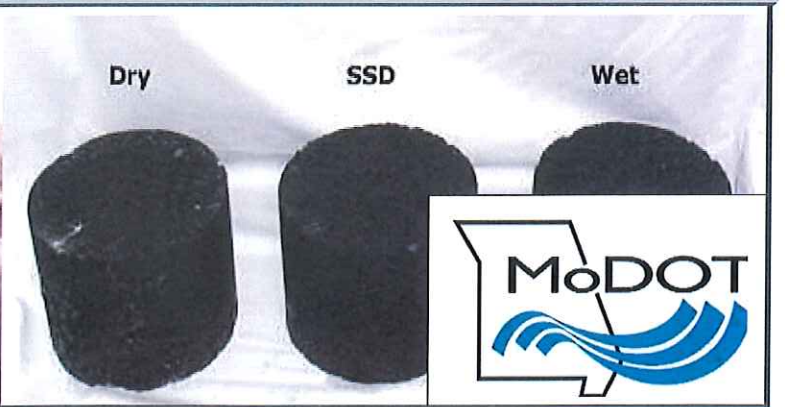


**2021-22 Edition**



Bulk Specific Gravity

# **BITUMINOUS TECHNICIAN**







# Bituminous Technician

## 2022 – Updates

- AASHTO T166 – updated temperature ( $77 \pm 1.8$  °F) to ( $77 \pm 2$  °F)

## 2021 – Updates

- No updates for 2021

## 2020 – Updates

- **NOTIFICATION:** To all material testers who work on Missouri Highways, this includes Consultants, Contractors, City, County, and MoDOT workers; you will be audited by **MoDOT IAS Inspectors** and sometimes **FHWA** personnel.
- The term **Bituminous Mixtures** has been replaced with **Asphalt Mixtures**
- The term **HMA** = “Hot Mix Asphalt” has been replaced with **Asphalt Mixtures**
- The term **Bituminous** has been replaced with **Asphalt** in all methods
- The name “**Bituminous Technician**” for this certification will remain
- **AASHTO T 168** is now **AASHTO R 97** Sampling Asphalt Mixtures
- **AASHTO R 97** Sampling Asphalt Mixtures, is different than the old method T 168

- Most slide shows have been updated in this manual to clarify methods
- EPG has been updated to the changes
- Proficiencies have been updated to the changes





# **COURSE CONTENT**

## **BITUMINOUS TECHNICIAN**

<b>MoDOT TM 20</b>	Measurement of Air, Surface or Asphaltic Mixture Temperature
<b>AASHTO R 66</b>	Sampling Asphalt Materials
<b>AASHTO R 97</b>	Sampling Asphalt Mixtures
<b>AASHTO R 47</b>	Reducing Samples of Asphalt Mixtures to Testing Size
<b>AASHTO T 329</b>	Moisture Content of Asphalt Mixtures by Oven Method
<b>AASHTO T 166</b>	Bulk Specific Gravity of Compacted Asphalt Materials Using Saturated Surface-Dry Specimens
<b>AASHTO T 269</b>	Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
<b>MoDOT TM 54</b>	Determining the Asphalt Content of an Asphalt Mixture

**Appendix**

**Glossary**

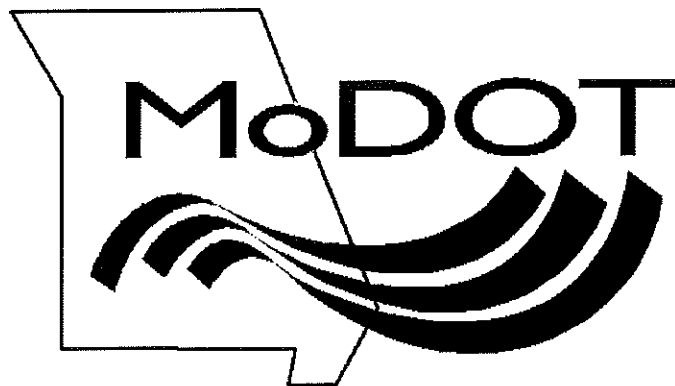






# **MoDOT TM 20**

## **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 till the end of the year.
- **Provide Proof;** when audited, present a MoDOT Certification Card, or a MoDOT Letter.

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## MoDOT TM 20

Measurement of Air, Surface, or Asphalt  
Mixture Temperature

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11/20/2019

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### 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. Most technicians use 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



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### Max-Min Thermometer

Air, Surface

Range: 20° F to 130° F

Increment: 2° F



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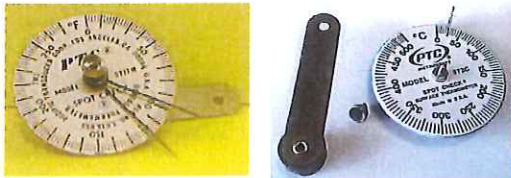
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### **Spot Check Disc Thermometer**

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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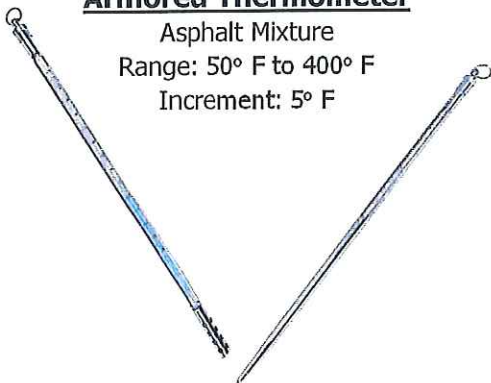
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### **Armored Thermometer**

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 this manual)



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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

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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

Procedure

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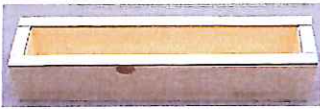
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## Surface Temperature (continued)

- 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.



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.



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 the paver augers.
  - Read temperature.



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.

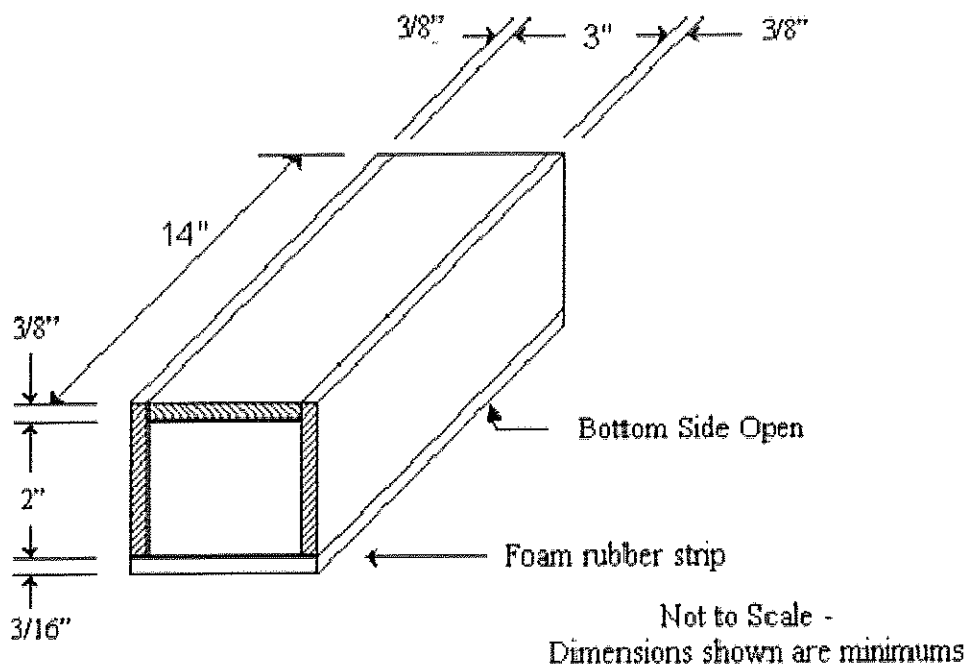
**Bi-Therm Dial Thermometer.** Used for loose bituminous mixture temperature determination. The thermometer should register in the range of 50° F to 400° F, with a maximum increment of 5 °F.

**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?		
<b>AIR</b>		
1. Pick correct thermometer		
2. Location <ul style="list-style-type: none"> <li>- <i>Mercury, Digital, Max-Min thermometers</i></li> <li>- shade, no direct sunlight</li> <li>- position 4.5 feet above surface</li> <li>- safe location</li> </ul>		
3. Document to nearest 2° F		
<b>SURFACE</b>		
4. Pick correct thermometer		
5. Procedure <ul style="list-style-type: none"> <li>- <i>Spot Check Disc</i>; place on surface until needle stops moving</li> <li>- <i>Infrared</i>; follow manufacturer recommendations</li> <li>- <i>Mercury or Max-Min</i>; place under wooden box wait 5 minutes</li> <li>- <i>Digital</i>; follow manufacturer recommendations</li> </ul>		
6. Document to nearest 2° F		
<b>ASPHALT MIXTURE</b>		
7. Pick correct thermometer		
8. Procedure <ul style="list-style-type: none"> <li>- <i>Infrared</i>; follow manufacturer recommendations</li> <li>- <i>Armored, BI-Therm Dial, or Digital</i>; place stem into mixture and wait until thermometer reading has stabilized</li> </ul>		
9. Document to nearest 5° F		

PASS    PASS

FAIL    FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_





# **AASHTO R 66**

## **Sampling Asphalt Materials**





# **AASHTO R 66**

## **Sampling Asphalt Materials**



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### **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.

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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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### SAFETY 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 water should be readily available in case of exposure to **HOT** asphalt materials.



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

Safety First



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## EQUIPMENT

- Safety equipment
- Hardhat
- Insulated gloves
- Eye protection
- Long sleeve shirt
- Bucket of water or source of water
- 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 together tightly
- Clean and dry
- Shall correspond to the required amount of sample



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- 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.



Sample Containers

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



Sample Containers

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## SAMPLING ASPHALT MATERIALS

### **Liquid Materials**

Sampled from: Pipes, Tanks, Drums, Barrels

Types of Liquid Asphaltic Materials:

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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### **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.

Sampling Liquids

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### Sampling Valve;

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



Sampling Liquids - Valves

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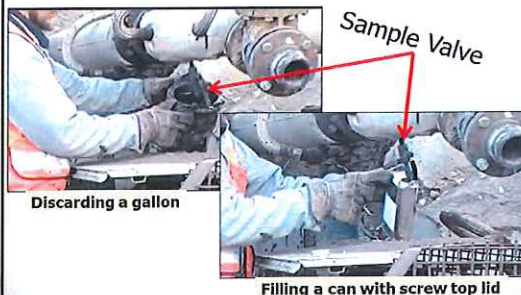
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Or use a **Sample Valve** on a **line** located down stream of blending or other processing at the plant.



Sampling Liquids - Valves

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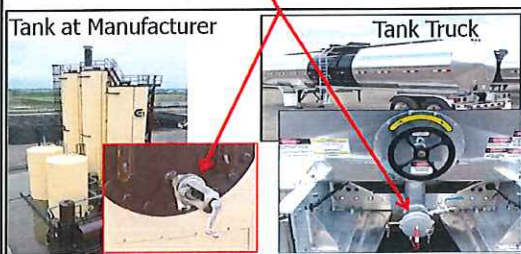
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### PROCEDURE

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



Sampling Liquids - Valves

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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  $\frac{1}{2}$ " from the top.



Procedure – Sampling - Valves 16

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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"



Procedure – Sampling - Valves 17

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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.



Procedure – Sampling - Valves 18

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**Ship or deliver to the MoDOT Central Lab**

SAMPLE

From DISTRICT St. Louis District

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**Ship to:**  
Missouri Department of Transportation  
Central Laboratory 1617 Missouri Blvd.  
Jefferson City MO 65109

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SIGNED BY: Billy Bob      DATE: 07/17/2019

Procedure – Sampling

(19)

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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**.



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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 (24)

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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 not less than 1/4 lb.

Sampling – Semisolid Materials (25)

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- 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

- **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:  
**P**erformance **G**rade



(29)

Binders

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#### 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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Sampling – PG Binders

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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

- Liquid asphalt materials will be sampled at the source by Materials Inspectors.
- Truck shipments of liquid asphalt materials may be accepted by a copy of the shipping ticket.
- Plant inspectors must insure 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 ordinary temperature).



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.



**RS-2 Emulsion**  
Site Manager ID  
Supplier  
Date

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.



**RS-2 Emulsion**  
Site Manager ID  
Supplier  
Date

Sampling - Emulsions

35

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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 ordinary temperatures.



Sampling - Cutback Asphalt

36

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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 (37)

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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.

Engineering Policy Guide

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

MoDOT EPG (38)

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# EXAMPLE OF A BILL OF LADING



## 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. A3MF-1.C.C. No. 8 issued by F. O. Freund, Agent, supplements thereto or releases 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 SOL 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: *[Signature]*

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  
PG64-26  
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 660F	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 C#	=	275
150 C#	=	307
200 C#	=	291
50 C#	=	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**  
Need:  
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 RTFO*			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.

## 1015.1 Apparatus

All sample containers and equipment used in sampling bituminous materials are to be clean, dry and free of all contaminants. The apparatus consists of:

- (a) Sample containers, one quart (1 L), friction or screw top type cans and one gallon (4 L) plastic bottles. Use new sample containers that have not been washed, rinsed, or wiped with an oily cloth.
- (b) Appropriate thief, dipper, or sampling device to obtain a representative sample.
- (c) Labeling materials.
- (d) Rule with suitable graduations to accurately measure the material to be inspected.

### Approved Products

[Qualified Bituminous Materials Sources](#)

[Qualified PG Binder Sources and Laboratories \(QC/QA Approved Sources\)](#)

### MGS Information

[Current General Services Specifications \(MGS\) By Subject](#)

## 1015.2 Procedure

### 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 \(QC/QA Approved Sources\)](#).

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.

### Asphalt, Permeability

[Report 2009](#)

See also: [Innovation Library](#)

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.





# 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, °F (°C)	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**

<b>Metal Containers</b>	
<b>Approved Packaging</b>	<b>Stock Number</b>
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
<b>Cardboard Containers</b>	
<b>Approved Packaging</b>	<b>Stock Number</b>
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, 3/4 in., (19 mm)	Obtain locally



<b>Plastic Zip Seal Bags</b>	
<b>Approved Packaging</b>	<b>Stock Number</b>
Bag Poly Zip Lock Containment (10" X 12")	3054205018
Bag Poly Zip Lock Containment (13" X 18")	3054205022
<b>Shipping Labels</b>	
<b>Approved Packaging</b>	<b>Stock Number</b>
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.	



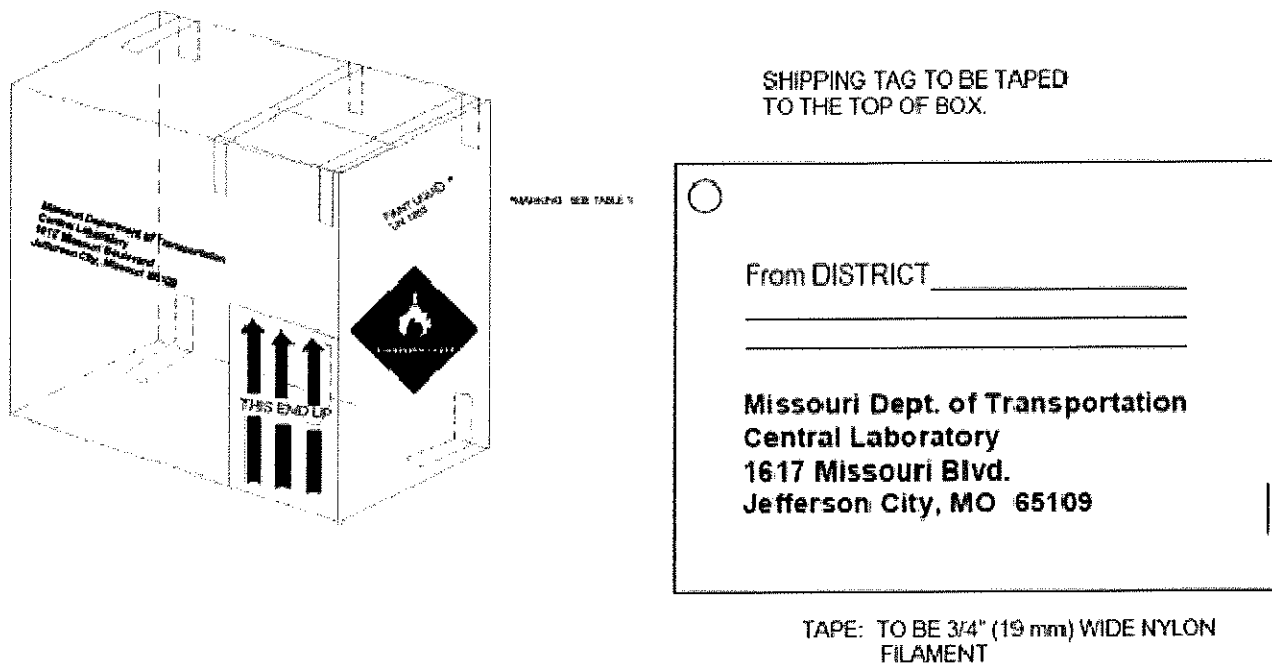
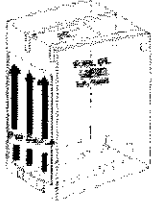


Fig. 106.3.1.4.1 Shipping of Flammable Liquids

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

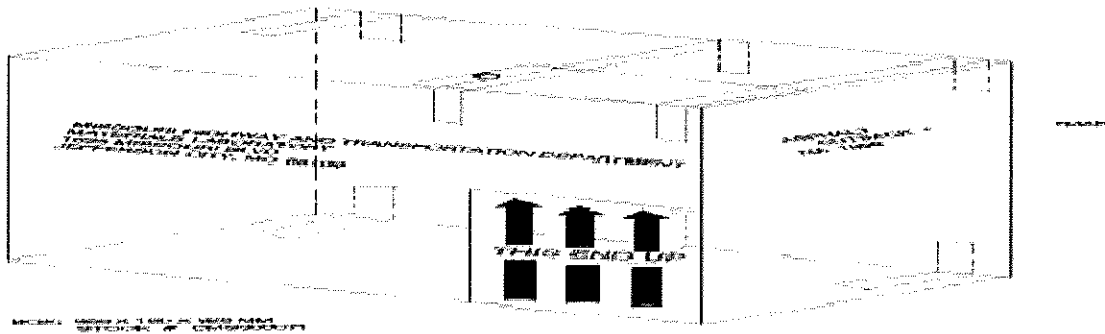


Fig. 106.3.1.4.2 Shipping of Combustible Liquids

## 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 RTFO*			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 \(QC/QA Approved Sources\)](#).

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.

Asphalt, Permeability

[Report 2009](#)

See also: [Innovation Library](#)

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
<b>Describe procedure for taking a daily plant asphalt binder sample:</b>		
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 1/2" 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.		
9. Identify the sample on the can itself, include the Site-Manager 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

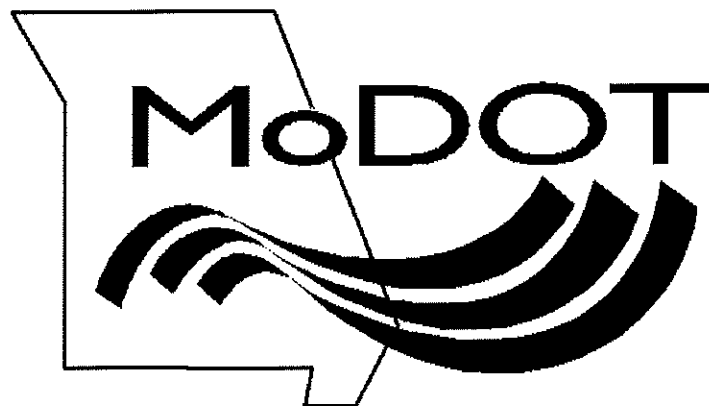
FAIL    FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_



# **AASHTO R 97**

## **Sampling Asphalt Mixtures**







# **AASHTO R 97**

## **SAMPLING ASPHALT MIXTURES**

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Rev 07/22/2019

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### **SCOPE**

- This practice covers sampling of asphalt paving mixtures at points of manufacture, storage, delivery, or in place.
- 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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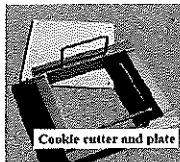
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### **EQUIPMENT**

- Square nose shovel, scoop, trowel
- Sample containers – buckets, pan, boxes
- Safety equipment – protective garments
- Labeling material – markers, tags, etc.
- Cookie Cutter – 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.
- 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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- Sample Size – Depends on the test methods to be performed. Obtain sufficient quantity of material to perform all tests.

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## **SAMPLING PROCEDURES**

### **1. Roadway Samples**

- Plate with "Cookie Cutter" or square template
- "Cookie Cutter"
- Plate and shovel

### **2. Stockpile Samples**

### **3. Truck Samples (Transport Units)**

*Not recommended by MoDOT*

### **4. Stream Samples**

**NOTE:** MoDOT does not sample asphalt mixtures from windrows, bin storage, hopper, conveyor belt, or from paver auger.

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## **1. Roadway Sampling Procedure**




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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

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Sampling with a "cookie cutter" template

MoDOT Roadway Sampling

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- 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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## 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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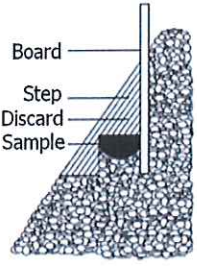
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## Sampling from Bituminous Stockpiles

**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.





AASHTO R 97 Stockpile Sampling

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**Figure 3—Sampling from a Stockpile**

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### 3. Truck & Plant Sampling

- Sampling from a truck is **not recommended** by MoDOT.



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### 4. Stream Samples

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



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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)

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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.

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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.**
  - **Job Mix Formula (JMF)**
  - **Date**
  - **Time and sample location**

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

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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.




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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.

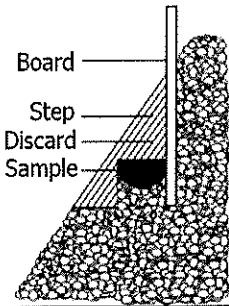
# AASHTO R 97

## Sampling Asphalt Paving Mixtures

### PROFICIENCY CHECKLIST

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

	Trial#	1	2
<b>Describe procedure for taking a loose mix sample from:</b>			
<b>Roadway</b>			
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			
<b>Stockpiles</b>			
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			
<b>Streams</b>			
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

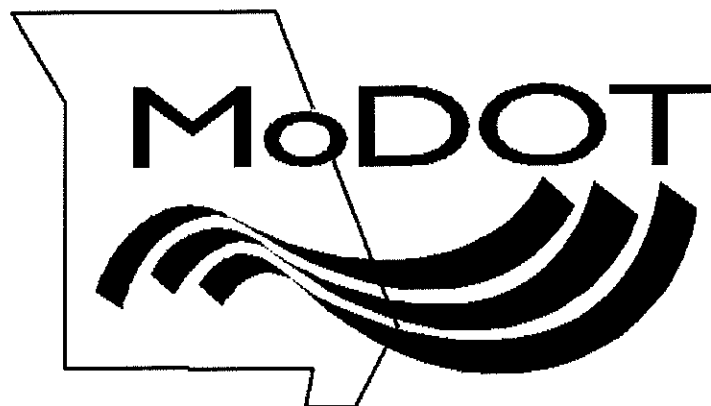
FAIL FAIL

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 07/30/2019

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### **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

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### **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.

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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



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**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

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- 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).

Selection of Method

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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.

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Procedure Type A

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7. 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.

Procedure Type A

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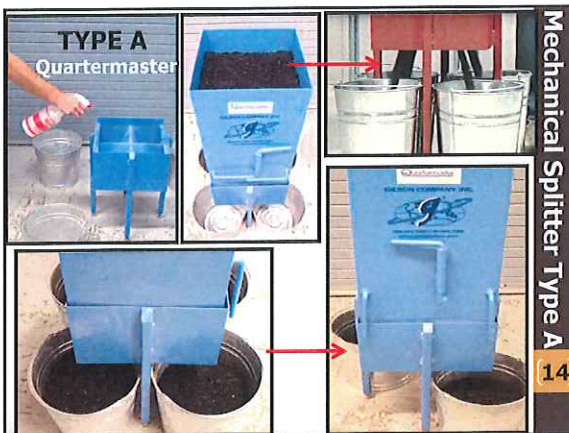
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## MECHANICAL SPLITTER METHOD

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.
- 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

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**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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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.

Procedure for Type B

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## QUARTERING METHOD

Quartering Template Method



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- **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.

Quartering Method

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- 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.



Quartering Method

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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 over at least 4 times using a flat bottom scoop.



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



Procedure for Quartering

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



Procedure for Quartering

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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.

Using a straight edge.



Procedure for Quartering

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

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



Procedure for Quartering

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



7. Repeat steps 2 through 8 until the desired sample size is obtained.

Procedure for Quartering

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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

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

	Trial #	1	2
<b>Mechanical Splitter Methods</b>			
<b>Using Type A Splitter (Quartermaster)</b>			
1. Checked for cleanliness and applied approved asphalt release agent			
2. Positioned sample receptacles properly 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			

<b>Using Type B Splitter (Riffle Splitter)</b>		
1. Checked for cleanliness (optional: Riffle Splitter can be heated, not exceeding 230°F or 110°C)		
2. All surfaces coming into contact with 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 straight edge pan)		
5. Rate at which sample introduced allows free flow into sample containers		
6. Repeated until sample size obtained		

<b>Quartering Method</b>		
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 template completely down to bottom surface dividing the pile into four quarters		
6. Removed two opposite quarters, including the fines		
7. Repeated steps 2 through 8 until desired sample size was attained		

PASS PASS

FAIL FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_

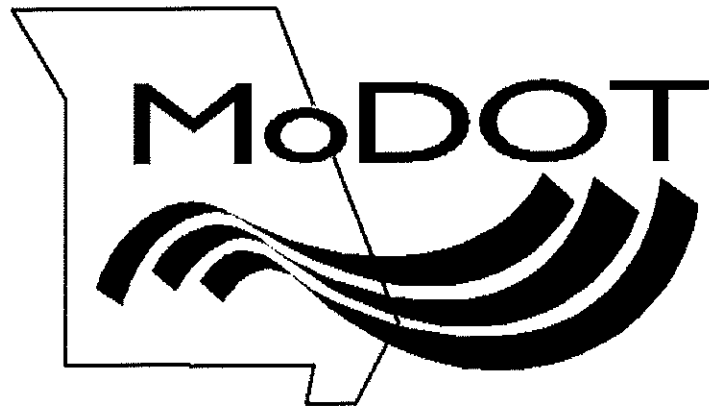




# **AASHTO T 329**

## **Moisture Content of Asphalt Mixtures**

**by Oven Method**





# AASHTO T 329

## Moisture Content of Asphalt Mixtures by Oven Method

( 1 )

Rev 08/08/2019

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### 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.

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### 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.  
( $\approx$  5% binder and  $\approx$  95% aggregate)
- **Constant Mass:** The mass at which further drying does not alter the mass by more than 0.05%.

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### SUMMARY

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

*mass = weight*

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### EQUIPMENT

- **Balance or Scale** – 2,000 gram capacity, readable to at least 0.1 g.
- **Oven** – Forced-Air, Ventilated, or Convection, capable of maintaining  $325 \pm 25^{\circ}\text{F}$  ( $163 \pm 14^{\circ}\text{C}$ )
- **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  $5^{\circ}\text{F}$  ( $2^{\circ}\text{C}$ ), armored-glass, dial type, or digital thermometers with metal stems are recommended.

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### 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.**

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### PROCEDURE

1. Determine and record the mass of the sample container to the nearest **0.1 g**.
2. Place the test sample in the sample container, distributed evenly, and initial temperature taken and recorded = 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<sub>i</sub>**)

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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**)

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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 **0.1%**

#### Reminder:

First subtract the container weight from the total weight for A and B then record the weights to the nearest **0.1 g** before calculating % change.

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**10.** Determine if constant mass was reached.

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

$\leq 0.05\%$  = Constant Mass has been reached

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

Procedure

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**11.** 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)

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### 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%**

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

- Therefore 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.

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**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

EXAMPLE PROBLEM

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**ENLARGED**

**EXAMPLE PROBLEM**

**% Moisture Calculation:**

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

**Initial:** 2543.2 – 650.0 = 1893.2

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

**After 30 min:** 2536.1 – 650.0 = 1886.1

**After 30 min:** 2535.4 – 650.0 = 1885.4

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

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

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

(15)

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**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

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

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

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

**% Moisture Calculation:**

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

ANSWER CLASSROOM PRACTICE

(17)

ENLARGED

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**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)

**Answer = % Moisture is 0.67%**

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## Common Errors

- Not subtracting weight of container from total weight in moisture calculation.
- Not drying until mass is constant.

Common Errors

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## ANSWER TO EXAMPLE PROBLEM (Slide 15)

$M_i$  1. Initial:  $2543.2 - \overset{\text{Pan wt.}}{650.0} = 1893.2$

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:  $2535.4 - 650.0 = 1885.4$

ENLARGED

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

3.  $\frac{(1888.5 - 1886.1)}{1888.5} \times 100 = 0.127 = 0.13\%$

Not  $\leq 0.05\%$ 

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

 $\leq 0.05\% = \text{Constant Mass}$ 

% Moisture Calculation:

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





**ANSWER TO CLASSROOM PRACTICE PROBLEM****Answer to Classroom Practice (Slide 17)**

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

3.

$$\frac{(1797.8 - 1795.8)}{1797.8} \times 100 = \text{XXXXX}\%$$

**0.11%**

ENLARGED

4.

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

**% Moisture Calculation:**

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



#### 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
<b>Sampling</b>		
Test sample obtained by AASHTO R 97		
Representative sample obtained; 1000 g minimum		
<b>Procedure</b>		
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 = <u>original temperature</u>		
3. Mass of sample and container determined to nearest 0.1 g		
4. Calculate the mass of the moist sample = <b>(M<sub>i</sub>)</b>		
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 = <b>(A)</b>		
7. Returned to oven for 30 ± 5 minutes		
8. After 30 minutes, determine the sample mass = <b>(B)</b>		
9. Calculate the percent change and determine if the sample is at constant mass  $\% \text{ Change} = \frac{(A - B)}{A} \times 100$		
10. Continued to dry the sample in 30 minute intervals until reached constant mass, when change in mass was ≤ 0.05%		
11. Sample and container cooled to <u>original temperature</u> , then weighed = <b>(M<sub>f</sub>)</b>		
12. Percent Moisture calculated and reported to the nearest 0.01%  $\text{Moisture Content, \%} = \frac{(M_i - M_f)}{M_f} \times 100$		

PASS PASS

FAIL FAIL

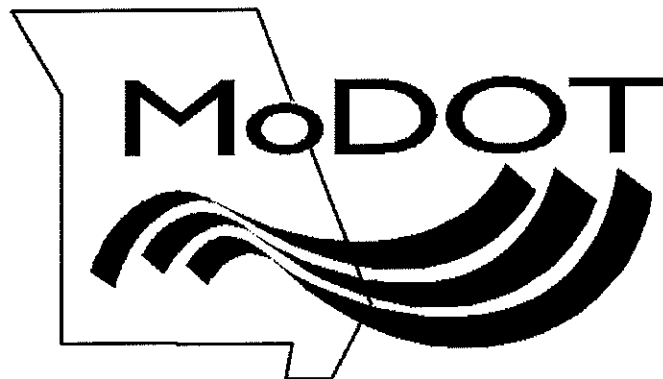
Examiner: \_\_\_\_\_ Date: \_\_\_\_\_





# **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



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 Rev 09/23/2021

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### SCOPE

- This test method covers the determination of bulk specific gravity (G<sub>mb</sub>) 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 AASHTO T 275 (Bulk Specific Gravity Paraffin Coated) or T 331 (Bulk Specific Gravity Vacuum Sealed).

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- 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.

Scope

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### 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.
- **g** = gram
- **Gmb** = Bulk Specific Gravity
- **Mass = Weight**

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- **Room Temperature:**  $77 \pm 9^\circ \text{F}$  ( $25 \pm 5^\circ \text{C}$ )
- **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)

Terminology

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### TEST SPECIMENS

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



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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.

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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.



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**SPECIMEN PREPARATION**

- Before testing, a specimen must be dry and at room temperature  $77 \pm 9^\circ \text{ F}$  ( $25 \pm 5^\circ \text{ C}$ ).

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

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### Information:

- Recently molded specimens which have NOT been exposed to moisture do not require drying. (i.e. Gyratory Pucks)



Specimen Preparation

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### Oven Dried:

1. Initially dry specimen overnight at  $125 \pm 5^\circ\text{F}$  ( $52 \pm 3^\circ\text{C}$ )
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

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### Vacuum Dried:

1. Weigh the specimen.
2. Complete at least **two** cycles in the vacuum drying apparatus.
3. Weigh the specimen after each cycle and report to nearest **0.1g**.
4. Continue vacuum cycles until weight change is no more than **0.05%**.

See Method:  
**AASHTO R 79**



Procedure

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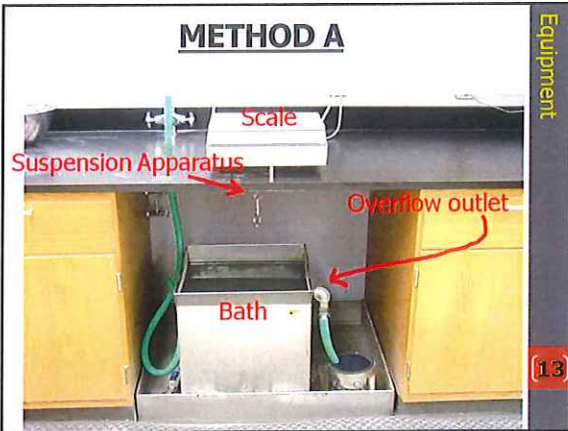
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**EQUIPMENT**

- **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.
- **Thermometer** - Having a range of 66 to 80°F (19 to 27°C), graduated in 0.2°F (0.1°C) subdivisions. ASTM 17C thermometer meets this criteria. Most use an electronic thermometer.

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Equipment

- **Water Container** - Large enough to completely immerse the specimen basket including bale.
- A water flow outlet for maintaining a constant water level.
- **Potable Water** - Maintained at a temperature of  $77 \pm 2^\circ\text{F}$  ( $25 \pm 1^\circ\text{C}$ ).
- **Damp Towels**
- **Timer**

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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  $77 \pm 2^{\circ}\text{F}$  ( $25 \pm 1^{\circ}\text{C}$ )

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### PROCEDURE – METHOD A SUSPENSION

1. DRY the specimen to a constant mass by oven drying or vacuum drying.

**NOTE:** Recently molded specimens NOT exposed to moisture do NOT need drying.

2. Cool the specimen to room temperature  $77 \pm 9^{\circ}\text{F}$  ( $25 \pm 5^{\circ}\text{C}$ ).
3. Tare the scale (with basket attached) then weigh the **specimen in air** to nearest **0.1g**, record as **A**.

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4. Remove specimen from the scale, tare the scale, then immerse the specimen in  $77 \pm 2^{\circ}\text{F}$  ( $25 \pm 1^{\circ}\text{C}$ ) water bath for  $4 \pm 1$  minutes.
5. Record the weight of the **specimen in water** to nearest **0.1g** record as **C**.



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**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.

Procedure Method A

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### CALCULATIONS

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

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

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 3 decimal places 0.001**

**Gmb = Bulk Specific Gravity**

Calculating Gmb

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### Calculation Example for Gmb

Example: Dry weight in air = 1940.1 grams **A.**

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

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

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

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

**Bulk Specific Gravity = Gmb**  
**Report Gmb to the nearest 0.001**

Calculations

21

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### Calculating % Water Absorbed by Volume

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

where:

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

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

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

**Report to the nearest 0.01%**

**NOTE:** If the percent of water absorbed by the specimen exceeds **2.0%** this method can not be used, use either AASHTO T 275 or T 331 to determine the Bulk Specific Gravity.

Calculations

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### Calculating % Water Absorbed by Volume

Example:

Dry weight in air = 1940.1 grams **A**

Surface dry weight (SSD) = 1946.8 grams **B**

Weight in water = 1163.9 grams **C**

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

Volume =  $\frac{(1946.8 - 1940.1)}{(1946.8 - 1163.9)} \times 100 = 0.86\%$

Report Vol. to the nearest 0.01%

Calculations

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

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Classroom Exercise 1 <span style="color: red;">ANSWER</span>			
SPECIMEN #	1	2	3
<span style="color: red;">A.</span> WEIGHT IN AIR	3795.2	3775.0	3778.2
<span style="color: red;">B.</span> SSD WEIGHT	3813.8	3802.0	3795.8
<span style="color: red;">C.</span> 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)

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<u>Common Errors</u>
<ul style="list-style-type: none"> <li>• Specimen temperature not <math>77^{\circ} \pm 9^{\circ}\text{F}</math> (<math>25^{\circ} \pm 5^{\circ}\text{C}</math>).</li> <li>• Not maintaining water temperature at <math>77^{\circ} \pm 2^{\circ}\text{F}</math> (<math>25^{\circ} \pm 1^{\circ}\text{C}</math>) and/or using dirty water.</li> <li>• Water level not maintained.</li> <li>• Going over the 15 second time limit for blotting and weighing the specimen for SSD.</li> <li>• Not wringing the excess water from the towel between specimens.</li> </ul>

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

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

<b>METHOD A - Suspension</b>	<b>Trial</b>	<b>1</b>	<b>2</b>
*Test Specimens are laboratory-compacted specimens, or cored from asphalt pavements.			
*Recently compacted laboratory samples (not exposed to moisture) do not require drying.			
<b>DRYING THE SPECIMEN</b>			
<b>Oven dried</b> the specimen to a constant mass			
a. Initially overnight 125 ± 5°F (52 ± 3°C)			
b. Next day weigh in 2hr. intervals until change of less than 0.05%			
c. Cooled specimen to room temperature 77 ± 9°F (25 ± 5°C)			
<b>OR</b>			
<b>Vacuum dried</b> the specimen to a constant mass (AASHTO R 79)			
a. Completed at least 2 cycles in the Vacuum Drying Apparatus			
b. Specimen weighed after each cycle and reported to 0.1 g			
c. Continued vacuum cycles as needed until the weight change was less than 0.05%			
d. Cooled specimen to room temperature 77 ± 9°F (25 ± 5°C)			
<b>Equipment Preparation:</b>			
a. Basket is immersed, centered & attached to scale			
b. Filled the bath until water flowed out the overflow outlet			
c. Adjusted temperature of bath to 77 ± 2°F (25 ± 1°C)			
d. Prepared damp-dry towel, wrung out excess water			
<b>PROCEDURE</b>			
<b>1.</b> Dried Specimen to a constant mass (if needed)			
<b>2.</b> Specimen at room temperature <b>77 ± 9°F (25 ± 5°C)</b>			
<b>3.</b> (Tared the scale with basket attached) Weighed specimen in air to nearest <b>0.1g</b> , reported as "A"			
<b>4.</b> Immersed the specimen in <b>77 ± 2°F</b> (25 ± 1°C) water for <b>4 ± 1 minutes</b>			
<b>5.</b> Recorded the weight under water to <b>0.1 g</b> , reported as "C"			
<b>6. Within 15 seconds:</b> Specimen was removed from the bath, blotted with damp-towel to SSD state, and weighed specimen to the nearest <b>0.1g</b> , reported as "B"			
<b>7.</b> Calculated Bulk Specific Gravity (Gmb), result reported to the <b>0.001</b>			
$\frac{\text{Weight in Air (A)}}{\text{Weight Surface Dry (B)} - \text{Weight in Water (C)}}$			
<b>8.</b> Calculated Percent of Water Absorbed by Volume, reported to nearest <b>0.01%.</b> <b>NOTE: Test not valid if over 2.0%</b>			
$\frac{\text{Weight Surface Dry} - \text{Weight in Air}}{\text{Weight Surface Dry} - \text{Weight in Water}} \times 100$			

PASS    PASS

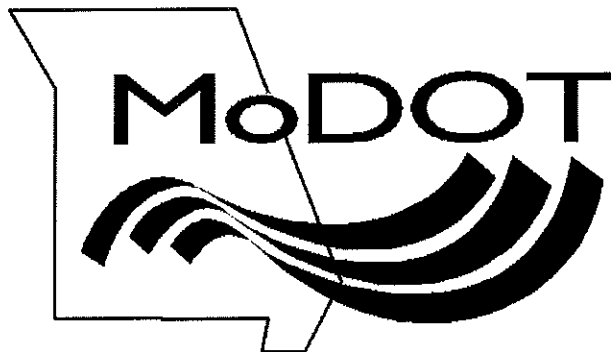
FAIL    FAIL

Examiner: \_\_\_\_\_ 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

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08/08/2019

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### SCOPE

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

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### SIGINIFICANCE 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.

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## 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.

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- **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).

Terminology

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- **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).

Terminology

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### SAMPLING

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

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### 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)

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

**AASHTO T 209**

**OR**

**JMF "Job Mix Formula"**

(Gmm can be found on the JMF sheet)

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Procedure

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[illegible]

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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**

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## **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  $G_{mb}$  to 3 decimal places 0.001**

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

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**CALCULATIONS**  
**Percent Air Voids**

$$\% \text{ Air Voids} = 1 - \left( \frac{G_{mb}}{G_{mm}} \right) \times 100$$

**G<sub>mb</sub>** = Bulk Specific Gravity = G<sub>mb</sub> or G<sub>mc</sub>

**G<sub>mm</sub>** = Maximum Specific Gravity

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

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**CALCULATIONS**  
**Density**

$$\% \text{ Density} = \left( \frac{G_{mb}}{G_{mm}} \right) \times 100$$

**G<sub>mb</sub>** = Bulk Specific Gravity = G<sub>mb</sub> or G<sub>mc</sub>

**G<sub>mm</sub>** = Maximum Specific Gravity

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

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**Example Problem**

$$G_{mb} \text{ or } G_{mc} = 2.323$$

$$G_{mm} = 2.433$$

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

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

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Classroom Exercise

Enlarged

AASHTO T-283

Gmm comes from method T209 or JMF

Mix Number

SUPERGOOD

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 (Gmb)						
% AIR VOIDS						
% DENSITY						

T166

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Classroom Exercise

Answers

T166

AASHTO T-283

Mix Number

SUPERGOOD

Gmm=

2.515

SPECIMEN #	1	2	3	4	5	6
WEIGHT IN AIR	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD WEIGHT	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT IN WATER	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 (Gmb)	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

T166

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Enlarged

Job Mix Formula

# MISSOURI DEPARTMENT OF TRANSPORTATION - DIVISION OF MATERIALS

ASPHALTIC CONCRETE TYPE SP125B

DATE = 07/24/06		CONTRACTOR = TIGER PAVING										SP125 06-104			
IDENT.		PRODUCT CODE		/ PRODUCER, LOCATION		BULK APPAR.		SP. GR.		FORMATION		LEDGES		% CHERT	
		85JSJ002		100207.LD1		/ MO-Tiger Cy., Central, MO		2.802		2.722		1.7		Argentine 2 0.0	
		85JSJ004		100205.LD1		/ MO-Tiger Cy., Central, MO		2.573		2.718		2.0		Argentine 2 0.0	
		85JSJ006		1002MS.MSLD		/ MO-Tiger Cy., Central, MO		2.546		2.734		2.7		Argentine 2-3	
		85JSJ008		1002MS.MSCT		/ Flint Rock Cy., Chief, OK		2.553		2.671		Flint Chat		FLINT CHAT	
		85JSJ010		1002MS.MSCT2		/ Flint Rock Cy., Chief, OK		2.533		2.642		Flint Chat		FLINT CHAT	
		85JSJ012		1002NS.NS1		/ Miner Sand & Gravel, South Town, MO		2.825		2.850		Missouri River Sand		SAND	
		85JSJ014		1002BH.BH		/ Tiger Asphalt Plants, Capital, MO		2.824		2.824		Bag House Fines		(Designed with 2%)	
		85JSJ016		1015ACPG.7622		/ Jet Fuel Oil Co., Jet City, MO		1.045		PG76-22		Gyro Mold Temp. 288-288°F			
		MATERIAL													
IDENT #		85JSJ002		85JSJ004		85JSJ006		85JSJ008		85JSJ010		85JSJ012		COMB.	
08121		3/4"		100.0		1/2" MAN SAND		MAN SAND		MAN SAND		NS		NS	
1 1/2"		100.0		100.0		100.0		100.0		100.0		100.0		100.0	
1"		100.0		100.0		100.0		100.0		100.0		100.0		100.0	
3/4"		0		100.0		100.0		100.0		100.0		100.0		100.0	
1/2"		0		100.0		100.0		100.0		100.0		100.0		100.0	
3/8"		1		100.0		100.0		100.0		100.0		100.0		100.0	
#4		13.2		80.0		89.0		45.0		100.0		100.0		100.0	
#8		5.0		80.0		82.0		9.0		96.0		96.0		96.0	
#16		2.0		4.5		33.0		53.0		4.0		88.0		88.0	
#30		2.0		4.2		25.0		31.0		3.0		65.0		65.0	
#50		2.0		4.0		13.0		15.0		2.0		23.0		23.0	
#100		2.0		3.0		8.0		5.6		1.0		2.0		2.0	
#200		2.0		3.6		8.0		3.5		1.0		0.2		0.2	
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		3888		Ndes = 125		MIN. AGG. 64.6%			
AASHTO T312		Gsb = 2.561		% FILLED = 72		Gyro Wt. = 4730		Nmax = 205		ASPHALT CONTENT 5.4%					
CALIBRATION NUMBER		80126		MASTER GAUGE BACK CNT. = 2143						A1 = -4.083767					
MASTER GAUGE SER. NO. =		2602		SAMPLE WEIGHT = 7200						A2 = 3.103065					

Gmm





Mix Number **SUPERGOOD**

Gmm= 2.515

AASHTO T283 (TSR)

SPECIMEN #	1	2	3	4	5	6
WEIGHT IN AIR	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD WEIGHT	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT IN WATER	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
VOLUME						
SpG (Gmb)						
% AIR VOIDS						
% DENSITY						

AASHTO T269



## AASHTO T269: Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

Applicant \_\_\_\_\_

Employer \_\_\_\_\_

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						

	Trial#	1	2
Answers Correct			
Reported to proper decimal place			

PASS PASS

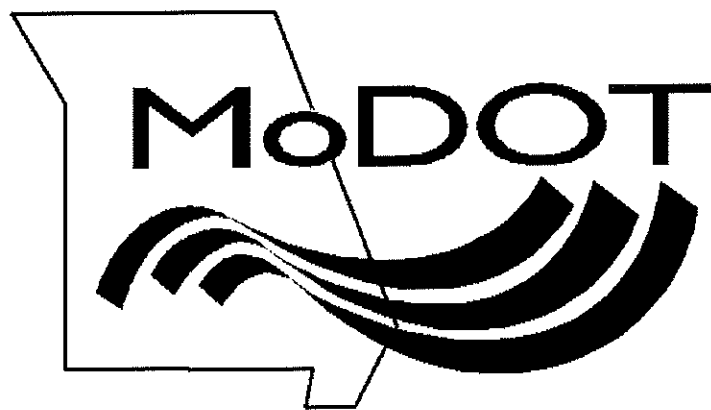
FAIL FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_



# **MoDOT TM 54**

## **Determining the Asphalt Content of an Asphalt Mixture**







# **MoDOT TM 54**

## **Determining the Asphalt Content of an Asphalt Mixture**

Rev 12/04/2019

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### **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.

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### **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**

Equipment

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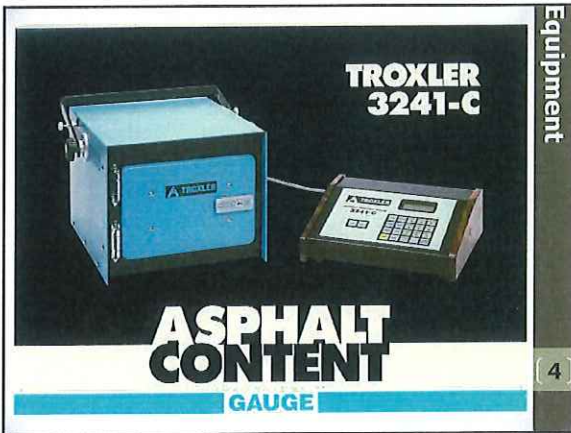
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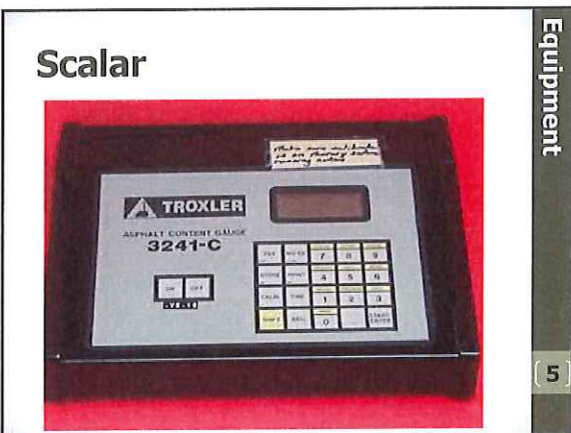
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**PRECAUTIONS**

- 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 effect the operation of the gauge.

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- 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

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### **GAUGE PREPARATION**

- Instructions for the stability test, background count test, and a calibration transfer can be found in the back of this section.
- Need a current stability test every **3 months** when gauge is in use.
- Stability test is ran at **20 counts** for **1 minute**.

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

Gauge Preparation

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- 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.

(11)

- Enter the mixture calibration data into the nuclear gauge.
- Instructions for entering Job Mixture Formula *Cross-Calibration* Data for MoDOT gauges is included in this material. Contractor calibration data is entered in a similar manner.

[illegible]

- 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

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- Fill the pan with more mix until the weight from the Job Mix Formula (JMF) is obtained, **± 5 grams**.
- 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

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- Compact the mixture until it is even with the lip of the pan.
- Reweigh the pan to assure it is still **±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

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### **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.

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### **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 mix hot when compacting in pan.
- Not properly securing the nuclear gauge.

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

From Engineering Policy Guide

This 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](#)
- [106.3.2.54.2 Precautions](#)
- [106.3.2.54.3 Standardization](#)
  - [106.3.2.54.3.1 Statistical Stability & Drift Tests](#)
  - [106.3.2.54.3.2 Background Test](#)
  - [106.3.2.54.3.3 200-Count Stability Test](#)
- [106.3.2.54.4 Lab-to-Field Gauge Cross-Calibration](#)
- [106.3.2.54.5 Calibration Sample Preparation](#)
- [106.3.2.54.6 Gauge Calibration](#)
- [106.3.2.54.7 Field Testing](#)
  - [106.3.2.54.7.1 Checking the sample for moisture content](#)
- [106.3.2.54.8 Procedure for 200-Count Stability Test using Troxler Software Version 2.13](#)
- [106.3.2.54.9 Procedure for 200 Count Stability Test using Troxler Software Version 2.18](#)
- [106.3.2.54.10 Procedure for Calculating Precision Limit](#)
- [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](#)
  - [106.3.2.54.11.2 Procedure for Drift Test](#)

#### 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  $375^{\circ} \pm 5^{\circ}\text{F}$  ( $190^{\circ} \pm 3^{\circ}\text{C}$ ).
- 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  $\pm 0.10$  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  $\pm 0.10$  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  $325^{\circ} \pm 5^{\circ} \text{ F}$  ( $163^{\circ} \pm 3^{\circ} \text{ C}$ ) 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.

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

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,  $\pm 2$  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  $\pm 5$  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 sections 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.





# **Troxler Gauge**

## **Instructions**



## Calibration Transfer – Inputting Mix Design

1. Press *Shift*
2. *Special*
3. *Yes*    Next Menu
4. *5*       Calibration Transfer
5. *2*       Transfer
6. *1*       Select master gage serial no. from JMF. 2502 or 2505
7. Choose 2(-) then enter curve coef. A1   .
8. *Enter*
9. Choose 1(+) then enter curve coef. A2   .
10. *Enter*
11. Choose 1(+) 0
12. *Enter*
13. *2143*    Master gage background count from JMF
14. *7200*    Sample weight from JMF
15. *Yes*
16. *60126*   Calibration number from JMF
17. *Enter*
18. *06.104* Mix ID number from upper right corner of the JMF
19. The gage should return to gauge ready prompt with 60126/X as the cal. Which means the cross calibration is being used.



## Taking a Background Count

1. Press *Time* Change time to 16 minutes.
2. *Yes* Do you want to change time?
3. 4 Which represents 16 minutes. Scalar will return to gauge ready.
4. *BKG* Shows the last background, ask if you want a new background.
5. *Yes* "Empty chamber & press start for 16 minute background"
6. *Start* Leave the area. Conditions should be as they will when a sample is being tested.
7. At this point the gauge reads "New background count = 2125 Want to use the new count?"
8. *Yes* Accepts new background count.
9. The gauge returns to gauge ready prompt.





## Running a Sample

1. Obtain a loose mix sample using approved methods.
2. Place mix in pan until half full, use spatula or similar device to make sure corners are filled taking care not to compact.
3. Continue filling until the pan is the correct weight from the JMF.
4. Using metal or plywood plate, compact sample until even with top of pan.
5. Reweigh sample. A tolerance of  $\pm 10$  grams is allowed though  $\pm 5$  is easily obtained.
6. Press *Time* Change time to 16 minutes. "Do you want to change time?"
7. *Yes*
8. *4* Which represents 16 minutes. The machine returns to gauge ready.
9. Place sample pan into chamber.
10. *Start* Gauge will ask for "Empty pan weight"
11. *Enter* "Fill pan to 7200 wt."
12. *Enter* Leave the area.
13. At this point the gauge reads "Counts = 3015" & "AC Content 6.20%"
14. Record both counts and %AC.
15. *Enter* The gauge returns to gauge ready prompt.



# MoDOT TM 54: Determining the Asphalt Content of an Asphalt Mixture

## PROFICIENCY CHECKLIST

Applicant: \_\_\_\_\_

Employer: \_\_\_\_\_

Trial#	1	2
<b>Note:</b> Student will be allowed to use the module instructions for following 3 items:		
1. Input a calibration transfer		
2. Run a background count test		
3. Run a test on a sample		
<b>Gauge Preparation Checklist</b>		
1. Have a current 20 – 1 minute stability test, 3 months or less		
2. Run a background daily or when conditions change		
3. Make certain proper calibration is being used		
<b>Explain a Nuclear Sample Preparation and Testing Procedure</b>		
1. Obtain proper asphalt mixture sample		
2. Place sample in sample pan in two lifts		
3. Place on tared scale and check for proper sample weight		
4. Compact sample into the pan		
5. Recheck the weight		
6. Place sample pan in the nuclear machine and press start/enter button		
7. Record gauge results		

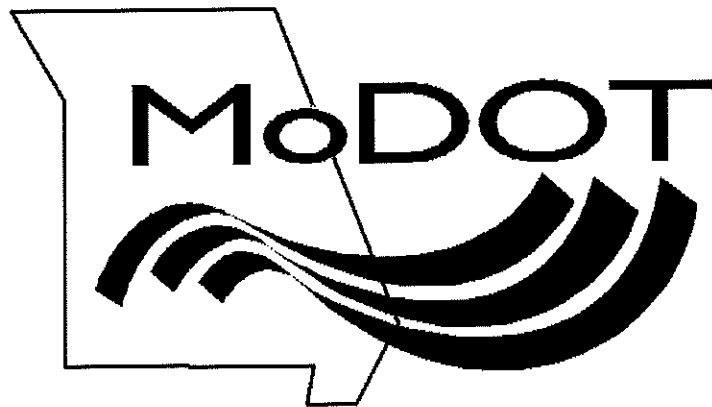
PASS PASS

FAIL FAIL

Examiner: \_\_\_\_\_ Date: \_\_\_\_\_



# Appendix







## STANDARD PRACTICE OF SAMPLING HMA PAVING MIXTURES

### 1. Scope

8 This practice covers sampling of HMA paving mixtures at points of manufacture, storage, or delivery.

1.2 The values stated in acceptable metric units are to be regarded as the standard. The values in parentheses are provided for information purposes only.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

C 702	Practice for Reducing Field Samples of Aggregate to Testing Size <sup>2</sup>
D 979	Standard Practice for Sampling HMA Paving Mixtures <sup>5</sup>
D 2234	Test Method for Collection of a Gross Sample of Coal <sup>3</sup>
D 3665	Practice for Random Sampling of Construction Materials <sup>6</sup>
E 105	Practice for Probability Sampling of Materials <sup>4</sup>
E 122	Practice for Choice of Sample Size to Estimate the Average Quality of a Lot of Process <sup>4</sup>
E 141	Practice for Acceptance of Evidence Based on the Results of Probability Sampling <sup>4</sup>

### 3. Significance and Use

#### 3.1 General:

3.1.1 Sampling is equally as important as the testing, and the sampler shall take every precaution to obtain samples that will yield an acceptable estimate of the nature and conditions of the materials that they represent.

3.1.2 Samples for the development of preliminary data are obtained by the party responsible for the development of the data. Samples for control of the product at the source of manufacture or storage, or at the site of use, are obtained by the manufacturer, Contractor, or other parties responsible for accomplishing the work. Samples for tests to be used in acceptance or rejection decisions by the purchaser are obtained by the purchaser or his authorized representative.

### 4. Procedure

4.1 Inspection - The material shall be inspected to determine discernible variations. The seller shall provide equipment needed for safe and appropriate inspection and sampling.

4.2 Sampling - The procedures for selecting locations or times for sampling are described in Practice D 3665.

4.2.1 *Sampling from a Conveyor Belt* - Stop the conveyor belt. Randomly select at least three areas of approximately equal size on the belt for sampling. In each of the locations to be sampled, insert templates, the shape which conforms to the shape of the belt. From the selected areas obtain approximately equal increments of material which will form a sample whose quantity equals or exceeds the minimum recommended in 4.3.2. Carefully scoop all material between templates into a suitable container.

4.2.2 *Sampling from Truck Transports or Paver Hoppers* - By a random method, select the units to be sampled from the production of materials delivered. Obtain at least three approximately equal increments. Select at random from the unit being sampled and combine to form a field sample whose quantity equals or exceeds the minimum recommended in 4.3.2. The sample may be obtained by collecting the increments with a scoop or shovel.

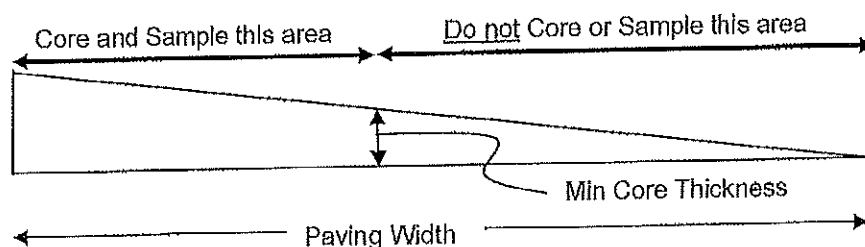
4.2.3 *Sampling from the Roadway Prior to Compaction* - When only one sample is to be taken, obtain at least three approximately equal increments, selected at random from the unit being sampled, and combine to form a field sample whose quantity equals or exceeds the minimum recommended in 4.3.2.

4.2.3.1 When three or more samples are to be taken in order to evaluate a lot of material, utilize a random method to locate the locations to be sampled. Select a sample from each location, assuring the quantity of each sample exceeds the minimum recommended in 4.3.2.

4.2.3.2 Take all increments or samples from the roadway for the full depth of the material, taking care to exclude any underlying material. When necessary, place templates on the existing roadway to exclude any underlying material. Clearly mark the specified area from which each increment or sample is to be removed. Templates which are placed before the mixture is spread will be a definite aid in securing approximately equal increment weights.

4.2.4 *Sampling from a Skip Conveyor Delivering Mixture to Bin Storage* - Select the units to be sampled from the skip conveyor by a random method based on the bin's storage capacity. Stop the skip conveyor immediately following pug mill discharge. Dig a furrow 6 in. (150 mm) in depth extending from the top to the bottom of the pile. Obtain three approximately equal increments from the top, middle, and bottom of the furrow depositing each portion in a container. The combined portions should form a field sample whose quantity equals or exceeds the minimum recommended in 4.3.2.

- 4.2.5 *Sampling from a Funnel Device Feeding a Conveyor for Mixture Delivery to Storage* - Select the units to be sampled from the funnel device by a random method based on the bin's maximum storage capacity. Obtain at least three approximately equal increments of material for each sample by passing a bucket or pan or other suitable container across the full flow of materials as it drops from the funnel device onto the conveyor. The combined portions should form a field sample whose quantity equals or exceeds the minimum recommended in 4.3.2.
- 4.2.6 *Sampling from Roadway after Compaction* - Select the units to be sampled by a random method from the material in place. Obtain at least three approximately equal increments selected at random from the unit being sampled. Test each increment and average the test results to determine the acceptability. Take all increments from the roadway for the full depth of the material, taking care to exclude any underlying material. Each increment shall be obtained by coring, sawing, or other methods in such a manner as to ensure a minimum disturbance of the material.
- 4.2.7 *Sampling HMA Loose Mix from Wedging* - Stick the mat to find the width that meets the minimum thickness required for coring. The width subject to loose mix sampling and coring will need to meet the minimum thickness required for coring for the particular nominal max aggregate size in the mix. If this width is less than 3 feet use a mini-stockpile for sampling.



**Figure 2: Sampling from Wedging; only sample from pavement area that meets minimum core thickness.**

- 4.2.8 *Sampling HMA Loose Mix from Mini-Stockpile* - Select the tonnage to be sampled by a random method. Have the Contractor form a mini-stockpile (approximately 3 to 5 tons). For one composite sample, take at least four approximately equal increments of material from around the stockpile (front, back, right, and left) and at different heights. At each location around the stockpile, obtain an increment of the sample by digging into the pile approximately one foot, forming a vertical face to remove the segregated material. The shovel is then brought up the entire vertical face to obtain the sample; this material will be placed in a bucket with all other

increments sampled from that stockpile to form one composite sample.

#### 4.3 Number and Quantities of Field Samples:

- 4.3.1 The number of field samples (obtained by one of the methods described in 4.2) required depends on the criticality of, and variation in, the properties to be measured. Designate each unit from which a field sample is to be obtained prior to sampling. The number of field samples from the production should be sufficient to give the desired confidence in test results.

**NOTE 1- Guidance** for determining the number of samples required to obtain the desired level of confidence in test results may be found in Method D 2234, Practice E 105, Practice E 122, and Practice E 141.

- 4.3.2 A guide to the quantity of material in field samples is given in Table 1. The quantities depend on the type and number of tests to which the material is to be subjected, and sufficient material must be obtained to provide for the proper execution of these tests. Standard control and acceptance tests are covered by ASTM Standards and specify the portion of the field sample required for each specific test.

**TABLE 1**  
Guide for Estimating Quantity of Sample

Maximum Nominal Size, of Aggregates <sup>A</sup>	Approximate Weight of Uncompacted Mixture, min, lb (kg)	Approximate Area of Compacted Mixture, min, in <sup>2</sup> (cm <sup>2</sup> )
No. 8 (2.36-mm)	4 (1.8)	36 (232)
No. 4 (4.75-mm)	4 (1.8)	36 (232)
3/8" (9.5-mm)	8 (3.6)	36 (232)
2" (12.5-mm)	12 (5.4)	64 (413)
3/4" (19.0-mm)	16 (7.3)	100 (645)
1" (25.0-mm)	20 (9.1)	144 (929)
1-1/2" (38.1-mm)	25 (11.3)	144 (929)
2" (50-mm)	35 (15.9)	225 (1453)

<sup>A</sup>The nominal maximum size of aggregate is the largest sieve size listed in the applicable specification upon which any material is permitted to be retained.

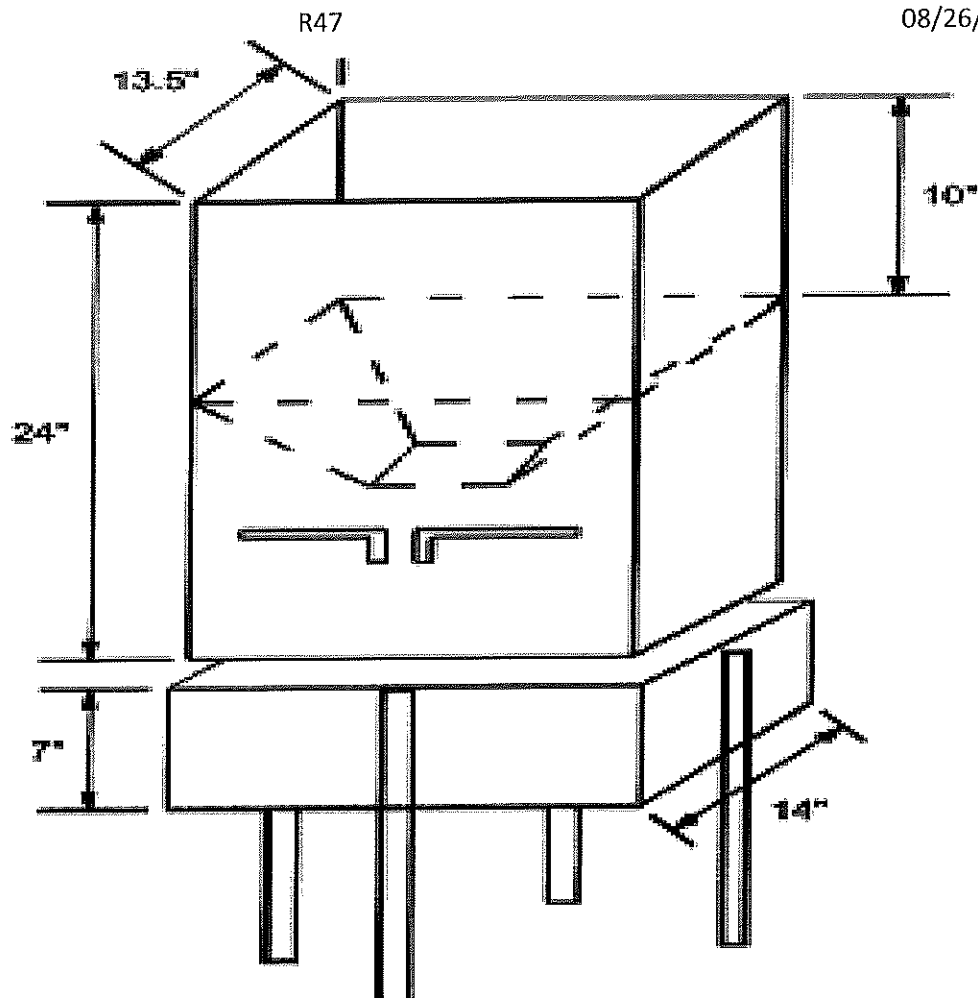
Generally, the amounts specified in Table 1 will provide adequate material for routine testing. Extract test portions from the field sample by quartering or splitting in a similar manner to Practice C702 or as required by other applicable test methods.

**NOTE 2** - The approximate areas of a sample for a given weight are given in Table 1. These dimensions are based on normal lay down thicknesses for each aggregate size. Differences in thickness, specific gravity of the aggregate and mix design will cause some variance in these areas.

5. Shipping Samples

- 5.1 Transport samples in containers so constructed as to preclude loss or contamination of any part of the sample, or damage to the contents from mishandling during shipment.
- 5.2 Samples shall have individual identification attached giving the information required by the sample user. Typical information that may be useful could include, but not necessarily be limited to, the following:
  - 5.2.1 Job for which the material is to be used, giving project number, highway route number, county, and other pertinent geographical information.
  - 5.2.2 Source of sample, including for plant-mixed samples the name of owner or operator of plant, location of plant, type of plant, size of batch, and identification of bitumen and mineral aggregates used in the mixture.
  - 5.2.3 Point at which sampled, for samples taken from roadway, both by station number and location transversely in pavement; also whether sampled from completed pavement windrow, etc.
  - 5.2.4 Quantity represented.
  - 5.2.5 By whom sampled and title.
  - 5.2.6 Date of most recent mixing, if road-mixed.
  - 5.2.7 Date sampled.
  - 5.2.8 By whom submitted and address.
  - 5.2.9 Purpose for which sample was taken.
  - 5.2.10 To whom report is to be made.





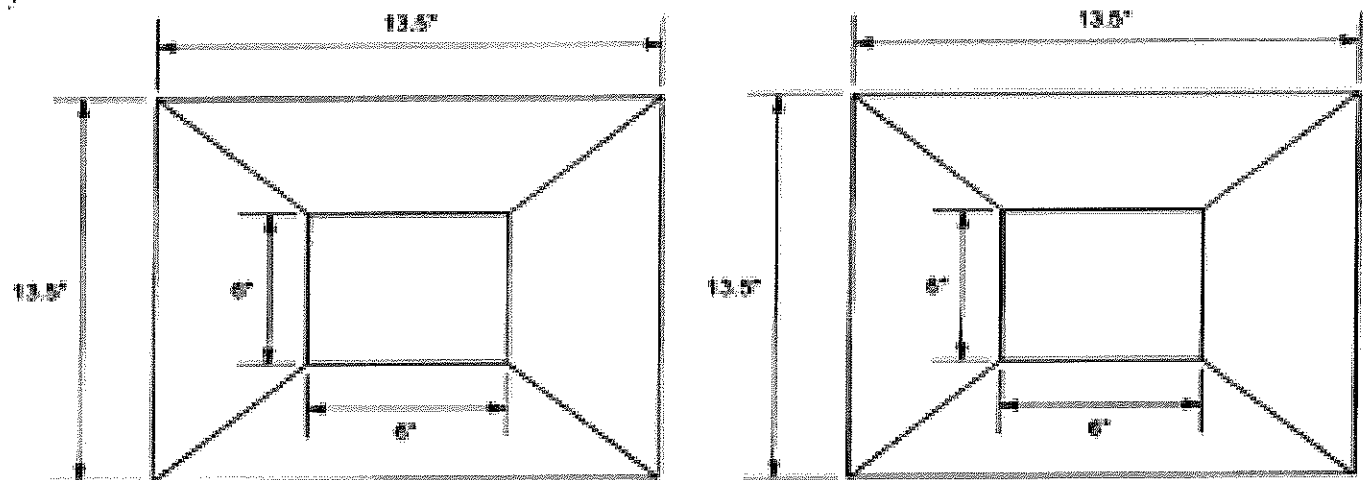
Metric Equivalents	
in.	mm
7	178
10	254
13.5	343
14	356
24	610

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.

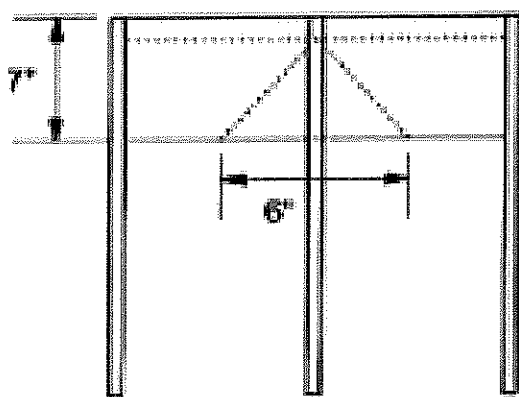


## Metric Equivalents

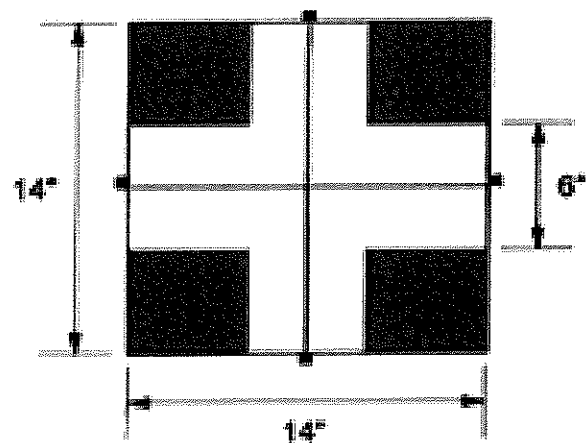
in.	mm
6	152
13.5	343

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

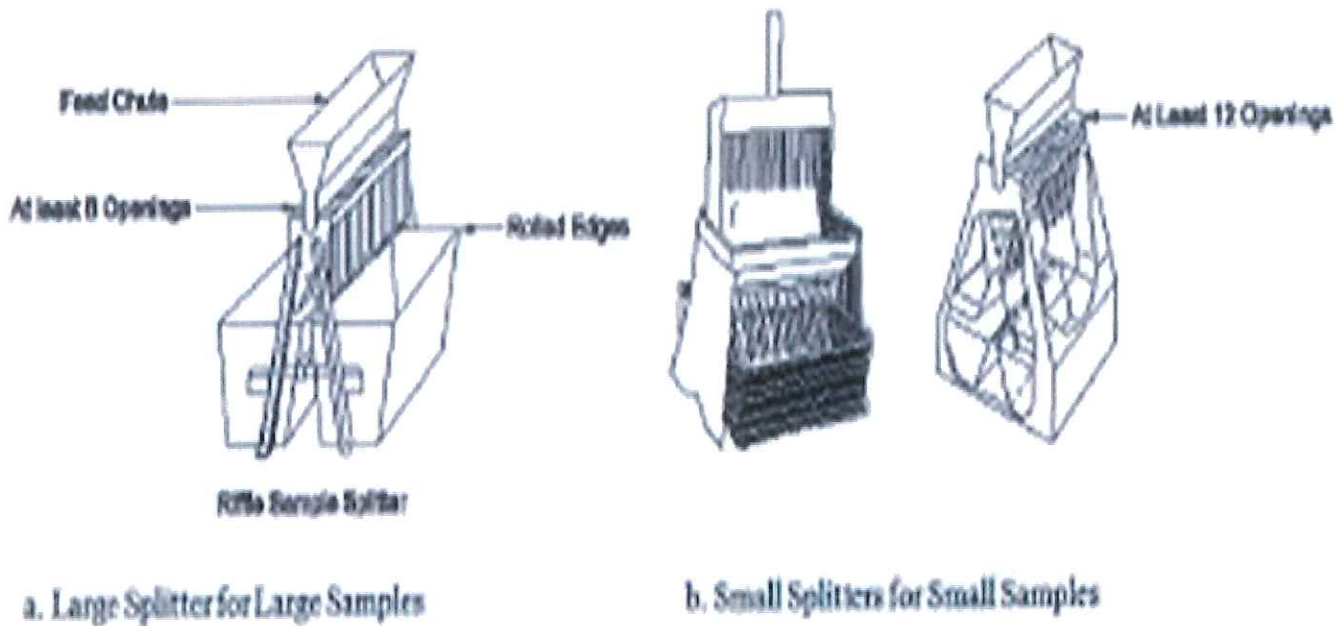
in.	mm
6	152
7	178
14	356

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 following 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 which 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.



### Splitter Type B

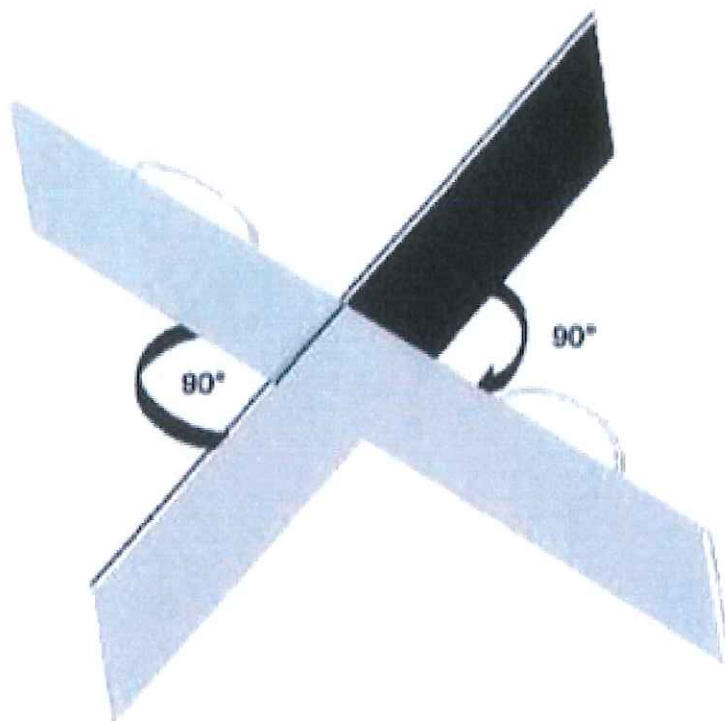
**Note 1** – Type B mechanical splitters are commonly available in sizes adequate for asphalt mixtures having a nominal maximum aggregate size not over 1 inch. Use closed versions for larger sizes.

**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° angle at their juncture. See image below:



**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 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

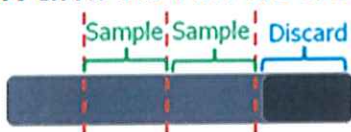
**Miscellaneous Equipment**

- 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  $\frac{1}{4}$  of loaf
5. Cut off (collect) desired sample sizes
6. Re-mix and re-roll as necessary

**30**





# Glossary





## Asphalt Industry Glossary of Terms

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

<a href="#">A</a>	<a href="#">B</a>	<a href="#">C</a>	<a href="#">D</a>	<a href="#">E</a>	<a href="#">F</a>	<a href="#">G</a>	<a href="#">H</a>	<a href="#">I</a>	<a href="#">K</a>	<a href="#">L</a>
<a href="#">M</a>	<a href="#">N</a>	<a href="#">O</a>	<a href="#">P</a>	<a href="#">R</a>	<a href="#">S</a>	<a href="#">T</a>	<a href="#">U</a>	<a href="#">V</a>	<a href="#">W</a>	

Another valuable resource for terms is [MS-4 Asphalt Handbook](#)

### A

<b>Absolute Viscosity</b>	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.
<b>Aggregate Spreaders</b>	Machines used for spreading aggregate evenly at a uniform rate on a surface.
<b>Aggregate Storage Bins</b>	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.
<b>Aggregate Trucks</b>	Trucks equipped with hydraulic lifts to dump the aggregate into the spreader or storage area.
<b>Aggregate</b>	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.
<b>Air Voids</b>	Internal spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix.
<b>Asphalt (asphalt cement)</b>	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.
<b>Alligator Cracks</b>	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.
<b>Asphalt Application</b>	The application of sprayed asphalt coatings not involving the use of aggregates.
<b>Asphalt Binder</b>	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.
<b>Asphalt Concrete</b>	A mixture of asphalt binder and aggregate thoroughly mixed and compacted into a mass.

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<b>Asphalt Distributor</b>	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.
<b>Asphalt Emulsion</b>	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).
<b>Asphalt Emulsion Mix (Cold)</b>	A mixture of unheated mineral aggregate and emulsified (or cutback) asphalt binder. It can be plant-mixed or mixed in-place.
<b>Asphalt Emulsion Mix (Warm)</b>	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).
<b>Asphalt Emulsion Slurry Seal</b>	A mixture of slow-setting emulsified asphalt, fine aggregate, and mineral filler with a slurry consistency
<b>Asphalt Leveling Course</b>	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.
<b>Asphalt Pavement Structure</b>	A pavement structure that is designed and constructed so that all courses above the subgrade are asphalt concrete (Full-Depth Asphalt Pavement).
<b>Asphalt Pavements</b>	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.
<b>Asphalt Prime Coat</b>	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.
<b>Asphalt Primer</b>	Low viscosity asphalt (highly liquid) that penetrates into a non-bituminous surface upon application.
<b>Asphalt Rubber - Asphalt Concrete (AR-AC)</b>	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.
<b>Asphalt Rubber Binder (AR)</b>	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.



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<b>Asphalt Tack Coat</b>	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.
<b>Asphaltenes</b>	The high molecular weight hydrocarbon fraction precipitated from asphalt by a designated paraffinic naphtha solvent at a specified solvent-asphalt ratio.
<b>Automatic Cycling Control</b>	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.
<b>Automatic Dryer Control</b>	A system that automatically maintains the temperature of aggregates discharged from the dryer within a preset range.
<b>Automatic Proportioning Control</b>	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

<b>Back-calculation</b>	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.
<b>Bank Gravel</b>	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).
<b>Base Course</b>	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.

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<b>Batch Plant</b>	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.
<b>Binder Course</b>	The hot mix asphalt course immediately below the surface course, generally consisting of larger aggregates and less asphalt (by weight) than the surface.
<b>Bitumen</b>	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.
<b>Blast-Furnace Slag</b>	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.
<b>Bleeding or Flushing Asphalt</b>	The upward migration of asphalt binder in an asphalt pavement resulting in the formation of asphalt film on the surface.

## C

<b>California Bearing Ratio (CBR)</b>	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). $CBR = \text{load required to force a calibrated piston into a soil specimen} / \text{load required to force a like piston into a crushed stone specimen}$ capacity and ride quality of the pavement system.
<b>Cape Seal</b>	A surface treatment where a chip seal is followed by the application of either slurry seal or micro-surfacing.
<b>Channels (Ruts)</b>	Channeled depressions that sometimes develop in the wheel paths of an asphalt pavement.
<b>Chemical modification of asphalt</b>	The chemical modification of asphalt is typically with Polyphosphoric Acid (PPA).
<b>Clinker</b>	A fused or partially fused by-product of the combustion of coal. Also includes lava and Portland Cement and partially vitrified slag and brick.
<b>Coal Tar</b>	A dark brown to black cementitious material produced by the destructive distillation of bituminous coal.



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<b>Coarse Aggregate</b>	Aggregate retained on the 2.36 mm (No. 8) sieve.
<b>Coarse-Graded Aggregate</b>	One having a continuous grading in sizes of particles from coarse through fine with a predominance of coarse sizes.
<b>Cold In-place Recycling Train</b>	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.
<b>Compaction</b>	The act of compressing a given volume of material into a smaller volume.
<b>Consensus Properties</b>	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.
<b>Consistency</b>	The degree of fluidity of asphalt cement at any particular temperature. The consistency 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.
<b>Corrugations (Washboarding) and Shoving</b>	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.
<b>Crack</b>	An approximately vertical random cleavage of the pavement caused by traffic loading, thermal stresses and/or aging of the binder.
<b>Crack and Seat</b>	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.
<b>Crack-Relief Layer</b>	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.
<b>Crusher-Run</b>	The total unscreened product of a stone crusher.



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<b>Curing</b>	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.
<b>Cutback Asphalt</b>	Asphalt cement that has been liquified by blending with petroleum solvents (dilutents). Upon exposure to atmospheric conditions the dilutents evaporate, leaving the asphalt cement to perform its function.

## D

<b>Deep Strength Asphalt Pavement</b>	Pavements containing at least four inches of HMA over non-stabilized base courses.
<b>Deflection</b>	A load-induced, downward movement of a pavement section.
<b>Deflection Basin</b>	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.
<b>Rebound Deflection</b>	The amount of surface rebound when a load is removed.
<b>Representative Rebound Deflection</b>	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.
<b>Residual Deflection</b>	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.
<b>Deflection Sensor</b>	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.
<b>Delivery Tolerances</b>	Permissible variations from the exact desired proportions of aggregate and bituminous material as manufactured by an asphalt plant.
<b>Dense-Graded Aggregate</b>	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%.
<b>Densification</b>	The act of increasing the density of a mixture during the compaction process.

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<b>Design ESAL</b>	The total number of equivalent 80-kN (18,000-lb.), single-axle load applications (equivalent single axle loads) expected throughout the design period.
<b>Design Lane</b>	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.
<b>Design Period</b>	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.
<b>Design Subgrade Resilient Modulus</b>	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.
<b>Disintegration</b>	The breaking up of a pavement into small, loose fragments caused by traffic or weathering (e.g. raveling).
<b>Distortion</b>	Any change of a pavement surface from its original shape.
<b>Drum Mix Plant</b>	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.
<b>Dryer</b>	An apparatus that will dry the aggregates and heat them to the specified temperatures.
<b>Ductility</b>	The ability of a substance to be drawn out or stretched thin. While ductility is considered an 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.
<b>Durability</b>	The property of an asphalt pavement that represents its ability to resist disintegration by weathering and traffic.



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## E

<b>Edge Joint Cracks</b>	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.
<b>Effective Thickness</b>	The ratio of the thickness of an existing pavement material compared to the equivalent thickness of a new HMA layer.
<b>Emulsifying Agent or Emulsifier</b>	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.
<b>ESAL (equivalent single axle loads)</b>	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

<b>Fatigue Resistance</b>	The ability of asphalt pavement to resist crack initiation caused by repeated flexing.
<b>Fault</b>	A difference in elevation of two slabs at a joint or crack.
<b>Fine Aggregate</b>	Aggregate passing the 2.36 mm (No. 8) sieve.
<b>Fine-Graded Aggregate</b>	One having a continuous grading in sizes of particles from coarse through fine with a predominance of fine sizes.
<b>Flexibility</b>	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.
<b>Fog Seal</b>	A light application of diluted asphalt emulsion. It is used to renew old asphalt surfaces, seal small cracks and surface voids, and inhibit raveling.
<b>Fractured Slab Techniques</b>	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.
<b>Full-Depth Asphalt Pavement</b>	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.

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## G

<b>Grade Depressions</b>	Localized low areas of limited size.
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## H

<b>Heavy Trucks</b>	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.
<b>Hot Aggregate Storage Bins</b>	Bins that store heated and fractionated aggregates prior to their final proportioning into the mixer.
<b>Hot Mix Asphalt (HMA)</b>	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.
<b>Hot Mix Asphalt (HMA) Overlay</b>	One or more courses of HMA over an existing pavement.

## I

<b>Impermeability</b>	The resistance an asphalt pavement has to the passage of air and water into or through the pavement.
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## K

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

<b>Lane Joint Cracks</b>	Longitudinal separations along the seam between two paving lanes.
<b>Lift</b>	A layer or course of paving material applied to a base or a previous layer.
<b>Lime Treated Subgrade</b>	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.
<b>Lime-Fly Ash Base</b>	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.



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

## M

<b>Maintenance Mix</b>	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.
<b>Mechanical Spreaders</b>	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).
<b>Medium-Curing (MC) Asphalt</b>	Cutback asphalt composed of asphalt cement and a diluent of medium volatility.
<b>Mesh</b>	The square opening of a sieve.
<b>Micro-Surfacing</b>	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.
<b>Milling Machine</b>	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.
<b>Mineral Dust</b>	The portion of the fine aggregate passing the No. 200 (0.075 mm) sieve.
<b>Mineral Filler</b>	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.
<b>Modified Asphalt Rubber - Asphalt Concrete (MAR-AC)</b>	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.
<b>Modified Asphalt Rubber Binder (MAR)</b>	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.

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<b>Multiple Surface Treatment</b>	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.
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## N

<b>Natural (Native) Asphalt</b>	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.
<b>Nondestructive Testing (NDT)</b>	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

<b>Open-Graded Aggregate</b>	One containing less-fine aggregate in which the void spaces in the compacted aggregate are relatively large and interconnected, usually 10% more.
<b>Open-Graded Asphalt Friction Course</b>	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

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



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<b>Penetration Grading</b>	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.
<b>Penetration</b>	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.
<b>Performance Graded (PG)</b>	Asphalt binder grade designation used in Superpave. It is based on the binder's mechanical performance at critical temperatures and aging conditions.
<b>Planned Stage Construction</b>	A construction process where stages of the project are performed sequentially according to design and a predetermined time schedule.
<b>Plant Mix (Cold)</b>	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.
<b>Plant Mix Base</b>	A foundation course produced in an asphalt mixing plant, which consists of a mineral aggregate uniformly coated with asphalt cement or emulsified asphalt.
<b>Plant Screens</b>	Screens located between the dryer and hot bins, which separate heated aggregates into proper hot bin sizes.
<b>Pneumatic-Tire Roller</b>	A compactor with a number of tires spaced so their tracks overlap delivering a kneading type of compaction.
<b>Poise</b>	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.
<b>Polished Aggregate</b>	Aggregate particles in a pavement surface that have been worn smooth by traffic.
<b>Polymer-Modified Asphalt (PMA) Binder</b>	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.



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<b>Potholes</b>	Bowl-shaped openings in the pavement resulting from localized disintegration.
<b>Power Sweeper</b>	A power operated rotary broom used to clean loose material from the pavement surface.
<b>Present Serviceability Index (PSI)</b>	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.
<b>Present Serviceability Rating (PSR)</b>	The rating assigned to a specific pavement section.
<b>Present Serviceability</b>	The ability of a specific section of pavement to serve its intended use in its existing condition.
<b>Pumping</b>	Slab deflection under passing loads sometimes resulting in the discharge of water and subgrade soils along joints, cracks and pavement edges.

## R

<b>Rapid-Curing (RC) Asphalt</b>	Cutback asphalt composed of asphalt cement and a naphtha or gasoline-type diluent of high volatility.
<b>Raveling</b>	The progressive separation of aggregate particles in a pavement from the surface downward or from the edges inward.
<b>Reclaimed Asphalt Pavement (RAP)</b>	Excavated asphalt pavement that has been pulverized, usually by milling, and is used like an aggregate in the recycling of asphalt pavements.
<b>Reclaiming Machine</b>	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.
<b>Recycled Asphalt Mix</b>	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.
<b>Reflection Cracks</b>	Cracks in asphalt overlays (usually over deteriorated PCC pavements) that reflect the crack pattern in the pavement structure below it.

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<b>Residue</b>	<b>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.</b>
<b>Resilient Modulus of Elasticity (MR)</b>	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.
<b>Resistance Value (R-value)</b>	A test for evaluating bases, subbases, and subgrades for pavement thickness design.
<b>Road Oil</b>	Asphalt cement and oils of low volatility, usually similar to one of the slow-curing (SC) grades.
<b>Roadway</b>	All facilities on which motor vehicles are intended to travel such as secondary roads, interstate highways, streets and parking lots.
<b>Roughometer</b>	An instrumented, single-wheel trailer, which measures the roughness of a pavement surface in accumulated millimeters, or inches, per mile.
<b>Rubblization</b>	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

<b>Sand Asphalt</b>	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.
<b>Sand</b>	Fine aggregate (any fraction below a No. 8 sieve) resulting from natural disintegration and abrasion or processing of rock.
<b>Sandwich Seal</b>	A surface treatment consisting of the application of a large aggregate, then a spray applied asphalt emulsion, and covered with a smaller aggregate.



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<b>Sandy Soil</b>	A material consisting essentially of fine aggregate particles smaller than 2.36 mm (No. 8) sieve and usually containing material passing a 75 $\mu$ m (No. 200) sieve. This material usually exhibits some plasticity characteristics.
<b>Saw-Cut and Seal</b>	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.
<b>Scaling</b>	The peeling away or disintegrating of the surface of portland cement concrete.
<b>Seal Coat</b>	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.
<b>Self-Propelled Spreaders</b>	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.
<b>Sheet Asphalt</b>	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.
<b>Shoving</b>	A form of plastic movement resulting in localized bulging of the pavement.
<b>Shrinkage Cracks</b>	Interconnected cracks forming a series of large blocks, usually with sharp corners or angles.
<b>Sieve</b>	An apparatus for laboratory work in which the openings in the mesh are square for separating sizes of material.
<b>Single Surface Treatment</b>	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.
<b>Skid Hazard</b>	Any condition that might contribute to the reduction of friction forces on the pavement surface.
<b>Skid Resistance</b>	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.

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<b>Slippage Cracks</b>	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.
<b>Slow-Curing (SC) Asphalt</b>	Cutback asphalt composed of asphalt cement and oils of low volatility.
<b>Slurry Seal</b>	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.
<b>Soil/Cement Base</b>	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.
<b>Solubility</b>	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.
<b>Source Properties</b>	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.
<b>Spalling</b>	The breaking or chipping of a PCC pavement at joints, cracks, or edges, usually resulting in fragments with feathered edges.
<b>Stability</b>	The ability of an asphalt paving mixture to resist deformation from imposed loads. Stability is dependent upon both internal friction and cohesion.
<b>Standard Deviation</b>	The root-mean-square of the deviations about the arithmetic mean of a set of values.
<b>Stationary Plants</b>	Asphalt plants that are so constructed that moving them is not considered economically feasible.
<b>Steel-Wheel Static Rollers</b>	Tandem or three-wheel rollers with cylindrical steel rolls that apply their weight directly to the pavement.
<b>Steel-Wheel Vibratory Rollers</b>	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.



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<b>Stoke</b>	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.
<b>Structural Overlay</b>	A HMA overlay constructed for the purpose of increasing the structural value and ride quality of the pavement system.
<b>Subbase</b>	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.
<b>Subgrade Resilient Modulus</b>	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.
<b>Subgrade, Improved</b>	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.
<b>Subgrade</b>	The soil prepared to support a pavement structure or a pavement system. It is the foundation of the pavement structure.
<b>Superpave Gyratory Compactor (SGC)</b>	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.
<b>Superpave Mix Design</b>	An asphalt mixture design system that integrates the selection of materials (asphalt, aggregate) and volumetric proportioning with the project's climate and design traffic.
<b>Superpave™</b>	Short for "Superior Performing Asphalt Pavement" a performance-based system for selecting and specifying asphalt binders and for designing asphalt mixtures.

## T

<b>Transverse Crack</b>	A crack that follows a course approximately at right angles to the centerline.
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<b>Travel Plants</b>	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.
<b>Truck Factor</b>	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

<b>Upheaval</b>	The localized upward displacement of a pavement due to swelling of the subgrade or some portion of the pavement structure.
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## V

<b>Viscosity Grading</b>	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.
<b>Viscosity</b>	A measure of a liquid's resistance to flow with respect to time.

## W

<b>Well-Graded Aggregate</b>	Aggregate graded with relatively uniform proportions, from the maximum size down to filler.
<b>Wet Mixing Period</b>	The interval of time between the beginning of application of asphalt material into a pugmill and the opening of the discharge gate.
<b>Whirl Spreaders</b>	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.
<b>Workability</b>	The ease with which paving mixtures may be placed and compacted.