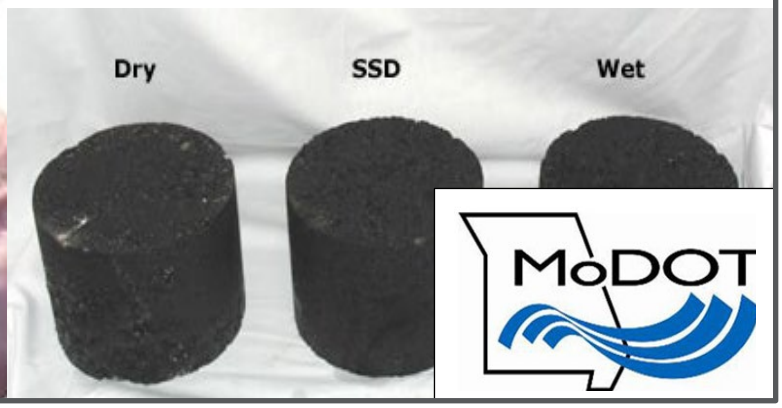
2025 Edition

BITUMINOUS TECHNICIAN



Bituminous Technician Updates

2025: **AASHTO T166:**

- **Added definitions:** Immersion Thermometer, Mass, Weight.
- **Clarification** of specimen preparations, Moist vs Recently Molded.
- **Added** Thermometer information to the appendix.
  - **Water Bath Thermometer Requirements:**
    - Immersion Thermometer
    - Meets M339M/M339
    - Temp range includes testing temperature.
    - Resolution 0.2°F (0.1°C)
    - Max error of 1°F (0.5°C)
  - **Suitable Thermometers:**
    - Glass thermometer ASTM 17F/17C
    - Thermistor as described in E879.
    - Digital thermometer as described in E2877.
    - Thermocouple thermometer, Type T, Class 1
- **Equipment:** Added Oven, and info to potable water.
- Added information on T133 - Gmb by vacuum sealing.

2024 – No Updates

2023: **AASHTO T166:**

- **Water Bath**: The thermometer for measuring the temperature of the water bath shall meet the requirements of M339M/M339 with a temperature range of at least 20 to 45°C (68 to 113°F) and an accuracy of ±0.25°C (±0.45°F) (see note 2),
  - NOTE 2: Thermometer types to use include:
    - ASTM E1 Mercury Thermometer
    - ASTM E879 thermistor thermometer
    - ASTM E1137/E1137M Pt-100 RTD platinum resistance thermometer, Class A
    - IEC 60751: 2008 Pt-100 RTD platinum resistance thermometer, Class AA
- **Room Temperature**: Meeting the requirements of M339M/M339 with a temperature range of at least 15 to 45°C (59 to 113°F) and an accuracy of ± 0.5°C (± 0.9 °F) (see note 3),
  - NOTE 3: Thermometer types to use include:
    - ASTM E1 Mercury Thermometer
    - ASTM 2877 digital metal stem thermometer
    - ASTM E230/E230M thermocouple thermometer, Type T, Special Class
    - IEC 60584: thermocouple thermometer, Type T, Class 1

- **Oven**: The thermometer for measuring the oven temperature shall meet the requirements of M339M/M339 with a range of at least 40 to 60°C (104 to 140°F) and an accuracy of ± 0.75°C (± 1.35°F) (see note 4),
    - NOTE 4: Thermometer types to use include:
        - ASTM E1 Mercury Thermometer
        - ASTM 2877 digital metal stem thermometer
        - ASTM E230/E230M thermocouple thermometer, Type T, Special Class
        - IEC 60584: thermocouple thermometer, Type T, Class 1

- **AASHTO T329:**
    - **Asphalt Mixtures**: The thermometer for measuring the temperature of asphalt mixtures shall meet the requirements of M339M/M339 with a temperature range of at least 50 to 200°C (122 to 392°F) and an accuracy of ±2°C (±3.6°F) (see note 1),
        - NOTE 1: Thermometer types to use include:
            - ASTM E1 Mercury Thermometer
            - ASTM 2877 digital metal stem thermometer
            - ASTM E230/E230M thermocouple thermometer, Type T, Standard Class
            - IEC 60584 thermocouple thermometer, Type T, Class 2
            - Dial gauge metal stem (Bi-metal) thermometer
- **AASHTO TM 54:**
    - The thermometer shall meet the requirements of M339M/M339 with a range of at least 10 to 260°C (50 to 500°F) and an accuracy of ± 0.5°C (± 9°F)
        - NOTE 1: Thermometer types to use include:
            - ASTM E1 Mercury Thermometer
            - ASTM 2877 digital metal stem thermometer
            - ASTM E230/E230M thermocouple thermometer, Type T, Special Class
            - IEC 60584: thermocouple thermometer, Type T, Class 1

2022: AASHTO T166:

- updated temperature (77 ± 1.8 °F) to (77 ± 2 °F)

2021 – NO Updates

COURSE CONTENT

BITUMINOUS TECHNICIAN

MoDOT TM 20	Measurement of Air, Surface or Asphalt Mixture Temperature
AASHTO R 66	Sampling Asphalt Materials
AASHTO R 97	Sampling Asphalt Mixtures
AASHTO R 47	Reducing Samples of Asphalt Mixtures to Testing Size
AASHTO T 329	Moisture Content of Asphalt Mixtures by Oven Method
AASHTO T 166	Bulk Specific Gravity of Compacted Asphalt Materials Using Saturated Surface-Dry Specimens - AASHTO R79 - Vacuum dry, - AASHTO T133- Gmb by Vacuum sealing.
AASHTO T 269	Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
MoDOT TM 54 **AASHTO T287**	Determining the Asphalt Content of an Asphalt Mixture

Appendix

Glossary

MoDOT TM 20

Measurement of Air, Surface, or Asphalt Mixture Temperature

Required Audits

All testers on Federal-Aid Projects (MoDOT or Off-System) are required by the FHWA to be audited at least once per year.

Reasons:

- To ensure proper test procedures are being utilized.
- To ensure testing equipment is calibrated and operating properly.

- **Types of Audits;** procedure or comparison.
- **Be Proactive;** schedule your audit as early as possible with MoDOT Materials in district offices, do NOT wait until the end of the year.
- **Provide Proof;** when audited, present a MoDOT Certification Card, or a MoDOT Letter.

1

MoDOT TM 20

Measurement of Air, Surface, or Asphalt Mixture Temperature

2

05/13/2021

2

WHY IS TEMPERATURE IMPORTANT?

- The temperature is required of many AASHTO specifications in testing of asphalt materials as well as concrete.
- Temperature is used to provide quality assurance and to prevent early pavement deterioration.

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EQUIPMENT CALIBRATION

- Calibrate thermometers **annually**.
- Calibration of a thermometer will establish a **correction factor** to adjust the thermometer reading to the true temperature.
- Information on how MoDOT owned thermometers are verified may be obtained from the District Materials Staff.
- Thermometers can be sent to the manufacturer on a yearly basis to be verified/calibrated.

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A Record of calibration/verification that is traceable to

National Institute of Standards and Technology

(NIST) Traceable Standards is needed for thermometers.

Keep a copy of this record in the Laboratory's Quality Control Manual.

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Infrared Thermometer

Surface, Asphalt Mixture

Range: 20° F to 400° F

Increment: 2° F

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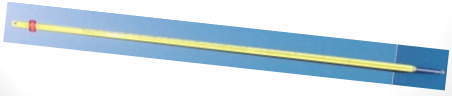
Mercury Thermometer

Air and Surface

Range: 20° F to 130° F

Increment: 2° F

Note: Mercury Thermometers are **rarely** used due to the potential of mercury contamination, if broken. Today technicians are using digital type thermometers with a metal probe.



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Digital Thermometers

Air, Surface, Asphalt Mixture

Range: 0°F to 400°F,

Increment: 1°F

NIST Traceable

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Max-Min Thermometer

Air, Surface

Range: 20° F to 130° F

Increment: 2° F

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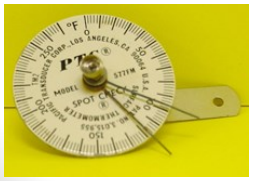
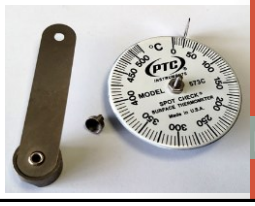
Spot Check Disc Thermometer

Surface

Range: 32° F to 250° F

Increment: 2° F





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BI-Therm Dial Thermometer

Asphalt Mixture

Range: 50° F to 400° F

Increment: 5° F

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Armored Thermometer

Asphalt Mixture

Range: 50° F to 400° F

Increment: 5° F

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Wooden Box

Surface

See EPG Test Method TM 20 for dimensions.

(included in EPG at the end of this section)

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PRECAUTIONS

- Do not use BI-Therm Dial thermometer (poker) for surface or air temperature.
- Infrared thermometers are for surface or asphalt mixture temperature only.
- Do not check surface temperature of asphalt immediately after roller has passed.
- Always check surface temperatures on a stationary target.

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PROCEDURE

Air Temperature

- Thermometers: Mercury, Digital, Max-Min
- Location:
  - Shaded area
    (Not exposed to direct sunlight).
  - Safe area
- Position: 4.5 ft. above the surface
- Report to nearest 2°F

15

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Surface Temperature

- Infrared Thermometer
  - Follow the manufacturer's recommendations
- Spot Check Disc Thermometer
  - Place on surface
  - Read when needle stops moving
  - Report to nearest 2°F

Procedure

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Surface Temperature (continued)

- Max-Min or Mercury Thermometer
  - Place thermometer on surface
  - Place wooden box over top (open side down covering thermometer)
  - Leave thermometer under box for a minimum of 5 minutes
  - Lift the box enough to read the temperature. Report to nearest 2°F

Procedure

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Asphalt Mixture Temperature

- Digital, Armored or BI-Therm Dial Thermometer
  - Place stem in loose asphalt mixture.
  - Do not disturb until reading has stabilized.
  - Read temperature.
  - Report to nearest 5°F

Procedure

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- **Asphalt Mixture Temperature** (continued)
  - Infrared Thermometer
    - Follow manufacturers instructions.
    - Direct reading of asphalt loose mix located in truck, a receiving hopper, or material at the end of paver augers.
    - Read temperature. Report to nearest 5°F

Procedure

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DOCUMENTATION

- Read and record the air, surface or asphalt mixture temperature to the accuracy listed below in a bound field book.
  - Air, nearest 2° F
  - Surface, nearest 2° F
  - Asphalt Mixture, nearest 5° F

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106.3.2.20 TM-20, Measurement of Air, Surface or Bituminous Mixture Temperature

From Engineering Policy Guide
Jump to: navigation, search

This method describes the equipment and procedures required to determine air temperature, surface temperature of a base or pavement, and bituminous mixture temperature in the loose state.

106.3.2.20.1 Apparatus

Infrared Thermometer. Used for surface and loose bituminous mixture temperature determination. The thermometer should register in the range of 20° F to 400° F, with a maximum increment of 2 °F. Operation of this instrument should be based on the manufacturer's instructions.

Mercury Thermometer. Used for air or surface temperature determination. Typically a straight glass thermometer or a U-shaped glass thermometer in a plastic housing commonly referred to as a MAX-MIN thermometer. The thermometer should register in the range of 20° F to 130° F, with a maximum increment of 2 °F.

Armored Thermometer. Used for loose bituminous mixture temperature determination. The thermometer should register in the range of 50° F to 400° F, with a maximum increment of 5 °F.

Bi-Therm Dial Thermometer. Used for loose bituminous mixture temperature determination. The thermometer should register in the range of 50° F to 400° F, with a maximum increment of 5 °F.

Spot Check Disc Thermometer. Used for surface temperature determination. The thermometer should register in the range of 32° F to 250° F, with a maximum increment of 2 °F.

Digital Thermometer. Used for air surface or bituminous mixture temperature determination. Thermometer will measure temperature in the range of 0° F to 400° F as a minimum with a maximum increment of 1° F. Thermometer will have a remote probe and may have recording capabilities of maximum and minimum temperature reading. Thermometer, when purchased, shall have a record of calibration to NIST Traceable Standards provided.

Wooden Box. Used to cover a mercury thermometer when determining the temperature of a base or pavement. The box will be wooden with a material thickness of not less than 3/8 in. The minimum inside dimensions will be 2 in. tall, 3 in. wide and 14 in. long. The bottom side of the box is to be left open. The bottom edge of the sides and ends shall have attached a strip of foam rubber 3/16 in. thick and the same width as the thickness of the side and end boards. The outside of the box shall be painted with aluminum paint. See Fig. 106.3.2.1.20, below, for a pictorial description.

Calibration of Thermometers. Thermometers shall be calibrated **annually** against a known standard.

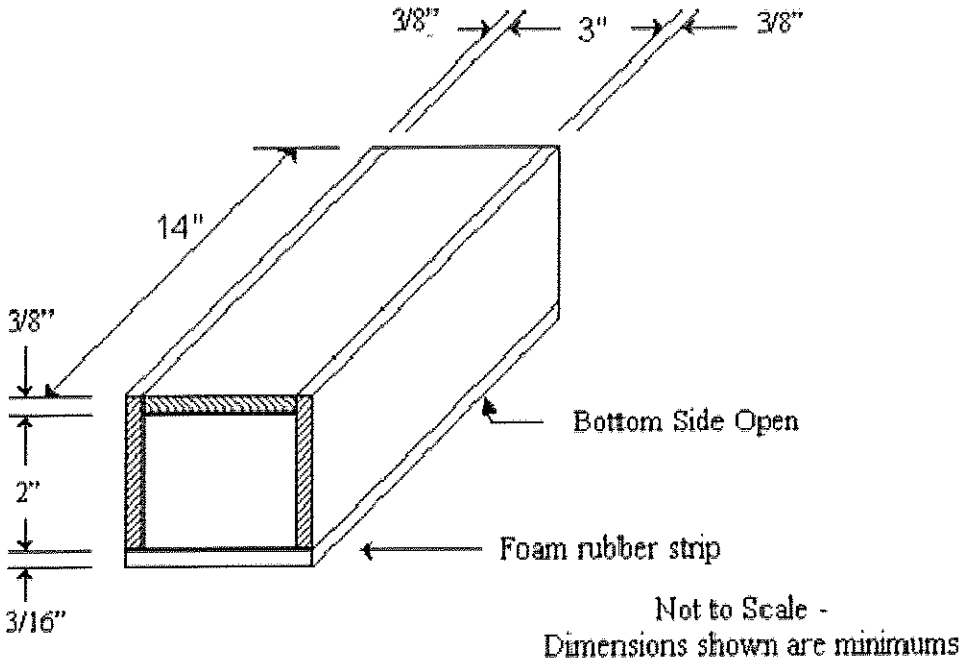


Fig. 106.3.2.1.20

106.3.2.20.2 Procedure

Air Temperature. The mercury thermometer or digital thermometer probe shall be positioned in a shaded area and shall not be exposed to direct sunlight. The thermometer shall be 4.5 ft. above surface level, measured from the surface to the bulb of the thermometer. Care should be taken to ensure no artificial heating or cooling occurs near the thermometer. The thermometer will be left in this location until the reading stabilizes. Air temperature shall be recorded to the nearest 2 °F.

Surface Temperature, mercury thermometer. The thermometer cannot be disturbed for at least 5 minutes while conducting this test, so select a location where this criteria can be met. Place the thermometer on the test surface and place the wooden box firmly over the thermometer ensuring the foam rubber strips are in contact with the test surface. The box should remain over the thermometer for a minimum of five minutes. After the 5 minutes, tip the box on edge only far enough to read the thermometer. The surface temperature shall be recorded to the nearest 2 °F.

Surface Temperature, infrared thermometer. When using an infrared thermometer, follow the manufacturer's recommended procedure. When obtaining the temperature of a surface, make sure air currents do not affect the reading. The surface temperature shall be recorded to the nearest 2 °F.

Surface Temperature, spot check disc thermometer. Place the thermometer on the surface and wait until the needle stops moving. Read the temperature. The surface temperature should be recorded to the nearest 2 °F.

Surface Temperature, digital thermometer. The thermometer probe cannot be disturbed for at least 5 minutes while conducting this test, so select a location where this criteria can be met. Place the thermometer probe on the test surface and place the wooden box firmly over the thermometer probe ensuring the foam rubber strips are in contact with the test surface. The box should remain over the thermometer probe for a minimum of five minutes. After the 5 minutes, read display of thermometer. The surface temperature shall be recorded to the nearest 2 °F.

Bituminous Mixture Temperature, armored or Bi-Therm Dial - The thermometer shall have the stem of the thermometer embedded in the loose bituminous mixture. The thermometer should not be disturbed until the thermometer reading has stabilized. When the thermometer has stabilized, read the thermometer. The bituminous mixture temperature shall be recorded to the nearest 5 °F. A digital thermometer that has a range capable of measuring the bituminous mixture temperature and a probe that can withstand the mixture temperature can be used in lieu of an armored or bi-therm dial thermometer.

Bituminous Mixture Temperature, infrared - The thermometer shall be used as recommended by the manufacturer. The location for determining the temperature of the loose bituminous material shall be either in the delivery truck bed, the receiving hopper of the paver or MTV, or at the material head at the end of the paver augers prior to entering the paver screed. The bituminous mixture temperature shall be recorded to the nearest 5 °F.

MoDOT TM 20
Measurement of Air, Surface, and Asphalt Mixture Temperature
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial #	1	2
Certificates or Report of Verification of Accuracy (Annual calibration) available?		
AIR		
1. Pick correct thermometer		
2. Location - *Mercury, Digital, Max-Min thermometers* - shade, no direct sunlight - position 4.5 feet above surface - safe location		
3. Document to nearest 2° F		

SURFACE		
4. Pick correct thermometer		
5. Procedure - *Spot Check Disc*: place on surface until needle stops moving. - *Infrared*; follow manufacturer recommendations. - *Mercury or Max-Min*; place under wooden box wait 5 minutes. - *Digital* ; follow manufacturer recommendations		
6. Document to nearest 2° F		

ASPHALT MIXTURE		
7. Pick correct thermometer		
8. Procedure - *Infrared*; follow manufacturer recommendations. - *Armored, BI-Therm Dial, or Digital*; place stem into mixture and wait until thermometer reading has stabilized		
9. Document to nearest 5° F		

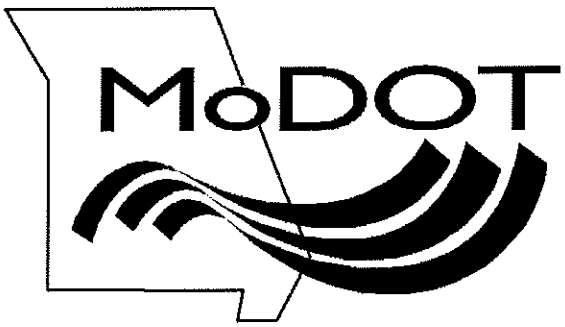
PASS PASS

FAIL FAIL

Examiner:_____Date:_____

AASHTO R 66

Sampling Asphalt Materials



AASHTO R 66

Sampling Asphalt Materials

1

Rev 08/29/2024

1

SCOPE

- This standard applies to sampling asphalt materials at production facilities, storage facilities, or the point of delivery. Samples may be taken from tanks, stockpiles, vehicles, or containers used for the storage or shipping of asphalt materials.

2

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SIGNIFICANCE AND USE

- Sampling is a critical step in determining the quality of the material being sampled. Care shall be exercised to ensure that the sample is representative of the material in the line or vessel being sampled.

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DEFINITIONS

- **Asphalt Materials**: A solid, liquid, or semisolid mixture of heavy hydrocarbons and nonmetallic derivatives; obtained from naturally occurring bituminous deposits or from residues of petroleum refining.
- **Bituminous Materials:** Materials containing bitumen, bitumen is a sticky black liquid or semi-solid form of petroleum.
- **Note**: More definitions are located in the back of this manual.

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SAFTEY FIRST !

- When sampling HOT asphalt material, always wear the proper safety attire and follow required safety procedures.
- Always use extreme caution when sampling HOT asphalt material around pipes and valves.
- A supply of clean cool water should be readily available in case of exposure to HOT asphalt materials. If not carry have several ice packs with you in a cooler and have it near you as you sample.

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Safety First

- If HOT Asphalt Material lands on your clothing, remove the article of clothing, unless it adheres to your skin. In that instance, submerse in cool water. (A bucket or cooler with Ice Water is best)
- If it lands on your skin, DO NOT touch it, rub it, or try to remove solidified asphalt binder. Instead, immediately submerse the affected area in cool water or cover with ice packs until you can get help.
- DO NOT try to remove the material from your skin with solvents. (BAD IDEA!)
- SEEK IMMEDIATE MEDICAL ATTENTION!

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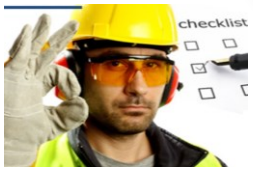
EQUIPMENT



- Safety equipment
- Hardhat
- Insulated gloves
- Eye protection
- Long sleeve shirt
- Bucket of water or source of cool water, Ice packs
- Different types of sample containers
- Appropriate dipper or sampling device
- Labeling materials, such as markers, tags, clean dry cloth
- Thermal cooler; if needed

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Sample Containers:

- Must be new
- Lid and container shall fit tightly together.
- Clean and dry
- Shall correspond to the required amount of sample

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Sample Containers

- Containers for liquid asphalt materials, except emulsified asphalt, shall be double-seal friction top cans, cans with screw caps or small-mouth cans with screw caps.
- Containers for emulsified asphalt samples (tack coats) shall be in plastic wide-mouth jars or bottles with screw caps.

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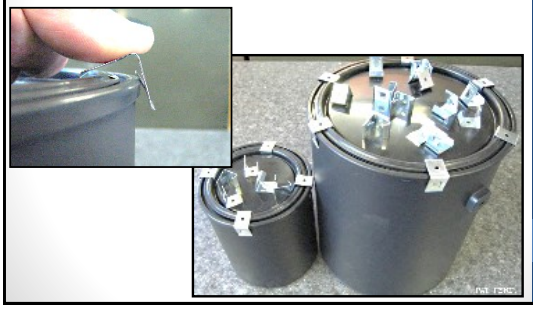
Sample Containers

- **Optional:** Clips can provide additional security in protecting friction type cans from leakage and contamination.



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SAMPLING ASPHALT MATERIALS

Liquid Materials

Sampled from: Pipes, Tanks, Drums, Barrels

Types of Liquid Asphaltic Materials:
Performance Graded (PG) Binders, Emulsions, Cut-Backs

Semisolid Materials

Sampled from: Drums, Barrels, Cartons, Bags

Types of Semisolid Materials:
Crack Sealers, Asphalt Patch Material

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Sampling Liquids

Liquid Materials

Liquid asphaltic materials can be sampled from a **Sample Valve** attached to a tank or a line. **(Preferred method)**

OR

by the **Dip Method** from above down into a tank or barrel.

NOTE: It is recommended that the contractor personnel obtain the sample under the inspector's observation.

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Sampling Valve;

Use a **Sample Valve** on a storage tank

Sampling Liquids - Valves

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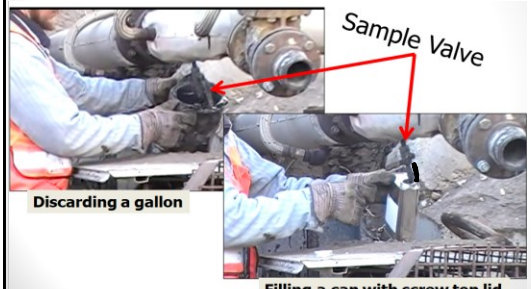
Or use a **Sample Valve** on a **line** located down stream of blending or other processing at the plant.



Sampling Liquids - Valves

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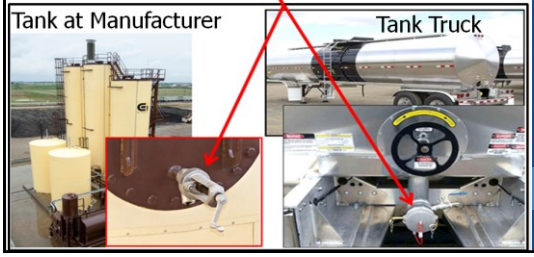
PROCEDURE

1. Wear safety gear and have a water source available (Everything may be HOT!)
2. Find a **Sample Valve** on a tank or line.



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Procedure – Sampling - Valves 16

Continue with the following steps or observe the following steps:

3. Discard at least one gallon of the material.
4. Have a new, clean, dry container ready.
5. Fill the container to within **½"** from the top.

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Procedure – Sampling - Valves 17

6. Immediately put the lid on the container.
7. Use a clean-dry cloth to wipe the can clean while it is still very warm.
8. Write the ID, Supplier, Grade and the Date sampled on the can "Not the lid".

17

Procedure – Sampling - Valves 18

9. Place the can into a heavy-duty sealable plastic bag and place it into the proper shipping container.
10. ID the shipping container and ship or deliver to the MoDOT Central Lab ASAP.

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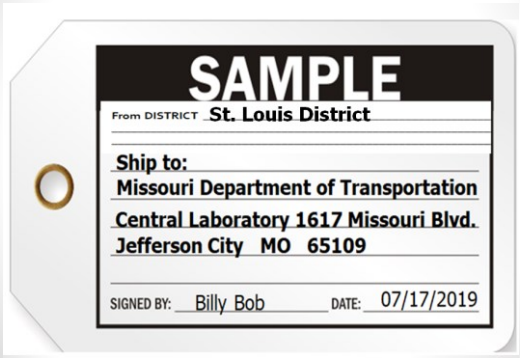
Ship or deliver to the MoDOT Central Lab



Procedure – Sampling

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Things to know:

- The use of filters or screens in sampling devices or nozzles are not allowed.
- Avoid transferring the sample from one container to another, except where required by the sampling method.
- Do not submerge the container in solvent or wipe it down with a solvent-saturated cloth.
- Avoid breathing any fumes, mists and or vapors.
- Do not smoke near asphalt materials.

Sampling Liquids

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Sampling Liquids By The Dip Method

- Liquid asphalt materials, including the materials liquefied by heating may be taken by the **Dip Method** using a clean wide-mouth plastic jar or friction-top can in a suitable holder.
- A clean container must be used to take each sample, and the materials sampled shall then be transferred to another new and clean container for retaining or testing the sample.

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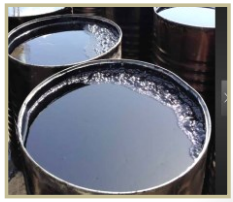
Sampling Liquids From Drums/Barrels

- Select barrels or drums at random, thoroughly mix the material in the drum or barrel, use the **Dip Method** to take a quart of material from each barrel or drum selected.
- Combine the quart samples, thoroughly mix and take a gallon from the combined material.



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Sampling Semisolid Materials

- **Drums, Barrels, Cartons, and Bags**
  - When the lot of material is from a single run or batch, one container shall be selected at random.
  - When the lot is NOT from a single run or batch, select the number of samples at random indicated in **Table 1**.

23

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Table 1 – Sample Size Selection

Containers in Shipment	Containers to Select
2 to 8	2
9 to 27	3
28 to 64	4
65 to 125	5
126 to 216	6
217 to 343	7
344 to 512	8
513 to 729	9
730 to 1000	10

Sampling – Semisolid Materials

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- Samples shall be taken from at least 3 inches below the surface and at least 3 inches from the side of the container.
- A clean hatchet may be used if the material is hard enough to shatter or a stiff putty knife may be used if the material is soft.
- When more than one container in a lot is sampled, each individual sample shall have a mass of ¼ lb. or more.

Sampling – Semisolid Materials 25

25

- When the lot of material is from a single run or batch, all samples from the lot shall be melted and thoroughly mixed, and an average of **one-gallon** sample taken from the combined material.
- If more than a single run or batch is included and the batches can be clearly differentiated, a composite one-gallon sample shall be prepared from each batch.
- Where it is not possible to differentiate between the various batches, each sample shall be tested separately.

Sampling – Semisolid Materials 26

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SAMPLING AT THE POINT OF SHIPMENT DELIVERY

- Sampling of asphalt materials shall be completed as soon as practical after the asphalt material has arrived at the site or at the time of unloading.
- Deliver the samples to the MoDOT laboratory as soon as practicable.

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EXAMPLES of Liquid Asphalt Materials

1. PG Binder
2. Emulsions
3. Cut-Back

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1. PG BINDERS

Binders

- **PG Binder**: Acts as a binding agent to glue aggregate particles into a cohesive mass called Asphalt Mixture to create pavement. Binders are liquid when hot, when cooled it becomes sticky and hardens into a solid.
- Sample PG Binders while HOT!

PG stands for:
Performance **G**rade

- Do Not use solvent to clean the Outside of the cans.
- Do Not leave the samples out in the rain.

updated

29

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PG Binders

Sampling – PG Binders

- **PG Binder - Grades**
  - PG 64-22
  - PG 64-22H
  - PG 58-28
  - PG 70-22
  - PG 64-22VH, etc.

Note: PG = Performance Grade
H = Heavy Traffic
VH = Very Heavy Traffic

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PG Binders

- Use sample containers with double-seal friction type lids.

Gallon Can: For Trial Mixes.

Quart Can: For Tank Samples

Pint Can: For Daily Plant Samples.

Double-seal friction lid

Sampling-PG Binders

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PG Binders

- Material Inspectors will sample or observe sampling of liquid asphalt materials at the source. updated
- Truck shipments of liquid asphalt materials may be accepted by a copy of the shipping ticket.
- Plant inspectors must ensure that properly certified asphalt is on hand prior to use and obtain daily plant samples during production.

Sampling- PG Binders

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2. EMULSIONS

- **Emulsified Asphalt** - A mixture of asphalt cement, water and emulsifying agent (free flowing liquid at room temperature 34 - 86°F).

Emulsions

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Emulsions

- **Emulsified Asphalt Grades**: RS-2, RS-1, CPEM-1, SS-1, HFMS-2H, EA-90, EA-150, CSS-1HM, scrub seal, CMS-2M, etc.

(Tack Coat Materials)

MS = Medium Set

RS = Rapid Set

The numbers describe the viscosity of the emulsion.

Need one gallon, plastic container with screw top.

Sampling - Emulsions

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Emulsions

- Emulsified Asphalt Samples:
  - **Protect from freezing.**
  - Do not sample under pressure.
  - Limit air in the container by:
    - Filling a container with emulsified asphalt until a small amount of space remains, squeeze the container to cause the content to fill to the top then place the cap and tighten it.
  - Use a plastic gallon container with screw tight lid.
  - Used for tack coats, seal coats, surface treatments, and cold mix asphalt. Cost-Efficiency.

Sampling - Emulsions

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3. CUTBACK ASPHALT

- **Cutback Asphalt** is manufactured by blending asphalt cement with a petroleum solvent like kerosene. Cutback Asphalt is liquid at room temperature 34 - 86°F.

Cutback Asphalt is used for patching.

Sampling - Cutback Asphalt

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Cutback Asphalt

Cut-Back Grades

RC-70, MC-800, RC-800, MC-3000, SC-250, etc.

RC = Rapid Cure
MC = Medium Cure
SC = Slow Cure

Need one quart (1L) screw top can, place in a sealed bag in an approved box.

Sampling - Cutback Asphalt

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MoDOT Sampling Notes

- For truck, refinery, or terminal sampling requirements, see EPG section 1015.
- For daily plant samples of asphalt binder, see EPG Section 460.
- Sampling procedures are further defined in the EPG section 106.
- EPG Section 400.
- EPG is located on MoDOT web

https://www.modot.org/doing-business-modot

MoDOT EPG

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EXAMPLE OF A BILL OF LADING

Jebro Inc.

MOTOR CARRIER BILL OF LADING
ORIGINAL

This shipment shall be governed by (a) the contract between shipper and carrier, if carrier is a contract carrier; or (b) the terms of applicable bill of lading form described in National Motor Freight Classification No. A3 MF-I.C.C. No. 8 issued by F. G. Freund, Agent, supplements thereto or reissues thereof, if carrier is a common carrier, provided that, if this is an interstate shipment by common carrier in a state where bills of lading have been legally prescribed, this shipment shall be governed by the terms of the applicable bill of lading.

INVOICE TO:
Unassigned Control Record
Unassigned
Sioux City, IA 51111

DESTINATION:
5 miles west off of exit 234 on I29

MILEAGE: 230
DELIVERY TIME: 13:00
DELIVERY DATE: 05/08/98

PROJECT NUMBER: Test BOL Project

CONTRACT NUMBER: 0
PURCHASE ORDER #: 0

CONSIGNEE: Jebro Incorporated
FREIGHT TYPE: Prepaid
TIME IN: 5/8/98 6:00
TIME OUT: 5/8/98 6:30
CARRIER: Jebro Incorporated
UNIT NUMBERS: Jeb524 /Jeb223

Carrier certifies that the cargo tank supplied for this shipment is a proper container for transportation of this commodity as described by this shipper and that proper placards have been applied.

I hereby certify that the maximum legal weight for the vehicle transporting the goods described above is: John E. Doe

DRIVER

CUSTOMER

Arrival Time: _____
Unloading Began: _____
Unloading Complete: _____
Pump Used or Ordered: _____
Reason For Delay: _____

CUSTOMER SIGNATURE

PRODUCT INFORMATION
Elevated Temperature Liquid,
n.o.s., 9, UN 3257, PG III
Chemtrec: 1-800-424-9300
Jebro: 1-800-831-8037
PG64-28
SP.G. 1.0290
lb/gal: 8.5701 kg/lit: 1.0269
Temp 329 F 165 C Temp adj 0.90920
EMERGENCY CONTACT: 1-712-277-8855

LOAD WEIGHTS AND QUANTITIES

Gross Lbs	79,500 (	36,061 kg)
Tare Lbs	27,500 (	12,474 kg)
Net Lbs	52,000 (	23,587 kg)
Net Tons	26.00 (	23.59 Mg)
Net Gallons 60F	6,068 (	22,970 l)

This is to certify that the above named articles are properly described, and are packed and marked and are in proper condition for transportation according to the regulations by the Interstate Commerce Commission.

TEMPERATURE FOR KINEMATIC VISCOSITY OF:

300 Cs =	275
150 Cs =	307
200 Cs =	291
50 Cs =	369

SEAL NUMBERS:

CERTIFICATE OF COMPLIANCE
I certify that the asphalt material shipped on this bill of lading complies with Department of Transportation specifications for the state of Missouri
The transport tank was examined and found suitable for loading.
SHIPPER: JEBRO INC.

SUPPLIER AUTHORIZED REP. & WEIGHER
Read:
This certifies that the weights shown hereon were obtained on MoDOT approved scales and are correct within the specified scale requirements

Terminal: Sioux City, IA
Bill of Lading Number: 0

CUSTOMER COPY

460.3.12 Asphalt Binder

It is important that the binder is circulated through the feed lines and the storage tank(s) so that the temperature of the binder is kept uniform and within the mixing ranges in Standard Specification Section 1015.6 during production. All pumps and feed lines shall be properly insulated to keep the binder at the required temperature.

The plant inspector will accept truck shipments of binder on the basis of the supplier's certification of specification compliance (see Standard Specification Section 1015.2.2.1). The certifications will serve as inspection reports. These materials may be used immediately in the project. All accepted shipments will be reported in the APIW. The Asphalt Binder Record may also be used. If the binder is not properly certified or contains incorrect or incomplete information, the shipment will not be accepted and shall not be mixed in the storage tank(s).

The amount of binder in the storage tank(s) shall be determined before and after each production period so that the amount of material on hand and the exact amount used during the production period can be determined. This can be done with a meter or other methods. Periodically, an approximate determination of binder usage should be made. This is accomplished by checking the quantity used in the project against the quantity delivered to the plant for a predetermined period of time, accounting for the quantity on hand.

460.3.13 Asphalt Binder Sampling and Test Results

Take a daily sample, consisting of three one-pint friction top cans of material, from the binder line supplying the mixer. All three cans should be labeled identically. One can should then be given immediately to the producer for testing or retention. The second can will be collected and shipped to the MoDOT central lab for testing as defined below. The third can should be retained at the district level until the sample ID containing the related binder has been accepted at the Central Lab. In the event that a sample fails to meet the minimum criteria after testing, the third can be used for further evaluation of the material as needed. If the plant produces two or more mixes with the same PG binder grade, only one sample is required to represent that day's production. If the plant produces more than one mix in a day and each mix requires different PG binder grades, one sample is required for each binder used that day. A can from the first daily sample should be sent to the central lab immediate for testing. Following the first day's production, retain all of the daily binder samples on the project for one week until one of the following occurs:

- The weekly binder samples have been accumulated.
- The last binder sample for the project has been obtained.
- A possible binder related problem is observed.

When any of the above occurs, immediately ship the accumulated samples to the Central Laboratory. If a possible binder related problem is observed, notify the Central Laboratory immediately so that the samples can be given priority when they arrive. The weekly gathering of samples does not have to begin on Sunday. For example, if the district ships to the Central Laboratory on Thursday, then the samples should be collected from Thursday through Wednesday so they may be shipped at the earliest possible time after collection.

Enter a SiteManager record only for the first binder sample taken for each mix number used on a project. All binder samples for that mix number on that project will be reported to that SiteManager record. All testing performed on the binder samples taken for that mix number from that project will be reported by the Central Laboratory in that SiteManager record by adding additional test templates for each succeeding sample. The Central Laboratory will select random samples from each shipment for testing. If a test fails, all samples from the shipment will be tested to determine the extent of the problem. The project will be notified of failures as soon as possible.

The appropriate binder grade for reporting the material in SiteManager can be determined from looking at the "In-Line Grade" listed on the mix design. The in-line grade is the grade of the asphalt once all of the additives and modifiers have been incorporated and is the grade which should be listed when reporting a production binder sample. If using a binder which has been modified by ground tire rubber (GTR), use the material code which has a "R" at the end. The material name will list "GTR" next to the binder grade.

When sampling from the valve on a truck, a storage tank, or the plants' binder supply line, discard enough material to drain all lines of any material already present. This is important to ensure that the sample is representative of the material being sampled and does not include any material from previous shipments. All PG binders must meet specifications after the introduction of liquid anti-strip or any other additives. Therefore, ensure that the samples are taken after the introduction of any additives. The inspector should either perform the sampling or observe the plant personnel conducting the sampling. Before sampling, make sure the can is clean and dry. Samples containing even small amounts of water usually cannot be tested and may also pose a hazard for the Central Laboratory personnel during the heating process.

Leave approximately ½ in. of free space in the can to allow for proper sealing. However, do not substantially under fill the can. As soon as the sample has been taken, the lid should be secured tightly. Do not allow the can to sit in the rain and do not clean the can by dipping it in solvent. Allowing a hot can of binder to sit in the rain or submerging the can in solvent can create a vacuum inside the can that may draw the contaminant past the friction seal as the binder cools. When necessary, the outside of the can should be cleaned with a rag dipped in solvent, taking care not to let the solvent accumulate near the friction seal.

Label the can with the following information, keeping in mind that many samples will be identified only by the information on the sample container:

(1) SiteManager ID number that has been assigned to that mix number for that project.

(2) Inspector's SiteManager UserID.

(3) Date sampled.

(4) PG binder grade.

(5) Producer/supplier.

(6) Mix number.

All SiteManager records for a mix will be authorized by the Central Laboratory with the status "Informational" unless a sample fails to meet specifications. If a sample fails, that SiteManager record will be authorized with the status "Rejected". The Central Laboratory will retain all samples for approximately 1 year for additional testing, if necessary.

If the sample and check testing fail to meet the specification, the following penalties may apply:

For AASHTO M 320 graded binders the DSR values are based on the original binder. Failing samples will be tested to determine the high temperature true grading. For AASHTO M332 graded binders, the Jnr values are based on rolling thin-film oven, RTFO, aged binder.

Original DSR	**Jnr RFTO***			**Penalty**
DSR > 0.90	Jnr < Max + 0.1			No Penalty
True Grade Temperature	Gr. E	Gr. V	Gr. H	
< 2° below grade	< 0.6	< 1.1	< 2.2	No Penalty
> 2° & < 4° below grade	> 0.6 & < 0.7	> 1.1 & < 1.3	> 2.1 & < 2.7	3% of Mix Unit Price**
> 4° & < 6° below grade	> 0.7 & < 1.0	> 1.3 & < 2.0	> 2.7 & < 4.0	10% of Mix Unit Price**
> 6° below grade	> 1.0	> 2.0	>4.0	16% of Mix Unit Price**
* For Gr. S, use true grading temperatures.				
** Extraction and grading at the high temperature may be performed to prove acceptable mixture.				

Consult the Field Materials Office for special circumstances.

460.3.14.1 Loose Mix Sampling

Sampling behind the paver is the recommended method of obtaining a sample. Samples should be taken in one increment behind the paver prior to breakdown rolling. The sample should extend the full depth of the lift and include all of the mix from the sample location. Use a clean sample container and do not contaminate the sample with underlying material. The inspector should always be consistent in the sampling procedure to reduce, and possibly eliminate, testing errors.

For BB, BP, and SL mixes, the binder content sample may be taken at the plant or on the roadway. This is because the binder content of the mix is the same regardless of where the sample is taken.

460.3.17 Visual Inspection of Mix

460.3.17.1 Visual Inspection

The plant inspector should observe the mix frequently. The quality of the mix can be quickly evaluated by visual inspection. Visual inspection does not take the place of the job control tests (gradation, binder content, volumetrics, density, etc.), but it does have a place in the control of the mix. The inspector should also become familiar with the appearance of the mix in the correct temperature range. Some unsatisfactory conditions that may be easily recognized are described in Hand Spreading. If any of these conditions are observed, the inspector should immediately notify the contractor.

460.3.17.2 Segregation

Segregation results in the non-uniform distribution of aggregate in the mix and is detrimental to the long-term performance of the pavement. Also see Segregation in Mat Problems. If segregation is noticed at the plant, it may be caused by:

(1) The material is not being thoroughly mixed.

(2) Improper delivery of mix from the plant to the silo(s), if used.

(3) The discharge gate is too high above the truck bed.

(4) The discharge gate is not opening and closing fast enough or to the full extent.

(5) Loading trucks in a manner that the material segregates. To prevent this, trucks should be loaded in three or five drops depending on the size of the truck. If a typical haul truck is used, the first and second drops should be towards the front and back of the truck bed, respectively. The third drop should be in between the first and second drops. If a longer haul truck is used, the first and second drops should be towards the front and back of the truck bed, respectively. The third drop should be in the middle of the bed. The fourth and fifth drops should be between the second and third and the first and third drops, respectively.

106.3 Samples, Tests and Cited Specifications

From Engineering Policy Guide
This article covers the procedures to be used to properly sample, identify and ship a sample. Also included in this article is a list of MoDOT test methods utilized by MoDOT and information regarding non-MoDOT test methods used for materials acceptance.

EPG 106.3.2 MoDOT Test Methods

106.3.1 Sampling

106.3.1.1 Random Sampling

Careful and judicious selection of a sample cannot be overemphasized. It is the sampler's responsibility to secure a representative sample and take every precaution that it will remain representative until tested. The intent is always to obtain random samples that fully represent the characteristics of the material being sampled. Many materials are manufactured in identified lots/heats/groups, etc. indicating that the material is manufactured and identified with the same criteria and should be uniform in character. In some cases, this can aid in sampling procedures.

If an inspector is presented with an entire lot of material "X" to inspect and chooses samples, as may be the case in a warehouse, by using random sampling procedures there is assurance that the samples actually represent the character of that material. It is reasonable to report any part or all of that lot, on the basis of the random sample test results, at that time or later if the lot is believed to be uncontaminated and true. On the other hand, if the manufacturer made a lot of Brand "X" in Kalamazoo and the inspector is only allowed to see part of the lot at the fabrication shop in another location or on the construction job, as often happens with destination inspection, any sampling of that population U is not a random sample of the entire lot U. It is only a sample of the material lot that the manufacturer chose to send, i.e. a biased shipment. Therefore, it is not reasonable to assume that samples of the destination material represent the entire lot back at the factory or elsewhere, and a new shipment of the same lot requires new sampling. In the case where a shipment contains various lots or brands or other differentiation, it is not reasonable to assume that the sampling of one portion, is necessarily characteristic of the rest of the shipment.

In the true sense of random sampling, samples only represent the material that the inspector had access to at the time of sampling. Material arriving after sampling, regardless if it is a few minutes or days, is not a part of the sample population and is thus not technically represented. However, in a practical sense, sometimes it may be reasonable to assume that adjunct shipments of the same lot/heat/group are similar, when not unreasonably separated by time and interrupting manufacturing processes. Unless otherwise designated in sampling instructions, this may be considered an inspector determination provided uniform practices are followed and the highest calling is adhered to, i.e., uniform assurance of specification compliant and quality materials is mandated.

Inspectors are always within their right to sample per shipment or as necessary to assure quality and uniform materials. This article generally sets up more specific criteria for various materials in order to provide some expectation of sampling/testing uniformity, both for MoDOT as well as the supplier and the contractor.

However, Sec 106, which is a part of the contractor and supplier contract with MoDOT, clearly identifies that: a) the contractor is responsible for ordering quality material, b) all material is required to meet the quality requirements of the contract and be a uniform product, c) all materials must be approved by the engineer before use and d) material is subject to inspection and rejection at any point or time, prior to or after incorporation into the work. For liquids, container lids should be fastened tightly to prevent aeration or loss of any part of the sample. Always secure the lids of liquid samples shipped in friction top cans with a minimum of 4 metal safety retaining clips. Cleanly wipe the outside of sample cans after filling and before packaging for shipment to the Laboratory. In the case of liquid samples, leave approximately ½ in. (15 mm) of air space between the top of the container and the surface of the liquid; otherwise, expansion during shipment may burst the container and cause loss of the sample.

106.3.1.2 Submission of Laboratory Samples

106.3.1.2.1 Identification

Properly identify a sample by creating a SiteManager sample record (see Sample Record General Information), by properly attaching the associated sample identification number to the sample, and by providing any supplemental information that may be required for the specific material being submitted. Refer to the Engineering Policy Guide article that applies to the sample material to determine what supplemental information may be required and how it is to be provided. Furnish complete and accurate information relative to the material represented to the Laboratory. This is essential in order to have the proper tests performed in the Laboratory. Mark each sample container with the proper identification number or have the appropriate tag or label attached. Do not place any identifying information on container lids. Use only approved identification tags that have been obtained from Construction and Materials.

106.3.1.2.2 Transportation of Samples

Securely wrap and package samples to ensure arrival in the Laboratory without damage. Pack metal cans that do not contain liquid samples in cardboard containers or wrap with heavy paper. Seal plastic jugs containing liquids in a zip seal plastic bag and pack in cardboard boxes with an absorbent packing material. Cloth sacks need no packaging but must be securely tied. Package, label and mark materials classified flammable or combustible for shipping as required in ***Table 106.3.1.4.1 List of Flammable and Combustible Materials and Paint and Paint Constituents***. Examples of packaging and marking those materials are shown in ***Figures 106.3.1.4.1 and 106.3.1.4.2***. When shipping small sample containers, such as one-quart (1 L) cans, several may be packaged together to facilitate shipment; however, all cans must be sealed in a zip seal plastic bag if they contain liquids. This practice is also desirable to minimize transportation costs.

All liquid samples must be placed into at least one layer of heavyweight, sealable plastic bags such as zip seal (ZipLoc) bags, prior to placing the samples into the proper shipping container. It is especially important that sufficient absorbent material is placed around the plastic bags to contain any leakage that might occur during shipment. When liquid samples are shipped in friction top cans, the lids must be secured with a minimum of 4 metal safety retaining clips. The safety retaining clips are stocked in two sizes, one for pint/quart cans and the other for gallon cans. Be sure to use the correct clip for the correct size container and be aware that these clips are special locking clips and require a tool such as a screwdriver to properly apply to the can. Never

secure lids on friction top cans with tape. Pay particular attention to the requirements for labeling shown in Table 106.3.1.4.1 List of Flammable and Combustible Materials and Paint and Paint Constituents.

Never combine samples in the same bulk delivery container used for letter mail.

Samples are to be shipped to:

Missouri Department of Transportation
Central Laboratory
1617 Missouri Boulevard
Jefferson City, Missouri 65109

Addressed shipping labels are available from Construction and Materials and should be used. Shipping labels from Construction and Materials are duplex labels with shipping information on one side and sample information on the other. These tags may be tied or taped to the package and are desirable since additional sample information may be filled out on the tag and should accompany the sample. Samples of material submitted to the Laboratory should be sent by MoDOT vehicles traveling from the district to the Laboratory or by the freight shipping service contracted by General Services. Other means may be utilized if these modes are not available. The judgment of the District Construction and Materials Engineer will be relied upon to select the proper mode, taking into consideration the need for safety, shipping regulations, early test results, cost involved, and convenience.

106.3.1.2.3 Rush Tests

It is often necessary to receive Laboratory results as quickly as possible. Normally, you should not request rush tests unless necessary. Send samples as far in advance as possible of the time when the material represented will be needed. When a rush test is necessary, the sampler should be guided in marking the identification sheet, by the following instructions:

(a) If the material is needed for immediate use, mark the sample ID tag "Rush - telephone results". The Central Laboratory will complete the test as rapidly as possible and telephone the proper party.
(b) For all other samples, no "Rush" marking is necessary. The Laboratory will complete the tests as soon as possible consistent with current work and report results in SiteManager.

106.3.1.3 Sampling Supplies

The type of container to be used will depend on the material being sampled. Canvas material bags used for aggregate samples should be clean and free from tears or holes. Metal and plastic containers should be clean and dry to prevent any contamination.

The following supplies are available and may be obtained from the Laboratory in Jefferson City:

(a) Used canvas materials bags (when available).
(b) Plastic liners and small canvas bags for shipping cement samples.
(c) Ointment cans (3 and 6 ounce)[85 and 170 grams].
(d) Small plastic containers for paint activator components.

Obtain other sampling supplies, such as new canvas material bags, containers, metal safety retaining clips for friction top cans, and zip seal plastic bags from the district office. These supplies are among the many items listed in the Catalog of Garage Stock Items issued by General Services. Obtain shipping labels/ID tags from Construction and Materials.

Use only those supplies shown in Table 106.3.1.4.2 Supplies Required for Packaging and Shipping Flammable or Combustible Materials for packing and shipping materials listed in Table 106.3.1.4.1 List of Flammable and Combustible Materials and Paint and Paint Constituents.

106.3.1.4 Tables and Figures

Table 106.3.1.4.1 List of Flammable and Combustible Materials and Paint and Paint Constituents

List of Flammable and Combustible Materials				
Material Samples	**Flash Point, TCC, ºF (ºC)**	**Packaging**	**Labels Required**	**Marking**
Asphalt, Cutback (RC)	0 (-18)	Two 1 qt. (liter) Screw-top Metal Containers in Zip Seal plastic bag in approved box	Flammable Liquid This End Up	Asphalt, Cutback UN1999
Asphalt, Cutback (MC)	100 (38)	Two 1 qt. (liter) Screw-top Metal Containers in Zip Seal plastic bag in approved box	This End Up	Asphalt, Cutback UN1999
Diesel Fuel	125 (52)	Two 1 qt. (liter) Screw-top Metal Containers in Zip Seal plastic bag in approved box	This End Up	Fuel Oil, Diesel NA 1993
Gasoline	0 (-18)	Two 1 qt. (liter) Screw-top Metal Containers in Zip Seal plastic bag in approved box	Flammable Liquid This End Up	Gasoline UN1203
Concrete Curing Compound	50 (10)	One 1 qt. (liter) Metal Container in Zip Seal plastic bag in approved box	Flammable Liquid This End Up	Paint, Liquid UN1263

Table 106.3.1.4.2 Supplies Required for Packaging and Shipping Flammable or Combustible Materials

Metal Containers	
Approved Packaging	**Stock Number**
Can Frict. Top, "pt" (0.5 liter)(pheonolic lined)	3054205080
Can Frict. Top, "qt" (liter)(pheonolic lined)	3054205070
Can, Screw-Top, " qt" ([liter)(round)	3054205090
Eng. Supp. Misc. Clip Close, "Small" For (Pint/Quart) Friction Top Cans	3054205126
Eng. Supp. Misc. Clip Close, "Large" For (Gallon) Friction Top Cans	3054205127
Cardboard Containers	
Approved Packaging	**Stock Number**
Carton Concrete (sample)(14" X 14" X 7")	3054205110
Carton Asphalt (new style)(11" X 11" X 3")	3054205095
Carton Asphalt (old style)(13" X 13" X 4 1/2")	3054205100
Carton Water-Sample (gallon)(12" X 6 3/8" X 6 3/8")	3054205120
Filament Tape, ¾ in., (19 mm)	Obtain locally

Plastic Zip Seal Bags	
Approved Packaging	**Stock Number**
Bag Poly Zip Lock Containment (10" X 12")	3054205018
Bag Poly Zip Lock Containment (13" X 18")	3054205022

Shipping Labels	
Approved Packaging	**Stock Number**
Labels Attention, "THIS END UP" 4" X 8"	6150101211
Labels Warning, "FLAMMABLE LIQUID" 4" X 4"	6150101217

Cushioning - Use crumpled newspaper, paper toweling, rags, vermiculite absorbent, etc., to prevent movement and damage to inside containers and to absorb leakage during transit.

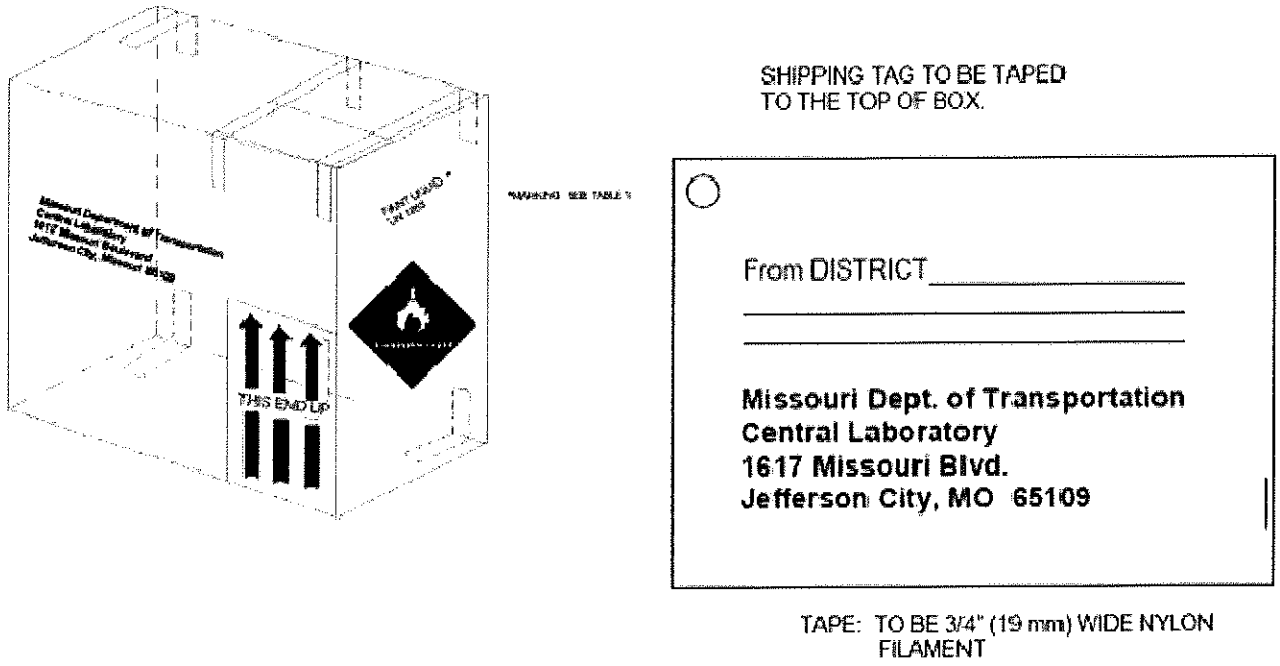


Fig. 106.3.1.4.1 Shipping of Flammable Liquids

SHIPPING TAG TO BE TAPED
TAPED TO THE TOP OF BOX

From DISTRICT_____

Missouri Dept. of Transportation
Central Laboratory
1617 Missouri Blvd.
Jefferson City, MO 65109

TAPE: TO BE ¾" (19 MM)
NYLON FILAMENT,
STOCK #STA.281948

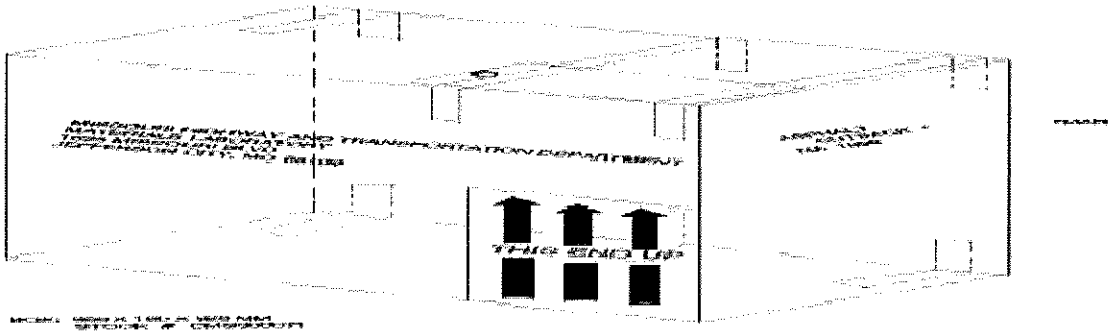


Fig. 106.3.1.4.2 Shipping of Combustible Liquids

460.3.13 Asphalt Binder Sampling and Test Results

Take a daily sample, consisting of three one-pint friction top cans of material, from the binder line supplying the mixer. All three cans should be labeled identically. One can should then be given immediately to the producer for testing or retention. The second can will be collected and shipped to the MoDOT central lab for testing as defined below. The third can should be retained at the district level until the sample ID containing the related binder has been accepted at the Central Lab. In the event that a sample fails to meet the minimum criteria after testing, the third can be used for further evaluation of the material as needed. If the plant produces two or more mixes with the same PG binder grade, only one sample is required to represent that day's production. If the plant produces more than one mix in a day and each mix requires different PG binder grades, one sample is required for each binder used that day. A can from the first daily sample should be sent to the central lab immediate for testing. Following the first day's production, retain all of the daily binder samples on the project for one week until one of the following occurs:

- The weekly binder samples have been accumulated.
- The last binder sample for the project has been obtained.
- A possible binder related problem is observed.

When any of the above occurs, immediately ship the accumulated samples to the Central Laboratory. If a possible binder related problem is observed, notify the Central Laboratory immediately so that the samples can be given priority when they arrive. The weekly gathering of samples does not have to begin on Sunday. For example, if the district ships to the Central Laboratory on Thursday, then the samples should be collected from Thursday through Wednesday so they may be shipped at the earliest possible time after collection.

Enter a SiteManager record only for the first binder sample taken for each mix number used on a project. All binder samples for that mix number on that project will be reported to that SiteManager record. All testing performed on the binder samples taken for that mix number from that project will be reported by the Central Laboratory in that SiteManager record by adding additional test templates for each succeeding sample. The Central Laboratory will select random samples from each shipment for testing. If a test fails, all samples from the shipment will be tested to determine the extent of the problem. The project will be notified of failures as soon as possible.

The appropriate binder grade for reporting the material in SiteManager can be determined from looking at the "In-Line Grade" listed on the mix design. The in-line grade is the grade of the asphalt once all of the additives and modifiers have been incorporated and is the grade which should be listed when reporting a production binder sample. If using a binder which has been modified by ground tire rubber (GTR), use the material code which has a "R" at the end. The material name will list "GTR" next to the binder grade.

When sampling from the valve on a truck, a storage tank, or the plants' binder supply line, discard enough material to drain all lines of any material already present. This is important to ensure that the sample is representative of the material being sampled and does not include any material from previous shipments. All PG binders must meet specifications after the introduction of liquid anti-strip or any other additives. Therefore, ensure that the samples are taken after the introduction of any additives. The inspector should either perform the sampling or observe the plant personnel conducting the sampling. Before sampling, make

sure the can is clean and dry. Samples containing even small amounts of water usually cannot be tested and may also pose a hazard for the Central Laboratory personnel during the heating process.

Leave approximately ½ in. of free space in the can to allow for proper sealing. However, do not substantially under fill the can. As soon as the sample has been taken, the lid should be secured tightly. Do not allow the can to sit in the rain and do not clean the can by dipping it in solvent. Allowing a hot can of binder to sit in the rain or submerging the can in solvent can create a vacuum inside the can that may draw the contaminant past the friction seal as the binder cools. When necessary, the outside of the can should be cleaned with a rag dipped in solvent, taking care not to let the solvent accumulate near the friction seal.

Label the can with the following information, keeping in mind that many samples will be identified only by the information on the sample container:

(1) SiteManager ID number that has been assigned to that mix number for that project.
(2) Inspector's SiteManager UserID.
(3) Date sampled.
(4) PG binder grade.
(5) Producer/supplier.
(6) Mix number.

All SiteManager records for a mix will be authorized by the Central Laboratory with the status "Informational" unless a sample fails to meet specifications. If a sample fails, that SiteManager record will be authorized with the status "Rejected". The Central Laboratory will retain all samples for approximately 1 year for additional testing, if necessary.

If the sample and check testing fail to meet the specification, the following penalties may apply:

For AASHTO M 320 graded binders the DSR values are based on the original binder. Failing samples will be tested to determine the high temperature true grading. For AASHTO M332 graded binders, the Jnr values are based on rolling thin-film oven, RTFO, aged binder.

Original DSR	**Jnr RFTO***			**Penalty**
DSR > 0.90	Jnr < Max + 0.1			No Penalty
True Grade Temperature	Gr. E	Gr. V	Gr. H	
< 2° below grade	< 0.6	< 1.1	< 2.2	No Penalty
> 2° & < 4° below grade	> 0.6 & < 0.7	> 1.1 & < 1.3	> 2.1 & < 2.7	3% of Mix Unit Price**
> 4° & < 6° below grade	> 0.7 & < 1.0	> 1.3 & < 2.0	> 2.7 & < 4.0	10% of Mix Unit Price**
> 6° below grade	> 1.0	> 2.0	>4.0	16% of Mix Unit Price**
* For Gr. S, use true grading temperatures.				
** Extraction and grading at the high temperature may be performed to prove acceptable mixture.				

Consult the Field Materials Office for special circumstances.

460.3.14 Asphalt Binder Content – Nuclear Gauge

Asphalt binder is the glue that holds the aggregate particles together. Binder also provides lubrication at high temperatures and cohesion at in-service temperatures. The binder content affects the mix properties and the pavement performance. An excessively high or low binder content may cause the mix to have a low stability. A high binder content results in low air voids and may promote flushing and cause plastic rutting of the pavement. A low binder content results in high air voids and may promote stripping and cause consolidation rutting.

MoDOT employees who operate nuclear gauges must have received Radiation Safety Training. MoDOT's license with the U.S. Nuclear Regulatory Commission (NRC) requires the storage of its nuclear gauges to be under a three-lock system; the door of the asphalt gauge, the shipping case the gauge is stored in, and the door of the building where the gauge is being stored or used. For added security, a fourth lock and chain should be used to secure the shipping case to a fixed object in the laboratory. Any untrained person will not have access to this area without the presence of the inspector. The NRC requires storage areas to have a radiation placard affixed to the door and an NRC Form 3 placed near the placard.

When a nuclear gauge is transported in a car, it should be stored in the trunk. If the gauge is transported in the bed of a pickup truck, it should be near the tailgate. The gauge must be secured either in a lockable box bolted to the bed or chained through the handles of the shipping case and locked to the bed of the truck. There should not be any slack in the chain, if used.

Contractor owned nuclear gauges may or may not be regulated by the NRC, depending upon which radioactive isotope the gauge uses. It is the contractor's responsibility to comply with all state and federal laws. However, the inspector should report all unsafe practices to their supervisor.

460.3.14.1 Loose Mix Sampling

Sampling behind the paver is the recommended method of obtaining a sample. Samples should be taken in one increment behind the paver prior to breakdown rolling. The sample should extend the full depth of the lift and include all of the mix from the sample location. Use a clean sample container and do not contaminate the sample with underlying material. The inspector should always be consistent in the sampling procedure to reduce, and possibly eliminate, testing errors.

For BB, BP, and SL mixes, the binder content sample may be taken at the plant or on the roadway. This is because the binder content of the mix is the same regardless of where the sample is taken.

1015.2.1 Inspection

The list of qualified sources of asphalt emulsions and cutback asphalt is shown in Qualified Bituminous Materials Sources list. The list of qualified sources for performance graded asphalt binder is shown in Qualified PG Binder Sources and Laboratories (QC/QA Approved Sources).

Asphalt, Permeability

Report 2009

See also: Innovation Library

Inspection at the refinery, terminal or emulsion plant will consist of the sampling and testing of shipments and storage tanks. Sample performance graded binder from storage tanks or blenders at the rate of one per month for each grade of binder that is currently being shipped to department projects. Sample cutback asphalt and asphalt filler at random at a rate of not less than ten percent of both storage tanks and shipments. Obtain emulsion samples at a frequency of not less than one sample for approximately each 100,000 gallons (375,000 L) shipped to MoDOT. Emulsion samples may be taken from storage tanks or shipments. All samples taken will be tested by MoDOT personnel. Reference should be made to EPG 1015.5 Laboratory Testing for Sec 1015 for procedures to be followed on testing and reporting bituminous materials.

Prior to shipment of performance graded binders, the refinery or terminal must comply with the QC/QA requirements of Sec 1015. An approved quality control plan must be on file in the source district as well as at Construction and Materials for PG binders. A quality control plan for emulsified asphalts and/or cutback asphalts may also be on file. In this case, acceptance of material from that source is based on compliance with the QC/QA requirements of Sec 1015 for cutbacks and emulsions. If no quality control plan is on file with MoDOT for emulsified asphalt or cutback asphalt, certified test results for each batch are to be furnished to MoDOT prior to shipment of the material.

For suppliers of performance graded binders who ship infrequently, the district, with concurrence from the Chemical Laboratory Director, may establish an arrangement with the supplier to suspend inspection activities if that supplier is not anticipating shipping to MoDOT work, until such time that binder is to be shipped to our work. In these cases, the supplier is required to continue quality control inspection at their facility in accordance with their quality control plan. These same arrangements are allowed through the winter months for normal suppliers when no binder is being shipped, without the concurrence of the Chemical Laboratory Director. For suppliers who ship infrequently, the district responsible for inspection must request that the supplier notify MoDOT well in advance of resuming shipments to ensure proper inspection. This option is not allowed for suppliers who anticipate shipping binder to department work more frequently than once every three months. (Note that this option is intended to be used for suppliers located a long distance from the district responsible for inspection and who wish to be approved to supply performance graded binders, but do not anticipate shipping to MoDOT work on a regular basis.)

Determine the quantity of material in truck shipments in accordance with Sec 1015 for gallons (L) and from the scale weights (mass) shown on the bill of lading, manifest or truck ticket for pounds (kg). Determine the volume of material in a railroad car by measuring the level of the material below the dome or in the dome, as the case may be, to the nearest 1/4 in. (5 mm). The measurements are taken to the oil level and not the foam level. With these measurements, the volume can be determined from the outage tables that are available from the manufacturer for all calibrated railroad cars. Obtain the temperature of the material in degrees Fahrenheit (Celsius) at the time of the measurement of material. This temperature is used to convert the volume of the material at its current temperature to its volume at 60° F (15.6° C).

Inspectors performing bituminous inspection are to:

(a) Obtain random, representative samples in accordance with the applicable requirements of this guidance. These samples are to be promptly submitted to the Laboratory, shall be reported through SiteManager and shall contain all pertinent information.
(b) Verify that the supplier of the performance graded binder is shown on the list of Qualified PG Binder Sources and Laboratories (QC/QA Approved Sources).
(c) Verify that the supplier of the emulsified asphalt, cutback asphalt, or asphalt filler is shown on the list of Qualified Bituminous Materials Sources.
(d) Check the required company certified emulsified asphalt, cutback asphalt, or asphalt filler tank and/or blender test results for specification compliance, initial and date the certification and retain on file in the district office.

1015.2.2 Sampling

The size of sample and type of container is:

Cutback Asphalt - 1 quart (1 L), screw top can.
Asphalt Filler - 1 quart (1 L), friction top or screw top can.
Emulsified Asphalt - 1 gallon (4 L), plastic container.
Performance Graded - Asphalt Binder - 1 quart (1 L), friction top can.

Type RC and MC cutback asphalts are to be packaged, labeled, and marked as described in EPG 106.3.1 Sampling.

Samples of bituminous material may be obtained by the dipper or thief method, or from drain cocks on the side of the tank if available. To ensure a representative sample when using the drain cock method, allow sufficient material (approximately 1 gallon (4 L)) to flow through the drain cock and discard before the sample is taken. Do not submerge the filled sample container. If cleaning is necessary, wipe the container with a clean, dry cloth.

AASHTO R 66: Sampling Asphalt Materials
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial #	1	2

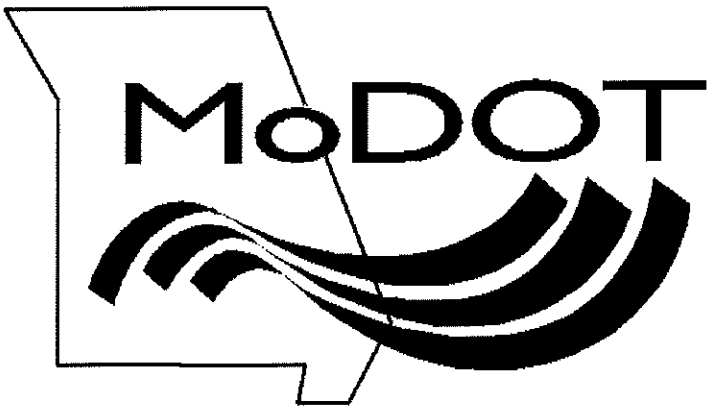
Describe procedure for taking a daily plant asphalt binder sample:		
1. Wear safety clothing, including insulated gloves, long sleeves, bring a marker, and tags.		
2. Obtain a clean dry sample container with lid: 1 pint friction top. Option: Write the sample information on the can before sampling.		
3. Open valve and discard at least 1 gallon of material.		
4. Shut off valve, place can underneath the spout.		
5. Open valve, fill can to within ½" of top.		
6. Shut off valve, wait until material quits flowing.		
7. Remove can and put on lid.		
8. Immediately wipe can with clean cloth, while hot. (do not use solvent to clean)		
9. Identify the sample on the can itself, include the ID Number, Supplier, Grade of the Binder, and Date.		
10. Place the sample in a sealed bag, and a MoDOT shipper if needed, deliver to the lab.		
	PASS	PASS
	FAIL	FAIL

Examiner: _____Date:_____

AASHTO R 97

Sampling Asphalt

Mixtures



AASHTO R 97

SAMPLING ASPHALT MIXTURES

1

Rev 08/29/2024

1

SCOPE

- This practice covers sampling of asphalt paving mixtures at points of manufacture, storage, delivery, or in place.
- QA – Quality Assurance = MODOT
- QC – Quality Control = Contractors
- Definitions located in the Glossary.

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MoDOT

- Sampling asphalt mixtures for MoDOT typically occurs behind the paver prior to compaction.
- On rare occasions, sample may need to be taken from asphalt mixture stockpiles or elevators.

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SIGNIFICANCE AND USE

- Sampling is equally as important as testing.
- Use care to obtain samples that are representative of the material.
- Avoid segregation and contamination of the material during sampling.

NOTE: Use AASHTO R 67 when obtaining cores from compacted asphalt mixtures.

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EQUIPMENT

- Square nose shovel, scoop, trowel
- Sample containers – buckets, pan, boxes
- Safety equipment – protective garments
- Labeling material – markers, tags, etc.
- Square steel sample template
- Thick metal sampling plate (sheet)
- Quartering equipment
- Mechanical sampling systems
- Release agent
- Insulated carrier

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PROCEDURE BASICS

- *Inspection* - The material shall be inspected to determine discernible variations.
- *Random Sampling* – Select sample locations using a random sampling procedure. (ASTM D3665)
- *Release Agents* – If used, the user and producer of the asphalt paving mixtures must mutually agree upon the use of a MoDOT approved release agent.

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Procedure Basics

- *Sample Size* – Depends on the test methods to be performed. Obtain enough material to perform all tests.

7

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SAMPLING PROCEDURES

1. **Roadway Samples**
   - Plate with Square Template
   - Square Template
   - Plate and shovel
2. **Stockpile Samples**
3. **Truck Samples (Transport Units)**
   Not recommended by MoDOT
   May sample from trucks for Tensile Strength Ratio (TSR) Samples.
4. **Stream Samples**

NOTE: MoDOT does not samples asphalt mixtures from windrows, bin storage, hopper, conveyer belt, or from paver auger.

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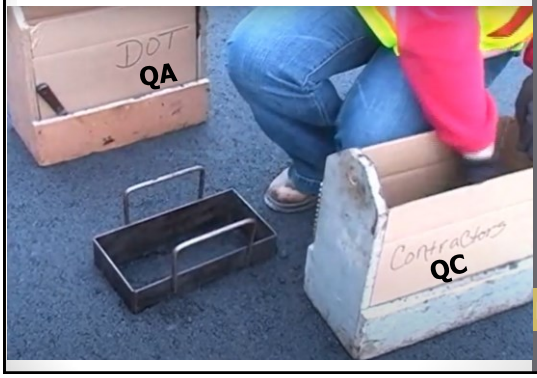
1. Template



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Roadway Samples

- Roadway samples are obtained to determine the properties of the material being placed on the roadway.
- Roadway samples are the *only* choice for pay factor volumetric tests.

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MoDOT Roadway Sampling Procedure

- Sample should be taken in ***one increment***, selected at a random location behind the paver by the inspector.
  - If using a "Cookie Cutter" template, may need to use more than once to acquire enough material for the increment.
- The quantity should be roughly 100 lbs. for QC and 100 lbs. for QA.

NOTE: This varies from AASHTO R 97 which requires 3 locations be sampled.

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MoDOT Roadway Sampling

- It is acceptable to place a metal sheet on the base or pavement to be paved to reduce chances for contamination by the underlying material.
- If the option of a metal plate is used under the template, place the metal plate at the prescribed location prior to paver passing over that location.

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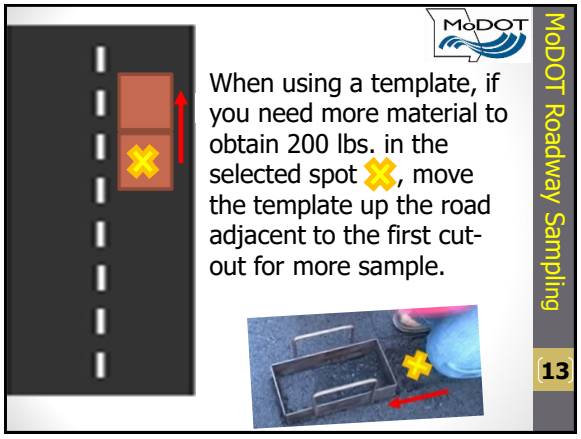
When using a template, if you need more material to obtain 200 lbs. in the selected spot, move the template up the road adjacent to the first cut-out for more sample.
MoDOT Roadway Sampling
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Sampling with a metal sheet and a shovel
MoDOT Roadway Sampling
14

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Sampling with a "Square" template
MoDOT Roadway Sampling
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15

- Using a template or a square nose shovel, clearly mark out an area to be removed.
- Remove all mixture within the area.
- **Do Not** contaminate sample with underlying material.
- Place material into a clean container.

MoDOT Roadway Sampling

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CAUTION!

- Filling one box (or bucket) at a time may render different characteristics box to box (or bucket to bucket), better to place one shovelful per box at a time.

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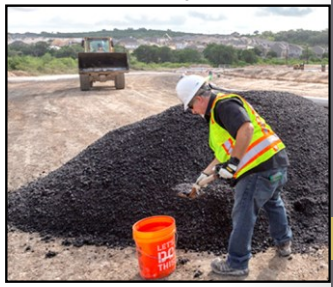
2. Stockpile Samples

- Stockpile samples are collected under special circumstances defined by MoDOT procedures.
- Examples: tensile strength ratio (TSR) testing or other testing requiring a large amount of mix.



Stockpile Sampling

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Sampling from Bituminous Stockpiles

Remove at least 4 inches from the surface before sampling; Shove a flat board against the vertical face behind the sampling location, discard sloughed material to create the horizontal surface. Obtain a Sample from a Horizontal surface on the stockpile, obtain at least 1 increment from Top, middle, & bottom & combine for a field sample ...see figure 3.

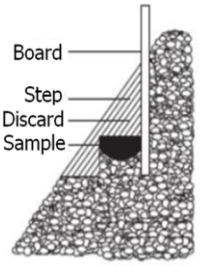

Figure 3—Sampling from a Stockpile

AASHTO R 97 Stockpile Sampling

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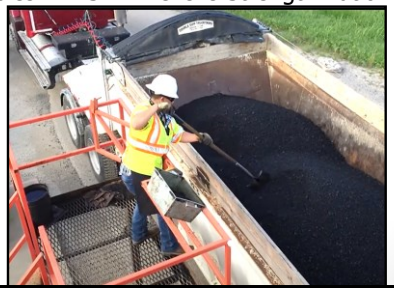
3. Truck & Plant Sampling

- Sampling from a truck is not recommended by MoDOT.
- However, truck sampling may be used for TSR samples. TSR = Tensile Strength Ratio



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4. Stream Samples

- Stream samples are collected under special circumstances defined by MoDOT procedures.
- Examples: Tensile Strength Ratio testing and plant control testing requiring a large amount of mix.

MoDOT Stream Sampling

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Stream Sampling Procedure

- Sample is to be taken in at least **3** equal increments.
- An increment is a pass of the sample catcher completely through the stream of the flow at an even speed.
- Pass the sample catcher through the full flow of the material. (**Do Not** overflow the catcher)

MoDOT Stream Sampling

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- If the passes of the sample catcher yields the proper amount of material combine the material into a sample container for shipping.
- If it yields more material than necessary for the sample, then reduce the material to the proper size by AASHTO R 47.

MoDOT Stream Sampling

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SAMPLE IDENTIFICATION & SHIPPING

- It is important to properly identify each sample by marking the sample container.
- Identification should include:
  - **Material type**
  - **ID No. (AWP #)**
  - **Job Mix Formula (JMF)**
  - **Date**
  - **Time and sample location**

This is the minimum information that should be included with each sample.

MoDO

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Special Instructions may include information Like:

- Sampled from the 4th truck
- Phone/Fax Results
- Possible Contamination
- Need AC Content
- Need: Gmm, Gmb, etc.
- Lot#, sublot#, Comparison Sample # if appropriate (ex. TSR samples and CT index/RT index/Hamburg – performance test samples.

New slide

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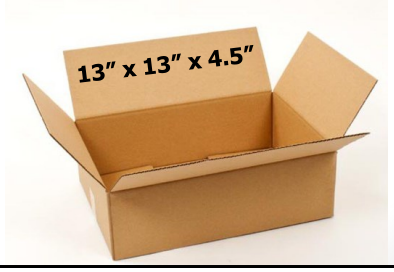
- Transport samples in containers constructed to prevent loss or contamination of any part of the sample, or damage to the contents from mishandling during shipment.



MoDOT Sample ID & Shipping

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COMMON SAMPLING ERRORS

- Segregating the material while sampling.
- Not taking sample in designated location.
- Contaminating sample with underlying material.
- Not getting the amount of field samples from the production to be sufficient to give a representative sample for testing.
- Over filling the sample catcher.
- Inconsistent speed of moving the sample catcher through the flow.

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460.3.14.1 Loose Mix Sampling

Sampling behind the paver is the recommended method of obtaining a sample. Samples should be taken in one increment behind the paver prior to breakdown rolling. The sample should extend the full depth of the lift and include all of the mix from the sample location. Use a clean sample container and do not contaminate the sample with underlying material. The inspector should always be consistent in the sampling procedure to reduce, and possibly eliminate, testing errors.

For BB, BP, and SL mixes, the binder content sample may be taken at the plant or on the roadway. This is because the binder content of the mix is the same regardless of where the sample is taken.

403.1.5 Mixture Production Specification Limits (Sec 403.5)

Intentional deviations from the JMF will not be permitted. The plant shall be operated in such a manner that the mix is produced as shown on the JMF. The specification tolerances are developed in an attempt to keep the mix as consistent as possible and to allow for some variation during production. However, these tolerances are not production limits. For example, if the target binder content is 5.0%, the binder content of the mix can range from 4.7% to 5.3% when the tolerances are applied. The contractor will not be allowed to produce the mix at 4.7% to save money.

Both QC and QA will use the following procedures to determine volumetrics of the mix and compliance with Standard Specification Sections 403.5.3 through 403.5.5. These procedures are discussed in greater detail in the ~~Levels 1 and 2 Bituminous Training~~ Bituminous Technician Manual.

A loose mix sample consisting of roughly 100 lbs. for QC and 100lbs. for QA will be taken from the roadway behind the paver, in accordance with ~~AASHTO T168~~ AASHTO R97, at the required frequency. The sample will be thoroughly mixed and quartered in accordance with AASHTO R47, or with an approved splitting/quartering device. Two opposite quarters will be retained for testing during the dispute resolution process, if necessary. The remaining two quarters will be mixed together and quartered again.

The required weight of mix, as listed on the JMF, will be taken from one quarter and used to compact a specimen in accordance with AASHTO T312. The mix will be compacted to N_{des} gyrations while the mix temperature is within the molding range listed on the JMF. Using the opposite quarter, follow the same procedure for the second specimen. The G_{mb} of each specimen will be determined and the average will be used to calculate the air voids V_a and the voids in the mineral aggregate (VMA). By specification, a minimum of two compacted specimens must be used to calculate these properties.

A third quarter will be used to determine the G_{mm} of the mix in accordance with AASHTO T209. The minimum sample size for each type of mix can be found in the training manual. This property is used to calculate the V_a and density. The volume of the sample, which is needed in the calculation, can be determined by either the weigh-in-air method or the weigh-in-water method. The weigh-in-air method consists of weighing the sample and container (with the lid) completely filled with water in air. The

weigh-in-water method consists of weighing the sample and container (without the lid) completely submerged in water.

The remaining mix should be mixed together and quartered again. To determine the binder content using the nuclear gauge, enough mix should be taken from opposite quarters. The required weight of mix is listed on the JMF. A moisture content sample should be taken from the same quarters. To determine the binder content using the binder ignition oven, enough mix should be taken from one quarter. The minimum sample size for each type of mix can be found in the training manual. A moisture content sample should be taken from the same quarter. Sometimes the ignition oven may not shut itself off. The oven may be shut off manually as long as 3 consecutive readings show less than 0.01% loss. The sample should be examined to assure that a complete burn has been achieved. This will be considered a valid test.

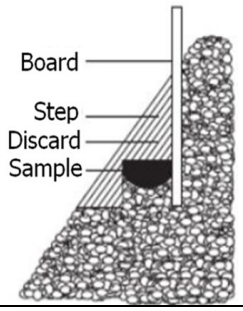
In situations where a retained sample must be tested, the following procedure should be used to reheat the sample. Heat the sample in an oven until the mix is workable. Take the mix out of the sample container (box, bucket, etc.) and spread it in a large pan or several smaller pans. Using this procedure, the mix will reach the molding temperature much quicker than it would if it were left in a mass in the sample container. Also, less aging of the mix occurs since the mix is in the oven for a shorter period of time. Once the mix has reached an acceptable temperature, the sample must be quartered using the procedures discussed above. The entire suite of tests must be performed on a retained sample.

AASHTO R 97
Sampling Asphalt Paving Mixtures
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial#	1	2
Describe procedure for taking a loose mix sample from:		
Roadway		
1. Obtain proper sample container for the application		
2. Use template or square nose shovel to define sample location		
3. Using a square nose shovel, obtain sample from defined area, including all fines and not disturbing underlying material		
4. Place collected material in non-absorbent, insulated container for transportation to lab		
5. Label the container: Material type, ID No., JMF, date, time, and location		

Stockpiles		
1. Remove 4 inches from the surface of the stockpile		
2. Create a step like below with a board and shovel and take the sample as shown 		
3. Obtain at least 1 increment from the top, middle, & bottom		
4. Combine to form a field sample		
5. Label the container: Material type, ID No., JMF, date, time, and location		

Streams		
1. Take 3 approximately equal increments with a sample catcher (Do not overflow the sample catcher)		
2. Combine to form a field sample		
3. Label the container: Material type, ID No., JMF, date, time, and location		

	PASS	PASS
	FAIL	FAIL

Examiner: _____ Date: _____

AASHTO R 47

Reducing Samples of Asphalt Mixtures to Testing Size

AASHTO R 47

Reducing Samples of Asphalt Mixtures to Testing Size

Rev 08/29/2024

1

1

SCOPE

- This standard practice outlines methods for reduction of large amounts of Asphalt Mixtures to test sample size while minimizing variations in measured characteristics.
  - Examples of test samples: Gyratory, Gmm or "Rice", Moisture, %AC

2

2

SIGNIFICANCE AND USE

- This method provides procedures for reducing the large sample obtained in the field or produced in the laboratory to a convenient size for conducting a number of tests to describe the material and measure its quality in such a manner that the smaller test sample portion is most likely to be a representation of the larger sample, and thus of the total supply.

3

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SAMPLING

- Obtain samples of asphalt mixtures according to AASHTO R97 or as required by individual test methods.
- When additional tests are to be conducted, ensure that the initial size of the field sample is adequate to accomplish all intended tests.
- Use similar procedures for asphalt mixtures produced in the laboratory.

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EQUIPMENT

- Heat-Resistant Gloves, Safety Glasses, Apron, Long Sleeves
- Scoop, Buckets, Cans, Hot-Plate, Spoon
- MoDOT approved Release Agent
- Mechanical Splitter A or B
- Quartering Template
- Flat-Bottom Scoop
- Large Spatulas, Trowels, Metal Straight Edge
- Nonstick Heavy Paper or Heat-Resistant Plastic

NOTE: See Appendix for more information.

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Release Agent

- Use Sparingly – avoid contamination of sample.
- Must be approved for use by MoDOT.
- Release agent used shall not contain any solvents or petroleum-based products that could affect asphalt binder properties.

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SELECTION OF METHOD

- **Mechanical Splitter Method**
  - Type A (Quartermaster)
  - Type B (Riffle Splitter)
- **Quartering Method**
  - Quartering Template
- **Incremental Method** (Not Recommended)
  - Incremental Loaf
  - More information on the Incremental Method can be found in the Appendix

7

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Selection of Method

- The selection of a particular method to reduce the large field sample to test size, depends on the amount of material being reduced.

Option for Splitters:

- Splitter A or B and accessory may be heated up to 230°F (110°C).

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MECHANICAL SPLITTER METHOD

Type A - (Quartermaster)

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Mechanical Splitter Type A
(Quartermaster)

- Designed so that the field sample (Asphalt Mixture) will flow smoothly and freely through the divider without restriction or loss of materials into four equal portions.
- Splitter has four equal width chutes.
- Four appropriate sized containers.
- Hopper with release handle.

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Procedure for Type A
(Quartermaster)

1. Place the splitter on a level surface, check for cleanliness, lightly coat the surfaces with a release agent.
2. Position four sample receptacles to receive the quartered portions without loss of material.

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3. Close and secure the hopper doors.
4. Fill the hopper with Asphalt Mixture in a continuous or segmented pour from multiple directions around the hopper.
5. Release the handle to drop the Asphalt Mixture through the dividers down into the receptacles.
6. Remove any material retained on the surface and place it into the appropriate receptacle.

Procedure Type A

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Procedure Type A

7. To further reduce the sample, reintroduce receptacles from opposite corners back into the hopper.
8. Repeat the process as many times as necessary to further reduce the Asphalt Mixture sample to testing size.

NOTE: Samples come from opposite quarters, in this case opposite buckets.

13

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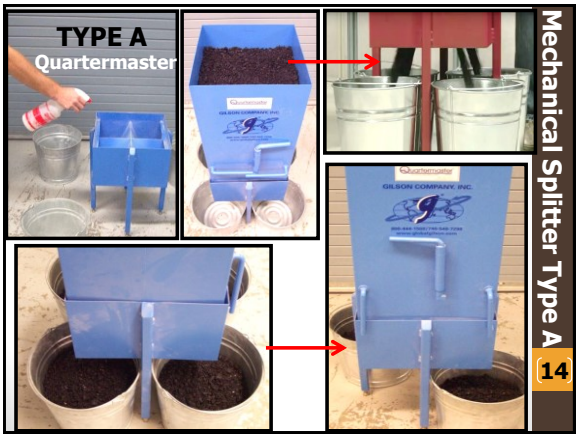
Mechanical Splitter Type A



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MECHANICAL SPLITTER METHOD

Type B - Riffle Splitter

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- **Mechanical Splitter Type B**

(Riffle Splitter)

  - Shall have even number of equal width chutes, which discharge alternately to each side, with no less than a total of eight chutes.
  - Openings 50% larger than largest particle to be split.
  - Shall be equipped with two receptacles to catch the two halves of the sample following splitting.

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- Hopper or straight-edged pan that has a width equal to or slightly less than the overall width of the assembly of chutes.
- Commonly used for Asphalt Mixture having a nominal maximum aggregate size not over 1 inch.

Mechanical Splitter Type B

17

17

Procedure for Type B

(Riffle Splitter)

1. Check for cleanliness.
2. Coat the surfaces with an approved release agent.
3. Place the receptacles under the splitter.
4. Place the sample uniformly into the hopper from edge to edge.
   (Can use a straight edge pan)

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Procedure for Type B

5. Introduce the sample at a rate to allow free flow through the chutes into the receptacles below.
6. Reintroduce the portion of the sample from one of the receptacles into the pan or hopper as many times as needed to reduce the sample to the test size.

- The portion of Asphalt Mixture collected in the other receptacle may be reserved for other tests.

NOTE: The entire sample may be mixed by repeated use of the splitter.

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QUARTERING METHOD

Quartering Template Method

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Quartering Method

- **Quartering Template** – A quartering template manufactured from a suitable metal that withstands heat and without deforming is recommended.
- The template should be configured in the form of a cross with sides of equal length sufficient to be 1.1 times the diameter of a flattened cone of the Asphalt Mixture sample to be quartered.

21

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Quartering Method

- The height of the sides should be sufficient to extend above the thickness of the flattened cone of the Asphalt Mixture sample to be quartered.
- The sides shall form a 90-degree angle at their juncture.

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Procedure for Quartering Template:

1. Sample placed on a hard, non-stick, clean, level surface.

NOTE: Approved release agent, non-stick paper, or heat resistant plastic may be used to make surface non-stick.

2. Thoroughly mix the sample by turning it over at least **4** times using a flat bottom scoop.

23

23

Procedure for Quartering

- Sample can also be mixed by alternately lifting each corner of a non-stick paper or plastic and pulling toward the opposite corner.

24

24

3. After the last turning, form a conical pile by depositing each scoop full on top of previous one or by lifting two opposite corners of the paper or plastic.

Procedure for Quartering

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25

4. Flatten the pile into a uniform thickness and diameter by pressing down on the apex.

- Diameter should be approximately **4 to 8** times the thickness.
- A visual check is done to ensure that the material is homogenous.

Procedure for Quartering

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26

5. Divide the flattened mass into four quarters using straight edge or a quartering template.

straight edge.

New slide

27

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Procedure for Quartering

- Press the quartering template down until it has complete contact with the surface of the pan or non-stick paper.

Quartering template.


28

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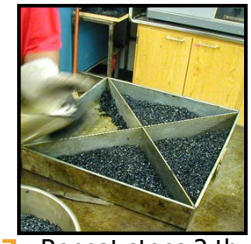
Procedure for Quartering

6. Select and remove two diagonally opposite quarters as "quartered" material. (including the fines)




7. Repeat steps 2 through 6 until the desired sample size is obtained.

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Common Errors

- Not keeping equipment adequately clean.
- Using unapproved release agent.
- Not thoroughly cleaning equipment when changing mixes (binder type or source).

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403.1.5 Mixture Production Specification Limits (Sec 403.5)

Intentional deviations from the JMF will not be permitted. The plant shall be operated in such a manner that the mix is produced as shown on the JMF. The specification tolerances are developed in an attempt to keep the mix as consistent as possible and to allow for some variation during production. However, these tolerances are not production limits. For example, if the target binder content is 5.0%, the binder content of the mix can range from 4.7% to 5.3% when the tolerances are applied. The contractor will not be allowed to produce the mix at 4.7% to save money.

Both QC and QA will use the following procedures to determine volumetrics of the mix and compliance with Standard Specification Sections 403.5.3 through 403.5.5. These procedures are discussed in greater detail in the Levels 1 and 2 Bituminous Training.

A loose mix sample consisting of roughly 100 lbs. will be taken from the roadway behind the paver, in accordance with AASHTO T168, at the required frequency. The sample will be thoroughly mixed and quartered in accordance with AASHTO R47, or with an approved splitting/quartering device. Two opposite quarters will be retained for testing during the dispute resolution process, if necessary. The remaining two quarters will be mixed together and quartered again.

The required weight of mix, as listed on the JMF, will be taken from one quarter and used to compact a specimen in accordance with AASHTO T312. The mix will be compacted to N_{des} gyrations while the mix temperature is within the molding range listed on the JMF. Using the opposite quarter, follow the same procedure for the second specimen. The G_{mb} of each specimen will be determined and the average will be used to calculate the air voids V_a and the voids in the mineral aggregate (VMA). By specification, a minimum of two compacted specimens must be used to calculate these properties.

A third quarter will be used to determine the G_{mm} of the mix in accordance with AASHTO T209. The minimum sample size for each type of mix can be found in the training manual. This property is used to calculate the V_a and density. The volume of the sample, which is needed in the calculation, can be determined by either the weigh-in-air method or the weigh-in-water method. The weigh-in-air method consists of weighing the sample and container (with the lid) completely filled with water in air. The weigh-in-water method consists of weighing the sample and container (without the lid) completely submerged in water.

The remaining mix should be mixed together and quartered again. To determine the binder content using the nuclear gauge, enough mix should be taken from opposite quarters. The required weight of mix is listed on the JMF. A moisture content sample should be taken from the same quarters. To determine the binder content using the binder ignition oven, enough mix should be taken from one quarter. The minimum sample size for each type of mix can be found in the training manual. A moisture content sample should be taken from the same quarter. Sometimes the ignition oven may not shut itself off. The oven may be shut off manually as long as 3 consecutive readings show less than 0.01% loss. The sample should be examined to assure that a complete burn has been achieved. This will be considered a valid test.

In situations where a retained sample must be tested, the following procedure should be used to reheat the sample. Heat the sample in an oven until the mix is workable. Take the mix out of the sample container (box, bucket, etc.) and spread it in a large pan or several smaller pans. Using this procedure, the mix will reach the molding temperature much quicker than it would if it were left in a mass in the sample container. Also, less aging of the mix occurs since the mix is in the oven for a shorter period of time. Once the mix has reached an acceptable temperature, the sample must be quartered using the procedures discussed above. The entire suite of tests must be performed on a retained sample.

Gradation (Sec 403.5.1)

See Sieve Analysis in Plant Inspection. The gradation of the mix is not a pay factor item. However, it does have a significant influence on the volumetrics of the mix. Samples may be taken from the hot bins at a batch plant or from the combined cold feed at a drum plant. It is acceptable to determine gradation from the binder ignition sample according to AASHTO Standard Test Method T 308. Contractors should be allowed the option provided that the chosen method is spelled out in the Quality Control Plan. Gradations of extracted samples would be satisfactory as well. QC is required to sample the aggregate and perform a sieve analysis twice per lot. QA is required to independently sample the aggregate and perform a sieve analysis once per lot. These testing requirements are minimums and should be increased as necessary. Minor deviations outside the tolerances given in Standard Specification Sections 403.5.1.1 or 403.5.1.2, whichever is applicable, may be allowed if the test results indicate that the binder content, volumetrics, and density of the mix are satisfactory. If the test results are unsatisfactory, adjustments of the JMF, in accordance with Standard Specification Section 403.11, are necessary.

AASHTO R 47
Reducing Samples of Asphalt Mixtures to Testing Size
PROFICIENCY CHECKLIST

Name: _____

Company: _____

Mechanical Splitter Methods Trial #	1	2
Type A Splitter (Quartermaster)		
1. Level, clean, lightly coated with release agent?		
2. Position 4 receptacles to receive the quartered portions, without loss of material?		
3. Hopper doors closed and secured?		
4. Poured sample using a continuous or segmented pour from multiple directions around the hopper?		
5. Released the handle to drop the asphalt mixture through the dividers into the receptacles?		
6. Removed any material retained on surface into the appropriate receptacle?		
7. Samples taken from opposing corners for reintroduction into hopper?		
8. Split as many times as necessary for appropriate test?		

Type B Splitter (Riffle Splitter)		
1. Checked for cleanliness? (Optional: Riffle Splitter can be heated, not exceeding 230°F or 110°C)		
2. All surfaces in contact with the asphalt mixture coated with approved release agent?		
3. Properly placed the receptacles under the splitter		
4. Placed the sample uniformly in the hopper from edge to edge? (Can use a straight edge pan)		
5. Introduced the sample at a rate that allows free flow into sample containers?		
6. Above steps, repeated until sample size obtained?		

Quartering Method		
1. Placed asphalt mixture on a non-stick, clean, and level surface? (Approved asphalt release agent can be used)		
2. Thoroughly mixed the material by turning it over at least 4 times using a flat bottom scoop?		
3. After the last turning, formed conical pile depositing each scoop full on top of the previous one?		
4. Flattened the pile into uniform thickness and diameter by pressing down on the apex? (Diameter should be approximately 4 to 8 times the thickness)		
5 Pressed quartering templates completely down to bottom surface dividing the pile into four quarters?		
6. Removed two opposite quarters, including the fines?		
7. Repeated steps 2 through 6 until desired sample size was attained?		

	PASS	PASS
	FAIL	FAIL

Proctor/Auditor Signature: _____Date: _____

AASHTO T 329

Moisture Content of Asphalt Mixtures

by Oven Method

AASHTO T 329

Moisture Content of Asphalt Mixtures by Oven Method

1

Rev 05/14/2021

1

SCOPE

- This method is intended for the determination of moisture content of asphalt mixtures by drying in an oven.
- Moisture content is an indicator of potential stripping, leading to poor asphalt coating of the aggregate which produces early failure of the bituminous mix.

2

2

TERMINOLOGY

- **Asphalt Mixture**: A mixture of asphalt binder and graded mineral aggregate, mixed at an elevated temperature and compacted to form a relatively dense pavement layer.

  (≈ 5% binder and ≈ 95% aggregate)

- **Constant Mass**: The mass at which further drying does not alter the mass by more than 0.05%.

3

3

SUMMARY

- A test specimen of asphalt mixture is dried in a forced-air, ventilated, or convection oven to constant mass.

4

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EQUIPMENT

- **Balance or Scale** – 2,000 gram capacity, readable to 0.1 g.
- **Oven** – Forced-Air, Ventilated, or Convection, capable of maintaining 325 ± 25°F (163 ± 14°C)
- **Sample Container** – A clean and dry container of sufficient size to allow sample to be evenly distributed in a manner that allows completion of test quickly.
- **Insulated Gloves**
- **Thermometers** – Readable to nearest 5°F (2°C), armored-glass, dial type, or digital thermometers with metal stems are recommended.

5

5

SAMPLING

- A sample of asphalt mixture shall be obtained in accordance with AASHTO R 97.
- See EPG section 460.
- The sample shall be reduced in size in accordance with AASHTO R 47. The size of the test sample shall be a **minimum of 1000 g.**

6

6

PROCEDURE

1. Determine and record the mass of the sample container to the nearest **0.1 g**.
2. Place the test sample in the container, distributed evenly, take the initial temperature, and record as the Original Temperature.
3. Determine and record the total mass of the sample and container to the nearest **0.1 g.**
4. Calculate the mass of the moist sample by subtracting the container mass from the total mass. **(M_i)**

7

7

Procedure

Dry the test sample at 325 ± 25°F to a constant mass.

- **Constant Mass**: When the change in mass is less than or equal to 0.05%.

5. Dry the sample initially for 90 minutes.
6. After 90 minutes, determine the sample mass, write it down. **(A)**
7. Put the sample back in the oven and dry an additional 30 minutes.
8. After 30 minutes, determine the sample mass, write it down. **(B)**

8

8

Procedure

9. Calculate the PERCENT CHANGE as follows:

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

A = Previous mass determination
B = Newest mass determination
REPORT = To the nearest **0.01%**

Reminder:
First subtract the container weight from the total weight for A and B then record the weights to the nearest **0.01 g** before calculating % change.

9

10. Determine if constant mass was reached.

- If the change in mass was NOT ≤ 0.05% = NOT constant mass, return the sample back to the oven for another 30-minute cycle of drying.
- If the change in mass was ≤ 0.05% = Constant mass; begin cooling the sample to approximately the same temperature as determined prior to drying and proceed to step 11.

≤0.05% = Constant Mass has been reached

STEPS 7 through 10 may need to be repeated several times to reach constant mass.

Procedure

10

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REMINDER: Cool the sample container and the test sample to approximately the same temperature as the original temperature.

11. After cooling, weigh the sample and calculate the final mass of the moist sample by subtracting the container mass from the total mass. **(M_f)**

12. Calculate the % Moisture Content of the Asphalt Mixture to the nearest **0.01%**.

Procedure

11

11

MOISTURE CALCULATIONS

$$\text{Moisture Content, \%} = \frac{(M_i - M_f)}{M_f} \times 100$$

Where:

M_i = mass of initial, moist test sample

M_f = mass of the final, dry test sample

Report = % Moisture to the nearest **0.01%**

12

12

NOTE: The following examples are set up for practice and designed similar to what will be on the written exam.

- However, in a normal laboratory setting you may do several more "30-minute drying cycles" than what is shown in the practice problems.
- Also, in the real world the "30- minute drying cycles" will stop when constant mass is achieved.

13

13

EXAMPLE PROBLEM

Calculate the percent change using the data below. Circle the weight at which the asphalt sample would be considered at constant mass. Determine the % moisture.

Container mass = 650.0 g

(Remember to subtract the weight of the container from each weight.)

	GRAMS
Initial Weight	1) 2543.2 – 650.0 and so on...
After 90 min	2) 2538.5
+30 min.	3) 2536.1
+30 min.	4) 2535.4

14

14

EXAMPLE PROBLEM

ENLARGED

M_i 1. Initial: 2543.2 – 650.0 = 1893.2 (Pan wt.)

2. After 90 min: 2538.5 – 650.0 = 1888.5 After 90min, no need to calculate

3. After 30 min: 2536.1 – 650.0 = 1886.1

M_f 4. After 30 min: 2535.4 – 650.0 = 1885.4

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

3. $\frac{(1888.5 - 1886.1)}{1888.5} \times 100 = 0.127 = 0.13\%$ Not ≤ 0.05%

Back to the oven for 30 min.

4. $\frac{(1886.1 - 1885.4)}{1886.1} \times 100 = 0.037 = 0.04\%$ ≤ 0.05% = Constant Mass

At this point, cool back to the original temperature.

% Moisture Calculation:

$$\frac{(M_i - M_f)}{M_f} \times 100 \quad \frac{(1893.2 - 1885.4)}{1885.4} \times 100 = 0.413 = 0.41\% \text{ Moisture}$$

15

15

Classroom Practice on your own,
Calculate the percent change using the data below. Circle the weight at which the sample would be considered at constant mass. Determine the % moisture.

Container mass = 450.5 g

Initial Weight	**1.** 2250.8 g
Weight after 90 min	**2.** 2248.3 g
After 30 min	**3.** 2246.3 g
After another 30 min	**4.** 2245.6 g
After another 30 min	**5.** 2245.2 g

Classroom Practice

16

16

1. Initial: $2250.8 - 450.5 = 1800.3$
2. After 90 min: $2248.3 - 450.5 = 1797.8$
3. After 30 min: $2246.3 - 450.5 = \mathbf{1795.8}$
4. After 30 min: $2245.6 - 450.5 = 1795.1$
5. Not necessary

ENLARGED

3. $\frac{(1797.8 - 1795.8)}{1797.8} \times 100 = \mathbf{0.11\%}$

Back to the oven for 30 min.

4. $\frac{(1795.8 - 1795.1)}{1795.8} \times 100 = \mathbf{0.04\ \%}$

At this point, cool back to the original temperature.

% Moisture Calculation:

$\frac{(1800.3 - 1795.1)}{1795.1} \times 100 =$ **0.29% Moisture**

ANSWER CLASSROOM PRACTICE

17

17

Practice on your own,
Calculate the percent change using the data below. Circle the weight at which the sample would be considered at constant mass.
Determine the % moisture.

Container mass = 232.6 g

Initial Weight	**1.** 1367.5 g
Weight after 90 min	**2.** 1361.8 g
After 30 min	**3.** 1360.4 g
After another 30 min	**4.** 1359.9 g
After another 30 min	**5.** 1359.6 g
After another 30 min	**6.** 1359.5 g

Practice

18

18

Common Errors

- Not subtracting weight of container from total weight in moisture calculation.
- Not drying until mass is constant.
- Not allowing the sample to cool to original temperature before weighing the final time.

Common Errors

19

19

ANSWER TO EXAMPLE PROBLEM

Pan wt.

M_i 1. Initial: 2543.2 – 650.0 = 1893.2

2. After 90 min: 2538.5 – 650.0 = 1888.5

3. After 30 min: 2536.1 – 650.0 = 1886.1

M_f 4. After 30 min: 2535.4 – 650.0 = 1885.4

ENLARGED

After 90min, no need to calculate

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

3. $\frac{(1888.5 - 1886.1)}{1888.5} \times 100 = 0.127 = 0.13\%$ Not ≤ 0.05%

4. $\frac{(1886.1 - 1885.4)}{1886.1} \times 100 = 0.037 = 0.04\%$ ≤ 0.05% = Constant Mass

% Moisture Calculation:

$$\frac{(M_i - M_f)}{M_f} \times 100 \quad \frac{(1893.2 - 1885.4)}{1885.4} \times 100 = 0.413 = 0.41\%$$ Moisture

ANSWER TO CLASSROOM PRACTICE PROBLEM

Answer to Classroom Practice

1. Initial: $2250.8 - 450.5 = 1800.3$
2. After 90 min: $2248.3 - 450.5 = 1797.8$
3. After 30 min: $2246.3 - 450.5 = \mathbf{1795.8}$
4. After 30 min: $2245.6 - 450.5 = 1795.1$
5. Not necessary

ENLARGED

3. $\dfrac{(1797.8 - 1795.8)}{1797.8} \times 100 = \mathbf{0.11\%}$

4. $\dfrac{(1795.8 - 1795.1)}{1795.8} \times 100 = \mathbf{0.04\ \%}$

% Moisture Calculation:

$\dfrac{(1800.3 - 1795.1)}{1795.1} \times 100 =$ **0.29% Moisture**

Moisture Worksheet

		-container
Initial Weight	**1.** _____ – _____ = _____	
Weight after 90 min	**2.** _____ – _____ = _____	
After 30 min	**3.** _____ – _____ = _____	
After another 30 min	**4.** _____ – _____ = _____	
After another 30 min	**5**. _____ – _____ = _____	
After another 30 min	**6**. _____ – _____ = _____	

$$\% \text{ Change} = \frac{(A - B)}{A} X\ 100$$

Moisture Worksheet

		-container
Initial Weight	**1.** _____ – _____ = _____	
Weight after 90 min	**2.** _____ – _____ = _____	
After 30 min	**3.** _____ – _____ = _____	
After another 30 min	**4.** _____ – _____ = _____	
After another 30 min	**5**. _____ – _____ = _____	
After another 30 min	**6**. _____ – _____ = _____	

$$\% \text{ Change} = \frac{(A - B)}{A} X\ 100$$

460.3.14.4 Moisture Content

A mix with a high moisture content results in an improper coating of the aggregate with binder, which may also lead to stripping. If the mix contains too much moisture because the aggregate was not thoroughly dried at the plant, the moisture will over lubricate the mix at high temperatures and prevent the binder from entering the aggregate pores. As a result, excess binder will be present between the aggregate particles instead of partially absorbed by the aggregate.

The moisture content must be subtracted from the binder content test results. The moisture content sample will be obtained at the same time as the binder content sample and performed in accordance with AASHTO T 329. The moisture content for all mixes shall not be greater than 0.50%. Record the moisture content results to the nearest 0.01% in the APIW.

Samples should be taken daily at the beginning of a project but may be reduced to once per week if the results are not changing significantly. If the weather changes, such as after a rain, the moisture content should again be determined on a daily basis until the moisture content of the mix stabilizes. When time is limited, the inspector may use the previous moisture content as an estimate if the recent test results show that the moisture content and the binder content have been stable. However, this is only an estimate.

If the moisture content of the mix is high, there are two methods that the contractor may employ to reduce the moisture. Both methods increase the retention time of the aggregate in drier so that the aggregate is actually dried longer. One method is to slow down production rates. The other method is to reduce the incline of the drier or to rearrange the configuration of the flights inside the drier. These methods are more effective than simply increasing the temperature of the mix.

AASHTO T 329: Moisture Content of Asphalt Mixtures by Oven Method
PROFICIENCY CHECKLIST

Applicant_____

Employer_____

Trial#	1	2
Sampling		
Test sample obtained by AASHTO R 97		
Representative sample obtained; 1000 g minimum		

Procedure		
1. Mass of the sample container determined to the nearest 0.1 g		
2. Sample placed into container, distributed evenly, and initial temperature taken and recorded = original temperature		
3. Mass of sample and container determined to nearest 0.1 g		
4. Calculate the mass of the moist sample = **(M_i)**		
5. Sample placed in a drying oven 325 ± 25°F (163 ± 14°C) for 90 ± 5 minutes		
6. After 90 minutes, determined the sample mass = **(A)**		
7. Returned to oven for 30 ± 5 minutes		
8. After 30 minutes, determine the sample mass = **(B)**		

Calculations		
1. Calculate the percent change and determine if the sample is at constant mass $\% \text{ Change} = \frac{(A - B)}{A} X\ 100$		
2. Continued to dry the sample in 30 minute intervals until reached constant mass, when change in mass was ≤ 0.05%		
3. Sample and container cooled to original temperature, then weighed = (**M_f**)		
4. Percent Moisture calculated and reported to the nearest 0.01% $\text{Moisture Content, \%} = \frac{(M_i - M_f)}{M_f} X\ 100$		
	PASS	PASS
`	FAIL	FAIL

Proctor/Auditor: _____ Date: _____

AASHTO T 166

Bulk Specific Gravity of Compacted Asphalt Mixtures

AASHTO T 166

Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens

Rev 08/16/2024

1

1

SCOPE

- This test method covers the determination of bulk specific gravity (Gmb) of specimens of compacted asphalt mixtures.
- This method should NOT be used with samples that contain open or interconnecting voids or absorbs more than 2.0 percent of water by volume. If it does, use method **T 331** (Bulk Specific Gravity Vacuum Sealed).
- Included information on AASHTO **T331** – Gmb by vacuum sealing method.
- MoDOT no longer uses AASHTO T275 with Paraffin Coated specimens.

2

2

Scope

- This test is used to determine density and volume properties; both are key performance indicators for any asphalt mix.

There are three variations of this test method defined in AASHTO;

A - Suspension
B - Using a Volumeter
C - Rapid Test

We will only review **Method A**;
Methods B & C will not be covered.

3

3

TERMINOLOGY

- **Constant Mass** – defined as the mass at which further drying of a specimen does not alter the mass by more than 0.05% when weighed at 2-hour intervals when using oven drying, or by more than 0.05% when weighed after at least two drying cycles of the vacuum-drying apparatus required in AASHTO R 79.
- **Mass =** The measure of the amount of matter in a body.
- **Weight** = Is the force acting on mass because of acceleration due to gravity.

Note: Even though mass and weight are different, you will find in some labs, technicities will use mass and weight if they were the same thing.

4

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- **g** = gram
- **Gmb** = Bulk Specific Gravity
- **Room Temperature**: 77 ± 9° F (25 ± 5° C)
- **Saturated Surface-Dry**: (SSD) the condition of a material when it has absorbed as much water as it can, and the outside of the material has no free water. (SSD = **B** in the calculations)
- **Immersion Thermometer:** Immersion refers to the length that the thermometer is submerged into a liquid. Liquid-in-Glass thermometers are categorized into 2 immersion types; Partial (76mm) Immersion and Total Immersion.

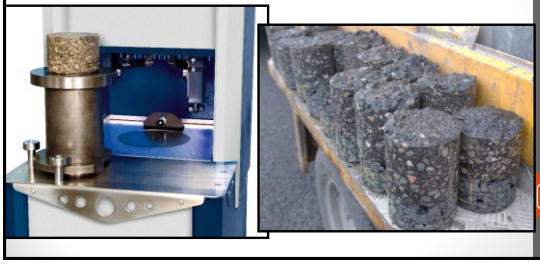
Terminology

5

5

TEST SPECIMENS

- Test specimens may be either laboratory-compacted asphalt mixtures or sampled from asphalt pavements.



6

6

Test Specimens

- Care shall be taken to avoid distortion, bending, or cracking of specimens during and after the removal from the pavement or mold.
- Specimens shall be stored in a safe, cool place.
- Specimens shall be free from foreign materials such as seal coat, tack coat, foundation material, soil, paper, or foil.

7

7

Test Specimens

- Specimens may be separated from other pavement layers by sawing or other suitable means.
- Care should be exercised to ensure sawing does not damage the specimens.

8

8

SPECIMEN PREPARATION

- Before testing, a specimen must be dry and at room temperature 77 ± 9° F (25 ± 5° C).

  DRY the specimen to a constant mass, if needed, either by **oven drying** or **vacuum drying.**

9

9

Specimens Exposed to Moisture:

1. Initially dry the specimen overnight at 125 ± 5 °F (52± 3°C)
2. Next day weigh in **2-hour** intervals until change in weight is no more than 0.05%.
3. Weigh to nearest **0.1g**.

Procedure

10

10

Specimens Exposed to Moisture:

1. Specimen surface temp more than 60°F (15°C).
2. Remove water from the surface with towel.
3. Weigh the specimen.
4. Complete at least **two** cycles in the vacuum drying apparatus.
5. Weigh the specimen after each cycle and report to nearest **0.1g.**
6. Continue vacuum cycles until weight change is no more than **0.3g** of each other repeat the drying cycles until they do .

AASHTO R79 Vacuum Dried

Procedure

11

11

Specimens Not Exposed to Moisture:

- Specimens that have NOT been exposed to moisture, do not require drying.

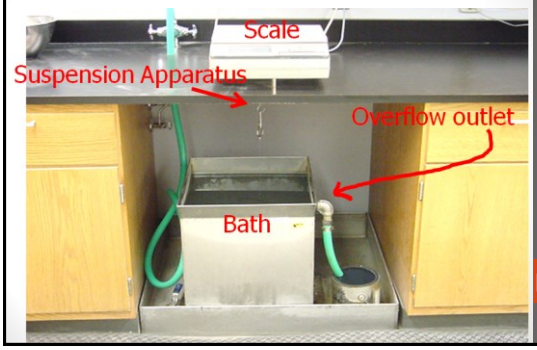
(i.e. Gyratory Pucks)

Specimen Preparation

12

12

METHOD A



Equipment

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EQUIPMENT

- **Scale** - Sufficient capacity to weigh to the nearest 0.1 gram.
- **Suspension Apparatus** - Attachable to scale - consisting of a hanger (wire shall be smallest practical size) and a specimen basket.
- **Immersion Thermometer** – Temperature range includes the test temperature.
  - Resolution of 0.2°F (0.1°C).
  - ASTM 17F/17C thermometer meets this criteria.
- **Damp Towels**
- **Timer**

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- **Water Container**
  - Large enough to completely immerse the specimen basket including bale.
  - A water flow outlet for maintaining a constant water level.
  - Capable of maintaining the test temperature of 77 ± 2°F (25 ± 1°C).
- **Potable Water**
  - Must always be clear
  - Does not need to maintain a potable condition once used.
- **Oven**
  - Can maintain temperature of 126 ± 5°F (52 ± 3°C).

Equipment

15

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EQUIPMENT - PREPARATION

- Hang the specimen basket from the scale and shake to remove any clinging air bubbles.
- Make sure the basket is centered in the tank, hanging freely and completely immersed in the water (including bale).
- Bring water to proper testing level by adding water to the bath until it comes out of the overflow outlet.
- Check the temperature of the water bath, adjust as needed to be 77 ± 2°F (25 ± 1°C).

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PROCEDURE – METHOD A
SUSPENSION

1. Dry the specimen to a constant mass by oven drying at 126 ± 5°F (52 ± 3°C).
   or vacuum dry AASHTO R79.

NOTE: Do not need to dry recently molded specimens that have not been exposed to moisture.

2. Cool the specimen to room temperature 77 ± 9°F (25 ± 5°C).

3. Tare the scale (with basket attached) then weigh the **specimen in air** to nearest **0.1g**, record as **A** (Dry Mass).

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4. Remove specimen from the scale, tare the scale, then immerse the specimen in 77 ± 2°F (25 ± 1°C) water bath for **4 ± 1** minutes.

5. Record the weight of the **specimen in water** to nearest **0.1g** record as **C.**

Procedure Method A

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Procedure Method A

6. **With in 15 seconds,** remove specimen from the water; damp-dry by **blotting** it with a damp towel; tare the scale; **weigh** the surface-dry specimen (SSD) to the nearest **0.1g** as "**B**"

- Rolling the specimen in a damp towel for SSD weight is NOT allowed.
- Any water that seeps from the specimen while weighing is considered part of the saturated specimen weight.
- Each specimen shall be immersed and weighed individually.
- A damp towel, is attained when no water can be wrung from the towel.
- Wring the excess water from the towel between specimens or prepare more than one damp towel in advance.

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Calculating Gmb

CALCULATIONS & REPORTING

Determine the bulk specific gravity of a compacted specimen by using the following formula:

$$\textbf{Gmb} = \textit{Bulk Specific Gravity} = \frac{A}{(B - C)}$$

where:

A = mass in grams of specimen in air, **0.1 g**

B = mass in grams of the surface-dry specimen (SSD) **0.1 g**

C = mass in grams of the specimen in water, **0.1 g**

Report Gmb to the nearest 0.001

20

20

Calculations

Determine the Gmb:

Dry weight in air = 1940.1 g **A.**

Surface dry weight (SSD) = 1946.8 g **B.**

Weight in water = 1163.9 g **C.**

$$\textit{Bulk Specific Gravity} = \frac{A}{(B - C)}$$

$$\text{Bulk Specific Gravity} = \frac{1940.1}{(1946.8 - 1163.9)} = 2.478$$

Report Gmb to the nearest 0.001

21

21

Percent Water Absorbed by Volume:

Calculating Gmb

Determine the % water absorbed by volume of a compacted specimen by using the following formula:

$$\text{Percent of Water Absorbed by volume} = \frac{(B - A)}{(B - C)} \times 100$$

where:

A = mass in grams of specimen in air, **0.1 g**

B = mass in grams of the surface-dry specimen (SSD) **0.1 g**

C = mass in grams of the specimen in water, **0.1 g**

Note: If percent of water absorbed by specimen exceeds **2.0%** this method can not be used.

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Report Vol. to the nearest 0.01%

22

Determine the % Absorbed by Vol:

Calculations

Dry weight in air = 1940.1 g **A.**

Surface dry weight (SSD) = 1946.8 g **B.**

Weight in water = 1163.9 g **C.**

$$\text{Percent of Water Absorbed by volume} = \frac{(B - A)}{(B - C)} \times 100$$

$$\text{Percent of Water Absorbed by volume} = \frac{(1946.8 - 1940.1)}{(1946.8 - 1163.9)} x100 = 0.86\%$$

23

Report Vol. to the nearest 0.01%

23

Classroom Exercise 1

Enlarged

SPECIMEN #	1	2	3
A. WEIGHT IN AIR	3795.2	3775.0	3778.2
B. SSD WEIGHT	3813.8	3802.0	3795.8
C. WEIGHT IN WATER	2209.0	2193.4	2194.2
% WATER ABSORBED BY VOL.			
Gmb			

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Classroom Exercise 1

ANSWER

SPECIMEN #	1	2	3
A. WEIGHT IN AIR	3795.2	3775.0	3778.2
B. SSD WEIGHT	3813.8	3802.0	3795.8
C. WEIGHT IN WATER	2209.0	2193.4	2194.2
% WATER ABSORBED BY VOL.	1.16%	1.68%	1.10%
Gmb	2.365	2.347	2.359

25

25

Information Only

AASHTO T331

Bulk Specific Gravity (Gmb) and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method.

Use this method for samples that contain open or interconnecting voids and/or absorb more than 2.0% of water by volume, as determined of T 166.

See the next few Pages for more information.

New Slide

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Common Errors

- Specimen temperature not 77° ± 9 °F (25° ± 5 °C).
- Not maintaining water temperature at 77° ± 2°F (25° ± 1 °C) and/or using dirty water.
- Water level not maintained.
- Going over the 15 second time limit for blotting and weighing the specimen for SSD.
- Not wringing the excess water from the towel between specimens.

Common Errors

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INFORMATIONAL

AASHTO T331
BULK SPECIFIC GRAVITY (G_{mb}) AND DENSITY OF COMPACTED ASPHALT MIXTURES USING AUTOMATIC VACUUM SEALING METHOD

SCOPE

This method covers the determination of bulk specific gravity (G_{mb}) of compacted asphalt mixture specimens in accordance with AASHTO T 331-22.

OVERVIEW

This method is used when specimens have open or interconnecting voids or absorb more than 2.0 percent of water by volume, or both, according to AASHTO T 166.

Bulk specific gravity (G_{mb}) determined by this method may be lower, and air voids higher, than the results determined according to AASHTO T 166. The differences may be more pronounced for coarse and absorptive mixtures. This procedure should be followed during laboratory mix designing if it will be used for control or assurance testing.

TEST SPECIMENS

Test specimens may be either laboratory-molded or sampled from asphalt mixture pavement. For specimens it is recommended that the diameter be equal to four times the maximum size of the aggregate and the thickness be at least one and one half times the maximum size of the aggregate.

APPARATUS

- Bag cutter: knife or scissors
- Balance or scale: 5 kg capacity, readable to 0.1 g, and fitted with a suitable suspension apparatus and holder to permit weighing the specimen while suspended in water, conforming to AASHTO M 231.
- Suspension apparatus: Wire of the smallest practical size and constructed to permit the container to be fully immersed.
- Water bath: For immersing the specimen in water while suspended under the balance or scale and equipped with an overflow outlet for maintaining a constant water level. Thermometer for measuring the temperature of the water bath shall have a temperature range of at least 20 to 45°C (68 to 113°F) and an accuracy of ±0.25°C (±0.45°F)
- Oven: Capable of maintaining a temperature of 52 ±3°C (126 ±5°F) for drying the specimens to a constant mass.
- Thermometer for measuring the room temperature: Accurate to ±0.5°C (±0.9°F) and with a temperature range of at least 15 to 45°C (59 to 113°F)

- Plastic bags: puncture resistant impermeable plastic bags that will not stick to the specimen and capable of withstanding temperatures up to 70°C (158°F). Between 0.100 mm (0.004 in.) and 0.152 mm (0.006 in.) thick. The bag correction factor (apparent specific gravity) is supplied by the manufacturer.
  - Small bag: less than 35 g with an opening between 235 mm (9.25 in.) and 260 mm (10.25 in.)
  - Large bag: 35 g or more with an opening between 375 mm (14.75 in.) and 394 mm (15.5 in.)

Note 1: The bag correction factor is usually located in the operator's manual. See the manufacturer's recommendations to ensure proper handling of bags.

- Specimen sliding plates: removable level and smooth-sided planar filler plates shall be inserted into the chamber to keep the samples of various heights level with the seal bar while being sealed.
- Specimen support plate: a plate with a cushioning membrane on top large enough to fully support the specimen and can easily slide on top of the smooth-sided plates.
- Vacuum chamber and sealing device: meeting the requirements of AASHTO T 331
- Vacuum gauge: meeting the requirements of AASHTO T 331

PROCEDURE

Recently molded laboratory samples that have not been exposed to moisture do not need drying.

1. Dry the specimen to constant mass, if required.
   a. Oven method
      i. Initially dry overnight at 52 ±3°C (125 ±5°F).
      ii. Determine and record the mass of the specimen. Designate as M_p.
      iii. Return the specimen to the oven for at least 2 hours.
      iv. Determine and record the mass of the specimen. Designate as M_n.
      v. Determine percent change by subtracting the new mass determination, M_n, from the previous mass determination, M_p, divide by the previous mass determination, M_p, and multiply by 100.
      vi. Continue drying until there is no more than 0.05 percent change in specimen mass after 2-hour drying intervals (constant mass).
      vii. Constant mass has been achieved; sample is defined as dry.
   b. Vacuum dry method according AASHTO R 79.

2. Cool the specimen in air to 25 ±5°C (77 ±9°F), and determine and record the dry mass to the nearest 0.1 g. Designate this mass as A.

Note 1: 3000 to 6000 g laboratory compacted specimens may be considered room temperature after 2 hr. under a fan. Cooling time may be reduced for smaller specimens.

3. Fill the water bath to overflow level with water at 25 ±1°C (77 ±1.8°F) and allow the water to stabilize.
4. Seal the specimen:
    a. Use a large bag for 150 mm (6 in.) in by 50 mm (2 in.) or greater specimens. Use a small bag for smaller specimens.
    b. Set the heat-sealing bar temperature according to manufacturer's directions.
    c. Inspect the bag for holes and irregularities.
    d. Determine and record the mass of the bag. Designate as B.
    e. Adjust filler plates in the vacuum chamber, adding or removing plates as needed.
    f. Place specimen support plate on top of filler plates.
    g. Place the bag on top of the specimen support plate in the vacuum chamber.
    h. Insert the specimen into the bag with the smoothest plane of the specimen on the bottom.

    Note 2: Inserting the specimen into the bag may be done inside the chamber while holding the bag open with one hand over the sliding plate and gently inserting the specimen with the other hand. There should be about 25 mm (1 in.) of slack between the presealed bag end and the specimen.

    i. Grab the unsealed end of the bag on each side.
    j. Gently pull and center the bag over the seal bar, overlapping at least 25 mm (1 in.). Ensure that there are no wrinkles in the bag along the seal bar before closing the lid.
    k. Close the lid and engage the lid-retaining latch.

    Note 3: The vacuum pump light will illuminate "red," and the vacuum gauge on the exterior of the chamber will become active, or a digital reading will show the vacuum state. It is normal for the bag to expand or "puff up" during this process.

    l. Once sealed, the 'de-vac' valve will open, and air will enter the chamber, causing atmospheric pressure to collapse the bag around the specimen.
    m. Disengage the lid-retaining latch, and carefully remove the sealed specimen from the chamber. Gently pull on the bag where it appears loose. Loose areas indicate a poor seal, and the process must then be restarted at Step 4 with a new bag and a new initial mass.
5. Zero or tare the balance with the immersion apparatus attached, ensuring that the device is not touching the sides or the bottom of the water bath.
6. Fully submerge the specimen and bag shaking to remove the air bubbles. Ensure no air is trapped under the bag or in the bag creases. Place the specimen on its side in the suspension apparatus.
7. Allow water level and scale to stabilize.

8. Determine and record the submerged weight to the nearest 0.1 g. Designate this submerged weight as E.

Note 4: Complete Steps 4 through 7 in 1 min. or less to reduce potential for bag leaks.

9. Cut the bag open.
10. Remove the specimen from the bag.
11. Determine the mass of the specimen. Designate as C.
12. Compare this mass, C, with initial dry mass determined in Step 2, A.

    If more than 0.08 percent is lost or more than 0.04 percent is gained, return to Step 1.
13. Calculate G_{mb} and record to three decimal places.

Calculations

$$Gmb = \frac{A}{(C + (B - A) - E - \left[\frac{(B - A)}{F}\right])}$$

Report to nearest 0.001

Where:

G_{mb} = specimen bulk specific gravity;
A = initial mass of the dried specimen in air, g;
B = calculated mass of the dry, sealed specimen, g;
C = final mass of the specimen after removal from the sealed bag, g;
E = mass of the sealed specimen underwater, g; and
F = apparent specific gravity of the plastic sealing material at 77°F, provided by the Manufacture.

REPORT

- Results on forms approved by the agency.
- Sample ID
- G_{mb} to the nearest 0.001

460.3.16 Density

The unit weight, or density, of a material is the weight of the material that occupies a certain volume. Density is an indication of the degree of compaction of the mix. AASHTO T166, Method A is used to determine the specific gravity of the core. If a lift is placed thicker than 6 times the nominal maximum aggregate size, the cores will be cut in half and the specific gravity of each half determined separately. This must be done because of differential compaction. On thick lifts, the compactive effort applied to the surface of the lift is much greater than it is near the bottom. Each half of the core will be evaluated independently.

The density is calculated by dividing the specific gravity of the core (G_{mc}) taken from the roadway by the theoretical maximum specific gravity (G_{mm}). For BB and BP mixes, the G_{mm} of the mix is shown in the lower left-hand corner of the JMF. For Superpave mixes, the G_{mm} of the mix is determined by AASHTO T209. The test result from the corresponding production period is then used to calculate the density of the core.

All test data will be recorded in the APIW for the represented production. Also, the applicable portions of the corresponding Asphalt Roadway Report should be completed and returned to the roadway inspector.

One or more of the following factors may affect the test results. The cores should be free of tack and all other foreign material. The cores may need to be separated from previous lifts. This should be done in a manner that will not harm the core. The cores should be cooled to room temperature. The scale should be tared before each weight is obtained. When weighing in water, the suspension apparatus should be centered on the scale and hang freely in the container, the core should be completely submerged, and the water in the container should be maintained within the proper temperature range and at the level of the overflow outlet. The water should be potable. The cores should not be stacked in the basket because this may trap air bubbles. Also, all air bubbles should be removed from the basket before performing the test.

Using a dry towel to dry the cores will absorb water from the voids and decrease the surface dry weight. This will give a test result that is higher than the actual density of the lift. Violent shaking or bumping of the cores will not be permitted. Doing so forces more water into the voids of the core and increases the surface dry weight. This will give a test result that is lower than the actual density of the lift. However, the cores may be rotated slowly underwater to remove any air bubbles.

AASHTO T 166
Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface Dry Specimens
PROFICIENCY CHECKLIST

Name: _____

Company: _____

SAMPLE PREPARATION	Trial 1	2
1. Core samples taken from asphalt pavements. Note: Cores are to be oven dried overnight at 125 ± 5ºF (52±3ºC) and at successive 2 hr. intervals to constant mass or vacuum dried R79 to constant mass.		
2. Laboratory-compacted specimens. Note: Recently compacted samples not exposed to moisture do not require drying.		

PROCEDURE METHOD A - Suspension		
1. Specimens dry and at room temperature?		
2. Tared the scale to zero with immersed basket attached?		
3. Mass of dry sample in air determined?		
a. Reported weight to **0.1g**		
4. Immersed mass of sample determined?		
a. Immersed 4 ±1 min.?		
b. Water is at 77 ± 2°F? (25 ± 1°C)		
c. Reported weight to **0.1g**		
5. Saturated surface dry mass determined?		
a. Removed specimen from water?		
b. Quickly blotted specimen with a damp towel within 15 seconds? Note: Damp is when no water can be wrung from wet towel.		
c. Reported weight to **0.1g?**		

CALCULATONS AND REPORTING:		
Calculate Bulk Specific Gravity (Gmb) and report the result to the nearest **0.001g** $\frac{Weight\ in\ \text{Air}\ (A)}{Weight\ \text{Surface Dry}\ (B)\ -\ \text{Weight in Water}\ (C)}$		
Calculate Percent of Water Absorbed by Volume and report to nearest **0.01%**. (**Test T166 not valid if over 2.0% must redo testing using T133 Vacuum Seal Method.)** $\frac{Weight\ Suface\ Dry - Weight\ in\ Air}{Weight\ Surface\ Dry - Weight\ in\ Water} x100$		

PASS PASS

FAIL FAIL

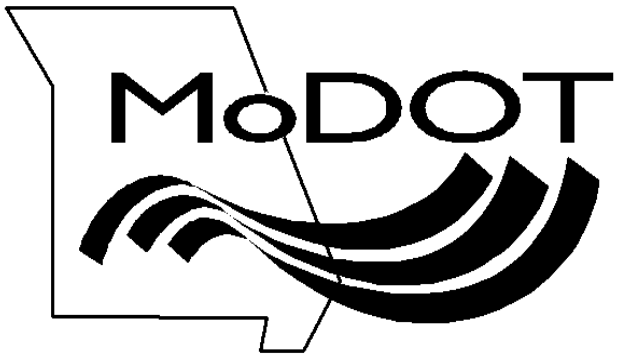
Proctor/Auditor Signature: _____ Date: _____

AASHTO T 269

Percent Air Voids in

Compacted Dense and

Open Asphalt Paving Mixtures



AASHTO T 269

Percent Air Voids in Compacted Dense and Open Asphalt Mixtures

1

08/29/2024

1

SCOPE

- This method covers the determination of the percent air voids (Va) in compacted dense and open asphalt mixtures.

2

2

SIGNIFICANCE AND USE

- The percent air voids in an asphalt mixture is used as one of the criteria in the design methods and for evaluation of the compaction achieved on asphalt paving projects.

3

3

TERMINOLOGY

- **AASHTO T331** – This is the standard method of test for Bulk Specific Gravity and Density of compacted asphalt mixture using an automatic vacuum sealing method.

- **Air Voids (Va)** – Internal spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix.

4

4

Terminology

- **Asphalt Mixture** = Aggregate + Binder + Air Voids
- **Dense Asphalt Mixture** – Asphalt paving mixture in which air voids (Va) are less than 10 percent when compacted.
- **Density** – Field Bulk Specific Gravity compared to the Field Maximum Specific Gravity.
- **Gmb** – Gravity mixture ***bulk*** (AASHTO T 166) laboratory molded specimen.
- **Gmc** – Gravity mixture ***core*** (AASHTO T 166) cored specimens.
- ***Gmm*** – Gravity mixture ***maximum*** a.k.a. Rice (AASHTO T 209). Gmm has zero air voids.

5

5

Terminology

- **Open Asphalt Mixture** – Asphalt mixture with air voids (Va) 10 percent or more when compacted.
- **Theoretical Maximum Specific Gravity** (Gmm) – Is the specific gravity excluding air voids. (AASHTO T 209).

6

6

SAMPLING

- Samples to determine the air voids shall consist of specimens from laboratory molded mixtures or cores from roadway compacted mixtures.

7

7

PROCEDURE

For Dense Bituminous Paving Mixtures:
(Air voids (Va) < 10 % when compacted)

1. Determine the bulk specific gravity (Gmb) of the compacted mixture by using either

AASHTO T 166
(Bulk Specific Gravity, Suspension in Water)

OR

AASHTO T 331
(Bulk specific Gravity, Vacuum Sealing)

8

8

Procedure

2. Determine the theoretical maximum specific gravity (Gmm) in accordance with

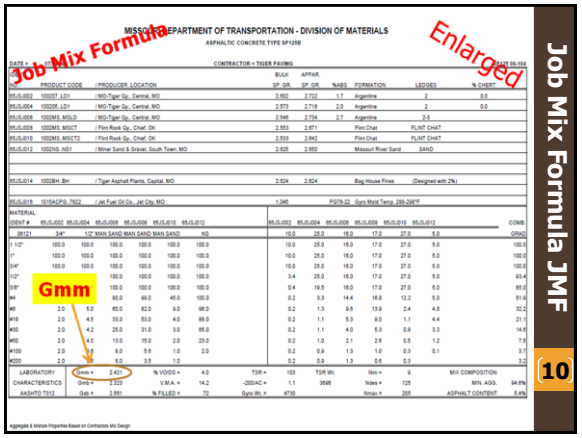
AASHTO T 209 (Rice Test)

OR

JMF "Job Mix Formula"
(Gmm can be found on the JMF sheet)

9

9



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CALCULATIONS
Volume

Volume = B - C

Where:

B = Mass in grams of the surface-dry specimen (SSD) **0.1 g**

C = Mass in grams of the specimen in water, **0.1 g**

Report to the nearest tenth **0.1 g**

11

11

CALCULATIONS
Bulk Specific Gravity

AASHTO T 166 or AASHTO T 331

Determine the bulk specific gravity of the compacted specimen by using the following formula where:

A = Mass in grams of specimen in air, **0.1 g**

B = Mass in grams of the surface-dry specimen (SSD) **0.1 g**

C = Mass in grams of the specimen in water, **0.1 g**

Report Gmb to 3 decimal places 0.001

Gmb = Bulk specific Gravity = G_{mb} or G_{mc}

Report to the nearest **0.001**

12

12

CALCULATIONS
Percent Air Voids

$$\% \text{ Air Voids} = \left[1 - \left(\frac{Gmb}{Gmm}\right)\right] \times 100$$

Gmb = Bulk Specific Gravity = G_{mb} or G_{mc}

Gmm = Maximum Specific Gravity

Report to the nearest tenth **(0.1)%**

13

13

CALCULATIONS
Density

$$\% \text{ Density} = \left(\frac{Gmb}{Gmm}\right) \times 100$$

Gmb = Bulk Specific Gravity = G_{mb} or G_{mc}

Gmm = Maximum Specific Gravity

Report to the nearest tenth **(0.1)%**

14

14

Example Problem

G_{mb} or G_{mc} = 2.323

G_{mm} = 2.433

$$\% \text{ Air Voids} = \left[1 - \left[\frac{2.323}{2.433}\right]\right] \times 100 = 4.5\ \%$$

$$\% \text{ Density} = \left[\frac{2.323}{2.433}\right] \times 100 = 95.5\%$$

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Classroom Exercise

Enlarged

Mix ID : SUPERGOOD SMA

NOTE: Gmm comes from T209 or JMF

Superpave SMA
Air Voids = 6 ± 0.5%

Gmm = 2.515

Specimen#		1	2	3	4	5	6
Weight in Air	**A.**	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD Weight	**B.**	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT In Water	**C.**	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
Volume	(B – C)						
SpG (G_{mb})	A/(B – C)						
% Air Voids	$1-\left(\frac{Gmb}{Gmm}\right)\times 100$						
% Density	$\left(\frac{Gmb}{Gmm}\right)\times 100$						
Absorption by Volume	$\frac{(B-A)}{(B-C)}\times 100$						

updated

16

Classroom Exercise

Answers

Mix ID : SUPERGOOD SMA

NOTE: Gmm comes from T209 or JMF

Superpave SMA
Air Voids = 6 ± 0.5%

Gmm = 2.515

Specimen#		1	2	3	4	5	6
Weight in Air	**A.**	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD Weight	**B.**	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT In Water	**C.**	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
Volume		1604.8	1608.6	1601.6	1602.6	1598.4	1594.1
SpG (G_{mb})		2.365	2.347	2.359	2.363	2.372	2.377
% Air Voids		6.0	6.7	6.2	6.0	5.7	5.5
% Density		94.0	93.3	93.8	94.0	94.3	94.5
Absorption by Volume		1.16	1.68	1.10	1.21	1.30	1.10

updated Notice specimen # 2 Air Voids are out of tolerance.

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Job Mix Formula

Enlarged

MISSOURI DEPARTMENT OF TRANSPORTATION - DIVISION OF MATERIALS

ASPHALTIC CONCRETE TYPE SP125B

DATE = 07/24/06 CONTRACTOR = TIGER PAVING SP125 06-104

IDENT. NO.	PRODUCT CODE	/ PRODUCER, LOCATION	BULK SP. GR.	APPAR. SP. GR.	%ABS	FORMATION	LEDGES	% CHERT
65JSJ002	100207..LD1	/ MO-Tiger Qy., Central, MO	2.602	2.722	1.7	Argentine	2	0.0
65JSJ004	100205..LD1	/ MO-Tiger Qy., Central, MO	2.573	2.718	2.0	Argentine	2	0.0
65JSJ006	1002MS..MSLD	/ MO-Tiger Qy., Central, MO	2.546	2.734	2.7	Argentine	2-3	
65JSJ008	1002MS..MSCT	/ Flint Rock Qy., Chief, OK	2.553	2.671		Flint Chat	FLINT CHAT	
65JSJ010	1002MS..MSCT2	/ Flint Rock Qy., Chief, OK	2.533	2.642		Flint Chat	FLINT CHAT	
65JSJ012	1002NS..NS1	/ Miner Sand & Gravel, South Town, MO	2.625	2.650		Missouri River Sand	SAND	
65JSJ014	1002BH..BH	/ Tiger Asphalt Plants, Capital, MO	2.624	2.624		Bag House Fines	(Designed with 2%)	
65JSJ016	1015ACPG..7622	/ Jet Fuel Oil Co., Jet City, MO	1.045		PG76-22	Gyro Mold Temp. 288-298°F		

MATERIAL IDENT #	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	COMB.
06121	3/4"	1/2" MAN	SAND	MAN	SAND	MAN SAND	NS	10.0	25.0	16.0	17.0	27.0	5.0	GRAD
1 1/2"	100.0	100.0	100.0	100.0	100.0	100.0		10.0	25.0	16.0	17.0	27.0	5.0	100.0
1"	100.0	100.0	100.0	100.0	100.0	100.0		10.0	25.0	16.0	17.0	27.0	5.0	100.0
3/4"		[illegible]0	100.0	100.0	100.0	100.0		10.0	25.0	16.0	17.0	27.0	5.0	100.0
1/2"		[illegible]9	100.0	100.0	100.0	100.0		3.4	25.0	16.0	17.0	27.0	5.0	93.4
3/8"		[illegible]1	100.0	100.0	100.0	100.0		0.4	19.5	16.0	17.0	27.0	5.0	85.0
#4		15.2	90.0	99.0	45.0	100.0		0.2	3.3	14.4	16.8	12.2	5.0	51.9
#8	2.0	5.0	60.0	82.0	9.0	96.0		0.2	1.3	9.6	13.9	2.4	4.8	32.2
#16	2.0	4.5	33.0	53.0	4.0	88.0		0.2	1.1	5.3	9.0	1.1	4.4	21.1
#30	2.0	4.2	25.0	31.0	3.0	65.0		0.2	1.1	4.0	5.3	0.8	3.3	14.6
#50	2.0	4.0	13.0	15.0	2.0	23.0		0.2	1.0	2.1	2.6	0.5	1.2	7.5
#100	2.0	[illegible]	8.0	5.6	1.0	2.0		0.2	0.9	1.3	1.0	0.3	0.1	3.7
#200	2.0	[illegible]	8.0	3.5	1.0			0.2	0.9	1.3	0.6	0.3		3.2

Gmm

LABORATORY	Gmm =	2.421	% VOIDS =	4.0	TSR =	103	TSR Wt.	Nini =	9	MIX COMPOSITION
CHARACTERISTICS	Gmb =	2.323	V.M.A. =	14.2	-200/AC =	1.1	3696	Ndes =	125	MIN. AGG. 94.6%
AASHTO T312	Gsb =	2.561	% FILLED =	72	Gyro Wt. =	4730		Nmax =	205	ASPHALT CONTENT 5.4%

CALIBRATION NUMBER 60126 MASTER GAUGE BACK CNT. = 2143 A1 = -4.063767

MASTER GAUGE SER. NO. = 2502 SAMPLE WEIGHT = 7200 A2 = 3.103065

Aggregate & Mixture Properties Based on Contractors Mix Design

Classroom Exercise

Enlarged

Mix ID : SUPERGOOD SMA

NOTE: Gmm comes from T209 or JMF

Superpave SMA
Air Voids = 6 ± 0.5%

Gmm = 2.515

Specimen#		1	2	3	4	5	6
Weight in Air	**A.**	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD Weight	**B.**	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT In Water	**C.**	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
Volume	(B – C)						
SpG (G_{mb})	A/(B – C)						
% Air Voids	$1-\left(\frac{Gmb}{Gmm}\right)\times 100$						
% Density	$\left(\frac{Gmb}{Gmm}\right)\times 100$						
Absorption by Volume	$\frac{(B-A)}{(B-C)}\times 100$						

AASHTO T269: HOMEWORK

Applicant_____

Employer_____

PROCEDURE	1	2
1. For Dense Bituminous Paving Mixtures		
a. Bulk specific Gravity determined by T166 (suspension) or T331 (Vacuum Sealing)?		
b. Theoretical maximum specific gravity determined by T209 (Rice Test) or from the JMF?		
2. Percent air voids calculated in accordance with test method T269?		

Calculate both % Density and % Air Voids using the following information:
Report values to the correct decimal place.

Mix Number Supergood

Gmm=	2.485

SPECIMEN #	1	2	3	4	5	6
WEIGHT IN AIR	3690.3	3691.9	3692.8	3690.6	3698.1	3693.4
SSD WEIGHT	3714.4	3715.6	3715.3	3716.4	3722.8	3715.2
WT IN WATER	2100.9	2101.2	2108.0	2099.6	2106.1	2113.7
VOLUME						
SpG (Gmb)						
% AIR VOIDS						
% Density						

AASHTO T269
Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
PROFICIENCY CHECKLIST

Name: _____

Company: _____

PROCEDURE	1	2
1. For Dense Bituminous Paving Mixtures		
a. Bulk specific Gravity determined by T166 (suspension) or T331 (Vacuum Sealing)?		
b. Theoretical maximum specific gravity determined by T209 (Rice Test) or from the JMF?		
2. Percent air voids calculated in accordance with test method T269?		

CALCULATONS:		
Theoretical Maximum Specific Gravity (Gmm) The Gmm can be found on the Job Mix Formula. OR from testing T209 (Rice Test) $$Gmm = \frac{A}{(A + D - E)}$$ • A=Dry Sample Mass in Air • D=Container & Water • E=Container, Water & Sample Report *Gmm* to nearest 0.001		
Bulk Specific Gravity (Gmb) $$Gmb = \frac{Weight\ in\ \text{Air}\ (A)}{Weight\ \text{Surface Dry}\ (B)\ \text{- Weight in Water}\ (C)}$$ Report Gmb to the nearest 0.001		
Percent Air Voids (Va) $$\text{Air voids } (V_a) = 100 * \left(\frac{G_{mm} - G_{mb}}{G_{mm}} \right)$$ *Or* $$\text{Air voids } (V_a) = 100 * \left(1 - \frac{G_{mb}}{G_{mm}} \right)$$ Report Air Voids to the nearest 0.1%		

PASS PASS

FAIL FAIL

Proctor/Auditor Signature: _____ Date: _____

MoDOT TM 54

AASHTO T287

Determining the Asphalt Content of an Asphalt Mixture

MoDOT TM 54

AASHTO T287

Determining the Asphalt Content of an Asphalt Mixture

1

Rev 8/30/2024

1

SCOPE

- Asphalt content affects the aggregate coating and volumetric properties of an asphalt mix.
- The gauge determines the asphalt content by measuring the amount of hydrogen atoms in the mix.
- Nuclear AC Content is covered in EPG section 460.3.14.2.

2

2

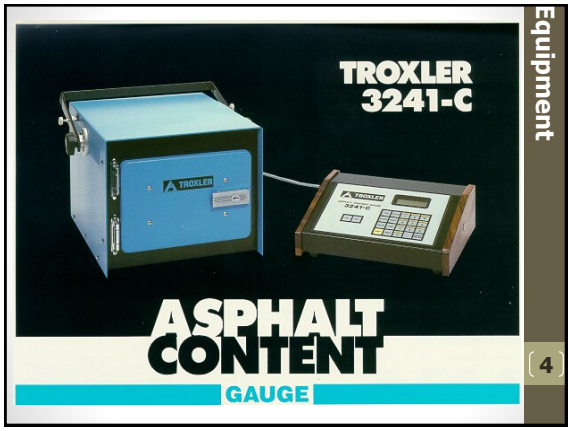
EQUIPMENT

Equipment

- **Gauge**, Troxler Model 3241-C
- **Gloves**
- **Plywood**, 3/4 in. or thicker, or **Metal Plate**, 3/8 in. or thicker, to compact the mix in the sample pans (Section 2.0 of the test method)
- **Sample pan**
- **Scale**, capable of weighing to 12 kg, readable to 1 g
- **Spoons, scoops, trowel and pans**

3

3



4

PRECAUTIONS

- Keep any other source of hydrogen and neutron radiation at least **30 feet** from the equipment.
- Inspectors should stay at least **15 feet** away from the gauge while running the test.
- Visually evaluate the surroundings to determine if conditions are present which would affect the operation of the gauge.

5

5

- Use a 2-barrier system when securing the gauge after testing is completed.
  - **Note**: 2 locks on the same barrier (i.e.. box, closet, cabinet) does ***not*** constitute 2 barriers.

Precautions

6

6

GAUGE PREPARATION

- Need a current stability test every **3 months** when gauge is in use.
  - Stability test is **20 counts** for **1 minute**.

7

7

- Complete a **16-minute** background count at least once a day; more if conditions change.
- Background test should be ± 1% of previous background test.
  - If not within 1% rerun background. Continue until 2 consecutive readings are within 1%. If unable to achieve this after a few attempts, consult technical support.

Gauge Preparation

8

8

16-minute background count

New slide

9

SAMPLING

- Obtain a proper loose mix sample according AASHTO R 97 or EPG 460.3.14.1.
- The preferred sampling location is from behind the paver.

10

10

- Prepare sample using an approved method.
- Place mix in a clean, tarred sample pan, in 2 lifts.
- Fill the pan one-half full. Do not exert pressure on the mix while distributing evenly in the pan.

Field Test

11

11

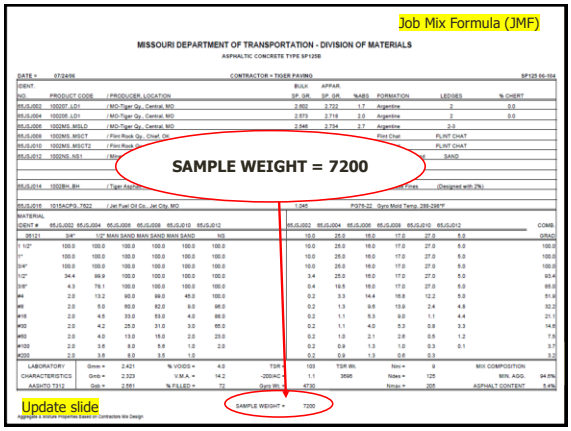
- Fill the pan with more mix until within **± 5 grams** of the weight listed on the Job Mix Formula (JMF).
- Level the mixture in the pan to an even head *above* the lip of the pan.

NOTE: Do not segregate while adjusting weight. (i.e., Don't just remove large pieces or all fines, keep as representative as possible.)

Field Test

12

12



13

- Compact the mixture until it is even with the lip of the pan.
- Reweigh the pan to assure it is still within **±5 grams** of the JMF.
- Run the test to obtain the asphalt content of the sample.

NOTE: If weight will not fit in pan, mix may be too cool to compact properly. Reheat and try again.

Field Test

14

14

REPORTING

- Subtract moisture (derived from, AASHTO T 329 test) from AC and report actual AC to the nearest **0.1%**
- Record the gauge readings for; background count, test count, and %AC on the daily plant inspectors report, plant, or project diary.

15

15

Common Errors

- Locating the nuclear gauge too close to people, water tanks, trucks loaded with asphalt, or traffic movement.
- Not running a current background count when changes occur in the lab environment.
- Not having the mix hot when compacting it in pan.
- Not properly securing the nuclear gauge.

16

16

106.3.2.54 TM-54, Asphalt Cement Content of Bituminous Mixtures by the Nuclear Method

From Engineering Policy Guide

his test method quantitatively determines the asphalt cement content of bituminous mixtures by testing a sample with a device that utilizes neutron thermalization techniques. This method can be used for rapid determination of the asphalt cement content of bituminous paving mixtures. Testing can be completed quickly so that adjustments, if necessary, can be made in the asphalt cement metering system with a limited amount of mix production. This procedure is useful in the determination of asphalt cement content only.

Unless the test sample is completely free of moisture, the percent moisture must be determined as described in EPG 106.3.2.54.7.1 Checking the sample for moisture content and a correction made to compensate for the moisture.

Contents

[hide]

106.3.2.54.1 Apparatus

a) Gauge, Model 3241-C manufactured by Troxler Electronic, Inc. with instruction manual.

b) Mixing Machine, Hobart A-200 with a 20-quart bowl or similar mixer with a wire whip mixing paddle (Central Laboratory).

c) Balance, capable of weighing to 15 kg, readable to 0.1 g (Central Laboratory).

d) Balance, capable of weighing to 12 kg, readable to 1 g (Field Laboratory).

e) Oven, capable of heating to 375° ± 5°F (190° ± 3°C).

f) Straightedge, steel, approximately 18 in. long.

g) Plywood, 3/4 in. or thicker, or metal plate 3/8 in. or thicker having an area slightly larger than the sample pans.

h) Spoons, scoops, mixing bowls, trowel and/or spatula.

i) High density polyethylene sheeting approximately 3/16 in. x 7 in. x 9 in. Size is not critical, however each size will produce specific readings. The readings should be within the intended working range of the gauge.

106.3.2.54.2 Precautions

Radiation leak test

Gauge operators shall have a valid Radiation Safety Training card in conformance with the Nuclear Regulatory Commission requirements 49CFR172, Subpart H in their possession.

Since the gauge equipment measures the total amount of hydrogen in the sample, this procedure is sensitive to changes in moisture content. It must be remembered that both asphalt cement and water contain hydrogen.

Keep any other source of neutron radiation at least 30 ft. from the equipment. Do not use the equipment where large amounts of hydrogenous material may be moved during the calibration or testing procedures (for example, people, water, trucks loaded with bituminous mix, or plastic materials.) A change in the hydrogen background during testing may affect final test results.

The operator should be aware of changing conditions that could affect gauge results. Additional standardization testing should be performed, as described in EPG 106.3.2.54.3, Standardization, if changes occur.

106.3.2.54.3 Standardization

Before operating a gauge in a new location, the surrounding conditions will be visually evaluated to determine if conditions are present which would affect the operation of the gauge. If visual evaluation is acceptable, proceed with the statistical stability and drift tests.

106.3.2.54.3.1 Statistical Stability & Drift Tests

The Statistical Stability (Stat) Test is performed for 1-minute intervals in accordance with Annex B. The Drift Test is performed in conjunction with the Stat Test. The tests are to be performed every 90 days during use and prior to using the gauge if 90 days have passed since the gauge was last used. Record all test results, passing or failing, and note any changes made in the surrounding environment or test conditions.

106.3.2.54.3.2 Background Test

A background test is to be performed at least daily prior to testing samples. The test period is to be 16 minutes. The gauge is to be left in the "power on" condition throughout the day. Record all background counts.

106.3.2.54.3.3 200-Count Stability Test

The count time for the 200-count stability test is to be 4 minutes. A 200-count stability test is to be performed in accordance with EPG 106.3.2.54.8 Procedure for 200 Count Stability Test using Troxler Software Version 2.13 or EPG 106.3.2.54.9 Procedure for 200 Count Stability Test using Troxler Software Version 2.18, as applicable, when necessary after repair of the gauge or to check stability in a controlled environment.

106.3.2.54.4 Lab-to-Field Gauge Cross-Calibration

The transfer of a calibration from the laboratory gauge to the field gauge requires that a correlation between the gauges be established. This is accomplished by performing a cross-calibration between the field gauge and the master gauge in the Central Laboratory. The Troxler's internal capability to correlate the gauges is to be used. This cross-calibration is to be done semiannually, and the counting of samples in each gauge is to be within 24 hours of each other. Before beginning a cross-calibration, the standardization procedures in EPG 106.3.2.54.3, Standardization are to be performed for each gauge. Record the results of the cross-calibration.

Cross-calibrations will be done with 7 samples. The 7 samples will have asphalt cement contents of 3.0, 3.5, 4.2, 4.9, 5.6, 6.3 and 7.0 percent. The asphalt cement contents can vary ± 0.10 percent from the target content and are based on 100 percent mixture.

The aggregates used will be from a mixture that was approved at not less than 6.0 percent asphalt content.

Cross-calibration samples will be prepared in accordance with applicable parts of the paragraph on calibration sample preparation.

106.3.2.54.5 Calibration Sample Preparation

A calibration will be performed by the Central Laboratory for each job-mix formula.

Materials for calibration samples are to be obtained in the same manner as trial mix materials for bituminous mixtures.

Samples for calibrating the gauge are to be prepared in a precise manner. The calibration is sensitive to the type of aggregate, percentage and source of asphalt cement, and aggregate gradation.

All aggregate will be separated into individual sieve fractions above the No. 8 sieve and recombined in the necessary quantities with the material passing the No. 8 sieve to meet the approved job-mix formula for which a calibration is being performed.

Three samples will be prepared for the calibration plus an initial batch to "butter" the mixture bowl and stirrers. This "butter" batch will be mixed at the low asphalt content point. The asphalt cement content of one sample will be the same as the job-mix formula, one will be 0.8 percent above and one 0.8 percent below the job-mix formula based on 100 percent mixture composition. These asphalt cement contents when calculated can vary ± 0.10 percentage point from the target content. The mixing order will be from lowest asphalt cement content to highest.

Each batch size will be as follows, unless additional material is needed to fill the sample pan.

Limestone mixtures - 8,000 grams
Porphyry or Steel Slag mixtures - 10,000 grams

The prepared aggregate and bituminous material will be heated to a mixing temperature of 325° ± 5° F (163° ± 3° C) for wet mixing by the mechanical mixer.

Determine and record the tare weight (W_t) of the mixing bowl to the nearest 0.1 gram. When both aggregate and bituminous material are at the required mixing temperature and the mixing bowl is approximately the temperature of the aggregate, the aggregate is to be added to the mixing bowl and a weight determined (W_{at}) to the nearest 0.1 gram and recorded. The amount of asphalt cement to obtain the desired asphalt content will be added to the aggregate in the mixing bowl. The weight of the combined components and the bowl (W_{ct}) will be determined to the nearest 0.1 gram and recorded.

The weight of the aggregate (W_a) and the combined components (W_c) is to be determined as follows:

$W_a = W_{at} - W_t$
$W_c = W_{ct} - W_t$

The calculated percent asphalt content (% AC) of the prepared sample will be determined as follows and the result rounded to the nearest 0.01 percent.

$$\%\,AC = 100 \times \frac{W_c - W_a}{W_c}$$

After determining the weight of the asphalt cement added to the mixing bowl, mix the sample for 2 minutes with the mechanical mixer.

After mixing, place the mixture into a batching pan. The sides of the bowl and stirrers are to be cleaned of mixture residue by scraping with a small limber spatula. The bowl and stirrers are not to be wiped with cloth or washed clean with solvent, except at the end of a calibration.

106.3.2.54.6 Gauge Calibration

The Laboratory will perform a calibration for each bituminous mixture. Before the calibration is performed, the standardization procedures as described in EPG 106.3.2.54.3 Standardization are to be performed. A calibration will be performed entirely in one gauge. That gauge serial number is to be recorded with the calibration results. All samples are to be mixed as specified in EPG 106.3.2.54.5 Calibration Sample Preparation and counted 16 minutes.

To begin a calibration, a test sample weight must be determined. The sample for the calibration with the lowest asphalt cement content is to be used to determine the test sample weight. Determine sample pan weight and record. Fill a clean sample pan one half full, then evenly distribute the sample in the pan with a trowel or spatula. Care should be taken not to exert pressure on the sample. Fill the remainder of the pan until the bituminous mixture in the pan is rounded slightly above the top of the pan. Level the top of the bituminous mixture using a spatula or trowel to an even head above the top lip of the pan. This head (approximately 1/2 in.) should be sufficient to create a condition that requires moderate effort to compress the sample into the sample pan. Use the metal or plywood plate to consolidate the bituminous mixture until it is even with the top of the pan. This should be done by placing the pan on the floor, placing the plate on top of the sample pan, and standing on the plate. Weigh and record the test sample weight (sample pan not included). This weight will be used for all calibration samples and all field or laboratory test samples using this calibration.

Prepare the remaining two samples at the test sample weight, ± 2 grams, as described above.

Each sample is then to be counted for 16 minutes in the master gauge.

The calibration curve is prepared by using the sample counts. The gauge will be used to develop this calibration curve. The percent asphalt cement content used will be based on 100 percent mixture. The curve will be a linear regression analysis of the gauge counts versus percent asphalt cement content. To be considered acceptable, a calibration should have a coefficient of correlation (Fit Coefficient) equal to or greater than 0.995.

The curve variables (A1 and A2), laboratory gauge background count, calibration sample weight, and the laboratory calibration gauge serial number will be transmitted to the field for use in the field gauges.

The calibration of a gauge with mixtures incorporating recycled asphalt pavement (RAP) presents special problems. The RAP must be of uniform gradation, asphalt cement content, and asphalt cement type. The RAP is to be mixed into the calibration samples in the same proportion as it will be used in the bituminous mixture. The calculated percent asphalt cement content used in the calibration will be the summation of added asphalt cement and asphalt cement content of RAP determined in accordance with AASHTO T 164, Method A.

106.3.2.54.7 Field Testing

The location of operation of a gauge is to be evaluated for acceptability using the standardization procedures described in EPG 106.3.2.54.3 Standardization.

The laboratory calibration values A1, A2, background count, and bituminous mixture test sample weight must be entered into the field gauge. When the gauge asks for a value of A3, enter +0. The values of A1 and A2 for the transferred calibration may differ from the laboratory calibration values for A1 and A2.

Obtain samples of the freshly produced bituminous mixture in accordance with AASHTO T 168 or by sampling from a flowing stream discharge.

A sample from a flowing stream discharge is to be obtained at random in at least three approximately equal increments so that when combined there is a sample at least four times the sample size required for testing. Take each increment from the entire cross section of the material (stream) as it is being discharged. It may be necessary to have a special sampling device constructed for use at each particular plant. The sampling device should consist of a container of sufficient size to intercept the entire cross section of the discharge stream and hold that quantity of material without overflowing. A set of rails may be necessary to support the container as it is passed through the discharge stream. Samples obtained from stream discharge will be quartered as specified in AASHTO T 248, Section 9.1.1.

Preparation of field test mixture samples will be as follows:

> Fill a clean, tarred, sample pan one half full, then evenly distribute the sample in the pan with a trowel or spatula. Care should be taken not to exert pressure on the sample. Fill the remainder of the pan until the test sample weight is achieved. Level the top of the bituminous mixture using a spatula or trowel to an even head above the top lip of the pan, approximately 1/2 in. Use the metal or plywood plate to consolidate the bituminous mixture until it is even with the top of the pan. This should be done by placing the pan on the floor, placing the plate on top of the sample pan, and standing on the plate. The sample should be reweighed to determine if the test sample weight, not including sample pan weight, has been achieved. Variation from this weight of ± 5 grams is acceptable.

Samples are to be tested in the gauge for a time period of 16 minutes. Record the gauge counts and percent asphalt content. Precautions as described in EPG 106.3.2.54.2 Precautions are to be carefully followed.

106.3.2.54.7.1 Checking the sample for moisture content

The test sample must be checked for moisture content. If moisture is present, the percentage determined must be subtracted from the apparent asphalt cement percentage as indicated by the nuclear gauge counts.

The determination of moisture content may be made in accordance with AASHTO T 110. These determinations may be done with a companion sample or with the test sample after testing in the nuclear gauge.

106.3.2.54.8 Procedure for 200-Count Stability Test using Troxler Software Version 2.13

The software version may be verified during the initial RAM test.

1) Move the gauge to an undisturbed location at least 30 ft. from other neutron sources (For example: other asphalt content gauges). This test takes approximately 13 1/2 hours to complete.

2) Turn the gauge on and allow it to run the RAM Test.

3) At the prompt "SAMPLE DATA --- ERASE", press **NO**. Note: This prompt may or may not come on the screen. If the prompt does not come up, proceed with the next step.

4) If the count time is something other than 4 minutes, change the count time to 4 minutes.

5) Take a 4 minute background count, record and use.

6) Place the polyethylene sheet in the chamber and close the chamber door.

7) Activate the factory calibration.

8) Press the following keys in the designated sequence **SHIFT**, **SPECIAL**, **.** and **0**.

9) At the prompt "ALL SAMPLE DATA WILL BE LOST! DO YOU WANT TO CONTINUE?", press "YES".

10) At the prompt "SELECT: 1=STORE DATA, 2=DUMP DATA, 3=ERASE & EXIT", press **1** to store data while the 200-count stability test is being run.

11) At the prompt "INPUT NUMBER OF PASSES (1-200)", input "200" and press **ENTER**.

12) "PASS # 1 OF 200", should come up at the top of the screen with "TIME XXX SEC" at the bottom of the screen. This indicates the 200-count stability test has begun.

13) At the end of the test period, the screen display will show the mean and standard deviation for Percent Asphalt Cement, Raw Count 1, and Raw Count 2. Also Pass/Fail information will be displayed for either the Percent Asphalt Cement or Raw Count 1 and Raw Count 2. If the gauge passes the 200 count test, record the displayed information and proceed with step 14. If the gauge fails on one or both of the Raw Counts, record the displayed information and rerun the 200-count test. If the gauge fails on the Raw Count a second time, again record the information and contact the Laboratory. If the gauge fails on percent asphalt, record the displayed information and calculate the precision ratio for each Raw Count as follows:

$$PR = RSD / (RM)^{0.5}$$

Where:

PR = Precision Ratio
RSD = Raw Count Standard Deviation
RM = Raw Count Mean

If $0.902 \leq PR \leq 1.098$ for both Raw Counts, the gauge is considered passing, otherwise calculate the precision limit in accordance with 106.7.54.10 Procedure for Calculating Precision Limit.

14) Press **ENTER**

15) At the prompt "SELECT: 1=STORE DATA, 2=DUMP DATA, 3=ERASE & EXIT", select **3** (ERASE & EXIT).

16) At the prompt "ARE YOU SURE, YOU WANT TO ERASE DATA", press **YES**.

17) Gauge should come back to "GAUGE READY" display.

106.3.2.54.9 Procedure for 200 Count Stability Test using Troxler Software Version 2.18

The software version may be verified during the initial RAM test.

1) Move the gauge to an undisturbed location at least 30 ft. from other neutron sources (For example: other asphalt content gauges). This test takes approximately 13 1/2 hours to complete.

2) Turn the gauge on and allow it to run the RAM Test.

3) At the prompt "SAMPLE DATA --- ERASE", press **NO**. Note: This prompt may or may not come on the screen. If the prompt does not come up, proceed with the next step.

4) If the count time is something other than 4 minutes, change the count time to 4 minutes.

5) Take a 4 minute background count, record and use.

6) Place the polyethylene sheet in the chamber and close the chamber door.

'*7)* Activate the factory calibration.

8) Press the following keys in the designated sequence: **SHIFT**, **SPECIAL**, **1**, **9**, **YES**, and **4**.

9) At the prompt "ALL SAMPLE DATA WILL BE LOST! DO YOU WANT TO CONTINUE?", press **YES**.

10) At the prompt "SELECT: 1=STORE DATA, 2=DUMP DATA, 3=ERASE & EXIT", press **1** to store data while the 200-count stability test is being run.

11) At the prompt "INPUT NUMBER OF PASSES (1-200)", input **200** and press **ENTER**.

12) "PASS # 1 OF 200", should come up at the top of the screen with "TIME XXX SEC" at the bottom of the screen. This indicates the 200-count stability test has begun.

13) At the end of the test period, the screen display will show the mean and standard deviation for Percent Asphalt Cement. Press **YES** and the screen display will show the mean and standard deviation for Raw Count 1, and Raw Count 2. Also Pass/Fail information will be displayed for either the Percent Asphalt Cement or Raw Count 1 and Raw Count 2. If the gauge passes the 200-count test, record the displayed information and proceed

with step 14. If the gauge fails on one or both of the Raw Counts, record the displayed information and rerun the 200-count test. If the gauge fails on the Raw Count a second time, again record the information and contact the Laboratory. If the gauge fails on percent asphalt, record the displayed information and calculate the precision ratio for each Raw Count as follows:

$$PR = RSD / (RM)^{0.5}$$

Where:

PR = Precision Ratio
RSD = Raw Count Standard Deviation
RM = Raw Count Mean

If $0.902 \leq PR \leq 1.098$ for both Raw Counts, the gauge is considered passing, otherwise calculate the precision limit in accordance with EPG 106.3.2.54.10 Procedure for Calculating Precision Limit.

14) Press **ENTER**

15) At the prompt "SELECT: 1=STORE DATA, 2=DUMP DATA, 3=ERASE & EXIT", select **3** (ERASE & EXIT).

16) At the prompt "ARE YOU SURE, YOU WANT TO ERASE DATA", press **YES**.

17) Gauge should come back to "GAUGE READY" display.

106.3.2.54.10 Procedure for Calculating Precision Limit

1) If the ambient temperature during the 200-count stability test changes more than 5°F, the gauge compares the percent asphalt data rather than the raw count data. Due to differences between actual background count and the factory background the comparison may be erroneously displayed as failing. This describes the procedure used to calculate a new precision limit.

2) Given: Factory Calibration Background = 2200

3) Given: Factory A(2) = 0.0030276

4) Calculate mean gauge count:

MGC = (AC + 2.971852) / FA2
Where:
MGC = Mean Gauge Count
AC = Percent Asphalt displayed at end of 200-count test.
FA2 = Factory A(2)

5) Calculate gauge A(2):

GA2 = (FA2)(GBKG) / (FBKG)
Where:
GA2 = Gauge A(2)
FA2 = Factory A(2)
GBKG = Gauge Background Count
FBKG = Factory Calibration Background Count

6) Calculate actual gauge count:

AGC = MGC + (GBKG - FBKG)
Where:
AGC = Actual Gauge Count
MGC = Mean Gauge Count
GBKG = Gauge Background Count
FBKG = Factory Calibration Background Count

7) Calculate the new precision limit:

$PL = (GA2)\ (AGC)^{0.5} / (PS)^{0.5}$
Where:
PL = Precision Limit
GA2 = Gauge A(2)
AGC = Actual Gauge Count
PS = Prescale

(PS=4 for 1 min. count, PS=16 for 4 min. count, PS=32 for 8 min. count, and PS=64 for 16 min. count.)

8) Compare the calculated precision limit to the percent asphalt standard deviation displayed by the gauge. If the calculated precision limit is greater than the displayed standard deviation for percent asphalt, the gauge has passed the 200-count stability test. If the calculated precision limit is less than the standard deviation for percent asphalt, the gauge has failed the 200-count stability test and should be run a second time. If the gauge fails the 200-count stability test twice, contact the Laboratory.

106.3.2.54.11 Procedure for Statistical Stability (Stat) and Drift Tests

106.3.2.54.11.1 Procedure for Statistical Stability (Stat) Test

1) With the gauge on and in the "Ready" position, press the yellow **SHIFT** key then the **9/SPECIAL** key.

2) From the "SPECIAL FUNCTION" mode display, press **1** (Stat Test)

3) Press **YES** at "STAT TEST...Time...Do you want to change?"

4) Select **1** (1 min.). This will do 20, 1-minute counts.

5) If you want to abort the Stat Test at this time, press **CE**.

6) Close the door and press **START**.

7) After the test has started, keep personnel and anything containing liquids at least 10 ft. away from the gauge. Keep other radioactive material 30 ft. away from the gauge.

8) The gauge will beep at the end of each test.

9) If the gauge shows "Failure", make sure no moisture source is within 10 ft. or any other gauge has been moved into the area. Rerun the Stat Test. If the retest fails, contact the repair technician at (573) 751-5081 for further instruction.

10) If the gauge shows "Pass" (acceptable limits for the Ratio are between 0.35 and 0.71), record the average counts (Avg. cnts) and the ratio (R).

11) Press NO to return to the "Gauge Ready" display. "All data will be lost" may display but the data remains in the internal memory.

DO NOT TURN THE GAUGE OFF OR USE IT.
WAIT 3 TO 4 HOURS, THEN RUN THE DRIFT TEST.

Note: Before performing drift test, the environment should be the same as before the stat test was performed.

106.3.2.54.11.2 Procedure for Drift Test

1) Press the yellow **SHIFT** key then the **9/SPECIAL** key.

2) From the "SPECIAL FUNCTION" mode display, press **2** (Drift Test)

3) Press **ENTER** at the "Drift Test" screen.

4) The new screen should read "Will take five 4 min. counts.", close the door and press **START**.

5) The gauge will beep at the end of each test.

6) If the gauge shows "Failure", make sure no moisture source is within 10 ft. or any other radioactive gauges have been moved into the area. Rerun the Stat Test. If the retest fails, contact the repair technician at (573) 751-5081 for further instruction.

7) If the gauge shows "Pass" (acceptable limit for the Drift is less than or equal to 1.6%), record the average counts (Avg. cnts) and the Drift %.

8) Press **NO** to return to the "Gauge Ready" display.

9) At this time, you can either continue to use the gauge or turn it OFF.

460.3.14 Asphalt Binder Content

Asphalt binder is the glue that holds the aggregate particles together. Binder also provides lubrication at high temperatures and cohesion at in-service temperatures. The binder content affects the mix properties and the pavement performance. An excessively high or low binder content may cause the mix to have a low stability. A high binder content results in low air voids and may promote flushing and cause plastic rutting of the pavement. A low binder content results in high air voids and may promote stripping and cause consolidation rutting.

MoDOT employees who operate nuclear gauges must have received Radiation Safety Training. MoDOT's license with the U.S. Nuclear Regulatory Commission (NRC) requires the storage of its nuclear gauges to be under a three-lock system; the door of the asphalt gauge, the shipping case the gauge is stored in, and the door of the building where the gauge is being stored or used. For added security, a fourth lock and chain should be used to secure the shipping case to a fixed object in the laboratory. Any untrained person will not have access to this area without the presence of the inspector. The NRC requires storage areas to have a radiation placard affixed to the door and an NRC Form 3 placed near the placard.

When a nuclear gauge is transported in a car, it should be stored in the trunk. If the gauge is transported in the bed of a pickup truck, it should be near the tailgate. The gauge must be secured either in a lockable box bolted to the bed or chained through the handles of the shipping case and locked to the bed of the truck. There should not be any slack in the chain, if used.

Contractor owned nuclear gauges may or may not be regulated by the NRC, depending upon which radioactive isotope the gauge uses. It is the contractor's responsibility to comply with all state and federal laws. However, the inspector should report all unsafe practices to their supervisor.

460.3.14.1 Loose Mix Sampling

Sampling behind the paver is the recommended method of obtaining a sample. Samples should be taken in one increment behind the paver prior to breakdown rolling. The sample should extend the full depth of the lift and include all of the mix from the sample location. Use a clean sample container and do not contaminate the sample with underlying material. The inspector should always be consistent in the sampling procedure to reduce, and possibly eliminate, testing errors.

For BB, BP, and SL mixes, the binder content sample may be taken at the plant or on the roadway. This is because the binder content of the mix is the same regardless of where the sample is taken.

460.3.14.2 Nuclear Gauge Methods

The binder content of a mix using a nuclear gauge will be determined in accordance with MoDOT Test Method TM-54. A background count must be performed daily before the binder content can be determined in order to account for the environmental conditions. If the conditions change, another background count should be performed. The gauge should be operated at least 15 ft. away from any

hydrogen source (water, people, etc.) and any other binder source (loaded trucks, etc.). Do not exert force on the mix while placing it in the pan.

Record the background count, the number of counts, and the percent binder content for each test in the gauge diary and the APIW. Report the binder content to the nearest 0.1%. If a plant is producing the same mix for more than one project during the production period, the test results are reported to each project receiving that mix. It is recommended that a binder content test be performed at any time that the visual appearance of the mix changes dramatically. The statistical stability (stat) and drift tests are required to be performed every 30 days or at the frequency recommended by the manufacturer. Record the results and the date performed in the gauge diary.

460.3.14.3 Use of the Contractor's Nuclear Gauge

To eliminate any possible problems that may occur as a result of having two nuclear gauges in the field laboratory, the inspector may use the contractor's gauge if the contractor approves. The same safety principles should be employed when using contractor owned nuclear gauges. Specification compliance will be verified by independent QA samples until a favorable comparison is obtained. At that time, the inspector may begin using the contractor's gauge and the QC test results will be used to determine the Pay Factor. A favorable comparison is obtained when the QA test results are within two standard deviations of the QC test results. An unfavorable comparison should be investigated and resolved immediately. The contractor shall be responsible for calibration (including stat and drift tests) of their gauge and all information regarding the calibration shall be available to the inspector.

460.3.14.4 Moisture Content

A mix with a high moisture content results in an improper coating of the aggregate with binder, which may also lead to stripping. If the mix contains too much moisture because the aggregate was not thoroughly dried at the plant, the moisture will over lubricate the mix at high temperatures and prevent the binder from entering the aggregate pores. As a result, excess binder will be present between the aggregate particles instead of partially absorbed by the aggregate.

The moisture content must be subtracted from the binder content test results. The moisture content sample will be obtained at the same time as the binder content sample and performed in accordance with AASHTO T 329. The moisture content for all mixes shall not be greater than 0.50%. Record the moisture content results to the nearest 0.01% in the APIW.

Samples should be taken daily at the beginning of a project but may be reduced to once per week if the results are not changing significantly. If the weather changes, such as after a rain, the moisture content should again be determined on a daily basis until the moisture content of the mix stabilizes. When time is limited, the inspector may use the previous moisture content as an estimate if the recent test results show that the moisture content and the binder content have been stable. However, this is only an estimate.

If the moisture content of the mix is high, there are two methods that the contractor may employ to reduce the moisture. Both methods increase the retention time of the aggregate in drier so that the aggregate is actually dried longer. One method is to slow down production rates. The other method is to reduce the incline of the drier or to rearrange the configuration of the flights inside the drier. These methods are more effective than simply increasing the temperature of the mix.

460.3.14.5 Deviations in Asphalt Binder Content

It is strongly recommended that the sampling and testing frequency be increased whenever the mix appears questionable and/or the binder content test results show that the mix is approaching the specification limits. It is also recommended to test several QC split samples at the beginning of a project to ensure that both QC and QA are performing the test properly.

See the applicable guidance ections for the procedure on failing test results. If there is reason to believe that the gauge is producing questionable test results or not operating properly, perform a stat and drift test to determine if the gauge is counting correctly. If a stat and drift test is not needed at this time, perform check samples with QC. If a problem is confirmed, send the gauge in for repairs as soon as possible. Technical assistance is available from the Construction and Materials Field Office.

MoDOT TM 54 (T287)
Determining the Asphalt Content of an Asphalt Mixture

PROFICIENCY CHECKLIST

Name: _____

Company: _____

Trial#	1	2
Preparation Note: AC = Asphalt Content		
1. Current 20 count – 1 minute stability test report, 3 months or less?		
2. Ran a 16-minute background daily or when conditions change?		
3. Background count within ±1 % of previous background test? - If not, more tests ran until two consecutive readings are w/n 1%?		

Procedure		
1. Obtained an asphalt mixture sample by R97, reduced by R47		
2. Tared a sample pan on the scale?		
3. Placed the sample in the pan in two lifts?		
4. Placed the sample on tared scale, check weight? (See JMF)		
5. Adjusted weight by adding or subtracting material from the pan to reach ± 5g of JMF sample weight? (do not segregate while adjusting)		
7. Compacted the sample in the pan using a leveling plate?		
8. Pressed down on the leveling plate to compact the sample level with top of the pan? • If the sample is not fitting, reheat the mix, try again.		
9. Rechecked the weight? Within ± 5g of JMF?		
10. Placed the sample pan in the nuclear machine and pressed the start/enter button (16 min count test)		
11. Get the results from a printed report or computer?		

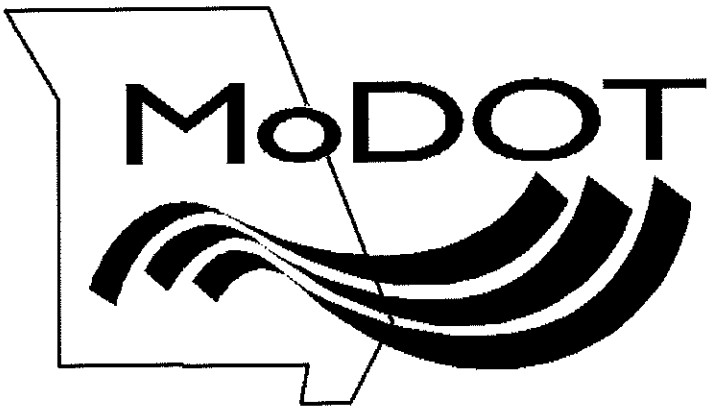
Reporting		
1. Subtracted the moisture (T329), from the AC and report actual AC to the nearest **0.1%**		
2. Recorded the gauge readings for: Background count, Test count, and %AC on daily plant inspectors report or diary.		

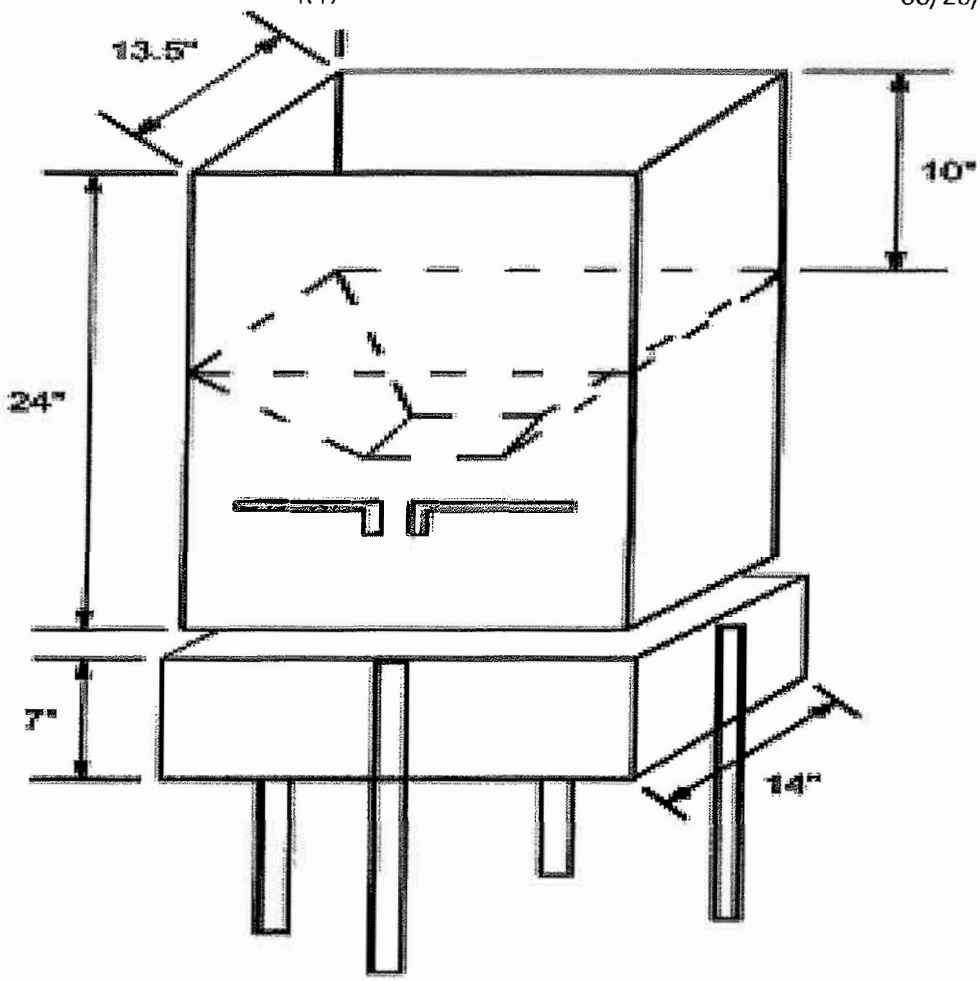
PASS PASS

FAIL FAIL

Proctor/Auditor's Signature: _____ Date: _____

Appendix





Metric Equivalents

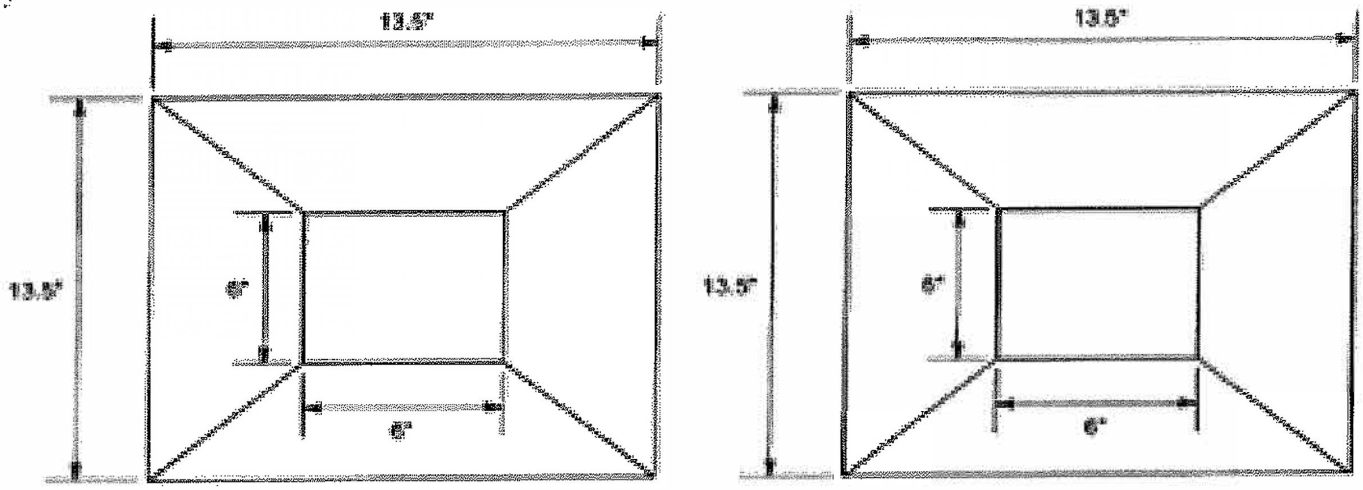
in.	mm
7	178
10	254
13.5	343
14	356
24	610

Note: All dimensions shown in inches unless otherwise noted.

Figure 1—Mechanical Splitter Type A

Mechanical splitter Type A –

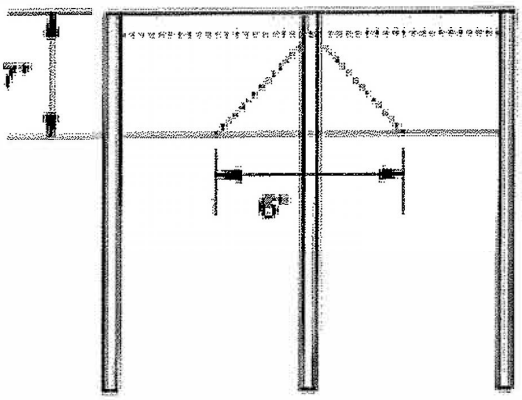
- Shall have 4 equal width chutes that discharge the material into 4 appropriately sized containers
- Shall be designed with a receiving hopper that will hold the field sample until a handle releases the material to fall through a divider and distributes it into 4 equal portions.
- Shall be designed so that the field sample will flow smoothly and freely through the divider without restriction or the loss of material.



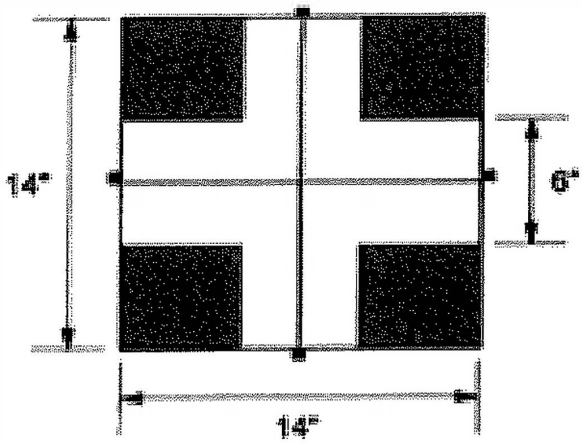
Metric Equivalents	
in.	mm
6	152
13.5	343

Note: All dimensions shown in inches unless otherwise noted.

Figure 2—Plan View of Splitter



a. Elevation View of Bottom Portion of Splitter



b. Plan View of Bottom Portion of Splitter

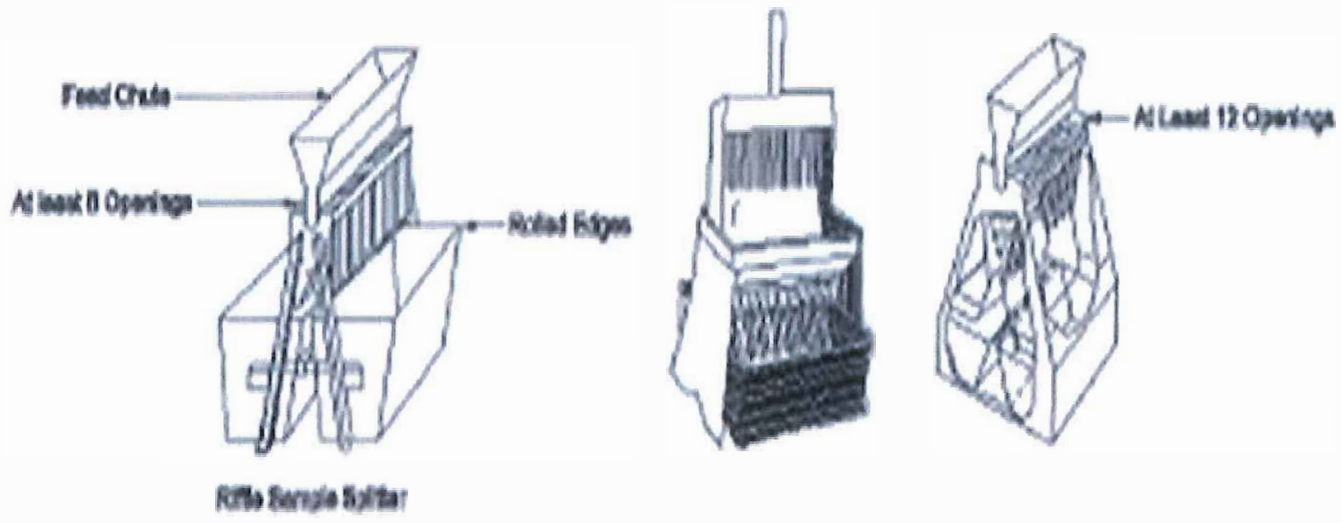
Metric Equivalents	
in.	mm
6	152
7	178
14	356

Note: All dimensions shown in inches unless otherwise noted.

Mechanical splitter Type A

Mechanical Splitter Type B

- Shall have an even number of equal-width chutes (no fewer than a total of 8 for a large splitter and no fewer than 12 for a small splitter), which discharge alternately to each side of the splitter.
- Minimum width of the individual chutes shall be approximately 50% larger than the largest particle to be split.
- Shall be equipped with 2 receptacles to catch the 2 halves of the sample follosing splitting
- Shall also be equipped with a gopper or straight-edge pan that has a width equal to or slightly less than the overall width of the assembly of chutes, by whigh the sample may be fed at a controlled rate to the chutes.
- Shall be designed so that the sample will flow smoothly and freely without restriction or the loss of material.



a. Large Splitter for Large Samples b. Small Splitters for Small Samples

Splitter Type B

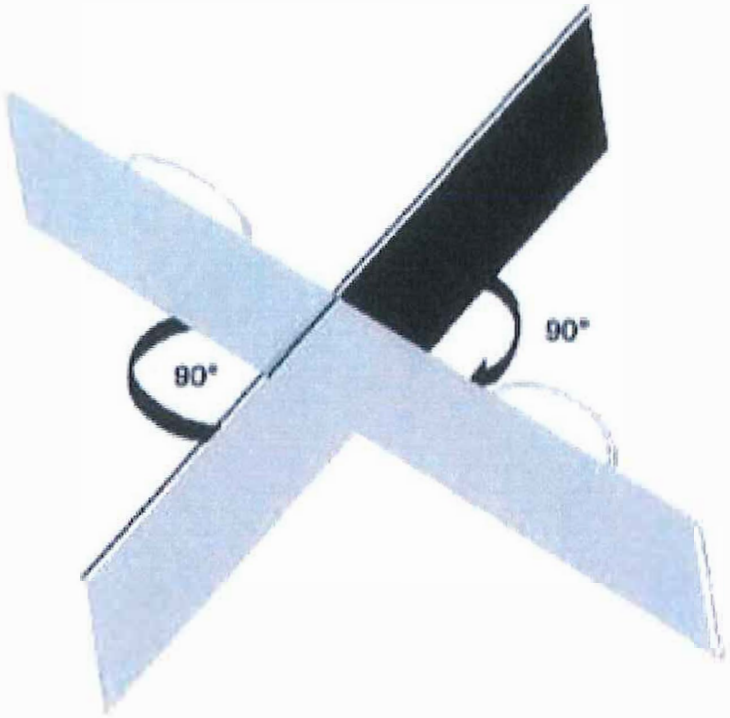
Note 1 – Type B mechanical splitters are commonly available in sizes adequate for asphalt mixtures having a nominal maximum aggregate size not over 1 inch. Use closed versions for larger sizes.

Noncontact Temperature Device (optional) – a noncontact temperature device suitable for determining the temperature of a heated splitter.

Asphalt Release Agent – Shall not contain any solvents or petroleum-based products that could affect asphalt binder properties.

Quartering Template –

- Template manufactured from a suitable metal that withstands heat and use without deforming
- Should be configured in the form of a cross with sides of equal length sufficient to be 1.1 times the diameter of the flattened cone of the asphalt mixture to be quartered.
- Height of the sides should be sufficient to extend above the thickness of the flattened cone of the asphalt sample to be quartered.
- Sides shall form a 90° angel at their juncture. See image below:

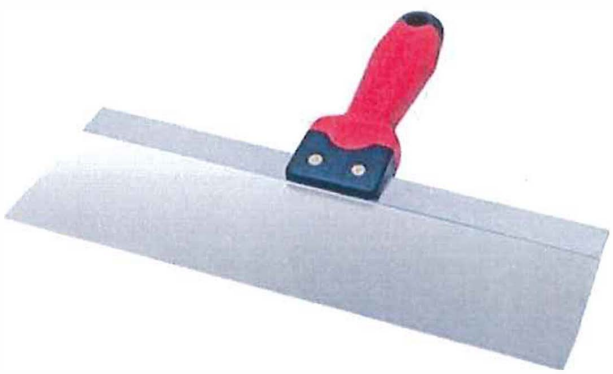


Flat –Bottom Scoop

- A large, straight-edged, flat-bottom scoop should be used to sample the asphaklt mixture
- A square shovel or trowel will meet the requirement

Straightedge

- Large spatula, trowel, or metal straightedge



INCREMENTAL METHOD APPARATUS:

Flat - Bottom Scoop

- A large, straight-edged, flat-bottom scoop should be used to sample the asphalt mixture.
- A square shovel or trowel will meet this requirement.

Nonstick heavy paper

Large spatulas, trowels, metal straightedge, or drywall taping knife

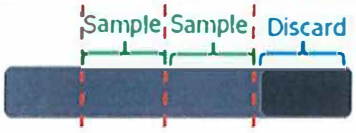
Miscellaneous Equipment

- Hot plate
- Non-asbestos heat resistant gloves or mittens
- Pans, Buckets, cans

AASHTO R47

- **Procedure for Incremental (Loaf) Method** (Not Recommended)

1. Place asphalt sample on a clean non-stick paper or plastic
2. Mix sample well, turning over 4 times
3. Roll asphalt into a cylindrical loaf and flatten the top
4. Discard end ¼ of loaf
5. Cut off (collect) desired sample sizes
6. Re-mix and re-roll as necessary



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Appendix for AASHTO T166

Equipment:

THERMOMETERS:

Updated : 08/20/2024

- **Added** Thermometer information to the appendix.
  - **Water Bath Thermometer Requirements:**
    - Immersion Thermometer
    - Meets M339M/M339
    - Temp range includes testing temperature.
    - Resolution 0.2°F (0.1°C)
    - Max error of 1°F (0.5°C)
  - **Suitable Thermometers:**
    - Glass thermometer ASTM 17F/17C
    - Thermistor as described in E879.
    - Digital thermometer as described in E2877.
    - Thermocouple thermometer, Type T, Class 1

EQUIPMENT FOR T133:

- **Bag Cutter** – knife, scissors, or other types of clipping devices may be used to open bags.
- **Oven** – same as for T166
- **Weighing device** – same as for T166
- **Plastic Bags** – Two most used size of bags are designated as small and large size bags.
  - Small bags: Minimum opening of 241mm (9.50 in.) and a maximum opening of 267mm (10.50 in.) with a mass of less than 35g.
  - Large bags: Minimum opening of 368 mm (14.50 in.) and a maximum opening of 394mm (15.5 in.) with a mass of 35g or more.

  Bags shall be made of a plastic material that will not adhere to asphalt film and shall be puncture-resistant, capable of withstanding sample temperature of up to 158ºF, impermeable to water, and contain no air channels for evacuation of air from the bag. The bags shall have a minimum thickness of 0.127 mm (0.005 in.) and a maximum thickness of 0.178 mm (0.007in.). The manufacturer shall provide the bag correction factor (apparent specific gravity) of the bags (usually located in the operator's manual).
- **Specimen Sliding Plates** – The plate shall be large enough to fully support the specimen but small enough to allow movement during the sealing process.
- **Vacuum chamber** – Large enough to seal samples of 6 x 14 x 6 inches. The heat setting shall be set according to the manufacturer's recommendations and the bag composition. The device shall automatically seal the plastic bag and exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic bag to the specimen. The air exhaust and vacuum operation time should be calibrated to bring the chamber to atmospheric pressure in 80 to 120 sec after completion of the vacuum operation.
- **Vacuum Gauge** – Standardized vacuum gauge shall be capable of being placed inside the automatic vacuum sealing device to verify vacuum performance and seal integrity. The gauge shall have a minimum range of 10 to 0 mmHg and shall be readable to 1 mmHg increments, as a minimum.
- **Water Bath** – Same as T166

Glossary

Asphalt Industry Glossary of Terms

This is an alphabetical listing of the terms and descriptions commonly used in the asphalt industry

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

A

Absolute Viscosity	A measure of the viscosity of asphalt with respect to time, measured in poises, conducted at 60°C (140°F). The test method utilizes a partial vacuum to induce flow in the viscometer.
Aggregate Spreaders	Machines used for spreading aggregate evenly at a uniform rate on a surface.
Aggregate Storage Bins	Bins that store the necessary aggregate sizes and feed them to the dryer in substantially the same proportions as are required in the finished mix.
Aggregate Trucks	Trucks equipped with hydraulic lifts to dump the aggregate into the spreader or storage area.
Aggregate	A hard inert mineral material, such as gravel, crushed rock, slag, or crushed stone, used in pavement applications either by itself or for mixing with asphalt.
Air Voids	Internal spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix.
Asphalt (asphalt cement)	A dark brown to black cementitious material in which the predominating constituents are bitumens, which occur in nature or are obtained in petroleum processing. Asphalt is a constituent in varying proportions of most crude petroleum and used for paving, roofing, industrial and other special purposes.
Alligator Cracks	Interconnected cracks forming a series of small blocks resembling an alligator's skin or chicken-wire, and caused by excessive deflection of the surface over unstable subgrade or lower courses of the pavement.
Asphalt Application	The application of sprayed asphalt coatings not involving the use of aggregates.
Asphalt Binder	Asphalt cement that is classified according to the Standard Specification for Performance Graded Asphalt Binder, AASHTO Designation MP1. It can be either unmodified or modified asphalt cement, as long as it complies with the specifications.
Asphalt Concrete	A mixture of asphalt binder and aggregate thoroughly mixed and compacted into a mass.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Asphalt Distributor	A truck or a trailer having an insulated tank, heating system and distribution system. The distributor applies asphalt to a surface at a uniform rate.
Asphalt Emulsion	An emulsion of asphalt binder and water that contains a small amount of an emulsifying agent. Emulsified asphalt droplets may be of either the anionic (negative charge), cationic (positive charge) or nonionic (neutral).
Asphalt Emulsion Mix (Cold)	A mixture of unheated mineral aggregate and emulsified (or cutback) asphalt binder. It can be plant-mixed or mixed in-place.
Asphalt Emulsion Mix (Warm)	A mixture of asphalt emulsion and mineral aggregate usually prepared in a conventional hot mix asphalt plant at a temperature less than 95°C (200°F). It is spread and compacted at a temperature above 65°C (150°F).
Asphalt Emulsion Slurry Seal	A mixture of slow-setting emulsified asphalt, fine aggregate, and mineral filler with a slurry consistency
Asphalt Leveling Course	A course of hot mix asphalt of variable thickness used to eliminate irregularities in the contour of an existing surface prior to placing the subsequent course.
Asphalt Pavement Structure	A pavement structure that is designed and constructed so that all courses above the subgrade are asphalt concrete (Full-Depth Asphalt Pavement).
Asphalt Pavements	Pavements consisting of a surface course of asphalt concrete over supporting courses such as asphalt concrete bases, crushed stone, slag, gravel, Portland Cement Concrete (PCC), brick, or block pavement.
Asphalt Prime Coat	An application of asphalt primer to an absorbent surface. It is used to prepare an untreated base for an asphalt surface. The prime penetrates or is mixed into the surface of the base and plugs the voids, hardens the top and helps bind it to the overlying asphalt course.
Asphalt Primer	Low viscosity asphalt (highly liquid) that penetrates into a non-bituminous surface upon application.
Asphalt Rubber - Asphalt Concrete (AR-AC)	High quality, thoroughly controlled hot mixture of asphalt rubber binder (AR) and well-graded, high quality aggregate, which can be thoroughly compacted into a uniform dense mass.
Asphalt Rubber Binder (AR)	Conventional asphalt cement to which recycled ground tire rubber has been added, that when reacted with the hot asphalt cement causes a swelling and/or dispersion of the tire rubber particles.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Asphalt Tack Coat	A relatively thin application of asphalt binder applied to an existing asphalt concrete or PCC surface at a prescribed rate. Asphalt emulsion diluted with water is the preferred type. It is used to form a bond between an existing surface and the overlying course.
Asphaltenes	The high molecular weight hydrocarbon fraction precipitated from asphalt by a designated paraffinic naphtha solvent at a specified solvent-asphalt ratio.
Automatic Cycling Control	A control system in which the opening and closing of the weigh hopper discharge gate, the bituminous discharge valve, and the pugmill discharge gate are actuated by means of self-acting mechanical or electrical machinery without any intermediate manual control. The system includes preset timing devices to control the desired periods of dry and wet mixing cycles.
Automatic Dryer Control	A system that automatically maintains the temperature of aggregates discharged from the dryer within a preset range.
Automatic Proportioning Control	A system in which proportions of the aggregate and asphalt fractions are controlled by means of gates or valves, which are opened and closed by means of self-acting mechanical or electronic machinery without any intermediate manual control.

B

Back-calculation	An analytical technique used to determine the equivalent elastic moduli of pavement layers corresponding to the measured load and deflections. In the iterative method, layer moduli are selected and adjusted until the difference between the calculated and measured deflections are within selected tolerances, or the maximum number of iterations has been reached.
Bank Gravel	Gravel found in natural deposits, usually intermixed with fine material such as sand or clay or a combination thereof; includes gravelly clay, gravelly sand, clayey gravel, and sandy gravel (the names indicate the relative proportion of the materials in the mixture).
Base Course	The layer in the pavement system immediately below the binder and surface courses. It usually consists of crushed stone, although it may consist of crushed slag or other stabilized or unstabilized material.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Batch Plant	A manufacturing facility for producing asphalt paving mixtures that proportions blending. They manufacture asphalt in batches rather than continuously and are more suited for small manufacturing runs and (frequent) changes in mixture types.
Binder Course	The hot mix asphalt course immediately below the surface course, generally consisting of larger aggregates and less asphalt (by weight) than the surface.
Bitumen	A class of black or dark-colored (solid, semisolid, or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons, of which asphalts, tars, pitches, and asphaltites are typical.
Blast-Furnace Slag	The nonmetallic product, consisting essentially of silicates and alumino-silicates of lime and of other bases, that is developed simultaneously with iron in a blast furnace.
Bleeding or Flushing Asphalt	The upward migration of asphalt binder in an asphalt pavement resulting in the formation of asphalt film on the surface.

C

California Bearing Ratio (CBR)	A test used for evaluating bases, subbases, and subgrades for pavement thickness design it is a relative measure of the shear resistance of a soil (see Soils Manual, MS-10). CBR = load required to force a calibrated piston into a soil specimen / load required to force a like piston into a crushed stone specimen capacity and ride quality of the pavement system.
Cape Seal	A surface treatment where a chip seal is followed by the application of either slurry seal or micro-surfacing.
Channels (Ruts)	Channeled depressions that sometimes develop in the wheel paths of an asphalt pavement.
Chemical modification of asphalt	The chemical modification of asphalt is typically with Polyphosphoric Acid (PPA).
Clinker	A fused or partially fused by-product of the combustion of coal. Also includes lava and Portland Cement and partially vitrified slag and brick.
Coal Tar	A dark brown to black cementitious material produced by the destructive distillation of bituminous coal.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Coarse Aggregate	Aggregate retained on the 2.36 mm (No. 8) sieve.
Coarse-Graded Aggregate	One having a continuous grading in sizes of particles from coarse through fine with a predominance of coarse sizes.
Cold In-place Recycling Train	A unit consisting of a large milling machine towing a screening/crushing plant and pugmill mixer for the addition of asphalt emulsion and production of cold mix base.
Compaction	The act of compressing a given volume of material into a smaller volume.
Consensus Properties	Aggregate characteristics that must follow certain criteria to satisfy a Superpave mix design. Specified test values for these properties are not source specific but widely agreed upon. They include Coarse Aggregate Angularity, Fine Aggregate Angularity, Flat or Elongated Particles, and Clay Content.
Consistency	The degree of fluidity of asphalt cement at any particular temperature. The con-sistency of asphalt cement varies with its temperature; therefore, it is necessary to use a common or standard temperature when comparing the consistency of one asphalt cement with another.
Corrugations (Washboarding) and Shoving	A type of pavement distortion. Corrugation is a form of plastic deformation typified by ripples across the pavement surface. These distortions usually occur at points where traffic starts and stops, on hills where vehicles brake on the downgrade, on sharp curves, or where vehicles hit a bump and bounce up and down. They occur in asphalt layers that lack stability.
Crack	An approximately vertical random cleavage of the pavement caused by traffic loading, thermal stresses and/or aging of the binder.
Crack and Seat	A fractured slab technique used in the rehabilitation of PCC pavements that minimizes slab action in a jointed concrete pavement (JCP) by fracturing the PCC layer into smaller segments. This reduction in slab length minimizes reflective cracking in new HMA overlays.
Crack-Relief Layer	A large stone, open graded asphalt mixture placed over a distressed pavement that minimizes reflective cracking by absorbing the energy produced by movement in the underlying pavement.
Crusher-Run	The total unscreened product of a stone crusher.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Curing	The development of the mechanical properties of the asphalt binder. This occurs after the emulsion has broken and the emulsion particles coalesce and bond to the aggregate.
Cutback Asphalt	Asphalt cement that has been liquified by blending with petroleum solvents (diluents). Upon exposure to atmospheric conditions the diluents evaporate, leaving the asphalt cement to perform its function.

D

Deep Strength Asphalt Pavement	Pavements containing at least four inches of HMA over non-stabilized base courses.
Deflection	A load-induced, downward movement of a pavement section.
Deflection Basin	The idealized shape of the deformed pavement surface as a result of a cyclic or impact load as depicted from the peak measurements of five or more deflection sensors.
Rebound Deflection	The amount of surface rebound when a load is removed.
Representative Rebound Deflection	The mean value of measured rebound deflections in a test section, plus two standard deviations, adjusted for temperature and most critical period of the year for pavement performance.
Residual Deflection	The difference between original and final elevations of the pavement surface resulting from the application to, and removal of, one or more loads from the surface.
Deflection Sensor	The term that shall be used to refer to the electronic device(s) capable of measuring the vertical movement of the pavement; and, mounted in such a manner as to minimize angular rotation with respect to its measuring plane at the expected movement. Sensor types include seismometers, velocity transducers, and accelerometers.
Delivery Tolerances	Permissible variations from the exact desired proportions of aggregate and bituminous material as manufactured by an asphalt plant.
Dense-Graded Aggregate	An aggregate that has a particle size distribution such that when it is compacted, the resulting voids between the aggregate particles, expressed as a percentage of the total space occupied by the material, are less than 10%.
Densification	The act of increasing the density of a mixture during the compaction process.

Another valuable resource for terms is MS-4 Asphalt Handbook

Design ESAL	The total number of equivalent 80-kN (18,000-lb.), single-axle load applications (equivalent single axle loads) expected throughout the design period.
Design Lane	The lane on which the greatest number of equivalent 80-kN (18,000-lb.) single axle loads (ESAL) is expected. This will normally be either lane of a two-lane roadway or the outside lane of a multi-lane highway.
Design Period	The number of years from the initial application of traffic until the first planned major resurfacing or overlay. This term should not be confused with pavement life or analysis period. Adding hot mix asphalt overlays as required will extend pavement life indefinitely or until geometric considerations (or other factors) make the pavement obsolete.
Design Subgrade Resilient Modulus	The value of the Subgrade Resilient Modulus (MR) used for designing the pavement structure. It is a percentile value of the subgrade resilient modulus test data distribution that varies with design ESAL.
Disintegration	The breaking up of a pavement into small, loose fragments caused by traffic or weathering (e.g. raveling).
Distortion	Any change of a pavement surface from its original shape.
Drum Mix Plant	A manufacturing facility for producing asphalt paving mixtures that proportions the aggregate, then dries and coats the aggregate with a proportional amount of asphalt in the same drum. Variations of this type of plant use several types of drum modifications, separate (and smaller) mixing drums, and coating units (coater) to accomplish the mixing process. They are more suited for long runs of the same product.
Dryer	An apparatus that will dry the aggregates and heat them to the specified temperatures.
Ductility	The ability of a substance to be drawn out or stretched thin. While ductility is considered and important characteristic of asphalt cements in many applications, the presence or absence of ductility is usually considered more significant than the actual degree of ductility.
Durability	The property of an asphalt pavement that represents its ability to resist disintegration by weathering and traffic.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

E

Edge Joint Cracks	The separation of the joint between the pavement and the shoulder, commonly caused by the alternate wetting and drying beneath the shoulder surface. Other causes are shoulder settlement, mix shrinkage, and trucks straddling the joint.
Effective Thickness	The ratio of the thickness of an existing pavement material compared to the equivalent thickness of a new HMA layer.
Emulsifying Agent or Emulsifier	The chemical added to the water and asphalt that keeps the asphalt in stable suspension in the water. The emulsifier determines the charge of the emulsion and controls the breaking rate.
ESAL (equivalent single axle loads)	The effect on pavement performance of any combination of axle loads of varying magnitude equated to the number of 80-kN (18,000-lb.) single-axle loads that are required to produce an equivalent effect.

F

Fatigue Resistance	The ability of asphalt pavement to resist crack initiation caused by repeated flexing.
Fault	A difference in elevation of two slabs at a joint or crack.
Fine Aggregate	Aggregate passing the 2.36 mm (No. 8) sieve.
Fine-Graded Aggregate	One having a continuous grading in sizes of particles from coarse through fine with a predominance of fine sizes.
Flexibility	The ability of an asphalt pavement structure to conform to settlement of the foundation. Generally, flexibility of the asphalt paving mixture is enhanced by high asphalt content.
Fog Seal	A light application of diluted asphalt emulsion. It is used to renew old asphalt surfaces, seal small cracks and surface voids, and inhibit raveling.
Fractured Slab Techniques	Processes used to rehabilitate PCC pavements by eliminating slab action through the reduction of slab size (crack/break and seat) or the pulverization of the PCC slab (rubblization) into essentially a granular base.
Full-Depth Asphalt Pavement	The term FULL-DEPTH (registered by the Asphalt Institute with the U.S. Patent Office) certifies that the pavement is one in which asphalt mixtures are employed for all courses above the subgrade or improved subgrade. A Full-Depth asphalt pavement is placed directly on the prepared subgrade.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

G

Grade Depressions	Localized low areas of limited size.

H

Heavy Trucks	Two-axle, six-tire trucks or larger. Pickup, panel and light four-tire trucks are not included. Trucks with heavy-duty, wide-base tires are included.
Hot Aggregate Storage Bins	Bins that store heated and fractionated aggregates prior to their final proportioning into the mixer.
Hot Mix Asphalt (HMA)	High quality, thoroughly controlled hot mixture of asphalt binder (cement) and well-graded, high quality aggregate, which can be compacted into a uniform dense mass.
Hot Mix Asphalt (HMA) Overlay	One or more courses of HMA over an existing pavement.

I

Impermeability	The resistance an asphalt pavement has to the passage of air and water into or through the pavement.

K

Kinematic Viscosity	A measure of the viscosity of asphalt, measured in centistokes, conducted at a temperature of 275°F (135°C).

L

Lane Joint Cracks	Longitudinal separations along the seam between two paving lanes.
Lift	A layer or course of paving material applied to a base or a previous layer.
Lime Treated Subgrade	A subgrade preparation technique in which the subgrade soil and added lime are mechanically mixed and compacted to produce a higher modulus base material than the in-situ material.
Lime-Fly Ash Base	A road base material consisting of a blend of mineral aggregate, lime, fly ash, and water, which when combined in proper proportions and compacted produces a dense mass of increased strength.

Another valuable resource for terms is MS-4 Asphalt Handbook

Load Equivalency Factor (LEF)	The number of 18,000-lb. (80-kN) single-axle load applications (ESAL) contributed by one passage of an axle.
Longitudinal Crack	A vertical crack in the pavement that follows a course approximately parallel to the centerline.

M

Maintenance Mix	A mixture of asphalt emulsion and mineral aggregate for use in relatively small areas to patch holes, depressions, and distressed areas in existing pavements. Appropriate hand or mechanical methods are used in placing and compacting the mix.
Mechanical Spreaders	Spreader boxes that are mounted on wheels. The spreaders are attached to and pushed by dump trucks (HMA boxes are pulled and chip spreaders are pushed).
Medium-Curing (MC) Asphalt	Cutback asphalt composed of asphalt cement and a diluent of medium volatility.
Mesh	The square opening of a sieve.
Micro-Surfacing	A mixture of polymer modified asphalt emulsion, crushed dense graded aggregate, mineral filler, additives and water. It provides a thin resurfacing of 3/8 to 3/4 inch (10 to 20 mm) to the pavement.
Milling Machine	A self-propelled unit having a cutting head equipped with carbide-tipped tools for the pulverization and removal of layers of asphalt materials from pavements.
Mineral Dust	The portion of the fine aggregate passing the No. 200 (0.075 mm) sieve.
Mineral Filler	A finely divided mineral product, at least 70 percent of which will pass a No. 200 (0.075 mm) sieve. Pulverized limestone is the most commonly manufactured filler, although other stone dust, hydrated lime, portland cement, and certain natural deposits of finely divided mineral matter are also used.
Modified Asphalt Rubber - Asphalt Concrete (MAR-AC)	High quality, thoroughly controlled hot mixture of modified asphalt rubber binder (AR) and well-graded, high quality aggregate, which can be thoroughly compacted into a uniformly dense mass.
Modified Asphalt Rubber Binder (MAR)	Conventional asphalt cement to which recycled ground tire rubber and compounds have been added, that when reacted with the hot asphalt cement causes a dispersion of the tire rubber particles and compounds.

Another valuable resource for terms is MS-4 Asphalt Handbook

Multiple Surface Treatment	**Two or more surface treatments placed one on the other. The maximum aggregate size of each successive treatment is usually 1/2 the previous one. It may be a series of single treatments that produces a pavement course up to 1 in. (25mm) or more in thickness. A multiple surface treatment is a denser wearing and waterproofing course than a single surface treatment.**

N

Natural (Native) Asphalt	Asphalt occurring in nature, which has been derived from petroleum through natural processes of evaporation of volatile fractions, leaving the asphalt fractions. The native asphalt of most importance is found in the Trinidad and Bermudez Lake deposits. Asphalt from these sources is often called lake asphalt.
Nondestructive Testing (NDT)	In the context of pavement evaluation, NDT is deflection testing, without destruction to the pavement, to determine a pavement's response to pavement loading.

O

Open-Graded Aggregate	One containing less-fine aggregate in which the void spaces in the compacted aggregate are relatively large and interconnected, usually 10% more.
Open-Graded Asphalt Friction Course	A pavement surface course that consists of a high-void, asphalt plant mix that permits rapid drainage of rainwater through the course and out the shoulder. The mixture is characterized by a large percentage of one-sized coarse aggregate. This course prevents tires from hydroplaning and provides a skid-resistant pavement surface with significant noise reduction.

P

Pascal-Seconds	The SI unit for viscosity. 1 Pascal-second equals 10 poises.
Pavement Base	The lower or underlying pavement course atop the subbase or subgrade and under the top or wearing course.
Pavement Structure	The entire pavement system of selected materials from subgrade to the surface.

Another valuable resource for terms is MS-4 Asphalt Handbook

Penetration Grading	A classification system of asphalt cements based on penetration in 0.1 mm at 25°C (77°F). There are five standard penetration grades for paving: 40-50, 60-70, 85-100, 120-150, and 200-300.
Penetration	The consistency of a bituminous material expressed as the distance (in tenths of a millimeter) that a standard needle penetrates a sample vertically under specified conditions of loading, time and temperature.
Performance Graded (PG)	Asphalt binder grade designation used in Superpave. It is based on the binder's mechanical performance at critical temperatures and aging conditions.
Planned Stage Construction	A construction process where stages of the project are performed sequentially according to design and a predetermined time schedule.
Plant Mix (Cold)	A mixture of emulsified (or cutback) asphalt and unheated mineral aggregate prepared in a central mixing plant and spread and compacted with conventional paving equipment while the mixture is at or near ambient temperature.
Plant Mix Base	A foundation course produced in an asphalt mixing plant, which consists of a mineral aggregate uniformly coated with asphalt cement or emulsified asphalt.
Plant Screens	Screens located between the dryer and hot bins, which separate heated aggregates into proper hot bin sizes.
Pneumatic-Tire Roller	A compactor with a number of tires spaced so their tracks overlap delivering a kneading type of compaction.
Poise	A centimeter-gram-second unit of absolute viscosity equal to the viscosity of a fluid in which a value of stress one dyne per square centimeter is required to maintain a difference of velocity of one centimeter per second between two parallel planes in the fluid that lie in the direction of flow and are separated by a distance of one centimeter.
Polished Aggregate	Aggregate particles in a pavement surface that have been worn smooth by traffic.
Polymer-Modified Asphalt (PMA) Binder	Conventional asphalt cement to which one or more polymer compounds (typically SBS or SBR) have been added to improve resistance to deformation at high pavement temperatures and often cracking resistance at low temperatures.

Another valuable resource for terms is MS-4 Asphalt Handbook

Potholes	Bowl-shaped openings in the pavement resulting from localized disintegration.
Power Sweeper	A power operated rotary broom used to clean loose material from the pavement surface.
Present Serviceability Index (PSI)	A mathematical combination of values obtained from certain physical measurements of a large number of pavements, so formulated as to determine, within prescribed limits, the Present Serviceability Rating (PSR) for those pavements.
Present Serviceability Rating (PSR)	The rating assigned to a specific pavement section.
Present Serviceability	The ability of a specific section of pavement to serve its intended use in its existing condition.
Pumping	Slab deflection under passing loads sometimes resulting in the discharge of water and subgrade soils along joints, cracks and pavement edges.

R

Rapid-Curing (RC) Asphalt	Cutback asphalt composed of asphalt cement and a naphtha or gasoline-type diluent of high volatility.
Raveling	The progressive separation of aggregate particles in a pavement from the surface downward or from the edges inward.
Reclaimed Asphalt Pavement (RAP)	Excavated asphalt pavement that has been pulverized, usually by milling, and is used like an aggregate in the recycling of asphalt pavements.
Reclaiming Machine	A self-propelled unit having a transverse cutting and mixing head inside of a closed chamber for the pulverization and mixing of existing pavement materials with asphalt emulsion. Asphalt emulsion (and mixing water) may be added directly through the machine by a liquid additive system and spray bar.
Recycled Asphalt Mix	A mixture produced after processing existing asphalt pavement materials. The recycled mix may be produced by hot or cold mixing at a plant, or by processing the materials cold and in-place.
Reflection Cracks	Cracks in asphalt overlays (usually over deteriorated PCC pavements) that reflect the crack pattern in the pavement structure below it.

Another valuable resource for terms is MS-4 Asphalt Handbook

Residue	**The asphalt binder that remains from an asphalt emulsion after the emulsifying agent has broken and cured, or the remains of a cutback after the volatiles have cured.**
Resilient Modulus of Elasticity (MR)	A laboratory measurement of the behavior of pavement materials to characterize their stiffness and resiliency (see Soils Manual, MS-10). A confined or unconfined test specimen (core or recompacted) is repeatedly loaded and unloaded at a prescribed rate. The resilient modulus is a function of load duration, load frequency, and number of loading cycles.
Resistance Value (R-value)	A test for evaluating bases, subbases, and subgrades for pavement thickness design.
Road Oil	Asphalt cement and oils of low volatility, usually similar to one of the slow-curing (SC) grades.
Roadway	All facilities on which motor vehicles are intended to travel such as secondary roads, interstate highways, streets and parking lots.
Roughometer	An instrumented, single-wheel trailer, which measures the roughness of a pavement surface in accumulated millimeters, or inches, per mile.
Rubblization	The pulverization of a portland cement concrete pavement into smaller particles, reducing the existing pavement layer to a sound, structural base that will be compatible to an asphalt overlay.

S

Sand Asphalt	A mixture of sand and asphalt cement, cutback asphalt or emulsified asphalt. It may be prepared with sand or clay or combinations thereof including gravelly clay, gravelly sand, clayey gravel, and sandy gravel (the names indicate the relative proportions of the materials in the mixture). Either mixing-in-place or plant mix construction may be employed. Sand asphalt is used in construction of both base and surface course and may or may not contain mineral filler.
Sand	Fine aggregate (any fraction below a No. 8 sieve) resulting from natural disintegration and abrasion or processing of rock.
Sandwich Seal	A surface treatment consisting of the application of a large aggregate, then a spray applied asphalt emulsion, and covered with a smaller aggregate.

Another valuable resource for terms is MS-4 Asphalt Handbook

Sandy Soil	A material consisting essentially of fine aggregate particles smaller than 2.36 mm (No. 8) sieve and usually containing material passing a 75 µm (No. 200) sieve. This material usually exhibits some plasticity characteristics.
Saw-Cut and Seal	A method of controlling reflective cracking in HMA overlays that involves constructing joints in the new overlay exactly over the joints in the existing pavement.
Scaling	The peeling away or disintegrating of the surface of portland cement concrete.
Seal Coat	A thin surface treatment used to improve the surface texture and protect an asphalt surface. The main types of seal coats are fog seals, sand seals, slurry seals, micro-surfacing, cape seals, sandwich seals and chip seals.
Self-Propelled Spreaders	Spreaders having their own power units and two hoppers. The spreader pulls the truck as it dumps its load into the receiving hopper. Conveyor belts move the aggregate forward to the spreading hopper.
Sheet Asphalt	A hot mixture of asphalt binder with clean, angular, graded sand and mineral filler. Its use is ordinarily confined to reservoir liners and landfill caps; usually laid on an intermediate or leveling course.
Shoving	A form of plastic movement resulting in localized bulging of the pavement.
Shrinkage Cracks	Interconnected cracks forming a series of large blocks, usually with sharp corners or angles.
Sieve	An apparatus for laboratory work in which the openings in the mesh are square for separating sizes of material.
Single Surface Treatment	A single application of asphalt to a road surface followed immediately by a single layer of aggregate. The thickness of the treatment is about the same as the nominal, maximum size aggregate particles.
Skid Hazard	Any condition that might contribute to the reduction of friction forces on the pavement surface.
Skid Resistance	The ability of a paved surface, particularly when wet, to offer resistance to slipping or skidding. Proper asphalt content and aggregate with a rough surface texture are the greatest contributors. The aggregate must not only have a rough surface texture, but also resist polishing.

Another valuable resource for terms is MS-4 Asphalt Handbook

Slippage Cracks	Crescent-shaped cracks resulting from traffic-induced horizontal forces that are open in the direction of the thrust of wheels on the pavement surface. They result when severe or repeated shear stresses are applied to the surface and there is a lack of bond between the surface layer and the course beneath.
Slow-Curing (SC) Asphalt	Cutback asphalt composed of asphalt cement and oils of low volatility.
Slurry Seal	A mixture of emulsified asphalt, well-graded fine aggregate, mineral filler or other additives, and water. A slurry seal will fill minor cracks, restore a uniform surface texture, and restore friction values.
Soil/Cement Base	A hardened material formed by curing a mechanically mixed and compacted mixture of pulverized soil, portland cement and water used as a layer in a pavement system to reinforce and protect the subgrade or subbase.
Solubility	A measure of the purity of asphalt cement. The ability of the portion of the asphalt cement that is soluble to be dissolved in a specified solvent.
Source Properties	Aggregate characteristics that must follow certain criteria to satisfy a Superpave mix design. Specified values are established by local agencies. They include Toughness, Soundness, and Deleterious Materials.
Spalling	The breaking or chipping of a PCC pavement at joints, cracks, or edges, usually resulting in fragments with featheredges.
Stability	The ability of an asphalt paving mixture to resist deformation from imposed loads. Stability is dependent upon both internal friction and cohesion.
Standard Deviation	The root-mean-square of the deviations about the arithmetic mean of a set of values.
Stationary Plants	Asphalt plants that are so constructed that moving them is not considered economically feasible.
Steel-Wheel Static Rollers	Tandem or three-wheel rollers with cylindrical steel rolls that apply their weight directly to the pavement.
Steel-Wheel Vibratory Rollers	A compactor having single or double cylindrical steel rolls that apply compactive effort with weight and vibration. The amount of compactive force is adjusted by changing the frequency and amplitude of vibration.

Another valuable resource for terms is MS-4 Asphalt Handbook

Stoke	A unit of kinematic viscosity equal to the viscosity of a fluid in poises divided by the density of the fluid in grams per cubic centimeter.
Structural Overlay	A HMA overlay constructed for the purpose of increasing the structural value and ride quality of the pavement system.
Subbase	The course in the asphalt pavement structure immediately below the base course. If the subgrade soil has adequate support, it may serve as the subbase.
Subgrade Resilient Modulus	The modulus of the subgrade determined by repeated load, triaxial compression tests on soil samples. It is the ratio of the amplitude of the accepted axial stress to the amplitude of the resultant recoverable axial strain, generally designated by the symbol MR.
Subgrade, Improved	Subgrade that has been improved as a working platform by: 1) the incorporation of granular materials or stabilizers such as asphalt, lime, or portland cement into the subgrade soil; 2) any course or courses of select or improved material placed on the subgrade soil below the pavement structure.
Subgrade	The soil prepared to support a pavement structure or a pavement system. It is the foundation of the pavement structure.
Superpave Gyratory Compactor (SGC)	A device used during Superpave mix design or quality control activities for compacting samples of hot mix asphalt into specimens used for volumetric analysis. Continuous densification of the specimen is measured during the compaction process.
Superpave Mix Design	An asphalt mixture design system that integrates the selection of materials (asphalt, aggregate) and volumetric proportioning with the project's climate and design traffic.
Superpave™	Short for "Superior Performing Asphalt Pavement" a performance-based system for selecting and specifying asphalt binders and for designing asphalt mixtures.

T

Transverse Crack	A crack that follows a course approximately at right angles to the centerline.

Another valuable resource for terms is MS-4 Asphalt Handbook

Travel Plants	Self-propelled pugmill plants that proportion and mix aggregates and asphalt as they move along the road. There are three general types of travel plants: 1. One that moves through a prepared aggregate windrow on the roadbed, adds and mixes the asphalt as it goes, and rear discharges a mixed windrow ready for aeration and spreading. 2. One that receives aggregate into its hopper from haul trucks, adds and mixes asphalt, and spreads the mix to the rear as it moves along the roadbed. 3. Batch mixing units, such as slurry machines, that haul materials to the site and then mix and apply the materials.
Truck Factor	The number of ESALs contributed by one passage of a vehicle. Truck Factors can apply to vehicles of a single type or class or to a group of vehicles of different types.

U

Upheaval	The localized upward displacement of a pavement due to swelling of the subgrade or some portion of the pavement structure.

V

Viscosity Grading	A classification system of asphalt cements based on viscosity ranges at 60°C (140°F). A minimum viscosity at 135°C (275°F) is also usually specified. The purpose is to prescribe limiting values of consistency at these two temperatures. 60°C (140°F) approximates the maximum temperature of an asphalt pavement surface in service in the U.S. 135°C (275°F) approximates the mixing and laydown temperatures for hot mix asphalt pavements.
Viscosity	A measure of a liquid's resistance to flow with respect to time.

W

Well-Graded Aggregate	Aggregate graded with relatively uniform proportions, from the maximum size down to filler.
Wet Mixing Period	The interval of time between the beginning of application of asphalt material into a pugmill and the opening of the discharge gate.
Whirl Spreaders	Spreaders that are attached to or are built onto dump trucks. Aggregate is fed onto the spreader disc through an adjustable opening. The speed of the disc controls the width of spread.
Workability	The ease with which paving mixtures may be placed and compacted.