

## **WSDOT FOP for WAQTC TM 8**

### ***In-Place Density of Bituminous Mixes Using the Nuclear Moisture-Density Gauge***

#### **Scope**

This test method describes a test procedure for determining the density of bituminous mixes by means of a nuclear density gauge employing either direct transmission or thin layer methods. Correlation with densities determined under SOP 730 is required.

#### **Apparatus**

- Nuclear density gauge with the factory matched standard reference block.
- Drive pin, guide, scraper plate, and hammer for testing in direct transmission mode.
- Transport case for properly shipping and housing the gauge and tools.
- Operator manual for the specific make and model of gauge.
- Radioactive materials information and calibration packet containing:
  - Daily Standard Count Log
  - Factory and Laboratory Calibration Data Sheet
  - Density Standard Decay Sheet
  - Leak Test Certificate
  - Shippers Declaration for Dangerous Goods
  - Procedure Memo for Storing, Transporting, and Handling Nuclear Testing Equipment
  - Other radioactive materials documentation as required by local regulatory requirements.

#### **Material**

WSDOT does not use filler material.

#### **Radiation Safety**

This method does not purport to address the safety concerns, if any, associated with its use. This test method involves potentially hazardous materials. The gauge utilizes radioactive materials that may be hazardous to the health of the user unless proper precautions are taken. Users of this gauge must become familiar with the applicable safety procedures and governmental regulations. All operators will be trained in radiation safety prior to operating nuclear density gauges. Some agencies require the use of personal monitoring devices such as a thermoluminescent dosimeter or film badge.

Effective instructions together with routine safety procedures such as source leak tests, recording and evaluation of personal monitoring device data, etc., are a recommended part of the operation and storage of this gauge.

#### **Calibration**

WSDOT performs calibrations according to the manufacturer's operators manual.

## Standardization (Standard Count)

1. Turn the gauge on and allow it to stabilize for a minimum of 45 minutes prior to taking a Standard Count. Leave the power on during the day's testing.

**Note 1:** If for any reason the gauge loses power or is turned off during the work period, the Standard Count must be re-established prior to use.

2. Prior to any correlation of the nuclear gauge, perform a Stat Test in accordance with the gauge's operator manual. If the gauge passes the Stat Test, perform a Standard Count. If the gauge fails the Stat Test, run a second Stat Test. If the gauge fails the second Stat Test, it should be repaired or recalibrated.
3. Take a Standard Count at the start of each day's work and as often as deemed necessary by the operator or agency. Daily variations in Standard Count shall not exceed the daily variations established by the manufacturer of the gauge. Compare the daily Standard Count to the Density Standard Decay Sheet (Note 2) to ensure the standard count falls within acceptable limits. If the daily variations in Standard Count are exceeded after repeating the Standard Count procedure or if the daily Standard Count is outside the range of the Standard Decay Sheet, the gauge should be repaired and or recalibrated.
4. Record the Standard Count for both density and moisture in the Daily Standard Count Log. Instructions for taking a Standard Count are found in the gauge's operator manual.

**Note 2:** The Density Standard Decay Sheet is found in the calibration documentation packet. This sheet shows the anticipated standard count range based on the calculated decay rate of the gauges radioactive source over the passage of time.

## Test Site Location

1. Select a test location(s) randomly and in accordance with WSDOT Test Method T 716. Test sites should be relatively smooth and flat and meet the following conditions:
  - a. At least 33 ft (10 m) away from other sources of radioactivity.
  - b. At least 10 ft (3 m) away from large objects (i.e., vehicles).
  - c. No closer than 24 in (600 mm) to any vertical mass, or less than 6 in (152.0 mm) from a vertical pavement edge.

## Overview

There are two approved methods for determining in-place density of bituminous mixes:

- Direct Transmission – When the lift thickness is 0.15 foot or greater.
- Thin Layer – When the lift thickness is 0.10 foot or greater. Only gauges with two sets of photon detectors (i.e., Troxler 3450) operating in “Thin Layer Mode” will be allowed.

**Note 3:** When a density lot is started in thin layer mode, it must remain in thin layer mode until the lot is completed. If a density lot is started in direct transmission mode, the lot must be completed in direct transmission mode unless the pavement depth falls below 0.15 feet. In such a case, the gauge must be correlated in thin layer mode prior to use.

## Procedure

### *Direct Transmission Mode*

1. Maintaining maximum contact between the base of the gauge and the surface of the material under test is critical.
2. Use the guide and scraper plate as a template and drill a hole to a depth of at least  $\frac{1}{4}$  in (7 mm) deeper than the measurement depth required for the gauge.
3. Place the gauge on the prepared surface so the source rod can enter the hole. Insert the probe in the hole and lower the source rod to the desired test depth using the handle and trigger mechanism. Position the gauge with the long axis of the gauge parallel to the direction of paving. Pull the gauge so that the probe is firmly against the side of the hole. Draw an outline around the entire gauge base for correlation coring, when applicable.

**WSDOT Note:** For alignment purposes, the user may expose the source rod for a maximum of 10 seconds.

4. Take test in accordance with manufacturer's recommendation.
5. Take one 4-minute test and record the wet density (WD) reading.

### *Thin Layer Mode*

1. Maintaining maximum contact between the base of the gauge and the surface of the material under test is critical.
2. A thin layer gauge (i.e., Troxler 4640) or a moisture density and thin layer gauge that has a thin layer mode setting (i.e., Troxler 3450) is required to perform this testing.
3. Ensure that the depth entered into the gauge matches the pavement depth and the depth at which the gauge was correlated. Draw an outline around the entire gauge base for correlation coring.
4. Take test in accordance with manufacturer's recommendation.
5. Take one 4-minute test and record the density (D) reading.

## Calculation of Percent of Compaction

The percent compaction is determined by comparing the in-place wet density (WD) or density (D), as determined by this method, to the Average Theoretical Maximum Density of the bituminous mix as determined by the WSDOT SOP 729.

The density gauge operator will receive a new average Theoretical Maximum Density from the tester at the bituminous mix plant each day that production requires a mix test. The density gauge operator will continue to use the previous moving average until a new moving average is received from the tester at the bituminous mix plant.

Each gauge shall be correlated in accordance with WSDOT SOP 730. A correlation factor will be provided to the density gauge operator for each gauge.

Use the following equations to calculate the percent of compaction:

1. Calculate the corrected gauge reading to the nearest tenth of a percent as follows:

$$\text{Corrected Gauge Reading} = \text{WD} \times \text{CF} \text{ or } \text{D} \times \text{CF}$$

Where:

WD = moisture density gauge wet density reading

D = Bituminous Mix Density reading for thin layer mode gauge

CF = gauge correlation factor (WSDOT SOP 730)

2. Calculate the percent compaction as follows.

$$\text{Percent Compaction} = \frac{\text{Corrected Gauge Reading}}{\text{Average Theoretical Maximum Density}} \times 100$$

### **Correlation With Cores**

WSDOT has deleted this section, refer to WSDOT SOP 730.

### **Report**

Report the results using one of the following:

- Materials Testing System (MATS)
- DOT Forms 350-092 and 350-157
- Form approved in writing by the State Materials Engineer

Report the percent compaction to the nearest tenth of a percent (0.1 percent).

## Tester Qualification Practical Exam Checklist

### *In-Place Density of Bituminous Mixes Using the Nuclear Moisture-Density Gauge FOP for WAQTC TM 8*

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

<b>Procedure Element</b>	<b>Yes</b>	<b>No</b>
1. The tester has a copy of the current procedure on hand?		
2. All equipment is functioning according to the test procedure, and if required, has the current calibration/verification tags present?		
3. Gauge turned on?		
4. Gauge standardized and Standard Count recorded?		
5. Standard Count compared with Density Standard Decay sheet?		
6. Test location selected appropriately?		
7. Direct Transmission Mode:		
a. Hole made a minimum of ¼ inch deeper than measurement depth?		
b. Gauge placed parallel to direction of paving, probe extended, gauge pulled back so probe against hole?		
c. For alignment purposes did not expose the source rod for more than 10 seconds.		
d. One 4-minute test made?		
e. Wet density recorded?		
8. Thin Layer Gauge or Gauge in Thin Layer Mode:		
a. Gauge placed, probe extended to backscatter position?		
b. One 4-minute test made; gauge placed as described in the manufacturer recommendations?		
c. Density (D) recorded?		
9. All calculations performed correctly?		
10. Nuclear Gauge secured in a manner consistent with current DOH requirements?		

First Attempt: Pass      Fail                      Second Attempt: Pass      Fail

Signature of Examiner \_\_\_\_\_

Comments:

