815 Density Testing

CMM provisions mobilized by the contract: 815.10.2.1, 815.10.2.2

815.1 General
Field densities are taken by nuclear methods in accordance with established procedures as required by the contract. If the contract contains QMP density testing provisions, the contractor performs quality control density testing and the department performs quality verification density testing. If the contract doesn't include QMP density testing provisions, the department will perform all density testing conforming to standard spec 460.3.3.2. Once a method has been selected for determining mat density; that method should be used throughout the project.

815.2 Specify gauge life based on the manufacture date of the Cesium-137 source.

815.2 Nuclear Gauges
The State of Wisconsin Department of Health Services (DHS), Radiation Protection Section issues a license to WisDOT specifying that use of radioactive gauges by the department be supervised by the WisDOT Radiation Safety Officer (RSO). The RSO must be kept informed of the location and usage activities of WisDOT nuclear gauges at all times. The WisDOT RSO contact information will be supplied to each user of a WisDOT nuclear density gauge.

The WisDOT RSO may be contacted at the following telephone numbers:
(608) 516-6359, Primary
(715) 421-8002, Wisconsin Rapids Office

Nuclear gauge owners are responsible for compliance with State of Wisconsin DHS Radioactive Materials license or NRC license requirements. In addition, they must comply with WisDOT requirements when engaged in work on WisDOT projects. Personnel who either use nuclear gauges or directly supervise the use of gauges must be trained in radiation safety and transportation of radioactive materials and must maintain the appropriate Highway Technician Certification Program (HTCP) certifications.

Sampling and testing certification is an FHWA requirement in the CFR 23 part 637. The NUCDENSITYTEC-I class is offered only by the University of Wisconsin Platteville as part of the HTCP.

For certification class schedules contact the director of the HTCP at (608) 342-1545 or at: https://campus.uwplatt.edu/ems/highway-technician-certification-program

In addition to certification of the operator, the department requires that all individual nuclear moisture / density gauges used on WisDOT projects be on the approved list. This policy applies to all WisDOT, consultant, and contractor gauges used for acceptance or QMP density testing. Each gauge must be within 30 years of the Cesium-137 manufacture date as identified on the gauge's source plate or handle. Each gauge must be calibrated annually and before each construction season as follows:
- By a manufacturer approved calibration service provider.
- Using BTS gauge blocks located in the Wisconsin Rapids sign shop, 2841 Industrial St., Wisconsin Rapids, WI.

This procedure must be followed if the gauge is sent in for any manufacturer calibration or service during the construction season. Contact the RSO at the numbers listed above for access to the blocks and scheduling.

WisDOT maintains an annual list of consultants and contractors certified gauges approved to perform nuclear testing on WisDOT administered projects. Consultants and contractors must be on this list in order to perform acceptance and nuclear gauge testing on WisDOT projects. This list is established and maintained by the Quality Assurance Unit in central office and is on the APL.

To verify that the department has the correct information for your company, you must submit the following information yearly:
1. Current copy of your Wisconsin Agreement State License or your Federal Nuclear Regulatory Commission (NRC) license.
2. Copies of current nuclear moisture and density gauge 3 block calibration certificates (5 blocks for other states) conducted by the manufacturer or an approved calibration service.
3. Company contact person, RSO, or safety officer (please update as changes occur).
4. The WisDOT Block Calibration form (including new constants).

Please send this information to:
Wisconsin Department of Transportation
Bureau of Technical Services, Truax Center
ATTN: WisDOT RSO
3502 Kinsman Blvd
Madison WI 53704-2507
michael.bohn@dot.wi.gov
(Note: email is the primary means of sending this information)

Testing of some soils, fly ash, and coarse materials requiring special testing procedures, for which the operator will need additional training. Contact the WisDOT RSO for further information regarding special testing procedures.

815.3 Nuclear Density Gauge Safety

815.3.1 Lost or Stolen Gauges
If a gauge is lost or stolen, notify the Radiation Safety Officer (RSO) as soon as possible. The RSO will notify the appropriate regulatory agency per DHS 157.

815.3.2 Damaged Gauges
The operator will follow these procedures in the event of gauge damage (per DHS 157 Appendix H). All companies must have available an appropriate radiation survey meter in accordance with http://docs.legis.wisconsin.gov/code/admin_code/dhs/110/157.pdf
- Seal off the area for a distance of 15 feet around the gauge in question to prevent exposure to themselves and others. Protect the gauge from further damage.
- Stop the vehicle or heavy piece of equipment that is involved, it must be detained in order to verify that it is not contaminated.
- Never let the gauge in question be left unattended.
- Visually inspect the gauge to determine the extent of the damage to the source(s), source housing(s), and shielding. Check the base of the gauge for any splits or punctures. Take Pictures, take notes and statements to document incident.
- Do not handle the gauge if it has been damaged severely enough that source rod or internal shielding is cracked or broken open.
- Notify the Radiation Safety Officer (or notify supervisor who will contact the RSO) as soon as possible. The RSO will notify the appropriate regulatory agency.
- Follow the instructions of the RSO

815.4 Annual BTS Gauge Block Calibration Procedures
Run the block and procedure for each gauge as described below:

1. BTS block procedure
   - Maintain 30’ or greater spacing between gauges.
   - Sweep off yellow and green blocks.
   - Perform manufacturer recommended warm up time if applicable. Gauges should only be used when they stabilize to ambient room temperature.
   - Place the manufactures supplied poly standard block on the yellow concrete block and perform the Standard Count, and record data on department supplied block forms.
   - Remove the poly standard block and align the front of the gauge that it touches the front line on the yellow block, and center the gauge.
   - Take a four minute back-scatter (BS) test for CPN, Troxler, Humboldt and InstroTek gauges, or a two-minute test for both Contact and Air gap for Seaman nuclear gauges.
   - Without moving the handle for CPN, Troxler, Humboldt, or InstroTek, record required data Wet pounds per cubic foot (pcf), # Moisture, Density counts, and Moisture counts and then perform the next test.
   - For Seaman gauges record the required data Wet pcf, # Moisture, Density counts, Moisture counts. Re-center the gauge and perform the next test.
   - Take three tests for each concrete test block and record the data for each test. DO NOT perform a new standard for each block.
Record the Block results on the WisDOT Block Calibration form and submit to the RSO.

**815.5 Nuclear Density Testing HMA**

Take necessary steps to coordinate and schedule the required nuclear test equipment and a trained operator so the required density testing may be performed expeditiously within the specified time requirements. All density testing must be done as soon as practical after the completion of the compaction process and before opening to traffic. On a closed road testing must be completed before the end of the next business day after placement.

Gauges must be in the shielded position and locked when not in use. Gauges should never be left unattended when in use.

During tests, the gauge must be kept the following minimum distances from:

- Pavement transverse construction joints: 20 feet
- Bridge deck expansion joints: 20 feet
- Operator: 3 feet
- Bystanders: 15 feet
- Equipment, manholes, etc.: 15 feet
- Other nuclear devices: 30 feet
- Unrestricted edge of pavement: 1.5 feet
- Restricted edge of pavement: 1 foot

Gauges must be warmed up and checked following the manufacturer's guidelines.

**815.6 Project Nuclear Density Testing**

The operator will take new standard counts for density and moisture at the project. (Note: it is important to check the standard counts daily to account for changing conditions and to check gauge performance. An incorrect moisture count will cause a gauge to incorrectly determine density. This check should be done daily on all manufacturers' gauges (Troxler, CPN, Humboldt, Seaman and so forth).

**815.7 QMP QC and QV Nuclear Density Gauge Comparison**

Select a representative section of the compacted HMA pavement on or before the first day of paving for the comparison process. The section does not have to be the same mix design. Compare the 2 or more gauges used for density measurements (QC, QV). The QC and QV gauge operators will perform 5 four-minute density tests at jointly determined sites. Record the density measurement of each test site for the QC, QV and other acceptance gauges. Calculate the average of the difference in density between the QC and QV gauges of the 5 test sites. If the average difference exceeds 1.0 pcf investigate the cause, perform a new reference standard count, and conduct a second gauge comparison procedure. The 5 jointly-determined sites in the second gauge comparison do not need to be the same as those used in the first comparison. If the second gauge comparison procedure also results in an average difference exceeding 1.0 pcf, the regional HMA Coordinator, with the consultation of the RSO, will use their gauge to investigate the situation with the QC and QV personnel to determine necessary actions. If calibration factors need to be adjusted in the field, contact the RSO beforehand for guidance and documentation.

On Soils, Sand & Gravel, Recycled Materials, Stabilized Bases, etc, select a representative section of the compacted material on or before the first day of placement for the comparison process. Compare the 2 or more gauges used for QC and QV density measurements in BS or in DT mode. The QC and QV gauge operators will perform 5 four-minute density tests at jointly determined sites. Record the density measurement of each test site for the QC, QV and other acceptance gauges. Calculate the average of the difference in dry density between the QC and QV gauges of the 5 test sites. If the average dry density difference exceeds 1.5 pcf investigate the cause, perform a new reference standard count, and conduct a second gauge comparison procedure. The 5 jointly determined sites in the second gauge comparison do not need to be the same as those used in the first comparison. If the second gauge comparison procedure also results in an average difference exceeding 1.5 pcf, replace one or more gauges and repeat the comparison process.

Use the last two test sites from the final comparison process and proceed with your moisture basis calculations as explained in 815.12.1. If the difference in moisture content between a gauge and the corresponding sample exceeds 1.0 pcf, then a moisture bias needs to be calculated for that gauge for the specific soil classification. The bias needs to be checked during placement or if the material
classification changes. If testing in DT mode, operators need to be cautious to ensure that the pilot holes do not collapse. Provide one of the QC or QV gauges that passed the comparison process, within allowable tolerances, to perform density testing on the project.

**815.8 HMA QMP Reference Site Monitoring**

After performing the gauge comparison on HMA, establish a project reference site approved by the department. Clearly mark a flat surface of concrete or asphalt or other material that will not be disturbed for the duration of the project. Perform reference site monitoring of the QC, QV, and any additional gauges at the project reference site. Conduct an initial 5 four-minute density tests with each gauge on the project reference site and calculate the average value for each gauge to establish the gauge's reference value. Use the gauge's reference value as a control to monitor the calibration of the gauge for the duration of the project. Check each gauge on the project reference site at least once a day, before performing any density testing. Calculate the difference between the gauge's daily test result and its reference value. Investigate if a daily test result is not within 1.5 pcf of its reference value. Conduct 3 additional four-minute tests at the reference site once the cause of the deviation is corrected. Calculate and record the average of the 3 additional tests. Remove the gauge from the project if the 3 test average is not within 1.5 pcf of its reference value. The regional HMA coordinator will use their gauge to investigate these situations with the QC and QV personnel to determine necessary actions.

**815.9 Non QMP HMA Nuclear Density Reference Site Monitoring**

For non QMP HMA Nuclear Density projects, the regional block can be used as the project reference site. Each gauge needs to be within 1.0 pcf of the block's reference value. If the region chooses to use a project located reference site, use the procedure explained in 815.8.

**815.10 Use of Nuclear Moisture/Density Gauges on HMA**

During testing, the gauge must always be set on a flat level surface on the material being tested, with the longest dimension of the gauge positioned parallel to the edge of the pavement. Outline the gauge with a lumber crayon or paint stick and show the direction of the source. Record the sublot number, percent compaction and density in lbs/ft³ on the pavement for all acceptance and verification tests. Check the gauge on the reference site at least once a day if a new density or moisture standard is established, and before performing any moisture or density tests. The designated materials persons (standard spec 106.1.2) will determine how the documentation will be communicated at the preconstruction meeting. A new density and moisture standard must be established daily during paving operations of new HMA pavements that require density testing. A new standard is also required if testing different materials on the same day (e.g., testing aggregate base and then switching to HMA testing). Changing the HMA mix type, or base course material sources does not require a new standard.

The following data must be recorded daily on field project data sheets. These sheets will be made available to the project engineer upon request:

- Reference site block data
- Standard block data, including the density and moisture standard
- Density count, moisture counts or contact, and air gap counts

**815.10.1 Target Maximum Density**

The target HMA pavement density, determined to the nearest 0.1 pcf, is established using the mixture maximum specific gravity (Gmm). On the first day of paving an HMA mixture design, the target maximum density will be the Gmm value indicated on the mix design multiplied by 62.24 pcf. The target maximum density for all other days will be the Gmm four-test running average from the end of the previous days' production multiplied by 62.24 pcf. If four tests have not been completed by the end of the first day, the average of the completed Gmm test values multiplied by 62.24 pcf will be used until a four-point running average is established.

The following data must be recorded for each test on the worksheet for MRS entry:

- Density standard and moisture standard
- Density count, moisture counts or contact, and air gap counts
- Total wet density or bulk density
- % Compaction
- Manufacturer name and serial number
- Operators name
- Mix design number (WisDOT 250 ID) and daily Target max density target number (Gmm x 62.24 pcf)

815.10.2 Lots and Sublots

A lot is one day's production of each sublot type or one production shift if running 24 hours per day. Sublots are determined for each layer and target density. When determining sublots a paved lane refers to a traffic lane, shoulder, or a single pass of the paver, whichever is smaller. All sublots will be laid out by the linear sublot system. Two methods of determining test locations will be used depending on the type of pavement.

- Layout based on a single paved lane: mainline paving, shoulders, turn lanes, crossovers, ramps, and roundabouts.
- Layout based on multiple paved lanes within a contiguous pavement area: side roads, intersections, and appurtenances.

For all QMP projects, sublot names and locations must be determined by the contractor and provided to the QV team for all planned paving before project start-up. The QV team will use the same sublot names and locations as the contractor. For layout based on the multiple paved lanes within a contiguous pavement area, sublots may be adjusted in the field based on actual paved areas as determined by the engineer. Figures 815-1 and 815-2 show examples of sublot layouts for intersections and roundabouts. The number of tests within sublots 1 through 3 in each figure are laid out based on the single paved lane length according to 815.10.2.1, while those within sublots 4 and 5 are laid out based on multiple paved lanes within a contiguous pavement area according to 815.10.2.2.
FIGURE 815-1 Typical Sublot Layout for Intersections
The number of nuclear density tests required for mainline paving, shoulders, turn lanes, crossovers, ramps, and roundabouts prescribed in 815.10.2.1 is mobilized into the contract in standard spec 460.3.3.2.

815.10.2.1 Layout Based on a Single Paved Lane
Layout based on single paved lanes should generally be used for sublots oriented parallel to the primary paving project. This typically includes mainline paving, shoulders, turn lanes, crossovers, ramps, and roundabouts. Segmented, staged work with variable widths may require some adjustment to testing locations during construction. For any single paved lane less than 50 feet, testing is waived, and the material will be accepted by ordinary compaction according to standard spec 450.3.2.6.2. A sublot may include more than one day's paving. It is not required to take an additional non-random test if a sublot spans more than one day’s paving. Sublot names should progress in the order of increasing mainline stationing within the project.

815.10.2.1.1 Single Paved Lane greater than or equal to 1,500 feet
A typical sublot is defined as 1,500 lane feet. Sublots are divided into equal widths according to table 815-1 with the number of tests and offset widths per sublot determined by the lane width at the widest location. At the end of paving, partial sublots less than 750 lane feet are included with the previous sublot and those greater than 750 lane feet stand alone. Figures 815-3 and 815-4 show example testing layouts of single paved lanes greater than or equal to 1,500 feet for full-width and tapered pavement.
Steps for determining test locations within single paved lanes greater than or equal to 1,500 feet:

Step 1: Using table 815-1, determine the number of tests and offset widths required in each sublot, depending on the lane width. The offset width is determined by dividing the lane width by the required number of tests in the sublot.

Step 2: Determine random stations for each test in the sublot. The sublot random test stations are computed by multiplying the entire sublot length by a random number and adding the result to the beginning station of the sublot.

Step 3: Determine the test site offsets. A random transverse location must be computed for each test site by multiplying the offset width by a random number and adding the result to the beginning of the corresponding offset range.

FIGURE 815-3  Example Layout for Full Width Single Paved Lane greater than or equal to 1,500 feet

FIGURE 815-4  Example Layout for Tapered Pavement with Single Paved Lane greater than or equal to 1,500 feet
815.10.2.1.2 Single Paved Lane less than 1,500 feet

Single paved lanes less than 1,500 lane feet are divided into equal lengths according to table 815-2 with the number of tests and equal segments per sublot determined by the paved lane length at the longest location. A minimum of 1 sublot is required per single paved lane. Figure 815-5 shows an example layout for single paved lane less than 1,500 feet with tapered pavement.

<table>
<thead>
<tr>
<th>Lane Length</th>
<th>No. of Tests</th>
<th>Longitudinal Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 ft or less</td>
<td>1</td>
<td>Random</td>
</tr>
<tr>
<td>Greater than 500 ft to 999 ft</td>
<td>2</td>
<td>Random within 2 equal segments</td>
</tr>
<tr>
<td>1,000 ft to 1,499 ft</td>
<td>3</td>
<td>Random within 3 equal segments</td>
</tr>
</tbody>
</table>

Steps for determining test locations within single paved lanes less than 1,500 feet:

Step 1: Determine the number of tests and equal segments required in each sublot, depending on the lane length as prescribed in table 815-2. Equal segment lengths are determined by dividing the total sublot length by the required number of tests.

Step 2: Determine a random station for each test in each sublot. The sublot random test stations are computed by multiplying the length of each segment by a random number and adding the result to the beginning station of the segment.

Step 3: Determine the random transverse offset for each test location. A random transverse offset is computed for each test site by multiplying the entire lane width by a random number and using the result to determine the distance from the reference line.
815.10.2.2 Layout Based on Multiple Paved Lanes Within a Contiguous Pavement Area

The number of nuclear density tests required for side roads, intersections, crossovers, turn lanes, ramps, and roundabouts prescribed in 815.10.2.2 is mobilized into the contract in standard spec 460.3.2.2.

Layout based on multiple paved lanes within a contiguous pavement area should be used for sublots oriented approximately perpendicular to the primary paving project. This typically includes intersections, side roads, and appurtenances. The required tests per sublot is determined according to table 815-2. For any single paved lane less than 50 feet, testing is waived and the material will be accepted by ordinary compaction according to standard spec 450.3.2.6.2. A sublot may include more than one day's paving. It is not required to take an additional non-random test if a sublot spans more than one day's paving.

Unless the engineer directs otherwise, the shoulders of intersections, side roads, and appurtenances are tested with the traffic lanes according to table 815-3. For intersections, side roads, and appurtenances with single paved lanes greater than or equal to 1,500 feet, shoulders will be separated from the traffic lanes for density testing according to 815.10.2.1. Segment names within each sublot should progress in the order of increasing mainline stationing on the project. Figure 815-6 shows an example layout for side road.

Steps for determining test locations based on multiple paved lanes within a contiguous pavement area:

Step 1: Sum the multiple paved lane lengths within the contiguous pavement area. Determine the number of tests and equal segments required in each sublot, depending on the total lane length according to table 815-2. For combined lane lengths within the contiguous area greater than 1,500 feet, add 1 additional test and equal segment for each additional 500 lane feet or portion thereof up to 2,250 feet total. For total lane feet within the contiguous area greater than 2,250 feet, additional sublots are required.

Step 2: Determine a random station for each test in each sublot. The sublot random test stations are computed by multiplying the length of each segment by a random number and adding the result to the beginning station of the segment.

Step 3: Determine the random transverse offset for each test location. A random transverse location must be computed for each test site by multiplying the lane width by a random number. The test is offset by the computed distance relative to the reference line.
815.10.3 Location of Random Test Sites
The specifications require each lot to be sampled at random locations. Random locations are determined independently for each lane or shoulder sublot.

The centerline is used as the reference line to determine offset (identify either right or left of centerline).

Locations of test sites must be determined randomly using ASTM D3665, department approved spreadsheet, a calculator equipped to provide random numbers, or other approved method.

The operator must check the test location for being level below the gauge. To ensure that the surface is flat, check opposite corners of the gauge for rocking. When the test site does not meet the above conditions, the site may be moved within 5 feet ahead or back and 2 feet right or left of the selected site. If this adjustment in the site location will still not meet the above criteria for finding a level test location, randomly select a new test site. Record your reason in the remarks area on the work form.

815.10.4 Duration of Test and Gauge Placement
Each test must be conducted for one minute when using CPN, Troxler, and Humboldt and InstroTek gauges. Tests with Seaman gauges require thirty seconds in both contact mode and in air gap mode. Two tests are taken at each QC or QV test location with the gauge rotated 180 degrees between the two tests. If the difference between two readings is more than 1.0 pcf, a third reading is conducted in the same orientation as the first reading. In this event, all three readings are averaged, the individual
test reading of the three which falls farthest from the average value is discarded, and the average of the remaining two values is used to represent the location for the gauge.

If one of the three tests is exactly equal to the average of all three use the average of all three tests to represent the location. The HMA Density Field Worksheet can be used to calculate the average density at each test site using one-minute tests. This worksheet can be found at the WisDOT AASHTOWare Project Knowledge Base (AWKB) website:

https://awpkb.dot.wi.gov/Content/constr/Pantry/StatewideXLS.htm

When calculating the pcf value and percent of maximum density (Gmm), round to the nearest tenth place (0.1) for all individual test results and the overall average. If the contractor chooses to use a spreadsheet other than the HMA Density Field Worksheet provided by WisDOT the target maximum density must be calculated and rounded according to 815.10.1. When calculating the distance from the average for individual one-minute readings, each distance from the average value must be rounded to the nearest 0.1 pcf.

Example 1

Target Gmm = 2.440
Target Max Density (pcf) = 151.9

<table>
<thead>
<tr>
<th>Lot-Sublot</th>
<th>Reading 1 (pcf)</th>
<th>Reading 2 (pcf)</th>
<th>Reading 3 (pcf)</th>
<th>Final Average (pcf)</th>
<th>% Max Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-2A</td>
<td>140.0</td>
<td>142.0</td>
<td>141.0</td>
<td>141.0</td>
<td>92.8</td>
</tr>
<tr>
<td>2-2B</td>
<td>140.0</td>
<td>142.1</td>
<td>141.0</td>
<td>140.5</td>
<td>92.5</td>
</tr>
<tr>
<td>2-2C</td>
<td>140.0</td>
<td>141.0</td>
<td>___</td>
<td>140.5</td>
<td>92.5</td>
</tr>
</tbody>
</table>

2-2A: One of the values is exactly equal to the average so the average of all three values is used.

2-2B: None of the values are exactly equal to the average so the one furthest from the average is discarded.

2-2C: The difference between the first two readings is not more than 1.0 pcf so a third reading is not needed.

During testing of pavements, the gauge must always be set on a flat surface with the longest dimension of the gauge positioned parallel to the edge of the pavement, and at least 30 feet from other nuclear devices and 15 feet from equipment, vehicles etc. The density gauge must be oriented with the source rod toward the direction of paving for the first test.

To ensure that the surface is flat, check opposite corners of the gauge for rocking. Mark out the outline of the moisture density gauge with a lumber crayon or paint stick and an arrow indicating source rod location. Once the test location has been set the gauge reading at that location must be counted as a legitimate test. Mark the density pcf and the percent compaction on the pavement. Re-rolling of the test location is prohibited under all circumstances.

All moisture/density gauges have different shapes, so the operator must outline the gauge. For CPN, Troxler, Humbold and InstroTek gauges, mark an arrow in the direction the source rod is facing. For a Seaman C-75 gauge, the arrow should be marked forward if facing the display, and to the left facing the display for C-200 & C-300 gauges. Always align the gauges to the front of the footprint marked out on the pavement.

When testing soils or aggregate; prepare an area sufficient in size to accommodate the gauge. Remove all loose and disturbed material and plane the area to a smooth, flat, and level condition to obtain maximum contact between the gauge and the material being tested. When a void exceeds 1/16” in depth, the operator must use native fines or fine sand to fill these voids and then smooth the surface with a rigid plate or other suitable tool. The area filled beneath the gauge should not exceed 10 percent of the total area.

It is critical that the gauge is placed on a flat and level surface of the material to be tested to accurately determine the moisture/density of the material.

815.11 Procedure for Determining Limits of Unacceptable Material

Standard spec 460.3.3.1 requires the engineer to investigate a single nuclear density test result, greater than 3.0% below specified minimums. The engineer needs to access acceptability of that material by performing the following:

1. Test at 50-foot increments both ahead and behind the unacceptable site, using the same offsets as the original test.
2. Continue 50-foot incremental testing until the test value indicates conforming material (i.e., within 3.0% less than minimum required density).

3. Materials within the incremental testing indicating more than 3.0% below minimum required density are defined as unacceptable, and will be handled as follows:

   3.1. Remove and replace unacceptable materials with the same mix type, unless otherwise approved by the project engineer, and meeting the required specified density. This will be done to the full lane width as defined by the density requirements. The shoulder may be considered separately from the mainline. Unacceptable materials replaced are at contractor cost.

   3.2. If unacceptable materials are allowed by the project engineer to remain in place, tonnages will be paid at 50%.

Note: If the 50’ testing extends into a previously accepted lot, removal of the unacceptable material may be required or allowed to stay in place at a 50% payment deduct; however, the results of these tests must not be used to recalculate the previous accepted lot density.

815.12 Soils Reference Site Monitoring

After performing the gauge comparison on soils, establish a project reference site approved by the department. Clearly mark a flat surface of concrete or asphalt or other material that will not be disturbed for the duration of the project. Perform 5 four-minute density tests in BS mode with each gauge at the project reference site and calculate the average density value for each gauge to establish each gauge’s reference value. Use the gauge’s reference value as a control to monitor the calibration of the gauge for the duration of the project. Check each gauge on the project reference site a minimum of once per day during placement of materials on the project. Calculate the difference between the gauge’s daily test result and its reference value. Investigate if a daily test result is not within 1.5 pcf of its reference value. Conduct 3 additional tests at the reference site once the cause of the deviation is corrected. Calculate and record the average of the 3 additional tests, if applicable. Remove the gauge from the project if the 3-test average is not within 1.5 pcf of its reference value.

If the department supplies a ValiDator II for the established project reference site, conduct an initial 3 four- minute density tests in DT mode at all depths that will be tested in the field. Use the gauge reference value as a control to monitor the calibration of the gauge for the duration of the project. Check each gauge on the project ValiDator II a minimum of once per day at each testing location during placement of materials on the project. Calculate the difference between the gauge’s daily test result and its reference value. Investigate if a daily test result is not within 1.0 pcf of its reference value. Conduct 3 additional four-minute tests at the reference site once the cause of the deviation is corrected. Calculate and record the average of the 3 additional tests. Remove the gauge from the project if the 3-test average is not within 1.0 pcf of its reference value.

815.12.1 Use of Nuclear Moisture / Density Gauges on Soils, Base Course, etc.

During testing, the gauge must be set on a flat surface with no more than 1/16” void between the gauge’s surface and the material being tested. If any small air voids need to be filled, use only native material as filler.

All soil and base course (including recycled asphalt, recycled concrete, cold in-place recycled (CIR) asphalt material, etc.) are tested using 1 one-minute test per location. Prepare the test site and check the gauge for rocking. Position the gauge handle and perform testing in either BS mode or in DT mode at 4-inch, 6-inch, or 8-inch depths. The gauge test depth is set according to the thickness of the lift placed. The gauge’s test probe should be set as close to the bottom of the compacted lift as possible without extending into the underlying lift. If there is a possibility that the pilot hole will collapse during testing, then use the backscatter test mode. After each test, the operator must remove the material below the gauge and check for any visible voids, cobbles, or organics that could have affected the test results.

If the gauge needs to have a moisture bias for a specific soil, the gauge operator needs to conduct tests at 2 random locations with that soil type. After each moisture / density gauge test is completed, the material directly below the gauge will be retained and a 1-point Proctor test must be run at its natural moisture level. Then use part of the sample and perform a natural dry-back. Compare the average moisture content of the natural soil to the average moisture reading of the gauge. If the difference between the two averages exceeds 1.0 pcf, then a moisture bias is needed for that gauge for that specific material.
815.12.2 Establishing a Moisture Density Gauge Bias for Soils

A density gauge measures the moisture content simultaneously with the density of a material. A moisture bias represents the average difference in moisture content between in-situ nuclear gauge measurements and the oven-dried samples for a particular nuclear gauge and a particular type of material.

Determine a gauge moisture bias for every soil or aggregate base at startup of testing or during gauge comparison. Use the procedure below, corresponding with the gauge type, to establish the correct gauge bias for any particular type of soil or base.

1. On a compacted soil having a uniform moisture content, measure the density and moisture at two different locations using the density gauge in backscatter (BS) mode.

2. Obtain a soil sample from each test location (150 to 200 g) from directly beneath the center of the gauge footprint.

3. Weigh each wet sample. Oven-dry wet sample at 100°C, until the sample weight remains constant. Calculate the moisture content (M_{sample}) of each soil sample as follows:

\[
M_{sample} (%) = \frac{(Wet Weight - Dry Weight)}{Dry Weight} \times 100
\]

4. Determine the oven-dry moisture of each test site (M_{site}), in pounds per cubic foot, as follows:

\[
M_{site} = \frac{M_{sample} \times D_{gauge}}{M_{sample} + 100}
\]

Where:
- M_{site} = site moisture, pcf
- M_{sample} = moisture content, % of dry weight (step 3)
- D_{gauge} = gauge measured wet density, pcf (from step 1)

5. Determine the correction factor (gauge moisture bias) to be applied to the gauge moisture readings.

\[
M_{Bias} (pcf) = M_{site} - M_{gauge}
\]

The average of the two bias values is the gauge moisture bias. This value can be used for all field testing of that project with that gauge for that same soil type.

Check the gauge on the project reference site a minimum of once per day during placement of all material placed within the 1:1 slopes on the project and compare it to the gauge’s reference value. Maintain the reference site test data for the gauge at an agreed location.

All Proctor tests must have a minimum of 5 points, 2 ascending and 2 descending, with 1 point at or near the optimum moisture. The following data must be recorded on all project data sheets:

- Reference site block data
- Standard block data, including the density standard and moisture standard
- Density count, moisture counts or contact, and air gap counts
- Total wet density or bulk density
- Dry density or bulk density dry
- Moisture # and moisture %
- Proctor number and target number
- Pit number, grading area, soils classifications, elevation
- % compaction
- Manufacturer name and serial number
- Station, elevation, and offset
- Upper or lower zone
- Operators name
- Moisture bias noted in test remarks
815.13 Test Strip Requirements for Stone Matrix Asphalt (SMA) and Coarse (Gap-graded) mixes

The procedure for correlating gauges to pavement cores using as test strip for SMA and gap graded mixes prescribed in 815.13.1 is mobilized into the contract in standard spec 460.3.3.2.

815.13.1 Test Strip Description

Density determination procedures and requirements must be used to correlate nuclear gauges to pavement cores for SMA and gap graded mixes. Since SMA is a type of gap-graded mixture, only the term SMA will be used to describe both SMA and gap-graded mixtures.

FIGURE 815-7 SMA(Gap Graded) Gradations

Correlate nuclear gauges to pavement cores for SMA pavement using a WisDOT test strip. Construct one approved test strip for each mix design of SMA for each contract. Ensure the test strip is acceptably compacted and meets all requirements specified in the contract special provisions for SMA pavements. The test strip is to remain in place and becomes part of the completed pavement. The following describes the SMA density and volumetric testing tolerances required for an SMA test strip.

Notify the department at least 48 hours in advance of construction of the test strip. At the beginning of the first shift of production requiring a test strip, produce approximately 500 ton of SMA and cease production until the required testing is completed. Test strips must be located in a section of the roadway to allow a representative (i.e. not a ramp or shoulder, etc.) rolling pattern.

815.13.1.1 Sampling and Testing Intervals

Laboratory testing will be conducted from three split samples, with portions designated for QC, QV, and retained. Required field tests include contractor quality control (QC) and department quality verification (QV) nuclear density gauge tests and pavement coring.

During production for the test strip, HMA mixture samples are obtained from trucks before departure from the plant. Two split samples are collected during the production of test strip material. Sampling and splitting are in accordance with section 815.13.1.3 and as further detailed in 836. These two samples will be randomly selected from each half of the test strip tonnage (T), excluding the first 50 tons, and will be identified by the project engineer:
The project engineer will identify two zones in which gauge/core correlation is performed. These two zones are randomly selected within each half of the test strip length, inclusive of all material. Density zones must not overlap and must have a minimum of 100 lane feet between the two zones; therefore, random numbers may need to be shifted evenly to meet these criteria. Each zone consists of five locations across the mat as identified in figure 815-8. Both QV and QC teams must have a minimum of two nuclear density gauges present for correlation at the time the test strip is constructed. The following are determined at each of the five locations within both zones:

- two one-minute nuclear density gauge readings for QC team*
- two one-minute nuclear density gauge readings for QV team*
- pavement core sample

*If the two readings exceed 1.0 pcf of one another, a third reading is conducted and an average value for the location is calculated according to 815.10.4. Layout of nuclear density and core locations for correlation in each density testing zone appears in the field as follows:

![FIGURE 815-8 Nuclear/Core Correlation Locations Depicted](image)

Individual locations are represented by the symbol [●] as seen in figure 815-8 above.

The coring a circle
symbol is two-part, the nuclear the pavement, as shown here: for the core.
test locations and the location for by a rectangle for the test location and

The nuclear site is the same for QC and QV readings for the test strip, i.e., the QC and QV teams are to take nuclear density gauge readings in the same footprint. Each of the QC and QV teams are to take two one-minute readings per nuclear site, with the gauge rotated 180 degrees between readings, as seen here:
FIGURE 815-9  Nuclear gauge orientation for (a) 1st one-minute reading and (b) 2nd one-minute reading

(a)  
(b)

The core is then taken from the center of said footprint to be used to correlate each gauge with laboratory measured bulk specific gravities of the pavement cores. One core in good condition must be obtained from each of the 10 locations. If a second core is needed, it is obtained from within the same gauge footprint. The contractor is responsible for coring of the pavement. Coring and filling of core holes must be approved by the project engineer. The QV team is responsible for the labeling and safe transport of the cores from the field to the QC laboratory. Core density testing is conducted by the contractor and witnessed by department personnel. The contractor is responsible for drying the cores following testing. The department takes possession of cores following initial testing and is responsible for any verification testing.

The above nuclear/core correlation is conducted in accordance with sections 815.13.1.2 and 815.13.1.3. All test reports are submitted to the department upon completion and approved before paving resumes.

815.13.1.2 Field Tests

Daily standardization of gauges on reference blocks and a reference site is performed in accordance with 815.8. A gauge comparison according to 815.7 must be completed before the day of test strip construction. Nuclear gauge readings and pavement cores are used to determine nuclear gauge correlation in accordance with 815.13.1.1. The two or three readings per location per gauge are averaged. The readings for the five locations across the mat for each of two zones are provided to the project engineer. The project engineer will analyze the readings of each gauge relative to the densities of the cores taken at each location. The target maximum density used to determine core density is the average of the two QC volumetric/mix Gmm values from the test strip multiplied by 62.24 pcf. The project engineer will determine the average difference between the nuclear gauge density readings and the measured core densities to be used as a constant offset value. This offset is used to adjust density percent readings for the specific gauge for the remainder of that mix used on a single project and appears on the density data sheet along with gauge and project identification. An offset is specific to the mix and layer, and therefore a separate value must be determined for each mix placed over a given underlying material for the project. This constitutes correlation of that individual gauge to a given mix for the given layer. Each team must have at least two gauges correlated at the time of the test strip. Any data collected by a team without an acceptable gauge (i.e., correlated during test strip) will not be accepted. Two gauges per team are not required to be onsite daily after completion of the test strip.

Each core, 150 mm (6 inches) in diameter shall be taken at locations identified in section 815.13.1.1. Each random core must be full thickness of the layer being placed. This may require cutting/separation of core from underlying layers at the pavement layer interface to ensure that subsequent testing is performed only on the most recently placed layer/mix.

Coring and filling of core holes must be approved by the project engineer. Fill all core holes with non-shrink grout or SMA. When using rapid hardening mortar or concrete, remove all water from the core holes before filling. Mix the mortar or concrete in a separate container before placement in the hole. If SMA is used, fill all core holes with hot-mix matching that day's production mix type at that day's compaction temperature +/- 20F. The core holes must be dry and coated with tack before filling, filled...
with a minimum of two layers (single layer allowed for pavement layers < 2 inches in thickness), and compacted with a Marshall hammer or similar tamping device using approximately 50 blows per layer. The finished surface needs to be flush with the pavement surface. Any deviation in the surface of the filled core holes greater than 1/4 inch at the time of final inspection will require removal of the fill material to the depth of the layer thickness and replacement.

815.13.1.3 Laboratory Tests

QC and QV samples are tested for Gmm, Gmb, and AC. Air voids and VMA are then calculated using these test results. QC samples are also tested for aggregate gradation. Material is collected from trucks at the plant according to the frequency described in 815.13.1.1 above. Sample sizes must be consistent with the minimums for a three-part split as described in 836.5.2.2.

Bulk specific gravities for cores and gyratory compacted specimens are determined according to AASHTO T331 as modified in 836.6.5. Thoroughly dry cores obtained from the mat according to ASTM D7227 before determining in-place density. Two QC volumetric tests are conducted during the test strip, and the department representative randomly selects one of the two splits for QV testing. The Gmm is determined according to AASHTO T209 as modified in 836.6.6.

The bulk specific gravity values determined from field cores are used to calculate a correction factor (i.e., offset) for the QC and QV nuclear density gauges to be used throughout the remainder of the project for that mix and layer. QC and QV teams may wish to scan with additional gauges at the locations detailed in 815.13.1.1 above, as only gauges used during the test strip correlation phase will be allowed on the remainder of the project.

For additional information on sample size, splitting, and laboratory testing, refer to 836.

The 12 density tests required for determining the control strip density and rolling pattern for asphalt base, prescribed in 815.13.2 is mobilized into the contract in standard spec 460.3.3.2.

815.13.2 Density Testing Asphaltic Base Mixtures

The control strip consists of 1000 feet of the asphaltic base mixture that contains a minimum of one QC mixture test and twelve sites for nuclear density testing. Within the control strip, the department, using random numbers for sample determination, will identify twelve locations for density testing. Upon completion of the desired compaction for the control strip, nuclear density tests will be performed by the contractor at the twelve locations. Do not use additional materials to aid in seating the gauge.

The Control Strip accepted density will be determined by calculating the median value of the random twelve nuclear density locations. Within (4) hours, the contractor will provide the department with test results for the QC sample and Control Strip acceptance density. The QC sample is taken randomly within the first 300 tons of production not to include the first 50 tons. The Control Strip will validate the rolling pattern to be used for the remainder of the contract if the air voids from the initial QC sample taken during the control strip construction falls between 2.5% to 4.0%. If the test results do not meet these minimum requirements during the first control strip, an investigation will result, and a new control test strip and new QC sample will be required. Once the contractor has proven in the control strip that he can maintain a minimum density of 91.0% density, the rolling pattern will be accepted and used for the remainder of the project. The department maintains the right to verify that the rolling pattern is maintaining a minimum density of 91.0% at any time. If the department's test is less than 91.0%, a new control strip may be required, at the department's discretion. QMP nuclear density testing does not apply to asphaltic base. Mixture production will be stopped, and an investigation initiated if any of the following conditions occur:

1. The previous day's maximum specific gravity average from QC testing varies by ≥ 0.020 from the value of the initial QC test;
2. If a new mix design is required (i.e., 250 number), a new test strip will be required.
3. Any other condition occurs which in the judgment of the project engineer would warrant the establishment of a new control strip density.

Submit the results to the project engineer. The Materials Reporting System is not designed to accept nuclear density test results for Asphaltic Base. Asphaltic Base is not subject to density incentive/disincentive bid items. Also note that the control strip is not to be used for gauge comparison. That procedure is done as described in 815.7 and will be completed before density testing in the control strip.
815.14 Reports Forms
A Daily Nuclear Reference Check Record form must be completed each day that a gauge is used. All data fields must be recorded.

The operator must choose the form relevant to the gauge manufacturer and fill in all columns. This form may also be used for recording data when determining the value for a field reference location.

A copy of the appropriate form will be left with the project engineer, unless mutually agreed upon.

Nuclear density forms are on the AASHTOWare Project Knowledge Base (AWPKB) website at: https://awpkb.dot.wi.gov/Content/constr/Pantry/StatewideForms.htm

815.15 Acceptance and Incentive/Disincentive
For nuclear density testing data that indicate densities of less than the specified minimums, appropriate steps should be taken to identify and resolve the problem. Review all test procedures and derived data to ensure the test data is correct. Problems relating to the nuclear test equipment should be referred immediately to the RSO.

Additional tests taken for information purposes must not be averaged with the initial test or used to reduce payment when the tests are non-complying.

815.15.1 Disincentive for HMA Pavement Density
The determination is based on five factors:

1. Type of HMA Pavement, location, and layer.
2. Amount of deficiency in attained density in terms of percent below minimum required density. See standard spec 460.5.2.2 for percent of contract unit price allowed.
3. Contract unit price per ton of HMA pavement.
4. Number of tons of asphaltic mixture in the deficient lot. This may be determined by any available means, such as by plant or load records, delivery tickets, theoretical yield quantity, etc.
5. A non-compared gauge was used to conduct testing.

815.15.2 Incentive for HMA Pavement Density
Note: This section and the contained examples do not apply to SMA pavements
If the lot density is greater than the minimum specified in standard spec 460.3.3.1, table 460-3 and all air void test results for that mixture placed during the same day are within 2.5% to 4.0%, the pay should be adjusted for the lot as specified in standard spec 460.5.2.3 or the special provisions.

Examples of Computing Incentive/Disincentive for QMP Nuclear Density

Project Information for Examples 2 and 3:

A project begins at station 56+78 and ends at station 234+25. It is a 2-lane roadway with a shoulder on each side. The traffic lanes are 12 feet wide and the shoulders are 3 feet wide. Shown in figure 815-10 is the eastbound traffic lane and shoulder for the length of the project. The contractor will be paving the shoulder integrally with the traffic lane. The pavement is a 2-inch overlay and the same HMA mix type is used on the entire project. The bid price for the HMA pavement item is $41.75 per ton. The specified target density for the traffic lane is 93.0%. The target density for the shoulder is 92.0%.

Day One:
The contractor begins paving at station 56+78 and ends the day at station 102+97, a total length of 4,619 feet. A quantity of 677 tons was placed on the eastbound traffic lane, and 169 tons was placed on the integral shoulder.

Day Two:
The contractor begins paving at station 102+97. Due to traffic staging requirements, the contractor stops paving at station 159+93, 5,696 feet, and begins paving again at station 202+36. They end the day at the end of the project, station 234+25, 3,189 additional feet. A quantity of 1303 tons was paved on the eastbound traffic lane, and 326 tons was placed on the integral shoulder.

Day Three:
The contractor begins paving at station 159+93 and ends the day at station 202+36, 4,243 feet. A total of 622 tons was placed on the eastbound traffic lane, and 156 tons was placed on the integral shoulder.
FIGURE 815-10  Linear Sublot Example Project
Example 2:

Use the example project information and the following test results from Day One. All of the day's air voids tests were acceptable (Density Calculated off the pcf value, sublot is the average of the density %)

<table>
<thead>
<tr>
<th>Sublot ID</th>
<th>Test ID</th>
<th>% Density</th>
<th>Sublot Avg % Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 56+78 to 71+78</td>
<td>1</td>
<td>93.8</td>
<td>94.1</td>
</tr>
<tr>
<td>A 56+78 to 71+78</td>
<td>2</td>
<td>94.2</td>
<td></td>
</tr>
<tr>
<td>A 56+78 to 71+78</td>
<td>3</td>
<td>94.4</td>
<td></td>
</tr>
<tr>
<td>B 71+78 to 86+78</td>
<td>4</td>
<td>94.1</td>
<td>94.5</td>
</tr>
<tr>
<td>B 71+78 to 86+78</td>
<td>5</td>
<td>94.7</td>
<td></td>
</tr>
<tr>
<td>B 71+78 to 86+78</td>
<td>6</td>
<td>94.6</td>
<td></td>
</tr>
<tr>
<td>C 86+78 to 101+78</td>
<td>7</td>
<td>93.6</td>
<td>94.1</td>
</tr>
<tr>
<td>C 86+78 to 101+78</td>
<td>8</td>
<td>94.5</td>
<td></td>
</tr>
<tr>
<td>C 86+78 to 101+78</td>
<td>9</td>
<td>94.3</td>
<td></td>
</tr>
<tr>
<td>M 37</td>
<td></td>
<td>93.2</td>
<td>93.2</td>
</tr>
<tr>
<td>N 38</td>
<td></td>
<td>94.2</td>
<td>94.2</td>
</tr>
<tr>
<td>O 39</td>
<td></td>
<td>93.0</td>
<td>93.0</td>
</tr>
</tbody>
</table>

1. Compute the average density for each traffic lane sublot and each shoulder sublot.

   SOLUTION: See the results in the table above.

2. Compute the density incentive or disincentive for the day's paving.

   SOLUTION:
   - Traffic Lane:
     The specified target density for the traffic lane is 93.0%. All of the sublot averages were no more than one percent below the target density, so all of the day's traffic lane test results are used to compute the daily lot density and the lot incentive pay.
     - Lot density = (93.8 + 94.2 + 94.4 + 94.1 + 94.7 + 94.6 + 93.6 + 94.5 + 94.3) / 9 tests = 94.2%
     According to standard spec 460.5.2.3, this lot density is eligible for incentive pay of $0.40 per ton. 677 tons of HMA was placed on the traffic lane on day 1, therefore the contractor receives $270.80 density incentive for the day 1 traffic lane lot. This is for all of sublot A, B & C and the 119’ in sublot D that did not reach the random number.
   - Shoulder:
     The minimum required density is 92.0%. All of the sublot averages were acceptable, so all of the day's shoulder tests are used to compute the shoulder lot density. The average of all the shoulder tests is 93.5%. According to the specification, this lot density is eligible for incentive pay of $0.40 per ton. 169 tons of HMA was placed on the shoulder on day 1, therefore the contractor receives $67.60 density incentive for the day 1 shoulder lot.
Example 3:
Use the example project information and the following test results from day three. All of the day's air voids tests were acceptable.

<table>
<thead>
<tr>
<th>Sublot ID</th>
<th>Test ID</th>
<th>% Density</th>
<th>Sublot Avg % Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 161+78 to 176+78</td>
<td>22</td>
<td>91.8</td>
<td>91.8</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>91.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>91.7</td>
<td></td>
</tr>
<tr>
<td>I 176+78 to 191+78</td>
<td>25</td>
<td>95.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>94.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>94.9</td>
<td></td>
</tr>
<tr>
<td>J 191+78 to 202+36</td>
<td>28</td>
<td>92.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>91.8</td>
<td>91.9</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>91.9</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>44</td>
<td>91.9</td>
<td>91.9</td>
</tr>
<tr>
<td>U</td>
<td>45</td>
<td>94.4</td>
<td>94.4</td>
</tr>
<tr>
<td>V</td>
<td>46</td>
<td>92.1</td>
<td>92.1</td>
</tr>
</tbody>
</table>

Compute the density incentive or disincentive for the day's paving.

SOLUTION:

1. Traffic Lane:
   According to the specification, a minimum density of 93% is required for the traffic lane. When verifying whether or not the sublot densities meet the requirements, it is found that sublot H and sublot J have average densities that are more than one percent below the required minimum. According to the specification, the quantities of HMA pavement and asphaltic material items placed this day in each of these sublots is subject to disincentive, and the day's test results within these sublots are not included when computing the incentive for the remainder of the lot.

2. Sublot H:
   Day 3 began inside the limits of sublot G, at station 159+93, but beyond its random test location. The tests for sublot G represent material placed on day 2. The tests in sublot H represent the day 3 material from station 159+93 to 176+78, total length of 1685 feet long (185' from sublot G, paved on day 3, and 1500' in sublot H) by 12 feet wide.
   
   Quantity represented by tests in sublot H = 
   \[
   \frac{1685 \text{ ft} \times 12 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} \times \frac{2 \text{ in} \times 112 \text{ lb/ft}^2/\text{in}}{2000 \text{ lb/ton}} = 252 \text{ tons}
   \]
   
   According to the disincentive pay table in the specification, the quantities are subject to a pay factor equal to 95 percent of the contract price. This is equivalent to a 5 percent pay reduction.
   
   Disincentive Density HMA Pavement = 252 tons x ($41.75/ton x 0.05) = -$526.05

3. Sublot I:
   Quantity represented by tests in sublot I = 
   \[
   \frac{1500 \text{ ft} \times 12 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} \times \frac{2 \text{ in} \times 112 \text{ lb/ft}^2/\text{in}}{2000 \text{ lb/ton}} = 224 \text{ tons}
   \]
According to the incentive pay table, 224 tons of the HMA pavement item are eligible for an incentive of $0.80 per ton, or a total of $179.20.

4. Sublot J:

Day 3 ended within the limits of sublot J, beyond its random test location. The day 3 quantity placed within sublot J, from station 191+78 to 202+36, at length of 1,058 feet, is represented by its tests. The day 2 quantity placed toward the end of sublot J is represented by the tests taken on day 2 within sublot K.

Quantity represented by tests in sublot J = \[
\frac{1058 \text{ ft} \times 12 \text{ ft} \times 2 \text{ in} \times 112 \text{ lb/yd}^2 / \text{in}}{9 \text{ ft}^2 / \text{yd} \times 2000 \text{ lb/ton}} = 158 \text{ tons}
\]

According to the disincentive pay table in the specification, the quantities are subject to a pay factor equal to 95 percent of the contract price. This is equivalent to a 5 percent pay reduction.

Disincentive Density HMA Pavement = 158 tons x ($41.75/ton x 0.05) = -$329.83

5. Shoulder:

All of the day 3 shoulder sublots have acceptable density values, so we use all of the results to compute the day's shoulder lot density.

Day 3 shoulder lot density = (91.9 + 94.4 + 92.1) / 3 tests = 92.8%

The lot density of 92.8% is not more than 1.0% above the required minimum of 92.0%, therefore the day 3 shoulder pavement does not receive any density incentive.

Note: For shoulders paved integrally with the traffic lane see standard spec 460.5.2.3(3).

Day 3 Incentive/Disincentive Summary:

- Incentive Density HMA Pavement (Lot I) = $179.20
- Disincentive Density HMA Pavement (Lot H) = -$526.05
- Disincentive Density HMA Pavement (Lot J) = -$329.83

815.16 Density Data Submittal

After verifying the contractor's data, the department calculates pay adjustments using the department's MRS software. The contractor must submit the required density test information electronically using the MRS software. The contractor should contact Atwood Systems to have the necessary software installed. Call toll free phone: (877) 518-1920 or email at: support@atwoodsystems.com

Note: Asphaltic Base test results are recorded and submitted on DOT forms, and not submitted to the MRS system.