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**Remarks and Instructions**

The complete manual, revision packages, and individual chapters can be accessed at [www.wsdot.wa.gov/publications/manuals/m46-01.htm](http://www.wsdot.wa.gov/publications/manuals/m46-01.htm).

For updating printed manuals, page numbers indicating portions of the manual that are to be removed and replaced are shown below.

Chapter	Remove Pages	Insert Pages
Title Page	i-ii	i-ii
SOP 730 Correlation of Nuclear Gauge Densities With Hot Mix Asphalt (HMA) Cores	1-2	1-2
SOP 736 In-Place Density of Bituminous Mixes Using Cores	1-2	1-2

Please contact Linda Hughes at 360-709-5412 or [hughel@wsdot.wa.gov](mailto:hughel@wsdot.wa.gov) with comments, questions, or suggestions for improvement to the manual.

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**Washington State  
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# **Materials Manual**

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**Engineering and Regional Operations**  
Materials Laboratory

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## WSDOT SOP 730

### *Correlation of Nuclear Gauge Densities With Hot Mix Asphalt (HMA) Cores*

1. When evaluating HMA compaction:

1.1 A gauge correlation is required:

- a. For each combination of gauge and HMA Mix Design (initial JMF).
- b. When gauge mode changes (i.e., direct transmission to thin layer).
- c. When wearing course lift thickness changes per Note 1.
- d. When a gauge is recalibrated.

**Note 1:** For density determined with the “Thin Layer Mode,” a layer thickness change of greater than 0.08 feet requires a new correlation. For density determined with the “Direct Transmission Mode,” a layer thickness change of greater than 0.15 feet requires a new gauge correlation.

1.2 A gauge correlation is not required but may be considered by the Regional Materials Engineer when:

- a. Base material changes from the original correlation base (i.e., from a surfacing base to an asphalt base).
- b. The same gauge HMA Mix Design (Reference Mix Design) combination are used on a different contract within the same construction year.
- c. When JMF has been adjusted in accordance with *Standard Specifications* Section 9-03.8(7)A.

2. Gauge correlation is based on ten in-place HMA densities and ten cores taken at the same location as the in-place density.

2.1 In-place HMA densities shall be determined in accordance with WSDOT FOP for WAQTC TM 8.

2.2 Cores should be taken no later than the day following paving and before traffic has been allowed on roadway. Correlation cores are not required to be taken at record density locations. Therefore, a site outside the traveled way should be considered for worker safety, as long as the lift thickness matches that of the plan lift thickness of the record density locations.

**Note 2:** If a core becomes damaged, it shall be eliminated from the average.

**Note 3:** Cores may be taken sooner than the day after paving if the HMA is cooled to prevent damage during coring and removal of cores. Water, ice, or dry-ice may be used to cool the pavement. Another method of cooling that may be used is substitution of nitrogen gas or CO<sub>2</sub> for drilling fluids.

3. Obtain a pavement core from each of the test sites in accordance with WSDOT SOP 734. The core shall be taken in the nuclear gauge footprint.
  - 3.1 For “direct transmission mode,” locate the core at least 1 in (25 mm) away from the edge of the drive pin hole.
  - 3.2 For “thin layer mode,” locate the core in the approximate center of the nuclear gauge footprint. If the core thickness exceeds the plan pavement thickness by more than 0.04 feet, then the core shall be saw cut to the plan thickness prior to performing density testing. If a core thickness is less than the plan thickness by more than 0.04 feet, it shall be eliminated from the average.
4. Bulk Specific Gravity ( $G_{mb}$ ) of core shall be determined in conformance with WSDOT FOP for AASHTO T 166 Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens.

Calculate core density as follows, round to the nearest 0.1 pcf:

$$\text{Core Density} = G_{mb} \times 62.245 \text{ pcf}$$

Calculate gauge correlation factor as follows:

$$\text{Density Ratio} = \frac{\text{(core density)}}{\text{(nuclear gauge density)}}$$

Round Density Ratio to the nearest 0.001

$$\text{Gauge correlation factor} = \frac{\text{(Sum of ratios)}}{\text{(number of cores)}}$$

5. Gauge Correlation Factor shall be determined to 0.001.
6. Report the Gauge Correlation Factor using MATS or DOT [Form 350-112 EF](#).



## WSDOT SOP 736

### *In-Place Density of Bituminous Mixes Using Cores*

#### 1. Scope

This test method describes the procedure for determining the relative density of bituminous mixes by means of roadway cores.

#### 2. Procedure

Cores for densities will be taken in accordance with WSDOT SOP 734 Sampling Hot Mix Asphalt After Compaction (Obtaining Core)

The bulk specific gravity ( $G_{mb}$ ) of the core will be determined in accordance with WSDOT FOP for T 166 Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturate Surface-Dry Specimens.

The Theoretical maximum density of the mix will be determined in accordance with WSDOT FOP for AASHTO T 209 Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt Paving Mixtures.

Determine the average theoretical maximum density in accordance with WSDOT SOP 729 Determination of the Moving Average of Theoretical Maximum Density (TMD) for HMA

#### 3. Calculation of Percent of Compaction

The percent compaction is determined by comparing the density of the roadway core to the theoretical maximum density.

Calculate core density to the nearest 0.1 pcf as follows:

$$\text{Core Density} = G_{mb} \times 62.245 \text{ pcf}$$

Calculate percent compact (round to the nearest 0.1 percent) as follows:

$$\text{Percent Compaction} = (\text{Core Density}) / (\text{Average Theoretical Maximum Density}) \times 100$$

