Test Procedure for

DETERMINING ASPHALT CONTENT OF BITUMINOUS MIXTURES BY THE NUCLEAR METHOD

TxDOT Designation: Tex-228-F

Effective Date: February 2005

1. SCOPE

1.1 Use this test method to determine the quantitative asphalt cement content of bituminous mixtures by testing a sample with a device that uses neutron thermalization techniques. Use this device for the rapid determination of the asphalt cement content of bituminous mixtures and make adjustments, if necessary, in the asphalt cement metering system with a limited amount of mix production. This procedure is useful in determining asphalt cement content only and does not provide extracted aggregate for gradation analysis.

1.2 *CAUTION:* Only licensed operators may use nuclear gauges. The quantity of radioactive material contained in a nuclear gauge is relatively small, and the operator can use a properly operating gauge safely, day after day, without any known health hazard due to radiation exposure. However, all radioactive sources, no matter how small, must be handled with care. In the event the gauge becomes physically damaged, immediately notify the district Nuclear Safety Officer and the Department Radiation Safety Officer. Do not handle or approach the gauge.

1.3 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. APPARATUS

2.1 *Nuclear testing gauge*, with manufacturer's instruction manual and sample pans, able to determine the asphalt content of a sample containing 0–14% asphalt cement.

2.2 *Balance,* Class G2 in accordance with Tex-901-K.

2.3 *Oven*, capable of heating to 177 ± 3°C (350 ± 5°F).

2.4 *Plywood*, 19 mm (3/4 in.) or thicker, or metal plate 9.5 mm (3/8 in.) or thicker, having an area slightly larger than the top of the gauge sample pans.

2.5 *Thermometer*, with a temperature range of 10–300°C (50–500°F).

2.6 *Assorted spoons, scoops, mixing bowls, trowels, and spatulas.*

2.7 *Wax paper.*

2.8 *Mechanical mixing machine* (optional).

3. TEST RECORD FORM

3.1 Nuclear Asphalt Content Test

3.2 Nuclear Asphalt Content Calibration

3.3 Other suitable worksheets

4. PRECAUTIONS

4.1 The asphalt content gauge must be licensed according to applicable health and safety regulations prior to use.

4.2 Gauge operators must have received approved safety training and operational training.

4.3 Since nuclear equipment measures the total amount of hydrogen in the sample, this procedure is sensitive to changes in moisture content, as both asphalt cement and water contain hydrogen.

4.4 Keep any other source of neutron radiation at least 7.6 m (25 ft.) from the equipment during use. Do not place the equipment where large amounts of hydrogenous material may be moved during the calibration or testing procedures (e.g., people, water, trucks loaded with bituminous mix or asphalt, or plastic materials).

4.5 The operator must be aware of changing conditions that could affect gauge results. Additional standardization testing must be performed if changes occur.

5. SAMPLING

5.1 Obtain representative samples of the aggregates in accordance with Tex-204-F and Tex-400-A.

5.2 Obtain representative samples of the freshly produced bituminous paving mixture in accordance with Tex-222-F.

6. PREPARING TEST SAMPLE

6.1 Obtain a sample size large enough to fill the gauge sample pan (approximately 10 kg [22 lb.]) for each required test.

6.2 Check the test sample for moisture content in accordance with Tex-212-F. If moisture is present, subtract the percentage determined from the apparent asphalt cement percentage as indicated by the nuclear method. The sample may also be dried to a constant weight in an oven at 110 ± 5°C (230 ± 10°F), thereby nullifying the need for moisture correction.

6.3 Place the test sample in the gauge sample pan according to the manufacturer's recommended procedure.

7. CALIBRATION

7.1 This test method is sensitive to the type of aggregate, percentage and source of asphalt, and to the mix gradation. Accordingly, develop a calibration for each mix type.

7.1.1 Establish the curve with a minimum of three points.

7.1.2 Develop a new calibration curve whenever there is a change in the source of asphalt or aggregate, or a significant change in aggregate gradation (generally, one requiring a new mixture design).

7.2 Follow these steps to develop the calibration curve properly:

7.2.1 Sample the aggregates at the plant in accordance with Section 5 and blend the aggregates in the proper proportions. Obtain sufficient aggregate for a minimum of four samples.

7.2.2 Mix a minimum of three asphalt concrete samples in accordance with Tex-205-F:

- one at the design asphalt cement content
- one at 1.0% above the design asphalt cement content
- one at 1.0% below the design percentage.

7.2.2.1 Use the grade and type of asphalt cement along with any other additives that will be used in the tested asphalt concrete mixture.

7.2.3 Begin the calibration using the asphalt concrete mixture sample 1.0% above the design asphalt cement content.

7.2.4 Zero out or tare the gauge sample pan. Fill the gauge sample pan half-full, evenly distributing the sample in the pan.

7.2.5 Level the asphalt concrete mixture with a trowel or spatula and spade 20–30 times around the perimeter to minimize voids between the sample and edges of the pan. Take care not to exert pressure on the sample.

7.2.6 Fill the pan to the point that the asphalt concrete mixture is mounded slightly above the top of the pan and repeat the spading procedure. Record weight of the asphalt concrete mixture in the pan. This will be the base weight to be used for all calibration and test samples using this calibration.

7.2.7 Level the top of the bituminous mixture using a spatula or trowel to an even head (approximately 13 mm [0.5 in.]) above the top lip of the pan.

7.2.8 Use the metal or plywood plate with a covering of wax paper (to prevent sticking) to consolidate the sample in the pan until it is flush with top edges of the pan. Place the pan on the floor, and with the wax paper and plate on top of the sample pan, stand on the plate. The surface of the mixture must be uniform.

7.2.9 Measure and record the temperature and weight of the test sample. With nuclear gauges that do not have automatic temperature correction, the sample temperature is the temperature ± 5°C (10°F) at which all samples and calibration pans must be counted.

7.2.10 Place the sample pan containing the asphalt concrete mixture sample in the gauge and proceed as per manufacturer's instructions for equipment operations.

7.2.11 Measure and record the 16-minute gauge count.

7.2.12 Repeat the above process for the remainder of the calibration samples using the same sample weight of asphalt concrete mixture in each pan.

7.2.13 Generate a calibration curve using the software provided with the gauge.

7.2.13.1 The correlation factor must be greater than or equal to 0.995 to be acceptable.

7.2.13.2 It may be necessary to plot the calibration curve manually if the gauge cannot generate the curve internally.

7.2.13.3 Reference the gauge manufacturer's user manual for specific details on generating the calibration curve. (See Section 8.)

7.2.14 Repeat the calibration procedure for each asphalt concrete mixture that is to be used.

8. CALCULATIONS

8.1 Use the following to determine correlation factor:

$$Correlation\ Factor = \frac{n\left(\sum xy\right) - \left(\sum x\right)\left(\sum y\right)}{\left[n\left(\sum x^2\right) - \left(\sum x\right)^2\right] x \left[n\left(\sum y^2\right) - \left(\sum y\right)^2\right]}$$

Where:

n = number of calibration samples

x = percent asphalt cement

y = sample count

Σ = summation.

9. CALIBRATION TRANSFER

9.1 Some gauges will allow laboratory calibration values to be transferred to field gauges. After entering the values according to the manufacturer's procedures, the coefficient of correlation must be 0.990 or greater to be a valid transfer. If the coefficient of correlation is less than 0.990, re-enter the values and check lab-to-field gauge correlation. If the same results are achieved, the transfer is invalid and an independent calibration must be established for the field gauge.

10. FIELD TESTING

10.1 Place the test sample in the sample pan by the same method described in Sections 7.2.4 though 7.2.9. The sample weight must be equal to the base weight ± 1 g.

10.2 If the gauge has a temperature compensator feature, enter the temperature of the field samples, if required. If there is no temperature compensator feature, heat the sample to ± 5°C (10°F) of the calibration sample temperature.

10.3 Check the test sample for moisture content.

10.3.1 If moisture is present, subtract the percentage determined from the apparent asphalt cement percentage as indicated by the nuclear method.

10.3.2 Alternately, dry the sample to a constant weight in an oven at 110 ± 5°C (230 ± 10°F), thereby nullifying the need for a moisture correction.

10.4 Place the sample in the gauge and follow the manufacturer's instructions to obtain sample counts.

10.5 Determine the apparent asphalt cement content and correct for moisture (if needed).

Note 1—Accuracy and precision increase with longer count times.

11. STANDARDIZATION

11.1 All nuclear devices are subject to long-term aging of the radioactive source, detectors, and other electronic systems, which may change the relationship between count rate and asphalt cement content. Because of this aging, run new calibration curves a minimum of once a year. Changes in the surroundings of the asphalt content gauge may also produce increases or decreases in count rate.

11.2 In order to minimize these effects, record background counts daily, and keep the gauges out of the proximity of water or other hydrogenous substances.

11.3 Perform the following calibration tests per the manufacturer's instructions as indicated:

11.3.1 *Stability Test:*

11.3.1.1 Perform this test at least once every 2 weeks during continuous operation and before using the gauge if more than 4 days have passed since the gauge was last used.

11.3.1.2 If the stability test fails, evaluate the surrounding conditions for causes.

11.3.1.3 Conduct a stability test with passing results before using the gauge.

11.3.1.4 Maintain a log of all stability tests results for each gauge.

11.3.2 *Drift Test:*

11.3.2.1 Perform this test at least every 30 days during the gauge's use, and before using the gauge if 30 days have passed since the gauge was last used.

11.3.2.2 Conduct a stability test with passing results before performing the drift test.

11.3.2.3 Leave the gauge in the power on condition between the stability and drift tests.

11.3.2.4 Conduct a drift test with passing result before any sample testing is performed with the gauge.

11.3.2.5 Maintain a log of all drift test results for each gauge.

11.3.3 *Background (Standard) Test:*

11.3.3.1 Perform this test daily, for 16 minutes, before testing samples.

11.3.3.2 Maintain a log of all background test results for each gauge.

12. REPORT

12.1 Report must include:

- make, model, and serial number of the equipment
- name of the operator
- project identification data and date
- identification of the asphalt cement and aggregate materials
- type of materials and specified asphalt content
- calibration date and daily checks
- count rate for each sample and the corrected asphalt content, moisture content
- weight of the sample, method of sampling, and method of compaction.

13. ARCHIVED VERSIONS

13.1 Archived versions are available.