will require sawing earlier and cold weather will require a delayed sawing.

835.5.6 Air Content

Air content in concrete is important to the freeze-thaw durability. Low air content will reduce the freeze-thaw durability of the concrete. High air content increases the freeze-thaw durability; however, it lowers the ultimate strength.

In addition, the air spacing factor is a more accurate indication of the freeze-thaw performance. This property is tested with a Super Air Meter (SAM) or hardened air void analysis.

The contractor plots air content data using the department's MRS software.

835.5.7 Strength Specimens

It is important to measure the concrete strength to ensure it can support the loads being applied to it; the department requires either compressive or flexural strength specimens to confirm minimum strength of the concrete is reached at 28-days. Strength requirements are defined in the spec and also may be indicated within the plans.

The contractor/department is responsible for fabrication, curing, and strength testing of their respective strength specimens. Strength requirements are found in standard spec 710.5, 715.3, and 716.2. Strength cylinders used for quality assurance must be independent of field-cured cylinders used to confirm strength prior to removing forms, falsework, or opening to service.

835.5.7.1 Fabricating and Curing Strength Specimens

The contractor QC staff fabricates, cures, and tests strength specimens to determine the 28-day strength for each sublot. A set of three strength specimens is required. The contractor selects 2 of the 3 specimens at random and breaks them. If the breaking strengths are close to the same, the average strength of those 2 specimens defines the sublot strength. If the 2 breaking strengths are significantly different, the contractor breaks the third specimen and determines the sublot strength as the average of the 2 highest strength specimens.

The contractor records strength specimen data using the department's MRS software.

The department records strength specimen data using the department’s Material Tracking System (MTS) software.

Care should be taken during casting, curing, transporting, and breaking strength specimens to avoid anything that might bias the results. If vibrating strength specimens, the technician should take particular care to avoid over-vibration that can cause segregation and lower strength. Poor consolidation and careless sample handling techniques increase the variability of the strength results.

All HTCP certified technicians are trained to follow the same standard procedures. The department's independent assurance staff is charged with monitoring all project testing, whether by the contractor, the department, or a consultant, to make sure that those standard procedures are followed.

835.5.7.2 Strength Test Results

The 28-day strength is the benchmark strength the department uses for design, to measure the concrete quality, and to determine incentive/disincentive pay adjustment. The average strength of the 2 strength specimens from each sublot defines the 28-day concrete strength for that sublot.

835.5.7.3 Class I Pay Adjustment for Strength

The department determines a pay adjustment for 28-day concrete strength (compressive or flexural). For lots with less than 4 sublots, each sublot is evaluated individually. For lots with 4 or more sublots a statistical analysis is done to determine a lot-by-lot pay adjustment. After verifying the contractor's data, the department calculates pay adjustments using the department's MRS software. The contractor must submit the required strength test information electronically using the MRS software available at:

http://www.atwoodsystems.com/

The department administers incentives and disincentives under different items. The unit for both items is dollars. The engineer should always use these items for pay adjustment. On smaller jobs, there may be a

single pay adjustment done for the entire project. On larger projects pay adjustments may be issued with progress payments.

The incentive items are included in the contract schedule of items as predetermined prices fixed at bidding. The estimated amount of incentive included in the incentive item is 60% of the maximum possible incentive. These items allow the engineer to pay incentives without a construction change order. Because a contractor can earn 0% to 100% of the maximum strength incentives attainable for the project and the contract bid items were at 60% of the maximum attainable, a project can result in more or less pay for the concrete strength incentives.

The disincentives are applied to the contract using an administrative item. A list of administrative items is provided in CMM 238. Administrative items need to be applied to the contract by change order.

835.5.7.3.1 Pay Adjustment for Partial Lots (less than 4 sublots)

Statistical analysis cannot be performed on lots containing less than 3 sublots. The department requires 4 sublots to determine the statistical analysis. The department calculates the pay adjustment for a lot with less than 4 sublots by treating each sublot individually. Sublots with average sublot strength greater than or equal to the specification limit receive no adjustment. Sublots with an average sublot strength less than the specification limit receive a disincentive.

835.5.7.3.2 Statistical Pay Adjustment (4 or more sublots)

The department calculates the pay adjustment for a lot with 4 or more sublots using a PWL analysis based on the lot's average strength and the lot's strength standard deviation. Only those lots with a standard deviation below a specified threshold are eligible for incentive payment. The lower quality index, how many standard deviations the lot mean is above the specification limit, is calculated and used to determine the PWL for a given sample size. The resultant PWL is applied to a pay equation to determine the appropriate pay adjustment for the lot.

The basis for the analysis is the sublot average strength which uses the average of 2 QC strength specimens for each sublot. Weighted lot statistics are developed from the set of sublot average strengths as follows:

LOT MEAN:

$$X = \frac{C_1 w_1 + C_2 w_2 + C_3 w_3 + \cdots + C_n w_n}{W}$$

Where:

X = lot mean
C = sublot average strength for each sublot
w = sublot weighting factor (sublot size)
W = Sum of weighting factors (lot size)

LOT STANDARD DEVIATION:

$$S_n = \sqrt{\frac{(C_1 - X)^2 w_1 + (C_2 - X)^2 w_2 + \cdots (C_n - X)^2 w_n}{(n-1)W \div n}}$$

Where:

Sn = lot standard deviation
C = sublot average strength for each sublot
X = lot mean
w = sublot weighting factor (sublot size)
W = Sum of weighting factors (lot size)
n = number of sublots in lot

LOWER QUALITY INDEX:

$$Q_L = \frac{X - L}{S_n}$$

Where:

QL = lower quality index
X = lot mean
L = specification limit
Sn = lot standard deviation

835.5.7.3.3 Additional Payment Considerations

Special circumstances may require the engineer to modify the pay adjustment using the MRS software. Material that is represented by out-of-spec test results is not eligible for incentive payment. The engineer must deduct the appropriate amount from the lot pay adjustment that the MRS calculates. Testing frequencies for those other properties (aggregate gradation, air content, slump, and concrete temperature) may not correspond to the strength sublots. The engineer should note what additional adjustments were made and how the quantity was determined in the remarks of the HQMS report.

835.6 Quality Assurance Testing

Quality assurance testing, including quality control, quality verification and independent assurance sampling and testing are required to be performed by HTCP certified technicians.

835.6.1 Verification Testing

A department representative performs quality verification testing when contractor quality control testing is used for acceptance of material. Quality verification samples are required to be collected per the frequencies stated in the standard spec and independently obtained from the quality control samples. Testing of quality verification samples is conducted utilizing separate equipment and qualified laboratory. Quality control and quality verification are required to follow the same testing procedures defined by standard spec.

835.6.2 Independent Assurance Review

Independent assurance reviews are required to be conducted by a department representative in accordance with CMM 820.

835.7 Documentation

Contractor is required to document all observations, sampling and testing results, mix adjustments, and other pertinent material information. Submit required test results in the MRS software. In addition, all original testing records need to be submitted to the engineer in a neat and orderly manner according to the timeframes defined in standard spec 710.1.2.7.

Department is required to document all observations, sampling and testing results and other pertinent material information. Department will utilize Material Information Tracking (MIT) software and MTS software for material reporting. The department compiles a material archive document at the end of the project. Additional guidance on the material archive is found in CMM 845.

835.8 Material Placement Notification

The validity of WisDOT materials quality depends on acquiring the proper number of samples for acceptance program data analysis. Therefore, all parties involved must be notified when materials are placed on WisDOT projects.

The material placement notification (MPN) shall be followed per standard spec 106.3.4.1(3)2. The MPN requires the contractor to notify the department regarding the proposed placement of concrete materials in writing. The MPN should be provided at least one business day prior to placement. For nightwork, the contractor and engineer may mutually agree on an alternate timeframe for MPN. The MPN should be sent via email to:

- the engineer,
- the engineer's materials coordinator,
- the prime contractor,
- the Subcontractor performing the work (if different than the Prime), and the
- contractor's designated project materials coordinator.

This email distribution list should be documented in the QC plan and reviewed by the engineer. The engineer should document and contact TSS for all instances when the MPN is not provided. If multiple suppliers are providing concrete on the same job, the contractor shall distinguish which material supplier is used at each location.

If a QV test was missed and the MPN was not provided, follow-up testing to verify the quality of the in-place material should be paid by the contractor. The department will complete the required follow-up testing and administer a non-performance credit for the cost of testing. If the MPN is provided by the contractor and the consultant/department missed a test, there would not be a credit to the contractor. For missed QV tests in such scenarios, the department will assess costs as follows:

- For a missed QV test when the MPN is received and the testing is overseen/performed by a consultant, the consultant will bear the cost of the follow-up testing.
- For a missed QV test when the MPN is received and the testing is overseen/performed by the department, the department will bear the cost of the follow-up testing.

The following details should be included in the MPN:

- Each concrete mix design intended for use, specifying the work type (slipform or non-slipform).
- Station number or structure element.
- Quantity of material to be placed, including the units of measurement.
- Date and time of placement, along with the number of lots and sublots for QC tests.

Below are some examples of the MPN:

Example 1: Excel form to collect the pertinent information for proper sample scheduling:

Project ID	Submitted By Name / Company	Proposed Date of Placement	Proposed Time of Placement	Proposed Quantity Placed	Proposed Units of Measurement	Work Type	Slipform or non-Slipform	Contractor Mix Design ID	WisDOT 132 Mix ID	Material Producer	Plant Location	Proposed Number of QC sublots	Proposed Location of Placement
1234-11-11	John Doe, XYZ Company	4/1/2025	6:00 AM	2000	CY	Concrete Pavement	Slipform	Mix #8908	132-681-25	Redimix 123	Badger Plant #1	8	1800+50 NB
6789-00-00	Jane Doe, ABC Company	4/1/2025	6:30 AM	250	CY	Concrete Structures	Non-slip form	Mix #68121	132-623-25	Redimix XYZ	Badger Plant #4	5	East Abutment Wall

Example 2: Email notification with the pertinent information for proper sample scheduling:

Project ID: 1234-11-11
Submitted By Name / Company: John Doe, XYZ Company
Proposed Date of Placement: 4/1/2025
Proposed Time of Placement: 6:00 AM
Proposed Quantity Placed: 2000 CY
Work Type: Concrete Pavement
Slipform or Non-Slipform: Slipform
Contractor Mix Design ID: Mix #8908
WisDOT 132 Mix ID: 132-681-25
Material Producer: Redimix 123
Plant Location: Badger Plant #1
Proposed Number of QC Sublots: 8
Proposed Location of Placement: 1800+50 NB

Example 3:

The engineer and the contractor may mutually agree to an alternate process to submit the MPN, such as using a shared drive and spreadsheets, provided all pertinent information and time of notification is clearly documented.

SECTION 836 QMP - HMA

Hot Mix Asphalt (HMA) QMP sampling, testing, materials properties, and documentation as prescribed in CMM 836 are mobilized into the contract by standard spec 460.2.8.

836.1 General

836.1.1 Overview

This section addresses the standard specification for QMP, Asphaltic Mixture.

The QMP for Hot Mix Asphalt (HMA) is detailed in standard spec 460.2.8. Overview - WisDOT QMP Requirements:

- Personnel and required certifications (CMM 836.2 and standard spec 460.2.8.2.1.1)
- Laboratory facilities (standard spec 460.2.8.2.1.2)
- Random sampling and sampling frequency (CMM 836.4 and standard spec 460.2.8.2.1.3)
- Required testing (and calculated properties) (CMM 836.6 and standard spec 460.2.8.2.1.3)
  - Mixture bulk specific gravity (Gmb)
  - Mixture maximum specific gravity (Gmm)
  - Air voids (Va)
  - VMA (voids in mineral aggregate)
  - Aggregate gradation
  - Percent binder content
- Documentation (CMM 836.8 and standard spec 460.2.8.2.1.4)
  - Records
  - Control charts
- Control limits (standard spec 460.2.8.2.1.5)
- Warning bands
- Job mix formula adjustments (CMM 836.6.13.1 and standard spec 460.2.8.2.1.6)
- Corrective action (standard spec 460.2.8.2.1.7)
- Verification program (CMM 836.9 and standard spec 460.2.8.3.1)

836.1.2 Definitions

Interpret HMA related definitions used in 836 as follows:

Rule of retained	Split samples for comparison testing are retained. In order to test a retained portion of any sample, communications must occur between the department and contractor QMP teams. The department has ownership of QMP required split samples. There is implied joint ownership between contractor and department on any additional QC samples recorded.
Mixture production days	Days of production of a specific design mixture being tested.
Nonconforming materials	Mixture not meeting acceptable verification parameters but allowed to be left in place with appropriate payment reduction.
Unacceptable materials	Mixture not meeting acceptable verification parameters and being required to be removed and replaced.
Teams	Personnel listed on QMP organizational charts.

836.2 Personnel Requirements (Through HTCP)

The following list summarizes minimum personnel requirements and associated certifications to satisfy QMP Asphalt activities.

1. QC: Production process
   - Sampling: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Transportation Materials Sampling Technician (TMS)).
   - Production Control Testing: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Hot Mix Asphalt, Technician I, Production Tester (HMA-IPT))
   - Production process changes: HMA Tech certified at a level recognized for production process control and troubleshooting (HTCP-certified Hot Mix Asphalt, Trouble Shooting, Process Control Technician (HMA-TPC)).
   - Mix design: HMA Tech certified at a level recognized for conducting mix designs and report submittals (HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals Technician (HMA-MD)).
2. QV: Department quality verification

- Sampling: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Transportation Materials Sampling Technician (TMS)).
- Production Control Testing: HMA Tech certified at a level recognized for mixture production testing (HTCP-certified Hot Mix Asphalt, Technician I, Production Tester (HMA-IPT))
- Production process change review: HMATech certified at a level recognized for reviewing mix design work (HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technician)) or HMA Tech certified at a level recognized for conducting mix designs and report submittals (HTCP-certified Hot Mix Asphalt, Mix Design, Report Submittals Technician (HMA-MD)).

836.3 Laboratory Requirements

The laboratory must be:

- Furnished with equipment to comply with daily testing and communication requirements (calibrated testing equipment, phones, copy machines, etc.).
- Located at the plant site and operational before production.
- A Wisconsin Laboratory Qualification Program participant.

The intent is for the G_{mm} and G_{mb} materials to be tested at the same facility.

836.4 Sampling Hot Mix Asphalt

At the beginning of each day the contractor determines the anticipated tonnage to be produced. The frequency of sampling (minimum number of required tests for the day's anticipated production) is defined by the latest (QMP) HMA mixture standard spec 460.2.8.2.1.3. A test sample is obtained randomly from each sublot.

Example 1

Expected day's production is 1,900 tons. The number of required samples = 3 (per QMP standard spec 460.2.8.2.1.3).

Sample 1 – from 50 to 600 tons.
Sample 2 – from 601 to 1500 tons.
Sample 3 – from 1501 to 2700 tons.

The approximate location of each sample within the prescribed sublots is determined by selecting random numbers using WTM D3665 or by using a calculator or computerized spreadsheet that has a random number generator. The random numbers selected are used in determining when a sample is taken and will be multiplied by the sublot tonnage. This number will then be added to the final tonnage of the previous sublot to yield the approximate cumulative tonnage of when each sample will be taken.

To allow for plant start-up variability, the procedure calls for the first random sample to be taken at 50 tons or greater per production day (not intended to be taken in the first two truckloads). Random samples calculated for 0-50 ton should be taken in the next truck (51-75 ton).

Example 2

Required Sample	Sublot Sample Tonnage Range	Random No. ASTM D3665	Sublot Sample Ton (Random No. x Sublot ton)	End of Previous. Range	Cumulative Sample Tonnage
1	50 - 600	0.572	RN x 600= 343	0	343
2	601 - 1500	0.353	RN x 900= 318	600	918
3	1501 - 1900	0.656	RN x 400= 262	1500	1762

This procedure is used for any number of samples per day.

If the anticipated day's production is 1900 tons, then the third random sample would be calculated between 1501 and 1900 tons (i.e., 0.656 x 400 = 262 and 262 + 1500 = 1762). If production doesn't meet the anticipated tonnage to allow for obtaining the next randomly generated sample, then an additional sample will be taken within the last 100 tons of the day to fulfill the sampling frequency requirement defined in standard spec 460.2.8.2.1.3.1 (5) (Document reasons for any non-compliance Note: If this scenario occurs, by definition, this sample qualifies as being a random sample within the QMP program

frequency requirements, meaning, if anticipated tonnage is exceeded, a second sample should not be taken within the same interval.

The plant operator should not be advised ahead of time when samples are to be taken.

If belt samples are used during troubleshooting, the blended aggregate will be obtained when the mixture production tonnage approximates the sample tonnage. For plants with storage silos, this could be up to 60 minutes in advance of the mixture sample that's taken when the required tonnage is shipped from the plant.

QC Sample:

- Sample size only requires one "test" portion and one "retained" portion.

QV Sample:

- Must be directly observed by the project engineer.
- Project engineer takes immediate possession.
- The initial split of QV and QV-retained, can be performed by using a quartermaster. If the contractor performs this split, the project engineer, before taking possession, must directly observe it.
- Any dispute resolution testing requires QV personnel to obtain any backward QC-retained samples accumulated each time a QV sample is collected. This process also requires contractor to accumulate QC-retained samples between QV samples. If QC-retains are not available for verification testing if/when needed, liability for that mixture may include back/forward to production start-up/end or next available QV sample test result in either direction.

836.5 Sample Identification

Refer to WTM R97 section 6 in the Manual of Test Procedures for sample identification requirements. Figure 836-1 provides an example label.

FIGURE 836-1 Example of Sample Labeling

Contractor - Lab:	ABC Paving - I39 Lab
Sampling Technician:	John Doe, 123433
Sample Type:	QV
State Project ID:	1155-01-01
Date:	10/1/2019
Sample Number:	9-1
Mix Type:	4 MT 58-28 S
State Mix ID:	250-1001-19
Current JMF % Binder:	5.1%
Current Gsb:	2.722
Daily Tonnage Sampled:	1,206
QV Sample Witness:	Jack Smith, 123456, XYZ Engineering

The cumulative/total tons representing mix design production are recorded on the QC data sheets.

836.5.1 Vacant

836.5.2 Vacant

836.5.3 Splitting of SMA during Main Production

After completion of the test strip, a 3-part sample is no longer used and sampling/splitting returns to two-part splits, yielding portions for testing and retained portions (i.e., QC sample yields a QC for testing and a QC-retained, while a QV sample must yield a QV sample for testing plus a QV-retained, at a minimum).

836.5.4 Vacant

836.5.5 Vacant

836.6 Required Testing and Calculated Properties

If the digit or decimal place you are rounding to is followed by 5, 6, 7, 8, or 9, round up. If the digit or decimal place you are rounding to is followed by 0, 1, 2, 3, or 4, round down. For example, when rounding to the tenths place, 14.150 becomes 14.2 and 14.149 becomes 14.1.

836.6.1 QC Tests

QC testing must be completed, and data posted, on the day the sample was taken or as approved by the project engineer.

For administration of projects requiring only one, two, or three single tests per mix design, apply the following tolerances for mixture evaluation:

- Va = 1.5 - 5.0% (2.5 - 6.5% for SMA)
- VMA = - 1.0 from required minimums specified in standard spec 460.2.2.3, table 460-1
- AC = within -0.5 of JMF (determined by ignition oven method according to WTM T308, chemical extraction according to AASHTO T164 Method A or B, or automated extraction according to WTM D8159.

For results not meeting the above ranges, apply pay in accordance with the "Produced Outside JMF Limits" guidance listed in standard spec 460.5.2.1.

836.6.2 Vacant

836.6.3 Asphalt Binder Content (AC) Determination

Asphalt binder content will be determined by one of the following methods:

- Chemical extraction according to AASHTO T164 Method A or B
- Automated extraction according to WTM D8159.
- Ignition oven according to WTM T308. If the department is using an ignition oven to determine AC, conform to WTM H-003.

836.6.4 Vacant

836.6.5 Vacant

836.6.6 Vacant

836.6.7 Dryback Procedure for Absorptive Aggregates

Run dryback procedure, corrected G_{mm}, using WTM T209, Supplemental Procedure for Porous Aggregates.

- The dryback procedure is required for aggregate JMF blends with moisture absorption greater than or equal to 2.0%.
- Run a dryback procedure on Day 1-Sample 1 and determine a dryback correction factor for that test. Average the test dryback correction factor with the design JMF dryback correction factor and apply to the test data for a new G_{mm}. If the new average correction factor changes the G_{mm} by less than 0.010 then use the design JMF dryback correction factor until otherwise determined by additional testing.
- Run a dryback procedure every other day of production on the first test sample, or any time there is a change in binder content greater than 0.1%, or a change in component blend percentages greater than 10% (or 20% combined), using the same averaging method as above to validate the original design JMF dryback correction factor.
- If any average dryback correction factor changes the G_{mm} by more than 0.010, check for math or testing error first, otherwise a new dryback correction factor must be established by running drybacks on the next three samples. Average the new dryback correction factors and establish that average as the new JMF dryback correction factor.

836.6.8 Vacant

836.6.9 Voids in Mineral Aggregate (VMA)

Voids in mineral aggregate is calculated using the aggregate bulk specific gravity, G_{sb}, from the contractor mix design (unless a blend change has occurred in which case a new Gsb will be calculated), the asphalt content (P_b determined by one of the methods listed in CMM 836.6.3), and the average SGC specimen bulk specific gravity, G_{mb}, as follows (calculate and record to 0.1.):

$$VMA, \% = 100 - \frac{G_{mb} \times (100 - P_b)}{G_{sb}}$$

836.6.10 Vacant

836.6.11 Vacant

836.6.12 Additional Formulas and Example Calculations

1. Determining the aggregate effective specific gravity (Gse) for the following:

$$G_{se} = \frac{100 - P_b}{\left[\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)\right]} = \frac{100 - 4.5}{\left[\left(\frac{100}{2.567}\right) - \left(\frac{4.5}{1.030}\right)\right]} = 2.761$$

Given:

Pb = 4.5

Gmm = 2.567

Gb = 1.030

2. Determining the percent of asphalt content (Pb) for the following:

$$P_b = 100 \times \left(\frac{G_b}{G_{mm}}\right) \times \frac{(G_{se} - G_{mm})}{(G_{se} - G_b)} = 100 \times \left(\frac{1.030}{2.567}\right) \times \frac{(2.761 - 2.567)}{(2.761 - 1.030)} = 4.5$$

Given:

Gmm = 2.567
Gb = 1.030
Gse = 2.761

3. Determining the asphalt absorption, P_{ba}, for the following:

$$P_{ba} = 100 \times \frac{(G_{se} - G_{sb})}{(G_{sb} \times G_{se})} \times G_b =$$

$$100 \times \frac{(2.761 - 2.703)}{(2.703 \times 2.761)} \times 1.031 = 100 \times \frac{0.058}{7.463} \times 1.031 = 0.8$$

Given:

Gse = 2.761
Gsb = 2.703
Gb = 1.030

4. Determining the effective asphalt content, P_{be}, of the asphaltic mixture for the following:

$$P_{be} = P_b - \left(\frac{P_{ba}}{100}\right) \times P_s = 5.3 - \left(\frac{.8}{100}\right) \times 94.7 = 4.5$$

Given:

Pb = 5.3
Pba = 0.8
Ps = 94.7

5. Determining the percent voids filled with asphalt (VFA) for the following compacted mixture:

$$VFA = 100 \times \frac{(VMA - V_a)}{(VMA)} = 100 \times \frac{(14.4 - 3.7)}{(14.4)} = 74.3$$

Given:

VMA = 14.4
Va = 3.7

6. Determining the dust to binder ratio (or DP: Dust Proportion):

$$Dust\,to\,Binder\,Ratio = \frac{\%\ passing\ 0.075}{P_{be}} = \frac{5.0}{4.5} = 1.1$$

Given:

Pbe = 4.5
% passing 0.075 = 5.0

836.6.13 Field Adjusted JMF

The JMF may be adjusted in the field based on production test results see CMM 866.2.

When the JMF asphalt content is increased by 0.2% or more start new running average for G_{mm}. The compaction target maximum density for the day of the target change can be calculated using the most recent G_{se} and percent asphalt binder (P_b) for the new JMF and G_b (binder specific gravity) at 77 F from the mix design.

836.6.13.1 Job Mix Formula (JMF) Changes

Changes made to the current Job Mix Formula (JMF) during production must be submitted to the HMA-MD Technician representing the department for approval. Scenarios requiring a JMF change include but are not limited to the following:

- Decrease in JMF target binder content of 0.1% maximum.
- Change in asphalt binder PG grade (with the project engineer's approval and complying with CMM 866.2.3.2).
- Addition of an additive, except approved compaction aids.

- Changes to an additive type or dosage rate identified on a JMF.
- Change to JMF aggregate gradation percentages within aggregate gradation master range according to table 460-1.

A JMF target binder content decrease exceeding 0.1% from the original JMF target, elimination or addition of any aggregate component, or changes to the design aggregate component blend percentages exceeding 20%, in combination will require a new mix design.

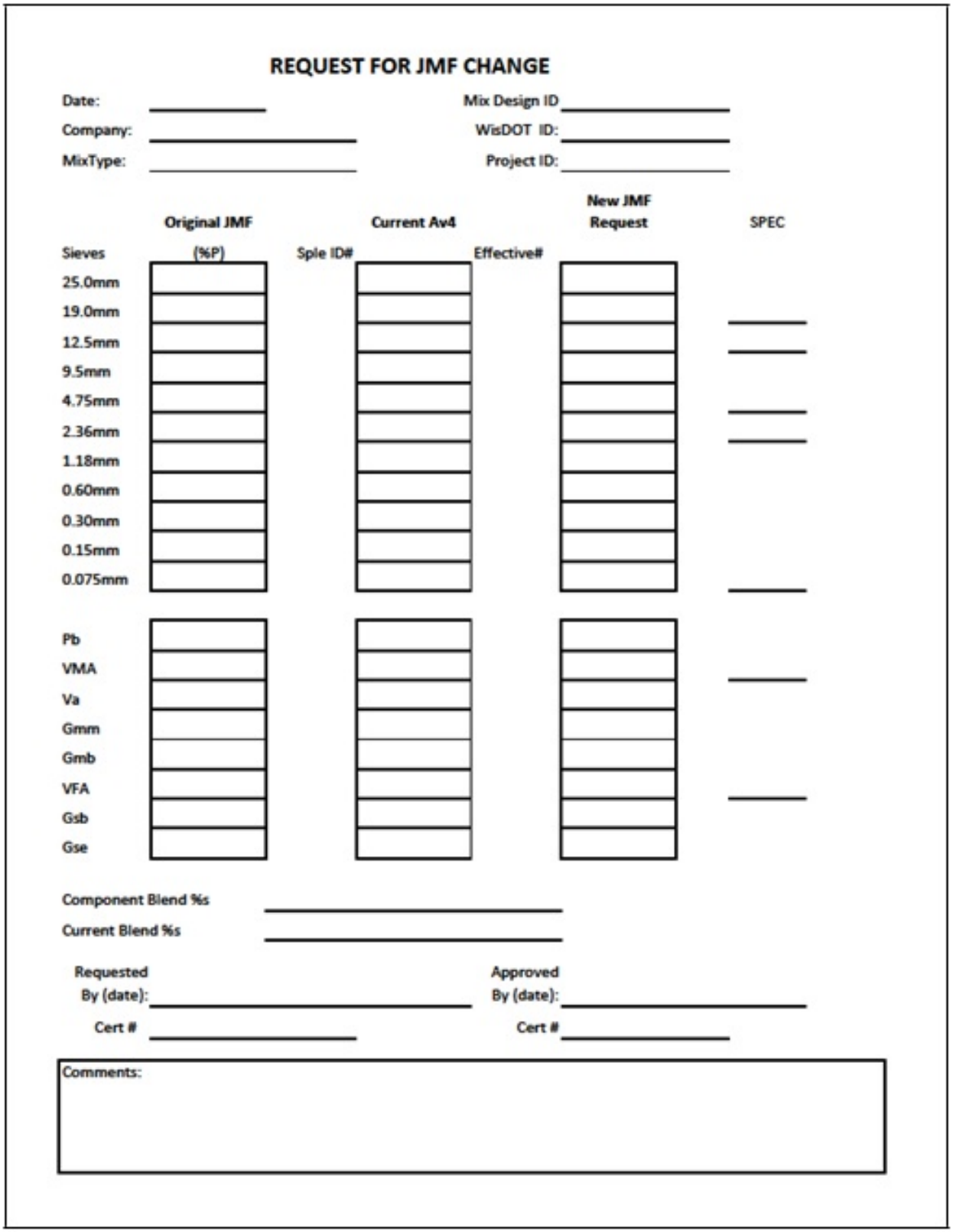
No JMF change requests are to occur before completion of three individual production tests for changes to a control sieve or mixture AC content. Recycled asphaltic binder change requests require two RAM extractions according to CMM 836.6.15. Data from prior production testing do not have to be from state projects but must be sampled and tested by HTCP certified personnel. Testing must occur in a WisDOT approved laboratory, following WisDOT approved methods. When requesting JMF changes, laboratory results must be submitted electronically to substantiate using materials from non-WisDOT projects.

The contractor notifies the project engineer of proposed changes using the "Request for JMF Change" form shown in figure 836-2. Comments must include the sample test number indicating when the change becomes effective. Production adjustments and JMF change request submittals cannot cause target values to violate design requirements. Production tolerances may exceed those targets.

The requested change can become effective up to four individual test points before the current average of four that is indicated on the submitted form. Electronic documentation indicating that the contractor and project engineer had discussed a possible JMF Change must exist, and support this request, if the department is to accept the change. The "Request for JMF Change" form must indicate the lot and sublot where the JMF change will become effective.

Further changes are not allowed until six additional individual test points, according to the normal sampling frequency, for the affected mix property are documented. Each JMF sieve is considered an individual mix property. Control charts for affected properties must accompany JMF change requests.

FIGURE 836-2 Request for JMF Change Form



REQUEST FOR JMF CHANGE

Date: _____ Mix Design ID _____

Company: _____ WisDOT ID: _____

MixType: _____ Project ID: _____

Sieves	Original JMF (%P)	Current Av4 Sple ID#	Current Av4 Effective#	New JMF Request	SPEC
25.0mm					
19.0mm					
12.5mm					_____
9.5mm					_____
4.75mm					
2.36mm					_____
1.18mm					
0.60mm					
0.30mm					
0.15mm					
0.075mm					_____
Pb					
VMA					_____
Va					
Gmm					
Gmb					
VFA					_____
Gsb					
Gse					

Component Blend %s _____

Current Blend %s _____

Requested By (date): _____ Approved By (date): _____

Cert # _____ Cert # _____

Comments:

836.6.14 Production Tensile Strength Ratio Tests

The tensile strength ratio (TSR) is determined according to the procedures in WTM T283. After manufacturing the specimens at the plant, they may be tested in an offsite laboratory. Mixes qualifying for field TSR testing are defined as one of the following:

- Any WMA
- HMA mixes with NMAS of #4 (12.5 mm) or #5 (9.5 mm) gradation with a design TSR < 0.86.

For production TSR, follow WisDOT PWL sampling & splitting procedure, yielding two boxes of material for each the contractor and BTS specifically for TSR testing. The total weight of material sent to the department will be a minimum of 100 lbs. The minimum production TSR requirement is 0.80. In the event TSR <0.80, corrective action must be taken and an additional random sample will be taken by the department to monitor impact of corrective action.

836.6.15 RAM Stockpile Samples

When test results indicate that a change has occurred in the RAM asphalt content, a change in the design RAM asphalt percentage may be requested by the contractor or the project engineer. The request will include at least two recent RAM extractions and also identify all applicable mix designs to be affected. For each affected mix design a new percent binder replacement (Pbr) needs to be calculated and reported. The requested change will be reviewed for the department by an HTCP-Certified HMA Technician at a level recognized for mix design (HMA MD Technician), and a revised JMF can be issued.

836.7 HMA QMP Documentation

836.7.1 General

The contractor is responsible for documenting all observations, records of inspection, and test results on a daily basis. Results of observations and records of inspection must be noted as they occur in a permanent field record. The testing records and control charts must be available in the QC laboratory at the asphalt plant.

The contractor must maintain standardized control charts. Test results obtained by the contractor must be recorded on the control charts the same day the tests are conducted. The aggregate gradation test data must be recorded on the standardized control charts for all randomly selected production samples tested.

Sieve sizes for aggregate gradation tests must include the maximum aggregate sieve size, the NMAS sieve, and any following sieves falling below the NMAS sieve in table 460-1:

1" (25.0mm)	3/4"(19.0mm)	1/2"(12.5mm)	3/8"(9.5mm)	# 4 (4.75mm)	#8(2.36mm)
# 16 (1.18mm)	# 30 (0.60mm)	# 50 (0.30mm)	# 100 (0.15mm)	# 200(0.075mm)	

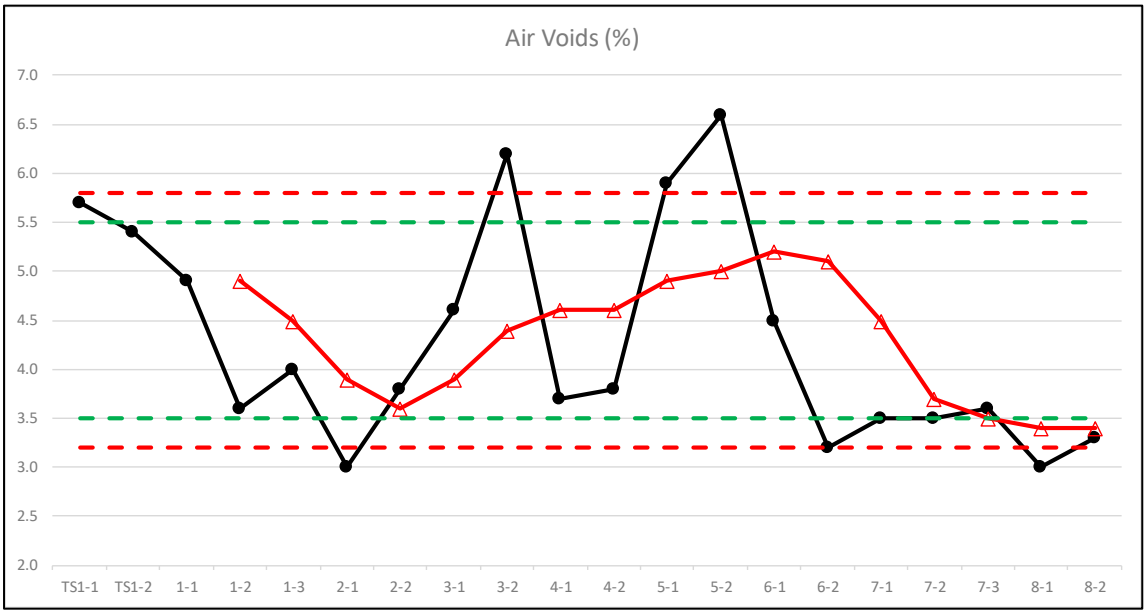
836.7.2 Example Pay Reductions for Control Charts

The engineer will evaluate contractor-supplied control charts and compare the 4-point running average to the control limits specified in standard spec 460.2.8.2.1.5 and the corrective action specified in standard spec 460.2.8.2.1.7. HMA individual data points are not typically analyzed independently. However, individual SMA air voids test results are subject to the additional corrective action criteria specified in standard spec 460.2.8.2.1.7(7) and to pay adjustment as specified in standard spec 460.5.2.1(5) in addition to the control limits that apply to the 4-point running average.

The following example illustrates how to make a pay reduction for SMA air voids.

Example 4

Running Average Analysis of Mixture Samples										
WisDOT Mix ID #: 250-0111-2020				Mix Type: 4 SMA 58-28 V			Site:			
				Cumulative	Gmb		Gmm		Air Voids	
Sample	Sample Date	Lot	Sublot	Sample Tons	Result	Mean	Result	Mean	Result	Mean
5001	7/11/2020	TS1	1	-	2.330		2.470		5.7	
5002	7/11/2020	TS1	2	-	2.360		2.496		5.4	
5755	7/27/2020	1	1	437.0	2.347		2.467		4.9	
5757	7/28/2020	1	2	1495.0	2.373	2.353	2.462	2.474	3.6	4.9
5758	7/28/2020	1	3	2005.0	2.364	2.361	2.463	2.472	4.0	4.5
6500	8/13/2020	2	1	2411.1	2.396	2.370	2.469	2.465	3.0	3.9
6501	8/14/2020	2	2	2846.1	2.375	2.377	2.468	2.466	3.8	3.6
6564	8/14/2020	3	1	3220.7	2.352	2.372	2.466	2.467	4.6	3.9
6567	8/15/2020	3	2	3851.7	2.327	2.363	2.480	2.471	6.2	4.4
6618	8/15/2020	4	1	4650.4	2.377	2.358	2.468	2.471	3.7	4.6
6622	8/15/2020	4	2	5392.4	2.383	2.360	2.477	2.473	3.8	4.6
6738	8/18/2020	5	1	6263.3	2.324	2.353	2.470	2.474	5.9	4.9
6739	8/18/2020	5	2	6941.3	2.307	2.348	2.470	2.471	6.6	5.0
6754	8/19/2020	6	1	7143.0	2.362	2.344	2.473	2.473	4.5	5.2
6758	8/20/2020	6	2	7596.0	2.389	2.346	2.467	2.470	3.2	5.1
7563	9/7/2020	7	1	8031.8	2.392	2.363	2.479	2.472	3.5	4.5
7572	9/8/2020	7	2	9247.8	2.396	2.385	2.483	2.476	3.5	3.7
7573	9/8/2020	7	3	9267.8	2.392	2.392	2.481	2.478	3.6	3.5
7723	9/12/2020	8	1	10472.2	2.397	2.394	2.471	2.479	3.0	3.4
7724	9/12/2020	8	2	10635.2	2.386	2.393	2.468	2.476	3.3	3.4
Count					20		20		20	
Mean					2.366		2.472		4.290	
JMF					2.358		2.469		4.5	
Warning Band (L)									3.5	
Warning Band (H)									5.5	
JMF(L)									3.2	
JMF(H)									5.8	



Example 4A

The first instance of nonconforming air voids in this example involves sublots 2-1, and 3-2. These two individual air voids tests within four consecutive points exceed the JMF limits.

The specified pay adjustment would be applied to the material from the point where an individual test is outside the JMF limit until another individual QV or QC test is within the JMF limits. In this case, the department would pay 80% of the contract unit price for the material from sublot 2-1 to 2-2 (435 tons) and from sublot 3-2 to 4-1 (798.7 tons).

Example 4b

The second instance of nonconforming air voids in this example involves sublots 5-1 and 5-2. These two individual air voids tests within four consecutive points exceed the JMF limits. In this case, the department would pay 80% of the contract unit price for the material from sublot 5-1 to 6-1 (879.7 tons).

Note: Two consecutive four-point running average values (sublots 8-1 and 8-2) exceed the warning limits requiring the contractor to stop production and make adjustments. Production can not resume until the engineer has been notified of the changes made. A new running average will be calculated at the fourth test after the required production stop.

836.8 Documentation

836.8.1 QC Records

In addition to the requirements of standard spec 460.2.8.2.1.4.1, the contractor must provide:

- A cumulative tonnage value and current control charts to the engineer daily.
- Random number generation results and associated tonnage for QMP sampling.
- When submitting charts and running average calculation sheets the contractor mix design ID and WisDOT 250 report number must be included on each sheet. Full name of qualified sampler, tester and qualified lab locations should be on individual sample test property worksheets.
- Blend change history including percentages of aggregates, RAM, AC%, and additives.
- Individual sample test property worksheets (*Note:* More detailed information may be requested or observed during actual production for evaluation purposes. To verify compliance with appropriate test procedure requirements, this information needs to be made available during that on-site evaluation).

Records should be the original (handwritten or electronic) documents. However, the original "source" documents should be maintained in the project records. If the data is entered directly into an electronic document then that is acceptable as the source document. If the original document is handwritten and then transferred to an electronic document, the original handwritten document should be maintained as the "source" document.

When supplying the original "source" document, a scanned copy is acceptable.

Electronic documents are considered to be acceptable during construction, but the original documents need to be submitted after project completion for final project closeout.

836.8.2 QV Records

The contractor needs to post results of department QV testing on the appropriate QC charts for air voids, AC%, and VMA, each represented with a unique symbol.

836.9 Quality Verification Program

836.9.1 Monitoring Contractor QMP

836.9.1.1 Preconstruction

The QV team is responsible for obtaining the following information:

- Obtain WisDOT test number of the quality test report for the aggregate source being used. If source quality testing hasn't been completed, notify the BTS laboratory.
- Obtain the WisDOT test number of the mix design intended for use or a copy of the contractor's mix design, the review report, if available, from department's Materials Tracking system, and any contract special provisions.
- Verify that the QC team personnel have the proper certifications.
- Verify that the QC Laboratory facility is WisDOT qualified and has the equipment required by the QMP specification (inclusive of communication devices).

Review any procedures for determining reheat correction factors and for the G_{mm} dry back correction factor (if applicable). Discuss any necessary calibrations, or pending recalibrations, for the gyratory compactor and what procedure will be used.

836.9.1.2 During Production

During production, the QV team should, as often as they feel necessary:

1. Random Sampling:
   - Check the QC procedures for proper random number generation for all samples.
   - Verify the QC team is aware they are not to inform the plant before the random sampling will occur.
2. Samples:
   - Ensure all required samples are being taken for mixture properties and blended aggregate gradations.

- Ensure that proper sampling and splitting procedures are being used and the field sample size is large enough to accomplish required testing.
- Ensure that stockpile samples are taken and tested for reclaimed asphaltic pavement (RAP) when applicable.
- Ensure tensile strength ratio (TSR) tests have been conducted at proper intervals for mixtures in standard spec 460.2.8.2.1.3.1(6).
- Ensure that the retained samples (mix and blended aggregate) are properly labeled and stored in a dry protected area.

3. Testing:
   - Observe the reduction of the field samples to test size.
   - Observe the testing procedures paying attention to temperature of test samples before compaction, compaction efforts, times allotted between tasks, dry backs, etc.
   - Review data calculations.
4. Control charts:
   - Check to see that required control charts are present and up to date.
   - Check to see that control limits and warning bands are accurately drawn.
   - Check to see that the proper values are being plotted correctly.
5. Documentation:
   - Check to see that records of compliance are being documented and are up to date.
   - Check to see that adjustments to mixtures and JMF changes are noted on field records.
   - Check to see that records have been provided to the QV team on a daily basis.

836.9.2 Verification Sampling

Product quality verification sampling is the responsibility of the department's QV team. This requires QV personnel to obtain any backward QC-retained samples accumulated each time a QV sample is collected. This process also requires contractor to accumulate QC-retained samples between QV samples. If QC-retains are not available for verification testing if/when needed, liability for that mixture may include back/forward to production start-up/end or next available QV sample test result in either direction.

836.9.2.1 Plant Sampling

Samples from the truck box will be taken by a member of the contractor QC team, and directly observed by the QV team member. In addition, if the initial split (QV / QV-retained) is performed by the contractor, it is also to be directly observed by the QV team member.

The QV team will determine and document the random sampling procedure employed for mixture verification samples. QV random samples should be determined from production tonnage.

If some other method is used, it should be mutually agreed upon between the QV and QC teams and documented before taking place.

The contract language specifies "two mixture production days" after the sample has been obtained by the contractor as the time within which the QV personnel must respond to the QC team relative to the agreement of data results. The intent is to provide information and feedback to the QC team as soon as practical in case there is data disagreement and the potential need to stop mix production.

If the QV mixture sample temperature is 230 degrees F or higher when delivered to the testing facility, quartering may start immediately. If the temperature is below 230F, place in a 300F oven, until workable for quartering, but not to exceed two hours. Microwaves are not to be used to reheat an HMA sample.

836.9.3 Determining Acceptable Verification Parameters

Whenever a flag has been raised by disagreement of QV test results with the defined acceptable parameters, immediate investigation will occur using additional testing, troubleshooting, and dispute resolution actions.

836.9.3.1 Additional Testing

When a QV test result does not meet the specified acceptance limits specified in standard spec 460.2.8.3.1.6 the engineer must collect the following samples and send them to BTS for dispute resolution testing:

- QV-retained sample.
- All QC-retained samples backward to the last passing QV test or to the beginning of the project if no QV samples have been taken.
- All available QC-retained samples forward to the next passing QV test or to the end of the project.

The engineer must send these samples to BTS immediately for referee testing. An additional non-random QV sample will be collected either when the department representative goes to the contractor to collect the necessary QC-retained samples (or as soon as production resumes if the mix is not currently being produced). The collection and shipment of necessary QC-retained samples to BTS will not be delayed by the collection of a non-random QV sample if the mix is not currently being produced.

Below are examples of the testing of QV-retained and any needed forward and backward QC-retained samples.

Example 5

A QV sample taken following QC test 5-3, falls outside of 2.0 to 4.3% air voids (3.2 to 5.8% for SMA). The WisDOT - BTS lab tests retained portion of QV sample, along with QC-ret sample 5-3 and QC-ret 5-4 once available. The Bureau continues testing of retained samples both forward and back until a test result in each direction meets criteria for 75% pay in accordance with figure 836-3 (i.e., 1.8 to 4.6% air voids, or 2.9 to 6.1% for SMA). If this criterion has not been met and no further QC-retained sample exists in a given direction, then liability for that mixture may include back to production start-up/end or QV sample.

BTS is to provide QC retained split sample testing on the nearest forward QC sample as soon as practical, and continue until the QC-retained split sample is 1.8 to 4.6% air voids and (2.9 to 6.1% for SMA) and within 0.7% minimum VMA.

In addition, when the QV team is back on the site to obtain the additional QC-retained samples, another QV sample will be taken.

Example 6

The QV sample taken following QC test 5-3, falls outside acceptable parameters. The QV team returns to the plant site on day 7 and obtains any QC-ret samples forward of sample 5-4 available at that time (to be sent to the WisDOT-BTS lab), and directs a new QV sample be taken representing day 7.

836.9.3.2 Troubleshooting

The following points are to be considered and re-checked:

- Calculations.
- QC data trends.
- Equipment calibration records.
- Sampling and splitting observations/notes.
- Proper use of re-heat correction factors.

If a 0.020 or greater variability exists between QC and reheated samples (matching QC-retained portion), then a Gmb reheat correction factor is determined to aid in troubleshooting.

- Gmb reheat correction factor (calculated to 0.001) = Gmb (un-reheated) / Gmb (reheated).
- Apply the correction factor to the reheated sample: Corrected Gmb = Gmb (reheated) X correction factor.
- When comparing the uncorrected Gmb to the corrected Gmb, if the difference is less than 0.005, then the correction factor will not be used.

If a 0.015 or greater variability exists between QC and reheated samples (matching QC-retained portion), then a Gmm reheat correction factor is determined to aid in troubleshooting. It should be calculated to 0.001.

- Gmm reheat correction factor (calculated to 0.001) = Gmm (un-reheated) / Gmm (reheated).
- Apply the correction factor to the reheated sample: Corrected Gmm = Gmm (reheated) * correction factor.
- When comparing the uncorrected Gmm to the corrected Gmm, if the difference is less than 0.005, then the correction factor will not be used.

836.9.3.3 Dispute Resolution

For the results of the additional testing conducted according to CMM 836.9.3, the contract language specifies reporting the results of the referee testing within three business days after receipt of the samples. The receipt day refers to receipt of the samples at BTS. The intent is to provide test information and feedback to the QC/QV team as soon as practical and targeting within 7 business days of the date of the failing QV sample.

At the completion of dispute resolution testing (QV-ret and required backward and forward QC-ret) the BTS personnel dealing with asphalt mix designs will provide documentation to the QV team recommending tonnages to be affected based on the following information:

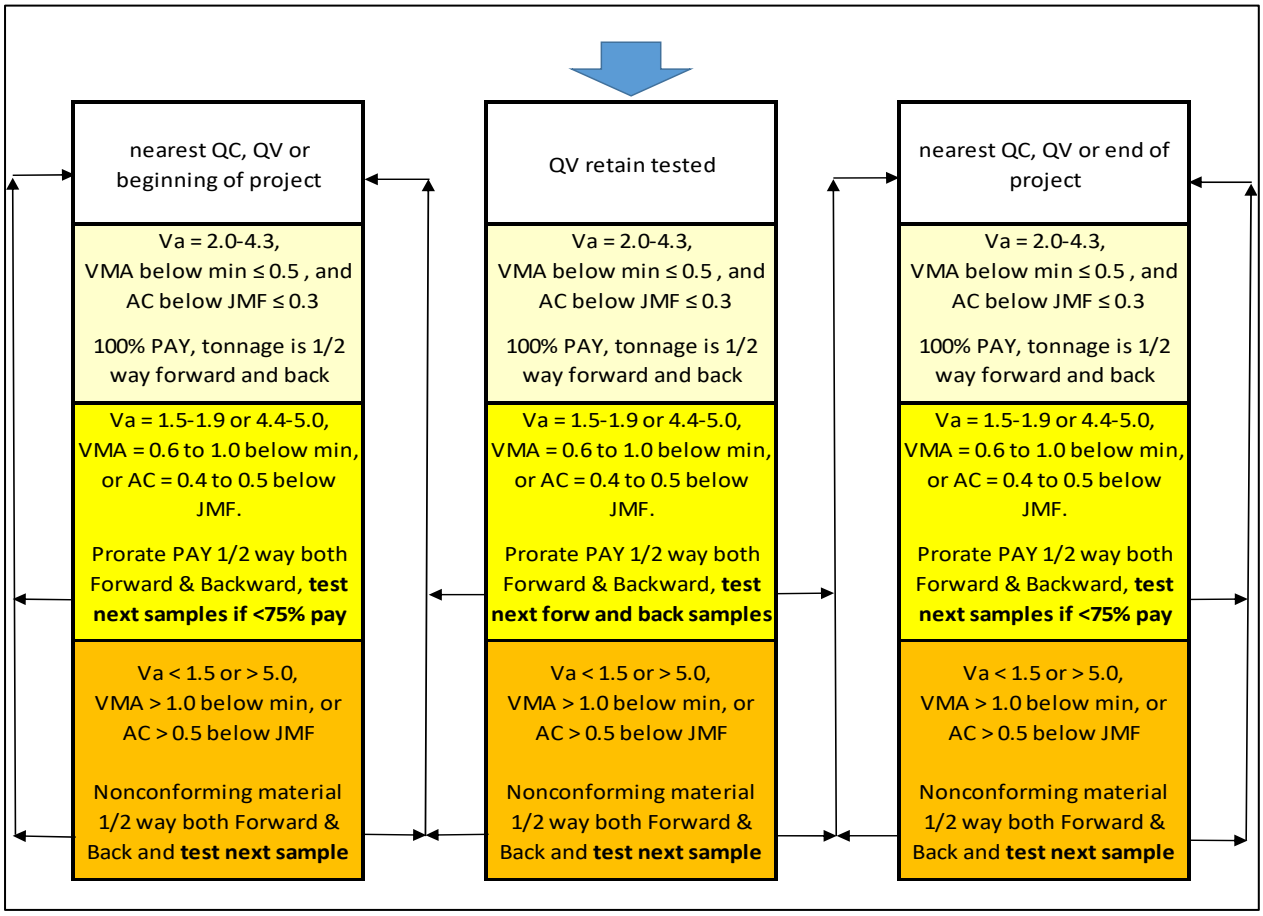
- Gmm & Gmb as measured by BTS.
- Air Voids as calculated from BTS volumetric data.

- VMA of QC/QV-ret samples tested by BTS.
- Asphalt binder % (AC) as determined by BTS using automated extraction.

The general process flow chart for dispute resolution is shown in figure 836-3. Example scenarios are provided in figure 836-4 (based on HMA requirements). If the range of affected tonnage is determined to be at the QV (isolated problem), a pay adjustment calculated to tonnage halfway between samples will be assessed. There is no intent to use multiple pay adjustments, but the lowest percent pay will supersede others.

The QV team will further complete documentation responsibilities by determining the dollar amount for any affected mixture tonnage and will forward that information to appropriate project personnel and the QC team. Figure 836-5 is an example of a spreadsheet used to calculate pay adjustments.

FIGURE 836-3 HMA Dispute Resolution Flow Chart



- Pay of less than 100% on QV-retain test will result in additional testing of forward and back sample.
- Pay of less than 75% on forward or backward QC-retain will result in testing of the next forward or backward sample.
- Unacceptable material must be removed and replaced at no cost to the department. Alternatively, the engineer may allow the material to remain in place with a 50 percent payment factor.

HMA prorated pay factors (between 50 and 100% pay) are as follows:

Description	Criteria	Pay Factor
High Air Voids Pay Factor	4.3% < Va ≤ 5.0%	= 100 - (Va - 4.3) * 71.4
Low Air Voids Pay Factor	1.5% ≤ Va < 2.0%	= 100 * [1 - (2.0 - Va)]
Low VMA Pay Factor	0.5% < VMA below min ≤ 1.0%	= 100 * [1 - (percent below min. - 0.5)]
Low AC Pay Factor	0.3% < AC below JMF ≤ 0.5%	= 75

When using figure 836-3 above for dispute resolution of SMA material apply the following:

- SMA 100% pay requires: Va = 3.2 - 5.8%, VMA below min ≤ 0.5%, and AC% below JMF ≤ 0.3%.
- SMA 50% pay corresponds to: Va < 2.5% or > 6.5%, VMA below min > 1.0%, or AC% below JMF > 0.5%.

SMA Prorated Pay Factors (between 50 and 100% pay) are as follows:

Description	Criteria	Pay Factor
High Air Voids Pay Factor	5.8% < Va ≤ 6.5%	= 100 - (Va - 5.8) * 71.4
Low Air Voids Pay Factor	2.5% ≤ Va < 3.2%	= 100 - (3.2 - Va) * 71.4
Low VMA Pay Factor	0.5% < VMA below min ≤ 1.0%	= 100 * [1 - (percent below min. - 0.5)]
Low AC Pay Factor	0.3% < AC below JMF ≤ 0.5%	= 75

FIGURE 836-4 HMA Verification Dispute Resolution Scenario Examples

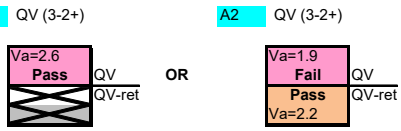
NOTE: *The following diagrams (A-H) represent standard scenarios. Specific project detail and troubleshooting activities may present cause for adjustment to this guidance*

= Testing performed by the Region
= Testing performed by the Referee third party (BTS)
= QC random production sample

A standard recommendation will be assessed based on the following requirements:

- Va is within a range of 2.0 to 4.3 percent.
- VMA is within minus 0.5 of the minimum requirement for the mix design nominal maximum aggregate size.
- AC is within minus 0.3 of the JMF

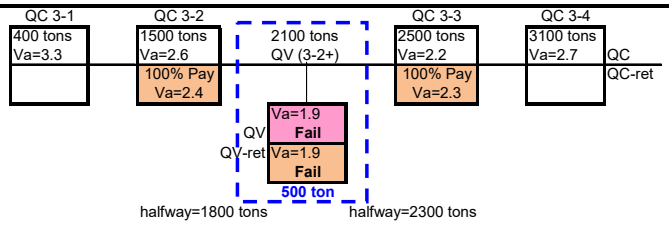
Example A



END RESULT

A **No Adjustment** (N/A) QMP Controls
**The Referee third party (BTS) test results determine the Pass/Fail status of the QV sample once it has gone into Dispute Resolution*

Example B 1



END RESULT

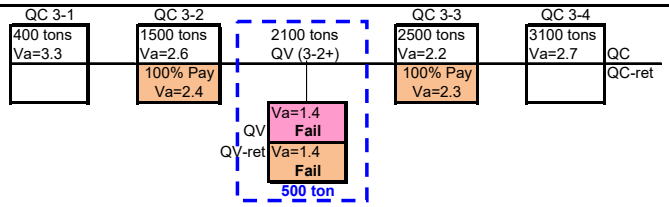
B1 **Isolated Area** : Localized Problem (Prorated)
Backward and forward QC-ret results are acceptable (100% pay)

Calculate halfway from failing QV-ret both forward and back

(ex: 2300 - 1800 = 500 ton @ 90% pay)

Percent pay for any adjustment will be determined by the tiered system presented in Figure 7

Example B 2



END RESULT

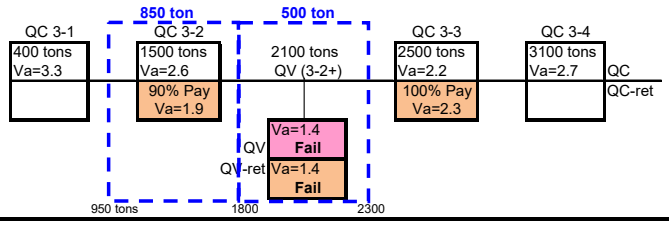
B2 **Isolated Area** : Localized Problem (50%)
Backward and forward QC-ret results are acceptable (100% pay)

Calculate halfway from failing QV-ret both forward and back

(ex: 2300 - 1800 = 500 ton @ 50% pay)

Percent pay for any adjustment will be determined by the tiered system presented in Figure 7

Example C



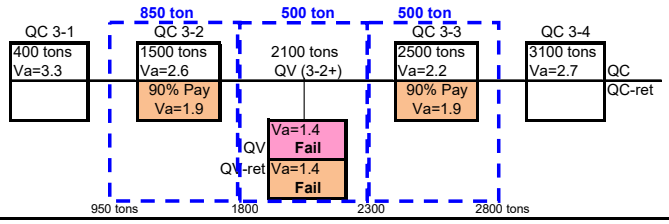
END RESULT

C **Uni-directional QC-ret <100% Pay**
Backward or forward QC-ret <100% Pay

Each test result represents the material halfway to the adjacent point. Therefore, this scenario results in one area of pay adjustment (in the Backwards direction) in addition to the initial verified QV-ret area. Testing does not continue if QC-ret ≥75% Pay

(ex: 1800-950 = 850 ton @ 90% pay)
(ex: 2300-1800 = 500 ton @ 50% pay)

Example D



END RESULT

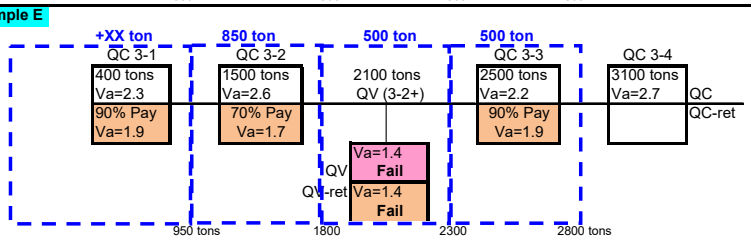
D **Bi-directional QC-ret <100% Pay**
Backward and forward QC-ret <100% Pay

This scenario results in two areas of pay adjustment in addition to the initial verified QV-ret area.

Testing does not continue if QC-ret ≥75% Pay

(ex: 1800-950 = 850 ton @ 90% pay)
(ex: 2300-1800 = 500 ton @ 50% pay)
(ex: 2800-2300 = 500 ton @ 90% pay)

Example E



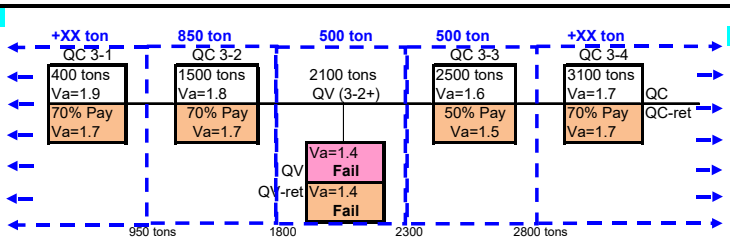
END RESULT

E **Additional Backward testing**
Backward QC-ret is < 75% Pay
Forward QC-ret is > 75% Pay

Backward testing continues beyond QC-ret 3-2, until resulting in ≥75% Pay, as seen with QC-ret 3-1.

Therefore, pay adjustment will affect tonnage halfway back to the last QC test of Day 2

Example F



END RESULT

F **Additional Forward & Backward testing**
Forward QC-ret is <75% Pay
Backward QC-ret is < 75% Pay

Both Forward & Backward testing continue until a QC-ret results in ≥75% Pay. Pay adjustements are then calculated for the appropriate tonnage per area & corresponding percent pay

Pay adjustment may continue to beginning & end of production.
Areas of 50% pay are subject to Remove & Replace

FIGURE 836-5 Adjustment Calculation Example

Project ID: xxxx-xx-xx MIX TYPE: 4 MT xx-xx S MTS Record: x-254-00xx-20xx

Recommended Adjustments	% Pay SS 460.2.8	Affected Mix Tons	Mix Bid Price	TOTAL Adjustment (w/h)
Air Void Failure	50%	500.0	$ 55.27	$ 13817.50
VMA Failure	75%	0.0	$ 55.27	$ -
				$ 13817.50
Comment:				

Alternate/Final Adjustments	% Pay SS 460.2.8	Affected Mix Tons	Mix Bid Price	TOTAL Adjustment (w/h)
Air Void Failure	50%	500.0	$ 55.27	$ -
VMA Failure	75%	0.0	$ 55.27	$ -
				$ -
REMARKS:				

Contact BTS for further assistance.

SECTION 838 Ride Quality

838.1 Profile Testing for Ride Quality

Under standard spec 740, the contractor is required to measure ride quality on all mainline travel lanes of all roadway classifications. This ride quality specification applies to all project types, including rehabilitation and maintenance projects, unless the contract includes a special provision intentionally removing the ride quality specification. Guidance in FDM 19-21 gives situations where using the ride spec may not be appropriate.

The contractor measures ride with an inertial profiler to determine the International Roughness Index (IRI) for each wheel path of each driving lane. Profile all mainline riding surfaces that are greater than 1500 feet in continuous length including bridge decks, bridge approaches, intersections, railroad crossings, and pavement gaps. If an area, such as a bridge deck, is not constructed under the contract and is excluded from localized roughness, the area is still profiled as the data is necessary to compute segment IRI ride quality and subsequent pay adjustments.

Profiling is done at a constant speed, so profilers need a minimum run-in length to reach that test speed. They also need a run-out after the profile run to slow the vehicle; 150 feet is the typical run-in and run-out length. A minimum continuous pavement length of greater than 1500 feet was established since that would provide the required 300-foot run-in and run-out lengths and still have at least 1200 feet of pavement between them to profile. Accelerating or decelerating during data collection will adversely affect results; consequently, roundabouts, entry and exit curves leading to and from roundabouts, ramps, turn lanes, and other areas that typically involve accelerating or decelerating are excluded from ride quality testing.

Auxiliary lanes longer than 1500 foot need to be profiled. Other locations, such as high-speed connection ramps, need to be profiled if specified in the contract special provisions.

Bike lanes and shoulders are not driving lanes and are not typically profiled.

838.2 Equipment and Personnel

The contractor is required to use a profiler on the department's list of approved devices and operated by a person who is certified under the department's highway technician certification program. A profiling device should be re-approved whenever changes or repairs are made to the device that may affect data collection or analysis, including repairs made to the profiler components or software. The contractor should provide the engineer with documentation related to recent calibration activities the contractor has performed with their profiler. Components to be calibrated include the height sensors, accelerometers, and distance measuring instruments. The engineer should verify that the profiler and operator are certified, the device has been properly calibrated, and daily calibration verification has been performed. The engineer should also verify proper use of the profiler on the project (correct wheel path locations, etc.).

838.3 Testing

The schedule for acceptance testing is at the contractor's discretion and is coordinated with the engineer. The anticipated acceptance testing schedule, along with any traffic control and lane closure needs, should be included in the contractor's quality control plan; deviations from the plan must be submitted in writing. The department prefers that acceptance testing of the ride quality be performed in a single run from one end of the project to the other, but this is not required.

If there is phased construction or other traffic control issues allowing public traffic onto portions of the roadway, the engineer may direct the contractor to profile those portions of a project separately. When performing acceptance profiling on portions of a project rather than an entire run, be sure to collect the data for whole segments at a time to allow for easy compilation of the data for the entire profile run. Trail vehicles should be used when profiling live traffic lanes to enhance visibility, provide a buffer zone, and promote safe data collection. The contractor should discuss any additional traffic control needs with the engineer.

Operators and field staff should be aware that the profile run distances and project stationing distances may not match as testing is performed. The project stationing is a horizontal distance on a specific reference line, while the measured profile distance is a traveled distance affected by vertical and horizontal curves along each wheel path location. The tester should start each profile at either the beginning or ending project station, depending on the direction of travel. It is important to keep proper documentation to ensure that necessary field-locates can be performed after data analysis is completed.

It is important that the operator follow the manufacturer's recommendations for proper run-in and run-out distances at the beginning and end of each run. Mark the profile start and end locations and conduct a 'dry' practice run, when possible.

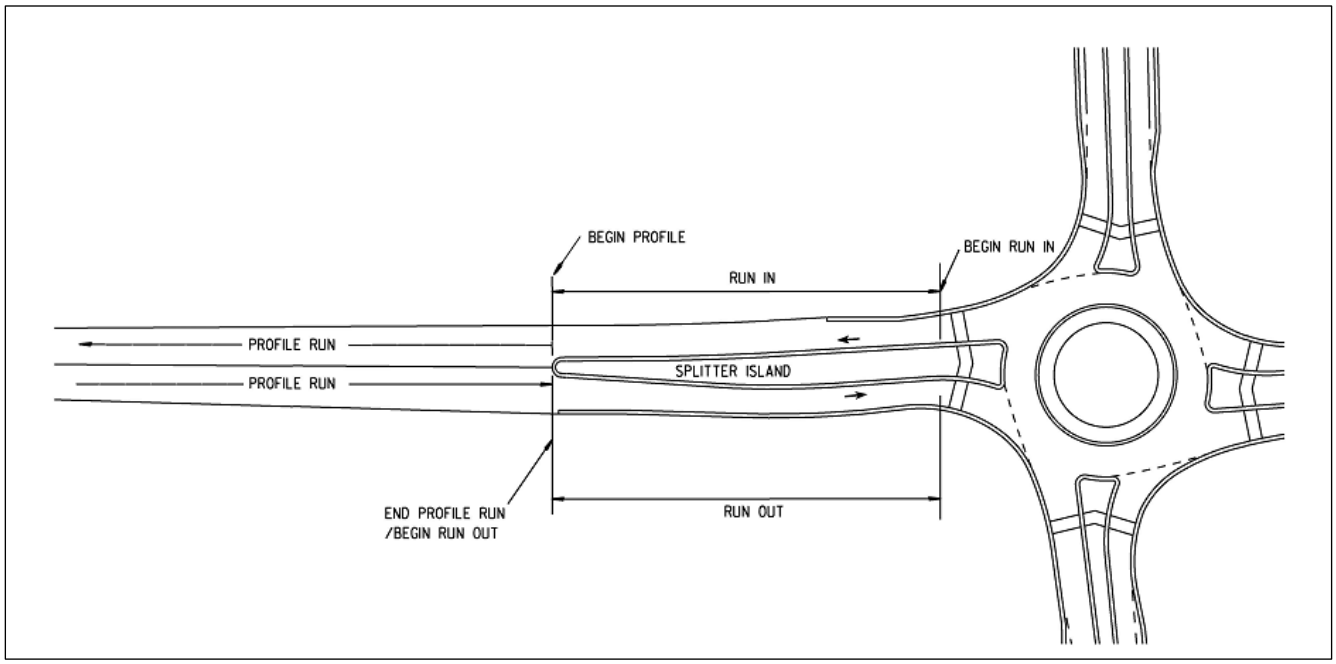
It is highly recommended that the contractor perform process control testing of the ride periodically during construction to identify problems and ensure that the end result will be a smooth pavement. Process control testing is not required by the contract, nor is the contractor required to have a profiler on site during paving operations. However, the engineer can request ride information if there appears to be a ride-related problem during construction of the pavement, and the contractor should provide the ride information in a timely manner to ensure that corrections can be made to the construction operations. Most contractors will be reluctant to assume the risk of a substantial disincentive pay deduction for ride at the end of the project and will want to measure ride frequently during construction to avoid that risk.

838.3.1 Profiling Pavements To and From a Roundabout

Pavements leading to roundabouts have entry curves to slow traffic as it approaches the circulatory roadway. Entry curves are designed to provide sufficient space for traffic to safely decelerate. Splitter islands typically extend to the beginning of entry curves, the point at which drivers are expected to begin decelerating and are usually a minimum of 200 feet in length. When profiling a lane leading to a roundabout, end the profile run at the end of the splitter island. The length of pavement alongside the splitter island will serve as the profiler run-out.

Many roundabouts, particularly those on high-speed roads, do not have exit curves or they have exit curves with very large radii. In most cases, the run-in can begin shortly after exiting the circulatory roadway and after any pedestrian crossings. Begin the profile run at the end of the splitter island if the manufacturer's recommended run-in length is met.

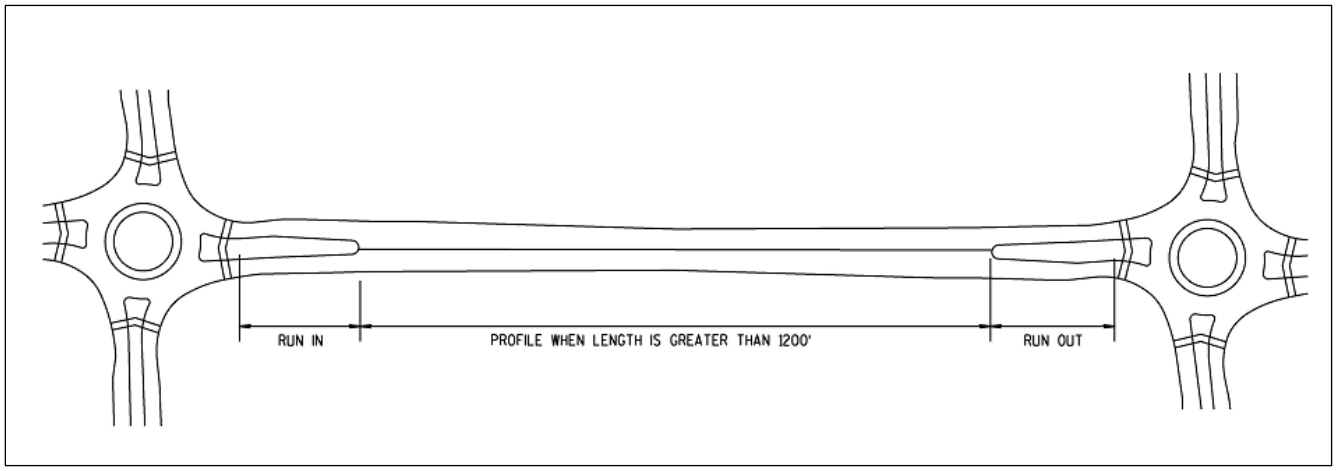
FIGURE 838-1 Profiling Pavements To and From a Roundabout



838.3.2 Profiling Pavements Between Roundabouts

Roadways between roundabouts should be profiled if the actual profile length, between the splitter islands, is greater than 1200 feet. Projects that meet this criterion will have pavement lengths, between pedestrian crossings, greater than 1500 feet since splitter islands are typically longer than the 150-foot minimum run-in/run-out length. Although the roundabout circulatory roadway and the pavement alongside the splitter islands are exempt from profiling, they are still subject to straightedging and engineer-directed corrective actions.

FIGURE 838-2 Profiling Between Roundabouts

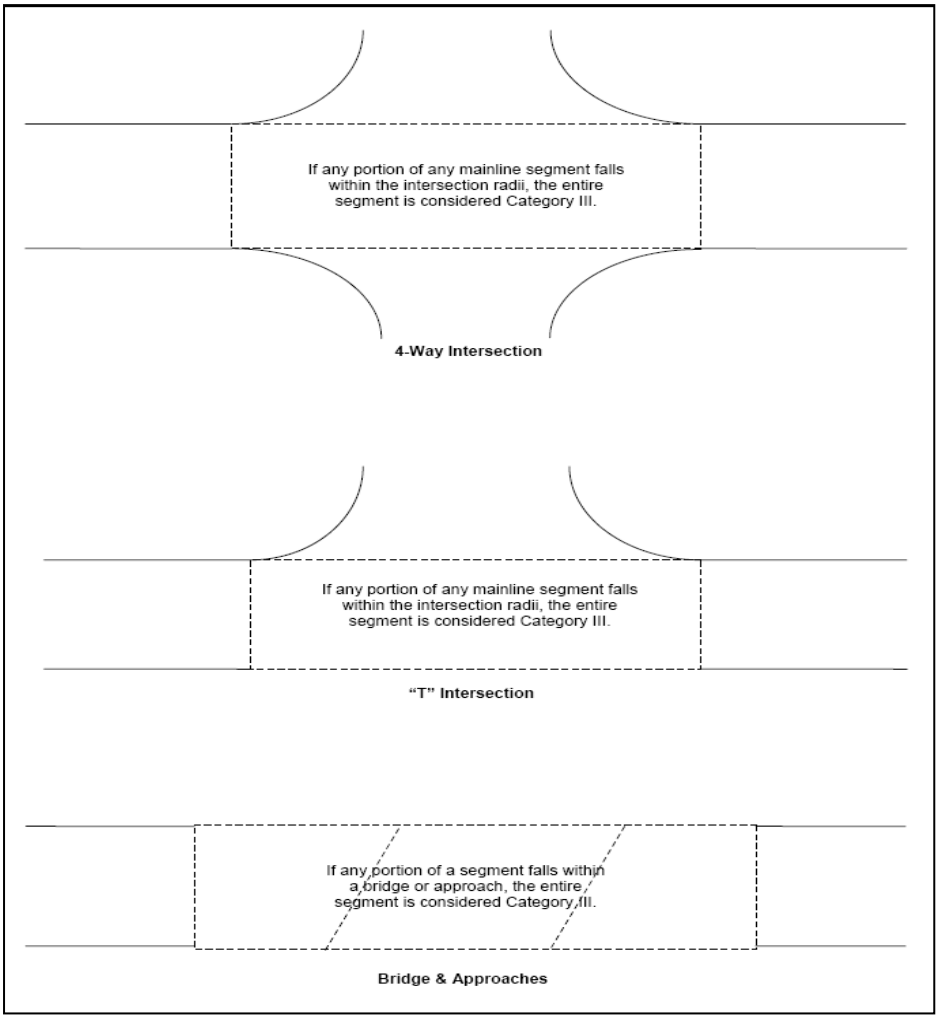


838.4 Pavement Categories

The Ride Quality specification subdivides mainline pavement into 500-foot long categorized segments. The categories are defined in standard spec 740.3.2 and are based on the pavement type, posted speed limits, and various factors that can affect the contractor's ability to construct a smooth riding surface. Category III segments have a posted speed limit of at least 55 mph and include any portion of a paving obstacle such as a bridge, bridge approach, railroad crossing, intersection, or a gap (for concrete pavements). Examples of Category III segment locations are shown in figure 838-3. Categories IV segments are HMA & PCC segments with any portion having a posted speed limit less than 55 mph and also include any portion of a paving obstacle as defined in category III segments. RCDG V and UCDG V categories apply to pavements that are to be continuously diamond ground.

The pay equations and specification limits vary with each category.

FIGURE 838-3 Category III Segment Locations



838.5 Localized Roughness

838.5.1 Localized Roughness Corrective Actions

All areas of localized roughness, whether determined from profiler data or by straightedge, are subject to engineer-directed corrective actions to improve ride quality. Contractors are compensated extra for corrective actions in exclusionary zones.

The engineer and contractor should carefully consider the cause of profile irregularities when analyzing the profile data. It is not always in the best interest of the department to require repairs when roughness is shown on the profile. Grinding may not be warranted nor desired in some locations such as bridge decks or near utility obstructions.

Category IV and UCDG V segments are found in urban areas where there are many factors to consider when determining the cause of roughness and the appropriate action to take. Dips, for example, will cause profile irregularities, and consideration should be made in those instances to ensure that proposed corrective actions will improve the ride quality and not adversely affect roadway drainage.

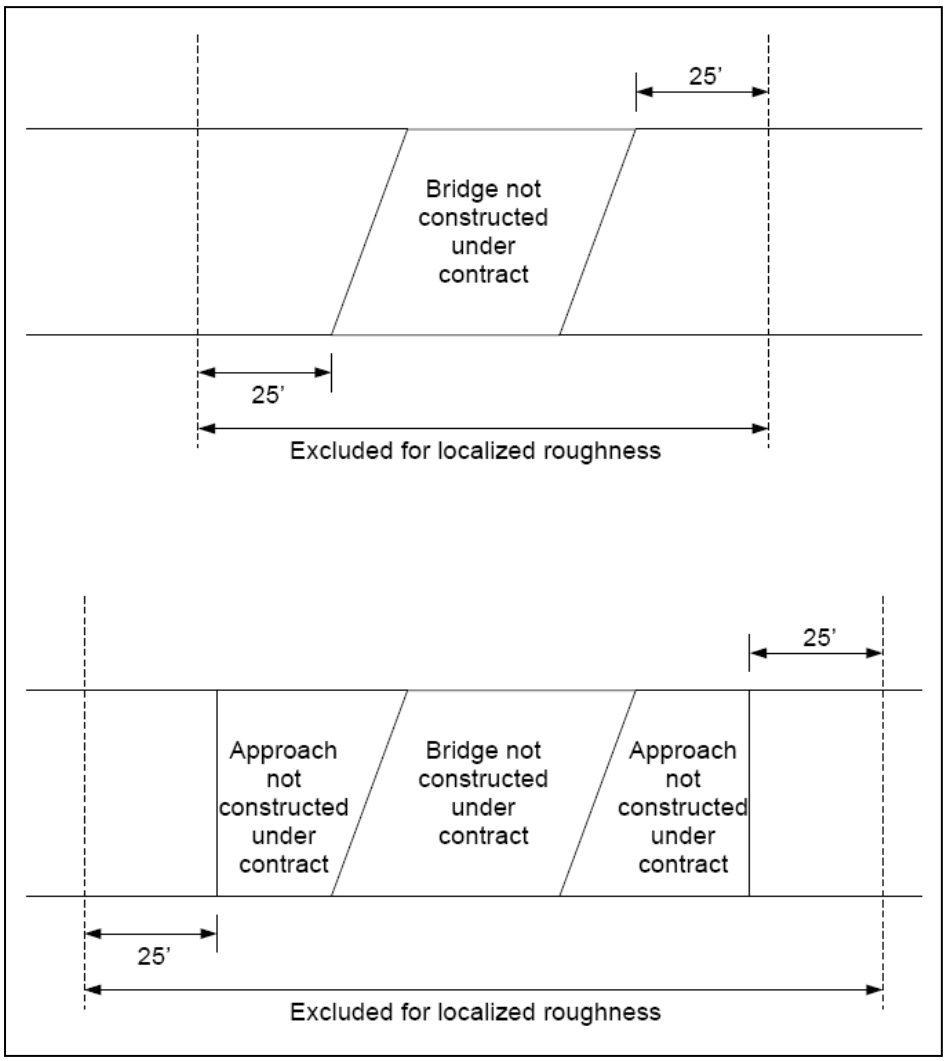
The engineer will not direct corrective action or assess a disincentive for area(s) of localized roughness without independent identification of that area as determined by physically riding the pavement.

838.5.2 Localized Roughness Pay Adjustments

Category IV and Category V segments are excluded from localized roughness pay reductions.

Bridges, bridge approaches, railroad crossings, and 25 feet of pavement leading to and from these paving obstacles are considered exclusionary zones if they are not constructed under the contract (see figure 838-4). As such, they are excluded from localized roughness pay reductions. The department will compensate the contractor for engineer-directed corrective actions within these exclusionary zones.

FIGURE 838-4 Localized Roughness Exclusionary Zones



If bridges, bridge approaches, or railroad crossings are constructed under the contract, then the 25 feet of pavement leading to or from these paving obstacles is subject to localized roughness pay reductions and corrective actions without extra compensation. However, the contractor is compensated extra for any engineer-directed corrections made on any bridge decks or bridge approaches. The engineer will not direct corrective action on any bridges or bridge approaches without authorization from BOS.

The engineer evaluates each area of localized roughness that was not corrected and is not excluded from localized roughness pay reductions. The engineer needs to first determine if the roughness can be felt when driving on the pavement. If the roughness can be felt, the engineer needs to consider whether or not the roughness could have been prevented.

It is the responsibility of the contractor to construct all items including manholes, curb & gutter, and the final riding surface according to the plans and specifications. Some design features may cause poor ride quality, including varying pavement cross-slopes for drainage or matching into roadside features, and stamped pavement or other surface enhancements required in the contract. If a design feature is the cause of poor ride quality, and all items, including the riding surface, were constructed as specified, then localized roughness disincentives are not warranted.

Some rehabilitation and expansion projects can be a challenge to construct smoothly since the condition of the existing pavement may affect the constructability. If a contractor utilizes all means to construct a smooth riding pavement, and localized roughness is due to existing conditions outside of their control, then localized roughness disincentives are not warranted.

If it is determined that areas of roughness could have likely been prevented by any means, then the engineer should apply localized roughness pay reductions.

Re-profile corrected areas to verify that all segment IRIs are less than 140 in/mile.

838.6 Segment IRI Pay Adjustments

IRI Ride incentives for Category I, II, III, and IV segments are based on the initial IRI of each segment. Ride incentives for Category III segments are based on the category of the adjoining segments. Ride incentives for Category V segments are based on the final IRI—after localized roughness corrections.

IRI ride disincentives only apply to Category I or II segments and are based on the final, after-correction, IRIs.

Ride disincentives are not applied to HMA pavements placed in cold weather because of a department-caused delay.

838.7 Documentation and Reporting

Figure 838-5 shows a recommended protocol for naming the data files of each profile run.

838.7.1 ProVAL

Analyze the ride data utilizing the ProVAL software. Instructions for downloading and using the software can be found at:

https://www.roadprofile.com/

Use ProVAL to compute the IRI for each segment, determine areas of localized roughness, and simulate any corrective actions. Create two ride quality reports—one for segment IRI and one of the localized roughness. Prepare the reports using the following parameters in ProVAL:

	FIXED INTERVAL	CONTINUOUS (LOCALIZED ROUGHNESS)
Base-length feet	25 feet	
Threshold inches/mile	inches/mile	

Create both ride quality reports in *.pdf format and also in *.xls format. The ride quality Excel (*.xls) files are generated to allow for easier editing of the data/format to accommodate importing into Materials Reporting System (MRS). After making the necessary modifications, save the files as text (tab delimited) (*.txt) files.

Submit the required ride quality information electronically using the MRS IRI software available at:

http://www.atwoodsystems.com/

838.7.2 MRS IRI

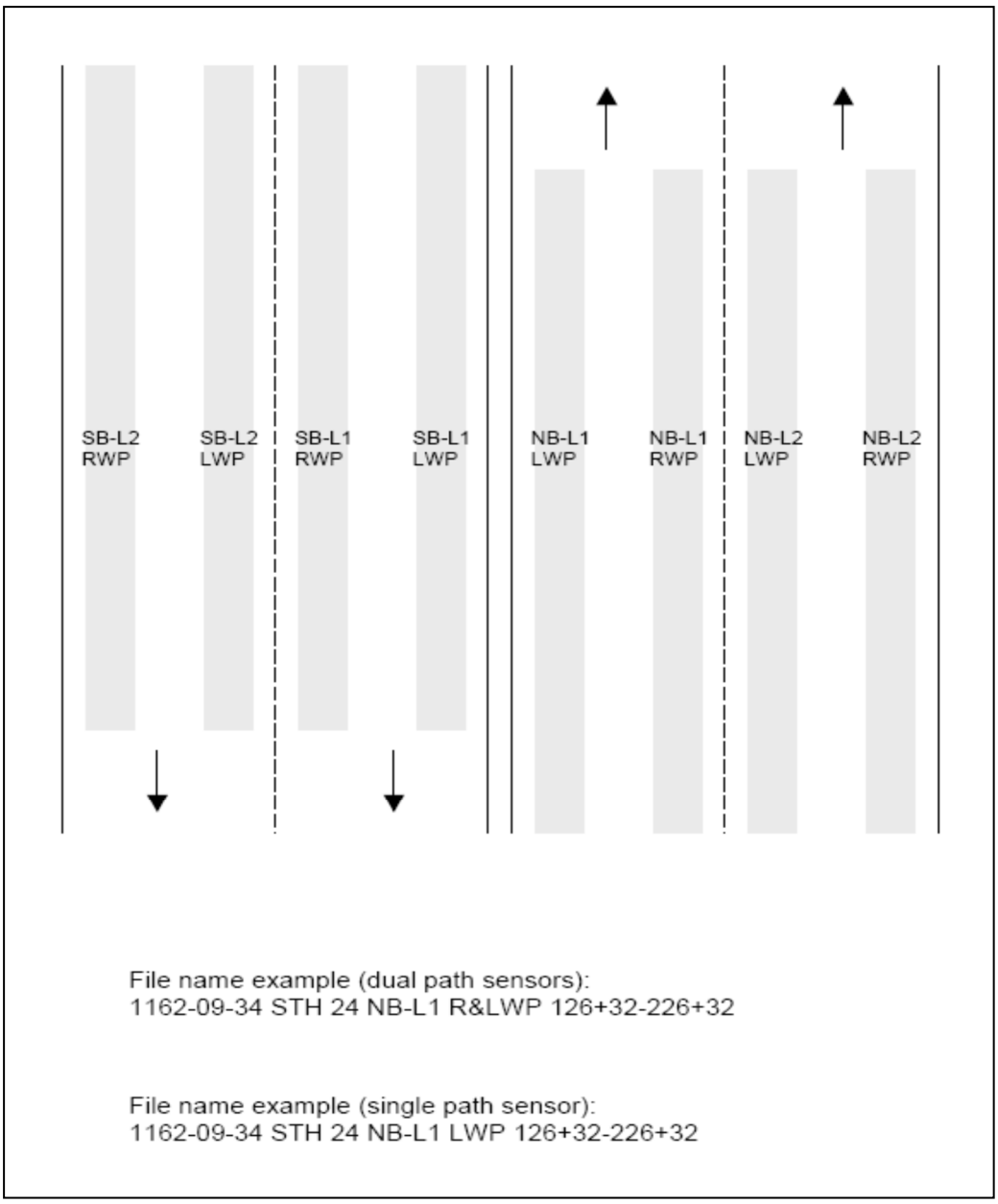
Use the 'Attach Source Files' tab to upload the profiler raw data files for each profile acceptance run and also to upload the two ride quality module reports in *.pdf format. Complete the data fields in all screens of MRS. The segment IRI and the localized roughness *.txt files can be imported into the 'Ride Details' and 'Roughness Data' screens, respectively. Submit the data and the reference files by selecting 'Send Verified Ride Data' and also 'Send *.ppf & Other Reference Files'. Notify the engineer after the data has been submitted.

838.7.3 Highway Quality Management System (HQMS)

The department reviews and verifies the contractor's data through the HQMS website. Verify the segment categories, exclusions noted, and carefully review the pay adjustments. Make any necessary adjustments. The HQMS website can be accessed at:

http://www.atwoodsystems.com/

FIGURE 838-5 Recommended Protocol for Naming Profile Runs



838.8 Diamond Grinding

Pavements may require diamond grinding to improve the ride. The equipment required depends upon whether the work is done under the Continuous Diamond Grinding Concrete Pavement bid item or if intermittent grinding is required to correct problems with new pavement.

The weight, grinding head width, and effective wheelbase for various applications are specified in standard spec 420. The department requires heavier, wider equipment to be used for continuous grinding while lighter weight, narrower equipment will suffice for intermittent grinding for ride correction. The department requires equipment used for continuous grinding on high speed installations to have a longer wheelbase than equipment used on lower speed installations or in areas difficult to access.

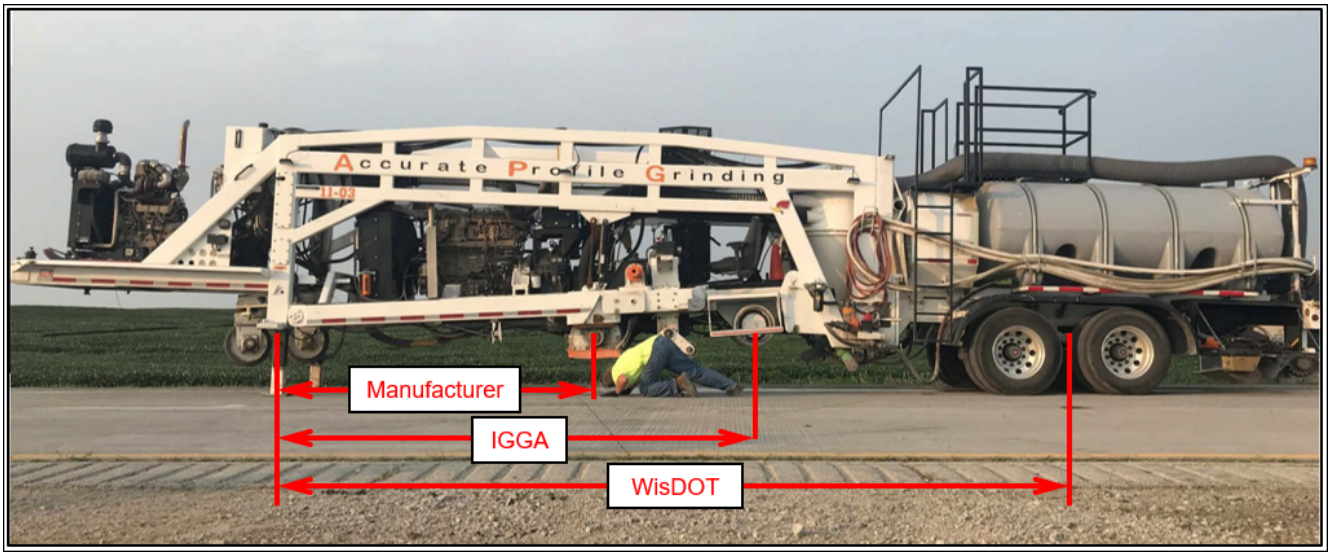
Because manufacturer's specifications define effective wheelbase one way and the International Grooving and Grinding Association (IGGA) guide specifications define it another way, to avoid confusion the department defines it explicitly in standard spec 420.3.2.1.

The contractor's equipment must conform the WisDOT definition illustrated below.

IGGA Distance from the front wheel assembly transverse pivot point to the transverse pivot point of the profile/depth control/ ground drive wheels.

Manufacturer Center of cutting head to center of front bogey.

FIGURE 838-6 Effective Wheelbase of Diamond Grinding Equipment



SECTION 840 Materials Sampling

840.1 General

Obtaining suitable samples of materials is the basis of materials control. Unless the sample is truly representative of material used or proposed for use, the test results are at best misleading and may result in nonconforming material being accepted and conforming material being rejected.

The following sections contain the approved sampling methods for those materials normally sampled in the field. Every effort should be made to follow these procedures as closely as possible to ensure a representative sample is obtained. There may be times when none of the sampling methods are applicable. When this occurs, the region person responsible for this area should be contacted for instructions.

840.2 Sampling Responsibility

It is the project engineer's responsibility to procure samples as often as advisable or necessary to ensure the quality of the material being incorporated into the work. To avoid any contention on the part of the contractor that samples taken by the state's inspector are non-representative, standard spec 106.3 requires that the contractor procure these samples under the observation of and in a manner approved by the project engineer. Under certain conditions, when agreeable with the project engineer and the contractor, this requirement may be waived and the sampling performed by the state's inspector.

840.3 Personnel

All personnel doing acceptance sampling and testing for all state highway improvement projects and laboratories used for the same purpose must be qualified by the Highway Technician Certification Program administered by the University of Wisconsin-Platteville and the WisDOT's Laboratory Qualification Program as required before they can be allowed to perform the work. For more information contact UW Platteville at:

https://campus.uwplatt.edu/ems/highway-technician-certification-program

840.4 Selection of Sampling Method

The place of sampling for determination of contract compliance will be determined by the project engineer. It is the intent of the specifications that conformity of materials to the specified requirements must be at the time, or just before the time, they are incorporated into the work. This should be the prime consideration when selecting a sampling method.

The sampling and testing methods described in this chapter should be used whenever possible and adhered to as closely as practical. Recognizing that certain situations may arise that these methods will not accommodate, the project engineer will devise a method suitable to the situation and make note of this in the project record. Once a sampling method has been chosen, it should be used for the duration of the project.

840.5 Submittal of Samples to Central Materials Laboratory

840.5.1 Identification

Complete information must be submitted with each sample. This should include the material, source (located to the nearest 40 acres for aggregates), project number, contract number, county, contractor, sampler, date of sampling, test(s) desired, applicable specifications or design, and any other information that will adequately and accurately identify the sample to the laboratory. If it is desirable to give the laboratory additional information regarding field gradation for asphaltic mixture or other special information, a letter of transmittal should be sent to the BTS laboratory or included with the sample.

Two accurately and completely filled out shipping tags are to be used. One tag is placed inside the sample container or securely wrapped around the sample or containers. The second tag must be securely attached to the outside of each package.

Currently there are two standard sample tags in use. DT1352 is used with samples of asphaltic materials. An example of a completed DT1352 is shown in figure 840-1. DT1499 is a tag for general use with samples of all materials except asphaltic materials or asphaltic mixtures. An example of a completed DT1499 is shown in figure 840-2.

String should preferably be used to attach the tag to samples, as tape cannot be removed from the tag without removing the surface of the tag and any information on it. If tape is used to attach sample tags to the sample or the sample container, it should be transparent type and should be applied to the ends of the tags without covering any information. Masking tape should not be used since information covered by it will likely be lost when the tape is removed.

Field personnel submitting samples for asphaltic mix design should check to see if wear and soundness tests have previously been run on the produced material (not to be confused with tests on unprocessed samples), and if so, indicate this by writing the applicable test number on the shipping tag.

The tag should also indicate the source and grade of asphalt to be used in an asphaltic mix design.

840.5.2 Packing

It is essential that the samples reach the laboratory in the same condition as when sampled. Containers must be clean and protect the samples from damage, spillage, or contamination. Fragile samples should be crated and protected by materials such as insulation against stock.

840.5.3 Shipping

Since it is more economical to ship one large package than several smaller ones, as many samples as possible should be combined into one shipment by packaging them together.

Samples should be shipped to the laboratory by the most economical mode of transportation available consistent with the time element involved. Samples of asphaltic materials (asphalt cement, cutbacks, and emulsions) should be shipped daily by special delivery parcel post or other expedient means of transportation.

840.5.4 Supplies for Sampling

The proper sample containers, identification tags, etc., are available through the BTS laboratory at 3502 Kinsman Blvd., Madison, and can be requested by contacting the region office.

FIGURE 840-1 Example Asphalt Sample Tag, DT1352

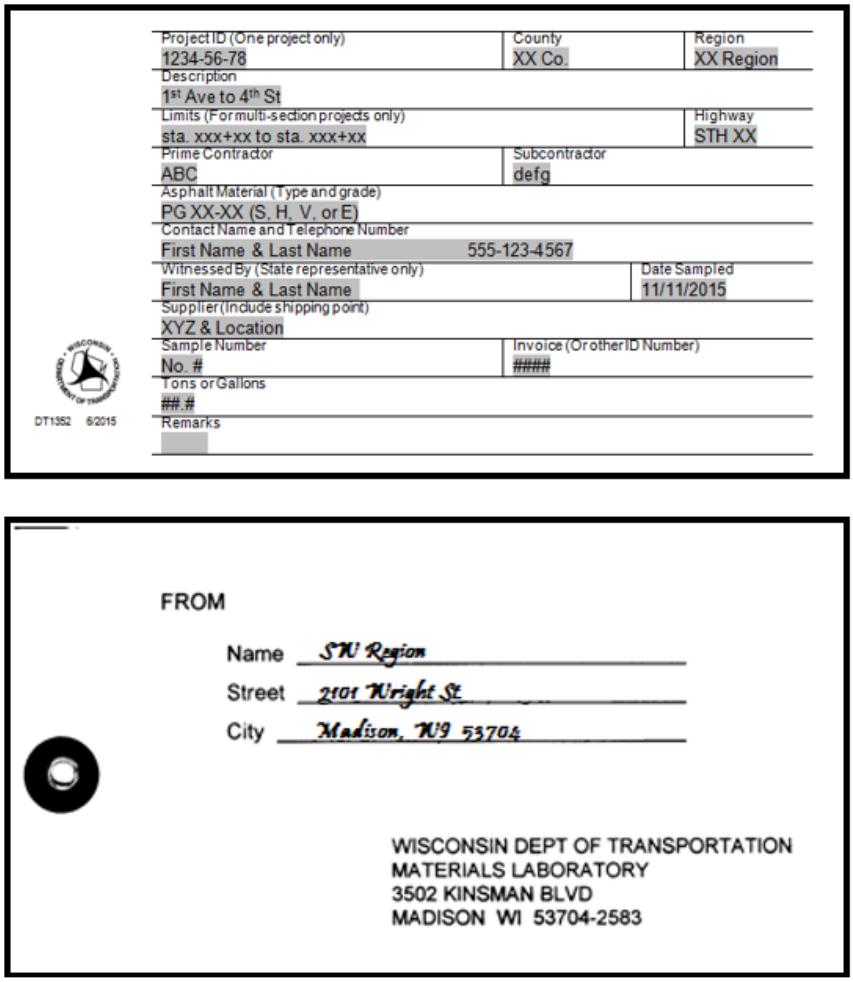
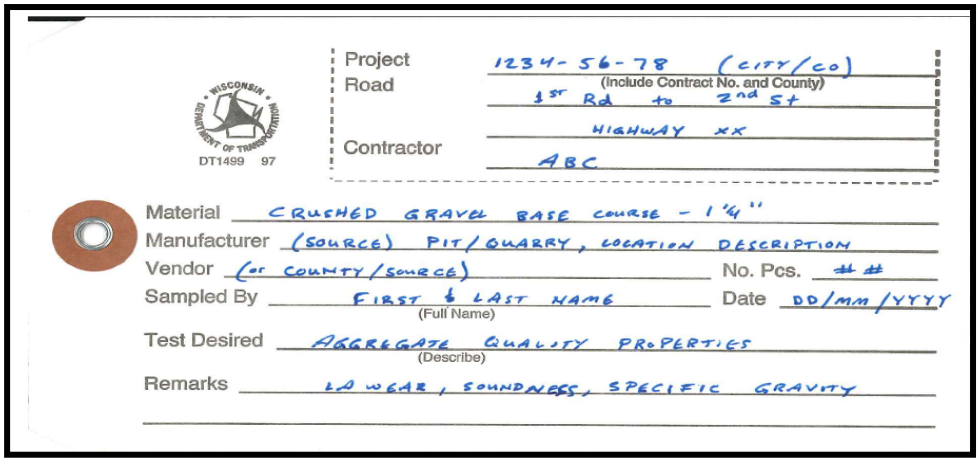


FIGURE 840-2 Example General Sample Tag, DT1499



840.6 Source of Materials Report, Department DT1349

This report provides the information that is needed before out-of-region or out-of-state tests, samplings, inspections, or procurement can be made on materials to be incorporated in the work. Tests and inspections at the source have to be authorized before they can be taken, with the authorization dependent upon submittal of DT1349.

Download DT1349, Source of Materials Report. An example of a completed DT1349 is shown below in figure 840-3.

Therefore, the contractor should provide the report as early as feasible to avoid delays in materials shipment. If the contractor has not decided on certain materials and items at the time a report is needed for other materials, the contractor can submit the initial report for the known materials and then send in supplemental reports, as other materials become known.

The contractor should submit three copies to the region office.

840.7 Material Specifications Transition Period

The possibility exists that issues of material non-conformance or availability may arise due to changes in specifications or production practices in the period between letting and procurement. In these cases, the project engineer should contact the designer to verify that the available products or materials comply with the intent of the design. Non-conforming products or materials should not be incorporated into the work without written guidance from the designer. It is understood by both parties that documented requirements may change between the time of project letting and construction, but it is the documented language at the time of letting with which the contractor must conform, unless contractual documentation clearly states otherwise.

FIGURE 840-3 Example Source of Materials Report, DT1349

SOURCE OF MATERIALS REPORT

DT1349 6/2007 (Replaces EL15L)

Wisconsin Department of Transportation

NOTE TO CONTRACTOR: Submit to Regional Office in triplicate as soon as possible to avoid delay in inspections. If all information is not known immediately, submit what is available and supplement it later.

Project ID	Federal Project Number	Contract Number	County
xxxx-xx-xx	IR xx-x(xxx)xx		Sauk/Juneau

Highway/Bridge	Project Description
B-29-19, B-56-31, 38, 40, 43, 45	Wisconsin Dells/I90 Westbound

Contractor	Type of Work
ABCD Co.	STRUCTURES

MATERIAL		DEALER AND/OR SOURCE		
AGGREGATES (Base Course)		SUB: Company ABC - Location		
AGGREGATES (Other)				
ASPHALT MIXTURE	Asphalt	SUB: Company 123 - Location		
	Principal Aggregate			
	Blending Aggr., Coarse			
	Blending Aggr., Fine			
CONCRETE JOB MIX		Brand & Type	Est. Amt.	Tons (Mg)
	Cement			
	Fine Aggregate			
	Coarse Aggregate			
CONCRETE READY MIX	Plant Name	XYZ Concrete - Location		
		Brand & Type	Est. Amt.	Tons (Mg)
	Cement			
	Fine Aggregate			
	Coarse Aggregate			
CONCRETE READY MIX	Plant Name			
		Brand & Type	Est. Amt.	Tons (Mg)
	Cement			
	Fine Aggregate			
	Coarse Aggregate			
		Brand & Type	Est. Amt.	Tons (Mg)
FLY ASH				
BAR STEEL REINFORCEMENT (Pavt.)		SUB: UVW Construction Co. - Location		
PIPE	Concrete	SUB: Another Construction Co. - Location		
	Metal			
STEEL BEAM GUARD		SUB: BCDE, Inc. - Location		
WOOD POSTS (Treated)				

(ADDITIONAL LISTINGS ON BACK)

FIGURE 840-3 Example Source of Materials Report, DT1349 (cont'd)

BAR STEEL REINFORCEMENT (Bridge)	SUB: Company Name Here - Location
BAR STEEL REINFORCEMENT (Bridge, Coated)	
STRUCTURAL STEEL (Bridge)	Appropriate Company Name - Location
FORGINGS (Bridge)	
CASTINGS (Bridge)	
RAILING (Bridge)	
LUMBER & TIMBER (Treated)	
TIMBER PILING (Treated)	
STEEL PILING	Responsible Company - Location
GEOTEXTILES	SUB: BCDE, Inc. - Location

OTHER MATERIALS

Prestressed Girder, Pavement Marking Materials, Fencing, etc. Additional materials 1, description	**DEALER AND/OR SOURCE** Company Name - Location
Mat'l 2 description	SAME
Mat'l 3 description	SAME
etc	etc

SECTION 845 Materials Testing and Acceptance - General

845.1 Material Testing and Acceptance - General

All materials must meet contract specifications. Guidance under 845 is for personnel and project material coordinators who inspect, sample, test, approve, document, and report on materials incorporated WisDOT highway projects. Independent assurance sampling and testing program requirements are in CMM 820.

Closely observe produced materials for visual evidence of changes in quality. It may be appropriate to increase the frequency and scope of both testing and acceptance activities to assure material compliance.

Consult the department regional materials representative regarding doubts pertaining to compliance of source inspected materials, field inspection reports, waivers of testing, unlisted items, evaluation of certifications, or other questions regarding acceptance procedures.

845.2 Material Requirement References

845.2.1 Material Testing and Acceptance Guide

In addition to the standard specifications, the Materials Testing and Acceptance Guide, CMM 850, details many of the sampling, testing, and documentation requirements for various materials, mobilized into the contract via standard spec 106.3. Minimum requirements are provided in the guide, as well as direction for additional testing on some materials when test results demonstrate nonconformance.

845.2.1.1 Acceptance of Small Quantities

The project engineer may waive field sampling, testing, or source inspection for small quantities of some materials that are supplied by a known manufacturer or producer. CMM 850, defines the items that qualify for small quantity acceptance as well as the quantity thresholds. Sampling and testing cannot be waived for structurally critical items or for materials/products that affect the safety of the traveling public.

Small quantities of materials that qualify, may be accepted by the project engineer based on one or more of the following methods:

1. Visual inspection provided the producer or manufacturer has recently furnished similar material found to be acceptable.
2. Certification by the producer or manufacturer stating that the material conforms to the specification requirements.
3. Material is on a WisDOT approved (pre-qualified) list.

845.2.2 E-Guide

E-Guide is an automated system that produces a handy sampling, testing, and documentation guide for material requirements on a project. The program generates guidance automatically based on the bid items included in a project and it also allows for manual input of non-standard special provision (SPV) items. The documents that are input into the E-Guide system are created by an E-Guide committee. The committee reviews the standard specifications and CMM 850 to compile the information into a succinct guide of specific material requirements.

The WisDOT project material coordinator prepares an E-Guide and provides a copy to the contractor's material coordinator. Consult the department's regional materials representative for guidance when developing the E-Guide. CMM 850 should be cross-referenced with the E-Guide since it contains detailed information for specific materials. Contact the regional materials engineer if any information within the documents is inconsistent. The materials engineers will work with the BTS, Quality Assurance Unit to resolve any issues. The E-Guide program can be accessed through the 'Log in' tab on Atwood Systems website at:

http://www.atwoodsystems.com/

The E-Guide does not supersede material requirements in the standard specifications, CMM, or contract special provisions.

845.2.3 Conditionally Preapproved-Shop or Source Inspected

Certain materials are conditionally preapproved at the manufacturing plant or source of supply based on inspection and review of relevant test results. Those materials will typically bear tags, stamps, or other markings that indicate that they have been preapproved. These materials may be incorporated into the work if the materials appear to be in acceptable condition based on a job-site examination. Documentation of the markings, stamps and physical condition should be included in the material diary entry under the basis for acceptance (BFA). Reference the original shop inspection and laboratory test reports in the Inspector's Daily Report and electronically in a MIT/MTS prefix 905 report.

If materials that require inspections and preapproval at the source are delivered to a project site without any appropriate markings indicating preapproval, they may be rejected by the project engineer. Or, the materials can be approved and incorporated into the work based on acceptable job-site examination and testing. Contact the department's regional materials representative to verify acceptance of the material.

845.3 Approval Methods

845.3.1 Approval Methods - General

Project staff will approve materials for use on the project. Method of required material approval is defined in the standard specifications, contract documents, and CMM. Primary approval methods are one or a combination of the following:

- Visual inspection.
- Manufacturer certificate of compliance.
- Certified report of test or analysis.
- Buy America certification.
- Product data sheets.
- Approved product lists.
- Material sampling.
- Material testing results.
- Bill of lading.
- On-site material photos.
- Shop drawings.
- DT forms.
- Shop/plant inspections.
- Source approvals.
- Field inspection.
- Other documentation as appropriate.

Note: Standard spec 106.3.2 stipulates that the department reserves the right to retest or re-inspect plant-inspected and other pre-approved materials after delivery to the project site and to reject materials that are found not to comply with the contract requirements.

If a material fails to meet specification requirements of the contract, document the specifics including disposition of the material within the remarks box of the applicable MIT/MTS certification of materials report. Refer to chapter 5.13 of the "MTS and MIT User Guide" found under the "Materials Reporting" heading on the QMP website.

https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/qmp/mtguide.pdf#dt1310

845.3.2 Approval Methods - Materials

845.3.2.1 Visual Inspection

Project staff is to document the properties inspected and record any necessary details regarding the approval of the material.

845.3.2.2 Manufacturer Certification

Manufactured products or assemblies may be approved based on tests performed by the manufacturer when certified. Some products only need a product certification, while others require a product certification and a production plant certification.

Manufactured products may be accepted by a certification of compliance or a certified report of test or analysis either as sole documentation for acceptance or as supplemental documentation (see standard spec 106.3).

Products that are from certified sources are approved by verifying that the source, manufacturer, or plant is on the appropriate approved list and provides a certification of product compliance showing that the product meets the pertinent specification and contract requirements. Or, by submittal of test results in meeting the same specification requirements.

845.3.2.2.1 Certificate of Compliance

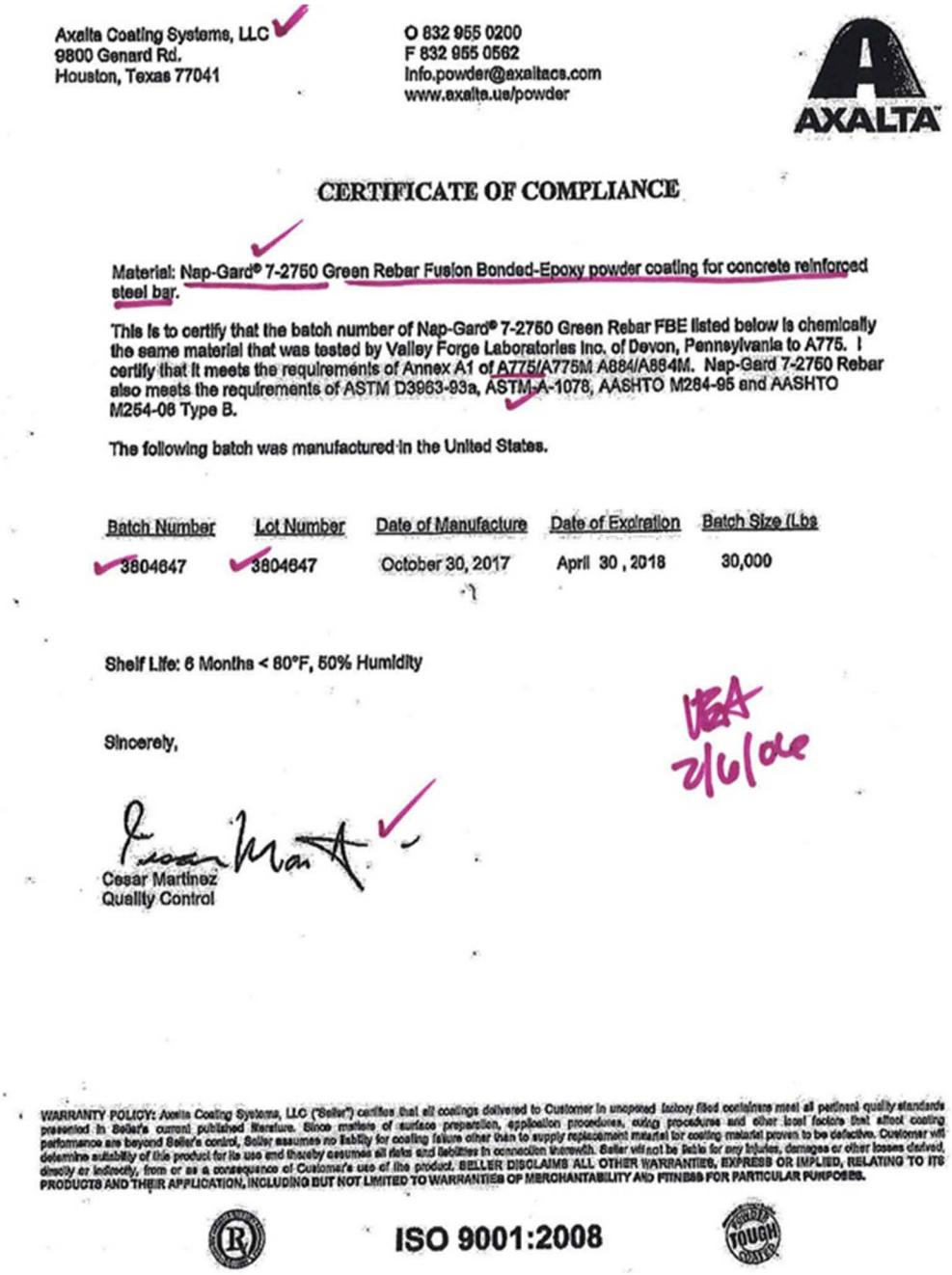
A manufacturer's certificate of compliance must include:

1. Name of the manufacturer or of the supplier.
2. Name and use of the product.

3. Statement of the specification that the product meets, such as AASHTO and ASTM and the specification number, or when applicable, the contract special provisions. In some cases, it may be the manufacturer's specifications.
4. Signature and job of a person in responsible charge of certifying the product who can bind the company and the signer's job title.

An example of a correct certification of compliance is shown in figure 845-1. Project staff should be reminded to, upon review, sign and date the certificate.

FIGURE 845-1 Example of Certificate of Compliance



Axalta Coating Systems, LLC
9800 Genard Rd.
Houston, Texas 77041

O 832 955 0200
F 832 955 0562
Info.powder@axaltacs.com
www.axalta.us/powder

AXALTA

CERTIFICATE OF COMPLIANCE

Material: Nap-Gard® 7-2750 Green Rebar Fusion Bonded-Epoxy powder coating for concrete reinforced steel bar.

This is to certify that the batch number of Nap-Gard® 7-2750 Green Rebar FBE listed below is chemically the same material that was tested by Valley Forge Laboratories Inc. of Devon, Pennsylvania to A775. I certify that it meets the requirements of Annex A1 of A775/A775M A884/A884M. Nap-Gard 7-2750 Rebar also meets the requirements of ASTM D3963-93a, ASTM-A-1078, AASHTO M284-95 and AASHTO M254-06 Type B.

The following batch was manufactured in the United States.

Batch Number	Lot Number	Date of Manufacture	Date of Expiration	Batch Size (Lbs
3804647	3804647	October 30, 2017	April 30 , 2018	30,000

Shelf Life: 6 Months < 80°F, 50% Humidity

Sincerely,

Cesar Martinez
Quality Control

WARRANTY POLICY: Axalta Coating Systems, LLC ("Seller") certifies that all coatings delivered to Customer in unopened factory filled containers meet all pertinent quality standards presented in Seller's current published literature. Since matters of surface preparation, application procedures, curing procedures and other local factors that affect coating performance are beyond Seller's control, Seller assumes no liability for coating failure other than to supply replacement material for coating material proven to be defective. Customer will determine suitability of the product for its use and thereby assumes all risks and liabilities in connection therewith. Seller will not be liable for any injuries, damages or other losses derived, directly or indirectly, from or as a consequence of Customer's use of the product. SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, RELATING TO ITS PRODUCTS AND THEIR APPLICATION, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSES.

ISO 9001:2008

845.3.2.2.2 Certified Report of Test or Analysis

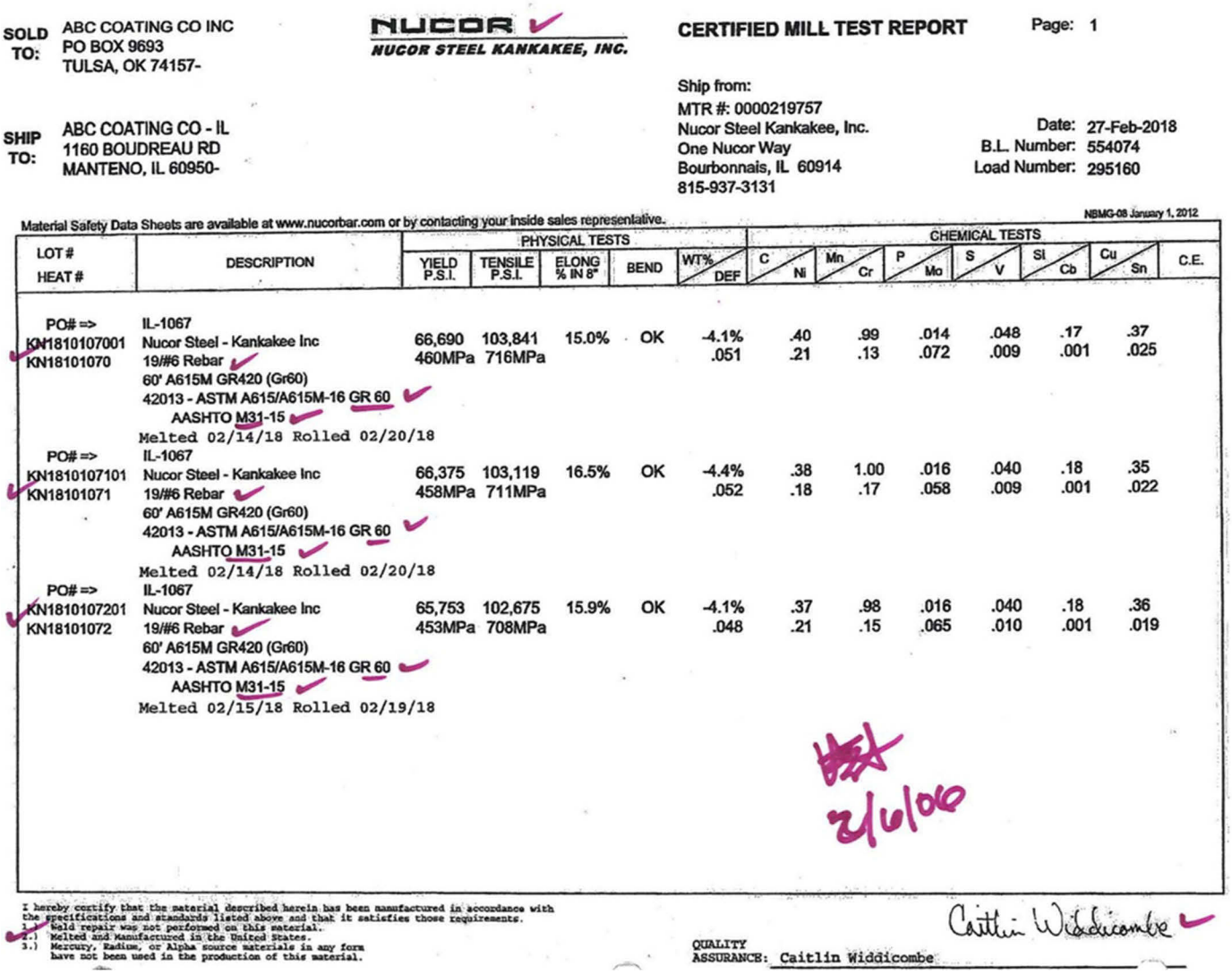
A manufacturer's certified report of test or analysis must include the following:

1. Name of the manufacturer or of the supplier.
2. Name and use of the product.
3. Statement of the specification that the product meets such as AASHTO and ASTM and the specification number, or when applicable, the contract special provisions. In some cases, it may be the manufacturer's specifications.

4. Lot, batch, heat numbers, etc., applicable to the material delivered.
5. Test results for both physical and chemical test requirements as specified.
6. Signature and title of a person in responsible charge of the testing facility.

An example of a correct certified report of test or analysis is shown in figure 845-2. Certifications of compliance and certified reports of test or analysis must be provided to the project engineer for material to be accepted. All certifications must be evaluated promptly for adequacy, completeness, and compliance with applicable specifications. Include proper notations on all certificates.

FIGURE 845-2 Example of Certified Report of Test or Analysis



SOLD TO: ABC COATING CO INC
PO BOX 9693
TULSA, OK 74157-

SHIP TO: ABC COATING CO - IL
1160 BOUDREAU RD
MANTENO, IL 60950-

NUCOR
NUCOR STEEL KANKAKEE, INC.

CERTIFIED MILL TEST REPORT Page: 1

Ship from:
MTR #: 0000219757
Nucor Steel Kankakee, Inc.
One Nucor Way
Bourbonnais, IL 60914
815-937-3131

Date: 27-Feb-2018
B.L. Number: 554074
Load Number: 295160

Material Safety Data Sheets are available at www.nucorbar.com or by contacting your inside sales representative. NBMG-08 January 1, 2012

LOT # / HEAT #	DESCRIPTION	PHYSICAL TESTS: YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT% DEF	CHEMICAL TESTS: C / Ni	Mn / Cr	P / Mo	S / V	Si / Cb	Cu / Sn	C.E.
PO# =>	IL-1067												
KN1810107001	Nucor Steel - Kankakee Inc	66,690	103,841	15.0%	OK	-4.1%	.40	.99	.014	.048	.17	.37	
KN18101070	19/#6 Rebar	460MPa	716MPa			.051	.21	.13	.072	.009	.001	.025	
	60' A615M GR420 (Gr60)												
	42013 - ASTM A615/A615M-16 GR 60												
	AASHTO M31-15												
	Melted 02/14/18 Rolled 02/20/18												
PO# =>	IL-1067												
KN1810107101	Nucor Steel - Kankakee Inc	66,375	103,119	16.5%	OK	-4.4%	.38	1.00	.016	.040	.18	.35	
KN18101071	19/#6 Rebar	458MPa	711MPa			.052	.18	.17	.058	.009	.001	.022	
	60' A615M GR420 (Gr60)												
	42013 - ASTM A615/A615M-16 GR 60												
	AASHTO M31-15												
	Melted 02/14/18 Rolled 02/20/18												
PO# =>	IL-1067												
KN1810107201	Nucor Steel - Kankakee Inc	65,753	102,675	15.9%	OK	-4.1%	.37	.98	.016	.040	.18	.36	
KN18101072	19/#6 Rebar	453MPa	708MPa			.048	.21	.15	.065	.010	.001	.019	
	60' A615M GR420 (Gr60)												
	42013 - ASTM A615/A615M-16 GR 60												
	AASHTO M31-15												
	Melted 02/15/18 Rolled 02/19/18												

Heat 2/6/06

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed above and that it satisfies those requirements.
1.) Weld repair was not performed on this material.
2.) Melted and Manufactured in the United States.
3.) Mercury, Radium, or Alpha source materials in any form have not been used in the production of this material.

QUALITY ASSURANCE: Caitlin Widdicombe

Caitlin Widdicombe

845.3.2.3 Buy America

Buy America certification is required for all steel, iron, and construction materials permanently incorporated into the project. CMM 228.5 provides additional guidance on the Buy America provision.

845.3.2.4 Product Data

Product data sheets provide basic information on a material. It includes the material name, product definition, applicable uses of the product and in some cases model numbers.

845.3.2.5 Approved Product/Supplier/Manufacturer/Fabricator/Plant Lists

Some products are approved for use based on previous testing and an acceptable performance history within the department. These products are on the APL.

The approved lists are maintained and updated regularly by BTS. Certain materials including, but not limited to; asphalt binder, portland cement, prestressed concrete, precast concrete, fabricated components for bridges, guardrail, barrier systems, and proprietary retaining walls must come from a certified supplier, manufacturer or plant.

These materials may be accepted after project staff verifies that the products and suppliers are included in the appropriate approved list and inspection upon delivery. Document the material acceptance and relevant inspection information in the IDR and electronically in a MIT/MTS prefix 905 report. Reference any applicable test reports or certifications.

If products or materials from an approved list exhibit lower than expected performance when placed in service, or if project-level testing indicates non-conformance of an approved product with the relevant specification, field staff should immediately contact the technical sponsor identified on the applicable published list for that material.

845.3.2.6 Field Sampling and Testing

Some materials are sampled and tested onsite during production and placement. Others are sampled at the source or during placement and tested in a laboratory. All sampling and testing personnel must be qualified under a department-accepted program for the materials they are working with and testing is performed in qualified laboratories. Test types and frequencies are in accordance with the governing specification or the department recognized common practices. Sampling and testing procedures are performed as prescribed in CMM 800 and WisDOT Manual of Test Procedures (MOTP) (https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/qmp/motp.pdf).

When the testing frequency of a material is determined by the quantity used, it is necessary to report the actual quantity used. When testing and subsequent acceptance requirements of a material do not depend upon quantity, it is necessary to provide detailed information within the remarks section of the applicable MIT/MTS report that will confirm that all of the materials incorporated into the work were thoroughly tested and within the specification requirements.

845.3.2.6.1 QC and QV Field Sampling and Testing (QMP)

Under WisDOT's QMP specifications, materials are approved based on the contractor's quality control (QC) sampling and testing when they conform to specifications and when the results are validated by department quality verification (QV) sampling and testing. Contractor QC test results are reported in the materials reporting system (MRS). department QV test results are documented in the appropriate MIT/MTS prefix report. QV testers must compare their test results to the appropriate QC test results to validate the material quality. Approval is based on acceptable QC and QV test results.

845.3.2.6.2 Central Office Laboratory Quality Assurance (QA) Testing

Some materials and products require testing by the department's central office (CO). Acceptance of these materials are typically reserved pending acceptable laboratory test results. Obtain representative samples of the materials from the job site or at the source of supply. Package and bind the material appropriately and securely attach an appropriate label that includes all pertinent or required information. Materials for CO laboratory testing are to be delivered to the region laboratory. Region Laboratory Coordinator will log and deliver to CO laboratory. Prompt submittal of properly bound and labeled samples will help ensure timely test results. Laboratory testers document the test results in the pertinent MIT/MTS prefix report(s). Test results are available to the project staff in MTS and in the Highway Quality Management System (HQMS) website.

845.3.2.7 Other Approval Methods

Other documents used to approve materials include but are not limited to:

1. Bill of Lading (BOL)
2. On-Site Material Photos
3. Shop Drawings
4. DT Forms
5. Shop/Plant Inspection Reports.

845.4 Material Inspection

Manufactured products, including conditionally approved products previously inspected and tested at the source, must be inspected as soon as possible after delivery to the job site for any evidence of damage or noncompliance.

The project engineer should follow these steps as a minimum for inspection of materials delivered to the project.

1. Inspect manufactured and pre-qualified products as soon as possible after delivery.
    - Including materials on approved lists, from certified sources, and conditionally approved products.
    - Record relevant inspection information in the material record.
2. Verify that products delivered match the certifications, approved lists, etc.

3. Review certificates of compliance and certified reports of test or analysis. As part of the review process, assure the documents are dated within two years of the project LET date. Older documentation may be acceptable for raw hot-rolled materials, such as piling or black reinforcement steel; the contractor must furnish additional written verification from the source or mill validating the data on certifications older than two years. Project staff is encouraged to contact sources directly if verification cannot be obtained by other means.
4. Ensure that the manufacturer/supplier name, product name, and appropriate ASTM/AASHTO reference, and signature and title of the person certifying the product for the company is included. Reviewer initials and dates certificates. Refer to CMM 845.3.2.2 for additional details regarding approval by certification.

845.5 Documentation - General

Final material records and affiliated documents are compiled by project staff and retained according to state law. In the event of an early failure, product recall/evaluation, in-kind replacement, or fulfilment of an open records request, the department will reference this documentation.

845.5.1 Documentation - Records

Documentation and reporting for material acceptance is essential and required on all WisDOT projects.

The final material record documents are separated into two categories:

1. Materials Project Records.
2. Materials Archive.

Materials Documentation Location Guide defines if the item belongs in Materials Archive, Materials Project Records, or has no documentation requirements.

Material Documentation Location Guide			
Section	Description	Archive, Materials Project Records, or No Requirements	Details
106	Control of Materials	Materials Project Records*	*Source of Materials
201	Clearing and Grubbing	No Requirements	
202	Roadside Clearing	No Requirements	
203	Removing Old Culverts and Bridges	No Requirements	
204	Removing or Abandoning Miscellaneous Structures	No Requirements	
205	Roadway and Drainage Excavation	No Requirements	
206	Excavation for Structures	Materials Project Records	
207	Embankment	No Requirements*	*No Bid Item associated with Section 207. Documentation will be recorded with applicable Bid Item.
208	Borrow	Archive	
209	Granular Backfill	Archive	
210	Structure Backfill	Archive	
211	Preparing the Foundation	Archive	
213	Finishing Roadway	No Requirements	
214	Obliterating Old Road	No Requirements	
301	Base, Subbase and Subgrade Aggregate	No Requirements*	*No Bid Item associated with Section 301. Documentation will be recorded with applicable Bid Item.
305	Dense-Graded Base	Archive	
310	Open-Graded Base	Archive	
311	Breaker Run	Archive	
312	Select Crushed Material	Archive	
313	Pit Run	Archive	
315	Asphaltic Base	Archive	
320	Concrete Base	Archive	
325	Pulverized and Re-laid Pavement	No Requirements	
330	Milled and Re-laid Pavement	No Requirements	
335	Rubblized Pavement	Archive	
340	Cracked and Seated Pavement	No Requirements	
350	Subbase	Archive	
390	Base Patching	Archive	
405	Coloring and Stamping Concrete	Archive	
415	Concrete Pavement	Archive	
416	Concrete Pavement - Appurtenant Construction	Archive	
420	Diamond Grinding	No Requirements	
450	General Requirements for Asphaltic Pavements	Archive*	*Cold Weather Paving Plan
455	Asphaltic Materials	Archive	
460	Hot Mix Asphalt Pavement	Archive	
465	Asphaltic Surface	Archive	
475	Seal Coat	Archive	

Material Documentation Location Guide			
Section	Description	Archive, Materials Project Records, or No Requirements	Details
501	Concrete	Archive*	*Information will be recorded in archive according to Region guidance.
502	Concrete Bridges	Archive	
503	Prestressed Concrete Members	Archive	
504	Culverts, Retaining Walls, and Endwalls	Archive	
505	Steel Reinforcement	Archive	
506	Steel Bridges	Archive	
507	Timber Structures	Archive	
509	Concrete Overlay and Structure Repair	Archive	
511	Temporary Shoring	Materials Project Records	
512	Steel Sheet Piling	Archive	
513	Railing	Archive	
514	Floor Drains, Deck Drains, and Downspouts	Archive	
515	Steel Grid Floors	Archive	
516	Waterproofing	Archive	
517	Paint and Painting	Archive	
519	Brick Masonry and Concrete Brick or Block Masonry	No Requirements*	*No Bid Item associated with Section 519. Documentation will be recorded with applicable Bid Item.
520	Pipe Culverts	Archive	
521	Corrugated Steel Culverts	Archive	
522	Reinforced Concrete Culverts	Archive	
524	Salvaged Culverts	Archive	
525	Corrugated Aluminum Culverts	Archive	
526	Temporary Structures	Materials Project Records	
527	Structural Plate Pipe and Pipe Arches	Archive	
530	Corrugated Plastic Pipe Culverts	Archive	
550	Driven Piles	Archive	
601	Concrete Curb & Gutter	Archive	
602	Concrete Sidewalks, Loading Zones, Safety Islands, and Steps	Archive	
603	Concrete Barrier	Archive	
604	Slope Paving	Archive	
606	Riprap	Archive	
608	Storm Sewer	Archive	
611	Catch Basins, Manholes, and Inlets	Archive	
612	Underdrains	Archive	
614	Semi-rigid Barrier Systems and End Treatments	Archive	
615	Treated Rustic Timber Items and Historical Markers	Archive	
616	Property and Right-of-Way Fence	Archive	

Material Documentation Location Guide			
Section	Description	Archive, Materials Project Records, or No Requirements	Details
617	Hauling	No Requirements	
618	Maintenance and Repair of Haul Roads	Materials Project Records	
619	Mobilization	No Requirements	
620	Concrete Corrugated Median and Concrete Median Nose	Archive	
621	Landmark Reference Monuments	Archive	
623	Dust Control Surface Treatment	Materials Project Records	
624	Water	Materials Project Records	
625	Topsoil and Salvaged Topsoil	Materials Project Records	
626	Peat Humus	Materials Project Records	
627	Mulching	Materials Project Records	
628	Erosion Control	Materials Project Records	
629	Fertilizer and Agricultural Limestone	Materials Project Records	
630	Seeding	Materials Project Records	
631	Sodding	Materials Project Records	
632	Furnishing and Planting Plant Materials	Materials Project Records	
633	Delineators and Markers	Archive	
634	Wood and Tubular Steel Sign Posts	Archive	
635	Structural Steel Sign Supports	Archive	
636	Concrete Sign Supports	Archive	
637	Signing	Archive	
638	State Owned Signs and Supports	Materials Project Records	
639	Drilling Wells	Archive	
641	Sign Bridges and Overhead Sign Supports	Archive	
642	Field Facilities	No Requirements	
643	Traffic Control	Materials Project Records	
645	Geosynthetics	Archive	
646	Pavement Marking	Archive	
648	Locating No-passing Zones	Materials Project Records	
649	Temporary Pavement Marking	Materials Project Records	
650	Construction Staking	No Requirements	
651	General Requirements for Electrical Work	No Requirements*	*No Bid Item associated with Section 651. Documentation will be recorded with applicable Bid Item.
652	Electrical Conduit	Archive	
653	Pull Boxes and Junction Boxes	Archive	
654	Bases	Archive	

Material Documentation Location Guide			
Section	Description	Archive, Materials Project Records, or No Requirements	Details
655	Electrical Wiring	Archive	
656	Electrical Service	Archive	
657	Poles, Arms, Standards, and Bases	Archive	
658	Traffic Signals	Archive	
659	Lighting	Archive	
660	High Mast Lighting	Archive	
661	Temporary Traffic Signals and Temporary Ramp Meters	Materials Project Records	
670	General Requirements for Intelligent Transportation Systems (ITS)	Archive	
671	Intelligent Transportation Systems - Conduit	Archive	
673	Communication Vaults	Archive	
674	Intelligent Transportation Systems - Cable	Archive	
675	Controllers and Detectors	Archive	
677	Cameras	Archive	
678	Communications Systems	Archive	
690	Sawing	No Requirements	
701	General QMP Requirement	Archive*	*Information will be recorded in archive according to Region guidance.
710	General Concrete QMP	Archive*	*Information will be recorded in archive according to Region guidance.
715	QMP Concrete Pavement and Structures	Archive	
716	QMP Ancillary Concrete	Archive	
730	QMP Base Aggregate	Archive	
740	QMP Ride	Archive	

845.5.1.1 Materials Project Records

Materials Project Records need to have all necessary documentation for the project staff to justify approval of the material for use. Any documentation project staff obtains or records on these materials should be kept in the construction field records (i.e.: construction diary, electronic field file, separate hardcopy folder, etc.). These material records will be kept with the construction field records and will follow the same Highway Construction Project Records Retention/Disposition Authorization (RDA) for record retention. Materials Project Records are not reviewed by the Region's Materials Unit and are not entered into the Materials Data Collection and Reporting Software System explained in CMM 846. All exceptions to the contract for these items are to be noted on Materials Project Records Deviation Log (DT1345) and not documented on Certification of Materials Report, DT1310. Keep (DT1345) with Materials Project Records.

Source of Materials Report (DT1349) should also be kept with the Materials Project Records.

845.5.1.2 Materials Archive

The Materials Archive requires entry in the Materials Data Collection and Reporting Software System (CMM 846), review of documents for compliance by Region Material Reviewer and completion of the Material Certification (DT1310). Each contract is required to have an entry in a MIT/MTS prefix 905 report for each bid item or bid item group, including bid items in the contract at the time of letting or items added to the contract but not used; those items should be reflected in the individual entry as "Not Used." The

Materials Archive is maintained for long term storage per the Materials Management Program RDA. Note all exceptions to the contract requirements for Materials Archive items on the DT1310.

Documents in Materials Archive are to be submitted to the region in a clearly labeled box, folder, binder or electronic submission format.

At a minimum, the following items are to be included in the Material Archive:

1. Certification of Materials Report (DT1310)
2. DT4567 Buy America Certification
    - Buy America Exemption Log (if used)
    - Material invoices
3. Materials Diary - MIT/MTS prefix 905 Report
4. E-Guide
5. QMP and Miscellaneous Summary Reports - MIT/MTS prefix 155 Report(s)
6. Approval Documents
7. QMP Documentation

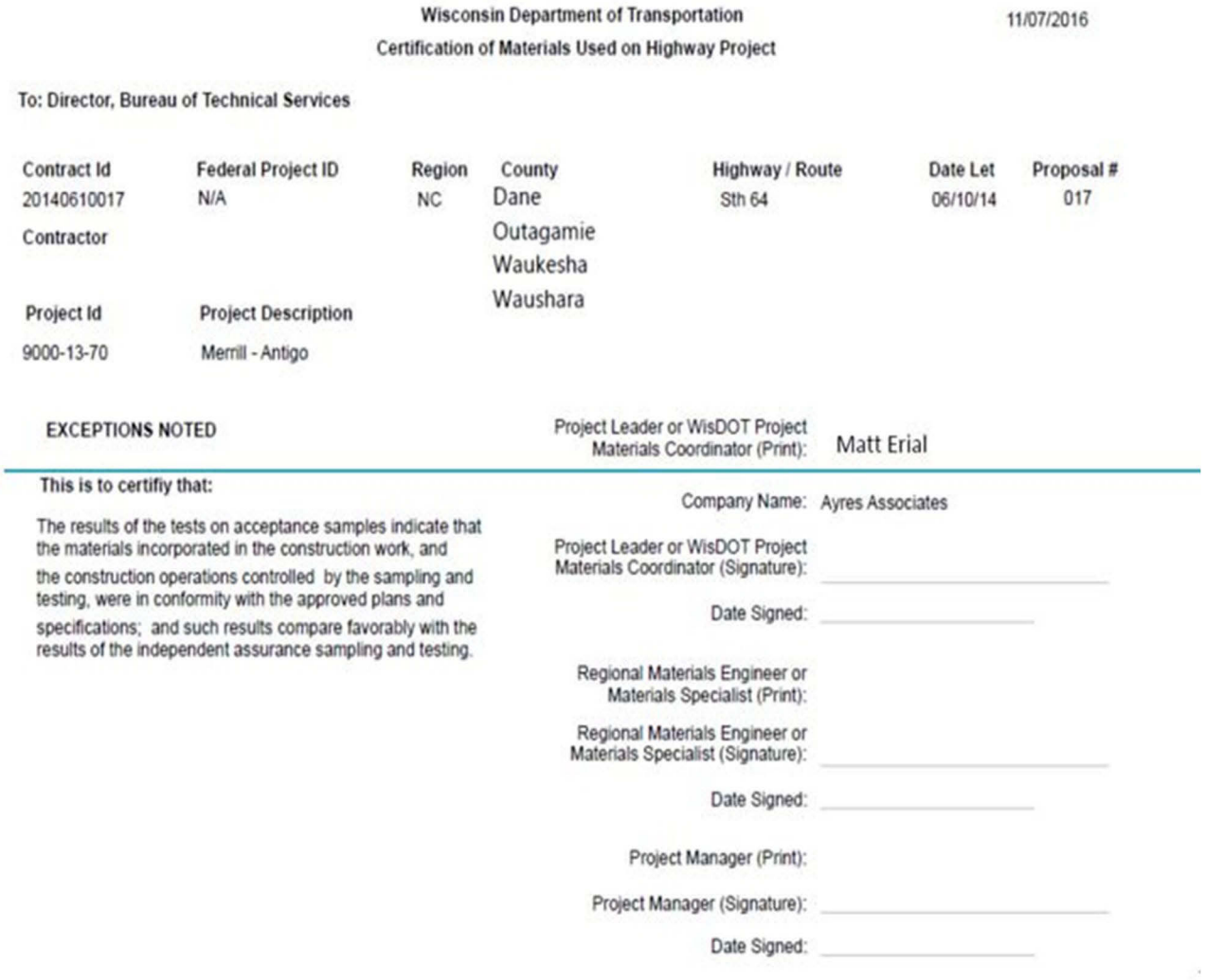
845.5.1.2.1 Certification of Materials (23 CFR §637.207 (3)) - DT1310

The DT1310 or Certification of Materials is used to document all material deviations from contract specifications and is required for all LET contracts. The completed form is used for reference by FHWA and department staff that were not involved on the project. All nonconformance issues, nonperformance issues, and disincentives are documented individually in an entry on the DT1310 report. Also, any material logged under the allowable Buy America Exemption amount needs an entry on the DT1310.

This form is only available electronically in MIT/MTS software. The project engineer or WDMC enters information electronically in MIT/MTS and must ensure the latest version of the software is being used before sending the DT1310.

An example of an unsigned cover page of a DT1310 is shown in figure 845-3.

FIGURE 845-3 Example DT1310 - Certificate of Materials Report



Wisconsin Department of Transportation

11/07/2016

Certification of Materials Used on Highway Project

To: Director, Bureau of Technical Services

Contract Id	Federal Project ID	Region	County	Highway / Route	Date Let	Proposal #
20140610017	N/A	NC	Dane Outagamie Waukesha Waushara	Sth 64	06/10/14	017

Contractor

Project Id	Project Description
9000-13-70	Merrill - Antigo

EXCEPTIONS NOTED

Project Leader or WisDOT Project Materials Coordinator (Print): Matt Erial

This is to certifiy that:

The results of the tests on acceptance samples indicate that the materials incorporated in the construction work, and the construction operations controlled by the sampling and testing, were in conformity with the approved plans and specifications; and such results compare favorably with the results of the independent assurance sampling and testing.

Company Name: Ayres Associates

Project Leader or WisDOT Project Materials Coordinator (Signature): _____

Date Signed: _____

Regional Materials Engineer or Materials Specialist (Print):

Regional Materials Engineer or Materials Specialist (Signature): _____

Date Signed: _____

Project Manager (Print):

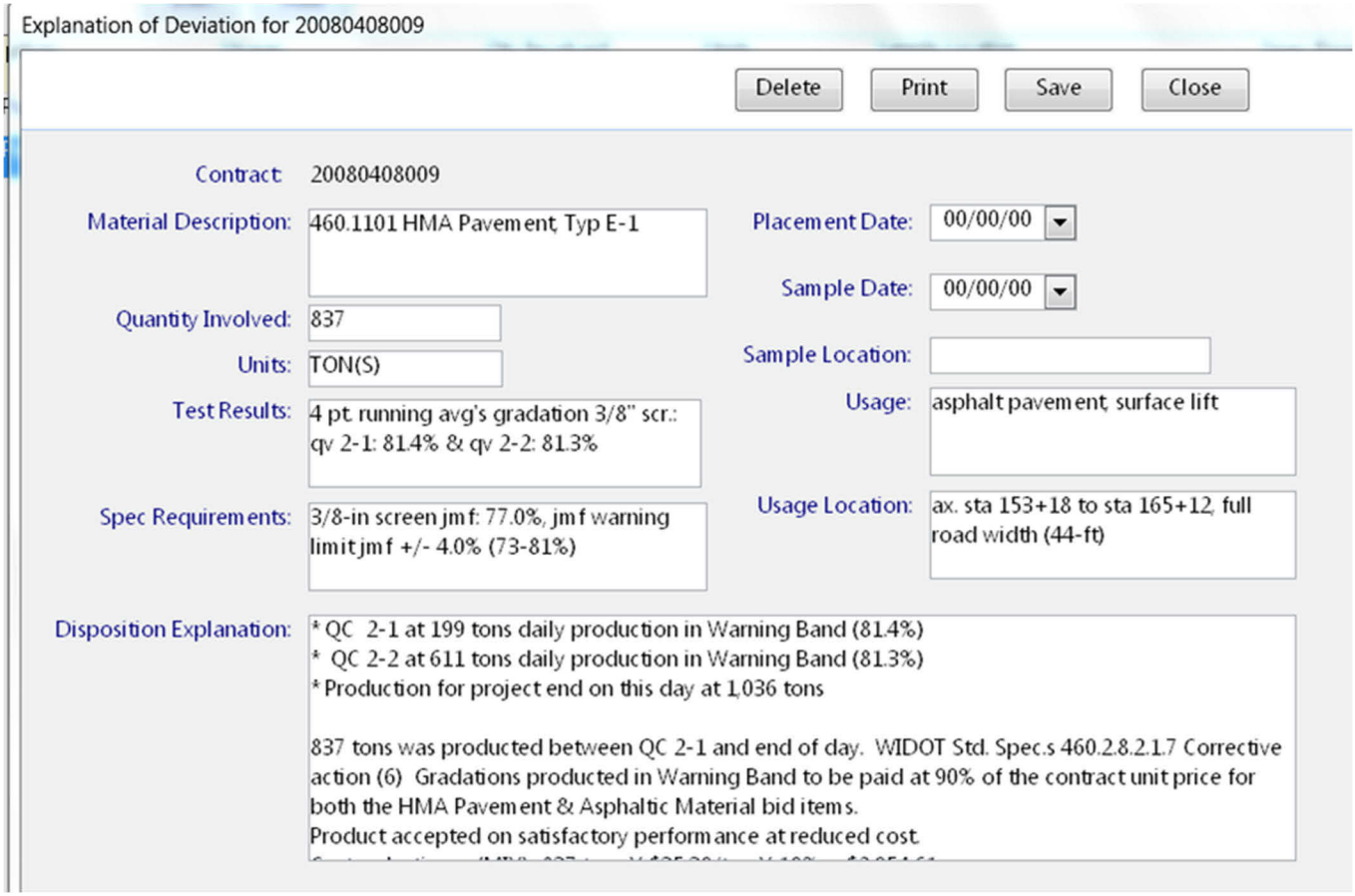
Project Manager (Signature): _____

Date Signed: _____

When entering deviations into a report, include detailed explanations by completing all the data fields, as shown in figure 845-4. Also, be diligent in ensuring that the issue has not already been entered. The electronic DT1310 can be sorted by any of the columns to help ensure that data information isn't duplicated. A DT1310 entry created by project staff cannot be deleted. If an entry is made in error, contact the region materials section for assistance.

The certification must be approved and signed by the project construction engineer or WPMC. Include a copy of the final, signed DT1310 in the material archive. After the region reviews the material records, the region material engineer/reviewer and region project manager will sign the DT1310. For federal oversight projects, a signed copy of the DT1310 must be sent via email to FHWA at: FHWAMaterialsWisconsin@dot.gov

FIGURE 845-4 Certificate of Materials Deviation Data Entry Fields



845.5.1.2.1.1 Non-Conformance Entry

There are different types of nonconformance entries:

1. Material not meeting testing specifications
    - If material fails specification and is not incorporated into the work or is removed, an entry on the DT1310 is required.
2. Material not meeting test methods (i.e.: utilizing different ASTM or AASHTO method than specified)

If a credit is not applied to the nonconformance, the disposition description should include a sentence stating that a credit was not taken and title of who allowed the nonconforming material to remain without a credit.

If a credit is applied to the nonconformance, a DT1310 entry needs to include the basic information required in figure 845-4, as well as:

1. Credit percentage/amount applied to the contract.
2. Contract Modification number used to apply the credit.
3. Standard specifications or CMM reference used to apply the credit.

845.5.1.2.1.2 Non-Performance Entry

Nonperformance of QMP is described in detail in CMM 830.13. All nonperformance of QMP by Quality Control (QC) or Quality Verification (QV) requires an entry in the DT1310 report. Each entry should have, at a minimum, the following information in the disposition explanation:

1. Description of non-performance (Non-Performance of QMP form, found in statewide pantry)
2. Problem encountered from CMM 830.13, table 830-2 and include percentage deducted from bid item
3. Total credit applied with written out calculation
4. Contract modification number used to apply the credit

845.5.1.2.1.3 Disincentive Entry

Disincentives that are applied to an item require a DT1310 entry. A schedule of administrative items used to assess disincentives is found in CMM 238.2.11, table 238-1.

Disincentives calculated in the Highway Quality Management System (HQMS) should include:

1. Reference to the specific HQMS module and Lot/Sublot
2. Total disincentive applied
3. Contract Modification number used to apply the disincentive

Disincentives not reported in HQMS should include:

1. Lot/Sublot, station etc. where disincentive is applied
2. Test result(s)
3. Specification reference of disincentive amount
4. Percentage of disincentive
5. Total disincentive applied
6. Contract Modification number used to apply the disincentive

845.5.1.2.1.4 Buy America Exception Entry

Buy America exemptions are allowed under the Buy America contract special provision. Additional information on Buy America can be found in CMM 228.5. If a project utilizes any part of the exemption amount, an entry in the DT1310 report is required. The entry needs to list:

1. Material being exempted
2. Amount being logged under exemption
3. Allowable exemption amount

FIGURE 845-5 Example DT1310 Buy America Exception Entry

1

Bid Item Name:
Various

Usage:
Project Wide

Placement Date: 02/01/18 Qty: 0 Units: N/A

Location:
Project Wide

Sample Date: Sample Location:

Disposition Explanation:

637.22XX Type 2 Sign - Mounting Hardware
3/8" 3 1/4" Bolt ($35.49)
3/8" Nut ($5.50)
4" Lag Screw ($16.22)
3" Lag Screw ($59.16)
Washer ($26.76)
416.1010 Concrete Surface Drain
Wire Mesh ($112.80)
634.0810 Posts Tubular Steel
2"x2"x10' Post ($1,024.40)
3'x2 1/4" Square Tube ($312.00)
18"x2 1/2" Square Tube ($598.00)

Spec Requirements:
All steel/iron needs Buy America certification.

Test Results:
Buy America Documentation not provided.

Total allowable exemption amount = $6,335.70
Total amount logged under exemption = $2,190.33
All items are logged on Buy America Exemption Report and have material invoice documentation. Documents are located in material archive with WS4567 Buy America Certification Form.

845.5.1.2.2 Buy America Certification

Buy America certification DT4567 and the Buy America Exemption Log can be found online in the statewide pantry at:

https://awpkb.dot.wi.gov/Content/constr/Pantry/StatewideForms.htm

Any material that is logged under the allowable Buy America Exemption needs to be accompanied by material invoices showing the cost of the material as it is delivered to the project.

Additional information on Buy America is located in CMM 845.3.2.3.

Buy America exemptions need to be logged on the DT1310 according to CMM 845.5.1.2.1.

845.5.1.2.3 Materials Diary - MIT/MTS Prefix 905 Report

A diary entry must be made in a MIT/MTS prefix 905 Materials Diary Inspection report for every material required in the material archive. Materials Diary Inspection entries are made to document visual field

inspections, test results, and to reference all external materials approval documents described in CMM 845.3.2.

CMM 845.4 provides a list of inspection steps that should be performed on all materials delivered to a project. When performing the material inspection, document in the MIT/MTS prefix 905 report basis for acceptance (BFA) what was physically done to approve the material for use. Some examples include: verified steel certification heat numbers with tags on rebar or confirmed source of base aggregate stockpile by visiting the pit/quarry.

Diary entries must include the following:

- Description: brand, model, type, system, species, markings, size, dimensions, lot/batch, heat number, application rate, etc.
- Quantity.
- Manufacturer, source and vendor.
- Evaluation and basis for acceptance - visual inspection remarks, product condition, compliance to specifications, etc.

An example of the format for diary entries is shown in table 845-1. Several similar materials may be included on a single report entry when appropriate.

Note: In special cases, when field inspection is specifically requested by the BOS Bridge Fabrication Unit, a copy of the report must be sent to them immediately after inspection. Copies of all reports of field inspection of material must be included with the Test Report Record when the project is completed.

TABLE 845-1 Example of Materials Diary Inspection Entries

Date of Inspection	Bid Item Description	Product Name	Manufacturer Name / Location	Evaluation / Basis for Acceptance (BFA)
3/11/2006	Tack Coat	CSS-1H	Koch- Dubuque	Type acceptable per specifications. Asphalt Emulsion for tack coat, diluted with 50% water. Application Rate - 0.07 Gals/SY on milled surface and 0.05 Gals/SY on paved surface. 455.0600b: Bill of Lading
3/12/2006	St Sewer Pipe Reinf Conc Class III xx-Inch - PIPE	18" / 24" / 36"	County Materials Corp Marathon, WI	Pipe was new and undamaged. Pipe Markings: CMC M170 C-76 Dated 5/23/05
4/1/2006	Bar Couplers - THREADED BAR COUPLER	No 8	Nucor Steel Charlotte, NC	No. 8 Lot #154449 (Heat #MM16106574, MM17103616) Supplier: Dayton Superior Corp., Allentown, PA. Fabricator: Plymouth Tube Co., Winamac, IN. Conforms to standard spec 505 and exceeds 125% of the specified yield strength of the grade 60 bar steel being spliced. See DT1310 for acceptance based on 2 tests/type instead of 3 tests. All lot/heat numbers recorded in the field match mill test reports/shipping documents.
4/1/2006	Bar Couplers - EPOXY	Greenbar 720A009	Valspar Corp Charlotte, NC	Batch #: 7V96026105 (Lot #15449), 7V96026237 (Lot #158012.) Coated by B.L. Downey Co., Broadview, IL. Acceptable visual inspection of coating not being damaged. Conforms to standard spec 505 and meets ASTM A775. Epoxy batch numbers accounted for and correspond with all steel coupler lot/heat numbers.
3/30/2006	Structural Steel HS - HIGH STRENGTH BOLTS	7/8" HS Bolts	CMC Steel SC Cayce, SC	Heat No: 7501468 Fabricated by Veritas Steel, Wausau, WI Galvanized by: Rodgers Brothers, Rockford IL - Type A325, Lot 4321 Supplied by: Uny-Tite Fastners Fort Bolt, MO

845.5.1.2.4 QMP and Miscellaneous Summary Reports - MIT/MTS Prefix 155 Report(s)

Prefix 155 reports, titled Miscellaneous Materials, are used to report activities and test results that aren't covered by other standard prefix-numbered reports. A prefix 155 is also used for QMP Summary reports to summarize all QMP activities that were performed for each individual QMP specification involved in a project. Department personnel should create a 155 report in MIT or MTS by using an appropriate QMP summary template(s).

QMP Summary templates are available for most QMP specifications to help standardize reporting and to ensure that all relevant information is captured. QMP Summary templates can be accessed by all department personnel in pantry under WisDOT Statewide Forms.

Due to the format of the QMP Summary templates, more than one QMP summary report may be required for a certain QMP specification. For example, the QMP Base Aggregate special provision requires a QMP Summary for each nominal aggregate size; 3/4", 1-1/4", and 3".

Examples of individual QMP summaries can be found in the online pantry under QMP form templates, located at:

https://awpkb.dot.wi.gov/Content/constr/Pantry/StatewideForms.htm

845.5.1.2.5 Approved Documents

All approval documents are to be assigned a document ID and recorded in MIT/MTS prefix 905 report under the appropriate material diary entry. See CMM 845.3 for types and descriptions of approval documents.

845.5.1.2.6 QMP Documentation

All required QMP documentation needs to be included in the material archive. The individual specification or special provision will state the required documents. Ensure that source documents are also included in the QMP records.

SECTION 846 Materials Data Collection and Reporting Software System

846.1 General

846.1.1 Overview

This section addresses the department's electronic materials data collection and reporting software system by discussing its associated components/modules and their general operation; provides troubleshooting procedures; listing user FAQs; and support contact information connecting users with regional expertise and subject matter experts.

The information presented is additional reference and guidance to aid in resolving and reporting malfunctions with the software system. Please note that the many functional aspects, access to the eGuide, and training materials are available electronically through the Atwood Systems website at:

http://www.atwoodsystems.com/

846.1.2 Terms and Definitions

MRS: Materials Reporting System. Contractor data entry consists of 4 individual modules (PCC; IRI; HMA; Soils & Aggregates).

MIT: Materials Information Tracking (Field Version). Department data entry (Regional/Local), database stored on local devices.

MTS: Materials Tracking System. Department data entry (BTS).

HQMS Highway Quality Management System website. Database web server for materials reports and test results. View and access reports through the Atwood Systems website.

Oracle Database: Software data storage system, object-relational database stored on centralized department servers.

eGuide: On-line document generator for developing a project-specific sampling and testing guide for standard bid items in each contract. Used primarily by the assigned project materials coordinators.

846.2 System Component Overview

Atwood Systems originally developed, currently provides, and assists with maintenance and upgrade activities for multiple department software components used for the reporting of materials sampling and testing results. These software components are linked to a centralized Oracle database and provide a permanent record of documentation supporting project materials acceptance. There are three primary software components for contractor and department construction personnel to be familiar with, along with the website where all submitted data is viewed.

846.2.1 MRS (Materials Reporting System)

The MRS component of the software is used by contractors and contains 4 separate modules for entering data generated on WisDOT construction projects. The modules are for HMA, PCC, IRI, and Soils & Aggregates. To have any of the appropriate MRS components installed onto individual user computers, contact Atwood Systems at:

http://www.atwoodsystems.com/

846.2.1.1 MRS-PCC

The MRS-PCC module is used by contractors to report concrete pavement and concrete structures data. More specifically, the contractors use the MRS PCC module to submit concrete mix designs, to report concrete compressive or flexural strength QC results, concrete pavement thickness measurements as determined by probing, and MIT Scan plate locations. Additional detail pertaining to requirements for concrete data submittals can be viewed in CMM 835 and standard spec 701.

846.2.1.2 MRS-HMA

The MRS-HMA module is used by contractors to report HMA pavement density QC data and to submit HMA mix designs to the department for approval. Additional detail pertaining to pavement density and HMA Mix Design submittals can be viewed in CMM 815.16 and CMM 866.2.5 respectively.

846.2.1.3 MRS-Soils and Aggregates

The Soils and Aggregates module of MRS was created for contractor use and currently consists of five test prefix reports: 162 - Fine and Coarse Aggregate for Concrete; 217 - Aggregate for Base Courses and Backfill; 224 - Coarse Aggregate Source Certification; 230 - Soils; 232 - Soils and Aggregate Nuclear Density. Additional detail pertaining to requirements for aggregate sampling, testing methods and data submittals can be viewed in CMM 834, CMM 860, and WisDOT's Manual of Test Procedures (MOTP) (https://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/qmp/motp.pdf).

846.2.1.4 MRS-IRI

The MRS-IRI module is used by contractors to submit ride profiling data. The program allows users to attach profiler *.ppf raw data files and also attach *.pdf files of the ride quality module reports to serve as reference files. The *.txt files of the ride quality module reports can be "imported" into MRS-IRI to auto-populate the data fields of the segment details and the roughness screens.

846.2.1.4.1 Automatic Calculation

The program calculates pay adjustments for segment IRI and for localized roughness. Reviewers are to evaluate the imported information in the Highway Quality Management System (HQMS) website. Pay attention to areas that were excluded and to segment categories since the categories trigger which formulas are used to calculate pay adjustments. Reviewers will provide comments regarding any revisions to pay adjustments.

Additional detail pertaining to specifications for Ride Quality measurements and reporting requirements can be viewed in standard spec 440 and CMM 838.

846.2.2 MIT

Materials Information Tracking is used by WisDOT and WisDOT consultant field staff to report QV (quality verification) and IA (independent assurance) sampling and testing data. MIT is similar to the contractor MRS program in that it consists of various numbered (prefix) test reports. It is also similar in the sense that it needs to be installed on users' individual computers and does not have a direct network connection.

846.2.3 MTS

The Materials Tracking System is a network-based system used by WisDOT Materials Lab personnel, IA Specialists, and regional materials personnel to enter materials test results or documentation data. The MTS is installed on numerous department Local Area Network (LAN) servers so that it can be accessed by department personnel from statewide regional offices and sign shop locations. Data entered into the MTS is uploaded into the Oracle database that is housed in central office. All materials numbered (prefix) test reports can be created or viewed in the MTS.

846.2.4 HQMS

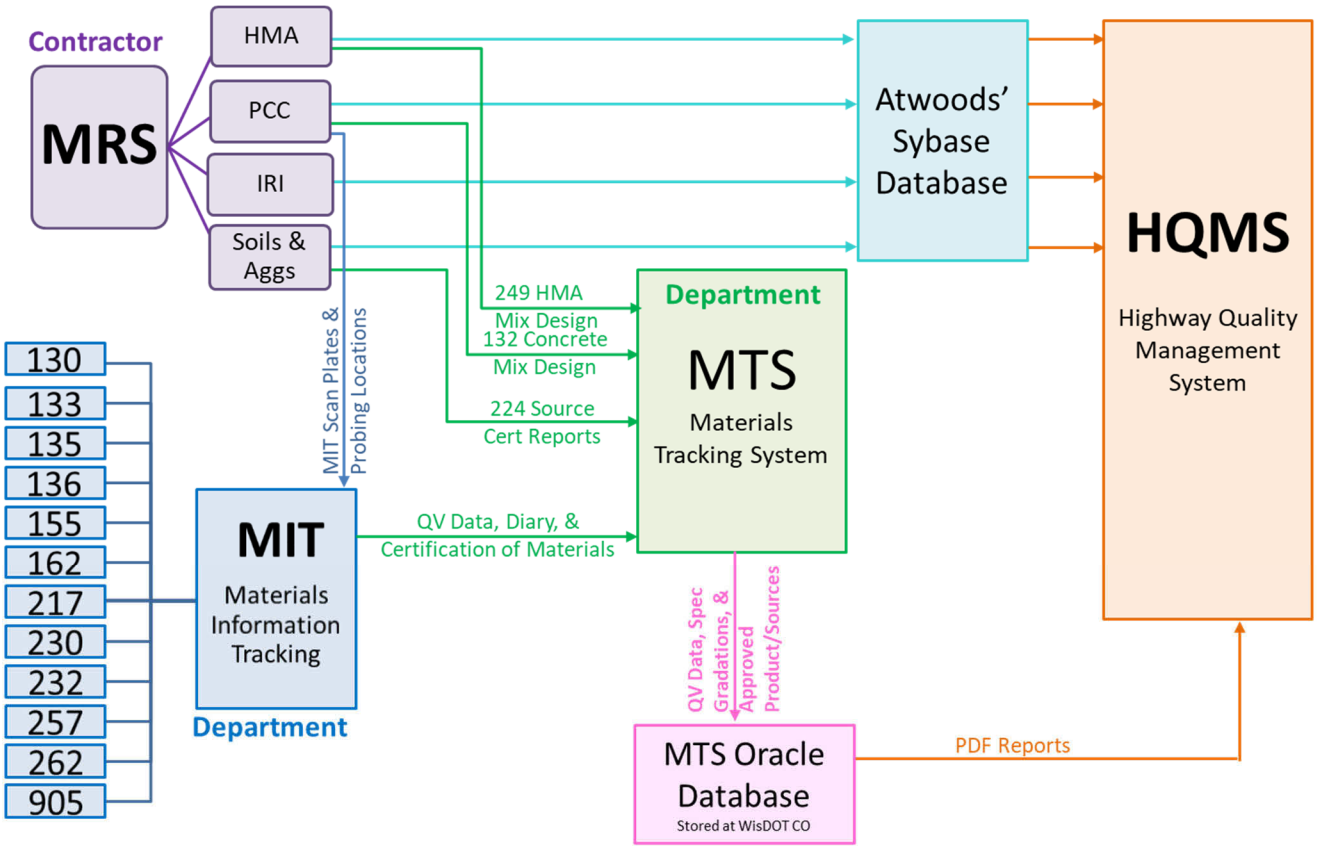
The Highway Quality Management System database is maintained by Atwood Systems and the HQMS website can be accessed through their homepage at:

http://www.atwoodsystems.com/

After logging into the HQMS website, users arrive at the HQMS main menu page. Information can then be searched for by Material Type and Project ID.

Figure 846-1 depicts the flow of information between the key software components and illustrates the path from independent computers to the database for final review and reporting to the Highway Quality Management System website. Notice that the pathway can vary based on the type of material or report you're working with.

FIGURE 846-1 Flow of Materials Information



846.3 Electronic Reporting System Operations

With the creation and requirement of QMPs, WisDOT recognized the importance of capturing materials test data electronically to represent the products being incorporated into construction projects. This data serves as a permanent record and also provides information on a statewide basis to improve specifications. The current system was developed and continues to evolve to service that need.

846.3.1 Primary Users, Logons (location IDs/Project IDs), Passwords

Software components are used by contractors, department staff, and consultant personnel. Material reports can be created, reviewed, edited, verified, viewed, printed, sorted, and searched. WisDOT approved products, certified suppliers, and source lists are also available through the website.

To logon to any of the software program modules or the website, each user is required to have a User ID and Password. As a "new user" the User ID and Password are requested, created and tracked through Atwood Systems. Some of the components allow the user to create their own ID and password while other areas define a standard password to gain access. Information required from a new user is minimal and of a non-personal nature. Logon IDs and associated passwords are required in order to assign user authorities/permissions and are employed to protect data integrity and system security, see figure 846-2 for log on for MTS and MIT pages.

FIGURE 846-2 Flow of Materials Information



To request or change authorities/permissions for MTS and MIT, contact the BTS representative. For MRS, contractors contact Atwood Systems directly. Contact information is located in CMM 846.6.2.

846.3.2 Prefix Title Listing

While reports have specific titles indicating the type of material being tested or type of report being compiled, it is common practice to reference the report entry screens by their test "prefix". The software system currently supports over 50 reports. A reference listing of these prefixes and associated subject titles can be found in table 846-1 or within the software system as a drop-down selection box list.

TABLE 846-1 MTS, MIT, and MRS Prefix List

No.	Description	Application	No.	Description	Application
101	Steel Bars - Concrete Reinforcement	MTS-CO	170	Geotextiles	MTS-CO
103	Steel Wire & Mesh - Concrete Reinforcement	MTS-CO	172	Geogrid	MTS-CO
105	Steel Plate Beam Guard	MTS-CO	177	Corrugated Drainage Pipe	MTS-CO
106	Uncoated Steel Strands - Prestressed Concrete	MTS-CO	180	Concrete Brick, Block, & Pipe	MTS-CO
112	Steel Sheets - Culverts	MTS-CO	217	Aggregates for Base Courses & Backfill	MTS, MIT, MRS
115	High Strength Bolts, Nuts, & Washers	MTS-CO	223	Fine Aggregate Source - Certification	MTS-CO, MRS
120	Chain Link Fence Fabric	MTS-CO	224	Coarse Aggregate Source - Certification Submittal	MTS-CO, MRS
121	Rolled Formed Sections - Chain Link Fence	MTS-CO	225	Coarse Aggregate Source - Certification Approval	MTS-CO
122	Pipe- Chain Link Fence	MTS-CO	230	Soils	MTS, MIT, MRS
123	Tension Wire - Chain Link Fence	MTS-CO	232	Soils & Aggregate Nuclear Density	MTS, MIT, MRS
126	Woven Wire Fence Fabric	MTS-CO	249	Asphalt Mix Design - Contractor Submittal	MRS
127	Barbed Wire - 2 Strands	MTS-CO	250	Asphalt Mix Design Verification	MTS-CO
128	Smooth Wire - Woven Wire Fence	MTS-CO	254	Asphaltic Mix Verification	MTS
130	Compressive Strength - Concrete Cylinders	MTS, MIT, MRS*	257	Asphalt Mix Testing	MTS, MIT
131	Water - Concrete	MTS-CO	259	Asphalt Job Mix Formula - Field Changes	MTS
132	Concrete Mix Designs	MRS	262	Asphaltic Pavement Nuclear Density	MTS, MIT, MRS*
133	Concrete Flexural Strength	MTS, MIT, MRS*	330	Performance Graded Binder	MTS-CO
134	Concrete Surface Resistivity	MTS, MRS*	332	Emulsified Asphalt	MTS-CO
135	PCC Probing Thickness	MTS, MRS*	334	Asphalt Binder AMRL - Lab Accreditation	MTS-CO
136	Concrete Thickness - MIT Scan	MIT, MRS*	801	Aggregate Gradation - IA	MTS
140	Concrete Curing Compound	MTS-CO	802	Concrete Mixtures - IA	MTS
150	Portland Cement	MTS-CO	803	Asphaltic Pavement Density - IA	MTS
151	Ground Granulated Blast Furnace Slag	MTS-CO	804	Asphaltic Mixtures - IA	MTS
152	Fly Ash	MTS-CO	805	Soils & Aggregate Nuclear Density - IA	MTS
155	Miscellaneous Materials	MTS, MIT	806	Compressive Strength Concrete Cylinders - IA	MTS
162	Fine & Coarse Aggregates - Concrete	MTS, MIT, MRS	905	Materials Diary Inspection	MTS, MIT

* Contractors report test result data in a similar format, but not on the "test prefix reports".

MTS-CO = Lan Central Office Contractors MTS = Lan Regions MIT = Regions MRS =

846.3.3 Data Entry-General

There is some basic/common information required for new test data being entered into the system. Once data has been entered a "save" action is required, and to eventually be followed by either a "submit" or

"verify" or "review" action. Pulldown menu boxes are provided to aid in maintaining consistency and efficiency.

There is a timeout function associated with the database, and users are cautioned/reminded to "save" data frequently to avoid having to re-enter when interruptions cause a timeout to their session.

846.3.4 Sample Card Tab

The sample card for materials test prefix reports is aimed at providing information that defines certified samplers/testers, dates, project IDs, and pertinent materials identification or test types. Required fields are typically denoted with a red asterisk and are sometimes necessary to be filled-in before moving on to new screens or report tabs.

846.3.5 Test Data Tab

For test prefix reports users click the "Test Data" tab to open the worksheet portion of the system. Cells available for raw data entry are typically indicated by "boxes" while many programed calculations are performed internally and additional fields are automatically populated.

846.3.6 Automatic Calculations

Many of the individual screens and programs have internal formulas to provide automatic calculations. These formulas are tied to specification requirements and in some cases perform calculations involving incentives and disincentives. Reviewers are to evaluate any imported information in the Highway Quality Management System (HQMS) website before final verification of reports. Reviewers will also provide comments regarding any revisions to pay adjustments.

846.3.7 Reports

Reports representing individual test prefix numbers can be previewed, generated, and printed on a per test, per project, or statewide basis. Reports representing multiple projects can also be exported into different formats for analysis. Any changes made to existing "verified" reports will require re-verification. Deleting existing test-prefix reports requires authorization to do so as the database automatic numbering system is affected.

846.3.8 Reviewing Reports and Data Entry

"Reviewers" will need to retrieve various data screens before final approvals/verifications to evaluate accuracies for quantities of affected materials and any estimated payments. Accessing reports is accomplished through the MTS or HQMS website.

846.4 System Version Updates

As new construction materials/products are introduced, specifications evolve, or new QMP requirements are developed, program edits and upgrades become necessary to document the associated acceptance activities. Due to the complexity of contract budgeting and software coding processes, it is intended that new full version releases are limited, yet timely enough to accommodate the department's reporting needs during construction.

846.4.1 Calendar Cycles/Frequency

Version updates are targeted to be once annually (i.e. early Spring/March). Enhancements are solicited annually through materials technical team meetings, user group conferences, and periodic user surveys.

846.4.2 Beta Testing

Beta testing on new program versions will be over a period of approximately 4 weeks and will occur with the help of subject matter experts before statewide new version releases.

846.4.3 Communications/Notification

Users will be notified through email by the department when new versions of MRS/MIT/MTS have been released. This upgrade to the servers typically occurs at the end of a week and requires users to be logged off their system in order for the new version to become effective upon next logon.

846.4.4 System Maintenance

Items considered to fall under the umbrella of "maintenance" are applied to existing system features or screens and would typically include corrections for: typographical errors or misspellings; cell labelling or terminology; adjusted formulas or calculation values; screen aesthetics for improving efficiencies or clarity; adding cell character length; adding print report features; etc.

A blanket work contract is used to maintain the system on an annual basis and is typically a standard lump sum to charge services against.

846.4.5 System Enhancements

Items considered as "enhancements" require either extensive program re-coding to existing features or involves the creation of new features. Some examples would be new test screens (prefixes); new

automation (ex: automatic cell populations); changes in formula anchors or the addition of new process calculations; database changes; creating new print-reports; operating system upgrades for compatibility; etc. Enhancement suggestions are considered based on the ability to improve system functionality. Enhancement "wish" lists are then compiled and prioritized for operational impact and available funding. Enhancements require that a work contract be developed, detailing the specific items being requested and their associated cost.

846.5 Troubleshooting System Malfunctions or Inconsistencies

Beta-testing is intended to assure full operational success with new version releases; however, a number of circumstances can influence the actual success rate. If users experience difficulty with the software programs or component features, a process has been put in place to log the issue, seek explanation, track and record debugging resolutions.

846.5.1 Contact Person

If users experience difficulties with data inputs or report outputs, follow these steps:

1. Check the "Top FAQs" in this section (8-46.7) for potential self-solve information.
2. Contact the regional support personnel listed in 8-46.6.1 to discuss the issue and possible resolution.
3. Email an informational request to BTS (see contact listing).
4. When warranted, work directly with Atwood Systems (8-46.2) on a fix, by allowing access to individual affected computer.

846.5.2 Follow-up

After a solution has been proposed and corrections made, the "user" originating the inquiry will be contacted by the solver if the user wasn't directly involved in the solution. If the user was part of the resolution process, the user or contact will notify BTS when the correction has been applied successfully.

846.6 Support and Contacts List

846.6.1 Oversight Committee (Department/Contractors)

The department has created a team to support user data entry activities. The primary goal of this committee is to provide subject matter expertise for the WisDOT materials reporting programs (MRS, MIT, and MTS). Team members will also recommend program enhancements and revisions and also assist with beta-testing of new versions before statewide releases.

The following is a list of primary and secondary contacts. Please contact your regional representatives for data entry assistance or to report software program concerns.

Region	Primary Contact	Secondary Contact
NW Region	Taylor Copp 715-392-7865 taylor.copp@dot.wi.gov	Roseann Bowe 715-839-3785 roseann.bowe@dot.wi.gov
NC Region	Steve Hunter 715-365-5753 steven.hunter@dot.wi.gov	Nick Krueger 715-365-5724 nickp.kruger@dot.wi.gov
NE Region	Travis Maatta 920-366-5790 travis.maatta@dot.wi.gov	Jamie Cynor 920-366-8096 jamie.cynor@dot.wi.gov
SW Region	Jeanette Frazer 608-792-0943 jeanette.frazer@dot.wi.gov	Matt Smith 608-516-6527 matt.smith@dot.wi.gov
SE Region	Deann Balog 262-548-5697 deann.balog@dot.wi.gov	Nicole Roberts 414-659-3055 nicoler.roberts@dot.wi.gov

Additional Bureau Contacts, BTS (Central Office):

1. Adam Johnson, 920-492-4124, adam.johnson@dot.wi.gov
2. Jeff Anderson (HMA), 608-246-5656, jeffrey.anderson@dot.wi.gov
4. Myungook (MK) Kang, 608-246-7957, myungook.kang@dot.wi.gov

846.6.2 Atwood Systems

Atwood systems provides expertise and services to WisDOT after developing a software system in 1999 capable of materials data collection and its subsequent management. Home page web address:

http://www.atwoodsystems.com/

1. Gary Lynch, 608-848-6085, garylynch@atwoodsystems.com
2. Ryan Seffrood, 608-848-6085, ryan@atwoodsystems.com

Address: Atwood Systems, 509 Commerce Parkway, Verona, Wisconsin 53593

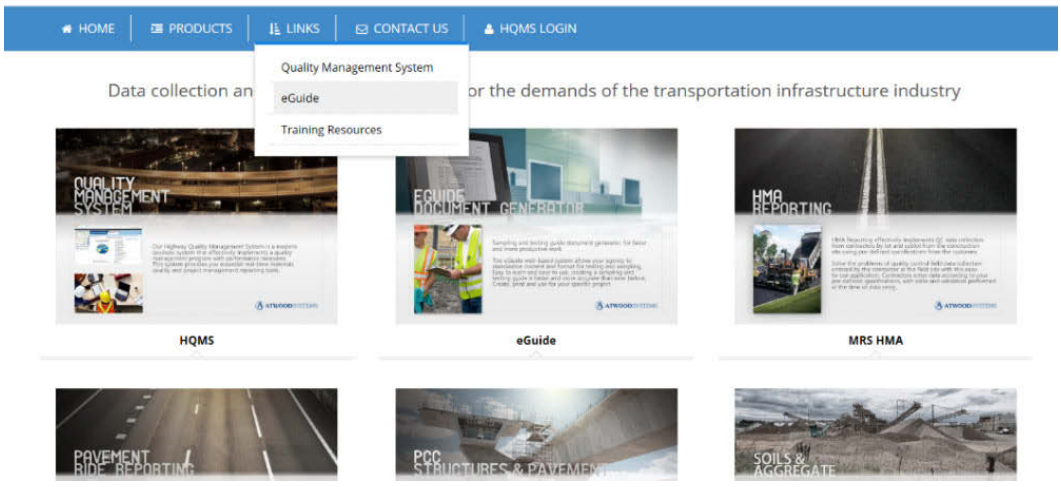
Office Phone: Toll Free at 877-518-1920, 608-848-6085, info@atwoodsystems.com

846.7 Top FAQs

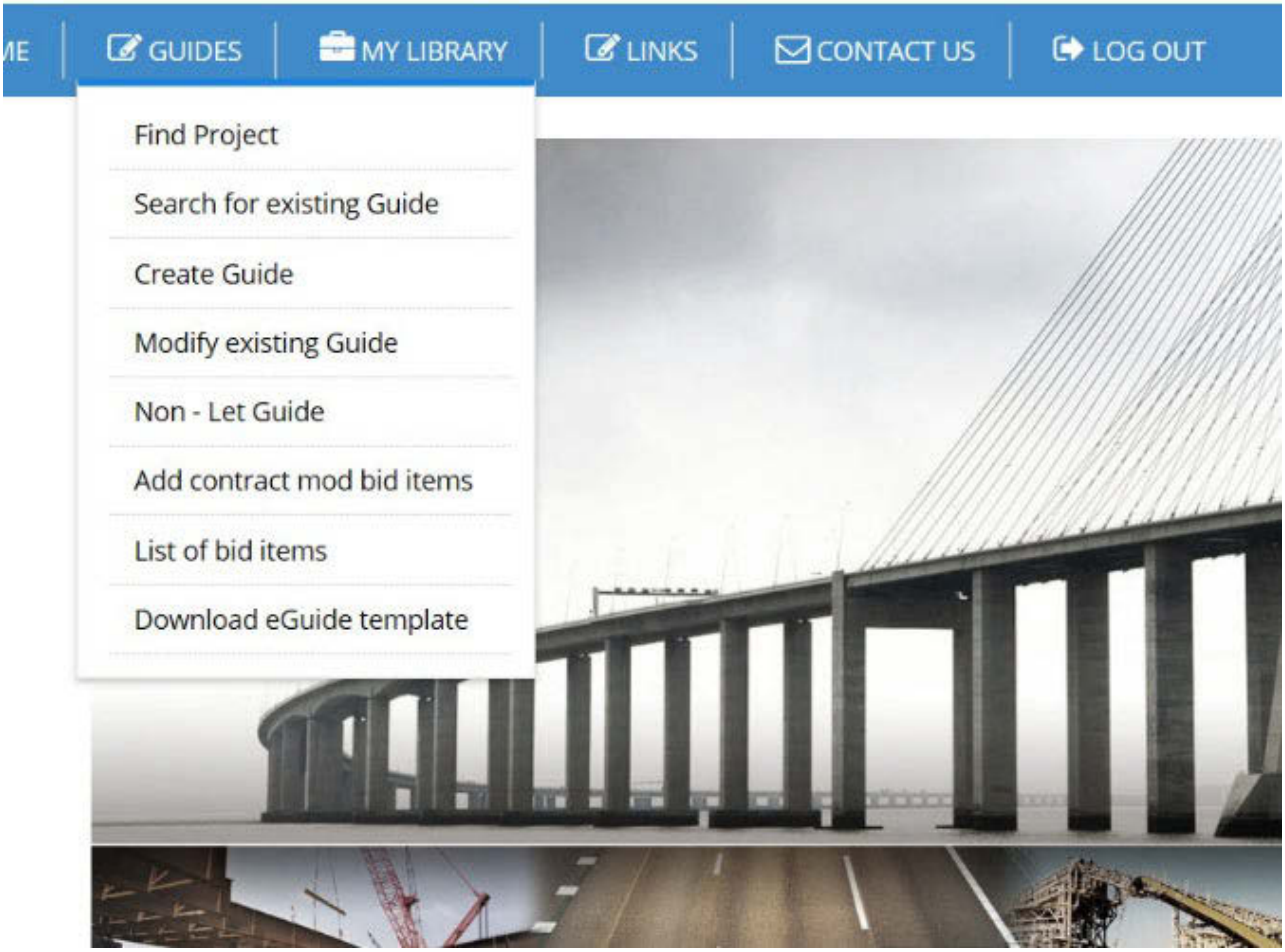
1. I can't remember my logon ID or Password? Contact Atwood Systems directly by email or phone.
2. I can't find a project ID in order to enter my test data? Check contract let date to ensure it would/should be in the system. Also check to see if the project is listed under the Non-Let Projects tab. Suggest using the "map" feature in HQMS if the project location is known or contact a WisDOT local/regional Materials Coordinator.
3. What happens if I'm interrupted during data entry and my screen times out? The system will only remember the information entered up to the last "save" action (this is part of the database security measures). It is recommended to "save" often, during entry activities.
4. How do I convert my profiler IRI measurements (from PROVAL) to submit to the department? Refer to CMM 838.
5. I've entered my HMA mix design onto a MTS-249 and submitted it to the department but I don't see the verified report? Be sure the proper associated time has elapsed before seeking the design approval information. Check to see that the design information has actually been "submitted" versus just being "saved".
6. I've received confirmation that my Aggregate source has been approved; however, I don't see it listed on the Approved Sources List, what do I do to start work "today"? Posting to Approved Products lists is a separate department process that may lag behind notification of source approvals. Suggest to check or "print" a copy of the associated test prefix report (ex: 162 or 225) to validate starting work, if meeting the appropriate specs.
7. My Aggregate source has historically been approved; however, during my data entry I receive a message stating it's "not available", what do I do? Check the pertinent 162 or 225 report against any updated specs or required verification testing parameters (ex: source quality testing timeframes for renewal per standard spec 106.3.4.2.2). If source meets the appropriate specs, suggest to complete data entry with a "save" action, to be edited at a later time, and note in the comments/remarks.
8. How do I interpret if an Aggregate Source can be used for my project? Pull up the APL and note the uses listed "beneath" the source legal description.

846.8 Atwood Systems Screenshots

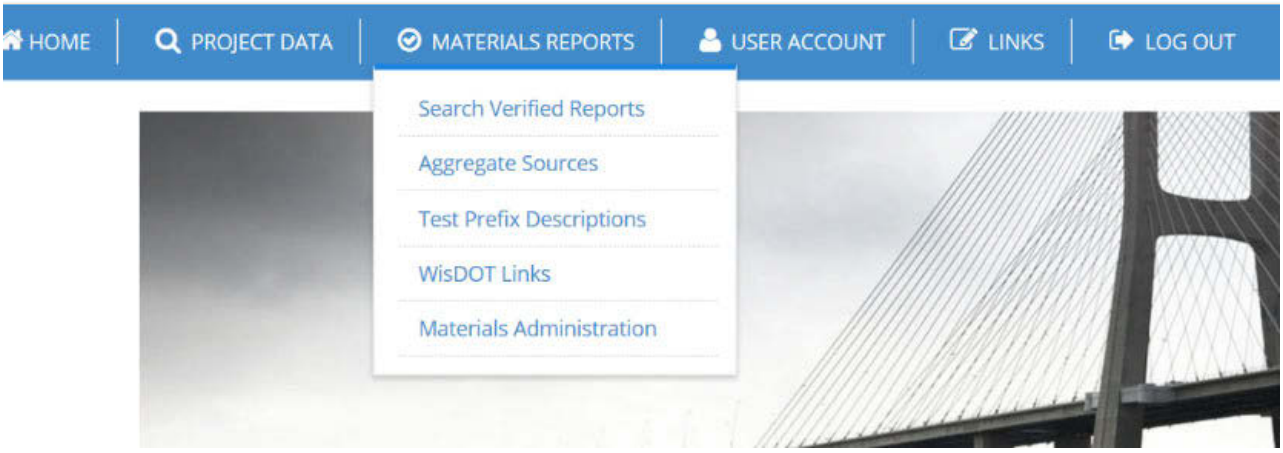
Home Page



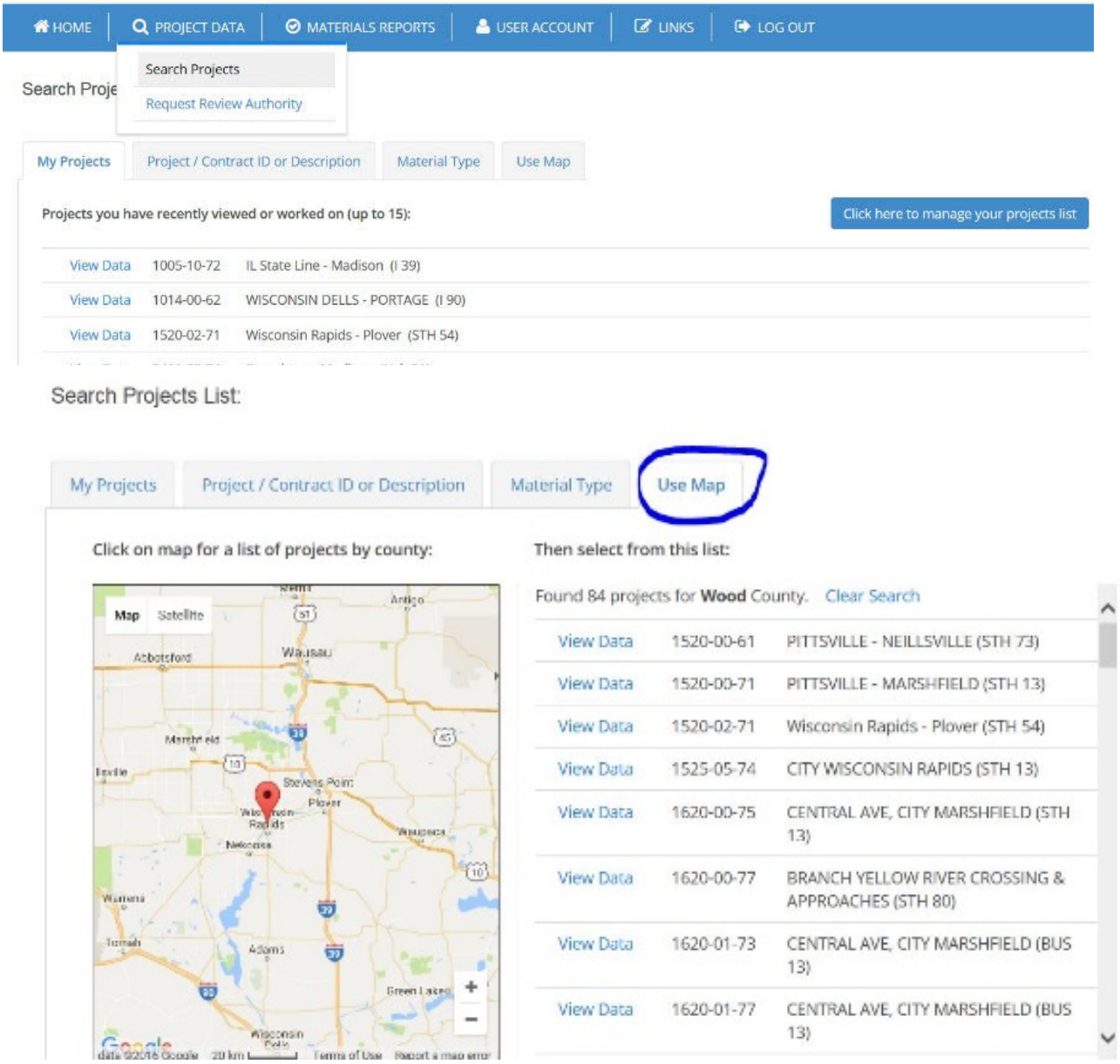
eGuide Menus



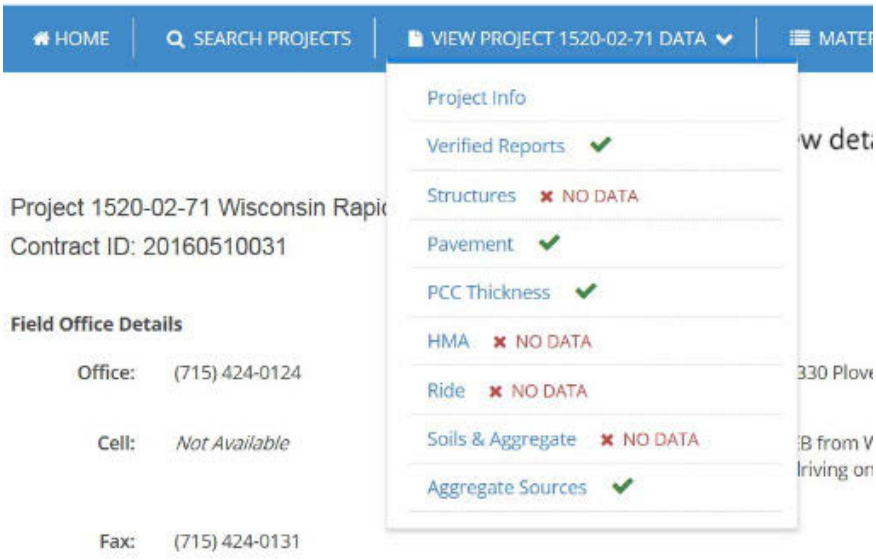
HQMS Example Search Menus



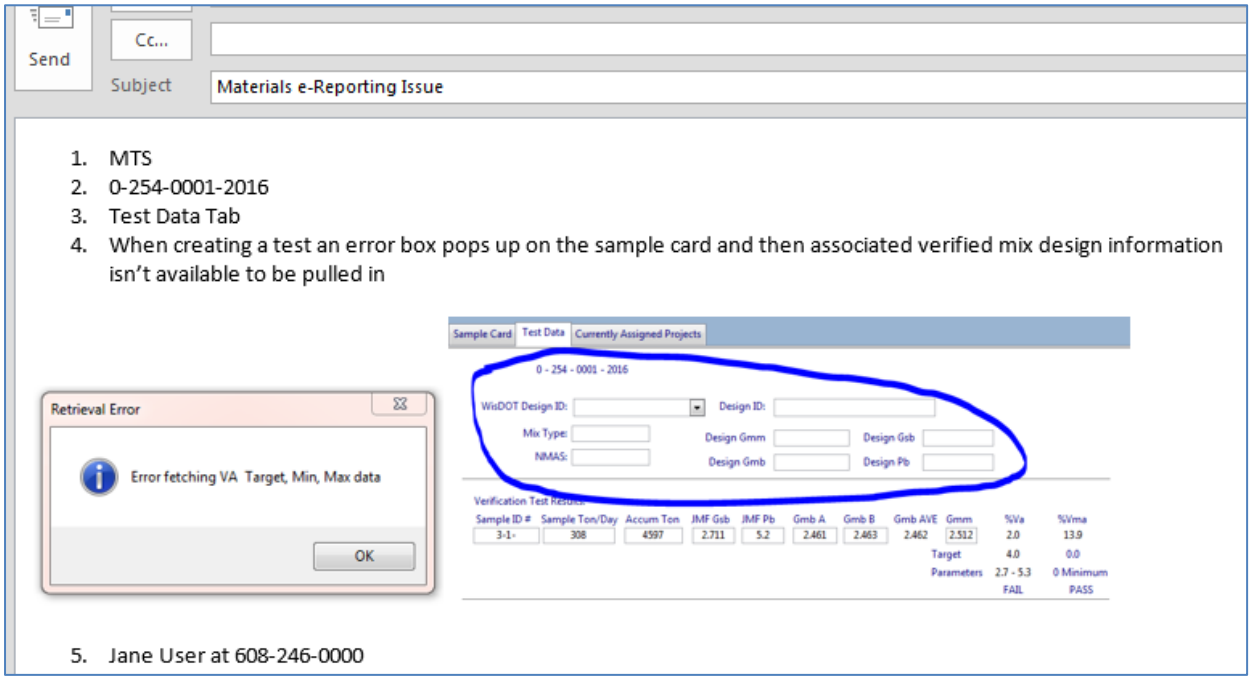
Search Projects



View Project Data



Issue Reporting Template - Example email Message



Please call to discuss or email the following information to the Regional Contact:

For emails, in the subject line use "Materials e-Reporting Issue", then in the body of the message:

1. System Component Affected (i.e. MRS-HMA, MRS-PCC, MRS-IRI, MRS-Soils and Aggregates, MIT, MTS, or Other)
2. Test Report Number or Screen Prefix
3. Function reference (i.e. login, sample card, test data, calculations, etc.?)
4. Short description of the problem and a representative screenshot(s)
5. Follow-up user contact phone number (if other than provided in the signature information)

SECTION 850 Materials Testing and Acceptance Guide

Materials sampling and testing methods and documentation prescribed in 850 are mobilized into the contract in standard spec 106.3.

850.1 Materials Testing and Acceptance Guide

Revise 850.1 (Materials Testing and Acceptance Guide) information for concrete materials, concrete curing and sealing, precast concrete, and prestressed concrete.

The minimum requirements for testing and acceptance of materials are specified for the following:

Aggregates - Source Testing	Electrical Conduit
Aggregates - Stockpile Testing	Embankment
Aggregates - Project Testing	Erosion Control Materials
Anchor Bolts and Anchor Rods	Fencing
Asphaltic Materials	Geosynthetics
Asphaltic Mixtures	High Strength Bolts
Asphalt Pavement Density	Joint Sealers
Bearing Pads	Lumber and Timber
Block and Brick	Mortar
Bridge Fabricated Components	Paint
Bridge Secondary Fabrications	Pavement Marking
Bronze Plates, Lubricated	Piling
Castings, Gray Iron	Posts, Treated Wood
Concrete Materials	Precast Concrete
Concrete Curing and Sealing	Prestressed Concrete
Concrete Mixing Water	Signing
Concrete Reinforcement	Steel Products
Concrete	Traffic Control Devices
Delineators	Waterstops
Drainage	Temporary Pedestrian Devices
Electrical	

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
AGGREGATES - SOURCE TESTING					
Source Testing for Quality: Wear, Soundness, etc.					The regional person responsible for this area will oversee the provisions in items [1] and [2] below.
Aggregate Base Course (Dense and Open-Graded)	Source	Central Lab or Qualified Lab	[1], [2]	100# [3]	Central and Qualified Laboratory Source Testing under standard spec 106.3.4.2 [1] A representative sample of processed material must be submitted from any deposit not previously tested. Samples for testing (except for soundness and wear) must be submitted as follows: Yearly - One per deposit, for deposits that exhibit substantial variation in test results. Five-year period - One per deposit, for deposits that exhibit minor variation in y test results. Additionally - When visually obvious changes in characteristics occur, as deposit is worked or as the material is delivered to the project. [2] Soundness and wear tests must be run once per pit deposit per five-year period and once per quarry deposit per three-year period. For deposits having marginal soundness and wear values (within 5 percent of specification maximum limits), at least one test per deposit per year. [3] 50# will suffice for wear and soundness tests if only R/No.4 (4.75 mm) material is submitted. This must be obtained by separating the graded material on a No. 4 (4.75 mm) sieve. [4] At least one test per contract. [5] At least one test for L.A. Wear per contract. Recycled concrete for use in concrete pavement will require a test for wear if material is supplied from a source outside the project limits. [6] For concrete-making properties: Processed: One bag (+/-1 cubic foot) each of the fine aggregate and two sizes of coarse aggregate, except as otherwise requested by the laboratory in specific instances. [7] 50# will suffice if about 90% or more of the material passes the No. 4 (4.75 mm) sieve.
Asphaltic Mixes			[1], [2]	100# [3]	
Breaker Run Stone			[1], [23]	100#	
Granular Subbase & Backfills (if there are plastic fines in the material)			[1]	100# [7]	
Pit Run			[1], [23]	100# [7]	
Concrete			[1], [2]	[6]	
Recycled/Reclaimed Materials or Industrial By-Products			[5]	100# [3]	
Seal Coat			[1], [2]	100# [3]	
Selected Borrow(when sieve analysis or P.I. required). See standard spec 208.			1], [23]	100#[7]	[23] Alternate engineer acceptance must be documented in the material records. For Breaker Run refer to standard spec 311.2, for Select Crushed Material refer to standard spec 312.2 and for Pit Run refer to standard spec 313.2.
Select Crushed Material			[1], [23]	100#	
AGGREGATES - STOCKPILE TESTING					
Aggregates Stockpile Testing	Source	Field[24]	[25]		[24] Refer to appropriate spec section or QMP to determine if WisDOT or contractor is to perform sampling and testing. [25] Perform gradation, plastic limit, liquid limit and/or fracture tests on one stockpile or loadout sample from each source before placement.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
AGGREGATES - PROJECT TESTING (Gradations, Plasticity, Fracture, etc.)					
QMP Contracts	Field	Field			QMP Contracts - See the specific contract documents for guidance. All aggregate QC and QV tests must be reported according to the timeline in the applicable QMP provision on the MIT/MTS prefix 217 or 162 as applicable. Projects require a MIT/MTS prefix 155 QMP Base Aggregate Summary Report base aggregate dense 1 1/4-inch nuclear density QC and QV tests on MIT/MTS prefix 232. Projects require a MIT/MTS prefix 155 and/or QMP Base Aggregate Dense 1 1/4-Inch Compaction Summary report.
Non-QMP Contracts	Field	Field			Non-QMP contracts - All acceptance tests must be reported on the Materials Tracking System. The locations of project acceptance tests must be randomly distributed throughout the project. When the aggregates are used as produced and when uniform production and deposit conditions prevail, the minimum field acceptance tests below must be made and, in addition, observation must be maintained at the point of use for indications of deviations from normal gradation. When such deviation is noted, additional tests and necessary adjustment must be made immediately to rectify the condition. The minimum tests are only adequate after plant operations have been stabilized and uniformity of production, well within specification limits, has been obtained. Each sample must be tested for sieve analysis and other tests, as necessary, for determination of conformance with specifications
Aggregate Base Course (Non-QMP contracts) Includes but is not limited to: - Crushed Agg. Base Course - Crushed Agg. Base Course, Open Graded - Recycled/Reclaimed Aggregates	Field	Field	[8]		[8] Contract ≤ 500 tons: Acceptance should be in accordance with CMM 845. tons through 3000 tons /contract. One sample. More than 3000 tons/contract: One sample per 3000 tons cumulative. For 3000 tons or less/contract the material may be sampled for acceptance in the stockpile at the last location before use.
Aggregate for chip seals, seal coats	Field	Field	[9]		[9] Contract ≤ 500 tons: Acceptance should be in accordance with CMM 845. tons through 1500 tons/contract: One sample. More than 1500 tons/contract: One sample per 1500 tons cumulative per contract.
Aggregate for Concrete Pavement & Ancillary Concrete (QMP Contracts)					QMP Contracts - See the specific contract documents for guidance.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
Aggregate for Concrete Masonry Structures (QMP Contracts)					QMP Contracts - See the specific contract documents for guidance.
Aggregate for Concrete Masonry Structures (Non-QMP Contracts)	Field	Field	[11]		[11] One CY through 100 CY of concrete/contract: One sample*. CY through 400 CY of concrete/contract: A) One sample* for all substructure units. B) One sample* per deck pour per day. More than 400 CY of concrete/contract: A) One sample* per 350 CY or fraction thereof for substructure units. Contact the regional materials section for guidance when conditions of construction are such that more frequent sampling may be warranted (e.g. an extensive length of construction, mixture/material changes). B) One sample* per deck pour per day. For pours over 450 CY, additional samples may be required, contact the regional person responsible for this area for guidance. * One sample must consist of sampling each size of aggregate being incorporated into the work.
Select Borrow	Field	Region	[12]		Follow same sampling and testing as Granular Backfill. Refer to special provisions for material requirements.
Granular Backfill [A]	Field	Field	[12]		[12] Contract ≤ 500 CY (1,000 TONS): Acceptance should be in accordance with CMM 845. Contract > 500 CY (1,000 TONS): One sample per 3,000 CY (6,000 TONS) or portion thereof. Material may be sampled for acceptance at the source. Contract quantities exceeding 20,000 CY (40,000 TONS) contact the region TSS/Materials unit. Testing frequency to be applied per source of material. Plasticity and Liquid Limit: Test first gradation sample. If sample is Non-Plastic, test a minimum of once per 10 gradation tests If sample is plastic, test every gradation sample. [A] Allowable Substitutions: Grade 1 granular backfill is an allowed substitution for Grade 2 granular backfill. Discuss with the Region how to document substitution.
Structural Backfill [B]	Field	Region	[12]		Follow same sampling and testing as Granular Backfill. [B] Allowable Substitutions: Type A structure backfill is an allowed substitution for Type B structure backfill. Discuss with the Region how to document substitution.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
Breaker Run Stone [C]	Field	Field	[13]		[13] Acceptance must be from a Source with current Quality Testing. If source does not have current quality testing, have Quality Test performed. Alternate source acceptance may be granted in accordance with standard spec 312. Perform visual gradation, fracture and durability tests. If visually obvious changes in quality characteristics occur or if material appears non-compliant, have fracture and gradation tests performed at the Regional laboratory. [C] Allowable Substitutions: Select Crushed is an allowed substitution for Breaker Run. Discuss with the Region how to document substitution.
Select Crushed Material	Field	Field	[13]		Follow same sampling and testing as Breaker Run Stone.
Pit Run [D]	Field	Field	[13]		Follow same sampling and testing as Breaker Run Stone. [D] Allowable Substitutions: 3" BAD, Breaker Run and Select Crushed are allowed substitutions for Pit Run. Discuss with the Region how to document substitution.
Subbase	Field	Region	[12]		Follow same sampling and testing as Granular Backfill.
Culvert Pipe Backfill Foundation [E]	Source	Contractor lab	[15]		[15] Contractor to supply sample gradation, plasticity index and liquid limit results to project engineer before placing material. Project engineer may waive contractor testing for known sources.
	Field	Region	[12]		Follow same sampling and testing as Granular Backfill. [E] Allowable Substitutions: Material with a GRADATION of ¾" BAD or 1 ¼" BAD are allowed substitutions for Culvert Pipe Foundation Backfill. Discuss with the Region how to document substitution.
Culvert Pipe Backfill Trench	Field	Field			Perform visual acceptance of material that complies with standard spec 520. If material does not meet specification, use a project engineer approved material.
Storm Sewer Backfill Foundation [F]	Source	Contractor lab	[15]		Follow same sampling and testing as Culvert Pipe Foundation Backfill.
	Field	Region	[12]		Follow same sampling and testing as Granular Backfill. [E] Allowable Substitutions: 3/4”BAD, 1 1/4" BAD and Crushed Stone Chips are allowed substitutions for Storm Sewer Foundation Backfill. Discuss with the Region how to document substitution. Gradation of Crushed Stone Chips is determined based on pipe size. Include pipe size on sample card when submitting to the region lab.
Storm Sewer Backfill Trench	Field	Region	[12]		Follow same sampling and testing as Granular Backfill. Allowable Materials: Culvert Pipe Foundation Backfill and Granular Backfill

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
ANCHOR BOLTS and ANCHOR RODS					
Structure Bolts and Rods	Shop				See CMM 845 for certification guidelines.
Base Structure Bolts	Field				A manufacturer's certification of compliance is required and must be made available by the contractor. Reference on MIT/MTS prefix 905. See CMM 845 for certification guidelines. The end of each fabricated anchor bolt unit must be painted to identify the grade as follows: (Grade 36 - Blue) (Grade 55 - Yellow) (Grade 105 - Red) Visually inspect and document dimensions, condition, color marking, etc. Reject rods if not correctly marked.
ASPHALTIC MATERIALS					
Asphalt Binder	Source and Field	Central Lab	Central Lab	1 quart (1 L) Tin container	The supplier or contractor personnel will obtain samples, under the observation of a project engineer, at the HMA plant site. For contracts greater than 1,000 ton of mix, obtain an In-Line sample at a rate of one-liter (one-quart) sample per 15,000 tons of mix for each supplier and grade of asphalt binder, or fraction thereof. For contracts with 1,000 ton of mix or less, one (1) non-random In-Line sample may be obtained at the discretion of the project engineer. For all contracts, one (1) non-random truck transport sample may be obtained at the discretion of the project engineer. In addition, obtain samples as directed by the project engineer at any time extra samples are deemed necessary. A list of approved asphalt suppliers and approved sampling methods/locations are shown in the Combined State Binder Group Method of Acceptance for Asphalt Binders at: https://engineering.purdue.edu/~csbg/method.html Provide sample tag DT1352, with sample. See CMM 865 for blank tag and example to be submitted.
Liquid Asphalt (MC, SC types)	Field	Central Lab	See standard spec 455.2.2.2	1 quart (1 L) Tin container	Sample in the field, one sample for each 10,000 gallons. Document sampling per CMM 865. Sample per WTM R66. Provide sample tag DT1352, with sample. See CMM 865 for blank tag and example to be submitted.
Emulsified Asphalts (Tack Coats, Slope Paving, etc.)	Field	Central Lab	See standard spec 455.2.5	2-quart plastic container	Sample in the field, 1 per contract when 2,500 gallons or more are used, no samples on contracts less than 2,500 gallons. Sample per WTM R66. Provide sample tag DT1352, with sample. See CMM 865 for blank tag and example to be submitted. Emulsified asphalts have a limited life and should be submitted to the Central Laboratory as soon as practical. DO NOT allow samples to sit in the sun, be exposed to excessive heat, or freeze. NEVER use metal cans for samples, always use plastic or other non-reactive clean containers (i.e.: ULINE ½ gallon jug, model number S-13509B or equivalent).

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
ASPHALTIC MIXTURES					
Uncompacted	Field	Field	[16]		[16] For QMP contracts, see the specific contract documents for guidance. All QV, and corresponding QC tests must be reported in a timely manner on the MIT/MTS prefix 254. Projects require MIT/MTS prefix 155 QMP HMA Mixtures Summary. [17] One to 500 tons (450 Mg)/contract acceptance may be in accordance with CMM 845. For ASPHALTIC SURFACE (Section 465) a visual inspection must be made and documented in the inspector's diary. If visual inspection indicates a problem may exist, the mixture may be sampled and tested for composition as determined by the project engineer. Reference the approved WisDOT mix design test electronically on a MIT/MTS prefix 905. Sample uncompacted mixtures in accordance with instructions in the CMM, "Methods of Sampling Asphaltic Paving Mixtures". See CMM 865.
ASPHALT PAVEMENT DENSITY					
Density	Field	Field			For QMP contracts, see the specific contract documents for guidance. For Non-QMP contracts, see standard spec 460.3.3. Report all HMA pavement Nuclear Density tests on MIT/MTS prefix 262. Projects require a MIT/MTS prefix 155 QMP HMA Nuclear Density Summary.
BEARING PADS					
Bearing Pads or Laminated Elastomeric Bridge Bearing Pads	Shop				These items are to be supplied from an approved fabricator. The list of approved fabricators for laminated elastomeric bearings are in the APL. If the bearing pads are not furnished by an approved fabricator, the project engineer must immediately contact the region person responsible for this area, and the Structure Fabrication Unit before installation. If approved by the above, the below noted documentation must be provided to the region contact for this area and the Structure Fabrication Unit. For sheet lead and preformed fabric, a manufacturer's certification of compliance must be made available by the contractor. See CMM 845 for certification guidelines. For elastomeric, the project engineer must have before use a manufacturer's certified report of test or analysis indicating conformance to the contract requirements.
BLOCK and BRICK					
Concrete Brick and Block	Field				These items are to be supplied from an approved fabricator. A list of approved manufacturers of concrete brick and block is on the departments approved products list APL. Bill of Lading or other documentation identifying the manufacturer and plant location is required. This is an incidental/non-pay item. Reference on MIT/MTS prefix 905.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
BRIDGE FABRICATED COMPONENTS					
Rail Posts, Anchor Assemblies for rail posts, Sleeves, Shims, Plates, Rail panels, Expansion devices, Guardrail anchors, Elastomeric pads, Bearing assemblies (steel), Structural steel diaphragms	Field				These items are to be supplied from an approved fabricator. The list of approved fabricators for fabricated bridge components is on the APL. See CMM 875 for acceptance procedures." If not on an approved list, immediately contact the regional person responsible for this area. Note: Each shipment must include a certification statement and a loading document from the fabricator. See CMM 875 for requirements of certification statement. Reference on MIT/MTS prefix 905.
BRIDGE SECONDARY FABRICATIONS					
Drains and Downspouts for Bridges	Field				An approved fabricator normally furnishes these items. The list of approved fabricators for Bridge Metal Secondary items is on the APL. In the event the item(s) is not furnished by an approved fabricator, a certification of compliance must be made available. See CMM 845 for certification guidelines.
BRONZE PLATES, LUBRICATED					
Bronze Plates, Lubricated	Shop or Field				If sourced from a fabricator on the approved list, the list of approved fabricators for Bridge Metal Secondary items is on the approved products list APL. If the plates are not from an approved fabricator, the project engineer must have before allowing their installation, a manufacturer's certified report, test or analysis indicating conformance with the contract requirements. See CMM 845 for certification guidelines.
CASTINGS, GRAY IRON					
Castings, Gray Iron	Field				The list of approved Gray Iron Casting manufacturers is on the approved products list APL. For all other manufacturers, a certification of compliance must be made available by the contractor. See CMM 845 for certification guidelines.
CONCRETE MATERIALS					
Concrete Aggregates					See Aggregate for Concrete in this document: Aggregates - Source Testing for Quality Aggregates - Stockpile Testing Aggregates - Project Testing

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
CONCRETE MATERIALS (Continued)					
Concrete Admixtures					Approved lists for concrete admixtures are on the approved products list APL. Refer to the approved lists for AASHTO M194 Types A and D admixtures and AASHTO M154 air-entraining admixtures. AASHTO M194 Types C, E, F, and G admixtures are accepted by certified report of test, reference on MIT/MTS prefix 905. Calcium Chloride as a set accelerator is not allowed, except as incidental to SHES bid items 416.1715, and 416.1725. MIT/MTS prefix 905, diary entry and DT2220 or DT2221 form should include concentration and addition rate.
Cementitious Materials: Portland Cement on APL	Region	Central Lab	One per year per source and type when in use on WisDOT work	4 lbs	The list of approved Portland Cement Manufacturers - Certified Suppliers is on the approved products list APL. See CMM 870 for the "Sampling of Cement." Note: Routine field sampling is not required for certified materials, unless noted on the approved list for a specific vendor/plant. Random sampling will be done through region materials staff in accordance with the Portland cement certification program
Cementitious Materials: Portland Cement not on APL.	Field	Central Lab	One test pre-project. During project one test per 400 tons.	4 lbs	Evaluated and approved for project level use only. See CMM 870 Acceptance of Portland Cement not on the Approved List section.
Cementitious Materials: Fly Ash	Field	Central Lab	Project with < 100 tons of fly ash, no field testing required. Project with >= 100 tons of fly ash, one sample per 2000 tons per source.	4 lbs.	At least 7 days before use, the project engineer must have a copy of a report of tests showing acceptable chemical and physical properties. Reference certified reports of test or analysis on MIT/MTS prefix 905. See CMM 845 for certification guidelines.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
CONCRETE MATERIALS (Continued)					
Cementitious Materials: Slag	Field	Central Lab	Project with < 100 tons of slag, no field testing required. Project with >= 100 tons of slag, one sample per 2000 tons per source.	4 lbs.	At least 7 days before use, the project engineer must have a copy of a report of tests showing acceptable chemical and physical properties. Reference certified reports of test or analysis on MIT/MTS prefix 905. See CMM 845 for certification guidelines.
Liquid Membrane Curing Compounds	Source or Field	Central Lab	When not source inspected. One per 2000 gallons or fraction thereof. *[18]*	1 quart	Liquid membrane curing compound, when source inspected, must be marked with evidence of being approved for use on WisDOT projects. If there is any doubt whether a batch is acceptable, contact the Regional Materials Section. Lists of WisDOT tested and approved batches of Liquid Membrane Curing Compounds for the current year is maintained on the approved products list APL. Lots or batches carried over from the previous year must be re-tested before use. When not source inspected, in addition to field sampling and testing at central lab, a manufacturer's certified report of test or analysis identified with the manufacturer's name or trademark listing the lot or batch number of the material delivered to the job is required, reference on MIT/MTS prefix 905. Field sampling may be waived for small quantities of 220 gallons or less. For these cases, a manufacturer's certificate of compliance must be made available when requested by the project engineer. The "Concrete curing compounds" approved list covers two types of curing compound: Poly-methyl-alpha-styrene (PAMS); ASTM C309 material for curing concrete pavement, called in 415.2.4 White Pigmented - ASTM C309 material called in 501.2.9, must be used in place of PAMS for pavement or base receiving an overlay. See CMM 845 for certification guidelines. A diary entry per CMM 845 is required for these items.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
CONCRETE CURING AND SEALING					
Clear and Translucent	Field				A manufacturer's certificate of compliance is required, reference on MIT/MTS prefix 905. This material is called under 502.2.6 and 502.3.8.1.1, for structure concrete surfaces not receiving protective surface treatment. Approved field practice allows substitution of material from the approved list for Cure & Seal Compounds for Non-Trafficked Surfaces on Structural Masonry/Pigmented Surface Sealer. No sampling or testing is required.0 See CMM 845 for certification guidelines. A diary entry per CMM 845, is required for lots or batches of curing compound.
Crack and Surface Sealers	Field				Lists of WisDOT- approved Crack and surface Sealers are on the approved products list APL. Also see standard spec 502. Crack and Surface Sealer - 502.2.11 calls three lists/applications as follows: Low Viscosity Crack Sealer, Non-pay, incidental to Item 502.0100: Per 502.3.13.1, primarily for use in sealing small deflection and shrinkage cracks in new bridge decks. Concrete Protective Surface Treatment, Item 502.3200: Per 502.3.13.2, primarily for use in surface sealing of the top and edges of bridge decks. Cure and Seal Compounds for Non-Trafficked Surfaces on Structural Masonry/Pigmented Surface Sealer, Item 502.3210: Per 502.3.13.3, primarily for use in sealing the inside faces and tops of parapets/barriers on bridges. See CMM 845 for certification guidelines. A diary entry per CMM 845 is required for all items.
Clear Protective Coating					Clear Protective Coating, Item 502.6500 - No approved list. Called in 502.2.13(1) primarily for sealing concrete substructure surfaces. A manufacturer's certificate of compliance must be made available by the contractor. Reference on MIT/MTS prefix 905. Also see standard spec 502.
CONCRETE MIXING WATER					
Municipal Sources	Field	Central Lab	*[20] [21]*		Samples must be submitted in a clean plastic or glass container, well packed for shipment to preclude breakage. Sample card DT1499 needs to accompany sample to be tested. *[20]* Water from municipal sources is not required to be tested per standard spec 501.2.6. *[21]* If problems with any water source are suspected, based on current conditions or historical data, the department may request sampling at any time. *[22]* Surface water sources need to be closely monitored at all times during concrete production. If conditions change significantly during the life of the project (i.e. an algae bloom or muddy storm runoff, etc.) a fresh sample must be tested before approval of continued use of the source.
Private Wells	Field	Central Lab	Source tested once every 5yrs *[21]*	2 quarts (1/2 gal)	
Surface Water	Field	Central Lab	Source tested once annually *[21] [22]*	2 quarts (1/2 gal)	

<table>
<tr><th>Material</th><th>Sampled Accepted</th><th>Tested</th><th>Min Sampling Frequency</th><th>Central Lab Sample</th><th>Remarks</th></tr>
<tr><td colspan="6">CONCRETE REINFORCEMENT</td></tr>
<tr><td>Bar Steel (Uncoated - "Black Steel")
and
Bar Steel (Epoxy Coated - "Green Steel")</td><td>Field</td><td>Central Lab</td><td>One for each 50,000 lbs. increment or portion for each individual bar size with a quantity equal to greater than 50,000 lb.</td><td>5 feet</td><td>
It is not necessary to submit samples from all heats and lots. Do not submit splice bars or test bars instead of cut samples. Apply the sampling threshold individually for each size of bar. Sample each bar steel size for which the project quantity equals or exceeds 50,000 lbs. Replace cut samples with bars long enough to provide additional lap length for splicing as prescribed in CMM 515.5.6.
When bars are delivered to the field the project engineer must:
- Be sure all bundles are identified with heat numbers.
- Obtain one copy of the mill test reports and shipping invoice representing all steel types, grades, bar sizes and heat numbers included in the shipment.
- When epoxy coated, in addition to the above, a copy of the resin manufacturer's certification of coating materials and the applicator's certification attesting to compliance with all of the coating details of the specifications.
- Attach to the invoice, the mill test reports and when applicable, the coating manufacturer's and applicator's certification. Place in the project records.
- Reference electronically on a Materials Tracking System prefix 905 the mill reports and certifications received.
For each sample selected, attach a tag with the following information and submit to the Central Laboratory for testing.
- Steel type, Grade, Bar size, Heat Number and manufacturer
- If epoxy coated, the epoxy resin manufacturer.
- Quantity of material the sample represents.
When quantities are less than 50,000 lbs. of any one bar size visually inspect and document in accordance with a diary entry per CMM 845.
Bar steel delivered without plainly marked heat # tags must not be accepted. If this occurs immediately contact the regional person responsible for this area.
<table>
<tr><th colspan="2">BAR STEEL MINIMUM SAMPLING FREQUENCY</th></tr>
<tr><th>BAR STEEL (pounds)</th><th>NUMBER OF SAMPLES</th></tr>
<tr><td>0 - 49,999</td><td>No sample required</td></tr>
<tr><td>50,000 – 99,999</td><td>2 samples required</td></tr>
<tr><td>100,000 – 149,999</td><td>3 samples required</td></tr>
<tr><td>150,000 – 199,999</td><td>4 samples required</td></tr>
<tr><td>200,000 – 249,999</td><td>5 samples required</td></tr>
<tr><td>250,000 – 300,000</td><td>6 samples required</td></tr>
<tr><td colspan="2">Add one sample for each 50,000 lb or portion thereof.</td></tr>
</table>
The list of approved epoxy coating for bar steel reinforcement is on the approved products list APL.
</td></tr>
</table>

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
CONCRETE REINFORCEMENT (Continued)					
Alternate Bar Couplers	Field	Central Lab	Three (3) samples for each type of coupler /rebar connection proposed for use.	Each sample is: Two 2-foot sections of rebar connected with coupler; 4-foot total length rebar required	Do not install bar coupler systems before department proof testing and engineer's written approval. Contractor to provide installation instructions to engineer. Project engineer must verify bar coupler system exceeds 125% of the specified yield strength (i.e. 1.25fy) of the bar steel being spliced.
Threaded Bar Couplers	Field	Field			Threaded bar couplers will not require sampling and may be accepted in the field. The contractor must furnish to the project engineer a certified report of test or analysis based on a minimum of 3 tests for each type of threaded bar coupler used in the work. Project engineer must verify bar coupler system exceeds 125% of the specified yield strength (i.e. 1.25fy) of the bar steel being spliced.
Tie Bars Dowel Bars Dowel Bar Assemblies	Field *[19]*				Tie Bars, Dowel Bars, & Dowel Bar Assemblies in concrete pavement will not require sampling and may be accepted in the field. The contractor must furnish to the project engineer a certified report of test or analysis for all heat numbers used in the work. See CMM 845 for certification guidelines.
Dowel Bar Lubricant	Field				Contractor to provide product data sheets. A diary entry per CMM 845 is required. See CMM 845 for certification guidelines.
Hook Bolts	Source or Field				An approved fabricator usually furnishes hook bolts for bridges. The list of approved fabricators for Bridge Metal Secondary items is on the approved products list APL. For hook bolts furnished by an unapproved fabricator, the contractor will have a manufacturer's certification of compliance available. See CMM 845 for certification guidelines.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
CONCRETE Note: For contracts with QMP provisions, see specific contract documents for guidance. Projects require MIT/MTS prefix 155 QMP Concrete Pavement Summary, QMP Concrete Structures Summary, and/or QMP Ancillary Concrete Summary. Below are testing and sampling/testing requirements for contracts without QMP provisions.					
Air Entrainment	Field	Field	Two tests per day except for small quantities. See remarks		See instructions in CMM 870 for testing procedures. Observations must be maintained for deviations from selected consistency and entrained air target values and additional tests and adjustments will be necessary when such occurs. Superstructure elements may also require more frequent testing to properly administer the contract requirements. For slip-form paving, slump testing will be as required by the project engineer.
Slump	Field	Field			
COMPRESSIVE STRENGTH (Note: One set of cylinders = two cylinders. See specific strength testing requirements below, based on use.)					
Miscellaneous Construction and Ancillary Concrete	Field	Lab	One set per 200 CY per contract		When daily pours exceed 200 CY using the same source and mix, the rate of sampling may be reduced to one set per day. For contracts with quantities less than 100 CY cylinders do not need to be cast. The QMP ancillary concrete item covers most miscellaneous concrete construction. Follow the requirements for QMP ancillary concrete specified in the contract.
Pavement and Base Course	Field	Lab	One set per 10,000 SY or less		
Bridge Substructures	Field	Lab			One set per substructure unit (e.g. pier, abutment).
Bridge Superstructures	Field	Lab			For bridge decks, one set for each 150 CY or fraction thereof, with at least one set for each pour in a span. For parapets, one set per unit.
Bridge Deck Overlay	Field	Lab			One set per pour. For pours over 450 CY, additional samples may be required, contact regional person responsible for this area for guidance
Culverts and Retaining Walls	Field	Lab			Mold and submit one set per 100 CY or fraction thereof.
DELINEATORS					
Bracket, Mounting Hardware, Reflectors, Posts	Field				A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
DRAINAGE (See PRECAST CONCRETE for concrete pipe and appurtenances) Note: A diary entry, per CMM 845, for requirements.					
Corrugated Metal Drainage Products	Field				All corrugated metal drainage materials supplied under the following categories must be from vendor(s) listed fabricators list for Corrugated Metal Pipe Products on the APL. Corrugated Steel Pipe (AASHTO M36/M218, M274, M289, ASTM A928, or AASHTO M218/M246) - Items 520.1000 - 3399, OR 520.3500 - 3599, OR 520.4100 - 8500, OR 521.0100 - 6899, OR 612.0100 - 0599 Corrugated Aluminum Pipe (AASHTO M196)- Items 525.0100 - 0499, OR 612.0100 - 0599 Structural Plate Pipe and Pipe Arches, Items 527.0100 - 0499, are not required to be from an approved vendor. A manufacturer's certificate of compliance with AASHTO M219 or M167 (as applicable) is required, reference on MIT/MTS prefix 905. For All Metal Pipe Materials: 1. Retain the Bill of Lading, or other documentation supplied with the material, which must identify the original manufacturer, plant location, AASHTO specification, the mill and heat number for the steel from which the product was manufactured, and a statement certifying compliance with the provisions of the Buy America Act, 23 CFR 635.410, in the project record. 2. Perform delivered material inspection on CMP. See CMM 550.3 for inspection and acceptance guidelines. 3. A diary entry per CMM 845, is required.
ABS Pipe, Polyvinyl Chloride (PVC) Pipe	Field				Pipe must be marked, ASTM D2680 (ABS Pipe) or AASHTO M278 (PVC Pipe) Bid items 612.0100 - 0599 A manufacturer's certificate of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.
Corrugated Polyethylene (PE) and Corrugated Polypropylene (PP) Pipe	Source				All corrugated PE and PP drainage materials supplied under the following categories must be from vendor(s) listed on the APL. **Corrugated PE Culvert Pipe** - Items 520.3300 - 3699, OR 530.0100 - 0299, OR 608.3000 - 3099, OR 612.0100 - 0599. Pipe must be marked AASHTO M294 **Corrugated PP Culvert Pipe** - Items 520.3300 - 3699, OR 530.1100 - 1299, OR 608.3000 - 3099. Pipe must be marked AASHTO M330 **Corrugated PE Drainage Pipe** - Items 612.0100 - 5099. Pipe must be marked AASHTO M252 or M294 Production of pipe in a NTPEP fully compliant plant is required. Pipe manufacturer and plant location must be on the approved list and marked with the applicable specification. Pipe not properly marked must be rejected. See CMM 845 for certification guidelines.
Composite Pipe	Field				Pipe must be marked ASTM D2680. A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. Items 608.6000 - 6099. See CMM 845 for certification guidelines.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
DRAINAGE (Continued) - (See PRECAST CONCRETE for concrete pipe and appurtenances) Note: A diary entry, per CMM 845, for requirements.					
Joint Materials (Storm Sewer) - External Rubber Gaskets - Rubber and Plastic Gaskets	Field				A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.
Pipe Mandrel for Deflection Testing	Field	Field	See remarks	N/A	Contractor mandrel testing by hand in the engineer's presence. See CMM 550.9 and standard spec 520.3.7 (culverts) or standard spec 608.3.7 (storm sewer) for mandrel size, type, and testing requirements.
ELECTRICAL					
Controllers and Related Equipment	Shop and Field				Acceptance of these items is based on their performing in accordance with the sequence in the contract and in many cases, passes an acceptance test by the WisDOT Electrical Shop in Madison. See the contract plans and specifications for detailed instructions.
Luminaires, Fuses, Tape, Fuse Holders, Varnish, Connectors, Breakaway Bases, Traffic Signal Standards, Polyethylene Duct, Traffic Signal Mounting Hardware, Traffic Signal Faces, Junction Boxes,-Pull Boxes, Cast Rings and Covers, Electrical Service Material, Splice Kits, Multi-Conductor Cable, Cable-In-Duct (Multiple Wires), Wiring (Lighting & Signalization)	Field				The department specifies approved materials and construction products for electrical work on the QPL. Accept electrical materials not on the QPL in accordance with standard spec 651.2. See CMM 845.
Electrical Wire & Cable for Lighting and Signalization	Field			24-inch pieces	Accept these electrical materials in accordance with standard spec 651.2. * Provide sample when requested by the project engineer or the state electrical engineer.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
ELECTRICAL (Continued)					
Anchor Rods Mast Arms Trombone Luminaire Monotubes Poles Bases, Pedestal and Transformer	Field	Central Lab	One per signal location		These items require a manufacturer's certificate of compliance. Submit the certificates of compliance to the project engineer list with the materials list. See CMM 845 for certification guidelines. Poles, arms and pedestal bases must be from an approved manufacturer. Pre-qualified manufacturers are listed in QPL. Per the requirements of standard spec 657, the contractor must furnish a certificate of compliance and shop drawings for all poles and arms. Provide a copy of these along with the materials list to the state electrical engineer (see FDM 8-45.2.4.3. Reference certifications of compliance, certified reports of test or analysis, and shop drawings electronically on MIT/MTS prefix 905. If the project engineer requests, the contractor is to provide one randomly selected sample pedestal base per traffic signal location. The department will base acceptance of all pedestal bases at that traffic signal location on destructive tests of that sample base.
ELECTRICAL CONDUIT					
- Rigid Metallic - Rigid Nonmetallic - PVC Schedule 40 and 80	Field				Conduit with an Underwriters Laboratories, Inc. (UL) label/emblem affixed to each piece signifies acceptable material and may be incorporated into the work. See standard spec 652.2.1. When the UL/NRTL label/emblem is not affixed, or the label/emblem is suspect, do not use the material. See CMM 655.
EMBANKMENT					
Embankment	Field				For QMP contracts, see the specific contract documents for sampling and testing guidance. For non-QMP contracts contact the regional soils engineer for the latest acceptance procedures and required documentation. For additional guidance, see the CMM as follows: Standard Compaction: CMM 330 Special Compaction: CMM 330 Report QV, QA and QC Soils Nuclear Density tests on MIT/MTS prefix 232 or 805 (if applicable).

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
EROSION CONTROL MATERIALS					
Erosion Control Materials	Field				See the PAL. The list has the following categories: Tackifier - Incidental to Items 627.0200 - 0205 Erosion Mat, all Classes and Types - Items 628.2000 - 2099 Soil Stabilizer Types A & B - Items 628.6500 - 6599 Inlet Protection1 - Items 628.7000 - 7099 Temporary Ditch Checks2 - Item 628.7504 ACCEPTANCE NOTES: Inlet protection devices may be fabricated according to the Plans, using Type FF fabric from the PAL, or proprietary devices from the PAL. Temporary ditch checks may consist of straw bales as detailed in the Plans, or proprietary devices from the PAL installed per manufacturer's recommendation. Straw bales for ditch checks are incidental to the bid item and will not be paid for separately. All materials listed require a diary entry per CMM 845. Retain the Bill of Lading or other documentation identifying the vendor as listed on the PAL for the particular material/bid item in the project record.
FENCING					
General	Field	Central Lab	NA	NA	If transporting materials to the central lab, package each sample with zip ties or “stretch wrap” and attach a sample card. If packaging material is unavailable, attach one sample card to each material being transported. Do not use one sample card to represent multiple material types.
Chain Link Fabric	Field	Central Lab	One per 50 rolls or fraction thereof.	1 SF	When test results indicate noncompliance, additional samples must be taken from two rolls, units, or coils other than initially sampled, both of which must meet the requirements. Reference standard spec 616.2.3.
Metal Posts and Bracing	Field	Central Lab	One per 500 or fraction thereof per size. See remarks	Two 1-foot lengths and one 3-foot length. See remarks	Two specimens for determination of weight of coating must be cut approximately 12 inches in length from opposite ends of the lengths of members selected for testing. Also, a third specimen, for determination of tensile strength, must be cut approximately three feet in length, from the center portion of each member selected for testing. Specimens must be cut from one length selected at random from each lot of 500 lengths, or fraction thereof, of each size. If the weight of coating and/or tensile strength test results of any lot indicate noncompliance, samples of two additional lengths must be taken for each test from the same lot as initially sampled both of which must meet the requirements. Reference standard spec 616.2.
Wood Posts, Staples, Post Tops, Pipe Fittings, Fabric Fasteners, Gates, Hardware	Field				A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. Refer to CMM 845 for certification guidelines. Reference standard spec 616.2.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
FENCING (Continued)					
Tension Wire	Field	Central Lab	One per 10 rolls or fraction	3 foot length	When test results indicate noncompliance, additional samples must be taken from two rolls, units, or coils other than initially sampled, both of which must meet the requirements. Reference standard spec 616.2.3.1.
Woven Wire Fabric	Field	Central Lab	One per 50 rolls or fraction thereof.	3 foot full width including 3 vertical stay wires	When test results indicate noncompliance, additional samples must be taken from two rolls other than initially sampled, both of which must meet the requirements. Reference standard spec 616.2.1.
Smooth Wire	Field	Central Lab	One per 50 spools or fraction thereof	3 foot length	When test results indicate noncompliance, additional samples must be taken from two spools other than initially sampled, both of which must meet the requirements. Reference standard spec 616.2.2.3.
Barbed Wire	Field	Central Lab	One per 50 spools or fraction thereof	6 barb lengths	When test results indicate noncompliance, additional samples must be taken from two spools other than initially sampled, both of which must meet the requirements. Reference standard spec 616.2.2.2.
GEOSYNTHETICS					
Geosynthetics (geotextile and geogrid) General Requirements	Field	Central Lab	See remarks		Sample size description applies for all types of geosynthetics. Samples must be full width of the material and a minimum of 6 feet long. The total sample size must be a minimum of 60 SF. See standard spec 645 and contract special provision specifications for additional information, including sampling requirements. Product data sheets will not be accepted as a substitute for the manufacturer's certified report of test or analysis. The delivered geosynthetic must bear markings to clearly identify it with the applicable test report furnished to the project engineer. If not so marked, the geosynthetic must not be used. Reference certified reports of test or analysis electronically on MIT/MTS prefix 905. See CMM 845 for certification guidelines. For contracts with quantities or fabrics not requiring a sample, a diary entry per CMM 845 is required. Label each sample roll's machine & cross machine directions. Machine direction is the longitudinal roll direction. Cross machine direction is the transverse roll direction.
Geotextiles	Field	Central Lab	See standard spec 645		Geotextile samples must be protected from ultraviolet light.
Geogrids	Field	Central Lab	See standard spec 645		Do not fold, bend or crease geogrid samples. For geogrid samples that are rolled, the inner diameter of the roll should be 6 in. or greater. These sample/shipping requirements are necessary to arrive at accurate laboratory test results.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
HIGH STRENGTH BOLTS					
	Field/Shop	Field/Shop			The contractor must provide a certified report of test or analysis giving the results of the supplier's rotational-capacity testing. Field rotational-capacity testing is completed by the contractor if no certified report of test or analysis is available for the rotational-capacity test, when the condition of the fasteners has changed or is in question by the Engineer. Have the contractor complete DT2113. Department staff must verify the test and submit the completed form as a part of the permanent project records.
High Strength Bolts, Structures standard spec 506	Field/Shop	Central Lab	Two bolts per size per length and/or contract. Three sets of nuts and washers per bolt size per length and/or heat contract		This item should be pre-sampled. The project engineer should check the particular project number for which this item is intended, test prefix 115 of the Materials Tracking System. In the event that no Central Laboratory test exists for the lots received, the project engineer must sample as indicated. Reference certified reports of test or analysis and field test reports on MIT/MTS prefix 905. For items fabricated in a shop, coordinate sampling with project staff.
JOINT SEALERS					
- Cold Poured Silicone Type - Hot Poured Elastic Type - Non-Bituminous	Field [23]				[23] A diary entry per CMM 845 is required for these items. A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.
- Preformed Elastomeric Compression Joint Seals	Field [23]				A manufacturer's certified Report of Test or Analysis must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.
LUMBER AND TIMBER					
Treated	Field				A certification of treatment and specification compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines. A diary entry per CMM 845, is required for these items.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
MORTAR					
Mortar Sand					Contractor to supply gradation test results before use.
Mortar Cement Portland Cement Masonry Cement Hydrated Lime					A manufacturer's certification of compliance is required. See CMM 845 for certification guidelines. A diary entry per CMM 845, is required for these items. Document percentage of each material used.
PAINT					
For Use on Metal - New Structural Steel - Structural Maintenance Painting - Other Metal Surfaces	Field Field				See contract special provision specifications for paint system requirements for new structural steel. A Paint - structural steel - new list is on the Structure Painting Systems APL. A Paint - structure maintenance list is on the Structure Painting Systems APL. See contract special provision specifications for all other paint system requirements.
PAVEMENT MARKING					
Paint, Epoxy, Tape	Source				Furnish pavement marking from the departments APL. Due to the volume of paint the contractors use, certifications should not be requested until two weeks before installation. See CMM 845 for certification guidelines. Reference certified reports of test or analysis on MIT/MTS prefix 905. See Standard Spec 646.2.1
Glass Beads and Elements	Source				Glass beads and elements for pavement marking under standard spec 646 require submittal of a certificate of compliance certifying that the beads supplied under the contract conform to the specifications. Central lab is no longer testing glass beads. A manufacturer's certificate of compliance with the specified gradation is required, reference on MIT/MTS prefix 905.
PILING					
- Steel - Sheet (Permanent Installation) - Bearing - Shell	Field	See remarks		See remarks	Before use, the project engineer must have certified copies of mill test reports showing acceptable chemical and physical properties for each heat or lot delivered for the contract. All piling materials are to be marked to identify the materials with the certified report of test documents. If identification markings are absent, the contractor must certify that all delivered materials are from the same lot as the test report represents. When mill test reports are not available, the project engineer must submit a section 2-feet in length and 9-inches in width to the Central Laboratory for testing. Reference Certified reports of test or analysis on MIT/MTS prefix 905.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
PILING (Continued)					
- Steel Oil Field Pipe	Field	Field	See remarks		See standard spec 511.2.2. Each piling delivered for the contract must be marked with a unique identification for each load that must conform to the bill of lading. The marking must be durable and legible. Markings can be transferred by contractor when cut offs are complete. A manufacturer's certification of compliance must be made available by the contractor. See CMM 845 for certification guidelines. The contractor must also furnish at or before delivery, a certification of chemical composition of the pipe from which a carbon equivalency (CE) may be determined. The CE must be computed by the following equation: CE = C + 1/6 (Mn + Si) + 1/5 (Cr + Mo + V) + 1/15 (Ni + Cu). (The equation items are the chemical composition values identified on the certification.) Reference Certified reports of test or analysis on MIT/MTS prefix 905. Pipe delivered in a magnetized condition must be limited to non-welded applications. Pipe delivered with a CE greater than 0.55 must not be incorporated into the work.
POSTS, TREATED WOOD					
- Guardrail - Right of Way (Security Fence) - Screen Fence - Sign, etc.	Field				A manufacturer's certification of treatment must be made available by the contractor upon request of the project engineer. A diary entry, per CMM 845, is required for these items.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
PRECAST CONCRETE					
Precast Concrete Materials	Shop				The following items are covered by the approved manufacturers or vendors on the APL. All the following precast materials must be from manufacturers or vendors on the APL: Category A Circular Reinforced Pipe - Items 522.0100 - 0699 OR 520.2000 - 5199 Circular Non-Reinforced Pipe - Items 607.0100 - 0399 (Not used on contracts let after 12/2015) Elliptical Reinforced Pipe - Items 523.0100 - 0499 Arch Pipe - SPV Cattle Pass - Item 522.2000 Apron Endwalls - Items 522.1000 - 1199 OR 520.1000 - 1199 Category B Manholes - Items 611.2000 - 2699 Components (Cones, Lids, etc.) - Incidental to Items 611.1000 - 3999 Riser Rings - Incidental to Items 611.8105 - 8115 Inlets - Items 611.3000 - 3999 Catch Basins - Items 611.1000 - 1999
Precast Concrete Materials	Shop				The following items are covered by the approved vendors on the APL. All the following precast materials must be from vendors on the APL: Category C Box Culverts - Item 504.2000.S Wall Panels (non-prestressed only) - SPV/MSE Panels Temporary Traffic Barrier - Item 603.8000 Special Structures - SPV/Three-Sided Precast Structures Category D Concrete Masonry Units/Concrete Brick - Incidental to Items 611.1000 - 3999 Modular Retaining Wall Blocks - SPV ** See project special provisions for acceptance requirements for precast materials/items not listed above, including: Noise Wall Panels Accelerated Bridge Construction elements (Columns, Pier Caps) All precast materials must be marked as follows: Manufacturer and Plant Location Date of manufacture Specification designation (Applies to all Pipe, Inlets, Manholes, Catch Basins, Box Culverts)

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
PRESTRESSED CONCRETE					
Prestressed Concrete					The shipping document must be stamped as indicated in the Plant Certification Program for Fabrication of Prestressed Concrete elements. See CMM 875. Reference the shipping documents on MIT/MTS prefix 905. The list of approved Prestressed Concrete suppliers is on the APL. If the supplier is not on the list of certified plants, immediately contact the BTS, BOS, and regional materials engineer responsible for this area.
SIGNING					
- Base - Sheeting - Message	Field				For sign base materials, a manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines. For sign sheeting materials, a listing of approved sign sheeting is on the APL. Ensure that the message material is from the same manufacturer or compatible with the underlying sheeting material. A diary entry per CMM 845, is required for these items.
Structural Units - Sign Bridges - Sign Supports	Shop or Field				A manufacturer's certification of compliance or a certified report of test or analysis indicating conformance with the contact requirements must be made available to the project engineer by the contractor for all materials not shop inspected. See CMM 845 for certification guidelines. A diary entry per CMM 845, is required for these items.
STEEL PRODUCTS					
Steel Forgings (Bridges)	Shop				Fabricator to be approved by the Bureau of Structures per project specifications and special provisions.
Steel Grid Floor	Shop or Field				When not shop inspected a manufacturer's certification of compliance must be made available by the contractor. See CMM 845 for certification guidelines.
Steel Plate Beam Guard, Sheet Steel Beams	Field	Field	See remarks		List of Steel Plate Beam Guard pre-qualified manufacturers is on the APL. See CMM 625.3.5 for acceptance procedure. Projects require MIT/MTS prefix 155 Beam Guard QV Summary Report.
End Shoe Sections, Terminal Sections, Anchor Assembly	Field				If the quantity is 20 or more, the project engineer must also have before installation a manufacturer's certified report of test or analysis indicating compliance with the contract requirements for all heat numbers delivered to the project. See CMM 845 for certification guidelines.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
STEEL PRODUCTS (Continued)					
Steel Reinforcement					See "Concrete Masonry Reinforcement."
Structural Steel - Bridges					Items are inspected at the steel fabrication shop and acceptance is on the basis of a shop inspection report (DT1832). Reference shop inspection reports on MIT/MTS prefix 905.
- Carbon Steel, Shaftings - Bronze and Steel Castings					These items are usually furnished through an approved fabricator though they are manufactured items. Acceptance is on the basis of a shop inspection report (DT1832).
Stud Shear Connectors	Field				A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.
TRAFFIC CONTROL DEVICES					
- Drums - 42-inch Cones - Flexible Tubular Markers - Channelizing Curb Systems	Field				The list of WisDOT approved devices is on the APL. A list of WisDOT approved work zone sheeting products for the current year is located is on the APL.
Signs	Field				A list of WisDOT approved work zone sheeting products for the current year is located is on the APL. The list of approved portable sign supports is on the APL. Post mounted sign, must use a crashworthy sign support method.
- Speed Feedback Trailers - Warning Lights - Arrow Boards - Portable Changeable Message Boards					The list of approved devices is in the APL. A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.

Material	Sampled Accepted	Tested	Min Sampling Frequency	Central Lab Sample	Remarks
WATERSTOPS					
Polyvinyl Chloride	Field				Polyvinyl Chloride - A manufacturer's certification of compliance must be made available by the contractor when requested by the project engineer. See CMM 845 for certification guidelines.
Rubberized Waterproof Membrane	Field				Must be selected from the department-approved list. The list of approved products is on the APL. The material must be backfilled within 30 days of installation or otherwise protected from ultraviolet radiation.
TEMPORARY PEDESTRIAN DEVICES					
Temporary Pedestrian Surface	Field				Temporary surface matting materials will be found on the APL.
Temporary Pedestrian Curb Ramp	Field				The list of approved Temporary Pedestrian Curb Ramps is on the APL.
Temporary Detectable Warning Fields	Field				The list of approved Temporary Detectable Warning Fields is on the APL.
Temporary Pedestrian Barricades					The list of approved Temporary Pedestrian Barricades is on the APL.

SECTION 855 Materials Testing and Acceptance - Earthwork

855.1 Field Test Procedures for Moisture-Density Relationship of Gravelly Soils

855.1.1 Scope

This method of test is intended for determining the relationship between the moisture content and density of soils containing appreciable quantities of R-4.75 mm (No. 4) material.

855.1.2 Apparatus

- Molds and Detachable Base Plate: Standard 4-inch molds having a capacity of 1/30 cu. ft. and base plate. The molds may not be the split type.
- Rammer: A rammer of 2-inch diameter having a flat circular face and weighing 5.5 lbs. The rammer must be equipped with a suitable arrangement to control the height of drop to a free fall of 12-inch above the elevation of the soil.
- Sample Extruder (Optional): Not needed with split molds.
- Balances: A balance or scale of at least 25 lbs. capacity sensitive to 4.5 g (0.01 lbs.), and a balance of at least 1,000 g capacity sensitive to 0.1 g, or other suitable scales or balances.
- Drying Equipment: An oven, hot plate, stove, or other device for heating and drying the sample uniformly and as rapidly as possible without damaging the material. The drying pan should be large enough to allow manipulation of material without spilling.
- Straightedge: A steel straightedge 12 inches in length and having one beveled edge.
- Sieves: Standard 8-inch diameter sieves. Sizes 50 mm (2-inch), 19.0 mm (3/4-inch) and 4.75 mm (No. 4).
- Mixing Tools: Miscellaneous tools such as mixing pan, spoon, trowel, spatula, knife, etc.

855.1.3 Sample

1. If the soil sample is damp when received from the field, dry it until enough moisture has been lost so that it becomes friable under a trowel. Drying may be in air or by heating, but the temperature of the sample should not exceed about 60ºC (140ºF). Then thoroughly break up the aggregations in such a manner as to avoid reducing the natural size of individual particles.
2. Select a representative portion of the sample, completely dry it and determine the percentage retained on the 4.75 mm (No. 4) sieve. This value will be needed for comparison with the amount of R-4.75 mm (No. 4) material present in field density tests.
3. Select a representative sample, weighing approximately 14 lbs., or more, of the soil prepared as described in Step 1 above. Sieve it over the 50 mm (2-inch) and 19.0 mm (3/4-inch) sieves. Discard the coarse material retained on the 50 mm (2-inch) sieve. Weigh the material passing the 50 mm (2-inch) sieve and retained on the 19.0 mm (3/4-inch) sieve and replace it with an equal weight of material passing the 19.0 mm (3/4-inch) sieve and retained on the 4.75 mm (No. 4) sieve. Take the material for replacement from the remaining portion of the sample.

855.1.4 Procedure

1. Thoroughly mix the selected representative sample with sufficient water to dampen it to a moisture content that is sufficiently below the optimum moisture content to form an adequate relationship to succeeding points.
2. Form a specimen by compacting the prepared soil in the 101 mm (4-inch) mold (with collar attached) in three equal layers to give a total compacted depth of about 127 mm (5-inches). Compact each layer by 25 uniformly distributed blows from the rammer, dropping free from a height of 305 mm (12-inches) above the elevation of the soil. During compaction, the mold must rest on a uniform, rigid foundation. Following compaction, remove the extension collar and carefully trim the compacted soil even with the top of the mold by means of the straightedge. Holes developed in the surface by removal of coarse material must be patched with smaller size material. Weigh the mold and moist soil. Multiply the weight of the compacted specimen and mold, minus the weight of the mold, by 1060, and record the result as the wet density in kilograms per cubic meters (or by 30 and record the wet density as pounds per cubic foot of compacted soil).
3. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces, weigh immediately, dry to constant weight and determine the moisture content. The moisture content sample must weigh not less than 500 g.
4. Thoroughly break up the remainder of the material until it will pass a 19.0 mm (3/4-inch) sieve and 90% of the soil aggregations will pass a 4.75 mm (No. 4) sieve, as judged by the eye. Add water in sufficient amounts to increase the moisture content of the soil sample by one or two percentage points and repeat the above compaction and moisture determination procedures. Continue this series of determinations until there is either a decrease or no change in the wet weight per cubic meter or per cubic foot of the compacted soil.

This procedure has been found acceptable in most cases. However, in instances where the soil material is fragile in character and will reduce significantly in grain size due to repeated compaction, and in cases where the soil is a heavy textured clayey material into which it is difficult to incorporate water, a separate

and new sample must be used in each compaction test. In these cases, separate samples must be thoroughly mixed with amounts of water sufficient to cause the moisture contents of the samples to vary by approximately two percentage points. The moisture contents selected must bracket the optimum moisture content, thus providing samples which, when compacted, will increase in weight to the maximum density and then decrease in weight. The samples of soil-water mixtures must be placed in covered containers and allowed to stand for not less than 12 hours before making the moisture-density test. This soaking allows time for uniform dispersion of the moisture throughout the sample before compaction.

855.1.5 Calculations

Calculate the moisture content and the dry weight of the soil as compacted for each trial, as follows:

$$W = \frac{W_1}{w + 100} X\ 100$$

$$w = A - \frac{B}{B - C} X\ 100$$

Where:

w = percentage of moisture in the specimen, based on oven-dry weight of soil

A = weight of container and wet soil

B = weight of container and dry soil

C = weight of container

W = dry weight, in pounds per cubic foot of compacted soil

W_1 = wet weight, in pounds per cubic foot of compacted soil

855.1.6 Plotting Moisture-Density Relationship

The above calculations must be made to determine the moisture content and corresponding oven-dry weight per cubic foot (density) for each of the compacted soil samples. The densities of the soil must be plotted as ordinates (y axis) and corresponding moisture contents as abscissas (x axis).

855.1.6.1 Optimum Moisture Content

When the densities and corresponding moisture contents for the soil have been determined and plotted, it will be found that by connecting the plotted points with a smooth line, a curve is produced. The moisture content corresponding to the peak of the curve is termed the "optimum moisture content" of the soil under the above compaction.

855.1.6.2 Maximum Density

The oven-dry weight per cubic foot of the soil at optimum moisture content is termed "maximum density" under the above compaction.

855.2 Field Determination of Density for Embankments

855.2.1 Embankments

Embankments are constructed under the requirements of standard compaction unless special compaction is required. When special compaction is required, the field density requirements can be checked by the nuclear method.

855.2.2 Compliance Testing

When special compaction is required under the contract, sufficient check tests of in-place density must be made to provide reasonable assurance of specification compliance within rates of frequency. The rates of density testing described below are a minimum for extremes of ideal and worst conditions expected to be encountered in embankment construction (Conditions I and II), and a minimum for backfilling operations (Condition III). Within these extremes, the engineer will select a rate of testing frequency using the exemplified conditions as guide. Also, generally more frequent testing will be done in the early stages of the work and reduced as conditions become stabilized and operations routine.

855.2.2.1 Condition I

One test per 20,000 C.Y. minimum. Condition I is defined by uniformity of soil type, moisture content, and operations of hauling, placing, and compacting; a relatively flat moisture density curve indicating little effect on density by appreciable variation in moisture content; visual evidence of adequate and uniform support under heavy construction equipment; and consistently acceptable results of previous testing at great frequency.

855.2.2.2 Condition II

One test per 20,000 C.Y. Condition II is defined by a substantial variation in soil type or moisture content in short distances or erratic operations of hauling, placing or compacting; a moisture-density relationship

resulting in a steep-slope curve; visual evidence of sponginess or variable support under heavy construction equipment; and a previous test indicating frequent unacceptable compaction.

855.2.2.3 Condition III

Condition III is defined by short confined backfill areas.

- Abutment backfill - 1 test per structure minimum.
- Mainline culverts - 1 test per 3 culverts minimum.

855.2.2.4 Information Testing

Standard spec 207.3.6.2 does not contain a numerical density requirement. It is desirable, however that sufficient testing be done on all projects so that data will be made available to indicate the approximate level of compaction that is being achieved statewide as related to the normal variables of contract, inspection personnel, soil types, weather conditions, and other pertinent factors.

Therefore, on all projects on which "Standard Compaction" is a requirement, a program of random testing for density, as related to the maximum density determined under AASHTO Designation: T 99, Method C, should be performed.

At least three tests will be made on each major soil type as sands, silts, clays, sandy clay, silty clay, etc. If the volume of soils exceeds 500,000 cubic yards, three tests will be run for each 500,000 cubic yards and three tests for each total or partial increment exceeding this. Where smaller volumes are involved, additional tests are valuable but are not required.

Tests will be made by nuclear methods. These tests should be made on a random basis. Be certain that compaction for the lift is completed before testing. Each in-place density test should be correlated to the proper maximum density and optimum moisture test for the soil tested. This means that AASHTO Designation: T 99 must be made on all principal soil types for the project.

The data attained should be reported to the Geotechnical Section of Technical Services. The field density should be reported as a percent of maximum density and moisture as a percent of optimum moisture. Note the depth below grade, for this affects consideration as to whether densities should be compared to 95% or 90% compaction depending on depth below grade. Also note if densities are corrected for R-4.75 mm (R-4) fractions.

SECTION 860 Materials Testing and Acceptance - Aggregates

Standard spec references to aggregate testing and sampling methods contained in this chapter:

Standard spec 209.2.3 ..... granular backfill sampling and testing

Standard spec 210.2.2 ..... structure backfill sampling and testing

Standard spec 301.2 ..... base aggregate sampling and testing

Standard spec 701.3 ..... concrete aggregate testing

WisDOT's Test Modified (WTM) standards mobilized by the contract:

WTM D5821 ..... fracture testing

WTM D4791 ..... flat and elongated aggregate pieces

860.1 General

There are two general categories for aggregate testing in the standard specification approval and acceptance. Approval testing is required before using aggregate sources in WisDOT projects. Aggregate acceptance testing is required throughout a project and is conducted either solely by the department, or by both the department (QV) and the contractor (QC) when under QMP provisions.

The following aggregate approval and acceptance guidance is intended to clarify the department's aggregate testing requirements outlined in the standard specifications and QMP provisions.

860.2 Aggregate Source Approval

Aggregate sources used in project construction must meet the contract specification minimum requirements for quality. Coarse aggregate source approval/certification testing is performed by both the contractor and the department on samples jointly obtained and split. The department also performs fine aggregate source certification testing on aggregate sources to be approved for use in concrete mixes.

There are four types of aggregate source approval:

1. New requests from suppliers planning to produce material. Sources that are not currently on the department's Approved Products List but plan to supply aggregates on future DOT projects.
2. Existing stockpile requests. Existing stockpiles in sources that are not currently producing aggregate materials.
3. Reapproval requests. Sources that are currently on the department's Approved Products List and are continuously producing and stockpiling aggregates for DOT projects.
4. Offsite approval. Aggregate that is processed and sampled in a different location from the quarry or pit.

Sampling scenario associated with the aggregate source approval types:

1. Scenario #1 - Prior to department sampling for new approval requests, suppliers should produce (crush) at least one day's worth of aggregate and stockpile at least 2500 tons.
2. Scenario #2 - Existing stockpiles greater than 2500 tons may be sampled by the department for aggregate source approval. Existing aggregate stockpiles of less than 2500 tons may be sampled and approved, but the source will not be placed on the approved list. Test results, for stockpiles of less than 2500 tons, will be placed on BTS 217 report and approved for the current construction year. The region independent assurance (IA) specialist must be notified before sampling existing stockpiles of less than 2500 tons.
3. Scenario #3 - There are no special considerations prior to department sampling for reapproval requests. Aggregate sources that have suspended processing operations and are requesting reapproval when resuming operations should be sampled like a new request in Scenario #1.
4. Scenario #4 - Aggregate suppliers may request sampling of material processed offsite (a different location from the pit or quarry) for source approval. Submit requests to central and regional office technical services staff member. Each request should include a detailed description of how the supplier plans to process material offsite. The request should include:
    - Supplier information
    - Original source information
    - Estimate of offsite processing quantity
    - Description of material processing method
    - Offsite location
    - Date range of offsite processing
    - This type of request is expected to be rare and may be rejected. Suppliers should provide process control quality test results with the request. Aggregate stockpiles are traced to the source location by allowing a DOT technical services staff member to observe the transportation of shot rock or pit run from the source to the offsite location. At the processing location, suppliers should clearly label and separate the offsite material from all other materials in that location. Photos, signage, email exchanges, and any tracking data may be used to document the process. Hauling of aggregate materials to projects should be from the original source location and not the offsite location. Materials

staff will request resampling at the source location to verify aggregate quality properties. Offsite processing of materials is expected to be temporary.

In addition to routine source certification/recertification testing, BTS conducts additional testing on select approved sources (i.e. marginal source testing) to validate aggregate quality. If department source certification or marginal source test results do not meet specifications or are not within the allowable tolerances of the contractor's test results, as identified in standard spec 106.3.4.2.2.3, the source is considered nonconforming and will not be approved for use.

BTS maintains lists of approved aggregate sources and updates the lists periodically. Sources that meet department specifications are approved for use and added to the approved source lists. The approved lists also show the aggregate quality test results.

860.2.1 Unique Source Identifier

Approved aggregate sources will be distinguished with a unique source identifier. The identifier will be tied to the geographic location of an aggregate source independent of the owner or operator. Unique Identifiers will be formatted as follows: SS-CC-XXX-YYY

Where, SS is the state FIIPS code and CC is the county number corresponding to the aggregate source location. XXX is an arbitrary number unique to each source within a county beginning with source 001. YYY indicates the source type; a three-letter description such as QRY for quarry, PIT for pit, or RCC for recycled concrete.

For example, the unique source identifier 55-01-001-QRY indicates that the source is located in Wisconsin (55), somewhere in Adams County (01), and is the first source to receive a unique number (001). For reference, table 860-1 contains a list of county codes. All unique identifiers are included on the approved aggregate source list.

TABLE 860-1 Wisconsin County Codes

Code	County	Code	County	Code	County
01	Adams	26	Iron	51	Racine
02	Ashland	27	Jackson	52	Richland
03	Barron	28	Jefferson	53	Rock
04	Bayfield	29	Juneau	54	Rusk
05	Brown	30	Kenosha	55	St. Croix
06	Buffalo	31	Kewaunee	56	Sauk
07	Burnett	32	La Crosse	57	Sawyer
08	Calumet	33	Lafayette	58	Shawano
09	Chippewa	34	Langlade	59	Sheboygan
10	Clark	35	Lincoln	60	Taylor
11	Columbia	36	Manitowoc	61	Trempealeau
12	Crawford	37	Marathon	62	Vernon
13	Dane	38	Marinette	63	Vilas
14	Dodge	39	Marquette	64	Walworth
15	Door	40	Milwaukee	65	Washburn
16	Douglas	41	Monroe	66	Washington
17	Dunn	42	Oconto	67	Waukesha
18	Eau Claire	43	Oneida	68	Waupaca
19	Florence	44	Outagamie	69	Waushara
20	Fond Du Lac	45	Ozaukee	70	Winnebago
21	Forest	46	Pepin	71	Wood
22	Grant	47	Pierce	73	Menominee
23	Green	48	Polk	00	Out-of-state
24	Green Lake	49	Portage	99	Obsolete
25	Iowa	50	Price		

860.2.2 Coarse Aggregate Source Certification Procedure

Coarse aggregate source certification testing is performed according to standard spec 106.3.4.2.2 and results are submitted to WisDOT electronically via prefix 224 report using the department's MRS Soils and Aggregates software program. Provide electronic email notification to BTS and the regional materials coordinator when a 224 report is submitted. Only one aggregate source report will be accepted per email notification. Aggregate quality test results can be viewed on the department's approved list.

If submitting test results for an aggregate source without a unique source identifier, leave Aggregate Source field blank and write "New Aggregate Source" in remarks window. BTS will assign a unique source identifier for future usage.

Region staff are responsible for reporting aggregate source name changes to BTS. BTS will populate name changes on approved lists as notified. If submitting test results for an aggregate source that is not listed in the MRS software, notify the region's IA specialist. Unique source identifiers will not change with a source name change.

860.2.3 Marginal Source Testing

Marginal source testing is performed annually and is prioritized based on aggregate source variability, history and usage. The following summarizes prioritization criteria in order of importance:

1. **Usage-**marginal aggregate sources anticipated to be used on an upcoming project.
2. **History-**marginal aggregate sources that do not have a history of at least five source approvals.
3. **Variability-** marginal aggregate sources with a history of high variability**.**

860.2.4 Approved/Certified Aggregate Sources

The department's approved aggregate sources can be viewed from the APL.

The 225 Aggregate Report shows certified coarse aggregate sources while the 162 Aggregate Report includes fine aggregate sources. The approved lists also show aggregate quality results from certification testing.

Sources identified as 'Not Certified' either failed to meet specifications or have an expired certification. Sources that are not certified cannot be used in WisDOT projects. Refer to the approved products list to view the most recent lists/test results.

860.2.5 Aggregate Quality Disputes

A contractor may request a second quality test if the first fails to meet approval criteria. However, request of a third sample/test requires a written submission that describes the corrective action(s) taken to produce conforming material. Corrective actions, including, but not limited to, modifications to crushing process, stockpiling and crushing location are acceptable.

The contractor may dispute the department's test results. Adequate justification is required to initiate a dispute resolution process. Testing proficiency or aggregate source variability are not acceptable justifications. Justifications, including, but not limited to, aggregate source history and aggregate geology.

860.2.6 Aggregate Quality Verification

Both the department and contractor should verify the quality of an aggregate source before incorporating into a project. Ensure that all sources have valid certifications and are approved for the appropriate use. Both parties should work together to help expedite any source approval/testing that is required.

860.2.7 Freeze-thaw Soundness Testing by WisDOT-Modified AASHTO T103

Follow AASHTO T103 Standard Method of Test for Soundness of Aggregates by Freezing and Thawing, procedure B, with modifications outlined in WTM T103.

860.3 Aggregate Acceptance

Material acceptance is based on additional sampling and testing performed throughout construction. Test methods, frequencies, failure criteria, and documentation requirements are prescribed in the governing specifications. All materials, including preapproved products or sources, are subject to additional department quality assurance testing to verify quality and conformance with specifications. Subsequent sections provide guidance and test method requirements for acceptance testing under standard specification and QMP provisions.

860.4 Marginal Source Testing

Aggregates furnished for base courses, and aggregates or granular materials furnished for subbase courses, that contain moisture in excess of 7% when measured by the ton are required to have the moisture content reduced to 7% or less before being weighed or have the moisture content in excess of 7% deducted from the measured weight. The moisture content of aggregates, including subbase materials, as determined by tests made on representative samples, will be based on and expressed as a

percent of the dry weight of the aggregates. The moisture content so determined will include both the free and the absorbed water in the aggregates. The procedure for obtaining the pay weight is as follows:

1. Pay weight of aggregates having a moisture content of 7% or less will be measured wet weight.
2. Pay weight of aggregates having a moisture content in excess of 7% will be 107% of their dry weight, expressed as follows:

$$Wp = \frac{Wd \times 107}{100}$$

3. Dry weight of aggregate will be 100 times the quotient of the measured wet weight divided by the sum of 100 and the percent of total moisture, expressed as follows:

$$Wd = \frac{Ww}{100 + M} \times 100$$

4. For aggregates having moisture content in excess of 7%, the following formula may be used in computing pay weight:

$$Wp = \frac{107\ Ww}{100 + M}$$

   This formula was derived by substituting for Wd in step 2 the value of Wd given in Step 3 and simplifying.

   The legend for the above formulas is:

   Wp = Pay weight of aggregates
   Wd = Dry weight of aggregates
   Ww = Measured wet weight of aggregates
   M = Percent of total moisture in the aggregates, determined by moisture tests run on representative samples and based on the dry weight of the aggregate sample.

5. Corrections for moisture content in excess of 7% may be made on each load and shown on the load ticket, or the correction may be made periodically on the summation of the measured weight, using the average of the moisture content determined. Periodic corrections should be for a period of not more than one day's operation, where the moisture tests show a minimum of variations in moisture content. When moisture tests show appreciable variations in moisture content due to changed conditions at the pit, or to other specific causes, correction periods should be for each range of different moisture content. For this purpose, "appreciable variations in moisture content" may be considered to be variations of about 1% or more between the moisture contents.

860.5 Sampling Aggregates

Follow WTM R90 Standard Practice for Sampling Aggregate Products.

860.5.1 Sample Size Requirements

860.5.1.1 General

The minimum weight of the field sample depends on the nominal maximum particle size of the aggregate that sampled. The weight of the field sample will always be greater than that portion required for testing and must meet the requirements in WTM R90.

Refer to CMM 850, Materials Testing and Acceptance Guide, for specific sample sizes required for submittal to the central laboratory.

The sample should be reduced to the size needed for a specific test by using either a riffle splitter, quartering method or miniature stockpile method for damp fine aggregate only.

860.5.1.2 Definitions

Field sample A composite of all increments sampled.

Nominal maximum particle size The nominal maximum size as indicated by the appropriate specification or description. If the specification or description does not indicate a nominal maximum size (for example a sieve size indicating 90-100% passing), use the maximum size (that sieve or size indicating 100% passing).

TABLE 860-2 Nominal Maximum Sizes Based on the AASHTO Definition

Material	Nominal Maximum Size	Remarks
Dense Graded Base, 3-inch	3-inch (75 mm)	
Dense Graded Base, 1 1/4-inch	1 1/4-inch (32 mm)	
Dense Graded Base, 3/4-inch	3/4 -inch (19 mm)	
Open Graded Base	1-inch (25 mm)	
Breaker run	6-inch (150 mm)	When testing is required
Select Crushed	5-inch (125 mm)	When testing is required
Concrete Aggregate - Size #2	1 1/2-inch (37.5 mm)	
Concrete Aggregate - Size #1	3/4-inch (19 mm)	
Concrete Aggregate - fine	No. 4 (4.75 mm)	
Granular Backfill (GBF), Trench	Varies	By strict definition, the 3-inch component would define the size. Use the largest size material in the sample irrespective of the specification to establish the nominal size. Example: If 100 % passes the 3-inch but there is 1-inch material in the R4, use 1-inch as the nominal maximum size.
Granular Backfill, Bedding	1-inch, may vary	See note above for GBF-trench
Structural Backfill	Up to 3-inch, may vary	See note above for GBF-trench

860.6 Reducing Samples of Aggregate to Test Size

860.6.1 General

Just as important as obtaining a truly representative sample is the testing of these samples. The results of these tests have a significant bearing on the production process, the acceptance or rejection of products, and the assurance that the final product will have the necessary ingredients and characteristics to perform as intended. Different sizes and types of aggregate will require different size samples for various tests. The field sample should be reduced to the size needed for a specific test. Do not attempt to arrive at an exact test sample weight. Portions of the original sample, which are eliminated by the reducing process, may be set aside for possible check testing.

Follow WTM R76 Standard Practice for Reducing Samples of Aggregates to Testing Size.

As in sampling, every effort should be made to follow these procedures as closely as possible to ensure that the test results are as reliable and accurate as the procedure is able to produce.

860.7 Aggregate Particle Shape

860.7.1 General

Particle shape is an important consideration in producing most products that use aggregate as a primary ingredient. Requirements for particle shape are specified for aggregates used for base, aggregates for HMA and concrete pavement, and other products used in transportation-related construction. Check the applicable specifications to determine if percent of fractured particles, percent of flat and elongated particles, or both must be determined for the material in question. The same test sample may be used to perform both tests.

860.7.1.1 Base Aggregate

In base aggregate, angular, nearly equidimensional particles having a rough surface texture are preferred over round, smooth particles. Angularity contributes to aggregate interlock, and a rough surface texture inhibits movement of one particle relative to another.

Flat and elongated aggregate particles have reduced strength when load is applied to the flat side of the particle. Flat and elongated particles are also prone to size segregation under handling and may breakdown during compaction. Where high stability is required, rounded aggregate should be avoided because of its tendency to shift under applied traffic loadings. WisDOT currently does not specify any limits for percent of flat and elongated particles for base aggregate.

860.7.1.2 Concrete

The particle shape and surface texture of an aggregate influence the properties of both fresh and hardened concrete. Rough-textured, angular crushed aggregate requires more water to produce workable concrete than smooth, rounded, naturally occurring aggregate. This extra water tends to reduce compressive strengths. However, the reduction in compressive strength is offset by an increase in the

bond between the cement paste and aggregate, particularly in high-strength concretes and pavement concretes where high flexural strength is usually desired. WisDOT currently does not specify any requirements for percent of fractured particles for aggregates used in concrete.

Flat and elongated particles decrease mix workability and, if more water is used to maintain workability, the strength of the concrete is also reduced. Flat and elongated particles that exceed a ratio of 3:1 should be limited to 15% of the total coarse aggregate (R 3/8 inch material).

860.7.1.3 Hot Mix Asphalt (HMA)

In HMA a high percent of fractured particles plays an important part in the strength of the pavement, helps to reduce rutting, and produces a surface with a higher coefficient of friction for improved vehicle control and braking.

Flat and elongated particles used in HMA tend to increase mixture voids and affect compactibility. Flat and elongated particles may fracture during compaction and under traffic. Aggregates that fracture in the mix have uncoated surfaces that are more susceptible to the detrimental influence of infiltrating water. Flat and elongated particles that exceed a 5:1 ratio should be limited to 5% of the total coarse aggregate (R #4 material) for all mixture types except stone matrix asphalt (SMA) where the ratio is 3:1 and the limit is 20% of the total coarse aggregate (R #4 material).

Methods for determining coarse aggregate fracture are mobilized into the contract by standard spec 106.3.4.2.2.1 and standard spec 604.2.

860.7.2 Fractured Particles

The purpose for specifying fractured face criteria is to maximize sheer strength by increasing inter-particle friction in either bound or unbound aggregate mixtures. Another purpose is to provide increased friction and texture for aggregates used in pavement in surface courses. Follow WTM D5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.

Methods for measuring flat and elongated particles are mobilized into the contract by standard spec 501.2.5.

860.7.3 Flat and Elongated Particles

860.7.3.1 General

The purpose for specifying a limit on the percent of coarse aggregate particles that are flat and elongated is to minimize the effect that these particles may have on the construction process and finished product. WTM D4791 describes three specifically different comparisons of the length, width, and thickness in determining if the particle is flat, elongated, or flat and elongated.

The department has previously used the term thin rather than flat in the specifications related to the ratio of the width of a particle compared to its thickness. Specifications previously indicating limits for thin or elongated particles have been revised and now contain limits for the percentage of flat and elongated particles (the ratio of the length dimension compared to the thickness dimension according to WTM D4791 definitions). Follow WTM D4791 Standard Method of Test for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

860.8 Field Determination of Moisture Content of Fine and Coarse Aggregates

860.8.1 Apparatus

- Suitable pan for weighing samples.
- A scale or balance readable to 0.2% of the sample weight.
- A hot plate or field stove of sufficient size capable of maintaining a uniform temperature.

860.8.2 Procedure

The size of the sample must be at least 1 lb. (500 g) for fine aggregate and 5.5 lb. (2500 g) for coarse aggregate or a mixture of fine and coarse aggregates.

1. After obtaining a representative sample of the material to be tested by standard size reduction procedure, place the sample in a suitable tared container and obtain the weight of the wet sample and container. Record this weight as:

   W_W = Weight of container plus wet material.

2. Dry the material by heating at a moderate temperature (230º F or less), until it has given up all free and absorbed moisture and has reached a constant weight. Occasional stirring with a spoon may accelerate the drying, but care must be taken not to lose any of the sample clinging to the spoon. The sample is thoroughly dry when further heating causes, or would cause, less than 0.1 percent additional weight loss.
3. Remove the container from the hot plate or stove and weigh carefully. This weight is recorded as:

   D_W = Weight of container plus dry material.

   T = Weight of container.

4. The percent moisture is calculated as follows:

$$\frac{(W_w - D_w)}{(D_w - T)} X\ 100$$

Example 1: Calculate Moisture Percentage

Weight of wet sample and container = 1,550 g

Weight of dry sample and container = 1,515 g

Weight of container = g

$$Percent\ \ Moisture\ \ Content\ = \frac{(1,550\ \ - 1,515)}{(1,515\ \ - 867)} X\ 100\ = 5.4\%$$

860.9 Field Test Procedures for Sieve Analysis of Aggregates

860.9.1 Washed Sieve Analysis

This test procedure is for determining the particle size distribution of fine aggregates, coarse aggregates, and mixtures of fine and coarse aggregates. It is intended for use in the sieve analysis of aggregates recovered from asphaltic mixtures or for the sieve analysis of mineral fillers.

For the purposes of these procedures, coarse aggregate is that having essentially all retained on the No.4 sieve, and fine aggregate is that having essentially all passing the No. 4 sieve. A graded base course material is an example of a mixture of fine and coarse aggregate.

860.9.1.1 Apparatus

The apparatus must consist of the following items:

860.9.1.1.1 Balances

The balance(s) or scale(s) must be sensitive to within 0.2% of the weight of the total sample to be tested.

860.9.1.1.2 Sieves (Washing)

A nest of two sieves must be used for washing the sample. The lower is a #200 sieve, with a #16 sieve above it.

860.9.1.1.3 Sieves (Gradation)

Sieves must be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. Suitable sieve sizes must be selected to furnish the information required by the specifications covering the material to be tested. The sieves must conform to Wire-Cloth Sieves for Testing Purposes, AASHTO Designation: M 92. The table 860-3 provides guidance on the maximum allowable weight on sieves. The amount of material retained on the overloaded sieve may be regulated by the introduction of a sieve having larger openings than in the critical sieve, or by sieving in increments.

The open screen area for the large Gilson screens is 14.75" x 22.75". The small Gilson screens have a screen area of 14" x14". The average open screen area of WisDOT rocker boxes is 10.5" x 10.5".

The limit for loading on the 8-inch diameter and 12-inch diameter sieves for the minus No. 4 sieves is 227(say 200 grams) and 511 (say 500 grams), respectively. The loads in table 860-3 are calculated from information taken from AASHTO T-27 (ASTM C136). Minus No. 4 sieve loads are calculated based on a maximum of 0.01 lb/in^2 (7 Kg/M^2).

860.9.1.1.4 Washing Container

A bucket, pail, or vessel large enough to contain the sample when covered with water and to allow vigorous agitation without inadvertent loss of any part of the sample of water is required. The containers should be kept clean.

TABLE 860-3 Allowable Loadings on Sieves

Sieve size	12 " dia.	8 "dia.	Gilson large	Gilson small-porta screen	12"x12"	Rocker Box
2" (50 mm)	20# (9,125g)	8.9# (4,050g)	60# (27,061g)	35# (15,806g)	25# (11,613g)	20# (8,891g)
1 1/2" (37.5 mm)	15# (6,844g)	6.6# (3,038g)	45# (20,296g)	26# (11,855g)	19# (8,710g)	15# (6,668g)
1 1/4" (31.75 mm)	11.7# (5318g)	5.0# (2262g)	37.8# (17129g)	21.4# (9723g)	16.3# (7374g)	12.4# (5636g)
1" (25.0 mm)	10# (4,563g)	4.5# (2,025g)	30# (13,531g)	17# (7,903g)	13# (5,806g)	10# (4,446g)
3/4" (19.0 mm)	7.6# (3,468g)	3.4# (1,539g)	22# (10,283g)	13# (6,006g)	9.7# (4,413g)	7.5# (3,379g)
1/2" (12.5 mm)	5.0# (2,281g)	2.2# (1,013g)	15# (6,765g)	8.7# (3,952g)	6.4# (2,903g)	4.9# (2,223g)
3/8" (9.5 mm)	3.8# (1,734g)	1.7# (770g)	11# (5,142g)	6.6# (3,003g)	4.9# (2,206g)	3.7# (1,689g)
No. 4 (4.75 mm)	1.9# (867g)	0.8# (385g)	5.7# (2,570g)	3.3# (1,502g)	2.4# (1,103g)	1.9# (845g)

860.9.1.1.5 Drying Equipment

An oven, hot plate, stove, or other device for heating and drying the sample uniformly and as rapidly as possible without damaging the aggregate will be needed. Samples should be stirred frequently in order to prevent popping or baking of aggregate. The drying pan should be large enough to allow manipulation during drying of the aggregate without loss by spilling. The drying pan should be kept clean.

860.9.1.2 Sample Size

Field samples for sieve analysis must be reduced to testing size using a riffle splitter, quartering method, or miniature stockpile method for damp fine aggregate only. See table in WTM R90 for required sizes of field samples. The field samples to be reduced must be thoroughly mixed, and the fine aggregate must be in a slightly moist condition. The test sample must be approximately the weight required as indicated in the following sections and must be the end result of reduction from the larger field sample by either using a riffle splitter, quartering method, or miniature stockpile method for damp fine aggregate only. The selection of samples of exact predetermined weight must not be attempted.

860.9.1.2.1 Fine Aggregate

Samples of fine aggregate for sieve analysis must weigh, after drying, a minimum of 1 lb. (500 grams).

860.9.1.2.2 Coarse Aggregates and Mixtures of Coarse and Fine Aggregate

Samples of coarse aggregate or mixtures of coarse and fine aggregate for sieve analysis must weigh, after drying, not less than the amount indicated in table 860-4.

TABLE 860-4 Minimum Sample Weights for Aggregates

Nominal Maximum Size of Particles[1]	Minimum Weight of Sample[2], g	Minimum Weight of Sample[2], lb.
3/8" (9.5 mm)	1,000	2.2
1/2" (12.5 mm)	2,500	5.5
3/4" (19.0 mm)	5,000	11
1" (25.0 mm)	10,000	22
1 1/4"(31.75 mm)	10,000	22
1 1/2" (37.5 mm)	15,000	33
2" (50.0 mm)	20,000	44
> 2" (greater than 50 mm)	25,000	55

If for coarse concrete aggregates, a washed analysis is made only for determining the amount of material passing the No. 200 (75µm) sieve, the test sample may be reduced to the minimum sizes shown in table 860-5.

TABLE 860-5 Minimum Sample Weights for P200 Test

Nominal Maximum Size of Particles[1]	Minimum Weight of Sample[2], g	Minimum Weight of Sample[2], lb.
3/4" - 1" (19.0 -25mm)	2,500	5.5
1-1/2" (37.5 mm) or over	5,000	11

[1] The nominal maximum particle size is defined as the nominal maximum size as indicated by the appropriate specification or description. If the specification or description does not indicate a nominal maximum size (for example a sieve size indicating 90-100% passing), use the maximum size (that sieve indicating 100% passing).

[2] For samples weighing 11 lb. (5,000g) or more, it is recommended that sieves or coarse aggregate fractions be mounted in 12-inch or larger frames, or the sieving may be done in increments using the standard 8-inch diameter sieves.

860.9.2 Procedure for Fine or Coarse Aggregates for Concrete Masonry

1. The test sample must be thoroughly dried.
2. After drying, cooling, and weighing, the sample must be placed in the container and sufficient water added to cover it. It is desirable to use as much water as possible in order to reduce the number of decantations needed. When clay balls or clay coatings on the aggregate particles are noted, the sample must be allowed to soak at least 10 minutes before to agitating and decanting. When aggregates have a particularly heavy or tight coating, it may be desirable to add a very small quantity of organic wetting agent (such as a household detergent) to the initial wash water.
3. The contents of the container must be agitated vigorously, and the wash water poured promptly over the nested sieves arranged with the coarser sieve on top. For dirty aggregates, it may be necessary to wait 10 to 15 seconds before decanting the wash water in order to avoid blocking the openings of the No. 200 sieve. When the No. 200 sieve becomes blocked, it may be reopened by back-washing the material retained on the No. 200 sieve into the drying pan. Agitation should be sufficiently vigorous to completely separate all of the passing the No. 200 material from other particles and to bring all the passing the No. 200 fraction into suspension in order that it will be removed by decantation of the wash water. Twisting of the pail handle will usually not result in vigorous enough action.

   Using a large spoon to stir and agitate the aggregate in the wash water has been found most acceptable. Care must be taken to avoid, as much as possible, the decantation of the coarse particles of the sample. The operation must be repeated until the wash water is substantially clear.
4. All material retained on the nested sieves must be returned to the washed sample. The washed aggregate must again be thoroughly dried.

   When performing this test to determine the percentage of material passing the #200 sieve (AASHTO T11) follow the calculation procedure described below.

   Calculations for the percent of material that passed the #200 sieve during washing should be made as follows:

$$\left(\frac{(Original\ \ Dry\ Weight\ -Washed\ \ Dry\ Weight\ )}{Original\ \ Dry\ Weight}\right)\times 100\ =\ Percent\ \ \ Passi\ \text{ng}\ The\ \#200\ Sieve$$

   When performing this test to determine sieve gradation requirements, cool the sample to prevent damage to the sieves, and place the washed and dried sample over a nest of sieves as required by the specifications with any additional sieves added to prevent overloading of the individual sieves. Follow the guidelines provided in the Materials Testing Guide to limit the quantity of material on a given sieve so that all particles have opportunity to reach sieve openings a number of times during the sieving operation. The sieving operation must be conducted by means of a lateral and vertical motion of the sieve, accompanied by jarring action so as to keep the sample moving continuously over the surface of the sieve. In no case should fragments in the sample be manipulated through the sieve by hand. Sieving must be continued until not more than 1% of the weight of the material retained on a given sieve passes that sieve during one minute of hand sieving.

   On that portion of the sample retained on the No. 4 and larger sieves, the procedure described above for determining thoroughness of sieving must be carried out with a single layer of material. When mechanical sieving is used, the thoroughness of sieving must be tested by using the hand method of sieving described above.
5. Calculations for the gradation of the washed sample should be made as follows:

$$\text{Percent Retained} = \frac{\text{Weight (2)}}{\text{Weight (1)}} \text{ x } 100$$

$$\text{Percent Passing} = 100 - \%\ \text{Retained}$$

   Weight (1) is initial weight of the dried unwashed sample, and Weight (2) is dry weight, after sieving, of the washed sample cumulatively retained on each sieve.

The electronic Materials Tracking System (MTS) provides the prefix 162, fine and coarse aggregates for concrete worksheet that should be utilized for calculating and reporting tests. Note that the final gradation results are calculated to the nearest 0.1% for all sieves. However, when results are reported, percentages are rounded off to the nearest whole percent except for the percent passing the No. 200 sieve, which is reported to the nearest 0.1% and administered in accordance with the specification requirements.

All tabulations of these gradation data should clearly indicate whether washed or unwashed testing was used.

860.9.3 Procedure for Mixtures of Fine and Coarse Aggregates for Base Course

1. The unwashed test sample must be thoroughly dried. Materials containing portions of reclaimed or recycled materials, when the materials would be altered by heat in the drying process, should be spread and air or oven dried at a temperature of 100 degrees F or less.
2. After cooling, the sample must then be separated on a No. 4 sieve, the two portions weighed, and the relative proportions determined.
3. The portion passing the No. 4 sieve must be reduced by use of the riffle splitter or quartering procedures to a sample weighting approximately 1 lb. (500g).
4. The material retained on the No. 4 sieve and the test sample of the material passing the No. 4 sieve must then be washed, dried, (recycle and reclaim content - air or oven dry 100 degrees F or less), cooled, and sieved separately in accordance with the procedure previously discussed.

   For 3-inch dense graded base course material only the material passing the No. 4 sieve needs to be washed.
5. The electronic Materials Tracking System (MTS) provides the prefix 217, aggregates testing worksheet that should be used for calculating and reporting tests. When using non-electronic methods calculations of gradation for washed analysis should be made as illustrated in the following and in figure 860-1.

DT1348, Sieve analysis for Mixture of Fine and Coarse Aggregates. is provided to help make these calculations orderly and accurately. Note that the final gradation results are calculated to the nearest 0.1% of all sieves. However, when results are reported, percentages are rounded off to the nearest whole percent, except for the percent passing the No. 200 sieve, which is reported to the nearest 0.1% and administered in accordance with the specification requirements.

All tabulations of these gradation data should clearly indicate whether washed or unwashed testing was used.

Example 2: Unwashed Sieve Analysis

Weight of total unwashed sample = 5,064g
Weight of R-4.75 mm (No. 4) fraction of total sample = 2,951g
R-4.75 mm (No. 4) fraction (proportion of total sample) = $\frac{2,951}{5,064} = 0.583(A)$
Weight of P-4.75 mm (No. 4) fraction of total sample = 2, 113g
P-4.75 mm (No. 4) fraction (proportion of total sample) = $\frac{2,113}{5,064} = 0.417(B)$
Weight of reduced size unwashed P-No.4 sample = 521g

SIEVE ANALYSIS OF WASHED R-No. 4 FRACTION

(Total weight of unwashed fraction = 2,951)

Sieve	(g)	Weight % Ret.	% Pass. (C)
1" (25.0 mm)	0	0	100.0
3.8" (9.5 mm)	1,318	44.7	55.3
#4 (4.75 mm)	2,776	94.1	5.9
#10 (2.00 mm)	2,871	97.3	2.7
#40 (425 µm)	2,873	97.4	2.6
#200 (75 µm)	2,887	97.8	2.2

SIEVE ANALYSIS OF WASHED P- No. 4 FRACTION

(Total weight of reduced size sample = 521 g.)

Sieve	(g)	Weight % Ret.	% Pass. (D)
#4 (4.75 mm)	0	0	100.0
#10 (2.00 mm)	113	21.7	78.3
#40 (425 µm)	386	74.1	25.9
#200 (75 µm)	443	85.0	15.0

The gradation of the total sample is obtained by combining gradations (C) and (D) in the proportions that the R-No. 4 and P-No. 4 fractions occurred in the original total sample, as follows:

1. Multiply each value (C) by (A).
2. Multiply each value (D) by (B).
3. Add the two values together for each sieve.

Sieve										Values Reported
#1 (25 mm)	(0.583 x 100)	+	(0.417 x 100)	=	58.3	+	41.7	=	100.0	100
3/8" (9.5 mm)	(0.583 x 55.3)	+	(0.417 x 100)	=	32.2	+	41.7	=	73.9	74
#4 (4.75 mm)	(0.583 x 5.9)	+	(0.417 x 100)	=	3.4	+	41.7	=	45.1	45
#10 (2.00 mm)	(0.583 x 2.7)	+	(0.417 x 78.3)	=	1.6	+	32.7	=	34.3	34
#40 (425 µm)	(0.583 x 2.6)	+	(0.417 x 25.9)	=	1.5	+	10.8	=	12.3	12
#200 (75 µm)	(0.583 x 2.2)	+	(0.417 x 15.0)	=	1.3	+	6.3	=	7.6	7.6

Figure 860-1 provides an example of DT1348 for washed sieve analysis.

FIGURE 860-1 Washed Gradation of a size No. 1 Gravel Base course Aggregate, (A portion of DT1348)

MOISTURE CONTENT
Weight of Sample (moist) 5170 g
Weight of Sample (dry) 5064
Moisture Loss 106
% Moisture 2.1

Weight of Total Sample (dry, unwashed) 5064 g
Weight of R4.75 mm (No. 4) dry, unwashed 2951 = 0. 583 (A)
Weight of P4.75 mm (No. 4) dry, unwashed 2113 = 0. 417 (B)

R-4.75 mm (R-4) MATERIAL Washed: ☑ Yes ☐ No

P-4.75 mm (P-4) MATERIAL Washed: ☑ Yes ☐ No
Wt. = 521 (Min. 500 g)

TOTAL MATERIALS (% Passing)

Sieve	Weight Retained	% Retained	% Pass (C)	Weight Retained	% Retained	% Pass (D)	4.75 mm (R-4) (A)(C)	4.75 mm (P-4) (B)(D)	Dry Sieved	Corr. Factor	Corr. Or Washed Results	Spec.
37.5mm (1-1/2")												
25 mm (1")	0	0	100	0	0	100	58.3	41.7			100	100
19 mm (3/4")	452	15.3	84.7	0	0	100	49.3	41.7			91.0	—
9.5 mm (3/8")	1318	44.7	55.3	0	0	100	32.2	41.7			73.9	40-75
4.75 mm (No. 4)	2776	94.1	5.9	0	0	100	3.4	41.7			45.1	25-60
2 mm (No. 10)	2871	97.3	2.7	113	21.7	78.3	1.6	32.7			34.3	15-45
425 μm (No. 40)	2873	97.4	2.6	386	74.1	25.9	1.5	10.8			12.3	—
75 μm (No. 200)	2887	97.8	2.2	443	85.0	15.0	1.3	6.3			7.6	3-12
In pan	16			7								

860.9.4 Procedure for Granular and Structural Backfill and Subbase

1. The sample size must meet the minimum requirements of table in WTM R90 (field sample) and table 860-4 (laboratory sample) based on the nominal maximum size of aggregate in the R4 component of the sample. The unwashed test sample must be thoroughly dried.
2. After cooling, the sample must then be separated on a No. 4 sieve, the two portions weighed, and the relative proportions determined.
3. The material retained on the No. 4 sieve is sieved and the percent passing for each sieve calculated based on the total dry unwashed sample weight.
4. The portion passing the No. 4 sieve must be reduced by use of the riffle splitter or quartering procedures to a sample weighting approximately 1 lb. (500g).
5. The test sample of the material passing the No. 4 sieve must then be washed and dried.
6. The electronic Materials Tracking System (MTS/MIT) provides the prefix 217, aggregates testing worksheet that should be used for calculating and reporting tests. The following example illustrates the calculations for backfill testing.

Calculation of the R4 sieve components is based on the total sample and is done unwashed. The P4 washed sieve analysis is based on the reduced dry unwashed sample and stands alone. R4 and P4 sieve results are individually compared to the specifications as cited in Standard Specification section 209.

When reporting granular backfill results indicate use as either trench backfill, or bedding backfill. This defines the general requirements of the material. The term "trench" backfill is also applicable to materials used for backfilling excavations for frost heave or other unstable materials, such as marsh backfill etc., when specified.

Example 3: Backfill Sieve Analysis

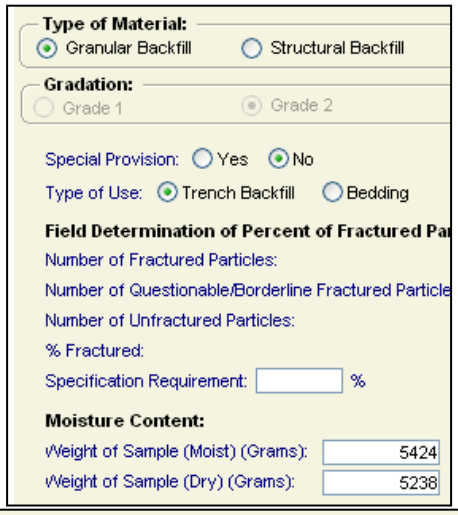
Weight of total unwashed sample = 26,890g (A)
Weight of R-4.75 mm (No. 4) fraction of total sample = 4,567g
R-4.75 mm (No. 4) fraction (proportion of total sample) = 4567g / 26890g = 0.17g
Weight of P-4.75 mm (No. 4) fraction of total sample = 2, 113g
P-4.75 mm (No. 4) fraction (proportion of total sample) = 22323g / 26890g = 0.83g
Weight of reduced size unwashed P-No.4 sample = 600g

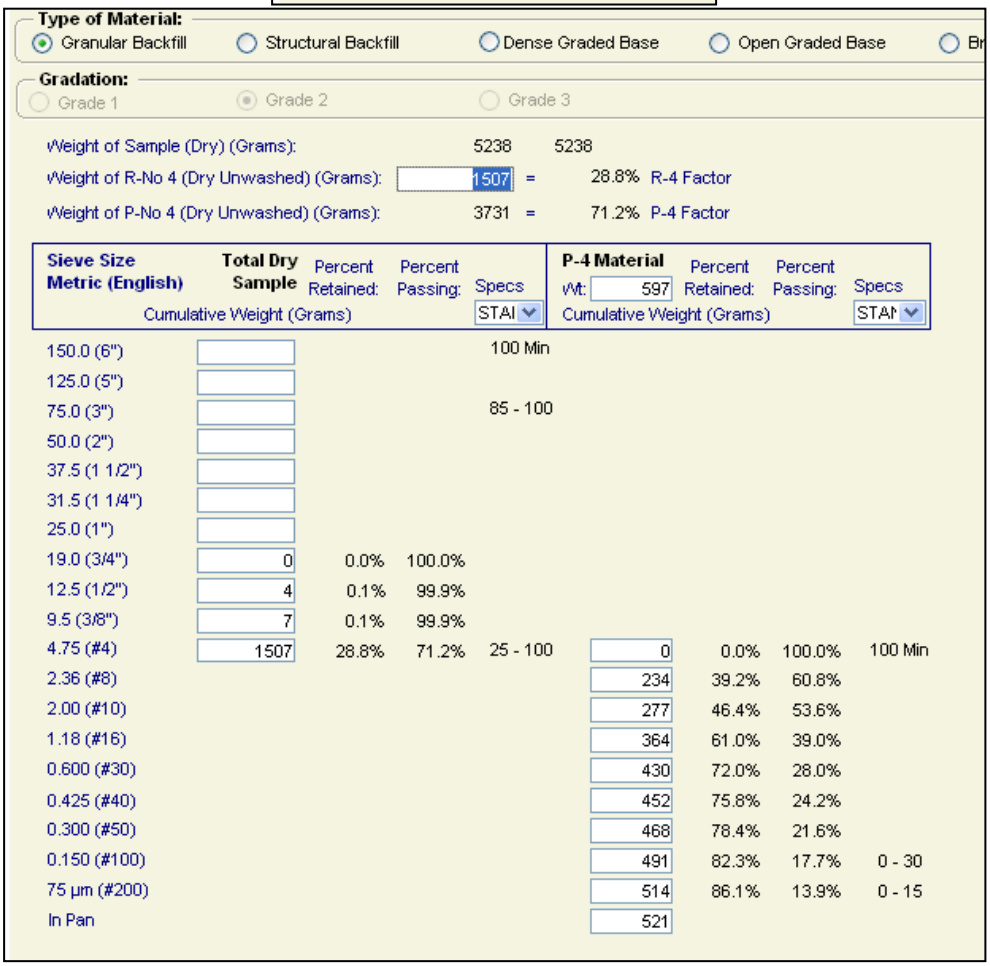
SIEVE ANALYSIS OF R-No. 4 FRACTION (Total weight fraction = 26890 [A])			
Sieve	(g) [B]	Weight % Ret. (B/A*100)	% Pass
6" (150 mm)	0	0	100.0
3" (75.0 mm)	3000	11.2	88.8
1" (25.0 mm)	3900	14.5	85.5
3/4"(19 mm)	4325	16.1	83.9
3/8" (9.5 mm)	4421	16.4	83.6
#4 (4.75 mm)	4567	17.0	83.0

SIEVE ANALYSIS OF WASHED P- No. 4 FRACTION (Total weight of reduced size sample = 600 g. [C])			
Sieve	(g) [D]	Weight % Ret.[D/C*100]	% Pass
#4 (4.75 mm)	0	0	100.0
#40 (425 µm)	155	25.8	74.2
#100 (150 µm)	530	88.3	11.7
#200 (75 µm)	561	93.5	6.5

Example 4: Materials Tracking System (MTS/MIT) prefix 217 entry screens for Backfill testing

As shown below, the type of use selection is required and sets the options for the R4 specifications.





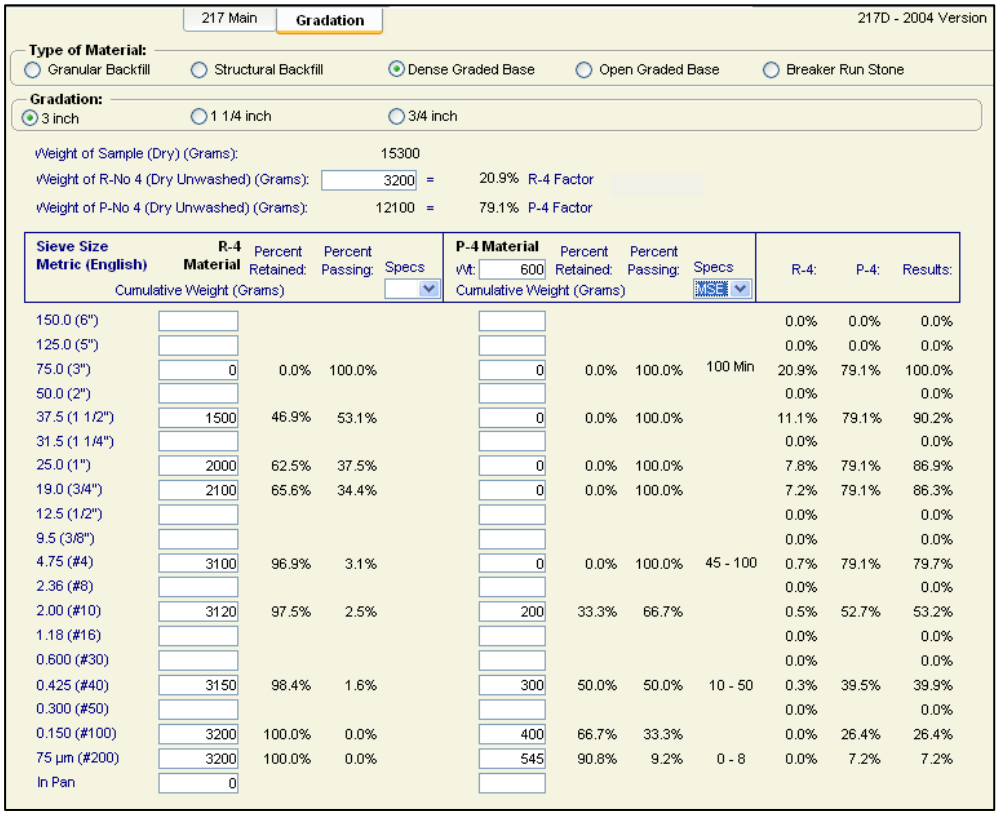
860.9.5 Procedure for MSE Wall Backfill Material (Standardized Special Provision)

This procedure is used when certain of the fine aggregate sieves need to comply with the specification based on the total sample and the percent passing the No. 200 sieve is based only on the percent passing the No. 4 sieve.

1. The sample size must meet the minimum requirements of table in WTM R90 (field sample) and table 860-4 (laboratory sample) based on the nominal maximum size of aggregate in the R4 component of the sample. The unwashed test sample must be thoroughly dried.
2. After cooling, the sample must then be separated on a No. 4 sieve, the two portions weighed, and the relative proportions determined.

3. The R4 material component is dry sieved and the percent passing for each sieve calculated based on the dry unwashed sample weight of the R4. This includes sieving of any materials that remain in the pan after sieving. Record the cumulative percent passing for all sieves as weighed except for the #200 sieve. The total of the R4 dry unwashed weight is recorded as the #200 weight. This way there is 0% contribution calculated from the R4 component.
4. The portion passing the No. 4 sieve must be reduced by use of the riffle splitter or quartering procedures to a sample weighting approximately 1 lb. (500g).
5. The test sample of the material passing the No. 4 sieve must be weighed, washed, dried, cooled and sieved.
6. The electronic Materials Tracking System (MTS/MIT) provides the prefix 217, aggregates testing worksheet that should be used for calculating and reporting tests. Select material type Dense Graded Base- 3-Inch. A specification for the MSE Wall Backfill Material is available for selection.

Example 5: Materials Tracking System (MTS/MIT) prefix 217 entry screens for MSE Wall Backfill Material



217 Main | Gradation — 217D - 2004 Version

Type of Material: (•) Dense Graded Base

Gradation: (•) 3 inch

Weight of Sample (Dry) (Grams): 15300
Weight of R-No 4 (Dry Unwashed) (Grams): 3200 = 20.9% R-4 Factor
Weight of P-No 4 (Dry Unwashed) (Grams): 12100 = 79.1% P-4 Factor

Sieve Size Metric (English)	R-4 Material Cumulative Weight (Grams)	R-4 Percent Retained:	R-4 Percent Passing:	R-4 Specs	P-4 Material Wt: 600 Cumulative Weight (Grams)	P-4 Percent Retained:	P-4 Percent Passing:	P-4 Specs: MSE	R-4:	P-4:	Results:
150.0 (6")									0.0%	0.0%	0.0%
125.0 (5")									0.0%	0.0%	0.0%
75.0 (3")	0	0.0%	100.0%		0	0.0%	100.0%	100 Min	20.9%	79.1%	100.0%
50.0 (2")									0.0%		0.0%
37.5 (1 1/2")	1500	46.9%	53.1%		0	0.0%	100.0%		11.1%	79.1%	90.2%
31.5 (1 1/4")									0.0%		0.0%
25.0 (1")	2000	62.5%	37.5%		0	0.0%	100.0%		7.8%	79.1%	86.9%
19.0 (3/4")	2100	65.6%	34.4%		0	0.0%	100.0%		7.2%	79.1%	86.3%
12.5 (1/2")									0.0%		0.0%
9.5 (3/8")									0.0%		0.0%
4.75 (#4)	3100	96.9%	3.1%		0	0.0%	100.0%	45 - 100	0.7%	79.1%	79.7%
2.36 (#8)									0.0%		0.0%
2.00 (#10)	3120	97.5%	2.5%		200	33.3%	66.7%		0.5%	52.7%	53.2%
1.18 (#16)									0.0%		0.0%
0.600 (#30)									0.0%		0.0%
0.425 (#40)	3150	98.4%	1.6%		300	50.0%	50.0%	10 - 50	0.3%	39.5%	39.9%
0.300 (#50)									0.0%		0.0%
0.150 (#100)	3200	100.0%	0.0%		400	66.7%	33.3%		0.0%	26.4%	26.4%
75 µm (#200)	3200	100.0%	0.0%		545	90.8%	9.2%	0 - 8	0.0%	7.2%	7.2%
In Pan	0										

860.9.6 Unwashed Sieve Analysis

Any gradation specification relates to the total gradation that generally implies the need for a washed sieve analysis. However, in some cases, the materials are of such nature and so devoid of coatings or lumps of P/No. 200 material that the gradation specification could be administered without the need for complete washed sieve analysis of every sample.

The procedures for unwashed sieve analysis are identical to those for washed analysis except for those references to washing operations.

The validity of the design to use unwashed analysis can be established only by testing and by acceptance of certain judgment criteria.

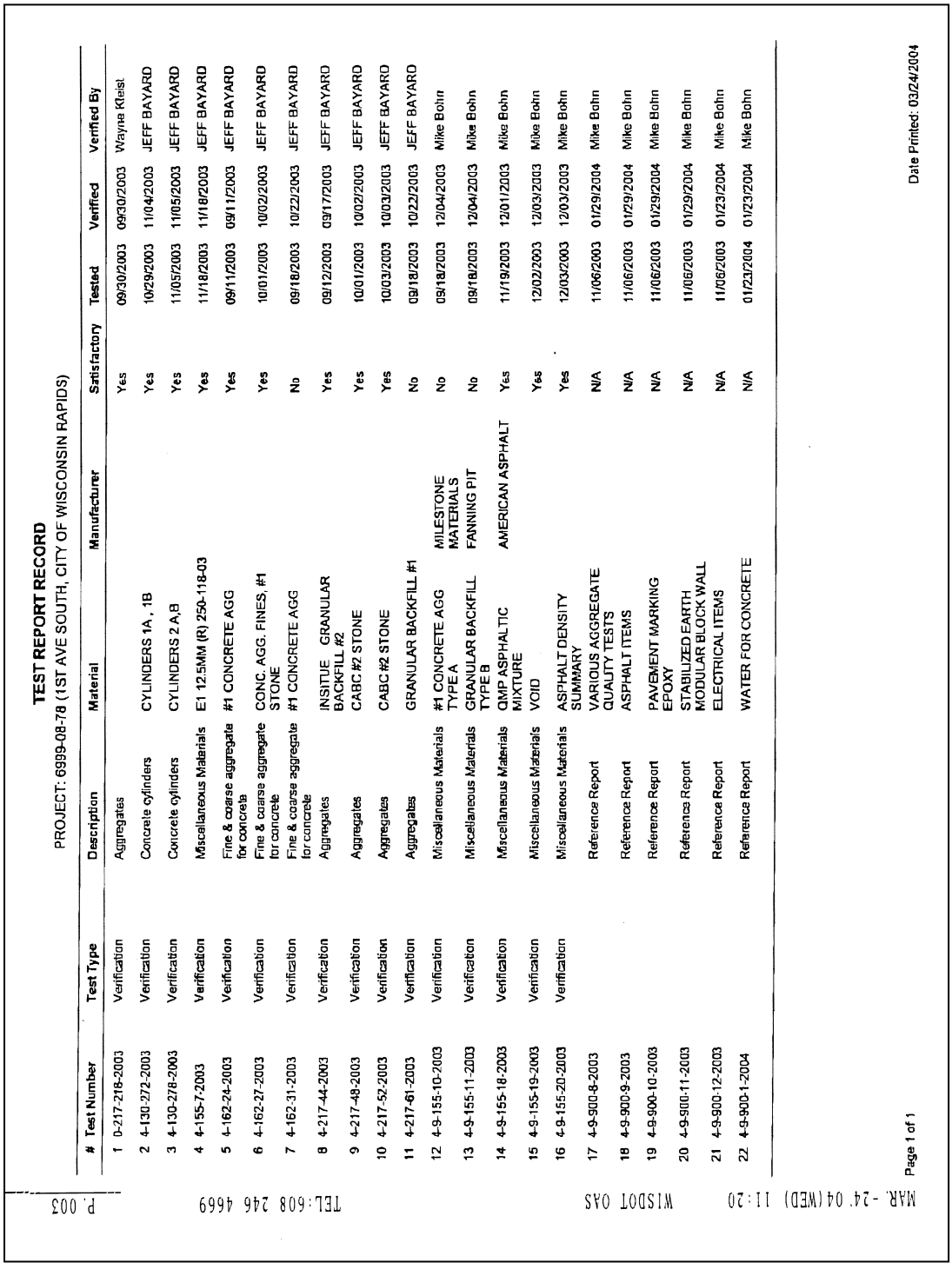
860.10 Aggregate Acceptance Tests

All results of acceptance tests made on aggregates for use in base course, asphaltic surfacing, Portland cement concrete, granular subbase, structural backfill, and granular backfill are to be reported. Report the results electronically on the MTS using prefixes 217, 162, or 257.

Aggregate acceptance tests are to be prepared for all contracts let to bid or entered into with municipalities on a force account or agreed unit price basis. Testing and acceptance must conform to the Materials Testing and Acceptance Guide. Reporting should be done in accordance with the requirements listed in CMM 845. When completing the form, it should be noted that the percent passing the 200 sieves is reported to the nearest tenth of a percent and administered to the nearest whole percent. Aggregate sieve analysis test reports are listed or referenced on the Test Report Record printed from materials tracking.

MTS prefix 217 for base course, subbase, granular backfill, should be used whenever possible. Use prefix 162 for PCC aggregate and 257 for aggregates in asphaltic mixtures.

FIGURE 860-2 Test Report Record



TEST REPORT RECORD

PROJECT: 6999-08-78 (1ST AVE SOUTH, CITY OF WISCONSIN RAPIDS)

#	Test Number	Test Type	Description	Material	Manufacturer	Satisfactory	Tested	Verified	Verified By
1	0-217-218-2003	Verification	Aggregates			Yes	09/30/2003	09/30/2003	Wayne Kleist
2	4-130-272-2003	Verification	Concrete cylinders	CYLINDERS 1A , 1B		Yes	10/29/2003	11/04/2003	JEFF BAYARD
3	4-130-278-2003	Verification	Concrete cylinders	CYLINDERS 2 A,B		Yes	11/05/2003	11/05/2003	JEFF BAYARD
4	4-155-7-2003	Verification	Miscellaneous Materials	E1 12.5MM (R) 250-118-03		Yes	11/18/2003	11/18/2003	JEFF BAYARD
5	4-162-24-2003	Verification	Fine & coarse aggregate for concrete	#1 CONCRETE AGG		Yes	09/11/2003	09/11/2003	JEFF BAYARD
6	4-162-27-2003	Verification	Fine & coarse aggregate for concrete	CONC. AGG. FINES, #1 STONE		Yes	10/01/2003	10/02/2003	JEFF BAYARD
7	4-162-31-2003	Verification	Fine & coarse aggregate for concrete	#1 CONCRETE AGG		No	09/18/2003	10/22/2003	JEFF BAYARD
8	4-217-44-2003	Verification	Aggregates	INSITUE GRANULAR BACKFILL #2		Yes	09/12/2003	09/17/2003	JEFF BAYARD
9	4-217-48-2003	Verification	Aggregates	CABC #2 STONE		Yes	10/01/2003	10/02/2003	JEFF BAYARD
10	4-217-52-2003	Verification	Aggregates	CABC #2 STONE		Yes	10/03/2003	10/03/2003	JEFF BAYARD
11	4-217-61-2003	Verification	Aggregates	GRANULAR BACKFILL #1		No	09/18/2003	10/22/2003	JEFF BAYARD
12	4-9-155-10-2003	Verification	Miscellaneous Materials	#1 CONCRETE AGG TYPE A	MILESTONE MATERIALS	No	09/18/2003	12/04/2003	Mike Bohn
13	4-9-155-11-2003	Verification	Miscellaneous Materials	GRANULAR BACKFILL TYPE B	FANNING PIT	No	09/18/2003	12/04/2003	Mike Bohn
14	4-9-155-18-2003	Verification	Miscellaneous Materials	QMP ASPHALTIC MIXTURE	AMERICAN ASPHALT	Yes	11/19/2003	12/01/2003	Mike Bohn
15	4-9-155-19-2003	Verification	Miscellaneous Materials	VOID		Yes	12/02/2003	12/03/2003	Mike Bohn
16	4-9-155-20-2003	Verification	Miscellaneous Materials	ASPHALT DENSITY SUMMARY		Yes	12/03/2003	12/03/2003	Mike Bohn
17	4-9-900-8-2003		Reference Report	VARIOUS AGGREGATE QUALITY TESTS		N/A	11/06/2003	01/29/2004	Mike Bohn
18	4-9-900-9-2003		Reference Report	ASPHALT ITEMS		N/A	11/06/2003	01/29/2004	Mike Bohn
19	4-9-900-10-2003		Reference Report	PAVEMENT MARKING EPOXY		N/A	11/06/2003	01/29/2004	Mike Bohn
20	4-9-900-11-2003		Reference Report	STABILIZED EARTH MODULAR BLOCK WALL		N/A	11/06/2003	01/29/2004	Mike Bohn
21	4-9-900-12-2003		Reference Report	ELECTRICAL ITEMS		N/A	11/06/2003	01/23/2004	Mike Bohn
22	4-9-900-1-2004		Reference Report	WATER FOR CONCRETE		N/A	01/23/2004	01/23/2004	Mike Bohn

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Date Printed: 03/24/2004

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860.11 Field Determination of Density for Aggregate Courses

When the plans or special provisions specifically require special compaction for granular subbase course or crushed aggregate base course, sufficient check tests of in-place density should be made to satisfy the frequency requirements discussed in the following sections. The density can be checked by either the sand cone method or the nuclear method.

860.12 Field Density Testing by the Sand Cone Method Part 1

860.12.1 Scope

The sand cone density procedures outlined here are intended as a guide for the individual inexperienced with the field density test. As experience is gained with field testing procedures and the inspector becomes more acquainted with the methods and techniques available, the speed and accuracy should improve.

For practical use and for simplicity, this guidance is divided into two parts. Part 1 is a general discussion of the sand cone density test and equipment, methods of calibrating the density and equipment, and the errors that may be caused by using inappropriate equipment and improper techniques. Part 2 outlines in detail the sand cone density test and procedures to be followed in calibrating the density sand and cone.

A field density flow chart that outlines the procedures to be followed by the inspector to prepare for and to perform the field density test is shown in figure 860-3.

A nomograph for correcting the standard laboratory density (if laboratory and field samples differ in gravel content) is also included. This nomograph will enable the inspector to determine a corrected standard maximum density for comparison with the field density. The nomograph is shown in figure 860-4.

FIGURE 860-3 Field Density Flow Chart

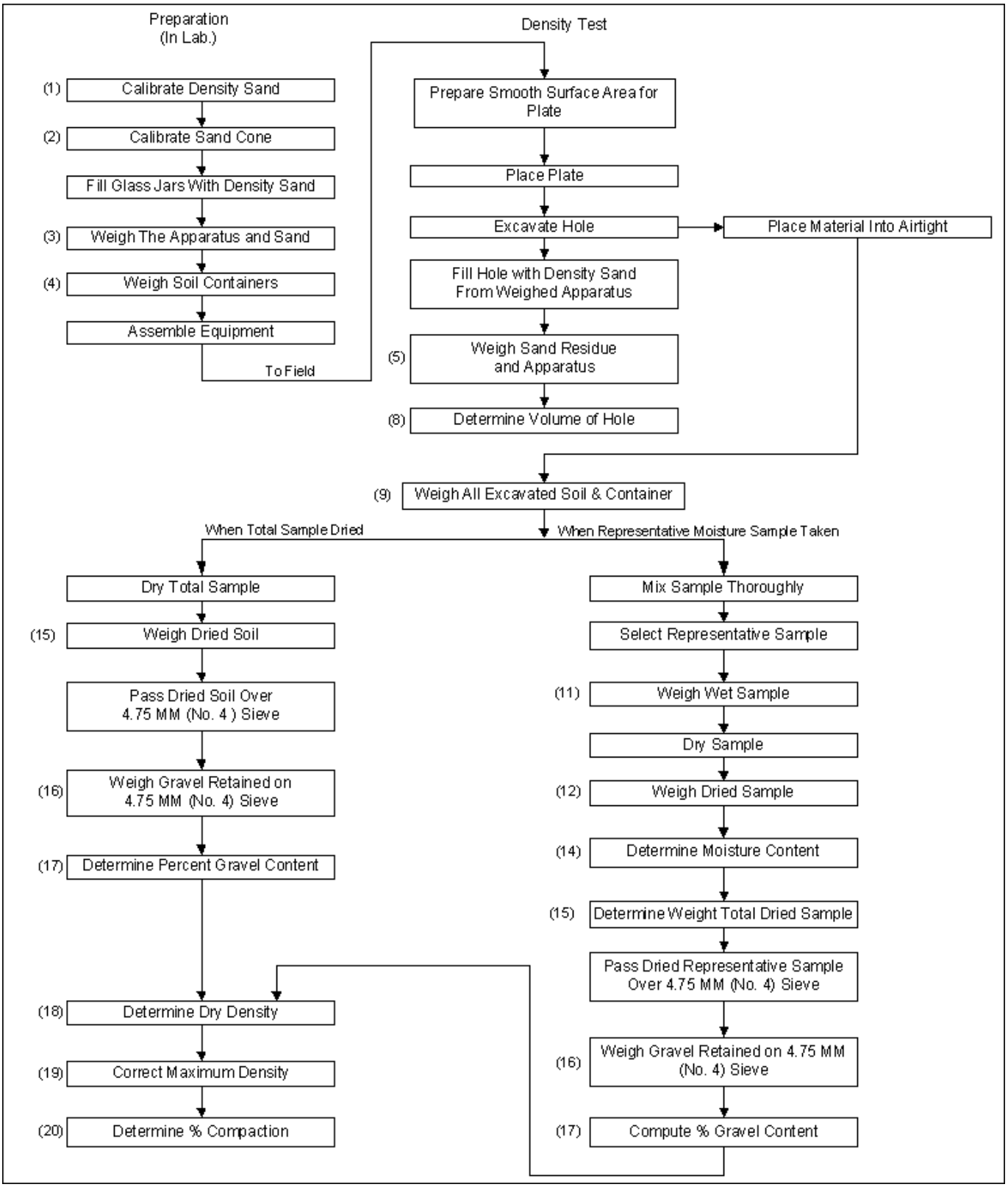
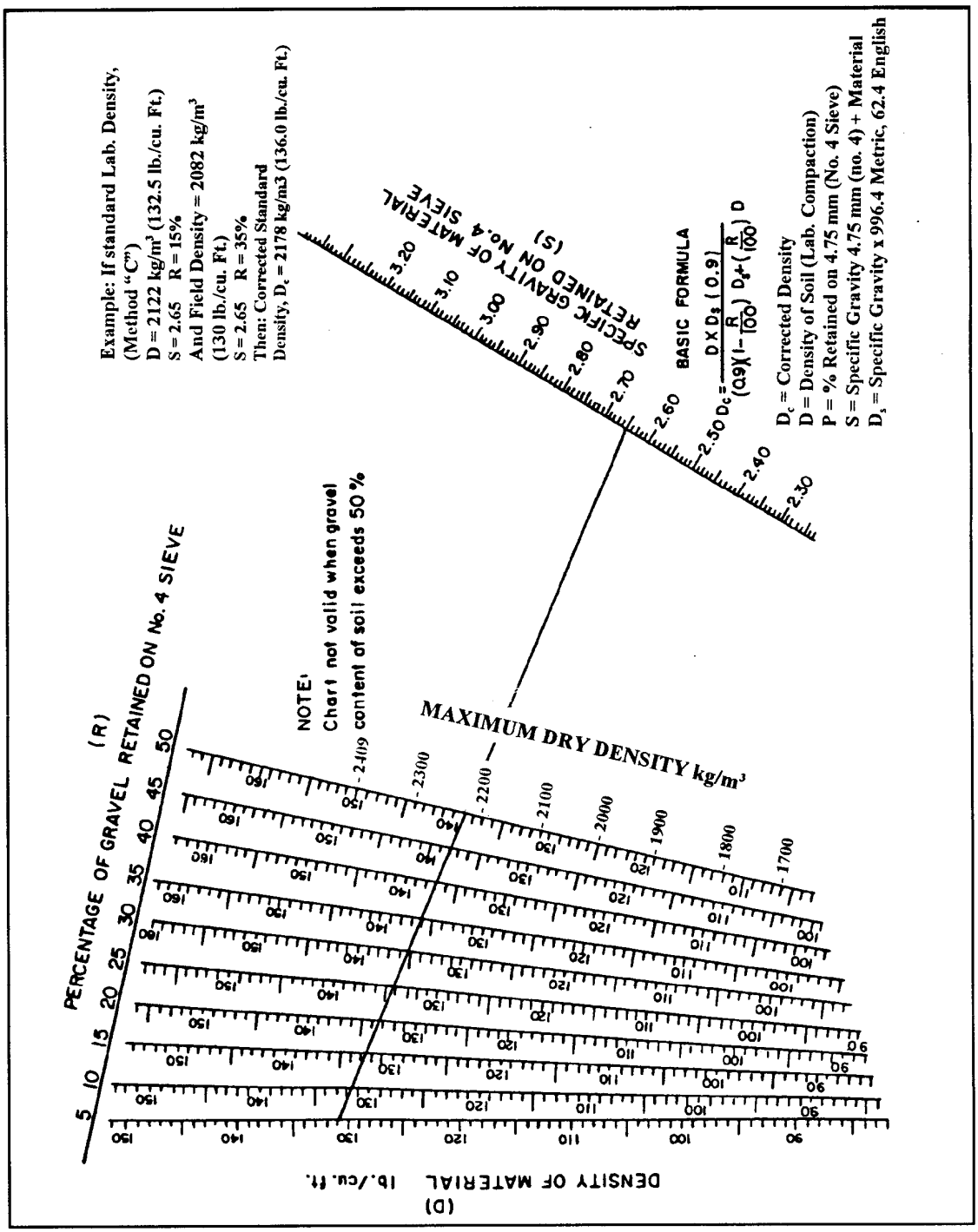


FIGURE 860-4 Nomograph for Determining Corrected Maximum Density for Soil with R No. 4 Sieve Material



860.12.2 Overview of Method

860.12.2.1 Equipment

Essentially, the sand cone apparatus consists of a 60-degree metal double-cone assembly fitted to a standard screw top glass jar and a 12-inch square metal plate. The assembly consists of a bottom cone with a 6-1/2 inch diameter base, a 1/2-inch valve and a top cone that is threaded for the screw top jar. The bottom cone fits into a recess in the metal plate that is placed over the area to be tested for density.

860.12.2.2 Density Sand

In accordance with ASTM, any sand with rounded particles passing the No. 10 sieve and retained on the No. 200 sieve may be used, providing the sand is clean, dry, and free flowing. To be acceptable, the sand should not have a variation in bulk density greater than 1%. It is possible to use locally prepared sand if it is washed thoroughly, oven-dried, and graded over the required sieves. This is usually time-consuming

and prohibitive for general use, especially when many tests are performed. It is usually cheaper to buy commercial sand. Portage silica sand, processed by the Manley Sand Company, Portage, Wisconsin, has served very well as calibration sand. It is uniformly graded with particles passing the No. 20 sieve and predominantly retained on the No. 50 sieve. Other sources of calibration sand are the Eau Claire Sand and Gravel Company and any local supplier of plaster sand.

After density sand is oven-dried, it should be calibrated before it is used. The sand should be kept in a covered container where it will remain relatively moisture free. During humid weather, the sand will absorb some moisture from the air, thus lowering its loose density. Therefore, frequent spot-checks are necessary to determine what changes, if any, occur. Although density sand may be free flowing, it may still contain enough absorbed moisture to alter its loose density. This small amount of absorbed moisture may cause the measured field soil density to be as much as 2-lbs/cubic foot lighter than the actual density. For this reason, supply containers holding density sand should be kept covered at all times. The spot-check should be made on every bag when about half of the sand has been used.

For economy, some field inspectors have been retrieving the density sand from the hole and using it on subsequent tests. This practice should be discouraged because the sand becomes contaminated with soil particles. The added time required to retrieve, wash, and process the sand is rarely worth the effort.

860.12.2.3 Calibration of Density Sand

Before any field density test is performed, the bulk or loose density of the sand to be used in the field test must be known. The bulk density is determined by filling a container of known volume with the density sand. The net weight of the sand divided by the volume of the container is the bulk density of the sand, expressed in pounds per cubic foot.

Various types of containers can be used to determine the bulk density of the dry sand. Types of containers and their use are explained in three methods. Containers should dimensionally approximate the largest test hole to be excavated.

The first method describes using such containers as the C.B.R. mold, 1/10-cubic foot mortar bucket and others in which the volume is known or can be determined without using water.

The second method outlines a procedure using the gallon glass or plastic jar that accompanies the sand cone. Any glass jar with slightly curved surface can be used, providing it is of proportions that will eliminate shoulder void. The volume of these containers is usually determined by water at a temperature between 35 F and 60 F. The density of water in that temperature range is close to 62.4 pounds per cubic foot.

The third method that is frequently used by field personnel involves using the sand cone apparatus to calibrate the density sand. In this method, a rubber gasket is required to prevent water from seeping around the threaded connection of the cone and jar. The gasket must be in place for both the water and sand weighings, and the cone threads must be turned on the jar threads to the same place. A check mark on each will help facilitate this determination. The method is acceptable, providing the glass jar does not have squared or sharp shoulders. Some gallon glass jars have a sharp curved portion just below the neck where bulking action of the sand occurs, and air pockets or voids are formed. These voids are visible on close observation. The condition introduces an error in the weight of the sand filling the jar and causes a sand density determination, which can vary as much as 1.5 lbs per cubic foot.

During all calibrations and tests, care should be taken to avoid jarring or vibrating the apparatus while the density sand is flowing and the valve is open.

860.12.2.4 Calibration of Cone

Before the volume of the test hole can be computed, the weight of the sand filling the sand cone and plate (between the ground surface and the valve of the apparatus) must be subtracted from the total weight of the sand used in the test. Because of dissimilarity in construction of sand cones and plates, the volumes of the different cones and plates may vary. For this reason, a sand cone and plate are kept together as a set and should not be interchanged.

860.12.2.5 Calibration Spot-Check

To reduce possibility of error due to an incorrect unit weight of the sand, a spot-check of the density should be made for each bag of density sand when the bag is approximately half full. This spot-check can be made by running a sand cone calibration as described under the calibration procedures.

Once the weight of sand filling the cone has been determined during the original calibration of the density sand, it is a simple matter to check that weight again.

When the weight of sand filling the cone remains the same, and the volume of the cone is constant, the density of the sand remains unchanged. If, during the spot-check, the weight of the sand filling the cone varies from the original calibration by 13.6 g (0.03 lbs.) one can assume that the density of the sand has

changed. The sand should then be recalibrated by one of the methods explained under the calibration procedures. When there is a variation of 13.6 g (0.03 pounds) in the weight of the sand filling a test hole of parabolic shape 6-inches in maximum diameter and 6-inches deep, the soil density will vary by approximately one pound.

Spot-checking of sand density is an integral part of an organized testing program. Without constant spot-checks the validity of the whole testing program can be questioned.

860.12.2.6 Trials

Whenever a calibration is performed to determine sand density, weight of sand filling the cone, or volume of container, three determinations or trials should be made unless the first two trials give the same reading. When three trials are made, the average of the three readings is taken as the final result.

860.12.2.7 Preparation

When filling the glass jars with calibrated sand in preparation for the field density test, it is suggested that all glass jars be filled with calibrated sand to a constant weight, say 16 lbs. This is to avoid errors in recording weights of jars plus sand if many jars are used on the project at one time.

The jar plus the sand may be weighed with or without the cone or jar cover attached. Either can be done, but it is recommended that the same procedure be followed throughout the job. When many tests are performed in the laboratory, it may be preferable to weigh the jar plus sand without the sand cone.

860.12.2.8 Field Density

Three very important steps in the field density test are preparation of the surface test area, excavation of the hole, and moisture determination. When preparing the surface area, an attempt should be made to prepare a surface without voids or protruding stones. Power equipment such as a motor grader, dozer, or front-end loader should not be used to level and smooth the surface test area. To reduce the surface roughness, some fine material may be scraped from the surrounding area or passed through the No. 4 sieve and sprinkled to just fill the surface voids. Then the surface is smoothed and compacted with a trowel. This procedure of filling the surface voids will greatly reduce the error due to surface roughness. When it is desired to completely eliminate the error due to surface roughness, a method is suggested in ASTM D1556.

It is occasionally helpful to secure the density plate in hard soil areas by driving a large spike adjacent to each plate edge. This prevents plate movement when the digging becomes difficult. The density plate is used for several reasons:

- The circular opening in the plate serves as a guide and template for digging the hole.
- The plate helps support the apparatus, especially in soft, loose soils.
- The plate helps reduce the loss when transferring soil from the test hole to the container.

860.12.2.9 Excavating the Density Hole

The test hole should be excavated in such a manner that the material surrounding the hole is neither compacted nor loosened. This is important because a discrepancy in the volume of the hole will directly affect the computed density. In a fine-grained soil there is a tendency to press down with the spoon, compacting the soil and enlarging the hole. This increases the volume of the hole and results in lower-than-actual density values.

Conversely, in a coarse-grained (gravelly or sandy) soil, the soil surrounding the hole is loosened when projecting rocks are extruded. This results in higher-than-actual density values. In either case, considerable care must be exercised when digging the hole. Sharp cutting edges on cutting tools or digging spoons are a necessity for excavation in silty or clayey soils.

When a nuclear device is used to check the density obtained by the sand cone method, all stones, regardless of size, should be removed and included with the soil from the test hole. Otherwise, the density determined by the nuclear device will generally be higher than that determined by the sand cone apparatus.

860.12.2.10 Moisture and Gravel Content Determination

The procedures outlined above for Field Density, are suggested because they give quick and reliable results. There are other reliable ways to determine moisture and gravel contents, although they may be more time consuming.

In the case of moisture content of a clayey soil, it is important to break the clay soil into clay lumps, pulverizing the lumps as the soil dries. As the clay soil dries, moisture is lost from the surface and a hard crust forms, trapping some moisture internally. Unless the lump is further broken apart to allow the internal moisture to escape, the clay will not completely dry as quickly, and an erroneous moisture

content may result. For this reason, the clay soil should be constantly manipulated, and the lumps broken down while drying, unless the soil is dried overnight in an oven to a constant weight.

The "Speedy" moisture device may be used to determine moisture content of fine grained soils accurately and quickly. Inspectors are cautioned against using the Speedy with coarse grained soil (high gravel content), since a very small moisture sample is used, and it may not be representative of the total sample.

In highly organic material, care should be taken to avoid burning the soil. At high temperatures the organic matter may be burned off, resulting in higher than actual moisture content determination.

860.13 Field Density Testing by the Sand Cone Method Part 2

860.13.1 Equipment

The equipment necessary for the field density test should include the following: (The first eight items may be included in a kit for field use.)

- 6-inch sand cone and 1-gallon glass jar. 4-inch cones and 1/2-gallon jars are not acceptable.)
- 1-gallon container with tight fitting lid (to hold excavated soil)
- 12" x 12" metal density plate with four large spikes for hold-downs
- Large screwdriver and geologist's hammer (wood handle) to loosen materials
- Large spoon with sharpened edges (for excavating material)
- Small trowel (to prepare test hole surface)
- Small paint brush (to sweep and collect loose material)
- Shovel, square-end, D-handle (to level test area)

The following equipment may be kept in a field laboratory:

- 20 kg solution balance or field scale, 35 lb. capacity. If a solution balance is used it will be necessary to convert kilogram or gram weights to pounds if reported in lbs./cubic foot.
- Gram scale, 2,000 g capacity
- Gasoline, electric or gas stove
- Drying pan approximately 9" x 12"
- Pie pan
- No. 4 sieve (to determine percent gravel and for specific gravity sample)
- Sand scope (for filling glass jars)
- Supply of dry density sand 100 lb. bags
- Field density data forms
- Gasoline can with flexible pouring spout (for gasoline stove)
- The following are optional
- Cardboard manila tags (for tagging gallon soil containers)
- Wax marking pencils (to mark apparatus and other equipment)
- Clipboard (to hold forms)

The term "apparatus" as used in these procedures refers to the glass jar with the sand cone attached.

860.13.2 Calibration Procedures

860.13.2.1 Calibration of Density Sand

1. Using containers with volume known or computed by actual measurement: C.B.R. mold - 6" diameter, 4.59" depth; volume 1/13.33 cubic foot. Mortar bucket - volume 1/10 cubic foot.
    A. Weigh the container.
    B. Fill the apparatus (glass jar with cone) with dry, clean density sand.
    C. Close the valve.
    D. Invert the apparatus and place it over the container so that the inside of the cone rests on the rim edge of the container. If the container is larger in area than the sand cone, place the metal plate that accompanies the apparatus over the container and set the sand cone apparatus on the plate.
    E. Holding the apparatus in place; open the valve and allow sand to flow into container. Avoid jarring or vibrating the container.
    F. When the sand stops flowing, close the valve and remove apparatus and plate carefully.
    G. Using a straightedge, strike off the surface of the sand level with the rim of the container. Avoid jarring or vibrating container when striking off.
    H. Tap the sides of the container to settle sand and thus avoid possible spilling or losing of sand from the container when transferring to scales.
    I. Brush excess sand off the outside of any protruding parts of the container.

J. Weigh the container and sand.
K. Determine net weight of sand: J minus A.
L. Calculate unit weight of sand: Unit weight of sand in pounds per cubic foot = net weight of sand divided by volume of container.

2. Using 1-gallon glass jar and glass plate or other containers with slightly curved or tapered sides: volume determined using cold water 35 F - 60 F
   A. For weight of sand filling container:
      1. Weigh glass jar.
      2. Invert a filled density apparatus (glass jar with cone and sand), and place onto the glass jar.
      3. Open valve and allow the sand to flow into the glass jar (avoid jarring or vibration).
      4. When the sand stops flowing, close the valve.
      5. Remove the density apparatus carefully.
      6. Using the straightedge, carefully strike off the surface of the sand level with the top rim of the jar (avoid jarring or vibrating jar with straightedge during this operation).
      7. Weigh the glass jar with the sand.
      8. Determine net weight of sand: Step 7 minus Step 1.
   B. For volume of jar:
      1. Weigh glass jar with glass plate.
      2. Fill the glass jar with cold water to the top rim of the jar neck.
      3. Place the glass plate on the jar (to eliminate excess water caused by surface tension).
      4. Dry the surface of the jar and glass plate.
      5. Weigh the jar with water and glass plate.
      6. Determine net weight of water: Step 5 minus Step 1.
      7. Volume of jar = net weight water divided by in pounds divided by 62.4 pcf. Sand unit weight = net weight of sand divided by volume of jar.
3. Using sand cone apparatus: 1-gallon glass jar with rubber gasket and sand cone attached.
   A. Find weight of the sand filling the apparatus:
      1. Weigh empty glass jar with cone and rubber gasket.
      2. Pour density sand into inverted apparatus through open valve until jar and valve are full. During this operation, try to keep the cone full of sand. Avoid jarring or vibrating the apparatus while sand is flowing until the valve is closed.
      3. Close the valve.
      4. Remove the excess sand in the cone.
      5. Weigh the jar with the cone and sand.
      6. Determine the net weight of the sand: Step 5 minus Step 1.
   B. Find volume of the apparatus:
      1. Weigh empty jar with rubber gasket and sand cone.
      2. Pour cold water into inverted density apparatus through open valve until water appears in the cone.
      3. Close valve, remove the excess water, and dry the cone and outside surface of apparatus.
      4. Weight the apparatus with the water.
      5. Determine net weight of water: Step 4 minus Step 1 in pounds.
      6. Volume of apparatus (including valve) = net weight of water divided by (62.4 pcf.
      7. Unit weight of sand = net weight of sand in pounds divided by volume of apparatus.

860.13.2.2 Calibration of Cone and Plate

1. Fill the glass jar with density sand and attach sand cone.
2. Weigh the glass jar with the density sand and attached cone.
3. Set the density plate on a smooth level surface.
4. Invert the apparatus and seat the sand cone in the hole of the plate.
5. Open the valve and allow sand to flow into the cone until it stops (avoid jarring or vibrating apparatus while sand is flowing).
6. Close the valve.
7. Re-weigh the apparatus (jar and cone) and remaining sand.
8. Determine net weight of sand used to fill the cone and plate. Step 2 minus Step 7.

9. Record this weight as the weight of sand filling cone.

860.13.2.3 Spot-Check Calibration

The spot-check calibration should be performed for each new bag of density sand.

1. Follow the procedures outlined Calibration of Cone and Plate.
2. If the weight of the sand filling the cone is 13.6 g (0.03 lbs.), more or less, than the original cone calibration, recalibrate the density sand.

860.13.3 Field Density Procedure

860.13.3.1 Preparation Preliminary to Test

1. Spot-check sand density using calibrated sand cone.
2. Recalibrate density sand, if necessary.
3. Fill all necessary glass jars with the calibrated sand to a constant weight.
4. Record the weight of each filled glass jar (always weigh filled jar with or without cone attached. Be consistent in procedure to avoid errors when several jars are used at one time).
5. Weigh and record the weight of all soil containers.
6. Assemble necessary equipment required in the field (take along extra filled jars in case hole dug is unusually large).

860.13.4 Performing the Field Density Test

1. Remove all loose and dry soil from the surface of the site to be tested. Go below depth disturbed by machinery.
2. Trim to a smooth, level surface an area large enough for the density plate to bed firmly. (If the surface is gravelly and irregular, sprinkle just enough fine material, scraped from the surrounding area or passing the No. 4 sieve, over the area to fill the surface voids; then smooth and compact with a trowel. Do not place a bedding layer for the plate thicker than 1/4").
3. Set the density plate firmly in place.
4. Loosen the soil with a screwdriver or geologist's pick and carefully remove the soil with a spoon.
5. Dig the test hole carefully, in such a manner that the material surrounding the hole is neither compacted nor loosened.
6. Place all soil from the hole into the airtight container.
7. Using a brush, gently sweep all loose particles from the sides of the hole and around the top edge of the plate hole into the hole. Remove and place all particles into the soil container.
8. Seal the container to prevent moisture loss from sample.
9. Invert the apparatus with the valve closed and set it onto the plate (make sure the lip of the cone edge is properly seated in the groove of the plate before opening valve).
10. Open the valve and allow the sand to flow into the hole and cone until it stops (there should be no vibration from earth-moving equipment in the immediate area until the valve is closed).
11. Close the valve and remove the apparatus with the remaining sand.
12. Weigh the apparatus with the remaining sand and record the weight to the nearest 5 g (0.01 lb.). (When outside, shield the scale from the wind. Maintain a level scale.)

    The glass jar with the remaining sand should be weighed either with or without the cone attached.
13. To find the weight of the sand filling the hole and the cone, subtract the remaining weight of apparatus and sand from the original weight of apparatus and sand.
14. The weight of sand filling the hole is found by subtracting the weight of sand filling the cone from the weight of sand filling the hole and the cone: Step 13 minus cone calibration.
15. The volume of the soil sample (hole) is found by dividing the weight of sand filling the hole by the weight per cubic foot of the density sand: Step 14 divided by sand density.
16. Weigh the soil sample and container. When outside, shield the scale from the wind. Maintain a level scale.
17. Record the weight to the nearest 5 g (0.01 lb.).
18. Find weight of wet soil: Step 16 minus weight of soil container.
19. Determine dry weight and gravel content of total soil sample:
    A. When time allows, the total wet soil sample may be dried for greater accuracy:
        1. Dry the entire sample to a constant weight. Manipulate and stir the soil; pulverize any clay lumps for more complete and rapid drying.
        2. Weigh the total dry sample to the nearest 5 g (0.01 lb.) and record.
        3. For gravel content, pass total sample over No. 4 sieve. Make sure gravel retained contains no clay lumps.

4. Weigh the gravel fraction retained on the No. 4 sieve to the nearest 5 g (0.01 lb.) and record.
5. Find percent gravel content: Weight of gravel retained multiplied by 100 and the result divided by dry weight of total sample. Step 4 multiplied by 100 and divided by Step 2.

B. When time does not allow drying the total soil sample, or if the material does not contain an appreciable amount of gravel, a representative sample may be taken as follows:

1. Thoroughly mix the total wet soil sample.
2. Select a representative sample for moisture and gravel content according to the following:

Suggested Minimum Size of Moisture Content Samples		
Maximum Particle Size	Moisture Content Sample, lb.	Moisture Content Sample, g
No. 4 Sieve	0.22	100
1/2" Sieve	0.55	250
1" Sieve	1.1	500
2" Sieve	2.2	1,000

3. Weigh the moisture content sample and record the weight to the nearest 0.1 g.
4. Dry the moisture content sample to a constant weight. For sandy soils, manipulate and stir. Pulverize any clay lumps for more complete and rapid drying. For clay soils, begin stirring and manipulating immediately upon heating to prevent the formation of a hard crust and to allow internal moisture to escape.
5. Weigh the dry sample and again record weight to nearest 0.1 g.
6. Find weight of moisture loss: Weight wet sample minus weight dry sample. Step 3 minus Step 5.
7. Determine percent moisture content: Weight of moisture loss multiplied by 100 and the result divided by dry weight of sample. Step 6 times 100 divided by Step 5.
8. For dry weight of total sample: Total dry weight = total wet weight divided by (1.0 + % moisture/100.)
9. For gravel content: Pass dried moisture content sample over the No. 4 sieve (make sure material retained on No. 4 sieve contains no hardened clay lumps).
10. Weigh gravel portion retained on No. 4 sieve to nearest 0.1 g and record.
11. Find the percent gravel content: Weight of the gravel retained multiplied by 100 and the result divided by the dry weight of the moisture content sample: Step 10 times 100 divided by Step 3.

In the case of fine-grained soils which contain no gravel, the "Speedy" moisture device may be used for a quick determination of the moisture content.

20. Specific gravity of gravel: If not previously known, the specific gravity of the gravel may be determined by the method described in AASHTO Designation: T85.
21. Find dry density of field soil sample:

$$\text{English : Dry density, pcf} = \frac{\text{Dry weight total sample, lbs.}}{\text{Volume of hole, cf.}}$$

22. Correct standard maximum density if gravel content of field sample differs from laboratory compaction sample by 5% or more.
23. Percent compaction

$$\text{Percent Compaction} = \frac{\text{Field density}}{\text{Corrected standard density}}(100)$$

860.13.5 Calculations

860.13.5.1 Calculations (Metric)

1. Volume of density apparatus (jar with sand cone attached):

$$\text{Volume, } m^3 = \frac{\text{Weight of water filling jar, kg}}{996.4 \text{ kg/ } m^3}$$

2. Unit weight of sand.

$$\text{Density, kg/ m}^3 = \frac{\text{Weight of sand filling container, kg}}{\text{Volume of container, m}^3}$$

3. Volume of test hole.

$$\text{Volume, m}^3 = \frac{\text{Weight of sand filling hole, kg}}{\text{Unit weight of sand, kg/ m}^3}$$

4. Moisture content:

$$\text{Moisture, \%} = \frac{\text{Wetweight - dry weight}}{\text{Dry weight}}(100)$$

5. Dry weight of soil sample from hole

$$\text{Dry weight (kg)} = \frac{\text{Wet weight sample, kg}}{\frac{1 + \text{\% moisture}}{100}}$$

6. Dry density of soil sample from hole.

$$\text{Dry density, kg/ m}^3 = \frac{\text{Dry weight, kg}}{\text{Volume of test hole, m}^3}$$

7. Percent of standard laboratory density

$$\text{\%} = \frac{\text{Field density}}{\text{Corrected standard density}}(100)$$

860.13.5.2 Calculations (English)

1. Volume of density apparatus (jar with sand cone attached

$$\text{Volume,cf.} = \frac{\text{Weight of water filling jar, lbs.}}{\text{62.4 lbs./cf.}}$$

2. Unit weight of sand:

$$\text{Density, lbs./cf.} = \frac{\text{Weight of sand filling container, lbs.}}{\text{Volume of container, cf.}}$$

3. Volume of test hole

$$\text{Volume, cf.} = \frac{\text{Weight of sand filling hole, lbs.}}{\text{Unit weight of sand, lbs./cf.}}$$

4. Moisture content

$$\text{Moisture, \%} = \frac{\text{Wetweight - dry weight}}{\text{Dry weight}}(100)$$

5. Dry weight of soil sample from hole:

$$\text{Dry weight (lbs.)} = \frac{\text{Wet weight sample, lbs.}}{\frac{1 + \text{\% moisture}}{100}}$$

6. Dry density of soil sample from hole:

$$\text{Dry density, lbs./cf.} = \frac{\text{Dry weight, lbs.}}{\text{Volume of test hole, cf.}}$$

7. Percent of standard laboratory density:

$$\text{\%} = \frac{\text{Field density}}{\text{Corrected standard density}}(100)$$

860.13.6 Laboratory Standard Density Correction for Variation in Gravel Content

These instructions pertain to using the nomograph as a guide for grading inspectors and others concerned with field compaction.

By referring to the nomograph with the specific gravity of the aggregate and a laboratory compaction density of the material, the inspector can establish the standard maximum density for a field sample containing a certain gravel content. The field density can then be compared with the standard density and the percent of compaction determined.

Example 5: Using Nomograph to Determine Maximum Density

Given:

1. Field density = 13.0 pcf
   with gravel content = 35%
   and specific gravity = 2.65
2. Laboratory compaction = (Method C)
   Maximum density = 132.5 pcf
   Gravel content = 15%
   Specific gravity = 2.65

Find:

Standard maximum density for the field sample containing 35% gravel.

Procedure:

1. Find on the nomograph the laboratory density value of 132.5 pcf at the 15% line and the specific gravity of 2.65 at the specific gravity line.
2. Using a straightedge, draw a straight line through the two points, 132.5 at the 15% line and 2.65 specific gravity, and extend it to the 5% line at the extreme left. The standard maximum density for a specific soil type with a certain gravel content will be found along the drawn line. This line indicates how the maximum density varies with a variation in the gravel content.
3. Move along the drawn line to the 35% retained column and read 136 pcf as the standard density for the field sample containing 35% gravel.
4. To find the percent of compaction, divide the field density value 130.0 pcf by 136.0 pcf, and multiply by 100. This will give 95.7% compaction.

SECTION 865 Asphaltic Binder Materials

Asphalt material sampling and testing methods as prescribed in CMM 865 are mobilized into the contract in standard spec 301.2.3 and standard spec 460.2.6.

865.1 General

Each asphalt binder provided to the project must be tested. A change in supplier or asphalt grade or designation constitutes a new binder.

The number of samples to be taken and the sampling method used must be in accordance with the current version of the Combined State Binder Group Certification Method of Acceptance for asphalt binders and is summarized here within.

https://engineering.purdue.edu/~csbg/method.html

865.2 Sampling Asphaltic Materials

The method for sampling asphalt PG binders must be in accordance with the current version of the Combined State Binder Group Certification Method of Acceptance for Asphalt Binders. For all other types of asphaltic materials, see standard spec 455. Regional personnel will be responsible for observing the sampling procedure, filling out and attaching sample tags, and shipping of the samples procured at the job site. They should also make sure the following points are given appropriate attention:

1. Sample conforming to WTM R66 and CMM 850.
2. Include bill of lading for material the sample represents.
3. After the asphaltic material has been properly sampled and labeled, ship to the laboratory the same day, if feasible. Shipments that take an excessive amount of time to arrive at the laboratory and those inappropriately sampled may cause test results that deviate from the contract requirements. Samples should be shipped with a sample tag, DT1352 (a blank form is available for use at this link.).

FIGURE 865-1 Asphalt Binder Sample Tag

For Central Lab Use Only

DT1352 10/2022

Sample Type		
◉ Asphalt Binder Sample ○ Asphalt Emulsion Sample		
Project ID (One project only)	**County**	**Region**
6420-00-78	Portage	North Central
Project Description		**Date Sampled**
Village of Plover, Post Road		2/6/2023
Limits		**Highway**
Green Drive to Springville Drive		Bus. 51
Prime Contractor	**Subcontractor**	
A-1 Asphalt Pavers Inc.		
Contact Name and Telephone Number (State Representative Only)		
T. Tutone (555) 867-5309		
Asphalt Binder PG Grade (i.e.: 58-28 S)	**Quantity (In Tons, as stated on BOL)**	
PG 58-28H	26.91	
Asphalt Product Sampled From		
In-Line		
Supplier (Include Shipping Point)		
Midwest		
Witnessed By (State Representative Only)		
Alex Call		
Sample Number	**Bill of Lading Number**	
No. 2 Lab #20	48180	

865.3 Certification Method of Acceptance for Asphalt Binders

Acceptance of asphalt binder by the Certification Method provides for acceptance of these materials for use on WisDOT projects upon the producer's or supplier's certification that the product as furnished to the contractor (or purchasing agency) complies with the pertinent specification and contract requirements.

A list of certified suppliers can be found in the Combined State Binder Group Certification Method of Acceptance for Asphalt Binders document or on the approved product list APL.

For samples tested by the department with non-complying results, the engineer should ensure that the procedure listed in the Certification Method has been followed.

SECTION 866 Asphalt Mixture Design

Asphalt material sampling and testing methods as prescribed in CMM 866 are mobilized into the contract in standard spec 301.2.3 and standard spec 460.

866.1 Asphaltic Mixture Design

Provide an Asphaltic Mixture Design Job Mix Formula (JMF) report representing the materials intended for use along with their proportions for producing the final product. These procedures infer laboratory mixed and compacted specimens unless designated otherwise.

JMF Mix Design Reports are the responsibility of the Highway Technician Certification Program (HTCP) certified personnel and must comply with the materials and mix design requirements of standard spec 460.

If a contractor uses a consulting laboratory to supply a mix design, the contractor must authorize in writing that the consultant acts as the contractor's agent during the mix design approval process.

During the mix design submittal process, WisDOT will only accept 2 passing designs per each nominal maximum aggregate size or one mix design per combined bid item (whichever is greater), per project. During construction, any approved mix design matching the pay item may be used.

Current WisDOT project ID is required for mix design submittal.

The default WisDOT project number, 0250-11-11, is used on the 249 submittal form when a current WisDOT project number is not available at time of design. An example would be a non-DOT project requiring a DOT approved mix design.

Any mix design approaching expiration, can be renewed with a one-point verification and will retain its original 250 number when renewed on the approved list.

Any mix design that had been issued a 250 number "not using the 249 form" may contact BTS for instruction on how to obtain a 250 number in the current calendar year.

866.1.1 Acronyms and Definitions

Materials related acronyms and terms are defined in standard spec 450.2.1.

866.2 Laboratory Standard Method of Asphaltic Mix Design

866.2.1 Description

This method is used to determine the optimum asphalt binder content for virgin asphaltic mixtures and asphaltic mixtures containing recycled asphaltic materials (RAM). This method also defines the submittal requirements pertaining to mix design reports and materials, as well as any field changes affecting mix design reports.

866.2.1.1 General

Required test procedures for aggregate and hot mix asphalt (HMA) are shown in table 866-1 and table 866-2.

TABLE 866-1 Required Aggregate Test Procedures

AGGREGATE TEST	TEST PROCEDURE
Materials Finer than No. 200 (0.075mm)	WTM T11
Sieve Analysis of Aggregates	WTM T27
Mechanical Analysis of Extracted Aggregate	WTM T30
Sieve Analysis of Mineral Filler	AASHTO T37
Liquid Limit of Soils (from source aggregate quality report #225 or #162)	WTM T89
Plastic Limit of Soils (from source aggregate quality report #225 or #162)	AASHTO T90
Los Angeles Abrasion of Coarse Aggregate (from #225 report)	WTM T96
Specific Gravity and Absorption of Fine Aggregate	WTM T84
Specific Gravity and Absorption of Coarse Aggregate	WTM T85
Specific Gravity of Soils	WTM T100
Flat and Elongated Particles in Coarse Aggregates	WTM D4791
Soundness of Aggregate (from #225 report)	WTM T104
Freeze-Thaw (from #225 report)	WTM T103
Clay Lumps and Friable Particles in Aggregate	AASHTO T112
Fractured Faces (CAA)	WTM D5821
Uncompacted Voids Content of Fine Aggregates (FAA)	WTM T304
Sand Equivalency (Plastic Fines)	AASHTO T176

Requirements are specified in standard spec 460.2.2.3, table 460-1 or in standard spec 460.2.7, table 460-2.

TABLE 866-2 Required HMA Test Procedures

HMA TEST	TESTPROCEDURE
Practice for Superpave Volumetric Design for HMA	WTM R35
Specification for Superpave Volumetric Mix Design	AASHTO M323
Standard Practice for Mixture Conditioning HMA	WTM R30
Standard Method for Preparing and Determining the Density of HMA Specimens by Means of the SHRP Gyratory Compactor	WTM T312
Bulk Specific Gravity of Compacted Bituminous Mixtures	WTM T166
Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures	WTM T209
% Air Voids in Compacted Dense and Open Bituminous Paving Mixtures	WTM T269
Resistance of Compacted Bituminous Mixture to Moisture	WTM T283
Determination of Draindown for Uncompacted Asphalt Mixtures	AASHTO T305
Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)[1]	AASHTO T164 Method A or B
Asphalt Content by Ignition Oven[2]	WTM T308
Asphalt Content by Automated Extraction[1]	WTM D8159

[1] Not required as part of the mix design process.

[2] Only WTM AASHTO T308, Annex A - Correction Factors is required during the mix design process.

866.2.2 Summary of the Practice

1. Select aggregate components and the asphalt binder to be used and determine the required properties defining those materials.

2. Design an aggregate structure (or multiple trial aggregate structures). Determine aggregate component blend percentages.
3. Determine trial asphalt binder contents (estimated by experience or by calculation based on aggregate properties of trial blends).
    - Compact gyratory specimens using a minimum of 3 times, preferably 4, asphalt binder contents (0.5% increments) and covering a range to include the estimated optimum design binder content. Use Ndes for compaction effort.
    - All new mix design need at least one point that is a minimum of 0.5% below 3.0% Air Voids (≤2.5% Va) and one point that is at least 0.5% above 4.0% Air Voids (≥4.5% Va)
    - Compare trial binder content results. Select an optimum design binder content (by either graphing or interpolating the trial data results) meeting requirements as stated in standard spec 460.
4. Evaluate additional properties at the selected optimum design binder content.
    - Moisture Susceptibility, indicated by the tensile strength ratio (TSR), which is determined using WTM T283 according to standard spec 460.2.7, table 460-2.
    - Validate compliance of $\%G_{mm}$ at N_{max} and N_{ini} by compacting 2 specimens at the design binder content to Nmax gyrations.
    - For SMA designs, AASHTO T305 must be followed, and testing conducted at two temperatures. The two temperatures should be the anticipated production temperature and +15 C above the anticipated production temperature. Mix must be prepared at optimum AC%. Report the average percent Draindown (average percent of the mixture that drained) at each of the test temperatures.
    - Draindown value at anticipated production temperature and at 15˚C above anticipated production temperature, average of two (2) values at each temperature is required.
5. Complete a mix design report identifying materials used and summarizing volumetric properties in meeting required specifications in CMM 866.2.4.
6. Submit the mix design report, and representative materials when requested or required, to the department for review per CMM 866.2.5.

Additional guidance for materials selection and component composition involved in the mix design process can be referenced in, but not limited to, the following:

- Superpave Mix Design Manual SP-2 (Asphalt Institute)
- Mix Design Methods for Asphalt Concrete MS-2 (Asphalt Institute)
- NCHRP 9-33 (A Mix Design Manual for Hot Mix Asphalt)
- NCHRP Report 673 (A Manual for Design of Hot Mix Asphalt with Commentary)

866.2.3 Materials and Test Procedures: Additional Guidance

866.2.3.1 Aggregates

Refer also to CMM 860 and standard spec 106.3.4.2.2.

Test the aggregate source material for quality properties (LA wear, soundness, freeze-thaw, etc.) in accordance with the current department policy and required frequency. Count the current construction season as one year of aggregate quality eligibility.

The mix designer, using the previously listed test methods determines the aggregate properties with the following exceptions or comments:

- Fine aggregate angularity (FAA) is determined using Method "A" (WTM T304) on each individual component with more than 10% passing #8 sieve (2.36mm) and on the current JMF blend.
- Specific gravities on coarse and fine aggregates must be performed according to table 866-3. The extracted aggregate from RAM must be obtained by one of the following:
    - Chemical extraction according to AASHTO T164 method A or B.
    - Automated extraction according to WTM D8159.
    - Ignition oven according to WTM T308.

TABLE 866-3 Specific Gravity Testing

Criteria	Cut Sieve	Test Procedure
Less than 10% passing the #4 sieve.	#4	WTM T85
More than 10% passing the #4 sieve but less than 10% passing the #8 sieve.	#8	
More than 10% passing the #4 sieve and 10-90% passing the #8 sieve.	#4 or #8	WTM T84 and WTM T85
More than 90% passing the #8 sieve.	#4	WTM T84

- Flat and elongated particles are determined using particles retained on the #4 sieve (4.75mm) and larger. The determination of the F&E percentage is based on weight; however, the sample size is intended to be by count (200 pieces, minimum).

866.2.3.2 Asphaltic Binder Material

Select an asphalt binder meeting the contract requirements and having been defined or graded according to WTM M332 and the department's Combined State Binder Group Method of Acceptance for Asphalt Binders available at:

https://engineering.purdue.edu/~csbg/method.html

The asphalt binder source and grade indicated on the JMF Mix Design report must represent the material used during the mix design process in determining the optimum asphalt content. If recycled asphaltic materials are part of the mix design, additionally refer to standard spec 460.2.6.

During production, it is permissible to use a binder designation that is higher than that of the approved design. However, a lower binder designation may require a "verification check" to be submitted. For example, if a mix was designed for use with PG 58-28S, it is acceptable for use with H and V grades with no additional testing.

If a design was approved with PG 58-28H, it is acceptable for use with a V grade with no additional testing. However, if dropping to an S grade, evaluate the mix design criteria listed below. If all criteria are met, no additional testing is required and S grade is approved for use. If any of the conditions are not met, a verification check is required for the property in question.

Property	JMF Criteria[1]
TSR[2]	> 0.77
%Gmm at Nini	<88.5 (for HT mixes)
%Gmm at Nmax	< 97.5

[1] If the resultant "verification check (one-point)" indicates a need to adjust the mix design targets or component combinations to meet these criteria, then additional testing and separate design submittal is required.

[2] Compact each TSR specimen using AC content corresponding to 3.0% air voids and the current JMF blend.

Change in the asphalt binder source during production is acceptable if the new supplier is on the current approved products list APL, and sampled/tested accordingly, and the engineer is notified in writing of any change.

866.2.3.3 Preparation of Mixtures

Combine the aggregates and asphaltic binder noting the following exceptions:

- The requirement for using trial aggregate blends as prescribed in WTM R35 is optional.
- Compaction effort gyrations are set by the standard specifications and may deviate from WTM R35. Additionally, refer to standard spec 460.2.

866.2.3.4 Compaction of Specimens

Produce the required compacted specimens (minimum of 2 specimens for each asphalt binder content) using WTM T312 and WTM R30.

For aggregate JMF blends with moisture absorption greater than or equal to 2.0% a 4-hour cure time is used and indicated on the JMF mix design report. Report the actual absorption value on the report and additionally state the cure time within the report or comment section.

866.2.3.5 Determination of the specific gravity of SGC compacted asphaltic (Gmb)

Determine specimen Bulk Specific Gravity (Gmb), using WTM T166, Method A for dense-graded mixes. For open-graded mixes such as SMA, determine Bulk Specific Gravity using WTM T331. Report Gmb value to three decimal places (0.001).

866.2.3.6 Determination of the mixture maximum specific gravity (Gmm)

Determine Maximum Specific Gravity, (Gmm), using WTM T209. For aggregate JMF blends with moisture absorption greater than or equal to 2.0%, additionally use the supplemental procedure for mixtures containing porous aggregates not completely coated (dry back procedure). This data is listed on the JMF mix design report.

A minimum of two tests must be run, one each at two different asphalt trial binder contents. Calculate the Gse for each Gmm test run (to three decimal places, 0.001) and average the results. Use this calculated average Gse to determine all Gmm values for the trial data. Report any Gmm value to three decimal places (0.001).

866.2.4 Report

866.2.4.1 General

The mix designer/laboratory creates a summary report to be submitted electronically into Atwood's Systems using the 249 form for review, along with an electronic copy (pdf of the 249 form and mix design report) to BTS and the regional office. This summary must include trial data used to determine the design optimum binder content.

866.2.4.2 Report Items

The following is a breakdown of the minimal information needed to be listed on the mix design report. An example report can be found at the end of this section.

Summary of Aggregate Source/Component and RAM Data:

- Source name (as noted on 225 report), pit or quarry designation (P or Q), and 225 number, for each component, using the following format (225-xxxx-xxxx).
- Component Gradations: gradations for each aggregate and the final blend must be shown as the % passing (the nearest 0.1) for the1 1/2" (37.5mm), 1"(25.0mm), ¾"(19.0mm), 1/2"(12.5mm), 3/8" (9.5mm), #4(4.75mm), #8(2.36mm), #16(1.18mm), #30(0.60mm), #50(0.30mm), #100(0.150mm), and #200(0.075mm) sieves.
- The percent of each aggregate and RAM component as compared to the total aggregate.
- LA Wear loss, % (include department test number or listed values).
- Soundness loss, % (include department test number or listed values).
- Freeze-thaw, % (include department test number or listed values, refer standard spec 106.3.4.2.2).
- Aggregate Bulk specific gravity (Gsb).
    - For mixtures containing RAM extracted gradation data, Gsb and percent extracted asphalt content is required.
- Flat and elongated (Method B), %.
- Coarse fracture/crush count (1-face and 2-face), %.
- Fine aggregate angularity (Method A) for fine aggregate only. i.e.: Sands (Natural, Manufactured) and P#8 of RAM components.
- Moisture absorption %.

Aggregate Blend Data:

- Flat and elongated (Method B), %.
- Coarse fracture/crush count, %.
- Sand equivalency.
- Fine aggregate angularity.
- Moisture absorption %.
- Bulk specific gravity (Gsb).
- Effective specific gravity (Gse).

Asphaltic Binder:

- Binder source (supplier).
- Binder performance grade and designation level (S, H, V, or E).

- Binder specific gravity @ 77 / 77F (25 / 25C).
- Laboratory Mixing- and Compaction - Temperatures (based on WTM T312) for laboratory produced mixture evaluation.
- Type of Additive
- Amount of Additive

Mixture Properties (using trial asphalt binder contents)

- Binder content, % (Pb).
- Air Voids, % (Va).
- Maximum specific gravity (Gmm).
- Bulk specific gravity of the compacted mixture (Gmb).
- VMA (voids of the mineral aggregate), %.
- VFB (voids filled with binder) also called VFA (voids filled with asphalt), %.

Mixture Properties (design "optimum" asphalt binder content):

- Binder content, % (Pb).
- Maximum specific gravity (Gmm).
- Bulk specific gravity (Gmb).
- Air voids, % (Va).
- VMA (voids of the mineral aggregate), %.
- VFB (voids filled with binder), %.
- DP (dust/binder proportion), % (using effective binder content, Pbe, for calculation).
- Gyratory compaction effort (for Nini, Ndes and Nmax).
- %Gmm (for Nini, Ndes and Nmax).
- Gmm Dryback Correction Factor, % (if applicable).

Mixture Properties (3.0% "Air-Void Regression" asphalt binder content):

- Binder content, % (Pb).
- Maximum specific gravity (Gmm).
- Bulk specific gravity (Gmb).
- Air voids, % (Va).
- VMA (voids of the mineral aggregate), %.
- VFB (voids filled with binder) also called VFA (voids filled with asphalt), %.
- TSR (tensile strength ratio).
- TSR Compaction Effort (N = "x").

For Recycled Asphaltic Pavement Mixtures, also list:

- Added binder content, %.
- Total binder content, %.
- Extracted asphalt binder % (of recycled components)
- Percent Binder Replacement (Pbr)

Miscellaneous:

- Name of WisDOT - HTCP Certified HMA technician (at level designated for mix design) identifying responsibility for mix design data.
- Name of design laboratory facility, its address and phone number (contact location).
- Design date (representing completion of the mix design work).
- Design ID (unique number or name).
- Traffic level classification (e.g. LT, MT, HT).
- Asphalt mixture gradation (NMAS) (e.g., Gradation 1, 2, 3, 4, 5 or 6 representing 37.5mm to 4.75mm, respectively).
- Report draindown results (at two temperatures)

866.2.5 Report Submittal and Department Review

866.2.5.1 General

Mix design summary reports and either individual or batches of blended aggregates (if required or requested), are submitted to BTS before paving, using one of the following two methods: comparison level or express level.

Each mix designer will be subject to a minimum of one comparison level submittal per year.

In addition, mixes meeting the following criteria must have material submitted to BTS for comparison testing:

- Design values for VMA (+0.5%).
- FAA (+1.0%).
- TSR are within +0.05 of the lower limit requirements in standard spec 460.2, table 460 - 2.

The 10-day limit for comparison submittal does not apply.

In addition to the above requirements for comparison mix design submittal, BTS requires submittal of BTS-selected mixes for performance-based testing. If BTS selects a mix design for both comparison and performance-based testing, the contractor must submit the following:

- Only one batch of four 6800-gram specimens.
- Asphalt binder in either three full 1-quart containers or one full 1-gallon container.
- The number of TSR specimens the department requests.

Each mix subject to this requirement will be determined by BTS and communicated to each mix designer. Designation of a design laboratory, or a certified mix designer to a specific submittal level is determined by the BTS. BTS will authorize and direct movement between submittal levels.

Submittals received after 4pm (Mon-Fri) will be acknowledged as arriving the following work day.

Each design must be submitted using the WisDOT Mix Design Standard Data Input Form/Report 249 through WisDOT Material Reporting System (MRS). The contractor must provide electronic notification to BTS and the regional HMA Specialist when Form/Report 249 (http://wisconsindot.gov/rdwy/worksheets/form249.xlsx) is submitted.

Only one mix design per email notification will be accepted.

At BTS's discretion, any or all of the following testing may be performed.

Aggregates:

- Test the aggregate for compliance to standard spec 460.2, table 460-2:
  - Flat and elongated (Method B), %.
  - Coarse fracture/crush count (1-face and 2-face), %.
  - Sand equivalency.
  - Fine aggregate angularity (Method A)[1].
  - Moisture absorption %.
  - Bulk specific gravity (Gsb)[1].

[1] FAA and Gsb need to meet tolerances in table 866-4, compared to results provided on original Mix Design submittal.

HMA:

Test the HMA for compliance to standard spec 460.2, tables 460-1 and 460-2.

TABLE 866-4 Allowable Differences between Contractor and BTS Comparison Test Results

Test	Allowable Difference
Mixture bulk specific gravity (Gmb) [1]	+/- 0.030
Mixture maximum specific gravity (Gmm) [1]	+/- 0.020
Fine Aggregate Angularity (Method A), uncompact voids (%)	- 1
Aggregate Individual Bulk Specific Gravity (+No. 4 [+4.75mm]) (Dry)	+/- 0.025
Aggregate Individual Bulk Specific Gravity (-No. 4 [-4.75mm]) (Dry)	+/- 0.032

[1] The allowable difference is compared to results provided on original mix design submittal.

Individual component aggregates may be tested. Communication between BTS and the mix designer must take place before requesting materials.

If BTS's test results are less than the values in standard spec 460.2, table 460-2 for minimum TSR values, the mix may need to be redesigned and tested, also all future submittals using this source may require the submission of TSR samples for verification/acceptance testing until BTS is satisfied with the source. Communication with BTS is required and all testing is at the discretion of BTS.

The department can reject a superpave mix design, or stop the review, for reasons including but not limited to the following:

- Evaluation of a superpave mix design results indicate a failing design.
- Incorrect or insufficient submittals.

- Incomplete documentation.
- Aggregate physical requirements do not meet standard spec 460.2, table 460-2.
- The contractor/consultant requested combined gradation does not meet standard spec 460.2, table 460-1.
- No office notification of comparison level samples being sent to BTS office.
- Invalid aggregate quality number.
- Contractor/consultant suspends interest in submitted material.

Subject to BTS workload and after the contractor/consultant efforts are made to resolve all discrepancies in the submittal, BTS may resume the ten-day review procedure.

866.2.5.2 Comparison Level Submittals

This process requires submittal of the mix design summary report and blended aggregates representing the mix design job mix formula (JMF). The contractor needs to submit materials to the department a minimum of 10 working days before paving.

- The contractor must include four 6800 g (15 lb) batches of the blended aggregate, representing the mix design JMF, (inclusive of any components containing recycled asphaltic materials or stabilizing agents) and either three full 1-quart containers or one full 1-gallon container of design PG binder. Virgin blended aggregate is submitted separately from RAM and both must be dried before sending to BTS.
- BTS may request individual aggregate/RAM samples for each component and either three full 1-quart containers or one full 1-gallon container of the design PG binder in place of the composite aggregate samples.

If TSR's are requested, the contractor will supply 8 compacted specimens to BTS. Compact specimens to 7.0 +/- 0.5% air voids, or for SMA mixtures, to 7.0 +/- 1.0% air voids.

The following conditions indicate a need to follow this submittal procedure (communication with BTS is required):

1. Any design laboratory or certified asphalt mix designer submitting designs to the BTS for the first time (regardless of previous history for either).
2. Any design laboratory or certified asphalt mix designer having lacked submittals for a period of three consecutive construction seasons.
3. Any design laboratory or mix designer abusing the "express submittal" privilege (ex: multiple instances of incorrect or non-compliant data/information needing correction or formal amendment). Note: This condition will be identified and communicated when trending and then defined by notification from the BTS.

Transition from "comparison level" submittal requirements to "express submittals" will be by notification from BTS.

Results of the comparison review must be compared. When tolerances are exceeded in table 866-3 or if the results are less than the requirements in standard spec 460.2, tables 460-1 and 460-2, a new mix design may need to be completed and submitted by the contractor/consultant.

866.2.5.3 Express Submittal

Design laboratories or certified designers may use this submittal procedure with authorization from BTS.

The design laboratory must submit the mix design summary report (electronically) to the department for review and provide a copy to the department's regional office a minimum of 4 working days before the start of paving.

1. The department will review the mix design summary report and acknowledge specification compliance by the following 4th work day after submittal.

In the event that the submitted design does not meet specifications, or the individual contract requirements, the department will notify the mix designer and may elect to delay release of the review (potentially impacting paving); until such time that the specifications are met.

HTCP-Certified Hot Mix Asphalt, Mix Design, Report Submittals (HMA-MD) technicians requesting mix design comparison testing should follow the requirements for "Comparison Level" submittals and alert the BTS Truax Center Laboratory of the request to have properties checked. Use of this submittal procedure, while authorized for Express Level, does not negate further use of Express Level submittals.

866.3 Mixture Design Life

All HMA mix designs have a life of 3-years from the date of the initial assigned WisDOT 250 number. Count the current construction season as year one of mix design life eligibility. For any mix design to surpass the 3-year life, a one-point verification using lab or field produced materials is required as described in 866.1. One-point verifications are to be conducted on the current JMF blend (including all current approved JMF changes) and %AC corresponding to 4.0% air voids using Ndes gyrations for lab-batched material and at % AC corresponding to 3.0% air voids for plant produced material. This allows for plant-produced mix to be used for one-point verification. If plant-produced mix is used for one-point

verification it will be produced within 10 days of submittal, unless otherwise approved by BTS. In addition to the current JMF blend, the most recent control charts will be submitted to BTS for one-point verification. Results must be submitted electronically to BTS - Truax for review along with the current mix design including any current approved JMF changes. Individual specific gravities must not vary more than the allowable differences in table 866-4.

BTS will review the submitted data with-in 4 (four) working days and if compliant the mix will be put on the approved HMA Mix Design List for another 3-year cycle. BTS will review the results to verify they conform to the requirements listed in standard spec 460.2, tables 460-1 and 460-2.

The percent binder replacement (Pbr) in standard spec 460.2.5 must also be verified and reported to show results are within allowable tolerances. Note: The tolerances in table 866-4 are used to evaluate the one-point verification test results.

Previously approved mix designs not meeting the requirements of the Air Void Regression specification (i.e., having a point ≤3.0% Air Voids), require an additional point be run at the next lower 0.5% AC increment. In this instance, mixes are to be entered into MRS using the 249 form and will be assigned a new 250#. The previously assigned 250# number associated with the mix (before conducting the next lower 0.5% AC increment) will become inactive.

TABLE 866-5 Allowable Differences for One-Point Verification Check Test Results

HMA	Allowable Difference
Air Voids (Va) %	+/- 0.5
Aggregates	Allowable Difference
Aggregate Individual Bulk Specific Gravity (+No. 4 [+4.75mm]) (Dry)	+/- 0.025
Aggregate Individual Bulk Specific Gravity (-No. 4 [-4.75mm]) (Dry)	+/- 0.032

Mix designs carry over for subsequent construction seasons, with-in the 3-year design life, when all the following are met:

1. Department specification changes have occurred, and the mix design still meets those specifications for any current contract.
2. Aggregate quality data is current as specified in standard spec 106.3.4.2.2.1. See department 162 and 225 reports for approved aggregate sources on the APL.
3. Design aggregate component blend percentages will not be changed by more than 20% in any combination at any single point during production.
    - 3.1 Note that any single component blend adjustment will result in a need to adjust additional components to balance the blend (e.g.: any component adjusted by 10% will also require an additional "other" 10% change between the remaining components, resulting in the maximum 20% referenced change). However, component blend changes are not accumulative so component blend changes back towards the original JMF will not be considered as exceeding the 20% maximum. The following example illustrates changes to proportions and how to assess blend changes:
        - 3.1.1. For example, if the original proportions for the aggregates are: Agg1 = 25%, Agg2 = 25%, Agg3 = 45%, Agg4 = 5%. Then the initial component blend first changes by adjusting Agg1 to 35% and Agg2 to 15% resulting in a 20% change from the JMF. Then a second change had Agg1 moved back towards the original JMF to 30% and changed Agg2 to 20% resulting in a 10% net change from the original JMF. The second change does not get added to the first change of 20%. Each change is independently assessed against the original JMF, not added to other previous changes.
    - 3.2 Blend changes indicating an excess of the maximum 20% away from the original JMF will not be considered the same mix design within the same season or any subsequent season. Continued use will require a new mix design or approval of the project engineer (documenting the reason).

Any need for elimination or addition of new aggregate (inclusive of RAM) components requires a new mix design. Additives including a change in the dosage rates may require additional testing to ensure compliance. Recognizing all current design JMF target changes with associated QMP data from the end of the previous construction season is required and must be noted "as such" before initial paving.

A current list of approved asphalt mix designs is located on the APL.

866.4 Amended JMF Reports and JMF Report Reviews

Previously submitted mix designs needing to be edited or updated will be re-submitted along with an explanation for the nature of the change (and any supporting data). Examples of these instances could be:

1. Typographical Errors
2. Addition of PG binders in order to comply with CMM 866.2.3.
3. Mix Design Signatures (HTCP Accountability)

866.5 Non Traditional or Non-Standard Mixture Design Reports

For mix designs involving specialty products, components, or needing to meet a local special provision, identify in the comment section of the report or within the submittal correspondence.

866.5.1 Warm Mixed Asphalt

Warm Mixed Asphalt (WMA): Laboratory work should be completed at additive supplier recommended mixing and compaction temperatures. These temperature ranges are to be listed on the JMF report and the mix design submittal 249.

866.5.2 Stone Matrix Asphalt

Stone Matrix Asphalt (SMA): Laboratory work should be completed at supplier recommended mixing and compaction temperatures and using the contract specified asphalt binder type and designation. The temperature ranges and asphalt type are to be listed on the JMF report and the mix design submittal 249.

866.5.3 Polymer-Modified HMA Overlays

Laboratory work for polymer-modified HMA overlays should be completed at supplier recommended mixing and compaction temperatures and using the contract specified asphalt binder type and designation specified in the HMA Overlay Polymer-Modified contract special provision, STSP 509-035. The temperature ranges and asphalt type are to be listed on the JMF report and the mix design submittal 249.

SECTION 870 Materials Testing and Acceptance - Concrete

Standard spec references to concrete testing and sampling methods contained in this chapter:

Standard spec 701.3 ..... concrete testing

CMM provisions mobilized by the contract:

CMM 870.4.8 ..... strength/maturity relationship development

870.1 General

Portland cement concrete (PCC) is a major component for a number of bid items used on highway construction projects. The various properties of the component materials, the unhardened mixture, and the finished concrete product as well as required construction techniques are specified throughout parts 4, 5, and 6 of the standard specifications and in the contract special provisions, the plans, and other elements of the contract. These contract requirements can vary widely from contract to contract. The contractor is responsible for producing and delivering material that conforms to all the contract requirements.

The contract references this and other portions of the CMM to describe required sampling and testing procedures. These procedures apply equally to sampling and testing performed by the department, contractor, material supplier, or consultants performing work under the contract for the contractor or administering the contract for the department.

870.2 Concrete Mixtures and Materials

The properties of fresh concrete and the finished concrete product depend on the properties of the component materials. While all materials must meet the threshold, properties specified in the contract, a good mix design can yield quality concrete even if some of the component materials are less than perfect. Once a mix design is selected that optimizes the use of the available materials, consistent production of that design mix is key to concrete quality. Maintaining quality requires control of the component materials.

870.2.1 Component Materials

The four basic component materials in concrete are:

- Cementitious materials
- Mixing Water
- Aggregates (fine and coarse)
- Admixtures

Acceptance of the component materials are by various methods of department-approved sources (listed on the APL), prequalified sources by the department, and/or project engineer approval prior to use.

870.2.1.1 Cementitious Materials

Cement, fly ash, slag, silica fume, blended SCM's and ASCM's are cementitious materials. The quantity and percentages required or allowed depend on the product specified.

See listing of approved sources on the APL for Portland cement and fly ash class F.

Cementitious materials must conform to standard spec 501.2.4, as shown below.

Portland cement ..... standard spec 501.2.4.1
Supplementary Cementitious Material (SCM) ..... standard spec 501.2.4.2
Fly Ash Class C ..... standard spec 501.2.4.2.2.2
Fly Ash Class F ..... standard spec 501.2.4.2.2.3
Slag ..... standard spec 501.2.4.2.3
Silica Fume ..... standard spec 501.2.4.2.4
Blended SCM's ..... standard spec 501.2.4.2.5
Alternative Supplementary Cementitious Material (ASCM) ..... standard spec 501.2.4.3

870.2.1.2 Mixing Water

Test procedures described in this section are conducted for acceptance of concrete water under standard spec 501.2.6. Concrete mixing water acceptance testing is conducted by department staff at the BTS central laboratory per frequency in CMM 850. Water source approval is required prior to placing concrete.

Water from non-municipal sources must conform to the following:

Acidity ..... WTP C-001
Alkalinity ..... WTP C-001
Sulfate ..... WTP C-001
Chloride ..... WTP C-001

Water is tested during the concrete plant inspection. The engineer may test water on the project site for compliance.

It is a best practice for the engineer to visually inspect surface water prior to concrete production on the project. During the project, if there is a major rain event, revisit the water source and visually inspect to determine if there is a visible change from the initial visit due to runoff. Take note of the surrounding area to determine if there has been any land disturbance nearby that would increase the sediment or if manure has been recently applied to nearby fields as that can increase the sulfates. If there is a concern with the water source, talk with the contractor and monitor the other concrete properties being tested. If there are inconsistencies, the engineer may take a water sample to ensure the water properties have not changed.

870.2.1.3 Aggregates

870.2.1.3.1 General

Contractors must use aggregates from a source(s) on the approved products list (APL). Requirements for contractors adding/renewing aggregate sources to the APL are defined in standard spec 106.3.4 and CMM 860. The APL specifically needs to state concrete under the source for inclusion in concrete mixtures as shown on Figure 870-1.

FIGURE 870-1 Sample View of Approved Product List for Aggregate Testing

* = Not Certified	Location Description												Coarse					
Source Name	P/Q	Qrt	Qrt	Sect	Town	Range	County	Test Number	% Light weight Pieces	Freeze Thaw %	% SDS	LA Wear (%) 100	LA Wear (%) 500	Sp. Gravity OD	Sp. Gravity SSD	Absorp. % Crse	Absorp. % Fine
BADGERLAND X PIT	P		SW	9	17N	22E	Manitowoc	0-225-278-2018	0.1	0.0	1.3	6.0	27.5	2.774	2.799	0.870	
55-36-039-PIT	Approved Use : HMA<MT, HMA>=MT, CONCRETE, Base Aggregate																
Created On: 08/28/18																	

Aggregates used on department projects must also conform to specific contract requirements. Most of the required aggregate properties are specified in standard spec 501.2.7.

Aggregate acceptance is specified in standard spec 710.5.6. All aggregate testing is completed during concrete production and tracked by the cubic yards of concrete placed, not the actual quantity of aggregate used.

870.2.1.3.2 Contractor Aggregate Testing Responsibilities

Revise 870.2.1.3.2 (Contractor Aggregate Testing Responsibilities) to update standard specification reference and add text.

Contractors are required to submit aggregate control charts for each mix design used on the project. The frequency for contractor control charts is defined in standard spec Table 710-5. For testing purposes, each bid item will need to be converted to the cubic yardage of concrete.

Contractor should monitor aggregate production and establish a 4-point running average for each sieve. The monitoring of aggregates is for troubleshooting issues with the mix and provide the contractor an opportunity to control the process before corrective action would need to be taken. If the 4-point running average is not established and the individual aggregate test result indicate aggregate gradations are not meeting specification limits, the average of the tests results performed to date should be used to determine if the corrective action should be performed.

870.2.1.3.2.1 Contractor Small Quantity Requirements

Small quantities are defined in standard spec 710.2. Small quantities are determined by the LET quantity.

Contractor can provide one of two options listed in the spec for fulling the contractual requirements for small quantity concrete aggregates. To utilize the documented previous testing, the placement of concrete must start within the timeframe specified in the standard spec. The non-random start up gradation test is to be performed on the first day of concrete placement for that aggregate source. The requirements for small quantity are required for each aggregate source that is used for those items.

870.2.1.3.2.2 Contractor Requirements

A gradation report is required before placement of a given mix design for both Class I and Class II concrete. If the anticipated date of placement is postponed, another test is not required to be taken. The reason for the test being outside of the prior to placement window needs to be documented in the final QC plan and also in the department material records. The preplacement test is the start of the contractor control chart information for each mix design.

The frequencies for Class I concrete are found in standard spec Table 710-5. The testing frequency is dependent on the amount of concrete that is produced the day of the concrete placement. When two tests are required per day, it is preferred that one test is taken in the morning and one in the afternoon.

The frequency for Class II concrete is found in standard spec Table 710-5. The contractor's test is not required to be completed on a day of concrete placement.

A contractor test is allowed to be used for multiple mix designs and on multiple projects if those mix designs share the same aggregate sources. The contractor is allowed to take an aggregate test and then mathematically combine/proportion for each mix design.

Example:

Contractor has 3 different concrete mixtures being poured all the mixtures contain the exact same aggregate sources. Table 870-1 is a summary of the mixes to be placed by the contractor.

TABLE 870-1 CONTRACTOR MIX AND PLACEMENT SCHEDULE EXAMPLE

Project ID	Concrete Mix ID	Aggregate Source	Testing Frequency	Placement Schedule	No of Samples
1234-56-78	XYZ Class I Barrier	Coarse Agg No. 1 – Peninsula Coarse Agg No 2 – High Cliff Fine Aggregate - Aztalan	1 test / day	Placing on: Tuesday (750 CY) Wednesday (550 CY) Friday (625 CY)	3
9876-54-71	GHI Class II - Base	Coarse Agg No. 1 – Peninsula Fine Aggregate - Aztalan	1 test per calendar week	Placing on: Thursday (45 CY)	0
1234-56-78	ABC Class I Pavement	Coarse Agg No. 1 – Peninsula Coarse Agg No 2 – High Cliff Fine Aggregate - Aztalan	1 test / day	Placing on: Tuesday (775 CY) Friday (825 CY)	0

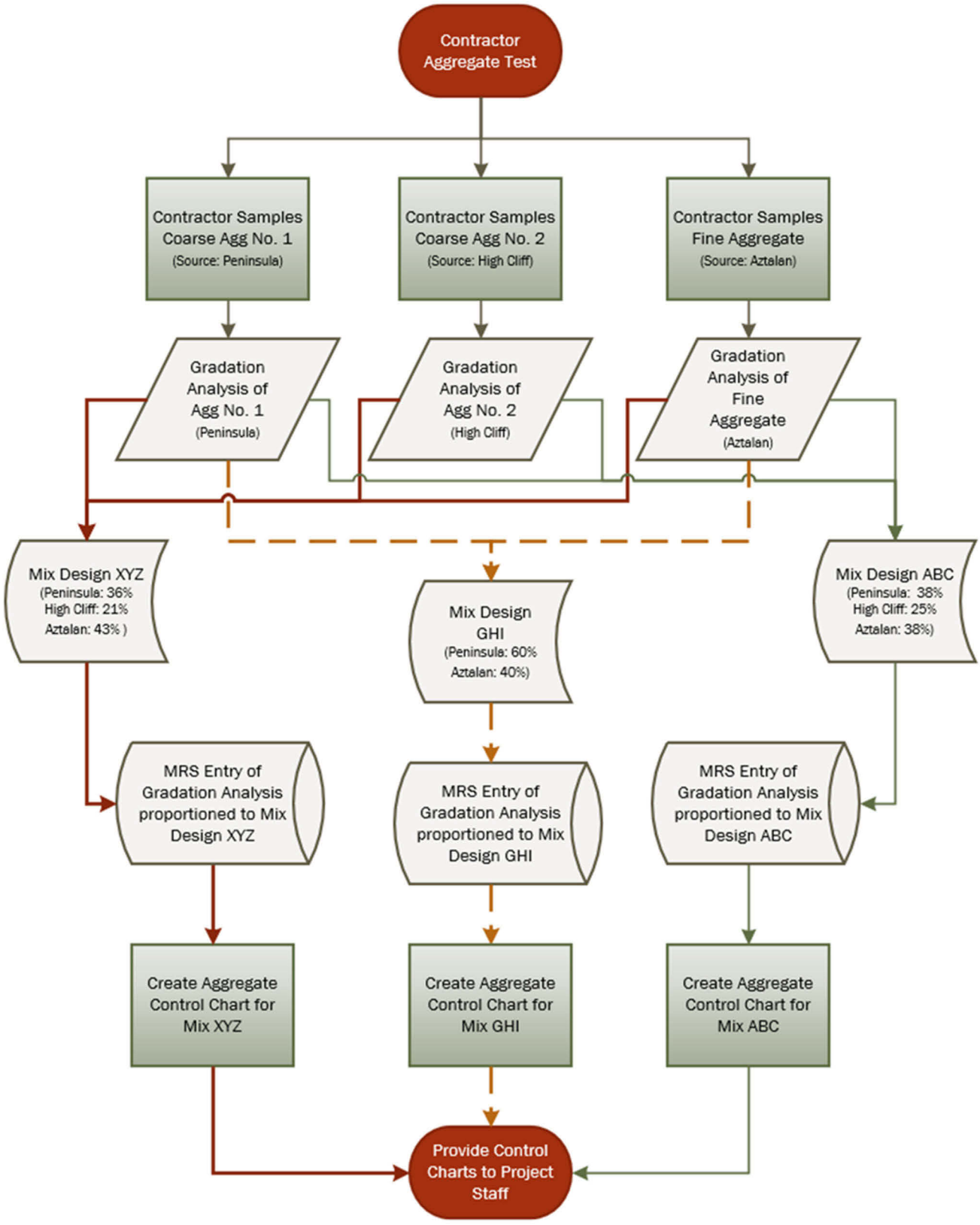
In total, 6 test reports need to be created for the aggregate control charts. However, only 3 samples, Coarse No.1, Coarse No. 2, and Fine Aggregates, per day of concrete placement are needed. The contractor will need to sample aggregates on Tuesday, Wednesday and Friday. Aggregate samples from Tuesday and Friday will be used to create two test reports for 1234-56-78 Class I Pavement concrete. One of the aggregate samples from Tuesday, Wednesday or Friday can be used to create the test reports for the 1234-56-78 Class II concrete. Figure 870-2 shows the flow of contractor aggregate sampling.

Overall, the following 6 aggregate test reports will need to be created:

- Tuesday aggregate test report for mix XYZ
- Tuesday aggregate test report for mix ABC
- Wednesday aggregate test report for mix XYZ
- Thursday aggregate test report for mix XYZ
- Friday aggregate test report for mix ABC
- One aggregate test report from either Tuesday, Wednesday, or Friday for mix GHI.

Figure 870-2 shows the flow of contractor aggregate sampling.

FIGURE 870-2 Contractor Aggregate Testing



870.2.1.3.3 Department Aggregate Testing Responsibilities

870.2.1.3.3.1 Department Small Quantity Requirements

Small quantities are defined in standard spec 710.2. Small quantities are determined by the LET quantity.

The department is required to test each aggregate source for a small quantity placement according to the standard spec Table 710-7 frequency. The requirements for small quantity are required for each mix design/aggregate source that is placed for those items.

870.2.1.3.3.2 Department Requirements

The department is required to randomly sample the concrete aggregates according to standard spec. 710, Table 710-6.

870.2.1.3.3.3 Class I - Department

870.2.1.3.3.3.1 Small Quantity Aggregate Testing

Determining random samples for small quantity can be done a number of different ways. One way to determine the testing for small quantity is by time of day. See Table 870-2 for an example based on a 10-hour workday.

TABLE 870-2 EXAMPLE RANDOM NUMBER CORRELATION

Random Number (X)	Time of Day
X <= 0.1000	6:00 am to 6:59 am
0.1000 <= X <0.2000	7:00 am to 7:59 am
0.2000 <= X < 0.3000	8:00 am to 8:59 am
0.3000 <= X < 0.4000	9:00 am to 9:59 am
0.4000 <= X < 0.5000	10:00 am to 10:59 am
0.5000 <= X < 0.6000	11:00 am to 11:59 am
0.6000 <= X < 0.7000	12:00 pm to 12:59 pm
0.7000 <= X < 0.8000	1:00 pm to 1:59 pm
0.8000 <= X < 0.9000	2:00 pm to 2:59 pm
0.9000 <= X < 1.0000	3:00 pm to 3:59 pm

870.2.1.3.3.3.2 Concrete Pavement Aggregate Testing

Concrete pavement is allowed to reduce testing frequency if the initial amount of department tests are all satisfactory. The days of placement do not have to be consecutive placement days. The placement can start and then gap over a few calendar days and then restart the placement.

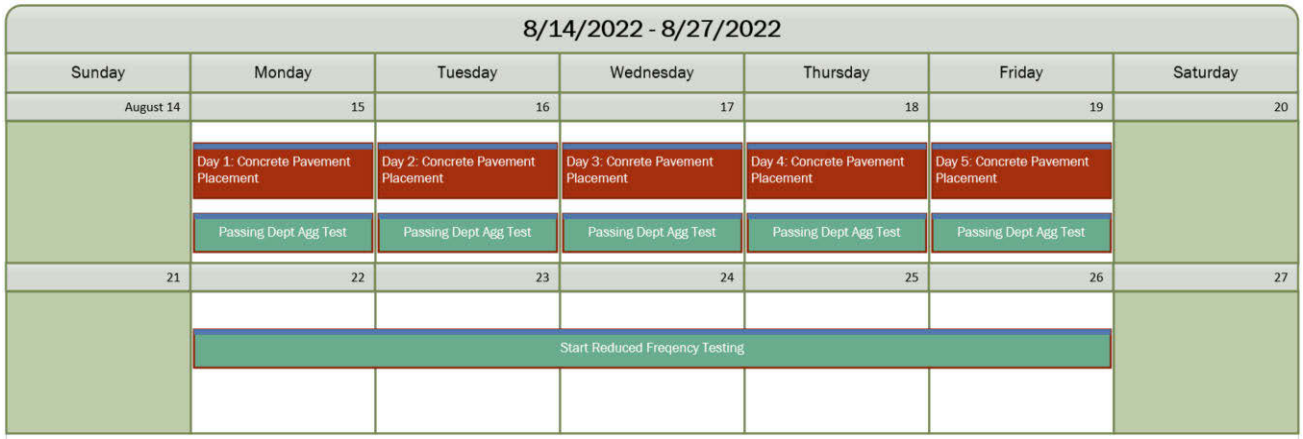
Random sampling for the initial frequency can be done similar to Table 870-2 Example Random Number Correlation. The reduced frequency random sampling can be accomplished multiple ways. One example of random sampling for the reduced frequency is detailed in Table 870-3. In addition, the sample time should be random.

TABLE 870-3 EXAMPLE REDUCED FREQUENCY RANDOM NUMBER CORRELATION

Random Number (X)	Day of Week
X <= 0.2000	Monday
0.2000 <= X <0.4000	Tuesday
0.4000 <= X < 0.6000	Wednesday
0.6000 <= X < 0.8000	Thursday
0.8000 <= X < 1.0000	Friday

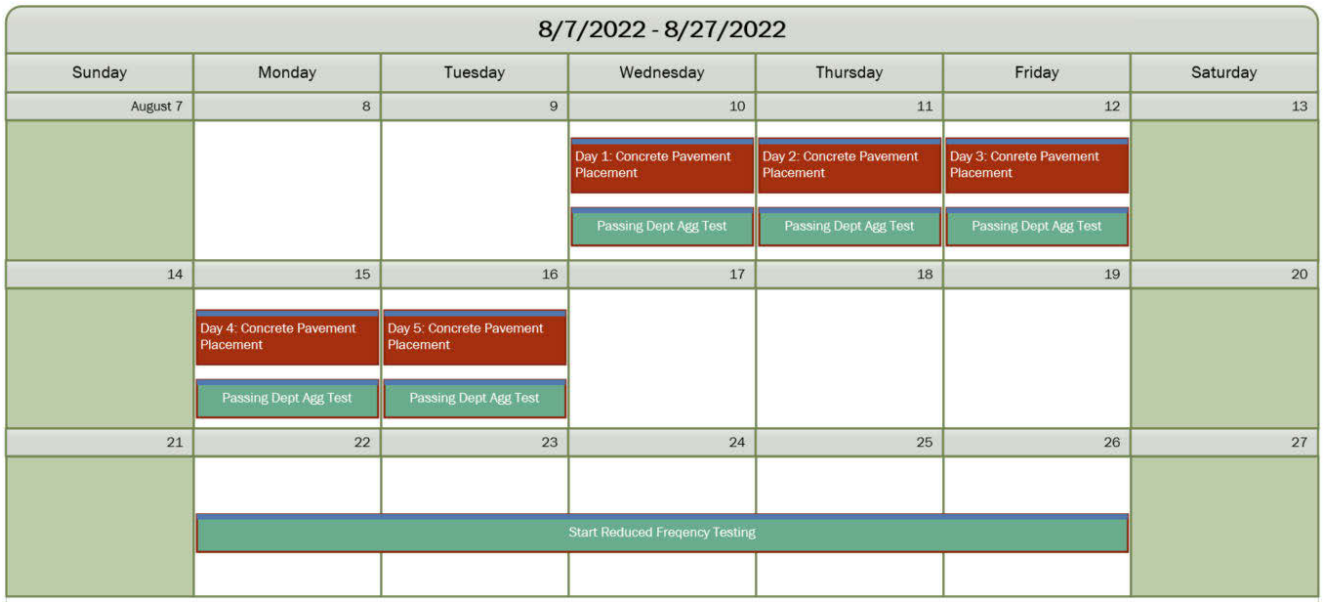
Scenario 1: If concrete placement is performed on Monday, Tuesday, Wednesday, Thursday and Friday of the same calendar week AND all department aggregate samples are satisfactory, the following calendar week, the department would begin the reduced frequency testing. Figure 870-3 visually represents Scenario 1.

FIGURE 870-3 SCENARIO 1: REDUCED AGGREGATE FREQUENCY TESTING



Scenario 2: If concrete placement spans over 2 calendar weeks. For example, placement starts on Wednesday and continues into the next week, the following week (3rd week of placement) would start the reduced frequency. Figure 870-4 visually represents Scenario 2.

FIGURE 870-4 SCENARIO 2: REDUCED AGGREGATE FREQUENCY TESTING



870.2.1.3.3.3.3 Structure Aggregate Testing

When quantities for structure concrete are over the small quantity amount, the department testing has a requirement to test once per concrete lot and to have a minimum of one test for the substructure concrete and one test for the superstructure concrete. The tests are to be representative of the cumulative concrete for the contract, regardless of the number of structures on the project.

The following scenarios help to understand the specification that is written.

Scenario 1: The two structures for the contract have a total of 654 CY of concrete. Structure 1 has 174 CY of substructure concrete and 286 CY of superstructure concrete. Structure 2 has 74 CY of substructure concrete and 120 CY of superstructure concrete. The department will need 3 tests for this contract. A minimum of one test is needed during placement of substructure concrete. A minimum of one test is needed during superstructure concrete.

For this scenario, the random numbers were calculated for the 250 CY increment required for testing and one test was for the substructure and two tests were taken for the superstructure. Table 870-4 portrays the number of department aggregate tests required.

TABLE 870-4 SCENARIO 1: DEPARTMENT STRUCTURE AGGREGATE TESTS

Pour Date	Pour Location	Qty Poured (CY)	Cumulative Qty (CY)	Test Increment (CY)
3/29/2022	Bridge 1: S Abutment (substructure)	33	33	
4/7/2022	Bridge 1: N Abutment (substructure)	33	66	42 CY
4/27/2022	Bridge 1: Pier 1 (substructure)	62	128	
5/7/2022	Bridge 1: Pier 2 (substructure)	46	174	
5/12/2022	Bridge 1: Deck (superstructure)	143	317	
5/13/2022	Bridge 1: Deck (superstructure)	143	460	460 CY
5/20/2022	Bridge 2: W Abutment (substructure)	37	497	
5/25/2022	Bridge 2: E Abutment (substructure)	37	534	
6/10/2022	Bridge 2: Deck (superstructure)	120	654	567 CY

Scenario 2: This one structure has 295 CY of concrete. 271 CY of superstructure concrete and 24 CY of substructure concrete.

For the following example, the random numbers were calculated for the 250 CY increment required for testing and one test was for the superstructure and one test was taken for the substructure as shown in Table 870-5.

TABLE 870-5 SCENARIO 2: DEPARTMENT STRUCTURE AGGREGATE TESTS

Pour Date	Pour Location	Qty Poured (CY)	Cumulative Qty (CY)	Test Increment (CY)
6/29/2022	Abutment Wings (substructure)	12	12	
7/6/2022	Deck (superstructure)	210	222	79
7/11/2022	Parapet (superstructure)	30	252	
7/13/2022	Parapet (superstructure)	30	282	
7/20/2022	Parapet Repair (superstructure)	1	283	
9/7/2022	Wing Repair (substructure)	3	286	
9/12/2022	Wing Repair (substructure)	1	287	
9/15/2022	Wing Repair (substructure)	5	292	292
9/18/2022	Wing Repair (substructure)	3	295	

870.2.1.3.3.3.4 Cast-In-Place Barrier Aggregate Testing

Cast-in-place barrier concrete aggregate testing frequency equates to one test per concrete lot. Follow normal procedures for determining random numbers and collecting samples.

870.2.1.3.3.4 Class II - Department

Class II concrete does not require a specified frequency of testing for concrete aggregate. The department may want to take a sample if there seems to be concerns with the concrete mixture. Staff should be monitoring the contractors aggregate control charts to help determine if the aggregate gradation could be a cause for a change in air content, workability or pumpability to name a few.

870.2.1.3.3.5 Department Sampling

The department test is allowed to be used for multiple mix designs using the same aggregates sources within the same contract. The frequency of the testing must be maintained for each type of concrete. The department is allowed to take an aggregate test and then mathematically combine/proportion for each mix design. The following depicts the department testing for the contractor example in CMM 870.2.1.3.2.2.

Example: Contractor has 3 different concrete mixtures being placed. The three mixes contain the exact same aggregate sources. Table 870-6 is a summary of the department's sampling requirements for the contractor's mix placement.

TABLE 870-6 DEPARTMENT SAMPLING REQUIREMENT EXAMPLE

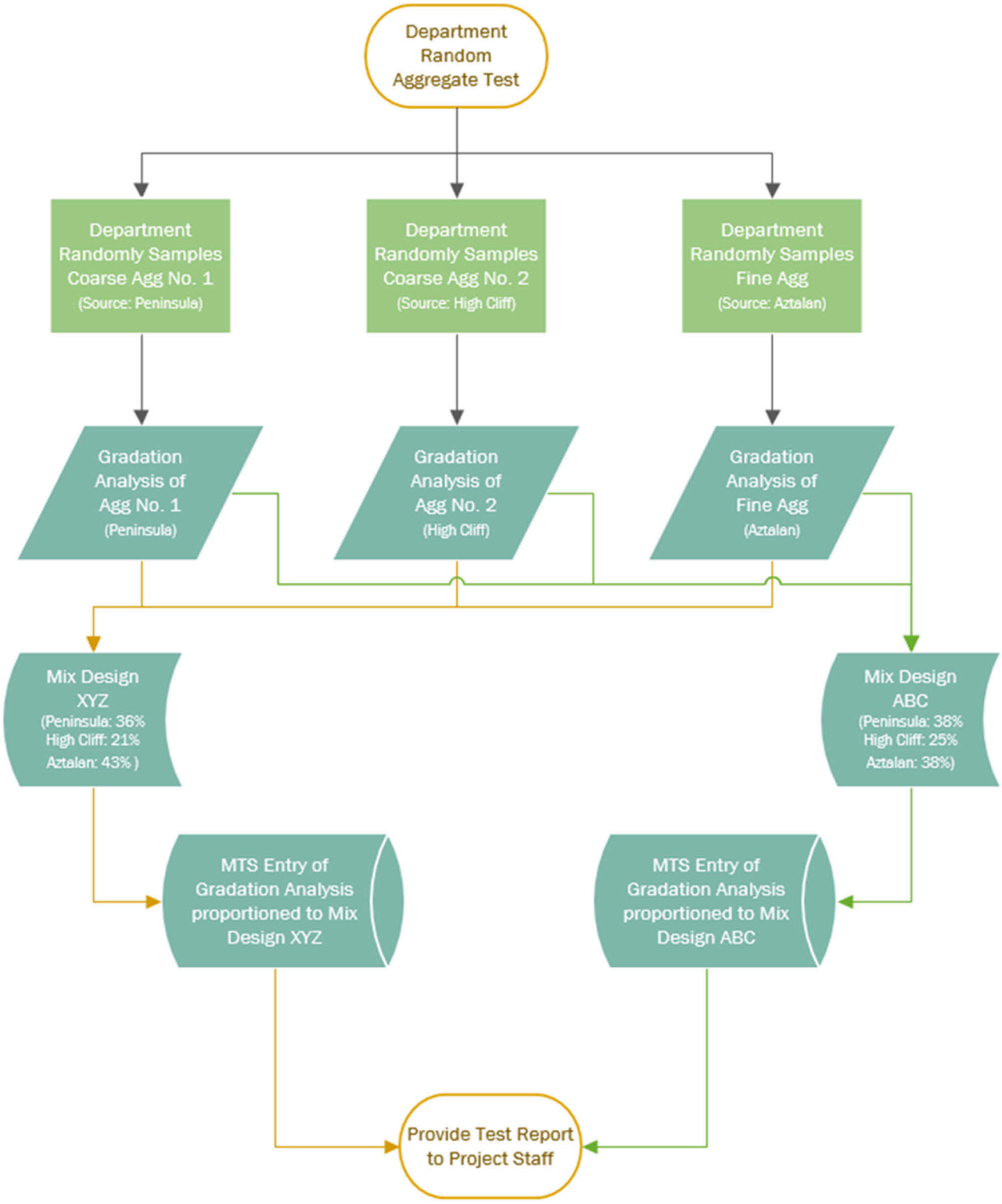
Project ID	Concrete Mix ID	Aggregate Source	Dept. Testing Frequency	Placement Schedule	No of Dept Samples
1234-56-78	XYZ Class I Barrier	Coarse Agg No. 1 – Peninsula Coarse Agg No 2 – High Cliff Fine Aggregate - Aztalan	1 test / 500 CY	Placing on: Tuesday (750 CY) Wednesday (550 CY) Friday (625 CY)	4
9876-54-71	GHI Class II - Base	Coarse Agg No. 1 – Peninsula Fine Aggregate - Aztalan	No minimum testing	Placing on: Thursday (45 CY)	0
1234-56-78	ABC Class I Pavement	Coarse Agg No. 1 – Peninsula Coarse Agg No 2 – High Cliff Fine Aggregate – Aztalan	1 test / day for 5 days	Placing on: Tuesday (775 CY) Friday (825 CY)	0

In total, 6 test reports need to be created for the aggregate control charts. However, only 4 random samples are needed. The barrier total is 1925 cy. The randoms for the barrier require a test on Tuesday (433 CY placed), Wednesday (676 CY placed) and two tests on Friday (1364 CY and 1652 CY placed). The samples taken for the barrier randoms can then be used for the daily aggregate tests required for the Class I Pavement because the following are true:

1. The mix designs are being placed on the same contract.
2. The mix designs are using the exact same aggregate sources.

Figure 870-5 shows the flow of aggregate sampling for this example project.

FIGURE 870-5 DEPARTMENT RANDOM AGGREGATE TESTING

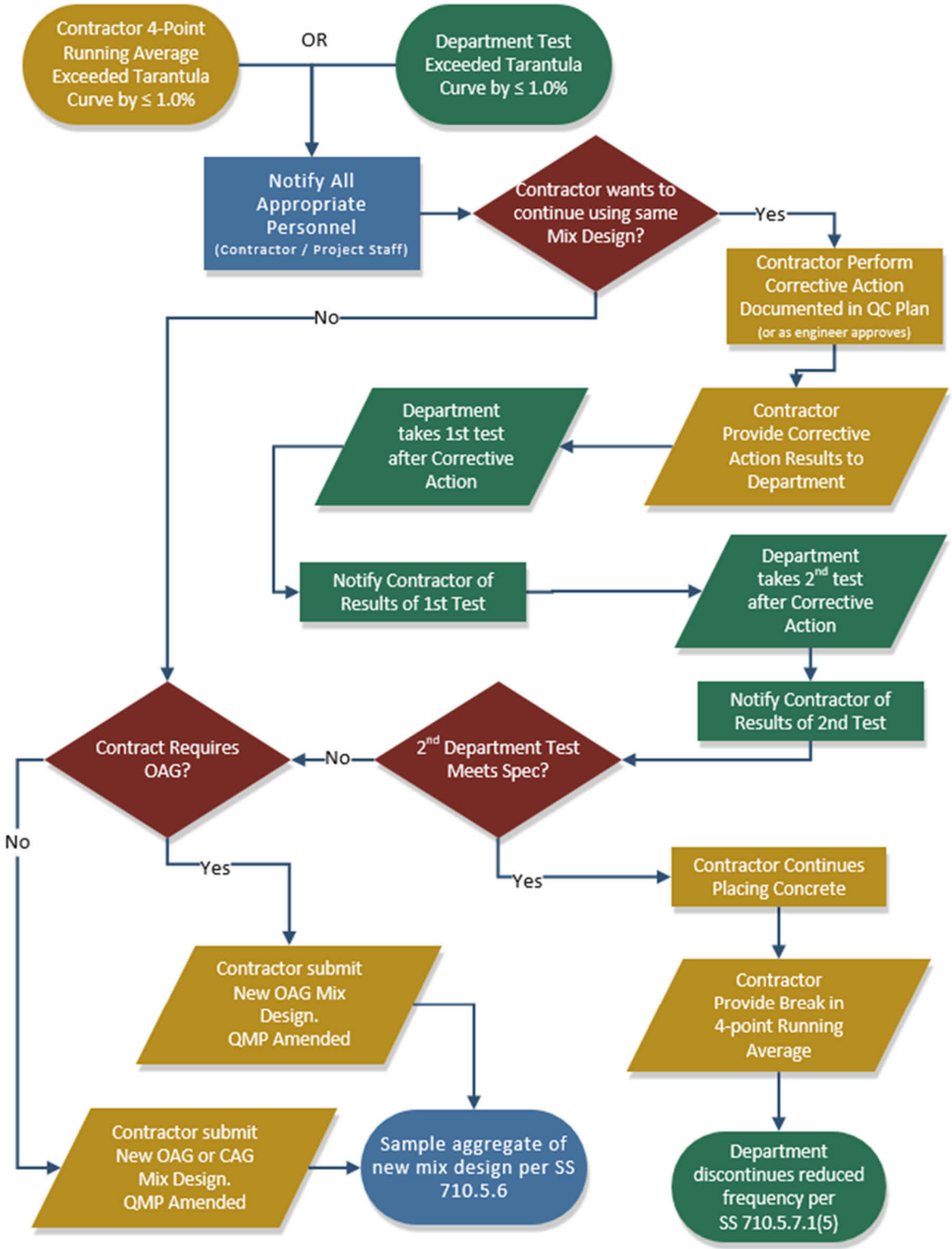


870.2.1.3.4 Corrective Action

870.2.1.3.4.1 Optimized Aggregate Gradation (OAG)

The corrective action for OAG is defined in standard spec 710.5.7.1. Figure 870-6 is a diagram of the sequence of actions for the contractor and department to follow if a new mix design is not required to be used.

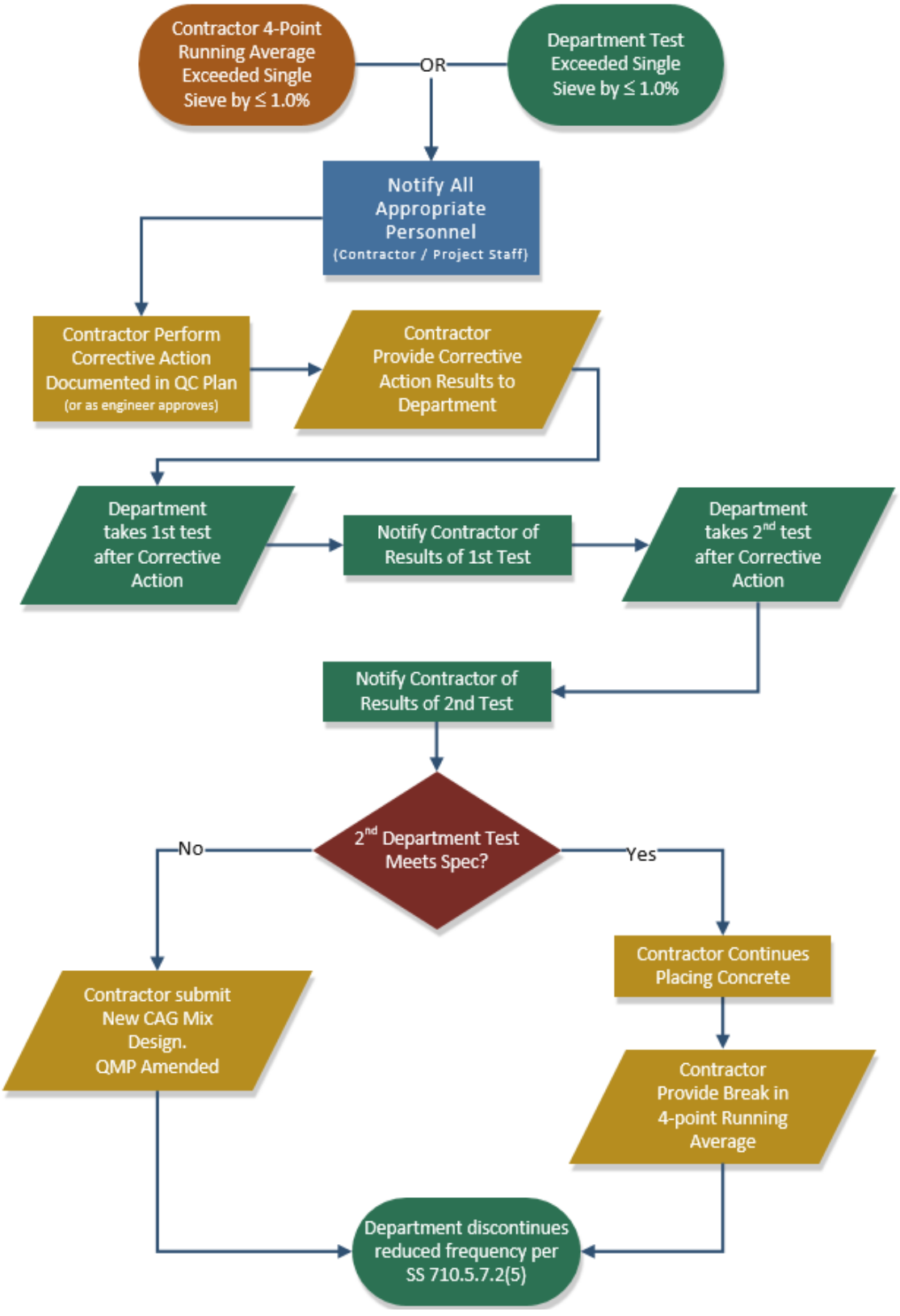
FIGURE 870-6 CORRECTIVE ACTION: OPTIMIZED AGGREGATE GRADATION



870.2.1.3.4.2 Combined Aggregate Gradation (CAG)

The corrective action for CAG is defined in standard spec 710.5.7.2. Figure 870-7 is a diagram of the sequence of actions for the contractor and department to follow if a new mix design is not required to be used.

FIGURE 870-7 CORRECTIVE ACTION: COMBINED AGGREGATE GRADATION



870.2.1.4 Admixtures

A well-designed concrete mixture may include admixtures to impart desired properties to the fresh or hardened concrete. Approved admixtures are on the APL. All admixtures must conform to standard spec 501.2.5. The most common type of admixture used for department concrete is an air entrainment agent. Other admixtures include retarding and water reducing admixtures. Air entrainment agents introduce microscopic air bubbles into a concrete mixture to enhance durability, reduce permeability, and increase workability.

Admixtures not on the approved list need to be approved by the project engineer before use. It is the responsibility of the contractor and concrete producer to ensure that the admixtures used produce the desired properties in the concrete. Some admixtures may have compatibility issues, and test batches should be made to ensure that the admixtures are compatible and produce the desired properties in the concrete.

BTS will need to approve the use of high-range water reducing and hydration controlling admixtures. Submit the concrete mix design and the intended use to the BTS Concrete unit for approval.

870.2.2 Mix Design

Details of the contractor mix design and approval process are defined in CMM 871.

870.3 Concrete Production and Equipment

870.3.1 General

It is very important that plants producing concrete mixtures can produce a consistent, quality mixture that meets specification requirements. It is the responsibility of the concrete producer and contractor to make sure that the plant used to produce a concrete mixture is fully functional and adequate to produce the required mixture.

870.3.2 Plant Inspection

Annual approval of permanent, commercial ready-mixed concrete plants may be accomplished by on-site inspection or by review of records at the region office. The engineer should request the plant inspection template from the BTS Concrete Materials Unit.

Upon request of the region staff, the ready-mix producer must submit a copy of the following current documentation to the region office:

- Certificate of calibration for plant scales, water meter, and admixture meters if used.
- List of source and type of all materials planned for use in WisDOT work for the upcoming season.
- Latest mill test reports for cement, fly ash, slag, and pozzolans in use.

Approval of portable concrete plants erected especially for production of concrete pavement and other related items on a WisDOT project will be made by the project engineer. Upon request of the project engineer, the contractor must submit a copy of the following documentation to the project engineer.

- Certificates of calibration for plant scales, water meter, and admixture meters if used in set-up on current project site.
- Completed DT1926 for initial checkout of plant on the current site.

The controls and tolerance check sheet must be completed the first time a check-out of the automatic controls and interlocks of the concrete batching plant is performed by the contractor during the first week of production, and weekly thereafter. The completed form should be kept in the project field file. Field staff can download DT1926, Automatic Controls and Tolerance Check Sheet for Portland Cement Concrete Plants.

870.4 Concrete Sampling and Testing

870.4.1 General

All personnel performing acceptance testing must be certified through the WisDOT Highway Technician Certification Program (HTCP) administered by the University of Wisconsin, Platteville. All laboratory testing must be performed at a laboratory that is qualified through the WisDOT Laboratory Qualification Program.

870.4.2 Portland Cement Sampling

Portland cement is evaluated for approval based on the process listed on the APL and additional requirements listed in attachment 870-1 Certification Method of Acceptance for Portland Cement. The central laboratory maintains a list of approved cement types from specific manufacturers. The list of approved cement types from approved portland cement manufacturers on the APL.

870.4.3 Concrete Sampling and Testing Standard Procedures

Perform sampling and testing of concrete mixtures in accordance with the following WisDOT Manual of Test Procedures, WisDOT Test Modified (WTM):

- WTM R60, Sampling Freshly Mixed Concrete.
- WTM T119, Slump of Hydraulic Cement Concrete.
  - Use a ruler or tape that starts at "zero" inches.
  - Do not use a piece from a metal roll-up tape.
- WTM T152, Air Content of Freshly Mixed Concrete by the Pressure Method.
- WTM T395, Characterization of the Air-Void System of Freshly Mixed Concrete by the Sequential Pressure Method.
- WTM R100, Making and Curing Concrete Test Specimens in the field.
- WTM T121, Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
  - This test is not required by WisDOT at this time but is generally used in the mix design process to ensure that a concrete mix design is producing the yield or volume that it was designed to produce.
- WTM T22, Compressive Strength of Cylindrical Concrete Specimens.
- WTM T97, Flexural Strength of Concrete (using simple beam with third-point loading).
- WTM T24, Testing Drilled Cores and Sawed Beams.
- WTM T358, Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration

870.4.3.1 Interferences for Air Content and Air Void Spacing

870.4.3.1.1 Pumping Operations

When pumping concrete, there is a potential for a loss of entrained air. According to the specifications, the contractor is to ensure that the discharge end of the hose is kept higher than the lowest point of the hose. This can be accomplished by laying a portion of the flexible hose on the bridge deck, tying a partial loop in the end of the hose, or any other method approved by the project engineer. The project engineer may approve alternate methods if the contractor can demonstrate that the air loss in the concrete created by the pumping process does not exceed 1.0 percent in any boom orientation.

Due to the potential for air loss, it is important to sample the mix from the point of placement, which is the discharge end of the pump line. This will ensure that the test results are a true representation of the in-place material. Due to the loss of air being dependent on the variable location or configuration of the pumping hose, it is generally not acceptable to use a correlation between the truck discharge and the end of the pump hose.

870.4.3.1.2 Dispute Resolution

If entrained air loss is >1.0 percent the contractor can request that the department have a hardened air analysis conforming to ASTM C457 performed at the contractor's expense. If requested, the contractor must notify the project engineer and the QC staff will cast a cylinder from the same load of concrete as the failing test. The cylinder must be immediately taken into possession by department staff for initial curing and transport to a third-party department qualified lab. A report containing the hardened air content test results signed by a professional engineer registered in the state of Wisconsin must be submitted to the project engineer. If the results of the hardened air analysis are within specifications, take no action. If the results are outside the specifications, apply a price reduction as outlined in standard spec 715.5.3.

870.4.3.2 Conveyor Belt Placement

When placing concrete with conveyor belts, there is a potential for air loss due to the movement of the mix from belt to belt and from the belt to the point of placement. It is important to have test results that truly represent the in-place material. The specified air content is for the point of placement location and it is intended that sampling take place at the point of placement.

870.4.3.3 Sampling During Underwater Placement

It is not possible to obtain a sample at an underwater point of placement. The contractor and project engineer should agree on a method and location of sampling. The sampling point should be as close as possible to the placement location, while ensuring the safety of testing personnel. It is important to document the sampling methods when not being performed at the point of placement.

870.4.4 Testing Equipment

All testing equipment used must be in good condition with documentation available showing that the equipment has been verified to be in compliance with specification requirements.

870.4.5 Identification and Shipping Specimens

Concrete cylinders must be plainly marked for identification with the project number, cylinder numbers, and the date on which the cylinders were cast. Sets of cylinders must be numbered consecutively with individual cylinders in each set designated by letters. Since the majority of cylinders are made to be tested at 28 days, and to promote uniformity among the regions, the 28-day cylinders should be lettered "A" and "B", respectively. All others should be lettered consecutively beginning with the Letter "C."

All QMP verification cylinders must be identified and tested at the end of the curing period indicated in the applicable QMP specification.

Cards for submitting data relative to test cylinders are furnished by the laboratory. These cards must be filled out and submitted with the specimens and must contain complete representative data correlated with the information on the cylinder for proper identification by the laboratory (as shown in Figure 870-8). Download DT1308 Concrete Cylinders Test Data Card.

FIGURE 870-8 Concrete Cylinders Test Data, DT1308

CONCRETE CYLINDERS TEST DATA

DT1308 1097

County: Dane		Project ID: 0617-32-10	
Contractor: CAPE		Cylinder Nos.: 1-1 A & B	
Test Age: 28 DAYS		Made By: JAMES COOL	
Concrete Grade: A-FA	Class: AE	Date Made: 1-1-01	
(Lbs) (kg) Cement/Cy (m3): 450	Cement Brand/Mill Location: LONESTAR/OGLESBY		Type: I
(Lbs) (kg) Fly Ash/Cy (m3): 150	Fly Ash Brand/Plant Location: MINERAL SOLUTIONS/COL.		Class: C
Lbs (kg) Slag/Cy (m3)	Slag Brand/Plant Location		Grade

Admixtures - Type	Amount Per (100 lb) (Kg) Cement
No. 1 DARAVAIR 1000	1.0 (Fl. Oz) (ml)
No. 2 WRDA-82	3.0 (Fl. Oz) (ml)
No. 3	Fl. Oz. (ml)
No. 4	Fl. Oz. (ml)

Aggregate Source(s)	Aggregate Test No(s).
FOX RIDGE PIT	0-162-0028-2001
Coarse ROCK SPRINGS QUARRY	0-162-0028-2001

Total Dry Agg/Cy (m3)	Sand - % of Total Dry Agg
3092 (Lbs) (Kg)	40 %

Net Water	Slump	Air Content
24 (Gal/Cy) (L/m3)	1.5 (In.) (mm)	7.0 %

Sample Location: STH 62 N.B. STA. 121+07

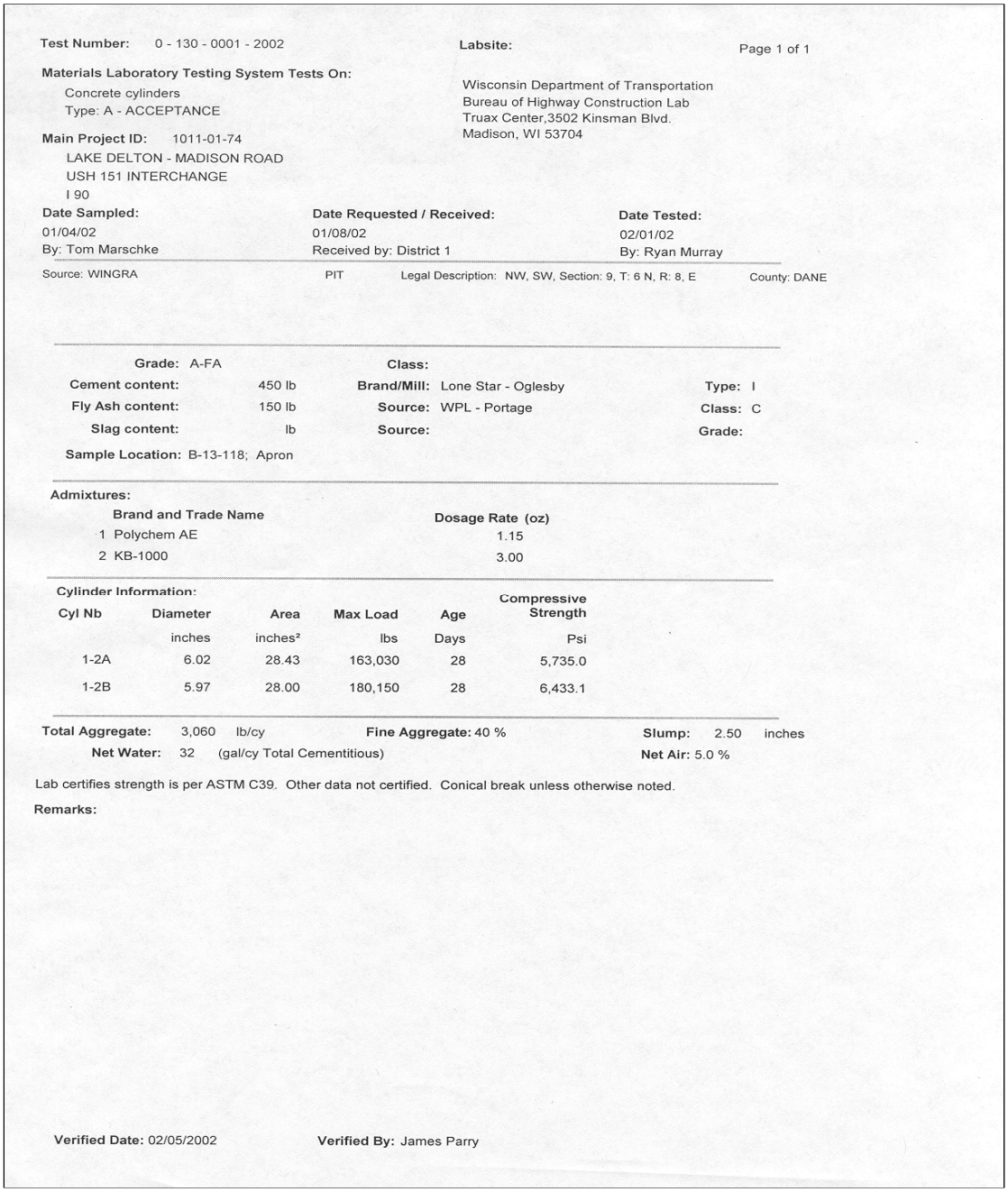
Remarks	DO NOT WRITE HERE
SLIP FORM	T

Wisconsin Department of Transportation

870.4.6 Concrete Cylinder and Beam Test Results

An example of the concrete cylinder test results reported in Materials Information Tracking (MIT) is shown below in figure 870-9. A system called the Materials Reporting System (MRS) is available for contractor entry of QC cylinder results for structures and is being developed for other concrete QMP specifications.

FIGURE 870-9 Concrete Cylinders Test Data



Test Number: 0 - 130 - 0001 - 2002 **Labsite:** Page 1 of 1

Materials Laboratory Testing System Tests On:
Concrete cylinders
Type: A - ACCEPTANCE

Wisconsin Department of Transportation
Bureau of Highway Construction Lab
Truax Center,3502 Kinsman Blvd.
Madison, WI 53704

Main Project ID: 1011-01-74
LAKE DELTON - MADISON ROAD
USH 151 INTERCHANGE
I 90

Date Sampled:	Date Requested / Received:	Date Tested:
01/04/02	01/08/02	02/01/02
By: Tom Marschke	Received by: District 1	By: Ryan Murray

Source: WINGRA PIT Legal Description: NW, SW, Section: 9, T: 6 N, R: 8, E County: DANE

Grade: A-FA **Class:**
Cement content: 450 lb **Brand/Mill:** Lone Star - Oglesby **Type:** I
Fly Ash content: 150 lb **Source:** WPL - Portage **Class:** C
Slag content: lb **Source:** **Grade:**
Sample Location: B-13-118; Apron

Admixtures:

	Brand and Trade Name	Dosage Rate (oz)
1	Polychem AE	1.15
2	KB-1000	3.00

Cylinder Information:

Cyl Nb	Diameter	Area	Max Load	Age	Compressive Strength
	inches	inches²	lbs	Days	Psi
1-2A	6.02	28.43	163,030	28	5,735.0
1-2B	5.97	28.00	180,150	28	6,433.1

Total Aggregate: 3,060 lb/cy **Fine Aggregate:** 40 % **Slump:** 2.50 inches
Net Water: 32 (gal/cy Total Cementitious) **Net Air:** 5.0 %

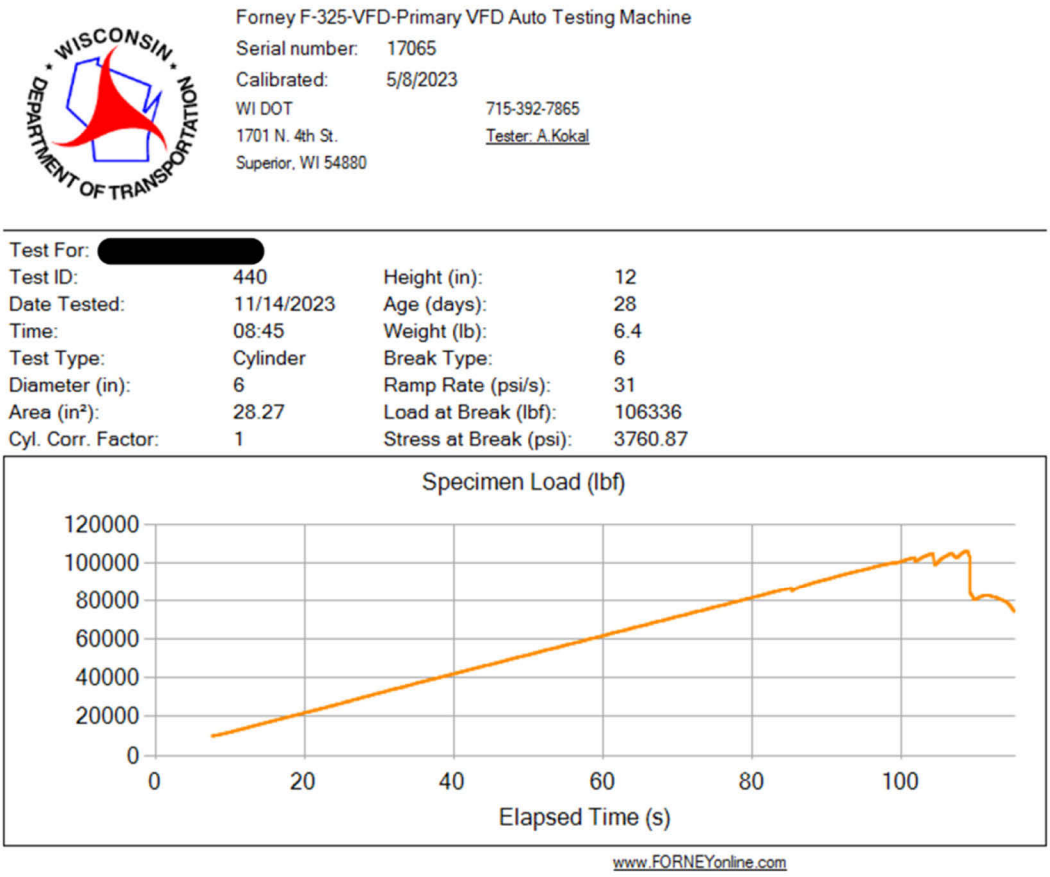
Lab certifies strength is per ASTM C39. Other data not certified. Conical break unless otherwise noted.

Remarks:

Verified Date: 02/05/2002 **Verified By:** James Parry

An example of an automatically generated concrete cylinder testing machine graph printout is shown in figure 870-10.

FIGURE 870-10 Concrete Cylinder Testing Machine Graph Printout



Cores required to determine concrete strength, entrained air content, or pavement thickness must be obtained according to WTM T24.

- WTM T24 - Obtaining and Testing Drilled Cores and Sawed Beams.

870.4.7 Concrete Pavement Thickness

Test procedures described in this section are conducted for acceptance of concrete pavement under standard spec 415.3.16. Concrete pavement thickness acceptance testing is conducted by department staff.

Thickness testing must conform to the following:

Magnetic Pulse Induction..... WTM E3209
Probing ..... WTP C-002
Preplacement Measurement..... WTP C-003

870.4.7.1 Magnetic Imaging Tomography Scan (MIT Scan)

This section discusses the application of magnetic imaging tomography, to determine the thickness of freshly placed concrete. This is the preferred method for testing concrete pavement for both basic and special units.

870.4.7.1.1 Test Plates

870.4.7.1.1.1 Obtaining Testing Plates

Construction staff will obtain test plates by contacting the regional materials section.

Each regional materials section is responsible for ordering test plates for the region's construction projects. Contact BTS Concrete Section for ordering process.

870.4.7.1.1.2 Project Reference Plate Locations

The purpose of a project reference plate is to have a location that the operator tests each day before taking thickness measurements for the project to ensure the MIT Scan is operating properly.

Any MIT Scan machine used on the project needs to perform the project reference plate readings.

A project reference plate is established at the first plate of each paving stage. A paving stage can be any phase in the construction where a new project reference plate needs to be defined due to the following circumstances:

- Previous project reference plate is under live traffic.
- Traffic switch made accessing first plate for testing unsafe.
- If the initial plate is greater than 5 miles from where testing needs to occur.

A project reference plate data sheet, DT3209, is needed for each project reference plate location established. Completed DT3209 forms are to be included in the material archive records.

870.4.7.1.1.3 Project Plate Locations

Department will randomly select the plate to read in the paving unit. Random numbers for plate readings are to be included in the material archive records.

870.4.7.1.1.4 Materials Information Tracking (MIT) Thickness Entry

The contractor enters the locations of all the test plates into the MRS system.

The department downloads the locations from the MRS system into MIT. The department enters all the MIT Scan thickness measurements into the department's MIT system, using test report prefix 136.

870.4.7.1.1.5 Troubleshooting

Things to consider if the MIT Scan is not within the project reference plate or test plate tolerance:

- Is the pavement wet?
  - Wet pavement can cause inaccurate readings. Let pavement dry out before testing.
- Pavement surface is dirty?
  - Tined pavements can have surface irregularities that are a result of the tining operation. Sweep and scrape the pavement until the surface is free of debris and anomalies.
- Cold weather?
  - Colder temperatures can have an affect on the MIT Scan reading. Best practice to take readings above 32 F.
- Utilities in the area?
  - Check around for underground or overhead utilities. Underground utilities can impact the readings if they contain metal.
- Nearby equipment?
  - The metal on equipment that is within the immediate vicinity of the MIT Scan can affect the readings.
- MIT Scan Unit?
  - Make sure the battery is charged before performing readings.
  - Try turning the machine off and back on. Sometimes computers need a fresh restart.
  - Ensure proper handling and storage of the MIT Scan unit. Repeated mishandling of the machine can cause damage to the unit. MIT Scan should never be thrown, shoved, or dropped. Properly case the unit and place in the backseat of the vehicle. Avoid transporting machine in the bed of a truck.
  - Ensure that all wheels are in contact with the surface during measurement. If all wheels are not in contact, false thickness readings will result.
- Measurements?
  - If measurements seem to have thickness irregularities along the pavement, contact BTS Concrete Unit to assist in troubleshooting.

870.4.7.1.1.6 Measurement and Calculations

The number of plates measured within the unit will depend on meeting the acceptable tolerances between individual plate readings and meeting the specified pavement thickness requirements. To determine how many plates should be measured, please see the scenarios and example below.

The department enters individual material tracking MIT Scan depth readings in whole numbers into the test prefix 136 report. The readings are reported in millimeters.

Scenario 1

- The randomly selected average plate readings within the unit are greater than specified thickness and all three measurements are within 3 mm.
- Calculate the average of three measurements from the randomly selected and measured plate.
- Example for Scenario 1 for a Pavement Design of 9-inch plan thickness:

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
19	A	7+67	228	229	229	**229**	**229**	**9.02**
	B							

Scenario 2

- The randomly selected average plate readings within the unit are lower than the specified thickness and all three measurements are within 3 mm.
- Second reference plate within the same unit should be measured.
- Calculate the average of all 6 measurements (3 measurements from first randomly selected reference plate and 3 from second reference plate)
- Example for Scenario 2 for a Pavement Design of 9-inch plan thickness:

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
20	A	12+88	199	200	199	199	**205**	**8.07**
	B	13+82	209	210	210	210		

Scenario 3

- The randomly selected average plate readings within the unit are lower than the specified thickness and three measurements are not within 3 mm.
- Second reference plate within the same unit should be measured.
- Calculate the average of three measurements from the second reference plate.
- Example for Scenario 3 for a Pavement Design of 9-inch plan thickness:

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
21	A	10+34	197	200	202	**Discard**	**210**	**8.27**
	B	12+34	209	210	210	**210**		

Scenario 4

- The randomly selected average plate readings within the unit are greater than specified thickness and three measurements are not within 3 mm.
- Second reference plate within the same unit should be measured.
- Calculate the average of three measurements from the second reference plate.
- Example for Scenario 4 for a Pavement Design of 9-inch plan thickness:

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
22	A	12+34	229	232	233	**Discard**	**230**	**9.06**
	B	12+88	229	230	230	**230**		

Scenario 5

- The randomly selected average plate readings within the unit are lower than the specified thickness and three measurements are not within 3 mm.
- Second reference plate within the same unit should be measured.
  - If the three measurements from second plate are also not within 3 mm, test is invalid, the average cannot be computed as we have 2 plates without consistent measurements.
  - The engineer should select the plate location that should be cored for thickness measurement.
  - If the initial thickness measurement is lower than the specified thickness, second plate location should be cored for thickness measurement.
  - Calculate the average thickness from both cores.
- Example for Scenario 5 for a Pavement Design of 9-inch plan thickness:

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
23	A	12+88	222	220	218	**Discard**		
	B	13+82	220	221	217	**Discard**		

Scenario 6

- If a randomly selected plate within the unit is missing, thickness measurement should be determined by coring at the location of a missing plate.

Cores required to determine concrete strength, entrained air content, or pavement thickness must be obtained according to WTM T24.

- WTM T24, Obtaining and Testing Drilled Cores and Sawed Beams.

Example for a Pavement Design of 9-inch plan thickness:

Step 1: Enter individual MIT Scan depth reading in whole numbers into the test prefix 136 report. Readings are reported in millimeters.

Raw Data

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
29	A	7+67	228	229	229			
	B							
30	A	**10+34**	229	229	229			
	B	**12+34**	215	214	214			
31	A	12+88	199	200	199			
	B	13+82	209	210	210			
32	A							
	B	17+07	230	229	230			

Step 2: The average plate readings are defined by adding the three individual readings and dividing by three. The average result is rounded to the nearest 1 millimeter. This is the plate average in millimeters.

Plate Average

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
29	A	7+67	228	229	229	229		
	B							
30	A	**10+34**	229	229	229	229		
	B	**12+34**	215	214	214	214		
31	A	12+88	199	200	199	199		
	B	13+82	209	210	210	210		
32	A							
	B	17+07	230	229	230	230		

Step 3: The unit average reading (mm) is defined by adding the six individual readings and dividing by six. The average result is rounded to the nearest 1 millimeter. This is the unit average in millimeters.

Unit Average

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
29	A	7+67	228	229	229	229	229	
	B							
30	A	10+34	229	229	229	229	221	
	B	12+34	215	214	214	214		
31	A	12+88	199	200	199	199	205	
	B	13+82	209	210	210	210		
32	A							
	B	17+07	230	229	230	230	230	

Step 4: The unit average reading (in) is defined by converting the unit average (mm) by dividing the unit average (mm) by 25.4. The unit average (in) is rounded to the nearest hundredth. This is the unit average in inches.

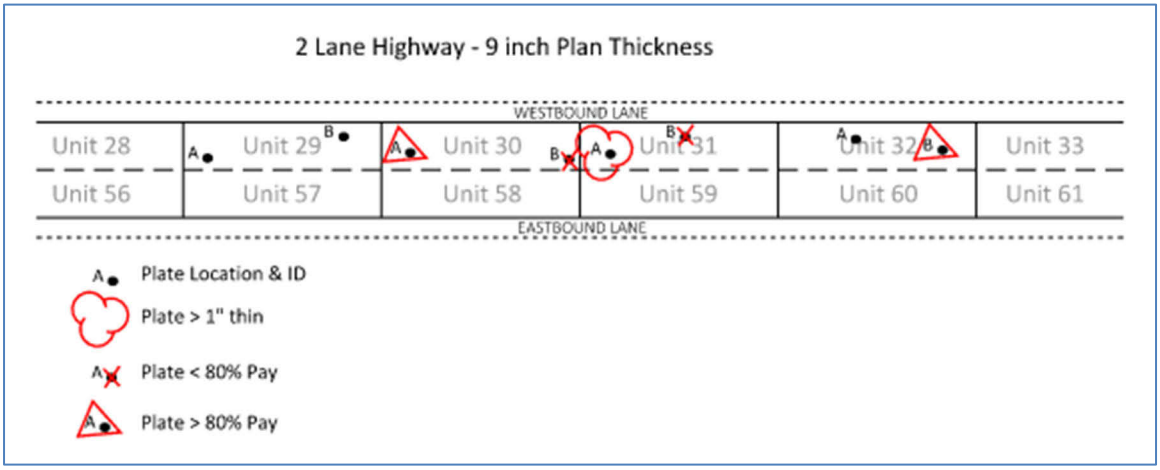
Converting Unit Average to Inches

Unit ID	Plate ID	Station	Depth Measurements (mm)			Plate Average (mm)	Unit Average (mm)	Unit Average (in)
			Reading 1	Reading 2	Reading 3			
29	A	7+67	228	229	229	229	229	9.02
	B							
30	A	10+34	229	229	229	229	221	8.70
	B	12+34	215	214	214	214		
31	A	12+88	199	200	199	199	205	8.07
	B	13+82	209	210	210	210		
32	A							
	B	17+07	230	229	230	230	230	9.06

870.4.7.1.1.7 Acceptance Testing

Determining the limits of unacceptable pavement. Refer to Figure 870-11 and the numbers recorded in 870.4.7.1.1.6 Calculations.

Figure 870-11



Scenario:

Plate 31-A is more than 1 inch thinner than contract plan thickness at 199.33 mm (7.85 in). To determine the limits of unacceptable pavement, perform the following:

Step 1: MIT Scan the plates stationed ahead and behind until the thickness test is plan thickness or greater.

- Behind:
  - Plate 30-B: less than plan pavement thickness at 214.33 mm (8.44 in). Continue measuring plates.
  - Plate 30-A: greater than plan pavement thickness at 229.00 mm (9.02 in). Stop measuring plates.
- Ahead
  - Plate 31-B: less than plan pavement thickness at 209.67 mm (8.25 in)
  - Plate 32-A: Need to test with MIT Scan. Plate Average is 218.67 mm (8.61 in). Less than plan thickness, need to continue measuring plates.
  - Plate 32-B: greater than plan pavement thickness at 229.67 mm (9.04 in). Stop measuring plates.

Step 2: Determine limits of unacceptable pavement.

- Behind:
  - Plate 30-B is less than 80% pay according to standard spec 415.5.2. Plate 30-A is greater than plan thickness.

- Coring needs to be performed between Plate 30-B and 30-A at 20 ft intervals. Measure each core. When core thickness is measured at 8.50 inches or greater, no additional coring is needed for this section.
- 2 cores were needed. STA 12+14 is the western limit of unacceptable pavement.

- Ahead
  - Plate 32-A is at 80% pay according to standard spec 415.5.2. Since the next plate 30-A is greater than plan thickness, no coring is needed. The ahead station of Plate 32-A is the limit of unacceptable pavement. STA 15+98.
- Limits of unacceptable pavement is STA 12+14 to STA 15+98 (384 FT). Due to being greater than 100 LF, this pavement will be removed and replaced to the nearest joint.

870.4.7.1.1.8 Pay Adjustment

Pay adjustments are determined according to standard spec 415.5.2.

870.4.7.2 Concrete Probing

This section discusses the concrete probing, to determine the thickness of freshly placed concrete. This method is used for testing special unit slip-formed concrete pavement.

870.4.7.2.1 Test Plates

Construction staff will obtain test plates by contacting the regional materials section.

Each regional materials section is responsible for ordering test plates for the region's construction projects. Contact BTS Concrete Section for ordering process.

870.4.7.2.2 Materials Information Tracking (MIT) Thickness Entry

The contractor enters the locations of all the probing test plate locations into the MRS system.

The department downloads the locations from the MRS system into MIT. The department enters all the MIT Scan thickness measurements into the department's MIT system, using test report prefix 136.

870.4.7.2.3 Troubleshooting

Things to consider when probing fresh concrete:

- Top plate not staying in place?
  - When extracting the probe, hold onto the T bar handle when pulling out of the concrete. Don't just pull on the plate.
- Thickness measurement seems inaccurate?
  - Ensure probe is perpendicular to the pavement when inserting into the concrete.
  - When entering the probe in the concrete, make sure that the probe is hitting the plate placed on the grade.

870.4.7.2.4 Calculations

The department enters individual probe depth readings to the nearest 1/8-inch the test prefix 136 report.

The unit average reading is defined by adding the two individual probe readings and dividing by two. The average result is rounded to the nearest thousandth of an inch.

870.4.7.2.5 Pay Adjustment

Pay adjustments are determined according to standard spec 415.5.2.

870.4.7.3 Preplacement Measurement (Stringline)

This section discusses string lining the concrete pavement to determine the thickness of pavement before placing concrete. This method is used for testing special unit hand placed concrete pavement.

Thickness measurements less than plan thickness are required to be corrected before paving according to standard spec 415.3.16.4.2.3.

870.4.7.3.1 Materials Information Tracking (MIT) Thickness Entry

The contractor enters the locations of all the random stringline locations into the MRS system.

The department downloads the locations from the MRS system into MIT. The department enters all final stringline thickness measurements (after any necessary base correction) into the department's MIT system, using test report prefix 136.

870.4.7.3.2 Calculations

The department enters individual stringline depth readings to the nearest 1/8-inch the test prefix 136 report.

The unit average reading is defined by adding the two individual stringline readings and dividing by two. The average result is rounded to the nearest thousandth of an inch.

870.4.8 Concrete Maturity Testing

If using the maturity method for determining concrete strength, either standard spec 502.3.10.1.3 or the special provisions require the contractor to follow the procedures defined in this section.

Maturity testing is an alternative to compressive strength tests for administering timing of job control functions such as ending the curing period or cold-weather protection periods, opening to service, or removal of forms or false work. Use data-encrypted sensor devices permanently embedded in the field-placed concrete. Data-encrypted sensors have a chip that records both temperature and time information that can be downloaded to a reading device not permanently attached to those sensors.

870.4.8.1 Calibration Curve

Develop a calibration curve representing the strength-maturity relationship for the concrete before using maturity testing for job control functions. A separate calibration curve is required for each concrete mix design. The contractor submits the maturity test results to the project engineer for approval before using for job control on the project. Develop a new calibration curve every time the mix changes or if project engineer verification cylinder strength varies from the expected value from the current calibration curve by more than 10 percent.

870.4.8.2 Calibration Procedure

Cast at least 15 standard 6x12 inch cylinders in accordance with WTM R100 from a single composite sample taken in accordance with AASHTO T141. Embed maturity sensors at the center of at least two cylinders. Cure concrete cylinders in conditions similar to which the field concrete will be exposed. Protect the cylinders from moisture loss. Perform compression tests in accordance with WTM T22, at 1, 3, 7, 14 and 28 days, or other intervals as determined appropriate for the mix design. Develop data points for the strength/maturity relationship up to at least 120 percent of the highest required opening strength for each mix design. Test two specimens at each age and compute the average strength. If the strength of the lower strength cylinder is less than 90 percent of the higher strength cylinder, also break a third cylinder. Discard the lowest of the three cylinder strengths and calculate the strength as the average of the two higher strength cylinders. At each test age, record the average maturity index for the instrumented cylinders.

Calculate the maturity index using the temperature-time factor maturity function as defined in ASTM C1074. Use a default datum temperature of 32 F (0 C) or use a mix-specific datum temperature per Annex A1 of ASTM C1074.

870.4.8.3 Field Procedures for Use of Maturity

Place at least one maturity sensor for each 2000 square yards of concrete pavement, and at least one sensor for each 100 cubic yards of concrete placed under non-pavement bid items. Embed the sensor in the fresh concrete as soon as practicable after concrete placement. When using this practice to allow critical operations to begin, install sensors in locations that are critical in terms of exposure conditions and structural requirements. Connect the sensors to maturity instruments and activate the recording devices as soon as practicable. When the strength at the location of a sensor is estimated, read the value of the maturity index from the maturity instrument. Using the strength-maturity calibration curve for that mix design, read off the value of compressive strength corresponding to the measured maturity index. Before performing critical operations such as false work removal or post-tensioning, supplement determination of concrete maturity with other tests to verify that the concrete has the necessary strength.

870.4.8.4 Verification Cylinders

Each workweek the contractor must provide a set of three verification cylinders to the project engineer for each strength/maturity field calibration curve currently in use on the project. The project engineer will designate the sampling location for these verification cylinders. Provide two cylinders for compressive strength testing, and one with a data-encrypted maturity sensor embedded in its center. Cast and cure these cylinders on-site as the project engineer directs, and in accordance with the requirements of WTM R100 for field curing. Deliver them to the project engineer promptly after attaining 50 percent of their opening maturity so the project engineer can perform verification testing as close as possible to the opening maturity level.

870.5 Acceptance

870.5.1 Portland Cement

Acceptance of portland cement is discussed in Attachment 870-1.

870.5.2 Hardened Air Content Testing As a Referee Test

The project engineer will consider the results of hardened air content tests conducted in accordance with ASTM C457 as a referee test for acceptance of concrete with nonconforming pressure air test results. A

report containing the hardened air content test results signed by a registered professional engineer must be submitted to the project engineer. Cores must be obtained in accordance with WTM T24.

870.5.2.1 Frequency

For each day of concrete production with nonconforming pressure air test results that are disputed by the contractor, the following minimum hardened air content test frequencies will be required. Where the quantity of concrete with nonconforming pressure air test results consists of three or more truckloads of material, three hardened air tests will be required. When the quantity of concrete with nonconforming pressure air test results consists of less than three truckloads of material, one hardened air test will be required for each truckload of material.

Where a large quantity of concrete is involved and results of hardened air content tests are mixed, after review of the hardened air content test results the project engineer may request additional hardened air content testing to define the true limits of the nonconforming material more closely.

870.5.2.2 Location

Coring locations for removing samples for hardened air content testing will be selected in areas of the in-place concrete item represented by the nonconforming pressure air test results. As well as can be determined, each core should be located in an area representing a separate truckload of concrete. If nonconforming pressure air test results are available for multiple individual loads of concrete, the core locations for hardened air content testing will be established to represent the three loads of concrete with the lowest pressure air test results. Otherwise, random core locations should be established which represent the area of nonconforming material. The project engineer must approve all coring locations before removing cores. Care should be taken to not hit reinforcement or appurtenances buried in the concrete.

870.5.2.3 Cost

When the contractor is disputing pressure air test results from QC testing on a QMP project, the contractor pays for traffic control, core hole filling, hardened air content analysis, and all costs for coring. When the contractor is disputing pressure air test results from department testing, the above costs are the responsibility of the party found to be in error.

870.5.2.4 Acceptance Criteria

Concrete represented by hardened air content tests will be deemed to be acceptable if one or both of the following are true:

- The total air content equals or exceeds the lower control limit for the in-place concrete item.
- The spacing factor is less than or equal to 0.0080 inches (0.200 mm.).

870.6 Department Defined Testing and Acceptance Methods for Concrete

The department defines its own methods for the following:

- Air Meter Field Check
- Concrete Pavement Thickness
- Portland Cement Acceptance
- Concrete Air-Void System

870.7 Surface Resistivity

870.7.1 Concrete Resistivity

Resistivity (ρ) is the measure of a material's ability to resist an electrical current. It is a function of Ohm's Law, the specimen's geometry, and the method of measuring resistivity. The units of resistivity are expressed in terms of kΩ-cm.

Using resistivity can help identify how permeable concrete is. It is important to know how permeable the concrete is so it can be determined how susceptible structures, pavements and other concrete elements are to outside chemical attack. Knowing this property will lead to better assessment of the concrete's durability and its future life expectancy.

870.7.2 Testing Concrete Resistivity

Testing concrete resistivity can be performed in one of two methods: bulk resistivity or surface resistivity. The department will be using surface resistivity to measure the concrete's resistivity. This test method is outlined in WTM T358. Surface resistivity utilizes a probe that generates an electric field within the sample. The probe measures the electric field and produces a value known as surface resistivity. Surface resistivity is not the resistivity of concrete. The results from the surface resistivity measurements must be corrected to get the resistivity of concrete. The corrections applied are located in the equations below:

SPECIMEN DIMENSION AND PROBE SPACING CORRECTION

$$k = 1.10 - \frac{0.73}{\frac{d}{a}} + \frac{7.34}{\left(\frac{d}{a}\right)^2}, where \begin{cases} d\ is\ the\ diameter\ of\ the\ cylinder\ (in.) \\ a\ is\ the\ probe\ spacing\ (in.) \end{cases}$$

Note: the correction factor k can only be applied to cylinders.

CONVERTING SURFACE RESISTIVITY MEASUREMENTS (ρm)TO RESITIVITY MEASUREMENTS (ρ)

$$\rho = \frac{\lambda * \rho_m}{k}, where \begin{cases} \lambda\ is\ the\ leeching\ correction\ factor \\ \rho_m\ is\ measured\ surface\ resistivity \\ k\ is\ the\ probe\ and\ sample\ shape\ correction \end{cases}$$

λ = 1.1 when cured in lime-water tanks

The corrections are applied to the set average rather than the individual measurements. After the corrections are applied to the set average, the resistivity of concrete is rounded to the nearest 0.1 kΩ-cm. DT 2232 performs these calculations automatically and is located on the department's website:

https://wisconsindot.gov/pages/global-footer/formdocs/default.aspx

870.7.3 Accelerated Curing for Surface Resistivity Specimens

The reason why the department requires the Accelerated Curing Method for surface resistivity specimens is to account for supplementary cementitious materials (SCMs) in the mixture. In the early stages of concrete's reaction, SCMs remain inert until certain conditions are met within the microstructure that trigger the reaction of SCMs. Placing concrete specimens in a hot lime-water bath, as specified in WTM T358, can cause the SCM reactions to happen faster. This will give the department a better idea of how effective a concrete mixture is when it contains an SCM. In addition, it will also give the department a better idea the permeability performance of concrete without SCMs because the extra heat will cause more of the cement to react. Accelerated cured concrete specimens cannot be used for strength acceptance and concrete strength specimens must not be placed in hot lime-water tanks.

870.7.4 Interferences during Surface Resistivity Testing

There are 3 major interferences that can occur during testing:

1. The temperature of the sample can cause errors during testing. Higher temperatures will decrease surface resistivity measurements while lower temperatures will increase the surface resistivity measurements.
2. Leeching of pore solution from the concrete will affect the surface resistivity measurement. Leeching of ions from the concrete will cause the surface resistivity to go down. A correction factor established by WTM T358 is applied to correct for these ions leeching out of concrete.
3. The surface condition of the sample during measurement does matter. Having a saturated surface will cause the electric current to move through the water on the surface resulting in a lower resistivity. The opposite happens if the surface is too dry. A dry surface condition will increase the surface resistivity measurement or make measurements difficult. The optimum surface condition for surface resistivity measurements is saturated surface dry (SSD).

AASHTO T358 explains other types of minor interferences in Section 5.

870.7.5 Delayed Surface Resistivity Testing

Surface resistivity testing is to be tested on day 28 of the final curing procedure. Due to the length of the final curing procedure, it is possible the 28th day could fall on a weekend or on a holiday. The best practice when this happens is to test at the next available time. Since the concrete specimens are coming out of hot lime-water and need to cool down prior to testing, remove samples from the hot bath and place in a wet/fog room or lime-water tank between 68-77°F before the leaving for the weekend or holiday when the day 28 measurements are supposed to be made. Try to test resistivity specimens no more than 32 days after the final curing process starts. Make a note during testing stating a delay in testing had occurred and the reason for the delay.

Attachment 870-1 Certification Method of Acceptance for Portland Cement

Revise Attachment 870-1 (Certification Method of Acceptance for Portland Cement) to update text.

Portland and blended cements are accepted for use on WisDOT projects based on acceptance process outlined in WisDOT's approved products list (APL). Portland and blended cements not on the APL can be accepted at the project level if they comply with requirements outlined below in the "Acceptance of Portland Cement Not on the Approved List" section of this document and comply with the pertinent specification and contract requirements.

WisDOT projects include state, county, and municipal federal aid and authorized county and municipal state aid projects. In order to provide Portland cement to WisDOT projects under the certification method, a manufacturer must comply with the following procedures and requirements.

Sampling Frequency

Minimum sampling frequency for cements on the APL will be one sample from each mill for each brand and type of cement per region per calendar year. The region materials section will coordinate sampling.

Routine field sampling of cements on the APL is not required at the project level for domestic suppliers. Project-level sampling is required for the following at the frequencies defined in CMM 850:

- Cement from sources not on the APL
- Foreign cement sources on the APL
- Fly ash
- Slag

When problems with the concrete mixture or cement are suspected or identified, the contractor should obtain additional samples under the observation of the regional IA for all cementitious materials, whether from a certified list or not. Testing these additional samples will provide valuable information in troubleshooting the problem.

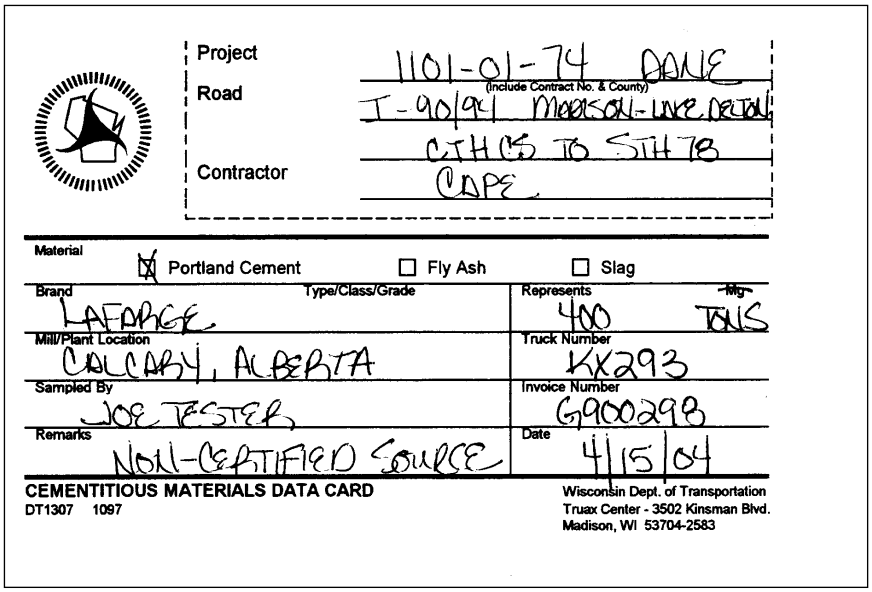
Sampling Procedures

The sample submitted for test must be a composite of several incremental samplings to provide a total weight of four to five pounds (2 - 2.5 kg). The increments may be obtained by means of a scoop or tube device and care must be exercised to assure that contamination due to the sampling equipment or environmental conditions is not introduced. The composite sample must be placed in a plastic bag and submitted to the BTS, Truax Center Laboratory in shipping containers provided by the department. A copy of the manufacturer's certified tests analysis (mill test report) for the production lot sampled must be furnished by the contractor and submitted with the sample.

Identifying Samples

Download DT1307, Cementitious Materials Data Card. An example of the completed card is shown below. Information from this card is necessary for the laboratory to identify the sample and to accurately and efficiently report the test results back to the regions. Therefore, it needs to be filled out completely and accurately. Record the railroad car number or the truck transport number of the shipment sampled and any other transports represented by the sample, the total quantity represented by the sample (all loads included), the location where sample was taken (such as on the project or at _____ Ready-Mix Concrete, _____, Wisconsin), and all other pertinent information called for. Place this card inside the shipping carton along with the sample. Also indicate the brand and type of cement on the shipping label on the outside of the carton.

Cementitious Materials Data Card, DT1307



Project: 1101-01-74 DANE (include Contract No. & County)
Road: I-90/94 MADISON-LUCK DRIVE CTH CS TO STH 78
Contractor: CAPE

Material: ☒ Portland Cement ☐ Fly Ash ☐ Slag
Brand: LAFARGE Type/Class/Grade:
Represents: 400 ~~Mg~~ TONS
Mill/Plant Location: CALGARY, ALBERTA
Truck Number: KK293
Sampled By: JOE TESTER
Invoice Number: G900298
Remarks: NON-CERTIFIED SOURCE
Date: 4/15/04

CEMENTITIOUS MATERIALS DATA CARD
DT1307 1097

Wisconsin Dept. of Transportation
Truax Center - 3502 Kinsman Blvd.
Madison, WI 53704-2583

(LAB. USE ONLY)

C - No. _____

TEST RESULTS Date Rec'd.

Autoclave Expansion | Mortar Air Content

Time of Set

COMPRESSIVE STRENGTH REMARKS:

☐ Satisfactory
☐

- Day		- Day	
Load, lbs (kg)	Stress, psi (MPa)	Load, lbs (kg)	Stress, psi (MPa)
Av. =		Av. =	

Manufacturer Quality Control and Documentation

The manufacturer must provide facilities and qualified personnel to perform all specification tests and maintain a quality control program. The manufacturer must maintain records of all its control testing done in the production of Portland cements. These test records must be available at all times for possible examination by BTS (or designated representative) and for a minimum period of five (5) years after use on a project. Acceptance of materials by this process will also be contingent upon acceptable compliance with procedures and conformance of materials to requirements as determined by test results for verification project site samples taken by state project personnel.

Project Site Verification Samples

The department's project personnel will obtain samples by random selection from shipments of material at the project sites. The sampling rate will be a minimum of one per cement mill, for each brand and type of cement per year in each WisDOT region. Sampling will be accomplished by taking a single sample of material according to the department standard practices for sampling cement. The Materials Section in each region will coordinate sampling. The samples will be sent to the department's central laboratory for testing. Testing will be according to AASHTO standard methods. The tests to be conducted on individual verification samples will be determined by the department central laboratory personnel as being necessary to acceptably monitor test properties of the cement.

A copy of the manufacturer's certified test analysis (mill test report) for the production lot sampled must be furnished by the contractor and submitted with the sample. In addition, ready-mix and on-site plants must

have the following documents available for department review at all times during cement concrete production for WisDOT work:

1. A mill-certified test report of analysis.
2. Load documents for each shipment stamped with the manufacturer's certification for the brand, type, and source of cement.

Sampling will need to be coordinated by the regions and be performed either at the plant or on the project.

Acceptance of Portland Cement Not on the Approved Product List

It is the intention of WisDOT to encourage manufacturers to become certified by following the process outlined on the APL. However, if situations occur where a manufacturer's designated product is not on the WisDOT APL, materials may be accepted for an interim period not to exceed one year. Manufacturer must provide required documentation and cement sample for testing.

List of required documentation:

- Safety Data Sheet
- Signed letters of certification stating the specifications meet each brand, type, and source of cement.
- Detailed record of monthly average manufacturer mill certifications for each brand, type, and source of cement that will be used for WisDOT work for the last 12 months.
    - The mill certifications must be dated and signed by a member of management who is authorized to certify the product and legally bind the cement supplier/manufacturer.
    - The cement testing for mill certifications must be conducted by an accredited American Association of State Highway and Transportation Officials (AASHTO) and Cement and Concrete Reference Laboratory (CCRL) testing laboratory/facility and the report must include the physical and chemical test data showing that cement has met or exceeded the requirements in outlined material property requirements section.
        - The testing laboratory/facility must participate in AASHTO/CCRL accreditation/inspection program, and the manufacturer/supplier shall provide a copy of the testing facility's current CCRL inspection report.
        - If submitting an independent laboratory test data, include the AASHTO/CCRL certification of the testing laboratory.
    - The mill certification must include the actual limestone content in cement in addition to target values.
- A copy of the plant's Quality Control (QC) plan, signed by the authorized personnel. The QC plan must include:
    - Control tests and testing frequencies completed by the manufacturer.
    - Description of laboratory facilities and equipment.
    - Programs to maintain test and shipment records at a minimum.

Cement will be subject to increased frequency of project site verification or acceptance sampling and testing.

Department costs for pre-testing and increased verification or acceptance sampling and testing are paid for by the manufacturer or their agent, unless the department agrees otherwise. After one year, the designated product will not be accepted for use in WisDOT projects until the brand, type, and source can be certified.

Verification Samples with Nonconforming Results

Should a verification sample tested by the department show noncompliance with specification requirements, actions will be taken to investigate the sample failure. The purpose of the investigation(s) will be to quickly obtain information to either substantiate the failure data or to provide conclusive evidence that the reported failure is unreliable. Prompt response may help to avoid or reduce additional sample failures. The details of the process to resolve sample failures will include part or all of the following:

1. The department central laboratory will notify the Region Materials Section and request them to investigate all region activities related to procuring, handling, and submitting the sample. Together they will establish the quantity and location of material involved, as well as possible. The region will notify the contractor.
2. The department central lab will conduct additional tests (retests) of the sample and review other pertinent data.
3. The department will work out a program to increase verification sampling frequency for the failed product, if deemed appropriate.

4. The department central laboratory will compile all information and data for the failing sample (including information from the region).
5. The department central laboratory will issue the standard test report for the failing sample and all additional tests (retests) to the region. Copies will also be sent to the manufacturer.
6. The department central laboratory will report the investigation information to the region materials section. The report will include recommendations for the region to resolve the sample problem.
7. The region construction section will make the final decision for resolving the sample problem using input by both the region materials section and central laboratory. This decision will be communicated to the contractor and, if warranted, to the manufacturer for information and possible production adjustments.
8. The department will review the results of the investigation and take action to eliminate reoccurrence of sample failures and use of unacceptable cement. These actions may include:
    - Increase verification sampling and testing of the specific cement brand, type, and source statewide.
    - Use the findings to determine the acceptability of the specific cement in WisDOT projects when the manufacturer submits their annual request for recertification.
    - Notify the manufacturer and regions that the brand, type and source of cement in question is being removed from the approved list of certified cements (i.e. decertified).

Attachment 870-2 Characterization of the Air-Void System of Freshly Mixed Concrete by the Sequential Pressure Method - Super Air Meter (SAM)

See the following link for videos on how to adjust, calibrate, and perform the Super Air Meter (SAM) test:

www.superairmeter.com

When performing the test special attention should be given to the following:

1. Check the clamp arm tension.
2. Clean the rim of the bucket thoroughly, ensure no sand is present.
3. Ensure all bubbles from the bottom chamber have been removed before each testing sequence.

Although currently there are no contractual specification limits, an acceptable SAM number is ≤0.25. Acceptable SAM numbers typically require a minimum of 4.0% air. Failing SAM numbers typically do not occur above 8.0% air.

Interpretation of low or high SAM results:

1. Negative SAM numbers.
    - Any negative SAM number is incorrect & indicates an error.
    - Fill with fresh concrete & re-test.
    - Check for leaks.
    - Make sure you are confident in water testing results before testing concrete.
2. SAM numbers >0.81 will result in a P-Error.
    - Almost always an unintended press of the top lever.

871 Concrete Mixture Design

Standard spec references to concrete testing and sampling methods contained in this chapter:

Standard spec 701.3 ..... concrete testing

871.1 General

The materials that make up a concrete mixture design are integral to the performance and service life of the concrete. Designing a long-lasting mixture requires knowledge of different materials, understanding of how the materials interact and how concrete properties are affected by different materials. Mixture designs for Class I concrete require the mix designer to be certified as a PCCTEC II. The HTCP class teaches mix designers how to develop a concrete mixture design according to WisDOT requirements. It is strongly suggested that Class II mix designers also become certified in PCCTEC II. The guidance in this chapter will assist with trial batching, concrete mixture design submittals, mixture modifications and material source changes.

Requirements for concrete mixture designs are found in the standard specifications listed below:

Special High Early Strength Concrete Pavement Repair and Replacement ..... standard spec 416.2.4
Composition and Proportioning of Concrete ..... standard spec 416.2.4.1
Cementitious Material ..... standard spec 501.2.4
Portland Cement ..... standard spec 501.2.4.1
Supplementary Cementitious Material (SCM) ..... standard spec 501.2.4.2
Chemical Admixtures ..... standard spec 501.2.5
Air Entraining Admixtures ..... standard spec 501.2.5.2
Retarding, Water-Reducing and Non-Chloride Accelerating Admixtures ..... standard spec 501.2.5.3
Water ..... standard spec 501.2.6
Aggregates ..... standard spec 501.2.7
Aggregate Gradations ..... standard spec 501.2.7.4.2
Concrete Grades ..... standard spec Table 501-5
Concrete Proportions ..... standard spec 501.3.2.2
Supplementary Cementitious Materials ..... standard spec 501.3.2.2.2
Optimized Concrete Mixtures ..... standard spec 501.3.2.3
Air Entrainment ..... standard spec 501.3.2.4.2
Prestressed Concrete Members: Concrete ..... standard spec 503.3.2.2
Concrete Mixes ..... standard spec 710.4
Class I Concrete Mixes ..... standard spec 715.2.2
Pavements and Cast-in-Place Barrier ..... standard spec 715.2.2.1
Structures ..... standard spec 715.2.2.2
Class II Concrete ..... standard spec 716.2.1
Class III Concrete ..... standard spec 716.2.2

871.2 Laboratory Trial Batching

Trial batching verifies the designed concrete mixture meets specification limits. Requirements in a contract can include

- compressive and/or flexural strength
- air content
- air void spacing
- workability
- permeability and
- other properties.

Trial batching will also help determine if there are compatibility concerns with the physical and mechanical properties of the concrete. For example, certain aggregates do well in compressive strength but may have issues obtaining flexural strength; when discovered during trial batching, adjustments to the mixture design can be made prior to use on a project. Trial batching, regardless of if it is required by the Standard Specification, is a useful tool and is encouraged to be utilized to confirm a mixture design's performance before being placed.

871.2.1 Structures

Trial batching for structures utilizes American Concrete Institute (ACI) 301 - Specifications for Concrete Construction, as stated in standard spec 715.2.2.2.

It is the responsibility of the designer to have the most recent version of the ACI 301 document. Revised ACI documents are published every 3 to 4 years.

871.2.1.1 Compressive Strength Requirements under ACI 301

American Concrete Institute (ACI) 301 requires mixture designers to vary the compressive strengths of the mixture design to determine if the design is acceptable for use. This is achieved by adjusting the proportions of the mixture that will cause the concrete strength to increase or decrease. ACI 301 does not call out how to perform this measure and is left up to the designer. Normally, the w/cm ratio of the proposed mixture design is adjusted so the compressive strength is impacted.

ACI 301 requires overdesign when it comes to the compressive strengths during trial batching. The reason for the overdesign is to capture material variability, testing variability and other sources of variability. Tables in ACI 301 dictate how much overdesign is required. The amount of overdesign is dependent on whether the mixture design has been used before or if the mixture design is brand new. During trial batching, the compressive strengths need to be above and below the target overdesign.

The strength overdesign specified by ACI 301 is only for trial batching purposes. During the mixture design submittal process, the designer needs to submit what the target compressive strength overdesign was for their mixture and the compressive strengths from trial batching. These compressive strengths should be above the required compressive strength stated in the contract.

871.2.2 Pavement and Cast-in-Place Barrier

Trial batching for concrete pavements and cast-in-place barrier does not follow the same requirements as structures. The procedure for trial batching is still the same, but pavements and barrier have different parameters that need to be tested. In addition to compressive strength specimens, slip-form concrete pavements must perform the Box Test and make flexural strength specimens. Another key difference between them is that trial batching for concrete pavement or barrier do not follow ACI 301's requirements. The requirements outlined in ACI 301 are strictly for structural use and does not cover areas that are critical to concrete performance for pavements and barrier.

871.2.2.1 Flexural Strength for Pavements

Flexural strength is required for all pavement designs developed for WisDOT use regardless of the acceptance method in the contract. Concrete mixture without necessary flexural strength will have a negative impact on the pavement's service life.

871.3 Concrete Mixture Design Submittal and Reporting

Revise 871.3 (Concrete Mixture Design Submittal and Reporting) to clarify concrete class.

Concrete mixture designs are required to be submitted to department staff prior to use on a project. In addition to project staff other WisDOT staff that need to have copies of the mixture design(s) are the Regional Materials Engineer and the Independent Assurance Technician. The department will perform a review of the mixture design to ensure the mixture design(s) follow the contract requirements.

All class I and class II concrete mixture designs need to be reported in MRS PCC software. The following needs to be reported in the mix design prefix 132 report:

- Contractor Mix ID
- Mix Grade
- Mix Class
- Total cement content (lbs./cy)
- Cement source
- Cement type
- Total SCM content (lbs./cy)
- SCM source
- SCM class/grade
- Net water (gals) and (lbs)
- Water cementitious ratio
- Water test report ID (if applicable)
- Total aggregate (lbs)
- Aggregate source name
- Individual aggregate contents in SSD conditions (lbs./cy)

- Target air content (%)
- Aggregate properties: specific gravities and absorption
- Admixture name and dosage rate (oz/cwt)
- Slump
- Air content
- SAM number (if applicable)

871.3.1 Department Mixture Design Documentation Review

Review of the concrete mixture design is a critical part of the construction process. These reviews are meant to verify the materials being used in the mixture follow the specifications and identify if additional documentation or permissions are needed. For instance, a mixture using a high range water reducer needs BTS approval prior to use according to standard spec 501.2.5.3.3. Another example of why reviews are critical is to ensure certain materials being used in the mixture are on the Approved Products List. Details like this need to be accounted for in the review process to make sure the mixture meets the requirements of the contract before construction starts. Refer to CMM 835 for additional information.

871.3.1.1 Class I Concrete

Class I concrete includes pavement items, cast-in-place barrier items and structure items. They require extensive documentation and need to be reviewed carefully prior to approving the mixture design. The following documentation needs to be reviewed:

- DT2220 or DT2221 Form
  - Check for errors and completeness on sections:
    - 1. Certification, 2. Aggregate System, 3. Paste Quality and 4. Mix Design.
    - For DT2221 Form only: 5. Unit Wt_Voids in Aggregate
- Trial Batching Data
  - Pavements and Cast-in-Place Barrier:
    - Compressive Strength results
    - Flexural Strength results – pavement only (trial batches for pavements must have compressive and flexural strength results)
    - SAM Number and Air content results
    - Box Test results – Slip-Form Concrete only
  - Structures:
    - Target Overdesign Strength – ACI 310 Report
    - Compressive strength results
    - SAM Number and Air content results
- Prefix 131 Water for Concrete report for well water or surface water sources
- Prefix 223 and 225 Aggregate Quality report
- Cement and SCM Mill Certifications
- Chemical admixture product data sheets including recommended dosage

871.3.1.2 Class II and Class III Concrete

Class II and Class III concrete covers concrete repair items, curb, gutter, sidewalk and other types of ancillary concrete. These mixture designs do not require as much documentation compared to Class I concrete. The following documents need to be reviewed:

- DT2220 or DT2221 Form
  - Check for errors and completeness on sections:
    - 1 Certification, 2 Aggregate System, 3 Paste Quality and 4 Mix Design
    - For DT2221 Form only: 5 Unit Wt_Voids in Agg
- Prefix 131 Water for Concrete report for well water or surface water sources
- Prefix 223 and 225 Aggregate Quality report
- Cement and SCM Mill Certifications
- Chemical admixture product data sheets
  - If a superplasticizer is permitted to be used, a certificated report of tests must be provided.
- Certificate of Compliance - Class III concrete mixtures

871.4 Concrete Mixture Design Modifications

Mixture modifications can happen under a variety of circumstances. These circumstances can range from supply chain issues for a material to correcting the performance of the concrete mixture. These

modifications allow the project to continue and, in some cases, improve the quality of the concrete. However, these modifications must be approved by the department and documented properly. Modifications to a concrete mixture design must be submitted to the project staff, regional materials engineer and the regional IA.

871.4.1 Cement

Revise 871.4.1 (Cement) to update Tables 871-1 through 871-5 and add text.

A cement source change is defined as changing the cement type or physical source of the cement. Cement source changes can happen but are rare. The main reasons why a cement change is necessary can come from:

- Supply issues
- Concrete performance issues:
  - Set times
  - Strength
  - Air content

It is recommended a contractor contact their cement supplier and work with them if the cement is suspected to be causing performance issues. A change in cement source, regardless of if it is from the same manufacturer, requires a new mixture design, trial batching and other actions.

The following is needed before the concrete mixture can be used on a project:

- Trial batching data
- Cement mill certifications from new source
- Updated DT2220 or DT2221 form
- New Mix ID: Contractor ID and MRS ID
- New lot layout
- Amendment to Quality Control Plan

A table with cement mix modification change actions is included in Table 871-1.

TABLE 871-1 CEMENT MIX MODIFICATION CHANGE TYPE

CEMENT								
Modification Type		Mix Design Change Type		DT Form	QC Plan	New Lots / Sublots	New MRS Number	Trial Batching Required[1]
		New Design	Mix Modification					
Type Change *(ie: Type I to Type IL)*		X		New Submittal	Amend	Yes	Yes	Yes
Source Change *(ie: change of mill location)*		X		New Submittal	Amend	Yes	Yes	Yes
Manufacturer Change *(ie: Holcim to St. Mary's)*		X		New Submittal	Amend	Yes	Yes	Yes
Total Cementitious Content Change	Not including HES/SHES mix	X		New Submittal	Amend	Yes	Yes	Yes
	For HES/SHES mix or to accommodate SCM rate change		Level II	Ensure HES mix included /Updated DT Form	Amend	Yes	Yes	No

[1] Class II and Class III concrete mixtures do not require trial batching to be completed.

871.4.2 Supplementary Cementitious Materials (SCMs)

A change in supplementary cementitious materials (SCM) is defined as a change in replacement rate, changing sources or changing to a different SCM type. SCM changes do not occur often, but when

changes occur it is typically a result of supply issues or performance issues. These materials are by-products of other industries and can be variable in both supply and performance.

871.4.2.1 Change in SCM Replacement Rate

SCM replacement rate changes do not require trial batching; however, it does require the following:

- Updated DT2220 or DT2221 form
- New Mix ID: Contractor ID and MRS ID
- New lot layout
- Amendment to Quality Control Plan

871.4.2.2 Change in SCM Source

871.4.2.2.1 Fly Ash

Under standard specification 710.4 (4), changing from a fly ash source to another of the same class for concrete pavements, barriers, and class II concrete does not require a new mixture design, trial batching or new lots/sublots. This requires a mill certification for the new fly ash source and an amendment to the Quality Control Plan.

Switching Class F fly ash sources may require extra documentation and action depending on the scenario. Changing from a Class F ash on the department's APL to another Class F source on the department's APL requires a mill certification for the new source and an amendment to the Quality Control Plan. However, changing from a Class F ash on the department's APL to a Class F ash source not on the APL, the replacement rate must be reduced to 15% according to standard spec 501.3.2.2.2. If the replacement rate is at or below 15%, then a mill certification is required and an amendment to the Quality Control Plan. If the replacement rate must change, review the guidance found in CMM 871.4.2.1.

871.4.2.2.2 Slag

Changing slag sources does not require trial batching; however, changing slag sources will be dependent on the situation. Changing from a slag source with the same grade will only require the mill certification for the new source. If the slag grades change, from 120 to 100 or vice versa, the following are required:

- Updated DT2220 or DT2221 form
- New Mix ID: Contractor ID and MRS ID
- New lot layout
- Amendment to Quality Control Plan

871.4.2.2.3 Silica Fume

Switching silica fume sources does not require a new mix design, trial batching or new lots. All that needs to be provided is the mill certification from the new source and an amendment to the Quality Control Plan.

871.4.2.3 Change in SCM Types

A change in SCM type is considered a new mixture design which will require trial batching, new lots and other actions. The following items will be required:

- Trial batching data
- SCM mill certifications from new source
- Updated DT2220 or DT2221 form
- New Mix ID: Contractor ID and MRS ID
- New lot layout
- Amendment to the Quality Control Plan

Changing SCM types includes the following and their opposites:

- Class C fly ash to Class F fly ash
- Fly ash to slag
- Fly ash to silica fume
- Fly ash to another SCM allowed under standard specification 501.2.2.2.

A table with SCM mix modification change actions is included in Table 871-2.

TABLE 871-2 SUPPLEMENTARY CEMENTITIOUS MATERIAL (SCM) MODIFICATION TYPE

SUPPLEMENTARY CEMENTITIOUS MATERIAL (SCM)									
Modification Type			Mix Design Change Type		DT Form	QC Plan	New Lots / Sublots	New MRS Number	Trial Batching Required [1]
			New Design	Mix Mod.					
Type Change (ie: Fly Ash to Slag)			X		New Submittal	Amend	Yes	Yes	Yes
Slag Source Change	Different Grade *(ie: Slag 120 to Slag 100)*			Level II	Updated DT Form	Amend	Yes	Yes	No
	Same Grade *(ie: Slag 100 to Slag 100)*			Level I	Updated DT Form	Amend	No	No	No
Fly Ash Source Change	Different Class *(ie. Fly Ash C to Fly Ash F)*		X		New Submittal	Amend	Yes	Yes	Yes
	Pavements, Cast-in Place Barriers, and Class II concrete	Same Class *(ie: Fly Ash C to Fly Ash C)*		Level I	Updated DT Form	Amend	No	No	No
		Same Class *(ie: Fly Ash F to Fly Ash F)*		Level II	Updated DT Form	Amend	Yes	Yes	No
	Structures	Same Class *(ie: Fly Ash C to Fly Ash C or Fly Ash F to Fly Ash F)*	X		Updated DT Form	Amend	Yes	Yes	Yes
Manufacturer Change (ie: Heidelberg to Cemex)			X		New Submittal	Amend	Yes	Yes	Yes
Replacement Rate Change (ie: 25% to 15%)				Level II	Updated DT Form	Amend	Yes	Yes	No

[1] Class II and Class III concrete mixtures do not require trial batching to be completed.

871.4.3 Chemical Admixtures

Chemical admixtures are useful tools that are used to enhance or better control certain concrete properties. They tend to be stable products when used in accordance with the manufacturer's recommendations. However, changing chemical admixtures can have adverse impacts on the concrete's performance. Even if the admixture is advertised to perform the same function (entrain air or increase workability) as another, the dosage rates can be different, the chemical family can be different, or they may be incompatible with another admixture. These differences can severely impact the concrete's performance if proper evaluation is not performed. If the admixtures from different manufacturer are used together in a concrete mix, the contractor and concrete supplier must ensure that they are compatible.

A change in chemical admixtures is considered a new mixture design, regardless of if it is from the same manufacturer. This will require trial batching and new lots. The following also needs to be provided:

- Trial batching data
- Product data sheets

- If a superplasticizer, it needs to be approved by BTS
- Updated DT2220 or DT2221 form
- New Mix ID: Contractor ID and MRS ID
- New lot layout
- Amendment to Quality Control Plan

A table with admixture mix modification change actions is included in Table 871-3.

TABLE 871-3 ADMIXTURE MODIFICATION TYPES AND ACTIONS

ADMIXTURES								
Modification Type		Mix Design Change Type		DT Form	QC Plan	New Lots / Sublots	New MRS Number	Trial Batching Required[1]
		New Design	Mix Mod.					
Product Change	Same Manufacturer *(ie: ConAir to ConAir X)*	X		New Submittal	Amend	Yes	Yes	Yes
	Different Manufacturer *(ie: AEA-92 to ConAir)*	X		New Submittal	Amend	Yes	Yes	Yes
Dosage Change *(ie: within ranges on the APL)*[2]			Level I	Updated DT Form	Amend	No	No	No
Addition/Deletion of Admixture	Except Type B or D *(ie: removal of water reducer)*	X		New Submittal	Amend	Yes	Yes	Yes
	Type B or D Admixture		Level I (on APL)	Updated DT Form	Amend	No	No	No
			Level II (Not on APL)					
Addition of Color Pigment			Level I	Updated DT Form	Amend	No	No	No

[1] Class II and Class III concrete mixtures do not require trial batching to be completed.

[2] If the admixture dosage rate is outside of recommended dosage rates as specified in the APL, BTS approval is required before use.

871.4.4 Mixing Water

Concrete mixing water can be changed depending on a variety of circumstances. These circumstances can be:

- Active water source fails a requirement under standard specification 501.2.6.
- Switching from warmer water to cooler water.
- Supply issues.

A change of water source does not require a new mixture design, trial batching or new lots/sublots. The documentation that is required is dependent on the type of water source that the mix will be switching to. The required documents that must be supplied before the change can be made are as follows:

- Changing from municipal water to well or surface water:
  - An active prefix 131 Water for Concrete report
  - Amendment to the Quality Control Plan
- Changing from well or surface water to municipal water:
  - The name of the municipal water source

- Amendment to the Quality Control Plan

A table with water modification change actions is included in Table 871-4.

TABLE 871-4 WATER MODIFICATION TYPE

WATER							
Modification Type	Mix Design Change Type		DT Form	QC Plan	New Lots / Sublots	New MRS Number	Trial Batching Required
	New Design	Mix Modification					
Source Change – Certified Source *(ie: Well to Municipal)*		Level I	Updated DT Form	Amend	No	No	No

871.4.5 Aggregates

Aggregates serve a pivotal role in concrete. They come in various shapes, sizes and geologies and make up most of the volume in a concrete mixture (approximately 70%). When most of the volume is made up of aggregate, the differences in aggregate sources can have an impact on the workability, strength, durability, and color of concrete. Changing an aggregate source does not happen often but can happen occasionally due to different circumstances. Nevertheless, it is important to understand how aggregates perform in a mixture prior to use.

Changing an aggregate source is considered a mixture design change. This will require trial batching and new lots. The following will also be required:

- Trial batching data
- WisDOT Aggregate Quality Report
  - 225 for coarse aggregates
  - 223 for fine aggregates
- Updated DT2220 or DT2221 form
- New Mix ID: Contractor ID and MRS ID
- New lot layout
- Amendment to Quality Control Plan

A table with aggregate modification change actions is included in Table 871-5.

TABLE 871-5 AGGREGATE MODIFICATION TYPE

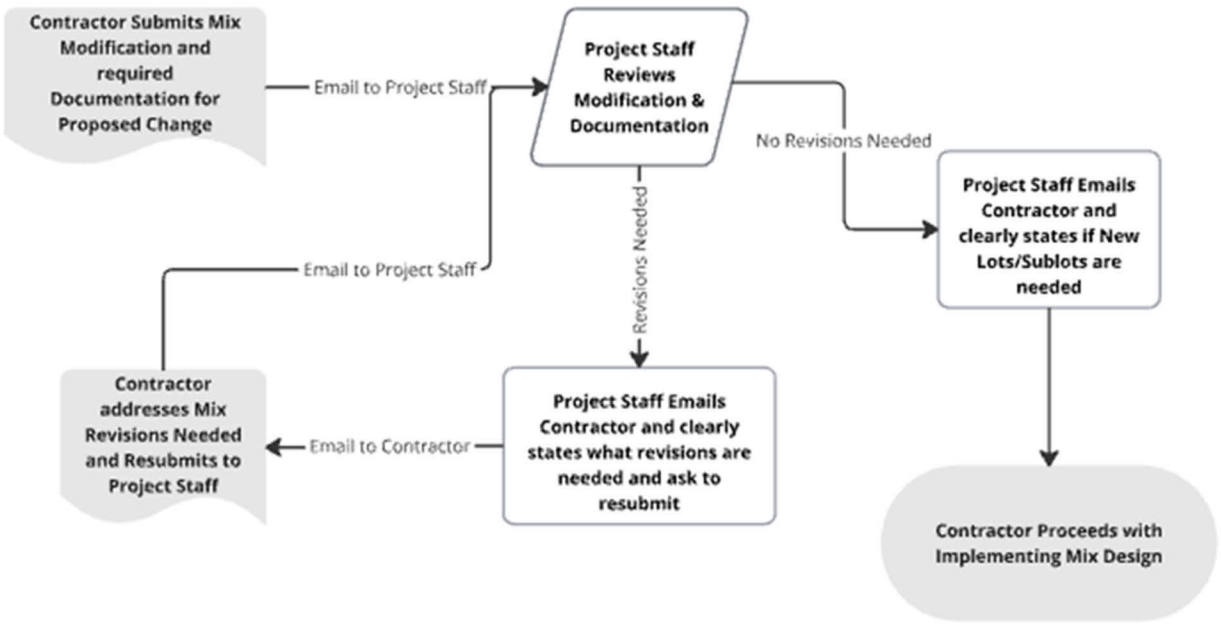
AGGREGATES							
Modification Type	Mix Design Change Type		DT Form	QC Plan	New Lots / Sublots	New MRS Number	Trial Batching Required[1]
	New Design	Mix Modification					
Source Change *(ie: Quarry to Diff Quarry)*	X		New Submittal	Amend	Yes	Yes	Yes
Blend Change *(ie: 56% coarse to 50% coarse)*		Level I	Updated DT Form	Amend	No	No	No
Type Change *(ie: Optimized to Combined)*	X		New Submittal	Amend	Yes	Yes	Yes

[1] Class II and Class III concrete mixtures do not require trial batching to be completed.

871.4.6 Submitting Mix Modifications

The process and flow chart for a mix modification is shown in Figure 871-1.

FIGURE 871-1 MIX MODIFICATION FLOWCHART



Documentation for new lots/sublots will require a new 132 prefix report as referenced in Figure 871-2. In the remarks section the following needs to be stated:

- Mix Modification Date
- Mix Modification Number
- Original Mix Design 132 prefix number
- When trial batching is not required, a note stating that trial batching was completed under the original mix design.

FIGURE 871-2 PREFIX REPORT - PAGE 2

Test Number: 0 - 132 - 0002 - 2024

Materials Laboratory Testing System Tests On:
Concrete Mix Design
Type: DR - DESIGN REVIEW

Main Project ID: 1100-20-70
IH 41 Zoo Freeway

Lab Site
Wisconsin Department of Transportation
Bureau of Technical Services-Central Lab
Truax Center, 3502 Kinsman Blvd.
Madison, WI 53704
+1 608-246-5320

Date Sampled:	**Date Requested / Received:**	**Date Tested:**
09/05/24 By: Adam Paver / 605325		09/05/24 By: Adam Paver / 605325

Source: Legal Description: , , Section: , T: N, R: , County:

Concrete

Slump Air Content: 7.5% SAM # : 0.25

Remarks:
High Early Strength (HES) Mix Mod 1
See Original Mix Design:
0-132-0001-2024 / Mix ID STH100-GrA-01
Added 175 lbs/cy of cement
See original mix design for trial batching

871.5 Optimized Concrete Mixtures

The following is guidance for contractors:

1. The paste system consists of the cementitious materials, water, w/cm ratio, chemical admixtures and air.
2. Recommended paste to void ratio, Vpaste/Vvoids, is 1.25 to 1.75. However, it may be necessary to use as high as a 2.00 to achieve a minimum cementitious content of 500 lbs.
3. Enough paste should be provided to not only fill the voids between aggregate but also to cover the aggregates and separate them to reduce inter particle friction when the mixture is in the fresh state.

SECTION 875 Materials Testing and Acceptance - Structures

875.1 Plant Certification Program for Fabrication of Prestressed Concrete Members

875.1.1 Introduction

Prestressed concrete members must be fabricated at plants certified by the department in order to be used on department projects. The purpose of this document is to outline the processes to obtain and maintain plant certification with the department. Generally, the fabricator must provide a quality control (QC) program for plant manufacturing. QC is all operations that control the product manufacturing process within the specification requirements. The fabricator is responsible for all QC functions for materials and fabrication identified in the specification and this plant certification procedure. Quality verification (QV) oversight (verification of the QC processes) is provided by the department or its agent.

Acceptance of prestressed concrete member items is contingent on the items being manufactured at plants complying with both this plant certification program and standard spec 503.

To provide prestressed concrete members to WisDOT projects, plants must:

- Be certified by the Precast/Prestressed Concrete Institute's (PCI) certification program for the type(s) of prestressed members to be produced.
- Have a PCI certified Level II inspector responsible for QC sampling, testing, and inspection.
- Be approved by the department as a certified prestressed concrete member fabrication plant before start of production for WisDOT projects.
- Comply with the additional requirements of this procedure (attachment 875-1).

Plants, at a minimum, must undergo an annual operation review and approval process. Certification is granted/renewed or denied subsequent to the review.

WisDOT projects include state, county, and municipal federal aid and authorized county and municipal state aid projects. Fabricators whose plants are not on the approved list to provide prestressed concrete members to WisDOT projects are given one year to establish certification according to this program. This period starts with their first notification to the department of their intent to provide products for WisDOT projects.

875.1.2 Scope

Throughout this document there are two distinctive inspection issues of plant certification addressed:

1. Materials incorporated into the products
2. Fabrication of the products

875.1.2.1 Fabrication Items

The items included under this plant certification program are as described in standard spec 503:

- Prestressed concrete girders
- Other prestressed concrete members

The item requirements must be according to the plans and specifications and contract. Prestressing of concrete members must be by the pretensioning method consisting of the following steps:

- Initial stressing of reinforcing tendons
- Placement of reinforcing steel, hardware and forms
- Production, placement, and curing of concrete
- Releasing stress from anchorages to the concrete after development of specified concrete strength
- Repairs, storage, and shipment

875.1.2.2 Department Plant Certification

The department's plant certification requirements are as follows (refer to attachment 875-1 for expanded information):

1. Prequalification by PCI plant certification as a fabricator in good standing.
2. A PCI certified Level II inspector responsible for QC.
3. A current quality control plan, based on PCI guidelines, and approved by the department.
4. WisDOT's annual plant review by the department's certification review team (refer to the "Authority for Plant Certification" section of this procedure) and approval process including QC/QV inspection requirements of this procedure and maintaining records identified in attachment 875-2 and 875-3.

875.1.3 General

Fabrication plants must provide facilities and qualified personnel to perform the specified tests (attachment 875-2) and maintain an acceptable quality control program. The plant must have a PCI Level II certified QC inspector either on the plant staff or from a consultant employed by the plant owner. This

inspector must report to personnel other than those responsible for production. The Level II QC inspector must be on duty at all times when the plant is in production of products for WisDOT projects. When differences exist between the PCI plant certification program aspects and standard spec 503, standard spec 503 prevails.

All materials intended for use in the fabrication of prestressed concrete members must be tested according to attachment 875-2. The fabricator must maintain records of all product ingredient test reports, certifications, and quality control testing done in the production of prestressed concrete members. These records must be available at all times for examination by the department QV inspector and must be retained for a minimum period of five years after the item has been accepted by the department.

Continued certification of a fabrication plant is contingent upon acceptable completion of an initial plant operation review by the department and, then, sustained by a minimum of one annual review thereafter.

The fabricator must be required to perform quality control inspections. The department intends only to perform quality verification inspections. By its QV inspection, the department intends only to facilitate the work and review the quality of work. This QV inspection does not relieve the fabricator of any responsibility for identifying and replacing defective material and workmanship.

The department QV inspector must be PCI Level II certified. The QV inspector(s) must observe the fabrication process and materials, review required testing and other records on file, and make a visual inspection of the quality of workmanship of completed products for conformance with specifications and freedom from defects. Before the start of production of girders or other prestressed concrete members for WisDOT projects, the fabricator must notify the department QV inspector of the plant production schedule. The fabricator must give the QV inspector safe and free access to the work. If the QV inspector observes any work not meeting specifications or unacceptable quality control practices, the QV inspector must advise the plant manager. If the corrective action is not acceptable to the QV inspector, the girder(s) or other member(s) are rejected by the department.

875.1.4 Plant Certification Qualification

Plants requesting approval to fabricate prestressed concrete members for use on WisDOT projects must provide the following prequalification documentation and information with their application:

1. PCI plant certification as a fabricator in good standing. A copy of the plant's PCI certification must be submitted to the department when application for certification is made. The plant's two most recent audit reports by PCI must be available at all times for review by the department and the department's certification review team. The reports must be reviewed only in the presence of plant personnel. The contents of the audit reports must remain confidential between the plant and the department and no parts of the report must be reproduced or removed from the plant premises.
2. A current quality-control plan based on PCI guidelines, including fabricator documentation of all girders and other prestressed concrete member items.
3. Apply in writing to the director of BTS (Attention: quality management engineer). The request for plant certified status must include information on the plant QC program (i.e. product control operations, testing capabilities, facilities information, programs/tracking mechanisms such as inspection, and testing and personnel to maintain quality including identification of the PCI Level II certified inspector and a copy of the certification, records keeping information, etc.). The QC program must ensure that all fabrication, materials, and processes, consistently comply with applicable specification requirements (attachment 875-2). Example QC plans are furnished by the department upon request.
4. Undergo an on-site plant review by the department's certification review team who observe fabricating processes, review records on file, and make visual inspections of the quality of workmanship of completed products for conformance with specifications and freedom from defects. The certification review team must have safe and free access to the plant at any time.

   The certification review team insures that the fabricator has facilities and equipment necessary to perform all operations to produce acceptable quality prestressed concrete products complying with all applicable specification requirements. The fabricator must be capable of consistently supplying acceptable products in quantity sufficient to avoid delays during construction. Any proposed modifications in plant methods, QC program, certified QC inspection personnel, or changes in sources of materials must be reported promptly to the region designated contact person where the plant is located. Department records of plant reviews previously made are used to evaluate those fabricators currently supplying products to WisDOT. Plant reviews are made a minimum of once per year.

   Fabricators are notified of their certification status subsequent to the plant review process. The department maintains a list of certified plants on its electronic materials test system (MTS).

875.1.5 Maintenance of Plant Certified Status

Fabricators must request plant re-approval annually. The request must be in writing and include any changes that have occurred in the fabricator's plant methods, QC program, and certified QC inspection personnel since the last approval. The request must be received by BTS within one year of the previous

approval; otherwise the approval status is terminated. Upon receipt of the request for re-approval, the department initiates a plant inspection review by the certification review team, at a time when the plant is in production of products for WisDOT projects, according to this program.

Plants on the department's approved list are subject to reviews (complete or partial) at any time by the department's certification review team and QV inspector(s). Plant reviews follow the guidelines of this program.

875.1.6 Loss of Plant Certified Status

Plant certification may be withdrawn for the following conditions:

- Loss of PCI plant certification.
- Inability to consistently fabricate products meeting specification requirements.
- Lack of maintenance of required records and improper documentation.
- Failure to maintain an approved quality control program.
- Failure to acceptably resolve deficiencies identified by certification reviews.

The director of BTS authorizes removal of plants from the certified list. The department provides notification of removal from the list in writing.

875.1.7 Plant Recertification Qualification

A plant that has lost certification must comply with the following to be recertified:

- Items 1 through 4 of "Plant Certification Qualification" section of this procedure.
- Submit documentation to the director of BTS identifying the reason(s) decertification occurred and the corrective actions taken by the fabricator.

During the time a plant is not on the approved list, due to loss of certification, prestressed concrete members fabricated at the plant are only accepted when the plant is under an increased level of QV inspection as determined by the department. The department's increased costs for QV inspection are paid by the fabrication plant or their agent, unless other arrangements are agreed upon by the department.

Under this program, a fabrication plant has 3 months to regain certified status. If, after three months, the plant has not met all requirements for recertification, prestressed concrete members that are fabricated in the plant are not accepted for use on WisDOT projects until the plant is recertified to furnish these products under this procedure (the department's plant certification program). Notification of this department action is sent to all WisDOT regions by BTS. Decisions regarding future qualification for certification of a plant are by the director of BTS.

875.1.8 Authority for Plant Certification

The director of BTS determines the plants to be certified based on recommendations of the department's certification review team. Notification of plant certification is made in writing to the fabricator.

The certification review team consists of representatives from WisDOT Central Office, WisDOT regions, and any others included by the department. FHWA may assist with the review upon request by the department.

875.1.9 Department Verification and Plant Certification Stamp

Each prestressed concrete member fabricated under this plant certification program requires, for acceptance of items upon delivery to projects, a shipping document stamped with the following plant certification and an acceptable visual inspection by the engineer at the job site.[2]

CERTIFIED TO MEET WISDOT SPECIFICATIONS

(*Name of Manufacturing Company*)

[2] The stamp serves as the fabricator's certification that the item has been fabricated in compliance with all specifications and the fabricator has all the pertinent documentation available for examination by the appropriate department personnel.

Furthermore, acceptance is contingent upon receipt and evaluation, by the department, of the cylinder test results as provided by the fabricator.

875.1.10 Certification of Plants Not on the Approved List

Prestressed concrete members fabricated in plants not on the WisDOT approved list may be accepted when the plant is under increased QV inspection by the department for an interim period not to exceed one year. After that time, the plant must have attained certification under the department's plant certification program or products are not accepted for use on WisDOT projects. The department's increased costs for QV inspection is paid for by the fabrication plant or their agent, unless other arrangements are agreed upon by the department.

875.1.11 Department Contact Person

Inquiries and comments regarding this plant certification procedure may be addressed to:

Concrete Materials Supervisor
Wisconsin Department of Transportation
Truax Center
3502 Kinsman Boulevard
Madison, Wisconsin 3704
Tel.: (608) 246-5320

875.2 Approved Fabricators for Steel Bridge Primary Members

875.2.1 General

Steel bridge primary members must be fabricated at shops that are on the APL for primary member fabricators, consistent with standard spec 101.2(2), on the bid closing date in order to be used on department projects. The purpose of this section is to outline the requirements for obtaining and maintaining fabricator shop approval status with the department. Acceptance of steel bridge primary members is contingent on the items being fabricated at shops complying with both these shop approval requirements and standard spec 506.

Fabrication must comply with the American Welding Society (AWS) D1.5 Bridge Welding Code To fabricate steel bridge primary members for WisDOT projects a fabricator must be certified by the American Institute of Steel Construction (AISC) as detailed in CMM 875.2.2.

The fabricator must provide facilities and qualified personnel to maintain an acceptable quality control program. The fabricator must provide a current copy of their Quality Management/Control Plan directly to the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor. The fabricator must upload mill test reports and certifications, shop drawings, and weld procedure specifications to the SharePoint fabrication library before starting the assembly process. The records must be available at all times for examination by the department inspector and for a period of 5 years after use on a project.

Acceptance of steel bridge primary members by the department is also contingent upon continued acceptable verification inspection at the project site by project personnel.

875.2.2 Qualification for Approved Fabricator List

To be included in the department's list of Approved Steel Bridge Fabricators, the fabricator must provide proof of AISC certification and an updated Quality Control/Management Plan (QMP/QCP) directly to the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor on a yearly basis. These submittals must be received by March 1 of each calendar year to maintain an approved fabricator status on the APL. Fabricators requesting product approval under the Certification Program must provide an application form to: DOTDLStructuresFabrication@dot.wi.gov

The application form is available at:

https://wisconsindot.gov/dtsdManuals/strct/fabrication/apl-bridge.docx

The required level of AISC certification is based on the complexity of the structure as detailed in table 875-1. Fabrication of structures with higher complexities than those allowed by the highest level of certification held by a fabrication shop is not allowed to occur at that facility.

TABLE 875-1 AISC Certification Level Requirements for Steel Bridges

Bridge Category - Certification Level	Allowable Fabrication
Certified Bridge Fabricator - Simple (SBR)	- Unspliced rolled sections
Certified Bridge Fabricator - Intermediate (IBR) Major	- Field or shop spliced rolled beam bridge, straight or with radius > 500ft - Built-up I-girder with constant web depth, straight or with radius > 500ft, spliced or unspliced - Built-up I-girder with variable web depth, straight or with radius > 1000ft - Truss with length < 200ft, almost entirely preassembled at the certified facility and shipped in no more than three subassemblies
Certified Bridge Fabricator - Advanced (ABR) Major	- Tub or trapezoidal box girders - Closed box girders - Truss with length > 200ft - Arches - Bascule bridges - Cable-supported bridges - Moveable bridges - Bridges with radius < 500ft
Fracture Critical Endorsement (FCE)	- Bridges with fracture critical members

875.2.3 Loss of Approved Fabricator Status

Approval to fabricate steel bridge members may be withdrawn for the following conditions:

- Failing to submit certifications an updated to the shop's QMP/QCP by the yearly deadline.
- Inability of a fabricator to consistently supply products meeting specification requirements.
- Lack of maintenance and submittal of required records, including: certified mill test reports, shop drawings for each structure, updates to the QMP/QCP, WPSs, welder certifications, welder continuity records, and weekly fabrication status reports.
- Failure to communicate and report any of the following: fabrication errors, accidents resulting in structural damage to steel members, intent to deviate from the contract plans, or substitute materials.
- Failure to request/obtain engineer approval for repairs when approval by the engineer is required by AWS/AASHTO codes.
- Improper documentation of shipments.
- Not maintaining an acceptable quality control program.

875.3 Approved Fabricators for Steel Sign Bridges and Overhead Sign Supports

875.3.1 General

Sign bridges and overhead sign supports must be fabricated at shops that are on the APL for sign bridge and overhead sign support fabricators, consistent with standard spec 101.2(2), on the bid closing date in order to be used on department projects. The purpose of this section is to outline the requirements for obtaining and maintaining fabricator shop approval status with the department. Acceptance of sign bridges and overhead sign supports is contingent on the items being fabricated at shops complying with both these shop approval requirements and standard spec 532.2.2.

Fabrication must comply with the American Welding Society (AWS) D1 welding codes. Products may be inspected at the fabrication facility by a WisDOT representative. To fabricate steel sign bridges and overhead sign supports for WisDOT projects, a fabricator must be certified by AISC as detailed in CMM 875.3.2.

The fabricator must provide facilities and qualified personnel to maintain an acceptable quality control program. The fabricator must provide a current copy of their Quality Management/Control Plan directly to the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor. The fabricator must upload mill test reports and certifications, shop drawings, and weld procedure specifications to the WisDOT fabrication library before starting the assembly process. The project leader or manager must review the certified mill test reports before the components are assembled and incorporated into the

structure. The records must be available at all times for examination by the quality assurance inspector and for a period of 5 years after use on a project.

Acceptance of steel sign structures by the department is also contingent upon continued acceptable verification inspection at the project site by project personnel.

875.3.2 Qualification for Approved Fabricator List

To be included in the department's list of Approved Sign Structure Fabricators, the fabricator must provide proof of AISC certification and an updated Quality Control/Management Plan (QMP/QCP) directly to the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor on a yearly basis. These submittals must be received by March 1 of each calendar year to maintain an approved fabricator status on the APL. Fabricators requesting product approval under the Certification Program must provide an application form to: DOTDLStructuresFabrication@dot.wi.gov

The application form is available at:

https://wisconsindot.gov/dtsdManuals/strct/fabrication/apl-sign.docx

The required level of AISC certification is based on the complexity of the structure as tabulated in table 875-2. Fabrication of structures with higher complexities than those allowed by the highest level of certification held by a fabrication shop is not allowed to occur at that facility.

TABLE 875-2 AISC Certification Level Requirements for Steel Sign Structures

Bridge Category - Certification Level	Allowable Fabrication
Certified Component Manufacturer (CPT)	- Monotube sign structures
Simple Bridge (SB)	- Truss sign structures - Monotube sign structures

Monotube sign structures: Full-span monotube, cantilever monotube, 2-chord with no web elements, and tapered monotubes

Truss sign structures: 4-chord full-span, 4-chord cantilever, 2-chord full-span with web elements, 2-chord cantilever with web elements, and sign supports for DMS/VMS signs

875.3.3 Loss of Approved Fabricator Status

Approval to fabricate sign structures may be withdrawn for the following conditions:

- Inability of a fabricator to consistently supply products meeting specification requirements. This is defined as three rejections of components, by department inspection, or field engineer, in a three-month period.
- Lack of maintenance and submittal of required records, including: certified mill test reports, shop drawings for each structure, updates to the QMP/QCP, WPSs, welder certifications welder continuity records, and weekly fabrication status reports.
- Failure to communicate and report any of the following: fabrication errors, accidents resulting in structural damage to steel members, intent to deviate from the contract plans, or substitute materials.
- Failure to request/obtain engineer approval for repairs when approval by the engineer is required by AWS/AASHTO codes.
- Failure to follow contract plans, special provisions, and specifications.
- Improper documentation of shipments.
- Not maintaining an acceptable quality control program.

875.4 Approved Fabricators for Fabricated Bridge Components

875.4.1 General

Fabricated bridge components must be fabricated by a fabricator on the APL for fabricated bridge component fabricators, consistent with standard spec 101.2(2), on the bid closing date in order to be used on department projects. Fabricators must also comply with the procedures and requirements detailed here in 875.4.

Fabrication must comply with the American Welding Society (AWS) D1 Welding Codes. Fabrication shops are subject to periodic inspections by the department and all products must be inspected at the job site by the engineer before use.

The fabricator must provide facilities and qualified personnel to maintain an acceptable quality control program. The fabricator must upload certified mill test reports for plates, shapes, and fasteners to the fabrication library before starting the assembly process. The project leader or manager must review the certified mill test reports before the components are assembled and incorporated into the structure. The fabricator must maintain records of certified mill test reports. The records must be available at all times for examination by the engineer or department inspector and for a period of 5 years after use on a project.

Acceptance of items by this process is also contingent upon continued acceptable verification inspection at the project site by project personnel.

875.4.2 Scope

Items included under Fabricated Bridge Components are the following:

TABLE 875-3 Fabricated Bridge Components

Railing Assemblies
Steel Bearing Assemblies
Expansion Devices
Structural Steel Diaphragms (for concrete girders)

875.4.3 Qualification for Approved Fabricator List

Fabricators requesting product approval under the Certification Program must provide the following to: DOTDLStructuresFabrication@dot.wi.gov

1. Application form is available at:

   https://wisconsindot.gov/dtsdManuals/strct/fabrication/apl-fbc.docx

2. The fabricator must provide an updated Quality Control/Management Plan (QMP/QCP) directly to the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor on a yearly basis.

The fabricator is required to undergo an on-site plant inspection by a department representative.

Fabricators are added to the Approved Fabricator List by the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor after review and acceptance of the required documentation.

875.4.4 (Vacant)

875.4.5 Loss of Approved Status

Decisions regarding future qualification for approval of an affected shop are made by the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor. Approval to provide fabricated bridge components may be withdrawn for the following conditions:

- Inability of a fabricator to consistently supply products meeting specification requirements. This is defined as three rejections of components, by department inspections, or field engineer, in a three-month period.
- Lack of maintenance and submittal of required records, including: certified mill test reports, shop drawings for each structure, updates to the QMP/QCP, WPSs, welder certifications, welder continuity records, test results required by the applicable sections of the standard specifications and CMM.
- Failure to produce accurate material traceability documentation, including chemical and mechanical testing.
- Failure to follow contract plans, special provisions, and specifications.
- Improper documentation of shipments.
- Not maintaining an acceptable quality control program.

If any of the conditions listed above occur, the fabricator is given written notice of the department's intent to remove the fabrication shop from the APL. The fabricator has the opportunity to provide a corrective action plan to the department for review by SFU. Proposed corrective actions must take effect immediately. If additional nonconformances occur the fabricator is removed from the APL.

875.4.6 Fabricator Qualification for Re-approval

A fabricator who has lost approved status and seeks to be re-approved, must comply with the following:

1. Fulfill all parts of CMM 875.4.3.
2. Submit documentation to the Structural Metals and Fabrication Quality Assurance Inspection Unit Supervisor identifying the corrective actions taken to resolve the problems.

875.4.7 Acceptance of Products From Shops Not on the Approved List

Fabricated bridge components from shop not on the approved list are not accepted. To be added to the approved fabricator list, follow the procedures outlined in CMM 875.4.3.

875.4.8 Fabricator Certification of Shipments and Documentation

Each shipment of fabricated bridge components must include a certification statement from a fabrication shop providing a loading document or shipping invoice, date, project information, and contractor identification that lists the products in the shipment by description and number. The certification statement must be on the fabricating company's letterhead, with signature and title of a person responsible for certifying the product to bind the fabricator, and be worded essentially as follows:

"The products covered by this fabrication statement were manufactured in compliance with (list applicable specifications) and comply with the "Buy America Provisions" of WisDOT contracts. Copies of certified mill test reports are on file and available for review at the plant from which the products were fabricated. Representative samples of finished products have been inspected for conformance with the requirements of (list applicable specifications)."

These documents must be submitted to the engineer at the time of delivery of products to a project. The documents must be retained with the project records.

The engineer must conduct a visual inspection at the job site when delivery of products is made. The engineer may accept secondary fabrication products at the job site for shipments that include a loading document, fabricator certification statement and an acceptable visual inspection.

875.5 Pile Driving Data, DT1924

Provide a driving log for the first piling at each unit of structure using DT1924. The driving log and associated data is required for informational and comparative purposes only. Record the following information

- All applicable data including type, length, size, location of the pile tested and description of the hammer.
- The "Fall H" column the height of fall (stroke) of ram or striking parts of the hammer for each foot of penetration of the pile.
- The "Penetration Resistance" column the number of blows of the hammer for each foot of penetration of the pile and the set (inches per 10 blows).
- The "Bearing" column the corresponding Nominal resistance values of the pile as computed in tons for each foot of penetration of the pile.
- Any unusual conditions encountered in driving the pile should be noted on the back of the report.

The log is a valuable tool for assessing reasonableness of piling requirements shown on the plan. If the driving record for the first pile deviates significantly from that which was anticipated, the project manager should promptly discuss findings with the region PDS supervisor.

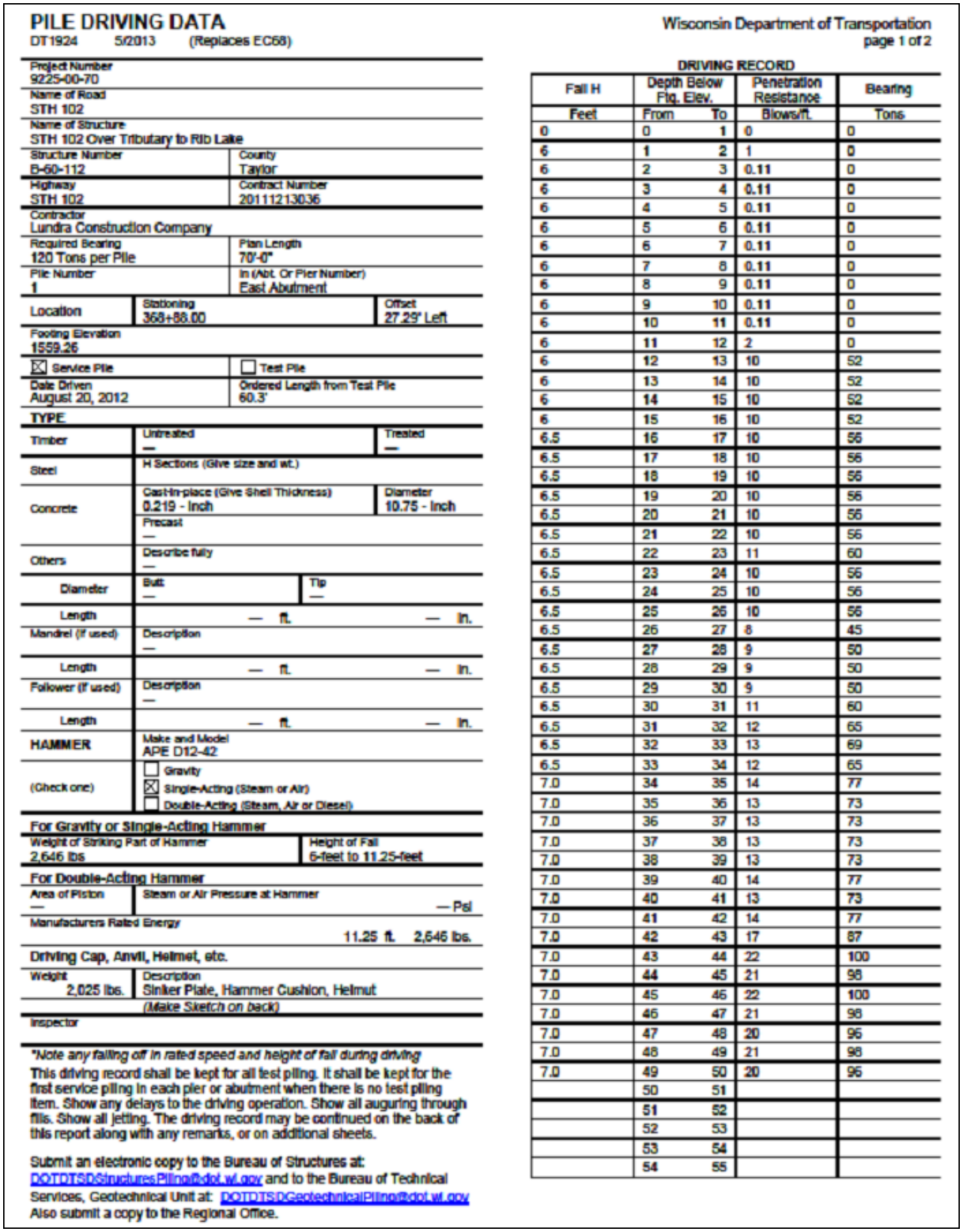
An example of a completed report is shown in figure 875-1. You should be aware the form provides, on the reverse side, a record for piling depths of 160 feet. The reverse side is not shown in this manual for the sake of brevity.

Electronic copies (PDFs) of DT1924 and DT1315 are to be submitted, with Project Manager concurrence, for all structures to BOS by email at: DOTDTSDStructuresPiling@dot.wi.gov

and to the BTS, Geotechnical Unit at: DOTDTSDGeotechnicalPiling@dot.wi.gov

Include the structure number (B, C, S, or etc.) in the subject field of the email.

FIGURE 875-1 Pile Driving Data, DT1924



PILE DRIVING DATA

DT1924 5/2013 (Replaces EC58)

Wisconsin Department of Transportation
page 1 of 2

Project Number: 9225-00-70		
Name of Road: STH 102		
Name of Structure: STH 102 Over Tributary to Rib Lake		
Structure Number: B-60-112	County: Taylor	
Highway: STH 102	Contract Number: 20111213036	
Contractor: Lundra Construction Company		
Required Bearing: 120 Tons per Pile	Plan Length: 70'-0"	
Pile Number: 1	In (Abt. Or Pier Number): East Abutment	
Location	Stationing: 368+88.00	Offset: 27.29' Left
Footing Elevation: 1559.26		
☒ Service Pile	☐ Test Pile	
Date Driven: August 20, 2012	Ordered Length from Test Pile: 60.3'	

TYPE

Timber	Untreated: —	Treated: —
Steel	H Sections (Give size and wt.)	
Concrete	Cast-in-place (Give Shell Thickness): 0.219 - Inch	Diameter: 10.75 - Inch
	Precast: —	
Others	Describe fully: —	
Diameter	Butt: —	Tip: —
Length	— ft.	— in.
Mandrel (if used)	Description: —	
Length	— ft.	— in.
Follower (if used)	Description: —	
Length	— ft.	— in.

HAMMER

Make and Model: APE D12-42

(Check one)

- ☐ Gravity
- ☒ Single-Acting (Steam or Air)
- ☐ Double-Acting (Steam, Air or Diesel)

For Gravity or Single-Acting Hammer

Weight of Striking Part of Hammer: 2,646 lbs	Height of Fall: 6-feet to 11.25-feet

For Double-Acting Hammer

Area of Piston: —	Steam or Air Pressure at Hammer: — Psi

Manufacturers Rated Energy: 11.25 ft. 2,646 lbs.

Driving Cap, Anvil, Helmet, etc.

Weight: 2,025 lbs.	Description: Sinker Plate, Hammer Cushion, Helmut

(Make Sketch on back)

Inspector

**Note any falling off in rated speed and height of fall during driving*

This driving record shall be kept for all test piling. It shall be kept for the first service piling in each pier or abutment when there is no test piling item. Show any delays to the driving operation. Show all auguring through fills. Show all jetting. The driving record may be continued on the back of this report along with any remarks, or on additional sheets.

Submit an electronic copy to the Bureau of Structures at: DOTDTSDStructuresPiling@dot.wi.gov and to the Bureau of Technical Services, Geotechnical Unit at: DOTDTSDGeotechnicalPiling@dot.wi.gov
Also submit a copy to the Regional Office.

DRIVING RECORD

Fall H	Depth Below Ftg. Elev.		Penetration Resistance	Bearing
Feet	From	To	Blows/ft.	Tons
0	0	1	0	0
6	1	2	1	0
6	2	3	0.11	0
6	3	4	0.11	0
6	4	5	0.11	0
6	5	6	0.11	0
6	6	7	0.11	0
6	7	8	0.11	0
6	8	9	0.11	0
6	9	10	0.11	0
6	10	11	0.11	0
6	11	12	2	0
6	12	13	10	52
6	13	14	10	52
6	14	15	10	52
6	15	16	10	52
6.5	16	17	10	56
6.5	17	18	10	56
6.5	18	19	10	56
6.5	19	20	10	56
6.5	20	21	10	56
6.5	21	22	10	56
6.5	22	23	11	60
6.5	23	24	10	56
6.5	24	25	10	56
6.5	25	26	10	56
6.5	26	27	8	45
6.5	27	28	9	50
6.5	28	29	9	50
6.5	29	30	9	50
6.5	30	31	11	60
6.5	31	32	12	65
6.5	32	33	13	69
6.5	33	34	12	65
7.0	34	35	14	77
7.0	35	36	13	73
7.0	36	37	13	73
7.0	37	38	13	73
7.0	38	39	13	73
7.0	39	40	14	77
7.0	40	41	13	73
7.0	41	42	14	77
7.0	42	43	17	87
7.0	43	44	22	100
7.0	44	45	21	96
7.0	45	46	22	100
7.0	46	47	21	96
7.0	47	48	20	96
7.0	48	49	21	96
7.0	49	50	20	96
	50	51		
	51	52		
	52	53		
	53	54		
	54	55		

875.6 Piling Record, DT1315

DT1315, Piling Record provides a summary record of all piling driven, except for test piling. Test piling data is reported on DT1924.

The inspector must complete a separate DT1315 for each unit of a structure containing piling. A sketch is made of the unit, with the location of each pile noted on the sketch. When a test pile is left in place to become a bearing pile, the location should be noted on the sketch with an "X" and the words "Test Pile."

DT1315 is an excel spreadsheet with three identical workbooks. If the number of piling within the substructure exceeds 16 piles, then the additional workbook(s) must also be completed. The cell formulas for the average nominal resistance, the total driven pay length and the average driven pay length need to be revised by the submitter to include all the appropriate column information in the additional workbooks.

The set (inches per 10 blows) and stroke (feet) at the end of driving operations should be recorded for each pile. These values are required to calculate the Nominal Resistance (Bearing Value) of the piles.

Electronic copies (PDFs) of forms DT1924 and DT1315 are to be submitted for all structures to BOS by email at DOTDTSDStructuresPiling@dot.wi.gov and to the BTS, Geotechnical Unit at DOTDTSDGeotechnicalPiling@dot.wi.gov. Include the structure number (B, C, S, or etc.) in the subject field of the email. A copy is retained in the region project files.

FIGURE 875-2 Piling Record, DT1315

PILING RECORD

Wisconsin Department of Transportation

DT1315 4/2013 (Replaces EB569)

County	Highway Number	Bridge Number
Rock	STH 26	B-53-259
Project Number	**Bridge Contractor**	
1390-04-79	Zenith Tech Inc.	
Pile Type	**Plan Length**	**Design Bearing Value**
CIP Concrete 12 3/4 x .375-inch	20 FT	206 Tons
Type of Driver – Type and Size of Hammer		
D-19-42, RAM = 4.00 kips		

Plan of Unit:



Pile Number	Set (inches per 10 blows)	Stroke (feet)	Nominal Resistance (tons)	Delivered Length (feet)	Splice Length (feet)	Cutoff Length (feet)	Driven (pay) Length (feet)	Date Installed (m/d/yy)
1	1.875	9.5	245.1	20.1	62.4	6.9	75.6	14-Nov
2	1.75	8.5	234.0	20.1	61.8	2.5	79.4	13-Nov
3	1.875	8	220.8	20.1	67.9	9.0	79.0	13-Nov
4	1.625	8	230.6	20.1	73.3	14.1	79.3	13-Nov
5	2	8	216.4	20.1	59.4	2.2	77.3	15-Nov
6	2.25	8.5	216.4	20.1	57.3	1.5	75.9	15-Nov
7	2.25	9	224.1	20.1	56.8	3.3	73.6	15-Nov
8	2	8.5	224.6	20.1	58.6	6.2	72.5	14-Nov
9	2.25	8.5	216.4	20.1	55.0	4.8	70.3	14-Nov
10	2	8.5	224.6	20.1	59.1	11.2	68.0	14-Nov
		Average:	225.3			Total:	750.9	
						Average:	75.1	

Project Engineer	Date (m/d/yyyy)
Project Engineer	11/14/2012

Submit an electronic copy to the Bureau of Structures at: DOTDTSDStructuresPiling@dot.wi.gov

and to the Bureau of Technical Services, Geotechnical Unit at: DOTDTSDGeotechnicalPiling@dot.wi.gov

Also submit a copy to the WisDOT Regional Office.

Use extra page for remarks

875.7 Bridge Inventory Report, DT 2006 and Bridge Inspection Report, DT 2007 and DT 2008

These forms must be completed whenever work is done on a bridge. The bridge maintenance engineer should be notified by the engineer in a timely manner, so the bridge can be inspected after completion, but before the contractor has left the site and the bridge is open to traffic.

Inspection is done by the bridge maintenance engineer, with assistance provided by the engineer or designee.

A copy of DT2006, DT2007 and DT2008 must be filed in the region maintenance section. A copy of DT2006 must be sent to BOS for their statewide bridge inventory file. If a local road is involved, a copy of DT2006 is sent to the county highway commissioner.

Attachment 875-1 Department Plant Certification Program Requirements

The department's plant certification requirements are:

1. Prequalification by PCI plant certification as a fabricator in good standing. Certification must be according to the PCI "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products. For information or a copy of this manual contact:

   PCI Director of Certification Programs
   West Jackson Boulevard
   Chicago, IL 60604-9773
   Phone: 312-786-0300

   A copy of the plant's PCI certification must be submitted to the department when application is made for plant certification. The plant's two most recent audit reports by PCI must be available at all times for review by the department and the department's certification review team. The reports must be reviewed only in the presence of plant personnel. The contents of the audit reports must remain confidential between the plant and the department and no parts of the reports must be reproduced or removed.
2. The fabricator must have a PCI certified Level II inspector who is responsible for QC sampling, testing and inspection who reports to personnel other than those responsible for production. Qualifications of other personnel performing QC work must be identified in the fabricator's QC plan.
3. A current quality control plan based on PCI guidelines, approved by the department.
4. In addition to the items listed above, a WisDOT annual certification review process which will include but not be limited to the following:
   - 4.1. Requests for approval of material sources
   - 4.2. Concrete mix design(s)
   - 4.3. Laboratory scale/balance calibrations
   - 4.4. Concrete mixer scale calibrations
   - 4.5. Cylinder testing machine calibrations
   - 4.6. Prestressing ram and dynamometer calibrations
   - 4.7. Aggregate gradations
   - 4.8. Fabrication procedures:
     - Hold down devices
     - Reinforcement placement, stressing and distressing sequences
     - Concrete production and placement
   - 4.9. Curing procedures
   - 4.10. Pre-approved girder repairs
   - 4.11. Storage operations
   - 4.12. Shipment operations

Attachment 875-2 Schedule of Tests

TEST	TEST DESIGNATION	FABRICATOR'S MINIMUM QUALITY CONTROL (QC)		WISDOT'S MINIMUM QUALITY VERIFICATION (QV)	
		TEST BY	FREQUENCY	TEST BY	FREQUENCY
CONCRETE INGREDIENT MATERIALS					
Aggregate Quality (Fine & Coarse)			Must be from a WisDOT approved source [1]	WisDOT Central Lab	
Aggregate Sieve Analysis (Fine & Coarse)	WTM T27	QC	One/source/week (for each aggregate)		
Water	WTP C001	QC	One/source/year	WisDOT Central Lab	One/Source/Yr
Cement		Mfr's Cert.	Must be according to WisDOT Method of Certification Acceptance [2]		
Fly Ash	ASTM C311	Mfr's Cert.	Must be according to WisDOT standard spec 501.3.7 [3]	WisDOT Central Lab	One/400 Tons(364 Mg)
Additives			Must be from WisDOT approved list of products [4]		
STEEL MATERIALS [5]					
Bar Steel (one 5ft length)	AASHTO T244 (Tensile)	Mfr's Cert.		WisDOT Central Lab	One/Heat
	AASHTO T285 (Bend)	Mfr's Cert.		WisDOT Central Lab	One/Heat
Prestressing Strands (8ft sample field cut in two 48" lengths)	AASHTO T244	Mfr's Cert QC	One/Heat	WisDOT Central Lab	One/Heat
CONCRETE MIXTURES					
Aggregate Moisture	WTM T255	QC	One/Day		
Slump	WTM T119	QC	Four/Line		
Air [6]	WTM T152	QC	One/Line		
Cylinders [7]: Release 28-Day Strength	WTM T22	QC QC	Two/Line Three/Line	WisDOT Central Lab	One/3 Month

[1] Aggregate sources must be tested for approval according to WisDOT Materials Testing and Acceptance Guide for PCC aggregate (refer to GUIDE in Construction and Materials Manual, Chapter 13).

[2] Portland cement must be selected from an approved source according to the WisDOT Method of Certification Acceptance.

[3] 30 days before use and every 30 days during work. Daily uniformity tests: specific gravity, % R#325, loss on ignition, moisture, sulphur trioxide and mortar air content.

[4] Additives must be either from WisDOT approved lists of products or by approval of the WisDOT Physical and Chemical Tests Engineer.

[5] All steel materials must be in compliance with Buy America provisions according to the contract specification requirements.

[6] Air testing must be required only when air-entrainment is used.

[7] Cylinders must be molded according to AASHTO T23.

Note: Test result differences between QC and QV will be monitored by WisDOT on an informal basis until further notification. Precision statements of the AASHTO Methods will be used, if available.

Fabricator's QC Schedule of Records

The fabricator must maintain records and have them available for inspection review until five years after final acceptance of the products by the department. The schedule of the records includes:

- Shop and detail drawings
- Equipment calibrations and certificates
- Records of aggregate source quality
- Manufacturer's certifications for materials (cement, fly ash, steel, etc.)
- Cement records required by the WisDOT certification acceptance program
- Buy America certification documents for steel materials
- Concrete mix design(s)
- Temperature charts for curing
- Records (reports) of all testing (cylinder testing and other) [1]
- Log of tests for neoprene cylinder caps
- Proof loading date records

[1] Copies of the test reports for concrete cylinder compressive strength must be provided to the department QV inspector by the completion of each contract.

Attachment 875-3 Plant Inspection Fabrication Forms

It is the consensus of WisDOT, fabricators and the FHWA that the plant inspection fabrication forms to be completed and retained by the fabricator must include the following:

General Information Required:

1. WisDOT Project I.D., Structure I.D. and Girder I.D.'s
2. Fabricator name and Job I.D
3. Date

Required Data for Elongation Calculation Record:

1. Average modulus of elongation for the strands used, from the strand manufacturer's certifications
2. Average area for the strands used, from the strand manufacturer's certifications
3. Nominal diameter of the strands used
4. Total length of strands being stressed
5. Losses in stress and elongation
   - 5.1 Splices - number and calculated loss (slippage)
   - 5.2 Chucks - number and calculated loss (slippage)
   - 5.3 Abutment/Anchor - loss (movement)
   - 5.4 Thermal Correction
     - Total length of girders
     - Air temperature at time of stressing
     - Concrete temperature at time of initial set
6. Total load per line (from plan)
7. Load per strand adjusted for the losses listed above
8. Initial load applied
9. Required elongation
10. Strands used (manufacturer, reel no., heat no., and WisDOT Lab Test No.)

Required data for field stressing and elongation record:

1. Draped strand elongations
2. Straight strand elongations
3. Strand location identification
4. Gauge reading (load applied)
5. Gauge jacking system used

Required data for the record of the concrete mix used:

1. Mix design
   - 1.1. Aggregates used (source/s and grade/size)
     - Quantity of each aggregate used
     - Fine (moisture, absorption and free water)
     - Coarse (moisture, absorption and free water)
   - 1.2. Cement used (source, type and quantity used)
   - 1.3. Admixtures (source, type and quantity used)
   - 1.4. Fly Ash (source, type and quantity used)
   - 1.5. Micro Silica (source, type and quantity used)
   - 1.6. Water (source and quantity used)
2. Concrete testing
   - 2.1. Slump
   - 2.2. Air
   - 2.3. Temperature of mix
   - 2.4. Cylinders (date, time and number cast with identification)
     - Required release and 28 day strengths
     - Compression test results
     - Age of tested cylinders
3. Time of pour completion
4. Concrete curing

4.1. Type of cure (air, steam, wet, etc.)
4.2. Time steam was applied
4.3. Time steam ended
4.4. Temperature record (chart or report in pour records or provide a traceable path to the information)

5. Release of strand stress into concrete member
5.1. Time of release and age of concrete member
5.2. Method of release (prescribed in QC plan)

Required data for the record of materials used:

1. Aggregate quality tests (WisDOT Lab)
2. Strand quality tests (one per heat no. from WisDOT Lab)
3. Manufacturer certifications or certified reports of tests
3.1. Cement, fly ash and micro silica
3.2. Reinforcement bars (Buy America)
3.3. Strands (Buy America)
3.4. Other metal products (bearing plates, hold-downs, etc.)
3.5. Admixtures (Approved List or meets appropriate ASTM requirements)
4. Aggregate sieve analysis (fabricator)

Required data for the record of product inspections:

1. Shop drawings (as built)
2. Prepour check list (documented)
3. Postpour check list (documented)
4. Initial sweep measurements
5. Initial camber measurements