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1.3 TYPES OF BRIDGE INSPECTIONS AND ASSESSMENTS

1.3.1 Introduction

There are numerous types of bridge inspections. Each inspection type has been designed to obtain specific information from a structure. For instance, when a structure is built, an Initial Inspection is done to document the as-built condition of the structure and its structural elements. This is the baseline inspection, and all future inspection findings are compared to this information. Routine Inspections are performed at regular intervals to monitor the working condition of structure elements. This is the most common type of inspection. The results from a Routine Inspection are used to assess structure safety and structure maintenance needs. Special Inspections are used to monitor known defects in a structure.

All of the inspection types that are used by the Wisconsin Department of Transportation (WisDOT) help to create a complete picture of a structure's condition and are described in detail in this chapter.

1.3.2 Initial Inspection

1.3.2.1 Purpose

CFR 650.305 states: *Initial Inspection. The first inspection of a new, replaced, or rehabilitated bridge. This inspection serves to record required bridge inventory data, establish baseline conditions, and establish the intervals for other inspection types.*

An Initial Inspection is the baseline inspection that shall be completed on every new, replaced, or rehabilitated structure preferably before <u>but no later than 3 months after the structure is open to traffic</u>. An Initial Inspection is a fully documented inspection, using the structure plans, to determine basic data about the structure for entry into the Highway Structures Information System (HSIS) file. In addition, special inspections such as Nonredundant Steel Tension Member (NSTM) or Underwater Dive inspections that are needed must be performed as soon as practicable, but within 12 months of the bridge being open to traffic.

Data gathered for Initial Inspections should include the following:

1. An existing set of plans, as-builts, shop drawings, design computations, and hydraulic computations for the bridge (if applicable).

2. An analytical determination of load capacity (performed by a qualified Wisconsin professional engineer).

3. All Structure Inventory and Appraisal (SI&A) data required by federal and state regulations.

4. Other relevant information required by the department to maintain an accurate bridge file.

5. Baseline structural conditions and element quantities.

6. Any existing problems or locations in the structure that may have potential problems.

7. Location and condition of any NSTM members or details.

8. Underwater channel profiles at the upstream and downstream fascia (for structures over water).

9. Using the profile information, assessment of the need for future underwater dive inspections.

When an initial inspection is conducted, a Structure Inventory and Appraisal Field Review must be completed and entered into the Highway Structures Information (HSI) System. This form can be generated by the HSI software for each bridge in the state and must be verified for accuracy at least once every 48 months.

As part of the Initial Inspection, inspectors need to review the appropriate inspection types required on the structure and verify that the HSIS system has those inspection types flagged.

For instance, imagine a bridge with a two-girder superstructure system spanning a waterway. The bridge has a supporting pier in the middle of the channel. First, a two-girder superstructure system does not provide redundant load paths. Should one girder fail, the entire bridge will collapse, and therefore is a NSTM structure. Next, the pier in the channel has affected the normal flow pattern of the water. As a result, the stream channel and the pier foundation may be subject to scour action. Finally, the depth of the stream or the turbidity of the water may obscure the visibility of the pier foundation. It is foreseeable, then, that this bridge will require a NSTM inspection, and possibly an underwater inspection. Once the inspector has decided what inspection types the structure will require, he/she should complete the appropriate boxes for the associated inspection interval in HSIS and notify the Inspection Program Manager.

Figure 1.3.2.1-1: Inspector Performing an Initial Inspection.

1.3.2.2 Precision

The Initial Inspection is required to document “as-built” **conditions**, not whether the structure was constructed per Plans and Specifications. Since this is a baseline inspection, all deficiencies, cracks, construction errors, alignment problems, etc. should be quantified and documented. The compiled documentation will be used during future inspections to determine if defects discover in the future existed when the structure was constructed or if they have materialized from the loading applied to the structure.

1.3.2.3 Inventory Update/Rating of Repairs

Since both the National Bridge Inventory (NBI) and Element Level rating scales are based upon existing structural conditions, repairs may improve the condition ratings assigned to a structure. When work is completed on an existing structure, a Special inspection shall be entered into the HSIS that takes into account the new structural condition.

1.3.2.4 Inspection Interval

Each newly constructed or rehabilitated structure shall receive an Initial Inspection as soon as practical but within 3 months of opening the structure to traffic. WisDOT prefers that an Initial Inspection be completed before the structure is open to traffic. An initial inspection should preferably be completed before a construction contract can be finalized.

Below is a list of required bridge inspections conducted after the initial inspection.

<table>
<tr><th colspan="3">Inspection or Activity Interval</th></tr>
<tr><th rowspan="2">Type</th><th colspan="2">Maximum Inspection Interval (Months)</th></tr>
<tr><th>Low Risk</th><th>High Risk</th></tr>
<tr><td rowspan="2">Routine</td><td>24</td><td rowspan="2">12 (2)</td></tr>
<tr><td>48 (1)</td></tr>
<tr><td>In-Depth</td><td colspan="2">Varies (48 to 72) (3)</td></tr>
<tr><td rowspan="2">NSTM</td><td>24</td><td rowspan="2">12</td></tr>
<tr><td>48 (6)</td></tr>
<tr><td rowspan="2">UW-Dive</td><td>60</td><td rowspan="2">24</td></tr>
<tr><td>72 (4)</td></tr>
<tr><td>UW-Profile</td><td>96</td><td>Varies (24 to 60) (5)</td></tr>
<tr><td>SI&A Review</td><td colspan="2">48</td></tr>
<tr><td>Scour POA</td><td colspan="2">48</td></tr>
</table>

1. **Structure must qualify per section 1.3.3.3**
2. **Includes bridges that are closed; see section 1.3.12 for more information**
3. **Interval is dependent on structural detail per section 1.3.4.3**

4. **Structure must qualify per section 1.3.7.3**
5. **Dive inspected bridges are on a 60-month cycle per section 1.3.6.1**
6. **Structure must qualify per section 1.3.5.3**

1.3.3 Routine Inspection

1.3.3.1 Purpose

CFR 650.305 defines a *Routine Inspection as: Regularly scheduled comprehensive inspection consisting of observations and measurements needed to determine the physical and functional condition of the bridge and identify changes from previously recorded conditions.*

1.3.3.2 Precision

Routine inspections are generally conducted from the deck, ground, or water level or from permanent work platforms and walkways. If any element of the bridge appears to be distressed, the inspector should take a closer look at that element. Critical load-carrying members (*e.g.,* steel and concrete girders, decks, slabs, concrete box girders, piers and bents, bearings, abutments) should be closely monitored. Failure prone details or elements should receive a detailed, close-up (arm's length) inspection. See Section 3.6, NSTM Inspection and Part 2 Appendix D, Fatigue Prone Details for typical critical details. Inspection of underwater portions of the substructure is limited to observations during low-flow periods, probing for signs of undermining, and streambed profile measurements where applicable. This is further discussed in Section 3.9 All inspection results should be fully documented on the report form stored in HSIS.

Any changed or deteriorated structural conditions that might affect previously recorded bridge load ratings should be noted on the inspection form. If the inspector determines that a new load rating is warranted, the "load rating" box should be marked with a "Y". <u>The owner is responsible for rating the structure.</u> That owner is also responsible for getting the updated structure data into the appropriate structure file(s) located in the HSI. The HSI electronic file is the Official Bridge File.

Public safety is the primary concern of the structure inspector. Therefore, the inspector should make sure Wisconsin's structures are physically safe as well as structurally stable. Special attention should be paid to the condition of parapets, railings, pedestrian fencing, guardrail, sidewalks, spalling concrete surfaces, and other safety related members. The following are examples of conditions that may warrant documentation and notification of the Local, County or Region Manager:

1. trip hazards, severe approach settlement, or large spalls on sidewalks;
2. rebar protruding from decks, walks, or parapets;
3. loose, missing, or damaged railings or parapets;
4. missing or damaged guardrail;

5. loose concrete that could fall onto a traveled way (road, walk, bike path, waterway, or rail line); and

6. any other condition that the inspector perceives as a threat to public safety.

The inspector may have several documents available to assist him in organizing and performing the inspection. These documents include: as-built plans, original shop drawings, as-built repair plans and shop drawings, and previous inspection reports.

1.3.3.3 Routine Inspection Interval

Routine inspections are performed at regular intervals not to exceed (NTE) 24 months. **For high risk bridges the regular interval shall not exceed 12 months.**

High Risk Bridges meeting the following criteria must in be inspected at intervals NTE 12 months:

- One or more of the Deck, Super, Sub, Culvert, or Scour Condition Rating is coded 4 or less, or the bridge is posted less than 40 tons based on load rating.

The routine inspection interval may be reduced by the county or region inspection program manager based on other factors such as element condition ratings, scour environment, history of vehicle impact damage, other known deficiencies, or inspector recommendation.

Where condition ratings are coded four (4) or less due to localized deficiencies, a special inspection limited to those deficiencies can be used in lieu of a routine inspection. A complete routine inspection must be conducted at its set interval. For structures that have rigorous routine inspection procedures and requirements, the owner may request that only a partial inspection be completed on the element(s) contributing to the NBI poor condition rating of 4 or less. Approval from the Statewide Inspection Program Manager must be granted 2 months or more in advance of the inspection including the reason for exemption and inspection procedure for the partial inspection. Inspections meeting this criterion must be entered in the Highway Structures Information system as a Routine inspection with only the inspected elements checked and inspection procedures for the partial inspection including BOS approval date. A full Routine inspection for each element must occur in a 24-month timeframe.

Low Risk Bridges meeting the following criteria are eligible for an extended regular interval of 48 months:

- NBI Deck, Super, Sub, Culvert ≥ 6 or N.
- Must have an initial or routine inspection and another routine inspection 24 months or more apart.
- Span Type – all slab types, all girder types (except thru girder, girder/floorbeam), all box girder - multiple, arch under fill without spandrel, 3 and 4 sided frames only, T-beam, and pipe.
- Span Material – Concrete or Steel
- Inventory Load Rating Factor ≥ 1.0
- Routine Permit Loads = A or N.
- Fatigue Details (E & E') = None

- Cannot have steel defect 1010 Cracking.
- Cannot be load posted.
- Routing Permit Load item = A (routine permit loads are not restricted) or N (no permit loads allowed)
- Cannot have Element 161 Steel Pin, Pin & Hanger Assemblies or Pin thru Web.
- Border bridges with adjoining states are eligible with adjoining state agreement.
- Not a NSTM (fracture critical) bridge
- Hwy Min Vertical Clearance ≥ 14.0’ (on or under)
- Scour Vulnerability = A or B (stable for scour)
- Scour Condition Rating ≥ 6
- Channel Condition ≥ 6
- Channel Protection Condition ≥ 6
- Must be less than 50 years old.
- No bridges with complex features

The routine inspection interval may be kept at the standard 24-month interval by the county or region inspection program manager based on other factors such as element condition ratings, scour environment, history of vehicle impact damage, other known deficiencies, or inspector recommendation.

For Steel twin-tub girder bridges that were analyzed and found to be no longer NSTM but system redundant member (SRM) bridges shall have a maximum required inspection Interval of 48 months for the interior of the tub girders. The rest of the bridge is to follow the eligible routine inspection Interval. For more information on SRM’s see section 1.3.4.7.

The 48-month extended Intervals is optional and is up to the structures owner to utilize. Local agencies are required to be assessed at a level of Compliance or Substantial Compliance for each of the FHWA 23 metrics to be eligible to utilize the extended Interval provisions.

Failure to assess at these levels for any of the 23 metrics will require the local agency to write a Plan of Corrective Action (PCA) to correct the deficiencies. The plan must be approved by the Statewide Inspection Program Manager and Regional Program Manager and the deficiencies must be corrected within the timeline agreed to in the PCA to maintain eligibility.

The structures owner interested in participating in the 48-month extended intervals needs to have the County PM or Commissioner fill out the DT2002 Structure Inspection Quality Control Form and follow the instructions enclosed.

1.3.4 In-Depth Inspection

1.3.4.1 Purpose

An In-Depth Inspection is a visual, hands-on inspection of one or more structure elements above or below water level that may be supplemented by non-destructive evaluation. This higher-level inspection can be performed on any structure type, though it is commonly performed on steel superstructure bridges with problematic details that need close up evaluation (as discussed below).

The exception to this is NSTM bridges, which have a federally mandated "In-Depth" inspection of all primary tension members. This specific type of In-Depth is called a NSTM inspection and is entered into the Highway Structures Information (HSI) System as a NSTM Inspection only. More information on this inspection type can be found in section 1.1.2 of this manual.

An In-Depth Inspection can be scheduled independently of a Routine Inspection, though generally at a longer interval, or it may be a follow-up for a Damage Inspection. Generally, specialized equipment is required to obtain the necessary hands-on, arm's length access to the element (snooper trucks, scissor lifts, ladders, etc.).

On small bridges, it may be practical to include all elements of the structure during the inspection. In this case, both the Routine and In-Depth boxes shall be checked in the Highway Structures Information (HSI) System when entering the inspection. If NDE is used during this inspection, or any other inspection type, the activity type for Non-Destructive Evaluation should also be checked.

For large and complex structures, In-Depth Inspections may be scheduled separately for defined segments of the bridge or for designated groups of elements, connections, or details that can be efficiently addressed by the same or similar inspection techniques. If the latter option is chosen, each defined bridge segment and/or each designated group of elements, connections, or details should be clearly identified in the inspection procedures and inspection specific notes as a matter of record.

The activities, procedures, and findings of In-Depth Inspections should be thoroughly documented with appropriate photographs, test results, measurements, and a written report in the HSI system. In addition, access methods must be clearly documented so that future scheduling needs can be determined.

WisDOT requires an In-Depth inspection at a defined interval for the structures mentioned in section 1.3.5.3. However, there are other conditions and/or structural details that may prompt an unscheduled In-Depth Inspection.

Several common conditions or structural details that could prompt an In-Depth Inspection (and possibly NDE) include:

- Apparent cracks in steel members
- Apparent cracks, de-bonding or loss of tendon section in a Prestressed or post-tensioned member
- Heavily corroded or failed hold down devices.
- Severe section loss in a steel member or primary gusset plate
- Buckled or bent steel girders or beams.
- Welded cover plate end terminations
- Live load bearing anchor pins, and link-bars

- Field welds on tension members
- Intersecting welds, or category D, E, or E' details
- Unique or Problematic Details

The decision to conduct an unscheduled, In-Depth Inspection, with or without the use of NDE, is the responsibility of the Regional Program Manager. Items to consider when making this decision include (but are not limited to) ADT, Condition, Age and Location.

1.3.4.2 Precision

As indicated previously, an In-Depth Inspection is a visual, hands-on inspection of one or more structural elements. Each element under investigation should be within arm's length of the inspector. The inspection may include a recommendation for a load rating to assess the residual capacity of damaged or deteriorated members, depending on the extent of the damage or deterioration. Nondestructive load tests may be conducted to assist in determining a safe bridge load-carrying capacity. The inspector should exercise sound judgment in recommending when a load capacity analysis is warranted.

1.3.4.3 In-Depth Inspection Interval

In-Depth Inspections are **required** for the following:

- Bridges with pin thru web or pin & hanger assemblies (excluding NSTM Structures)
- Steel Bridges with floor systems (excluding NSTM Structures)
- 3 or 4 Chord Deck Trusses

Maximum Required In-Depth Inspection Interval:

Bridge Type (non-NSTM Bridges)	Requirement	Maximum Interval
Pin & Hanger Assemblies	Visual, Hands-on	72 Months
Steel Floor Systems (Floorbeam/Stringer)	Visual, Hands-on	96 Months
3 or 4 Chord Deck Trusses	Visual, Hands-on	48 Months

Other In-Depth inspections can be scheduled to supplement routine inspections, or as a follow-up to a special, initial, or damage inspections. But these will generally not have a recurrence interval.

For In-Depth inspections on structures with pins, a minimum of 20% of the pins shall be evaluated with NDE methods, including all components that have indications of cracking, distress, fretting rust, or seizing. The locations that have been evaluated shall be thoroughly documented, and efforts shall be made in subsequent in-depth inspections to vary the components being tested.

1.3.5 Nonredundant Steel Tension Member (Fracture Critical) Inspection

1.3.5.1 Purpose

CFR 650.305 defines a Nonredundant Steel Tension Member (NSTM) inspection as: *A hands-on inspection of a nonredundant steel tension member.* An NSTM inspection is a specific type of In-Depth inspection. However, since it is specifically called out in the Code of Federal Regulations, NSTM Inspections must be coded separately from In-Depth inspections on the National Bridge Inventory submittal and in HSI.

CFR 650.305 defines a nonredundant steel tension member (NSTM) as: A *primary steel member fully or partially in tension, and without load path redundancy, system redundancy or internal redundancy, whose failure may cause a portion of or the entire bridge to collapse.*

Common NSTM's include (but not limited to):

- Tie girders on tied arch bridges
- Tension chords or tension diagonals on trusses
- Tension flanges on non-redundant girders
- Tension flanges on non-redundant steel pier cap beams
- Pins on non-redundant girder/truss bridges
- Primary gusset plates connecting NSTM's
- Connecting points of NSTM's chords/diagonals

Primary gusset plates, regardless of connecting NSTM or compression elements, with continuing deterioration (active corrosion, distortion) are risk factors. The locations of these elements, as well as the amount of deterioration shall be measured and documented in the bridge inspection report. The Interval and methods of measurement shall be recorded in the inspection procedures.

NSTM Inspections are regularly scheduled inspections. NSTMs require more thorough and detailed inspections than the members of non-NSTM bridges. In recognition of this, Federal Regulation 23 CFR 650.313(g) requires inspection procedures to be developed and documented for each NSTM bridge.

Figure 1.3.5.1-1: Inspectors Performing a NSTM Inspection

Bridges with NSTMs have written bridge specific inspection procedures and NSTM diagrams which clearly identify the location of all NSTMs, specify the Interval of inspection, describe specific risk factors unique to the bridge, and clearly detail inspection methods and equipment to be employed. Guidance for the specific inspection procedures is provided under Section 1.3.5.4.

An NSTM Inspection can be scheduled independently of a Routine Inspection, though it is common to schedule both during the same inspection. Generally, specialized equipment is required to obtain the necessary hands-on, arm's length access to the element (under bridge inspection vehicle, scissor lifts, ladders, etc.). The first NSTM inspection for a bridge or for a bridge with rehabilitated NSTMs must be completed as soon as possible but within 12 months of the bridge opening to traffic per CFR 650.313(f)(3).

On some bridges, it may be practical to include all elements of the structure during the inspection. In this case, both the Routine and NSTM (Fracture Critical (Arm's length)) boxes shall be checked in the Highway Structures Information (HSI) System when entering the inspection.

For some bridges, the NSTM Inspection may be scheduled and completed separately from the Routine Inspection. If this option is chosen, each defined NSTM shall be clearly identified in the inspection procedures and inspection specific notes as a matter of record.

The activities, procedures, and findings of NSTM Inspections must be thoroughly documented with appropriate photographs, test results, measurements, and a written report in the HSI system. In addition, access methods must be clearly documented so that future scheduling needs can be determined.

Floor beams spaced greater than 14 feet apart shall have a hands-on inspection for the entire tension portion of the floor beam. A hands-on inspection also applies to connections located in tension zones, such as the floor beam connection(s) to the primary load carrying member and connections to secondary members such as stringer to floor beam. These floor beams will be inspected using the same techniques as NSTM. This shall be noted in the inspection procedures. The floor beams shall be inspected at the NSTM inspection Interval for the bridge in question and be conducted by a certified NSTM inspector. When floor beams spaced greater than 14 feet are shown to be non-critical through analysis (approved by Bureau of Structures), the hands-on inspection is not required and should be inspected with typical visual methods.

In rare cases where arms-length access cannot be safely accomplished by traditional methods (reach-all, ladder, etc.), alternative means of inspection are necessary. These methods require detailed inspection procedures that must be approved by BOS prior to use. Please coordinate with BOS Structures Maintenance prior to developing these procedures.

In addition, if the owner agency has demonstrated that floor beam members spaced greater than 14 feet apart have system or internal redundancy based on an FHWA approved methodology per CFR 650.313(f)(1)(i), then NSTM procedures are not required for those members.

1.3.5.2 Precision

An NSTM Inspection is a hands-on inspection. CFR 650.305 defines a hands-on inspection as: *Inspection within arm's length of the member. Inspection uses visual techniques that may be supplemented by nondestructive evaluation techniques.* Every square foot of the member/member component is examined. The observations and/or measurements are used to determine the structural capacity of the member/member component, to identify any changes from previous NSTM Inspections, and to ensure that the structure continues to satisfy present safety and service requirements.

Under-bridge access equipment is typically required to move the inspector within arm's length of the members. There may be permanent work platforms and walkways available on some larger structures to aid in inspection work. The access methods used during the inspection must be documented in the inspection procedures.

1.3.5.3 Nonredundent Steel Tension Member Inspection Interval

Nonredundant steel tension members are inspected at regular intervals not to exceed 24-months except as required based on NSTM condition and inspection findings.

NSTM Bridges meeting the following criteria must in be inspected at intervals NTE 12 months:

- NSTM Inspection Condition State is coded ≤ 4

The inspection Interval must be identified in the written inspection procedures.

Maximum Required Inspection Interval:

Hands-on/visual .... 24 months

Hands-on/visual when NSTM Bridge Inspection Condition Item is coded ≤ 4 .... 12 months

Hands-on/visual for NSTM Bridge eligible for extended inspection intervals............ 48 months

Nondestructive Evaluation (NDE) .... 72 months

Details to consider for NDE of NSTM Components include:

- Pin and hanger assemblies
- Live load bearing anchor pins and link bars
- Pin thru web assemblies
- Welded cover plate end terminations on NSTM's
- Field welds on NSTM's
- Intersecting welds, or category D, E, or E' details on NSTM's
- Unique or Problematic Details on NSTM's

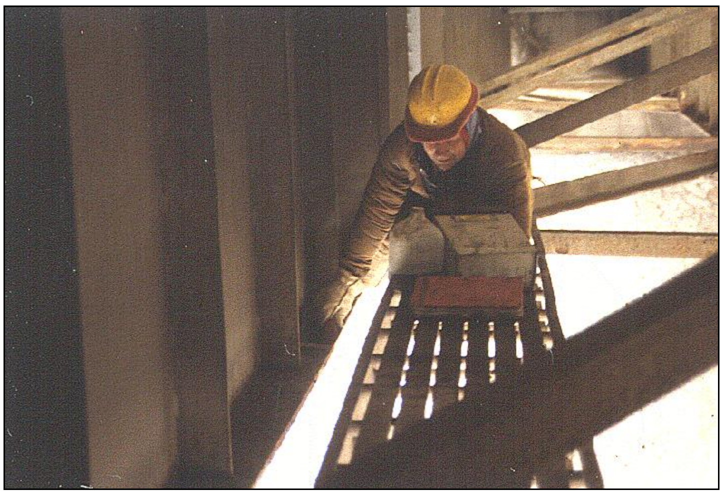


Figure 1.3.5.3-1: Inspector Performing Ultrasonic Testing for Crack Detection.

1.3.5.4 Specific Inspection Procedures

A bridge identified with a nonredundant steel tension member (NSTM) must have a detailed written inspection procedure specific to that bridge. These inspection procedures are to be kept in the bridge file, reviewed, and updated for **each** NSTM inspection. The inspection procedures should be written in a manner that is useful to the inspection team.

The inspection procedures must address any of the following areas that are relevant to the specific NSTM bridge.

- General Information –
    - Provide a general statement indicating the scope of the inspection
        - Include hands-on visual assessment of identified NSTMs
        - Identify problematic details.
    - Identify the method(s) to be used to complete the inspection.
    - Identify any other inspection types or activities that will be performed at the same time, for example, routine or NDT.

- Clearly specify the Interval of the NSTM hands-on visual inspection.
- NSTM Diagram which identifies the location of the nonredundant steel tension members, primary gusset plates, including any floor beams needing hands-on inspection. The team lead or inspection program manager should verify the diagram is up to date. Form DT2011 may also be used to document the NSTM diagram.
- Workforce/Staffing
    - Staffing level – number of inspectors, team members
    - Staff qualifications needed
    - Define the duties to be performed by each team member or team of inspectors.
- Inspection Tools
    - Special tools not common to a routine inspection
    - Special lighting needs – if needed
    - Nondestructive testing (i.e. magnetic particle, a dye penetrant kit or ultrasonic testing device).
    - Method of access and equipment needed for hands-on inspection of each nonredundant steel tension member. The minimum size and location on the bridge the equipment will be needed.
        - Rope/rigging
        - Ladders
        - Scaffolding
        - Aerial work platforms
        - Under-bridge inspection truck
- Traffic control needs – on and under including any permits required.
        - Roadway
        - Pedestrian
        - Navigation
        - Railroad
- Scheduling – include any conflicts. Some common conflicts to address are as follows:
    - Daytime inspection times
    - Traffic congestion times
    - Known conflicts under the bridge
    - Railroad or navigation traffic
    - Availability of inspection staff
- Site conditions that impact the inspection
    - NSTM condition
    - Clean surface areas (as necessary) to allow for thorough visual inspection
    - Lighting required to improve visibility
    - Utility attachments
    - Environmental concerns
    - Railroads
    - Safety Concerns
        - Confined spaces
        - Traffic (on and under)
        - Homeless people
        - Night work
- Describe the inspection sequence to inspect the NSTM's.
    - Planned sequence that prevents missing details.
    - Historic sequence.
- Contacts and/or situational awareness communication
    - State and local agencies (DNR, county hwy dept, local municipality)

  - Federal agencies (Coast Guard, FHWA, Army Corp, etc.)
  - Law enforcement
  - Emergency response
  - Adjacent property owners
  - Utility company
  - Media
  - WisDOT Region Communications Manager (WisDOT bridges)
- **Identify specific risk factors** that impact safety or serviceability and problematic details/locations affecting the NSTM. Some possible specific risk factors and problematic details are listed below:
  - Cover plates
  - Primary gusset plates with continuing deterioration (active corrosion or distortion). The locations of these elements, as well as the amount of deterioration shall be measured and documented in the inspection report.
  - Discontinuities resulting in stress risers
  - Bolted/riveted connections present
  - Fatigue and fracture prone details (category D, E and E' details)
  - Triaxial constraint
  - Problematic materials
  - Poor welding techniques
  - Intersecting welds
  - Tack/field/intermittent welds
  - Back-up bars
  - Out-of-plane distortion
  - Retrofits/repairs
  - Existing steel cracking
  - Steel section loss
  - Load posting
  - NSTM Condition item of 4 or less
  - Subject to oversized or overweight loads
  - Historic impact damage
  - Service life (>30 yrs)
  - High ADTT (>5,000)
  - NDT (MT, UT, PT, etc.) is required because of existing defect
  - Historically significant structure issue.
  - Pin/hanger or pin through web connections
  - Mechanical fasteners (bolts and rivets)
  - Other

NSTM Diagram included with the inspection report and procedures must clearly identify the location of all nonredundant steel tension members.

1.3.5.5 NSTM Supplemental Inspection Form

The nonredundant steel tension member (NSTM) inspection report must include a detailed supplemental inspection form which identifies and documents the condition of each NSTM and AASHTO fatigue detail. The inspection report must provide qualitative and quantitative information concerning the NSTM and fatigue detail. This information is important for several reasons: it can offer insight about the condition of the NSTM, it can provide a history of the bridge, and it can be used to substantiate the thoroughness of the inspection effort. The supplement inspection form will be included with form DT2007 for the NSTM Inspection Report. Links to the supplemental inspection forms are below.

Links to supplemental NSTM inspection forms:

DT2010 (Word Document) & DT2011 (Word Document)

Supplemental NSTM Inspection Form A (Excel Spreadsheet)

Supplemental NSTM Inspection Form B (Excel Spreadsheet)

Supplemental Steel Girder-NSTM Inspection Form (Excel Spreadsheet)

1.3.5.6 Highway Structures Inventory System (HSIS)

The specific inspection procedure and the supplemental inspection form must be uploaded into HSIS on the *Documents/Images* tab. The procedures will be loaded under the *Category* of Inspection Procedures and the supplemental inspection form will be loaded under the Category of NSTM.

1.3.5.7 Redundant Members

System Redundant Member (SRM) and Internal Redundant Member (IRM) Determination

The SRM and IRM policy and procedure contains all elements meeting the requirements of 23 CFR 650.313(f)(1)(i)(B) through (G). Refer to section 24.15 of the Wisconsin Bridge Manual.

Identification

WisDOT has select bridges with steel tub girder members that are classified as System Redundant Members (SRM) For steel tub girders, SRM determination was made in accordance with the "*AASHTO Guide Specifications for Analysis and Identification of Fracture Critical Members and System Redundant Members",* including the research and evaluation efforts conducted by Purdue University (Rob Connor) that lead to the development of said guide spec. In addition, there are a number of Integral steel Cross Heads, present on select tub girder structures designated as IRM. Internally Redundant Member determination was made in accordance with the "*AASHTO Guide Specifications for Internal Redundancy of Mechanically-Fastened Built-Up Steel Members" Note WisDOT has yet to conduct the analysis on these members, but will do so in accordance with the AASHTO IRM guide spec.*

Applicability

This policy applies to bridges that have members designated as SRM or IRM as outlined in the AASHTO Guides. WisDOT SRM or IRM are a select set of bridges with steel tub girders meeting criteria in WBM 24.15.

This policy does not apply to bridges with steel tub girders with any of the following:

a. The presence of a crack that has not been effectively arrested.

b. A primary load carrying member in Condition State 4 (CS4)

c. Unresolved impact damage to primary load carrying members, such as stress risers (cracks, sharp reentrant corners) or large out-of-plane distortion

The discovery of any condition listed above does not automatically revert a bridge with an existing SRM or IRM status to an NSTM. This shall be treated as a structural review and subject to the structural review policy and evaluation criteria below.

Evaluation criteria

The detection of the following defects through inspections after the initial baseline condition used in the SRM or IRM determination do not require a reevaluation of the structure's redundancy. Engineering judgement is to be used to determine if further action is warranted (e.g. repair or non-SRM analysis to support engineering judgement).

1. CS3 or CS4 distortion in the bottom flange or web of the tub girders in the negative moment region

2. CS3 or CS4 distortion in the bottom flange or web of the exterior diaphragms

3. Section loss < 10% of the gross bottom flange and web in the *negative* moment regions

4. Cracking and section loss of bottom flange and web in the *positive* moment regions

5. Missing bolts and section loss of field splices in the tub girders

6. Cracks distortion, section loss in the external diaphragms and/or missing bolts in diaphragm-to-girder connections

7. Fire damage.

Justification for these allowances is provided by the SRM analysis which included a reserve margin of 15% (the analysis is pass/fail criteria, so the analysis still passed with a 15% increase in demands, so this can be considered inversely that a small loss in capacity will not negate the results of the analysis)

A full reevaluation of the SRM is required if any of the following are met:

1. Loading conditions have changed

    a. The number of striped lanes has increased

    b. An increase in the deck dead load greater than the dead load considered in the original SRM analysis

        i. 10% additional dead load was considered in original analysis of the tub girder bridges

2. Section loss ≥ 10% of the gross bottom flange and web in the *negative* moment regions.

3. Removal of external diaphragms (not allowed).

If a reevaluation/analysis is required, the appropriate sections of the bridge will be defined as NSTM, and those procedures are to be followed until a time at which the structure is restored to its original conditions assumed in the current SRM analysis or the structure is reevaluated through a *new* SRM analysis (which requires FHWA approval).

Design and Construction Details

Modern steel tub girder bridges, specifically those in Wisconsin's inventory that have an SRM status, have been designed and constructed with fatigue and fracture resistant details. Most bridges have been fabricated with high performance steels (HPS) which give the members improved fracture toughness. Those bridges with non-HPS were fabricated with A709 steel per a fracture control plan with zone 2 Charpy V-notch toughness requirements. The integral cross heads, with IRM status, are fabricated with HPS70W. The integral cross heads are readily accessible and can be visually inspected during routine inspections. Newly constructed bridges need to follow the AASHTO guidance to be eligible.

Routine Inspection Requirements

Steel tub girder bridges analyzed and found to be system redundant member (SRM) bridges (no longer NSTM) receive a routine inspection per section 1.3.3.3. Document the access methods, focus areas and conditions to monitor in the bridge specific inspection procedures.

In-Depth Inspection Requirements

The in-depth inspection of SRM bridges with steel tub girders consists of a close-up detailed inspection of the interior and exterior of the tub girders, including the full depth exterior diaphragms. The in-depth inspection will serve to collect and document the existing condition of the interior and exterior of the steel tub girders in greater detail than a typical routine inspection. This may include a hands-on inspection at some locations which will be outlined in the bridge specific procedures for in-depth inspections. The inspection will include a close-up visual inspection by walking the full-length interior of the steel tub girder and by viewing or accessing the exterior of the steel tub girders, including the exterior full height diaphragms, using binoculars, drones, under-bridge inspection unit, or other access methods sufficiently so the inspector is confident the bridge and element condition can be assessed. The in-depth inspection may be completed in conjunction with the routine inspection.

The maximum in-depth inspection interval of steel tub girders for SRM bridges is 48 months. However, in-depth inspection interval is the lesser of 24 months or the eligible routine interval when any of the following occurs on the interior of the tub girder:

- Steel cracking or distortion defect exists in CS2, 3, and 4.

- Corrosion or Connection defects exist in CS3 over 5% of total Steel Closed Web/Box Girder element length in any one span. *For example, a 150' twin-tub girder span could have a maximum of 5% x 300' =15 LF total combined CS3 corrosion or connection defect in that span before being subject to a reduced interval for the interior inspections.*

Special Inspection Requirements

Refer to the special inspection section 1.3.9.

Specific Inspection Procedures

The in-depth inspection for SRM and IRM bridges require detailed written inspection procedures specific to the bridge. These inspection procedures are to be kept in the bridge file, reviewed, and updated for each in-depth inspection. Refer to Section 1.3.5.4 Specific Inspection Procedures for applicable information required in the redundant member specific inspection procedures. Additionally, address the following within the inspection procedures:

- Identify specific areas of concern/risk factors
  - Full-depth diaphragms
  - Review section 1.3.5.4 for additional applicable risk factors

1.3.6 Underwater Profile

1.3.6.1 Purpose

Scour is the leading cause of bridge failures. Federal Highway Administration (FHWA) regulations have been expanded to require bottom profiling and maintenance of channel records. The FHWA regulations reference the 2008 American Association of State Transportation and Highway Officials (AASHTO) The Manual for Bridge Evaluation, 1st Edition, which provides more specific information. Accordingly, the Department shall maintain such records on applicable bridges and ensure that local units of government do likewise.

Underwater profile activity involves gathering streambed elevations and alignment information used to assess streambed conditions and monitor channel movement at bridges and bridge like structures over waterways. The data gathered is compared to as-built information and past profiles. The survey is in the form of an underwater profile or a hydrographic survey. The underwater profile consists of cross-sections of the streambed taken parallel to the bridge. At a minimum, profiles must be obtained at the upstream and downstream fascia. It is not required to profile around substructure units (as these are covered by the underwater probe and/or Dive Inspections), but this may be done during the profile activity as directed by the inspection team leader or the inspection program manager.

The ability to capture the true picture of the underwater landscape with an underwater profile is limited. A hydrographic survey is performed in conjunction with the underwater dive inspection using sonar equipment on select bridges. Generally, a hydrographic survey is completed on bridges over larger bodies of water where the water stretches across the full span or multiple spans and boat access is necessary and possible.

The profile may be completed by a TM trained by a TL or PM. A review of the TM's work must be completed by a TL or PM. The results of the profile must be compared with historical data to ascertain potential movement of the channel and risk of substructure undermining. If potential movement of the channel and risk of substructure undermining exists, this may be considered a critical finding and require notification to the Statewide Program Manager. See Section 1.3.18 for the Critical Finding Process.

The results must be entered into HSIS with documentation that show or explain the profile. The HSI system will allow the uploading of numerous file formats including Excel spreadsheets. At the inspector's discretion, a spreadsheet may be created for a structure and uploaded to the HSI system for future reference and modification, if necessary. Example template spreadsheets can be utilized on our website under Inspection Sketches and Templates.

Bridges involved in a significant flooding event – Bridges and bridge like structures that experience a 25 year or greater storm event in 24 hours or that are located on river systems that reach flood stage require a post flood evaluation to ensure the channel has not shifted affecting the structural integrity of the bridge. A post flood evaluation will include a streambed profile when signs of channel movement, degradation, or aggradation exist.

Resources for determining precipitation estimates and flood events can be found through the National Weather Service. The **Precipitation Frequency Data Server** provides frequency predictions for precipitations amounts for locations throughout Wisconsin and **Advanced Hydrologic Prediction Service** provides flood predications and flood stages for river systems throughout Wisconsin.

In Conjunction with Underwater Dive Inspection

Structures that also require Underwater Dive inspections shall have extensive profiles taken during the Dive inspection; water depth measurements during an underwater inspection should also include the following "global area" locations:

1. Maximum water depth measurements at each substructure unit in the water.
2. Bottom elevations at sufficient intermediate points between substructure units at the upstream fascia and downstream fascia, to adequately determine the thalweg of the waterway.
3. Termini of upstream and downstream profiles shall be referenced or monumented to ensure that subsequent profiles are taken at the same locations. GPS coordinates are acceptable.
4. The lateral movement of the channel will be monitored by …
    a. Review existing arial photographs to compare to the field conditions.
    b. Take up/downstream photographs of the channel and conditions from the bridge deck.
        i. Capture enough photos from above the abutments and piers to capture an upstream and downstream view of the entire flood plain.
    c. Document signs of lateral movement of the channel
    d. Hydrographic surveys
        i. Generally, performed on bridges over larger bodies of water where the water stretches across the full span or multiple spans.

ii. Locations of bodies of water that are best surveyed using a boat for access.

iii. Locations that typical methods of channel survey would be impractical.

iv. Locations where monitoring lateral stream migration by methods identified under Action 3.a are not adequate.

Scour is the movement of channel bed material by the action of the moving water. This movement may result in degradation, or erosion, of material as well as aggradation, or accumulation of material. Degradation of the channel bed may lead to structure instability, posing an often-unseen threat to safety.

There are three forms of scour that can affect the safety of bridges and waterfront structures.

1. General scour is the general degradation or loss of the bed material along a considerable length of a waterway. It can be the result of natural erosion, mining activities, construction, or other events.

2. Contraction scour involves the removal of material from the bed and banks across all or the majority of the width of a channel. Contraction scour is caused by a reduction in the upstream channel cross-section, which results in increased flow velocities, increased bed shear stresses, and subsequent loss of material.

3. Local scour is the removal of material from a smaller area and is restricted to a minor portion of the width of the channel. The main mechanism of local scour is the formation of vortices at the base of piers, piles or other substructure elements as a result of currents, propeller wash, discharge/intake pipes, or other factors.

As discussed in Section 1.3.8, divers should note any signs of scour during underwater inspections. An important assessment during any inspection is how much of the substructure foundation is exposed when compared to design plans.

The inspector should check for scour at every structure over a waterway. The inspector should be aware that scour is generally most severe during periods of high flow[1] and when flows recede to normal levels; the presence of scour is often covered up with silt or timber debris, making detection difficult. Comparison of previous profiles is typically needed to detect and assess general and contraction scour.

[1] High flows following a major rainfall event can generally be expected to occur about 12 hours after precipitation ceases as a rough rule of thumb; however, every waterway is different, based on a variety of factors.

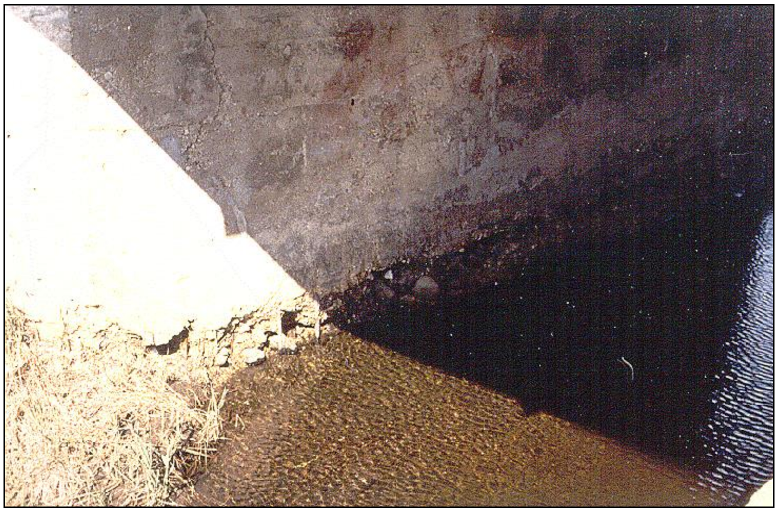


Figure 1.3.7.1-1: Local Scour at the Base of an Abutment.

1.3.6.2 Precision

Hydrographic survey data is used to evaluate trends in channel bottom movement and to compare channel bottom elevations to footing elevations. Water depth measurements should typically be recorded to the nearest tenth of a foot. However, scour evaluations are typically based on changes in elevations greater than 0.5 foot since most channel bottoms are irregular surfaces with random cobbles, debris, and sand ripples.

It is generally an acceptable practice for scour inspectors to measure the water depth relative to the water surface, in waterways without steep profiles or obvious hydraulic drops, assuming the waterline elevation in most waterways is constant over the surveyed area adjacent to the bridge. In actuality, since water always flows toward a lower topographic elevation, it is common for there to be at least 0.1 foot decrease in water surface elevation over a length of 500 feet in most waterways in Wisconsin. For waterways with steep profiles or obvious hydraulic changes in the water surface elevation, all water surface elevations must be recorded if direct water depth measurements are taken. Rather than documenting several water surface elevations, the inspector may choose to record the channel bottom elevation to a constant elevation using a surveyor's level or total station equipment.

During all underwater surveys, the water surface elevation shall always be referenced to a known elevation on or near the bridge.

In most instances, a bridge profile is located on a tangent or vertical curve. In order to expedite the streambed profile, the Wisconsin DOT recommends determining the elevation of an accessible bridge component. For example, the top of a bridge rail, or edge of deck are common landmarks an inspector can utilize when taking streambed elevations. The purpose of the profile is to observe changes to the streambed from inspection to inspection. So long as every inspector subsequently uses the same landmark and elevation for data recording, an accurate account is developed. Therefore, it is imperative that the inspector clearly identify the elevation of the landmark (these can be derived off existing plans or arbitrarily chosen) and the location the measurements are taken from (e.g. North Abutment – Upstream Fascia at Centerline of Bearing). When using an arbitrary elevation, the inspector may assume a constant elevation along the length of the structure, even if located on a vertical profile. Again, this is acceptable because the profile is a comparative tool. So long as the subsequent inspections replicated this arbitrary elevation and the locations at which measurements are taken, the data shall indicate whether there have been any changes to channel alignment or elevation.

While the true streambed elevation determined may be skewed due to the bridge profile following a tangent or vertical curve, the data will be able to be compared to later inspections.

1.3.6.3 Inspection Interval

1. All structures over water except 4-sided structures (i.e. box culverts and round/elliptical pipes) are required to have an initial underwater profile activity completed during the Initial Inspection with subsequent underwater profiles completed at a maximum interval of 96 months.

2. Bridges with a concrete floor for the streambed, other than culvert type bridges, require only an initial profile activity completed. The profile elevations should be obtained along the end of the concrete floor. If the concrete floor runs beyond the right-of-way, the initial profile can be taken along the bridge soffit.

3. Higher Risk Bridges are those meeting the criteria below. These bridges have the underwater profile activity completed at a maximum 24-month interval.

    a. B.C.09 Channel Condition Rating ≤ 4 (poor)
    b. B.C.10 Channel Protection Condition Rating ≤ 4 (poor)
    c. B.C.11 Scour Condition Rating ≤ 6
    d. B.AP.03 Scour Vulnerability = C, D, or U (bridge is scour critical)

4. Structures that require underwater dive inspections will have Global area profiles at 60 months and can forgo the 24-month requirement.

1.3.6.4 Equipment

Several water depth measurement methods, with a variety of equipment, can be used during a scour inspection with a hydrographic survey. These water depth measurements, often called soundings, can be obtained by manual means (lead line or sounding pole) or technological equipment (fathometer, sonar, radar, etc.). Refer to Chapter 19 in Part 5 for information on underwater profile equipment.

1.3.7 Underwater Inspection

1.3.7.1 Purpose

CFR 650.305 defines an underwater inspection as: *Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water or by wading or probing, and generally requiring diving or other appropriate techniques.*

Underwater Diving Inspections are a necessary part of an effective structure management program and are mandated by the Federal Highway Administration (FHWA) on routine intervals not to exceed 60 months. Underwater diving inspections should be completed in accordance with OSHA 29 CFR 1910 SUBPARTS T AND Y, and the requirements described in this section. An underwater diving structure inspection is required if water conditions exist at the structure that prohibit access to all portions of an element by visual or tactical means ensuring a level of certainty during Routine Inspections.

These specialized inspections serve an important part in protecting the public, providing reliable service, and reducing maintenance and construction costs. Structural conditions above water that could lead to failure, loss of life or property damage are often observed well in advance by inspectors, maintenance workers, and sometimes even passing motorists. Conversely, significant underwater structural conditions cannot be observed by these individuals until the defect has progressed to the point where distress is evident above water. Unfortunately, structures exhibiting significant underwater defects often collapse before the distress is evident above water.

Although each type of material has predominant mechanisms of deterioration, the environment (moderate temperatures, moisture, oxygen, and chlorides or other chemicals) at the waterline is most conducive to all forms of deterioration. Furthermore, unique mechanisms, such as bacterial corrosion, are also common near the waterline on structures. This deterioration and distress may not be recognizable from above water, nor can the extent and severity be determined in most cases without inspecting the underwater elements.

1.3.7.2 Precision

Due to limited underwater visibility, the inherent access restrictions of the underwater environment, and the presence of marine growth, the required underwater diving inspection precision depends on the level of effort. Three underwater diving inspection intensity levels are defined by the FHWA. The expected underwater diving inspection precision is based on the individual coverage percentage of these three levels of effort. A summary is provided in Figure 1.3.8.2-1 with narrative descriptions of each level following the figure.

Level	Purpose	Typical Detectable Defects/Expected Findings			
		Steel	**Concrete**	**Timber**	**Composite**
I	General visual/tactile inspection to confirm as-built condition and detect severe damage	Extensive corrosion and holes Severe structural damage	Major spalling and cracking Severe reinforcement corrosion Broken piles	Major loss of section Broken piles and bracings Severe abrasion or marine borer attack	Permanent deformation Broken piles Major cracking or structural damage
II	To detect surface defects normally obscured by marine growth	Moderate structural damage Corrosion pitting and loss of section	Surface cracking, spalling, erosion Rust staining Exposed reinforcing steel and/or prestressing strands	External pile damage due to marine borers Splintered piles Loss of bolts and fasteners Rot or insect infestation	Cracking Delamination Material degradation

Level	Purpose	Typical Detectable Defects/Expected Findings			
		Steel	Concrete	Timber	Composite
III	To detect hidden or interior damage, evaluate loss of cross-sectional area, or evaluate material homogeneity	Remaining thickness of material Electrical potentials for cathodic protection Change in material properties	Onset of reinforcing steel corrosion Internal voids Change in material properties	Internal damage due to marine borers (internal voids) Decrease in material strength Change in material properties	Change in material properties

Figure 1.3.8.2-1: Summary of Intensity Levels.

Level I Effort

An inspection involving a visual examination or a tactile examination using large sweeping motions of the hands where visibility is limited. Although the Level I effort is often referred to as a “Swim By” inspection, it must be detailed enough to detect obvious major damage or deterioration due to overstress or other severe deterioration. It should confirm the full-length continuity of all members and detect undermining or exposure of normally buried elements. A Level I effort may also include limited probing of the substructure and adjacent channel bottom. Refer to Figure 1.3.8.2-2 for a view of a structure during a Level I effort.

Figure 1.3.8.2-2: Inspector Conducting a Level I Inspection Effort.

Level II Effort

A Level II effort is a detailed inspection that requires marine growth to be removed from portions of the structure. Cleaning is time-consuming so there is a need to limit the detailed inspection to a representative sampling of components. For piles, a 12-inch high band should be cleaned at designated locations, generally near the waterline, at the mudline, and midway between the waterline and the mudline. On an H-pile, marine growth should be removed from both flanges and the web. On a rectangular pile, the marine growth removal should include at least three sides; on an octagonal pile, at least six sides; on a round pile, at least three-fourths of the perimeter. On large diameter piles, three feet or greater, one-foot squares should be cleaned at four locations approximately equally spaced around the perimeter, at each elevation. On large solid faced elements such as pier shafts, one-foot squares should be cleaned at four random locations, at each elevation. The Level II effort should also focus on typical areas of weakness such as attachment points and welds. The Level II effort is intended to detect and identify damaged and deteriorated areas that may be hidden by surface biofouling. The thoroughness of cleaning should be governed by what is necessary to discern the condition of the underlying material. Removal of all biofouling staining is generally not required. Refer to Figure 1.3.8.2-3 for a view of a structure during a typical Level II effort.

Figure 1.3.8.2-3: Inspector Conducting a Level II Inspection Effort.

Level III Effort

A detailed inspection typically involving nondestructive evaluation (NDE) or partially-destructive evaluation (PDE), conducted to detect hidden or interior damage, or to evaluate material homogeneity. Typical inspection and testing techniques include the use of ultrasonic, coring or boring, physical material sampling, and in-situ hardness testing. Level III testing is generally limited to key structural areas, areas which are suspect or areas which may be representative of the underwater structure. Refer to Part 5 of this Manual for additional information on nondestructive and partially destructive evaluation. Also, refer to Figures 1.3.8.2-4 and 1.3.8.2-5 for views of inspectors conducting Level III efforts.

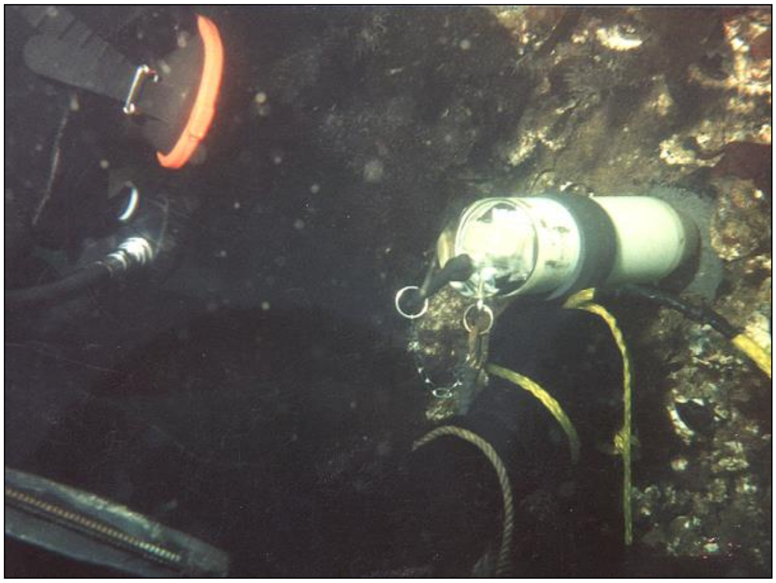


Figure 1.3.8.2-4: Inspector Using a D-Meter to Conduct a Level III NDE Inspection Effort.

Figure 1.3.8.2-5: Inspector Using a Drill to Conduct a Level III PDE Inspection Effort.

1.3.7.3 Underwater Diving Inspection Interval

CFR 650.311(b) establishes the minimum requirements for underwater inspection interval. These requirements are described and elaborated on in the NBIS *Metrics for Overview of the National Bridge Inspection Program*.

Inspection Interval – Underwater –Lower risk bridges:

UW inspections are performed at regular intervals not to exceed (NTE) 60-months, or NTE 72-months when adhering to FHWA approved UW criteria. The criteria a structure must meet to be considered for the 72-month Routine UW-inspection Interval are as follows:

- Underwater Inspection Condition item ≥ 6
- Structure must have at least two (2) Underwater Dive inspections on file to be eligible.
- Border bridges with adjoining states are eligible with adjoining state agreement.
- No bridges with complex features
- No substructure Elements with the Microbial Induced Corrosion Defect (8901).
- No substructures with timber substructure elements are eligible.
- NBIS Channel Condition and Channel Protection Condition items ≥ 6
- Scour Condition Rating item ≥6
- Scour Vulnerability item = A or B
- Must be less than 50 years old.

The 72-month extended UW-Inspection Intervals is optional and is up to the structures owner to utilize. The eligibility requirements are the same as previously describe for the 48-month routine inspections. The structures owner interested in participating in the 72-month extended UW-inspection Intervals needs to have the County PM or Commissioner fill out the DT2002 Structure Inspection Quality Control Form and follow the instructions enclosed.

Underwater High Risk bridges meeting the following criteria must be inspected at a reduced interval not to exceed 24 months:

- Underwater Inspection Condition ≤ 3
- Channel Condition ≤ 3
- Channel Protection Condition ≤ 3
- Scour Condition Rating ≤ 3

Partial underwater inspections may be completed on bridges meeting the reduced interval criteria for the underwater inspection due to localized deficiencies. The inspection program manager, with concurrence from the bridge owner, may request from the SPM, approval to complete a partial underwater inspection on the element(s) contributing to the condition rating of 3 or less. The request, including the reason for the exemption and the inspection procedure for the partial inspection must be provided to the SPM at least 2 months prior to the month the inspection is due. Bridges granted the partial underwater inspection by the SPM will have the inspection results entered in HSIS as an Underwater inspection with only the inspected elements checked, with the inspection procedures for the partial inspection, and with the documentation showing SPM approval. A full underwater dive inspection must occur on a 48-month interval. In addition, Wisconsin requires adherence to the following criteria:

1. An Underwater Profile is required as part of the Initial Inspection

2. An underwater diving bridge inspection should include at least a Level I effort on 100 percent of all underwater elements, a Level II effort on 10 percent of all underwater elements, and a Level III effort as determined by the Team Leader.

1.3.7.4 Methods of Underwater Inspection

After identifying that a structure requires an underwater diving inspection, it must be decided which underwater diving inspection method should be used. Underwater diving inspection methods are categorized as “manned” or “unmanned”. The following factors influence the determination of which method of underwater diving inspection is best suited for a structure:

1. Water depth (depth greater than 4.0 feet should be performed by diving)
2. Water visibility
3. Water velocity (if greater than 2 feet per second, should be performed by diving)
4. Streambed conditions (if soft or irregular, should be performed by diving)
5. Presence of debris or other obstructions/obstacles
6. Substructure configuration

The qualified “manned” methods consist of an inspection-diver using commercial Self-Contained Underwater Breathing Apparatus (SCUBA) equipment or surface supplied air (SSA) equipment. For qualified “manned” methods, the Team Leader is required to be a certified diver and be able to perform the underwater inspection.

The “unmanned” methods typically use a real-time submersible videography lens or electronic imaging devices to transmit observation data to a qualified Team Leader. Although electronic imaging devices are not often used in Wisconsin, submersible videography lenses have been used on telescopic poles and in remote operated vehicles (ROVs). When the diver is not a qualified Team Leader and the Team Leader is not a qualified diver, the lenses can be attached to a diver’s helmet. While these “unmanned” methods are acceptable if they are conducted in a way that ensures a sufficient level of certainty, they should be considered only as a secondary alternative if the more preferable qualified “manned” method is not feasible. The Team Leader’s assessment capabilities are adversely affected when unable to perform the actual physical inspection.

Underwater diving inspection in Wisconsin is most frequently conducted by a dive team using SCUBA equipment. This method consists of using a standard exposure suit and a portable air tank. The inspector(s) will make a visual and tactile evaluation of the substructure units by swimming around the individual units. SCUBA equipment allows the inspector greater freedom of movement, the ability to visually inspect the substructure units both above and below the waterline, even in poor water visibility, and to reach all areas even in deep water. Limitations of the SCUBA method are: the duration of the inspection due to a limited air supply (dive should typically be finished prior to a pressure gauge reading of 750 psi); a permissible depth range for safe operation (120 feet); additional tethering in swift currents; and specialized training and equipment for the inspectors. Refer back to Figures 1.3.8.2-2 to 1.3.8.2-5 for views of inspectors using scuba equipment.

Although more common in underwater diving construction, an underwater diving inspection can also be conducted by a dive team using a surface supplied air system. The equipment consists of a standard exposure suit, a full-face mask/helmet, and umbilical cords connecting the diver to the surface. The inspector(s) will make a visual and tactile evaluation of the substructure units by swimming around the individual units. This method of inspection provides many of the same benefits as a SCUBA inspection along with being well-suited for adverse diving conditions, such as swift velocities (typically up to 14 fps), polluted water, and long diving durations. Limitations of the surface supplied air method is that the equipment: limits free movement; a permissible depth range for safe operation (220 feet), and specialized training and equipment for the inspectors. Refer to Figure 1.3.8.4-1 for a view of an inspector using surface-supplied-air equipment.

Figure 1.3.8.4-1: Inspector Using Surface-Supplied Air Equipment.

1.3.7.5 Inspection Equipment and Tools

The underwater diving inspectors will require a larger than normal amount of equipment to complete the various tasks associated with the structure investigation regardless of the method used. These items are a mix of common tools and specialized equipment that will provide a breathing medium, means of movement, and aid the inspector in collecting data at the structure.

Personal Equipment

For an underwater diving inspection, a brief equipment list is as follows:

1. Exposure suit (wet or dry)
2. Dive mask or helmet
3. Breathing apparatus
4. Air supply (portable tank or surface compressor unit)
5. Weight belt
6. Dive fins
7. Buoyancy compensator
8. Depth gauge / pressure gauge (All dives should be terminated at 750 psi.)
9. Wristwatch
10. Light source

Furthermore, an inspector conducting a diving inspection should carry additional equipment such as a knife and reserve air tank or J-valve on the tank.

Access Equipment

While access is often gained from the shoreline, some structures are best accessed by use of a boat. Typically, an 18-foot or larger vessel can safely carry the equipment and crew. On some occasions, access may be gained from the structure itself.

Communication Equipment

While it is not mandatory to be in voice communication during shallow water dive inspections, two-way voice communication greatly aids in the efficiency of the inspection data collection and recording, and it provides an added level of safety. For deep-water inspections, the use of two-way voice or hand-signal communication is recommended. The advantages of direct voice communication are:

1. The diver can communicate directly with the note-taker to describe the location, type, and size of any observed defects.
2. The diver can discuss any observations with surface personnel.
3. When using video equipment, the surface personnel can direct the diver to specific areas that appear suspect or where closer investigation needs to be conducted.
4. The diver can immediately report the extent of any problems.

Tools

The inspection team should have access to the appropriate tools and equipment as warranted by the type of inspection being conducted. A number of tools should be available to the inspector and can be categorized as hand-tools or power-tools. Since power-tools are not frequently used, a brief list of typical hand-tools is as follows:

1. Ruler
2. Calipers
3. Probe (ice picks, awls, screwdrivers, etc.)
4. Geologist hammer
5. Scraper
6. Wire brush
7. Pry bar

Testing Equipment

Often an inspection requires some level of material testing to ascertain the condition of the substructure unit that may not visually show any significant signs of deterioration. Testing is also the main component of a Level III inspection. Testing may be either nondestructive or partially destructive and is described in detail in Part 5 of this Manual. Nearly all the methods in Part 5, which are applicable for use on substructures, can also be performed underwater.

Photography & Videography Equipment

A still or video camera can provide a visual record of defects or deterioration that is observed by the inspector. This information can be reviewed with others to better define and evaluate the significance of the defect.

A still camera can be fitted with a variety of lenses and flash units that are suited for different conditions. In low visibility, the camera will need to be placed close to the object and will require a wide-angle lens. Particles that are suspended in the water, which make it cloudy, reduce ambient light and can reflect light from the flash unit into the lens. When visibility is very low, clear water boxes can be used. A clear water box is constructed of clear plastic and is filled with clean water. By placing the box against the object to be photographed, the box of clean water will displace the murky water allowing for a clear photograph. Refer to Figure 1.3.8.5-1 for a view of a typical clear water box.

Figure 1.3.8.5-1: Inspectors Attaching a Clear Water Box to an Underwater Camera.

Video equipment is generally available as self-contained submersible units, or as a submersible camera lens attached to the diver with a cable connection extending to a surface monitor and controls. The latter allows a surface operator to direct the shooting, control the lighting and focusing, and communicate with the diver to obtain the optimum image. A sound track could also be dubbed with the video image by the diver or topside personnel to provide a running commentary pertaining to the observations.

1.3.7.6 Underwater Inspection Procedures

A bridge that receives an underwater inspection must have a detailed written inspection procedure specific to that bridge. These inspection procedures are to be kept in the bridge file, reviewed, and updated for **each** underwater inspection.

The inspection procedures must address any of the following areas that are relevant to the specific bridge receiving the underwater inspection.

- Clearly Identify the location of all underwater elements and assess all units during the dive inspection
    - Dry units can be documented as “dry” without additional detail
    - Units that can be probed shall be and notes shall be taken on the condition of the streambed and substructure unit
    - Units require diving shall be inspected according to guidelines in the SIM.

- Specify the interval of the underwater inspection

- Describe any specific risk factors

    - The specific risk factors shall be separated into Diver and Structure risk factors.

- **Diver Risk Factors**

  - For each bridge, include diver risk factors (diver safety) in a separated paragraph under the Inspector Site-Specific Safety Considerations section of the report. Start the paragraph "Diver risk factors:". If there are no diver risk factors, please note "Diver risk factors: None".

  - Some diver risk factors could be:

    - Debris accumulation
    - Limited visibility in the water
    - Rapid stream or current
    - Soft or unstable streambed or stream banks for walk in entry
    - Pollutants in water

Note this is not an exhaustive list so others may qualify as diver risk factors.

- **Structure Risk Factors**

  - Include all structure risk factors (related to scour, environment, or structure) at a bridge in the <u>specific procedures section</u> of the dive inspection report. Provide a separated section of the procedure to address structure risk factors. This section should be started with "Structure risk factors:". List or describe the structure risk factors. If there are no structure risk factors, please note "Structure risk factors: None". Remove any structure risk factors listed elsewhere outside of the UW-Dive specific procedures section or separate documents since they should only be listed in UW-Dive specific procedures section of the report.

  - Some structure risk factors could be:

    - Debris accumulation
    - Rapid stream or current
    - Pollutants in water
    - Marine environment
    - Meandering channel
    - Unknown foundation
    - Scour critical bridge
    - Observed scour

- Environmental conditions (i.e. MIC for steel, timber piling – limnoria) which may accelerate deterioration

Note this is not an exhaustive list so others may qualify as structure risk factors.

- Clearly detail inspection methods
- Equipment and tools to be employed

1.3.8 Underwater Probing/Visual (Wading) Activity

These methods of underwater inspection involve either wading or probing with a rod or the feet. Underwater Probing/Visual Inspection is the most basic type of underwater inspection and can often be performed by an inspector wading in the water with no additional training. This type of activity is required for all structures over water that are not dove at regular intervals and should be done in conjunction with the Routine inspection where applicable.

The inspection is conducted by evaluating the substructure units and the waterway by using a probe rod or sounding pole. The inspector wearing waders (or a dry/wet suit) walks around the substructure, probing the units and channel bottom with the rod and with his/her feet, while visually inspecting the areas above and directly below the waterline where visibility permits. Limitations of the wading inspection are deep water, poor water visibility, excessively soft or irregular streambed conditions, and swift currents that make movement difficult or dangerous. Refer to Figure 1.3.9-1 for a view of an inspector conducting a wading inspection.

The results of the probe are entered into the HSI system when an inspection type is created under the Tab titled Underwater. This tab lists all substructure units on the bridge. If the substructure unit is dry at the time of the probing, the inspector shall note that on the form for the unit in question.

Figure 1.3.9-1: Inspector Conducting a Wading Inspection.

1.3.8.1 Inspection Equipment and Tools

Personal equipment typically includes hip waders, a hard-hat, reflective vest, and tool belt for an inspector conducting an underwater probing/visual (wading) inspection.

1.3.8.2 Underwater Probing/Visual Inspection Interval

It is required that an Underwater Probing/Visual Inspection be performed every 24 months. Because of this recommended interval, it is often performed at the same time as the Routine Inspection. An Underwater Probing/Visual Inspection is also required as part of the Initial Inspection, as well as during an Underwater Dive Inspection.

1.3.9 Special Inspection

1.3.9.1 Purpose

A special inspection is scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency, or to monitor special details or unusual characteristics of a bridge that does not necessarily have defects. A TL is required on site for any special inspection whenever a bridge component condition rating(s) (B.C.XX items) is assessed. The following is a list of possible special inspection activities and required inspector qualifications:

Special Inspection Activities and Qualifications

Special Inspection Activity	**Minimum Qualifications**	**Interval**
NDE for Timber	TM under direction/oversight of a TL	As needed and determined by the PM
NDE for Steel	Certified or trained in the type of NDE being performed under direction/oversight of a TL (see SIM 5.1.2.1)	As needed and determined by the PM
NDE for Concrete	TM under direction/oversight of a TL	As needed and determined by the PM
Reduced interval in lieu of Routine Inspection	TL	Per SIM 1.3.3.3
Deck Evaluation	TM under direction/oversight of a TL	Per SIM Part 1 Appendix A

Special Inspection without Activity	TL	As needed and determined by the PM

*Under direction and oversight means TL may not be on site but provides training and review of TM work.

For special inspections where a TM completes the inspection, the TL must review the report and sign as reviewer in HSIS. If the TL identifies an issue the PM should be notified.

1.3.9.2 Special Inspection Procedures

Documented inspection procedures are to be included with the inspection report for special inspections used for monitoring conditions. The report should outline the scope of the inspection and document all findings. It should also detail the reason for the special inspection and make recommendations for condition rating changes, repairs necessary, or future monitoring activities.

1.3.9.3 Special Inspection Interval

In general, Special Inspections are scheduled at the discretion of the individual responsible for structure inspections for the unit of government that owns the structure.

1.3.10 Damage Inspection

1.3.10.1 Purpose

A Damage Inspection is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions. Flood damage, barge impact, and vehicle impact are common examples of events that may call for a Damage Inspection. A team lead qualified inspector will perform a damage inspection. Additional inspector qualifications for damage that may affect bridges with NSTM, SRM, IRM, or underwater elements are as follows:

- For NSTM, SRM, or IRM bridges, if the damage may affect an NSTM, SRM, or IRM member/element, the inspection must be performed by an NSTM TL qualified inspector following NSTM inspection procedures.
- For damage suspected to have occurred to an underwater portion of a bridge in water greater than 4 feet deep, the underwater portion must be completed by an UW Dive TL qualified inspector.

The TL is required to notify the PM with direct jurisdiction over the bridge as soon as possible. The PM is required to sign off as reviewer in HSIS if they were not the inspector no later than 30 days after the inspection is completed. The PM, with consultation with the TL, when necessary, must determine an appropriate inspection interval based on the condition of the bridge.

Figure 1.3.12.1-1: Impact Damage to a Steel Girder Bridge.

Figure 1.3.12.1-2: Failed Wingwall.

1.3.10.2 Precision

The scope of a Damage Inspection should be sufficient to determine whether there is a need for emergency load restrictions or closure of part or all of the structure to traffic. The inspector should also assess the level of effort necessary to repair the damage. The amount of effort expended on this type of inspection may vary significantly and depends on the extent of the damage. If major damage has occurred, inspectors should evaluate fractured and cracked members, determine the extent of section loss, make measurements for misalignment of members, and check for any loss of foundation support. A structure inspection form should be filled out and submitted for entry into the HSIS database with addenda and pictures, if necessary, with all the information mentioned above. This inspection may be supplemented by a timely In-Depth Inspection to document more fully the extent of damage and the urgency and scope of repairs. Proper documentation, verification of field measurements and calculations, and perhaps a more refined analysis to establish or adjust interim load restrictions are required follow-up procedures. The ability to make on-site calculations to establish emergency load restrictions may be desirable. A particular awareness of the potential for litigation must be exercised in the documentation of Damage Inspections. Therefore, all documentation should be legible and thorough.

1.3.10.3 Damage Inspection Interval

A Damage Inspection is an unscheduled inspection that is performed to determine if significant damage has been done to the bridge. Generally, a law enforcement officer on the site of an accident involving a structure will notify the appropriate individuals and request a Damage Inspection be performed to determine if the bridge should be closed. A Damage Inspection may be followed up by an In-Depth Inspection to document the full extent of the damage.

1.3.11 Service Inspection

1.3.11.1 Purpose

A service inspection is not a required inspection but is scheduled at the discretion of the bridge owner to identify major deficiencies, safety issues, and maintenance actions. It is performed by bridge maintenance or inspection staff under direction and oversight of a TL. The TL is not required to be on site but provides training and review of TM work. The inspections are meant to be performed from the ground and are not intended to be as rigorous as a routine inspection but requires documentation of any follow-up actions in the HSI. It's recommended to enter a service inspection in HSI if the inspector doesn't find anything during a bridge visit. Document the purpose of your visit under the inspection notes in the service inspection.

1.3.11.2 Service Inspection Interval

It is considered good practice to schedule a service inspection around the half inspection interval on bridges that have a history of safety or maintenance issues and on bridges with a 48-month inspection interval.

1.3.12 Complex Feature Inspection

1.3.12.1 Purpose

The focus of complex feature inspection is on the parts of bridges that warrant additional attention due to their inherent complexity. The NBIS definition of complex feature of a bridge is a component(s) or member(s) with advanced or unique structural members or operational characteristics, construction methods, and/or requiring specific inspection procedures. This includes mechanical and electrical elements of moveable spans and cable-related members of suspension and cable-stayed superstructures. WisDOT has identified complex features as the mechanical and electrical elements of moveable bridge and the primary cables of a cable stayed bridge. Complex features are subject to specialized inspection procedures, and additional inspector training and experience is required to inspect these types of structures. These inspections require greater engineering knowledge and/or expertise to accurately and fully determine the condition of the various bridge elements. They may also require specialized equipment or climbing to access these features. The qualification to inspect primary cables of a cable stayed bridge is to be a TL and possess the FC or NSTM NHI course certificate. Moveable bridge qualifications are described in Part 3 of this manual.

CFR 650.313(g) establishes the requirement for all complex structures to have an inspection procedure in place. Complex feature inspection procedures are to address the following topics applicable to those features:

- Equipment needs
- Personnel needs and qualifications
- Access requirements
- Scheduling considerations
- Coordination with agencies and/or partners
- Risk factors
- Identify/describe those portions of the bridge to be inspected
- Explain the inspection methods and techniques to be utilized
- Description of the inspection interval
- Documentation requirements
- Reporting and follow-up processes

Movable structures should normally receive the same types of inspections as fixed structures, as described in the foregoing. Furthermore, most movable bridges will require additional specialized inspections, such as NSTM, in-depth, underwater diving, and underwater survey inspections. In addition to the structural systems, the operating systems need to be inspected on a routine basis. It is typically most advantageous to perform the annual movable systems inspection in early spring. Specific inspection tasks relative to movable structures are described in detail in Part 3 of this Manual.

1.3.13 Closed Bridge Inspection

1.3.13.1 Purpose

All structures closed to highway traffic that remain in the HSI system as highway bridges shall continue to receive Routine inspections. The inspection shall include an evaluation of the closure system(s) and recorded under Assessment 9036 – Bridge Closure Systems.

Inspections such as NSTM, Complex, Underwater, etc. are no longer required for the closed structure unless those inspections are crucial to ascertaining the stability of the structure in the field. The Regional PM shall be consulted to determine if these inspection types are required for individual bridges.

1.3.13.2 Interval

Closed bridge inspections shall be conducted every 12 months and shall be entered as a Routine Inspection in the HSI system.

1.3.14 Load Posted Verification

1.3.14.1 Purpose

A Load Posted Verification is a review of the signage associated with a load posted bridge. Bridges not able to carry the State legal loads, as determined by the Statewide Program Manager (SPM), are load posted for reduced live load capacity. These bridges may have been designed for a truck load that is lighter than what is allowed by law today. Otherwise, these bridges may have suffered some sort of deterioration or damage that has reduced the load capacity below the legal statutory allowable load. In either regard, load posted bridges should be monitored regularly to ensure their serviceability and safety.

Figure 1.3.13.1-2: Load Posted Truss Bridge.

1.3.14.2 Precision

The inspector shall review the signage for the load posted bridge on-site to determine:

- Are all of the required load-posting signs (including advanced warning signs) in the proper locations?

- Are the signs legible, and do they have the correct load posting displayed?
- Does the HSI system have the correct load posting recorded in the data?
- Is Assessment 9034 (Weight Limit Posting) included in the inspection data?

The results of the inspection should be recorded as a Load Posted Verification activity in HSI (an inspection type is not required to be selected), including photos of ALL of the Signs. A new form DT2122 is required when a form is not on file or the load posting has changed. This type of activity does not need to be performed by certified bridge inspectors. A Team Member can be sent out to perform specific inspection or measurement tasks under the direction of an Inspection TL.

The load posting can be found in the HSI system under the Capacity tab and is also included on page 2 of the inspection report under the Capacity Section. Inspectors should review the capacity information with in-service signs and do the following:

1. If the Load Posting (Capacity Section) is blank and no signs are present in the field, Assessment 9034 should not be used in the inspection, and should be removed if it has carried forward from a previous inspection where signs were present.
2. If the Load Posting (Capacity Section) does not match posting signs present in the field, assessment 9034 shall remain in the inspection report, activity "Load Posted Verification" shall be added on the Create/Edit tab in HSI, and the Load Posting Verification Form (DT2122) shall be submitted with the inspection.
3. If the Load Posting (Capacity Section) has a weight limit value but no signs are present, assessment 9034 shall be used with the appropriate missing sign quantities in CS4.

Load posting signs and installation shall comply with Section 2B.59 of the FHWA Manual on Uniform Traffic Control Devices (MUTCD) and the Wisconsin MUTCD. Bridges requiring load posting may also require advance posting signs at the nearest intersecting roads or other points where a driver can detour or turn around.

A bridge located close enough to an intersecting road that the load posting sign can clearly be read from that intersection should have the advanced sign placed at a further approach intersection. Additional advanced warning signs can be placed at other approach road intersections that may generate prohibited vehicles.

1.3.14.3 Interval

This activity only needs to be performed when load postings change on the structure. Load posting signs must follow the Wisconsin Manual on Uniform Traffic Control Devices and shall be installed as soon as possible but no later than 30-days after the owner is notified of the need for the posting change. Missing or illegible posting signs shall be corrected as soon as possible but not later than 30 days after inspection or other notification determines a need. For structures that have a load posting at any level, form DT2122 – Bridge Load Posting Field Verification must be on record in HSI and must display the current signage. A new form is required when a form is not on file or the load posting has changed. This form shall be submitted immediately after sign installation.

1.3.15 Deck Evaluation

1.3.15.1 Purpose

Over time, bridge decks deteriorate. Routine inspectors use various methods of inspection (both visual and audible) to detect defects in bridges decks.

Chain dragging is a common audible method to help detect delaminations and shall be recorded in HSI under the Deck Evaluation activity. Only when one hundred percent of the wearing surface is chain dragged shall the Deck Evaluation activity be selected in HSI.

A sketch of the delaminated areas shall be uploaded into HSI for the activity. Often times, more in-depth methods are required to ascertain condition. Common methods employed by WisDOT include:

- Ground Penetrating Radar (Part 5, Chapter 10)
- Infrared Thermography (Part 5, Chapter 11)
- Chloride Ion testing (Part 5, Chapter 16)

When these testing methods are used, they shall be recorded in HSI under the Deck Evaluation activity and all reports from the testing shall be uploaded into the activity.

1.3.15.2 Precision

Refer to Part 5 of this manual for anticipated precision of each method.

1.3.15.3 Interval

For state-owned structures, deck evaluation interval is based on the Deck Scanning Policy in Part 1 Appendix A. Local bridge owners may choose to follow a similar interval to aid in the selection of appropriate bridge treatments.

1.3.16 Scour Plan of Action

1.3.16.1 Purpose

The National Bridge Inspection Standards (NBIS) regulation, CFR 650.313(o), requires *bridges determined to be scour critical or have unknown foundations, prepare and document a scour POA for deployment of scour countermeasures for known and potential deficiencies, and to address safety concerns. The plan must address a schedule for repairing or installing physical and/or hydraulic scour countermeasures, and/or the use of monitoring as a scour* countermeasure. *Scour plans of actions should be consistent with HEC 18 and 23.*

Bridges that are scour critical require that the HSI bridge file have a POA document on file.

1.3.16.2 Precision

In general, a plan of action should focus on providing information that the inspector needs when out in the field. The plan should refer to plans, previous inspector reports, UW-Profile data, and other items pertinent to the bridge.

The POA should detail the foundation type, previous scour history, and monitoring benchmarks for the inspector to assess while in the field. It should also include a bridge closure plan that details when the bridge should be closed, who's responsible for the closure, when the bridge can be re-opened and what detour route should be used during the closure.

1.3.16.3 Interval

The POA document shall be updated every four calendar years or after significant flooding events. This requires a new POA activity entry into HSI.

1.3.17 Vertical Clearance Measured Activity

1.3.17.1 Purpose

The clearances on or under a bridge shall be measured periodically to determine changes in clearance that affect the mobility of Oversize/Overweight vehicle traffic.

Figure 1.3.15.1-1: Vertical Clearance Photo

1.3.17.2 Precision

Clearances should be taken in every lane, at edge of lanes, edge of paved shoulders, and at barrier edges to determine the low point for vehicular travel.

1.3.17.3 Interval

This activity shall be completed every time there is a construction project on or under a bridge. In addition, after a bridge is hit the inspector conducting the damage inspection should determine if they need to re-measure clearances and if so, enter a vertical clearance verification along with the damage report.

1.3.18 Critical Findings Activity

1.3.18.1 Purpose

A critical finding is a structural or safety related deficiency that requires immediate action to ensure public safety. Furthermore, a CF is a deficiency found on a bridge which critically threatens the structural stability of the bridge and/or the public safety, and is of such severity that requires immediate follow-up action. See Part 1, Chapter 7 for more details.

Figure 1.3.16.1-1: Critical Finding Photo

1.3.18.2 Precision

When criterion is met to designate a critical finding, as defined by Part 1, Chapter 7, a critical findings activity shall be entered into HSIS with a completed DT2026 form attached.

1.3.18.3 Interval

This activity is entered into the HSI System on an as-needed basis.

1.3.19 Structural Review

1.3.19.1 Purpose

A structural review is completed by a licensed Wisconsin Professional Engineer to evaluate the observed field conditions and determine the impacts on the load rating and safety of the structure. Structural reviews may include a review of the field inspection notes and photographs, review of as-built plans or analysis as deemed appropriate by the engineer.

Both the owner and designated program manager of the bridge are responsible for ensuring that a qualified individual completes and documents the review in the Highway Structures Information System (HSIS). For locally owned structures, the local bridge owner is required to have a staff engineer, or consultant engineer perform the review (PE required).

1.3.19.2 Precision

Triggering events:

- When a primary structural element is newly observed to be in a severe condition (CS4).
- When the quantity of a pre-existing CS4 primary structural element has increased since the last inspection.
- When the quantity of a pre-existing CS4 primary structural element has not increased, but the severity of the defect has worsened (i.e. section loss from physical measurements increased from 15% to 25% since last review).

Timeline:

- The structural review shall be completed no later than 60-days after the inspection.
- The review must be documented in HSIS; the inspection that documented the defect cannot be signed without the review documentation entered.
- If during the review the defect is determined to be a Critical Finding, the owner agency shall follow the timeline(s) and steps set forth by that policy found in Part 1 Chapter 7.
- Repairs can be performed in lieu of the Structural Review, provided the repair is either a standard repair detail from WisDOT or the repair has been designed by a Wisconsin PE.
- The repair must be completed within 60 days of the finding. The inspection cannot be closed out until the repair is completed, and the plans and calculations are uploaded into the HSI system, along with photographs of the completed repair.

Requirements:

- If the result of the structural review indicates the need for a long-term bridge or lane closure, this shall happen immediately, and the Critical Findings policy and procedures shall be followed. Contact the Statewide Inspection Program Manager.
- If the result of the structural review indicates that the bridge be load posted, or the existing load postings be lowered, the agency shall follow load posting requirements set forth by the Department.
- If the review indicates that the load capacity of the structure is not controlled by the defect, then no action is required.
- In all cases (except error) the defect quantity shall remain in CS4 regardless of the outcome of the structural review until the element is repaired or replaced.

Documentation:
For all triggering events, the results of the review shall be documented in HSIS as follows:

- Under the Inspection tab, when a trigger event is entered as part of an inspection into HSIS for the element and defect, a Structural Review tab will appear. On that tab, the Engineer will enter the following information:
    1. Reviewer name and PE number.
    2. Method of review (engineering judgement, analysis, etc.)
    3. Overall notes pertaining to the review, as well as specific notes for each primary structural element that has a CS4 quantity
    4. Final recommended actions (load postings, closures, repair, monitoring, etc.)

- If calculations were performed, they must be uploaded into the HSI system.

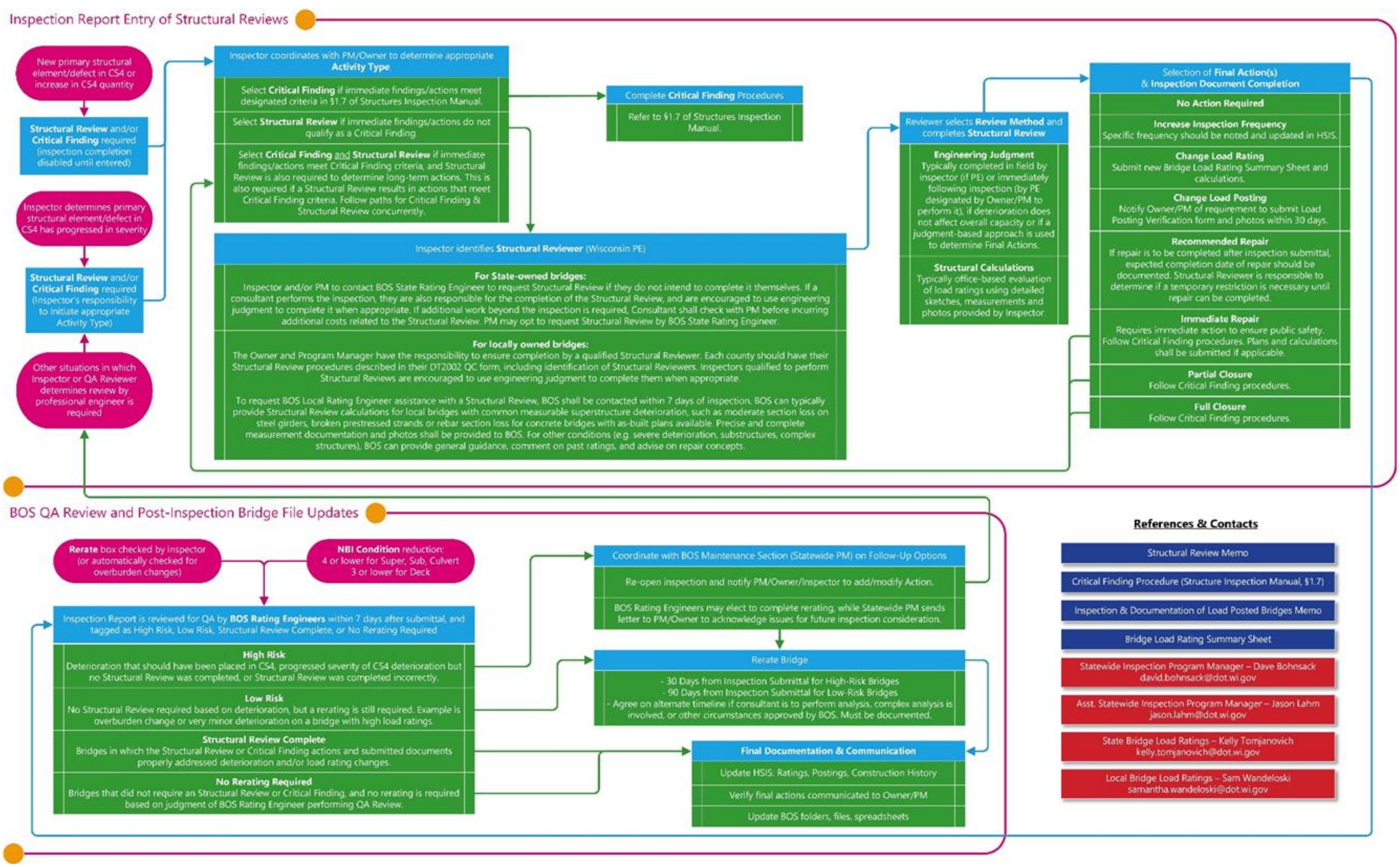
A structural review is **required** for the following element/defect combinations (and will be automatically selected by the HSIS):

- Any steel superstructure, substructure, or culvert element(s) with these Severe (CS4) material defects:
    - (1000) Corrosion
    - (1010) Cracking
    - (1020) Connection
    - (1900) Distortion
- Any concrete (prestressed or reinforced) superstructure or substructure element(s) with these Severe (CS4) material defects:
    - (1080) Delaminations/Spalls/Patch Areas/Exposed Prestressing
    - (1110) Cracking PSC
    - (1130) Cracking RC
    - (1190) Abrasion/Wear
    - (8906) Precast Concrete Connections
- Any timber superstructure or substructure element(s) with these Severe (CS4) material defects:

  - (1020) Connection
  - (1140) Decay/Section Loss/Abrasion/Wear
  - (1150) Checks/Shakes/Cracks/Splits/Delamination
  - (1900) Distortion
- Any masonry superstructure or substructure element(s) with these Severe (CS4) material defects:
  - (1610) Mortar Breakdown
  - (1620) Splits/Spalls/Patched Areas
  - (1640) Masonry Displacement
- Any substructure element with these Severe (CS4) structural defects:
  - (4000) Settlement
  - (6000) Scour
- Any bearing element with this Severe (CS4) material defect:
  - (2240) Loss of Bearing

In all other situations, the inspector may request a structural review for an element/defect combination if he/she feels that the condition warrants a review by a professional engineer.

The following is the structural review process guide to assist inspectors in HSI entry:


Inspection Report Entry of Structural Reviews
New primary structural element/defect in CS4 or increase in CS4 quantity
Structural Review and/or Critical Finding required (inspection completion disabled until entered)
Inspector determines primary structural element/defect in CS4 has progressed in severity
Structural Review and/or Critical Finding required (Inspector's responsibility to initiate appropriate Activity Type)
Other situations in which Inspector or QA Reviewer determines review by professional engineer is required
Inspector coordinates with PM/Owner to determine appropriate Activity Type
Select Critical Finding if immediate findings/actions meet designated criteria in §1.7 of Structures Inspection Manual.
Select Structural Review if immediate findings/actions do not qualify as a Critical Finding.
Select Critical Finding and Structural Review if immediate findings/actions meet Critical Finding criteria, and Structural Review is also required to determine long-term actions. This is also required if a Structural Review results in actions that meet Critical Finding criteria. Follow paths for Critical Finding & Structural Review concurrently.
Complete Critical Finding Procedures
Refer to §1.7 of Structures Inspection Manual.
Inspector identifies Structural Reviewer (Wisconsin PE)
For State-owned bridges:
Inspector and/or PM to contact BOS State Rating Engineer to request Structural Review if they do not intend to complete it themselves. If a consultant performs the inspection, they are also responsible for the completion of the Structural Review, and are encouraged to use engineering judgment to complete it when appropriate. If additional work beyond the inspection is required, Consultant shall check with PM before incurring additional costs related to the Structural Review. PM may opt to request Structural Review by BOS State Rating Engineer.
For locally owned bridges:
The Owner and Program Manager have the responsibility to ensure completion by a qualified Structural Reviewer. Each county should have their Structural Review procedures described in their DT2002 QC form, including identification of Structural Reviewers. Inspectors qualified to perform Structural Reviews are encouraged to use engineering judgment to complete them when appropriate.
To request BOS Local Rating Engineer assistance with a Structural Review, BOS shall be contacted within 7 days of inspection. BOS can typically provide Structural Review calculations for local bridges with common measurable superstructure deterioration, such as moderate section loss on steel girders, broken prestressed strands or rebar section loss for concrete bridges with as-built plans available. Precise and complete measurement documentation and photos shall be provided to BOS. For other conditions (e.g. severe deterioration, substructures, complex structures), BOS can provide general guidance, comment on past ratings, and advise on repair concepts.
Reviewer selects Review Method and completes Structural Review
Engineering Judgment
Typically completed in field by inspector (if PE) or immediately following inspection (by PE designated by Owner/PM to perform it), if deterioration does not affect overall capacity or if a judgment-based approach is used to determine Final Actions.
Structural Calculations
Typically office-based evaluation of load ratings using detailed sketches, measurements and photos provided by Inspector.
Selection of Final Action(s) & Inspection Document Completion
No Action Required
Increase Inspection Frequency
Specific frequency should be noted and updated in HSIS.
Change Load Rating
Submit new Bridge Load Rating Summary Sheet and calculations.
Change Load Posting
Notify Owner/PM of requirement to submit Load Posting Verification form and photos within 30 days.
Recommended Repair
If repair is to be completed after inspection submittal, expected completion date of repair should be documented. Structural Reviewer is responsible to determine if a temporary restriction is necessary until repair can be completed.
Immediate Repair
Requires immediate action to ensure public safety. Follow Critical Finding procedures. Plans and calculations shall be submitted if applicable.
Partial Closure
Follow Critical Finding procedures.
Full Closure
Follow Critical Finding procedures.
BOS QA Review and Post-Inspection Bridge File Updates
Rerate box checked by inspector (or automatically checked for overburden changes)
NBI Condition reduction: 4 or lower for Super, Sub, Culvert 3 or lower for Deck
Inspection Report is reviewed for QA by BOS Rating Engineers within 7 days after submittal, and tagged as High Risk, Low Risk, Structural Review Complete, or No Rerating Required
High Risk
Deterioration that should have been placed in CS4, progressed severity of CS4 deterioration but no Structural Review was completed, or Structural Review was completed incorrectly.
Low Risk
No Structural Review required based on deterioration, but a rerating is still required. Example is overburden change or very minor deterioration on a bridge with high load ratings.
Structural Review Complete
Bridges in which the Structural Review or Critical Finding actions and submitted documents properly addressed deterioration and/or load rating changes.
No Rerating Required
Bridges that did not require an Structural Review or Critical Finding, and no rerating is required based on judgment of BOS Rating Engineer performing QA Review.
Coordinate with BOS Maintenance Section (Statewide PM) on Follow-Up Options
Re-open inspection and notify PM/Owner/Inspector to add/modify Action.
BOS Rating Engineers may elect to complete rerating, while Statewide PM sends letter to PM/Owner to acknowledge issues for future inspection consideration.
Rerate Bridge
- 30 Days from Inspection Submittal for High-Risk Bridges
- 90 Days from Inspection Submittal for Low-Risk Bridges
- Agree on alternate timeline if consultant is to perform analysis, complex analysis is involved, or other circumstances approved by BOS. Must be documented.
Final Documentation & Communication
Update HSIS: Ratings, Postings, Construction History
Verify final actions communicated to Owner/PM
Update BOS folders, files, spreadsheets
References & Contacts
Structural Review Memo
Critical Finding Procedure (Structure Inspection Manual, §1.7)
Inspection & Documentation of Load Posted Bridges Memo
Bridge Load Rating Summary Sheet
Statewide Inspection Program Manager – Dave Bohnsack david.bohnsack@dot.wi.gov
Asst. Statewide Inspection Program Manager – Jason Lahm jason.lahm@dot.wi.gov
State Bridge Load Ratings – Kelly Tomjanovich kelly.tomjanovich@dot.wi.gov
Local Bridge Load Ratings – Sam Wandeloski samantha.wandeloski@dot.wi.gov