Approved Asphalt Quality Control Technician
(ODOT Level 2 Asphalt Technician)

This is a course designed for understanding the asphalt testing requirements of Ohio Department of Transportation projects.

Course Manual
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Introduction

Level 2 Prerequisite

To be approved as an Asphalt Level 2 Technician for Ohio DoT, you will need the following:

- A Certificate of completion from a recognized Radiation Safety Training Program.
  - Completion of this Radiation training is not required before taking this class or for the Hands-On Practical testing.
  - This class only includes classroom training of the Nuclear AC Gauge
  - The Practical test will only include use of the control panel and the chamber that contains the Nuclear Source.
  - However, Radiation Safety training must be completed and the Certificate must remain on file with the Asphalt Materials Section at the ODOT Central Lab in Columbus before a technician may be Level 2 approved.

- Successful completion of the Level 2 written examination.

- Successful completion of the hands-on practical examination (details to be announced).

- Note:
  - Written and Practical exams will be held a maximum of 2 months pending receipt of the radiation safety certification.
  - Should you not pass the written examination, then it should be retaken within a maximum of 3 weeks.
  - The hands-on practical examination must be completed within 1 month of successfully completing the written exam. Should this time elapse, then the tests will be discarded and the exams will need to be retaken in its entirety.
Asphalt Level 2
Pre-testing Information and Directions

Pre-Test opportunity: Anyone having the appropriate knowledge and experience wishing to schedule to take a Pretest may arrange to do so by contacting Tim Selby at 614-275-1338 or Steve McAvoy (614-275-1379) at the ODOT Central lab. A 90% Score is required to pass the Pretest. If this Level 2 Asphalt Technician pretest is failed, the Level 2 Asphalt Technician School must then be attended before a retest will be given. Written exam results will be e-mailed to you within one week.

Please provide the e-mail address that you would like your test results sent to. There is an area on the front cover of your test booklet ODOT employees' results will be sent to the HT office. Contact your HT coordinator.
If you do not have access to an e-mail address you may contact by phone No sooner than 1:00 pm on the Thursday following the test day. In the event you do not receive an e-mail by 1:00 pm on the Thursday following the test day or you have any questions please contact us at one of the numbers listed below.

Steve McAvoy – 614-275-1379  steven.mcavoy@dot.state.oh.us
Tim Selby – 614-275-1338  tim.selby@dot.state.oh.us

Those who successfully pass the written exam will then be scheduled for the hands on practical (details to be announced).
Those who do not pass the written portion of the exam may schedule a review and retake at the ODOT Central Lab in Columbus, Ohio on a first come basis, depending on the availability of the Test Lab staff.

ODOT Central Test Lab: 1600 W. Broad Street, Columbus, Ohio 43223.

Testing will take place on the second floor of the Lab in room 2015.

Directions to the Lab:

From I-70 Westbound: Exit at #97 W Broad St. Continue straight through the traffic light at the end of the ramp like you are getting back on I-70 West. Veer right into the ODOT complex. At the gate tell the call box attendant who you are there to see (ODOT employee name). Our building (1600) Materials Management is the first building on the right.

From I-70 Eastbound: Exit at #97 W Broad St. Turn left onto W. Broad St and pass under the bridge and turn Left at the first traffic light, like you are getting back on I-70 West. Veer right into the ODOT complex. At the gate tell the call box attendant who you are there to see (ODOT employee name). Our building (1600) Materials Management is the first building on the right.
Level 2 Technician Training and Approval – What is this all about?

The Level 2 training in this class provides the minimum skills and resources needed to get started on the road to becoming an experienced and competent asphalt lab testing technician. The Level 2 Approval enables you to perform QC and QA tests whether you are an asphalt contractor/producer employee, consultant employee or Ohio DOT employee. The Level 3 Approval allows you to perform and submit asphalt mix designs for Ohio DOT approval.

The Ohio DOT typically uses up to 5 million tons of asphalt concrete mix in a year. The material and placement cost for Ohio asphalt concrete mix is over $350,000,000.00. The vast majority of this material is produced by asphalt concrete mix contractors and producers who design, produce, test and place the asphalt concrete mix. Testing of asphalt concrete mix by the asphalt concrete mix contractor/producer is called QC (quality control).

The Ohio DOT performs testing also. Ohio DOT testing and review that validate the asphalt concrete mix contractor/producer QC is called monitoring. Ohio DOT tests that are used for payment of the asphalt concrete mix contractor/producer are called acceptance. Both monitoring and acceptance are called QA (quality assurance). The asphalt concrete mix contractor/producer QC along with Ohio DOT QA, makeup what is called the QC/QA program for asphalt.

All general asphalt concrete mix contractor/producer QC/QA requirements are found in Ohio DOT C&MS sections 403, 441 and/or 442. General mix and placement requirements are found in Ohio DOT C&MS section 401. Ohio DOT acceptance requirements are found in 403, 448 or 446.

A Level 2 technician should have all the documents needed to fully understand what is expected of the job he/she is working on. This includes the Ohio DOT C&MS specification book, Ohio DOT supplemental specifications, proposal notes if applicable, copies of all worksheets and forms submitted to the Ohio DOT, and copies of JMF (Job Mix Formula) approval letters. Ohio DOT monitoring checks on the asphalt concrete mix contractor/producer QC, including the Level 2 technician practices.

The Ohio DOT C&MS specification book, supplemental specifications and proposal notes can be viewed online at: http://www.dot.state.oh.us/construction/OCA/Specs/default.htm However, it is in the Level 2 technicians best interest to obtain hard copies for their personal use.

Finally, the Level 2 technician is responsible for maintaining their approval with the Ohio DOT by contacting the Office of Materials Management when their approval is up.

See the latest revision of S 1041 on the following 5 pages.
1041.01 Scope

A. This supplement outlines the requirements for Contractor's employees:

1. To perform asphalt concrete quality control testing under the Asphalt Quality Control Technician Level 2 approval program.

2. To perform asphalt concrete mix designs under the Asphalt Concrete Mix Design Level 3 approval program.

3. To perform supervision of asphalt concrete placement under the asphalt Field Quality Control Supervisor (FQCS) approval program.

B. This supplement outlines the requirements for a Contractor's or consultant’s laboratory to be equipped with:

1. The proper equipment to perform asphalt concrete quality control testing in accordance with 403, 441 and 442 (approved Level 2 Laboratory).

2. The proper equipment to perform asphalt concrete mix designs and quality control testing (approved Level 3 Laboratory).

1041.02 Administration

A. The Division of Construction Management is responsible for the administration of the asphalt approval programs. The Division of Construction Management Control Group will consist of the following Department personnel:

1. Deputy Director, Division of Construction Management
2. Administrator, Office of Construction Administration
3. Administrator, Office of Materials Management
B. The Approval Program Review Group will, when required per 1041.03 D., conduct reviews of complaints of approved personnel. The Approval Program Review Group consists of the Asphalt Materials Engineer, Office of Materials Management, Pavements Engineer, Office of Construction Administration, one District representative and one industry representative. The Approval Program Review Group will make recommendation to the Division of Construction Management Control Group.

C. The administration of the daily activities of the asphalt approval programs will be performed by the Asphalt Materials Engineer, Office of Materials Management.

1041.03 Personnel Approval

A. Asphalt Quality Control Technician Level 2

1. The Department will approve quality control personnel upon satisfactory completion of the Level 2 Examination.

2. Eligibility requirements for the examination are the submission of proof of successful completion of a Department approved asphalt concrete quality control course.

B. Asphalt Concrete Mix Design Technician Level 3

1. The Department will approve mix design personnel upon satisfactory completion of the Level 3 Examination.

2. Eligibility requirements for the examination are the submission of proof of successful completion of a Department approved asphalt concrete mix design course.

C. Field Quality Control Supervisor

1. The Department will approve FQCS personnel upon satisfactory completion of a Department approved FQCS course and verified minimum two years experience with asphalt placement operations on Department projects.

D. Removal from Work and Removal of Ohio DOT Approval

1. Contractors and their employees are subject to the provisions of C&MS 108.05. Approved personnel may also have their Department Approval removed.

2. The following will apply for possible removal of Department Approval. A complaint submitted by a District of an approved contractor or consultant employee will be reviewed by the District Engineer of Tests and Asphalt Materials Engineer, Office of Materials Management. A criterion for review, will be, but is not limited to, evidence of failure to meaningfully respond to deficiencies as outlined in ODOT C&MS. Lack of meaningful response is defined as a failure to respond to single event items that are major and obvious, or multiple event items that are recurring and minor in nature. Appropriate
response is expected even if not directed by Department personnel. The contractor QC Manager and employee in question will be contacted for information and opportunity for input. This initial review will be documented and a determination of action to be taken will be made. If it is determined a written reprimand is warranted, it will be recommended by the Asphalt Materials Engineer and issued by the Division of Construction Management Control Group. Appeals must be made to the Division of Construction Management Control Group within one month of a decision.

If it is determined further action may be required, the Approval Program Review Group will review the complaint and schedule a hearing with the employee. In lieu of a hearing, written statements may be submitted to the Approval Program Review Group by the approved employee. The Approval Program Review Group will make recommendation to the Division of Construction Management Control Group. All decisions will be made in writing to the employee in question and the contractor QC Manager. Appeals must be made to the Division of Construction Management Control Group within one month of a decision.

1041.04 Laboratory Approval

A. Level 2

1. A Level 2 Laboratory will contain the following equipment:

   a. Asphalt Content Nuclear Gauge (AC Gauge). This AC Gauge shall be a Troxler 3241-C with a 100mCi ± 10 percent Am-241; Be neutron source or an equivalent gauge, approved by the Laboratory, with a 100mCi ± 10 percent source and the capability of transferring its calibration data in accordance with Supplement 1043 to a Troxler gauge meeting the above requirements. Ensure each AC Gauge has its own unique manufacturer-provided ‘reference voltage’ tagged on the gauge or if not tagged a readily available letter from the manufacturer (on the manufacturer’s letterhead) stating the AC Gauge Serial Number and ‘reference voltage’. The AC Gauge shall be located in the Level 2 Laboratory such that it is at least 10 feet from the nearest variable hydrogen source. This includes haul roads, asphalt binder or emulsion tanks, water storage tanks, etc.
   b. A minimum 10,000 g digital balance which reads to the nearest 0.1 g.
   c. A minimum of eight (8) AC Gauge pans.
   d. An AC Gauge printer.
   e. Mechanical convection oven capable of maintaining a constant temperature of 355 ± 20 °F (180 ± 10 °C) for moisture testing.
   f. Mechanical convection oven(s) capable of maintaining 200 -320 °F (93- 160 °C) and with sufficient space for all required samples and equipment without delaying any testing.
   g. Ignition oven meeting Supplement 1054 when required by specification.
   h. Muffle furnace capable of maintaining 500 - 600°C (932-1112 °F) or an ignition oven meeting the requirements of Supplement 1054.
i. Mechanical shaker for 8.00 in (203 mm) or 12.00 in (305 mm) sieves for gradation analysis.

j. Set of 8 inch (200 mm) diameter or 12 inch (300 mm) diameter sieves meeting the requirements of ASTM E11, "Specification for Wire-Cloth and Sieves for Testing Purposes" and of the proper size to ensure conformance to the appropriate gradation specifications.

k. Balances that meet the appropriate specifications.

l. 3000 g electrical centrifuge meeting the requirements of ASTM D 2172.

m. Non-corrosive flat pan 12.00 in x 8.00 in x 1.00 in (305 mm x 203 mm x 25 mm) deep.

n. Hot plate.

o. 1000 ml graduate.

p. Crucible suitable for ash determination.

q. Bunsen burner or approved equal.

r. Water bath with clean water meeting the requirements of Supplement 1036 and including a switched suitable heater and switched circulator wired to a properly functioning ground fault interrupt outlet.

s. 4000 ml glass flask or metal pycnometer meeting AASHTO T 209.

t. Vacuum pump or water aspirator capable of evacuating air from the container to a residual pressure in accordance with AASHTO T 209.

u. Thermometers will be Type 17 C meeting the requirements of ASTM E 1.

v. Laboratory style timer with audible warning and visible timing (do not use devices such as watches, cell phones etc.).

w. Automatic, calibrated Marshall specimen compactor and extractor meeting the requirements of AASHTO T 245.

x. When 442 is specified, an automatic, calibrated gyratory specimen compactor meeting the requirements of AASHTO T 312. Include in the calibration internal angle validation per AASHTO T344. At a minimum calibrate the internal angle annually and when requested by the District for poor comparison. Measure and record the external angle at each internal angle validation and verify the external angle when a gyratory is moved (if possible for the model in question, otherwise calibrate the internal angle). Place a sticker on the gyratory with the date of internal angle validation and values of internal and external angles measured as appropriate for the model in question. Document internal angle validation per the QCP. Do not use gyratory compactors that cannot meet T 312 and T344 requirements.

y. Miscellaneous equipment as required by the appropriate specification.

Provide a Level 2 Laboratory with a minimum floor area of 250 square feet (18.6 m²). Provide in the lab a desk or similar space for both a technician and monitor to perform paperwork.

2. Maintain the condition of the lab equipment according to the contractor Quality Control Program (403.03). Maintain orderliness and cleanliness of the lab according to the contractor Quality Control Program (403.03). Maintain the inside temperature of a Level 2 Laboratory at 68 to 86 °F (20 to 30 °C) during working hours.
3. Level 2 Laboratories will be inspected at the time of the asphalt plant inspection by Department personnel. There is no maximum number of times a laboratory may be inspected.

4. Level 2 Laboratories are required to participate in the Department's Reference Testing Program.

B. Level 3

1. A Level 3 Laboratory will meet all the equipment and size requirements of a Level 2 Laboratory and will have the following equipment:
   a. Heated water bath capable of maintaining 140 ± 2 °F (60 ± 1.0 °C).
   b. Marshall test apparatus meeting the requirements of AASHTO T 245.
   c. All apparatus for meeting AASHTO T 283.
   d. Miscellaneous equipment as required by the appropriate specifications.

2. An asphalt ignition oven is not required for a Level 3 Laboratory.

3. A computer with Microsoft Office, internet access and ability to email attachments is required.

4. Level 3 Laboratories will be inspected a minimum of once every two years by Department personnel. There is no maximum number of times a laboratory may be inspected.

5. Level 3 Laboratories are required to participate in the Department's Reference Testing Program.

C. Loss of Approval

1. Failure to maintain required equipment in good condition may result in loss of approval of a laboratory. Loss of approval can be invoked, in written form, by the District Engineer of Tests or the Asphalt Materials Engineer. Re-approval will be granted once the deficiencies have been corrected.

2. Chronic failure to maintain required equipment in good condition may result in loss of approval of a Level 3 approved person to perform work per Section 1041.03.
Definitions

1. **AASHTO** - American Association of State Highway & Transportation Officials

2. **AC Gauge** - Asphalt Content Gauge

3. **Air Voids** - Pockets of air between the coated aggregate particles.

4. **ASTM** - American Society for Testing & Materials

5. **Asphalt Binder** - Liquid asphalt derived from crude oil.

6. **Asphalt Concrete or H.M.A.** - Hot Mix Asphalt

7. **BSG** - Bulk Specific Gravity - Test performed on compacted hot mix asphalt.

8. **Density** - The mass of a cubic meter of material at 25° C.

9. **F/A - Fines / Asphalt Ratio** - The value calculated to the nearest (0.1) one-tenth of the fines to asphalt (F/A) ratio, which is the percentage of aggregate passing the No. 200 (75 \( \mu \text{m} \)) sieve divided by the percentage of asphalt binder.

10. **F-T : Fifty - Thirty Value** – The value which is calculated to the nearest whole percentage point of the Fifty to Thirty (F-T) value, which is the percent of total aggregate retained between the No.50 (300 \( \mu \text{m} \)) and No. 30 (600 \( \mu \text{m} \)) sieves, minus the percent of total aggregate retained between the No. 30 (600 \( \mu \text{m} \)) and 16 (1.18mm)sieves.

11. **Hot Mix Asphalt Plants:**
   a) **Batch Plant** - A manufacturing facility for producing bituminous paving mixtures that proportions the aggregate and bituminous constituents into the mix by weighed batches, adds bituminous material by either weight or volume, and mixes the blend.

   b) **Drum Mix Plant** - A manufacturing facility for producing bituminous paving mixtures that continuously proportions aggregate, heats and dries in a rotating drum and simultaneously mixes them with a controlled amount of bituminous material. The same plant may produce cold-mix paving mixtures without heating and drying the aggregate.
12. **J.M.F. – Job Mix Formula** – It is an Asphalt Concrete Mix Design made up of a percentage of Aggregate and a percentage of Asphalt Binder blended to meet a mix types pre-determined design criteria.

13. **MSG - Maximum Specific Gravity** - Test performed on loose hot mix asphalt, commonly known as **RICE** test.

14. **Maximum Size Aggregate** - One sieve larger than the nominal maximum size.

15. **Nominal Maximum Size Aggregate** - One sieve size larger than the first sieve to retain more than 10 percent.

16. **PG - Performance Graded Asphalt (eg. PG 64 -22)** - Using the 64 -22 as an example the binder must meet high temperature physical property requirements at least up to a temperature of 64° C and low temperature physical property requirements at least down to -22° C.

17. **QA - Quality Assurance**

18. **QC - Quality Control**

19. **QCP - Quality Control Program**

20. **Specific Gravity** - Ratio of the mass of the given volume of material to the mass of an equal volume of water at the same temperature (25° C or 77° F)

   **NOTE:** Specific Gravity has NO SPECIFIC UNITS.

21. **Optimum Asphalt Content – Design Asphalt Content** – The asphalt content that best fits the blended materials chosen to be utilized in the design asphalt mix. This asphalt content is chosen by utilizing the volumetric properties of a mix design.

22. **D.E.T.** – This abbreviation stands for the **District Engineer of Tests**. This person is responsible for the quality of the materials being used on ODOT projects in their district. There are twelve (12) districts in the State of Ohio.

23. **D.C.A.** - This abbreviation stands for the **District Construction Administrator**. This person is responsible for the quality of the construction practices being used on ODOT projects in their district.
# Section 2, Calculations, Forms and Practice Problems

## Rounding:
- Procedure
- Practice Problem

## Aggregate Moisture Calculations:
- Example
- Practice Problems

## Extraction / Gradation Calculations:
- Formulas
- Extraction / Gradation Composite Worksheet
- F/A ratio and F-T Value Problems
- Moisture, AC, and F/A Problems
- Practice Problems

## Effective Asphalt

## Maximum Specific Gravity Calculations:
- Practice Problems

## Bulk Specific Gravity and Air Void Calculations:
- Temperature Conversion Chart
- Formulas for Calculations
- Practice Problems

## Field Worksheet:
- Practice Problem
ODOT Accepted Rounding off Procedure for Level 2 and 3 Asphalt Approval

Note:
If the last number your using to round off is a 5:
You will round up to the next number:

EXAMPLES:

**Rounding to the Whole number:**

38.5 = 39
38.501 or greater = 39

39.5 = 40
39.501 or greater = 40

**Rounding to the nearest 0.1:**

3.85 = 3.9
3.8501 or greater = 3.9

3.95 = 4.0
3.9501 or greater = 4.0

**Rounding to the nearest 0.01:**

1.374 = 1.37
1.375 = 1.38
1.378 = 1.38
1.37851 = 1.38

1.385 = 1.38
1.395 = 1.40

**Rounding to the nearest 0.001:**

1.3774 = 1.377
1.3775 = 1.378
1.3785 = 1.379
1.37851 = 1.379
ODOT RNDING
(Practice Problem)

When the number following the place holder is exactly 5 – **Round Up**

When the place holder is higher than 5 – **Round Up**

When the place holder is less than 5 – **Round Down**

**Examples:**

When rounding to the nearest **whole number:**

- 4.5000 rounds to 5.0
- 4.4999 rounds to 4.0
- 4.5001 rounds to 5.0

**Round to nearest whole number (1):**

<table>
<thead>
<tr>
<th>6.4</th>
<th>6.5</th>
<th>6.51</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6</td>
<td>6.501</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**Round to the nearest tenth (0.1):**

<table>
<thead>
<tr>
<th>7.450</th>
<th>6.649</th>
<th>6.651</th>
</tr>
</thead>
</table>

**Round to the nearest thousandth (0.001):**

<table>
<thead>
<tr>
<th>7.9905</th>
<th>6.7445</th>
<th>2.6499</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3354</td>
<td>7.002500001</td>
<td>2.999500000</td>
</tr>
</tbody>
</table>
AGGREGATE MOISTURE CALCULATIONS

Used at all Drum Mix Plants and Batch Plants where RAP is introduced at Hot Elevator

Formula:

Aggregate Wet Weight - Aggregate Dry Weight = Aggregate Moisture

\((\text{Aggregate Moisture} \div \text{Aggregate Dry Weight}) \times 100 = \% \text{ Moisture}\)

Example:

\[
\begin{align*}
\text{Agg. Wet Wt.} & \quad - \quad \text{Agg. Dry Wt.} = \text{Wt. of Moisture} \\
1000 \text{ Grams} & \quad - \quad 965 \text{ Grams} = 35 \text{ Grams of Moisture} \\
(35 \text{ Grams} \div 965 \text{ Grams}) \times 100 & = 3.6 \% \text{ Moisture}
\end{align*}
\]

Using the formula listed below Calculate the \% Moisture for each Aggregate and then combine the answers to obtain the \% of Total Moisture.

\[
\begin{align*}
\% \text{ Moisture in Agg.} \# 1 & \times \% \text{ Agg.} \# 1 \text{ used in mix (per JMF) (made into decimal)} \\
+ \% \text{ Moisture in Agg.} \# 2 & \times \% \text{ Agg.} \# 2 \text{ used in mix (per JMF) (made into decimal)} \\
+ \% \text{ Moisture in Agg.} \# 3 & \times \% \text{ Agg.} \# 3 \text{ used in mix (per JMF) (made into decimal)} \\
= \text{Total Moisture of Aggregates for this JMF.}
\end{align*}
\]

Given:

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Percentage in JMF</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>40%</td>
<td>3.6%</td>
</tr>
<tr>
<td>#2</td>
<td>20%</td>
<td>3.0%</td>
</tr>
<tr>
<td>#3</td>
<td>40%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{Agg.} \# 1 & = 3.6 \times 0.40 = 1.4 \% \\
\text{Agg.} \# 2 & = 3.0 \times 0.20 = +0.6 \% \\
\text{Agg.} \# 3 & = 4.0 \times 0.40 = +1.6 \% \\
\text{Total Moisture} & = 3.6 \%
\end{align*}
\]

NOTE: Round off to nearest 0.1 %
Moisture Practice Problem

Given the following information from a JMF:

(1) - Calculate the Moisture Content percentages for each Aggregate Size along with the Rap that is being utilized in this Job Mix Formula composition.

After completion of those calculations:

(2) - Calculate the Total Moisture percentage for the entire Job Mix Formula.

Agg. # 1 — # 57’s — 37 % used — Wet Wt. = 1000 grams — Dry Wt. = 965 grams
Agg. # 2 — # 8's — 16 % used — Wet Wt. = 1000 grams — Dry Wt. = 963 grams
Agg. # 3 — SAND — 32 % used — Wet Wt. = 1000 grams — Dry Wt. = 953 grams
Agg. # 4 — RAP — 15 % used — Wet Wt. = 1000 grams — Dry Wt. = 959 grams

Show all Calculations:

% Moisture for Agg. # 1 –
+ % Moisture for Agg. # 2 –
+ % Moisture for Agg. # 3 –
+ % Moisture for Rap # 4 –
% Total Moisture =
Moisture Practice Problem

(Answer Sheet)

Given the following information from a JMF:

(1) - Calculate the Moisture Content percentages for each Aggregate Size along with the Rap that is being utilized in this Job Mix Formula composition.

After completion of those calculations:

(2) - Calculate the Total Moisture percentage for the entire Job Mix Formula.

Agg. # 1 — # 57’s — 37 % used — Wet Wt. = 1000 grams — Dry Wt. = 965 grams
Agg. # 2 — # 8’s — 16 % used — Wet Wt. = 1000 grams — Dry Wt. = 963 grams
Agg. # 3 — SAND — 32 % used — Wet Wt. = 1000 grams — Dry Wt. = 953 grams
Agg. # 4 — RAP — 15 % used — Wet Wt. = 1000 grams — Dry Wt. = 959 grams

Show all Calculations:

Agg. # 1
1000 – 965 = 35 ÷ 965 X 100 = 3.6 % x .37 = 1.3 %

Agg. # 2
1000 – 963 = 37 ÷ 963 X 100 = 3.8 % x .16 = 0.6 %

Agg. # 3
1000 – 953 = 47 ÷ 953 X 100 = 4.9 % x .32 = 1.6 %

Agg. # 4
1000 – 959 = 41 ÷ 959 X 100 = 4.3 % x .15 = 0.6 %

Total = 1.3 % + 0.6 % + 1.6 % + 0.6 % = 4.1 % Total Moisture

% Moisture for Agg. # 1 — 1.3 %
% Moisture for Agg. # 2 — 0.6 %
% Moisture for Agg. # 3 — 1.6 %
% Moisture for Rap # 4 — 0.6 %
% Total Moisture = 4.1 %
**Formulas for Extraction / Gradation Worksheet Calculations**

The following information would be obtained through testing:

** Nuclear Gauge AC — ** Effluent — ** Ash per 100 ML

** Sample Gross — ** Extracted Aggregates — ** Grams (Sieves)

**Formulas:**

1) Mineral in Effluent (Grams) = Effluent ÷ 100 x Ash per 100 ML (Whole Number)

2) Net Wt. of Agg. (Grams) = Extracted Agg. + Mineral (From Calculation # 1)

3) % Passing (Sieves) = Grams ÷ Net Wt. of Agg. x 100 – 100
   (Round to the Whole Number except the 200 Sieve as it rounds to the 0.1 %)

4) Corrected Bitumen (Grams) = Sample Gross – Net Wt. of Agg. (Whole Number)

5) Corrected Bitumen % = Corrected Bitumen ÷ Sample Gross x 100 (0.1 %)

**To Calculate the Composite:  Follow these Steps:**

1) Add the Sample Gross Weights of each Sample Increment.

2) Add the Net Weights of Aggregate of each Sample Increment.

3) Add the Sieve Weights for each sieve size of each Sample Increment.

4) Add the Corrected Bitumen Weights of each sample Increment.

5) To Calculate the % Passing of each Sieve in the Composite – use #3 under Formulas

6) To Calculate the % Bitumen in the Composite – use #5 under Formulas

*** NOTE: Do Not Average The Composite, This can give False Information. ***

7) Calculate the F / A Ratio and the F - T Value

** F / A = % Passing the 200 ÷ Nuclear Gauge AC (Report to the tenth)
* F - T = (P30 – P50) – (P16 – P30) (Round to the Whole Number and report as + or - number)
Utilizing the following Data given from this Laboratory Extraction and Gradation analysis along with the Nuclear Asphalt Content Gauge reading:

A. Calculate the corrected gradation percentage and the corrected bitumen content of each sample increment.

B. Combine the increments arithmetically to form the composite sample result.

C. Calculate the Fines / Asphalt Ratio and the Fifty / Thirty Value for the composite.

<table>
<thead>
<tr>
<th>Individual Bowls</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncorrected Bitumen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflux</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear Gauge</td>
<td></td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Effluent (ML)</td>
<td>2700</td>
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<tr>
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<td>Mineral in Effluent</td>
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<th>%Pass</th>
<th>GMS</th>
<th>%Pass</th>
<th>GMS</th>
<th>%Pass</th>
<th>GMS</th>
<th>%Pass</th>
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<tr>
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<td>.075 (#200)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

F / A Ratio___________  F - T Value____________
F/A & F-T Practice Problem

Given the following Test Results:

Calculate the F/A Ratio and the F-T Value.

<table>
<thead>
<tr>
<th>% Passing</th>
<th>1/2</th>
<th>72 %</th>
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<tr>
<td>% Passing</td>
<td>3/8</td>
<td>58 %</td>
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<td>% Passing</td>
<td># 4</td>
<td>44 %</td>
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<tr>
<td>% Passing</td>
<td># 8</td>
<td>36 %</td>
</tr>
<tr>
<td>% Passing</td>
<td># 16</td>
<td>29 %</td>
</tr>
<tr>
<td>% Passing</td>
<td># 30</td>
<td>21 %</td>
</tr>
<tr>
<td>% Passing</td>
<td># 50</td>
<td>8 %</td>
</tr>
<tr>
<td>% Passing</td>
<td># 100</td>
<td>3 %</td>
</tr>
<tr>
<td>% Passing</td>
<td># 200</td>
<td>1.9 %</td>
</tr>
</tbody>
</table>

Extracted AC 5.3 %

Nuclear Gauge AC 5.7 %

Show All Calculations:

F/A__________                    F-T__________
Practice Problem

Given the following Test Results:

(A) Calculate the % Moisture Correction:

(B) Adjust the % PG Binder Content:

(C) Calculate the Fines to Asphalt Ratio:

Nuclear AC 5.9 %
Extracted AC 5.4 %
Mix Wt. Before Dry Back 2500 grams
Mix Wt. After Dry Back 2493 grams
% Passing # 200 Sieve 4.7 %

Moisture % __________
Adjusted AC % __________
Fines to Asphalt Ratio __________
# Practice Problem

*Utilizing the following Data given from this Laboratory Extraction and Gradation analysis along with the Nuclear Asphalt Content Gauge reading:*

A. Calculate the corrected gradation percentage and the corrected bitumen content of each sample increment.

B. Combine the increments arithmetically to form the composite sample result.

C. Calculate the Fines / Asphalt Ratio and the Fifty / Thirty Value for the composite.

<table>
<thead>
<tr>
<th>Individual Bowls</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Composite</th>
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<tbody>
<tr>
<td>Uncorrected Bitumen</td>
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<td></td>
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<td></td>
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<tr>
<td>Reflux</td>
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<td></td>
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<tr>
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<td></td>
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<td></td>
<td>4.8</td>
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<td>4050</td>
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<tr>
<td>Ash in 100 ML</td>
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<td>0.86</td>
<td>0.59</td>
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<tr>
<td>Mineral in Effluent</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample Gross</td>
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<td></td>
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<td>Extracted Aggregates</td>
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<td>GMS</td>
<td>%Pass</td>
<td>GMS</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>37.50 (1 ½ in)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.00 (1 in)</td>
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<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
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<td>19.00 (3/4 in)</td>
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<td>12.50 (½ in)</td>
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<td>1640</td>
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<tr>
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<td>2866</td>
<td>1874</td>
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</table>

**F / A Ratio________**

**F - T Value________**
Practice Problem
(Answer Sheet)

Utilizing the following Data given from this Laboratory Extraction and Gradation analysis along with the Nuclear Asphalt Content Gauge reading:

A. Calculate the corrected gradation percentage and the corrected bitumen content of each sample increment.

B. Combine the increments arithmetically to form the composite sample result.

C. Calculate the Fines / Asphalt Ratio and the Fifty / Thirty Value for the composite.

<table>
<thead>
<tr>
<th>Individual Bowls</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Composite</th>
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<td>Nuclear Gauge</td>
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<td></td>
<td></td>
<td>4.8</td>
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<tr>
<td>Effluent (ML)</td>
<td>4250</td>
<td>4050</td>
<td>2900</td>
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<tr>
<td>Ash in 100 ML</td>
<td>1.01</td>
<td>0.86</td>
<td>0.59</td>
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<tr>
<td>Mineral in Effluent</td>
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<td>35</td>
<td>17</td>
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<td>8025</td>
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<th>%Pass</th>
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</tr>
<tr>
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<td>(1 ½ in)</td>
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<td>25.00</td>
<td>(1 in)</td>
<td></td>
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</tr>
<tr>
<td>19.00</td>
<td>(3/4 in)</td>
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<tr>
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<td>(½ in)</td>
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<tr>
<td>9.50</td>
<td>(3/8 in)</td>
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<tr>
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<tr>
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<td>.600</td>
<td>(#30)</td>
<td></td>
<td></td>
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<td>(#50)</td>
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<td>2866</td>
<td>1874</td>
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<tr>
<td>Corrected Bitumen</td>
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<td>134</td>
<td>4.4</td>
<td>96</td>
<td>4.8</td>
<td>366</td>
<td>4.6</td>
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</tbody>
</table>

F / A Ratio 1.1
F - T Value +4
Effective Asphalt Content and F/A Calculation
Ohio DOT  Ver4/2011

This worksheet is used only when, according to specification, the calculation of the F/A ratio requires the use of the effective asphalt content. The fines portion of the F/A ratio always requires the use of the P200 from a washed gradation (or dry adjusted P200 from correction between previous dry and washed gradation noted on 199).

Date ___________________ JMF No________________________ Mix sample ID ________

**Step 1  Determine asphalt absorption**

\[ P_{ba} = \text{asphalt absorption, \% by mass of aggregate} \]

\[ G_{se} = \text{bulk specific gravity of aggregate (from mix design)} \]

\[ G_{b} = \text{specific gravity of binder (from mix design)} \]

\[ G_{se} = \text{effective specific gravity of aggregate (calculated):} \]

\[ G_{se} = \frac{P_{nmn} - P_{b}}{G_{nmn} - G_{b}} \quad G_{nmn} = \text{maximum specific gravity (from mix test)} \]

\[ P_{nmn} = 100 \]

\[ P_{b} = \text{asphalt content (from mix test)} \]

\[ G_{b} = \text{specific gravity of binder (from mix design)} \]

\[ G_{se} = \text{Show work:} \]

\[ P_{ba} = 100 \times \frac{G_{se} - G_{sb}}{G_{b}G_{se}} \quad x \quad G_{b} = \text{Show work:} \]

Note: \( G_{sb} \) should always be higher than the \( G_{sb} \), if not don't continue until the problem is corrected.

**Step 2  Determine effective asphalt content**

\[ P_{ba} = \text{effective asphalt content, \% by total mass of mix} \]

\[ P_{b} = \text{asphalt content, \% by total mass of mix (from mix test)} \]

\[ P_{ba} = \text{absorbed asphalt, \% by mass of aggregate (from above)} \]

\[ P_{s} = \text{aggregate content, \% by total mass of mix (100 - P_{b})} \]

\[ P_{be} = P_{b} - \frac{P_{ba} \times P_{s}}{100} \quad \text{Show work:} \]

**Step 3  Determine fines to asphalt ratio (F/A)**

\[ F = \text{washed or corrected dry P200 (attach gradation worksheet)} \]

\[ A = \text{effective asphalt content (P_{ba} from above)} \]

\[ F/A = \text{show work:} \] ephasph2011
Maximum Specific Gravity (Rice)

Practice Problem # 1

Given the following Test Results:

Calculate the Maximum Theoretical Specific Gravity:
NOTE: The sample is from a mix that does not require an SSD weight be obtained.

A = Dry Weight of Mix ------------------------------------------3669.7 grams

A* = S.S.D. Wt. of Sample -------------------------------------2669.7 grams

B = Weight of Container, Mix and Water ------------------------3343.6 grams

C = Weight of Container and Water (Constant) ------------------1809.6 grams

D = B – C

E = A* – D

F = A ÷ E

(Show all Calculations)

ANSWER ____________________
Maximum Specific Gravity (Rice)
Practice Problem # 2

Given the following Test Results:

Calculate the Maximum Theoretical Specific Gravity:
NOTE: The sample is from a mix that does not require an SSD weight be obtained.

A = \text{Dry Weight of Mix} \hspace{2cm} 2667.4 \text{ grams}

A* = \text{S.S.D. Wt. of Sample} \hspace{2cm} 2667.4 \text{ grams}

B = \text{Weight of Container, Mix and Water} \hspace{2cm} 3356.7 \text{ grams}

C = \text{Weight of Container and Water (Constant)} \hspace{2cm} 1809.6 \text{ grams}

D = B - C

E = A* - D

F = A ÷ E

(Show all Calculations)

ANSWER ____________________
Maximum Specific Gravity (Rice)

Practice Problem # 3
(Test Format)

Given the following information:

Calculate the Maximum Theoretical Specific Gravity:
NOTE: This mix is using the SSD weight of the mix in the calculation procedure.

Dry Weight of Mix ------------------------------- 1997.3 grams
S.S.D. Wt. of Sample ------------------------------- 1999.5 grams
Weight of Container, Mix and Water ------------------------------- 7289.1 grams
Weight of Container and Water (Constant) ------------------------------- 6120.9 grams
Temperature of Water -------------------------------- 25 Degrees C
PG Binder % ------------------------------------ 5.5%

(Show all Calculations)

ANSWER ____________________
# BULK SPECIFIC GRAVITY

Example Calculation Worksheet for a Set of (3) Marshall Specimen(s)

<table>
<thead>
<tr>
<th>Compaction Temperature</th>
<th>Weight in Air (A)</th>
<th>SSD Weight (B)</th>
<th>Weight in Water (C)</th>
<th>Volume, cc (D)</th>
<th>Actual Specific Gravity (E)</th>
<th>Max Theo. Specific Gravity (F)</th>
<th>% Air Voids</th>
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</thead>
<tbody>
<tr>
<td>290 F</td>
<td>1168.3</td>
<td>1174.6</td>
<td>668.5</td>
<td>506.1</td>
<td>2.308</td>
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<td></td>
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<tr>
<td>290 F</td>
<td>1170.1</td>
<td>1172.7</td>
<td>670.5</td>
<td>501.8</td>
<td>2.332</td>
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<tr>
<td>290 F</td>
<td>1165.9</td>
<td>1177.7</td>
<td>663.9</td>
<td>503.8</td>
<td>2.314</td>
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<td></td>
</tr>
</tbody>
</table>

Water Temp. is 21°C

Avg. Specific Gravity = 2.318

Corrected Avg. Specific Gravity = 2.320

% Air Voids = 4.3%

* Formula for Calculating % Air Voids:

\[
\frac{E}{F \times 100} - 100 = \% \text{ AIR Voids}
\]

\[
\frac{2.320}{2.425 \times 100} - 100 = 4.3\%
\]

Conversion Chart (This chart is also found in S 1036):
Absolute Density of Water and Conversion Factor (K) for Various Water Temperatures

<table>
<thead>
<tr>
<th>Temperature C</th>
<th>Correction Factor (K)</th>
<th>Temperature C</th>
<th>Correction Factor (K)</th>
</tr>
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<td>0.999467</td>
</tr>
<tr>
<td>17</td>
<td>1.001734</td>
<td>28</td>
<td>0.999187</td>
</tr>
<tr>
<td>18</td>
<td>1.001555</td>
<td>29</td>
<td>0.998898</td>
</tr>
<tr>
<td>19</td>
<td>1.001364</td>
<td>30</td>
<td>0.998599</td>
</tr>
<tr>
<td>20</td>
<td>1.001162</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Formula for Correcting Water Bath Temperature:

\[
\text{Correction Factor (K)} \times \text{Avg. Bulk Specific Gravity} = \text{Corrected Avg. Specific Gravity}
\]

Example for above Test: \[1.000950 \times 2.318 = 2.320\]
Bulk Specific Gravity and % Air Voids

Practice Problem # 1

Given the Following Test Results:

1) Calculate the Bulk Specific Gravity (BSG):

2) Adjust the BSG for Water Bath Temperature:

3) Calculate the % Air Voids:

Dry Weight in Air ------------------------------------------ 1147.5 Grams
S.S.D. Weight ------------------------------------------ 1148.9 Grams
Weight in Water ------------------------------------------ 640.9 Grams
Temperature of Water Bath ------------------------------ 27 Degrees C.
Maximum Theoretical Specific Gravity (MSG) ----------- 2.396

(Show all Work)

Answers:

1) Bulk Specific Gravity (BSG) ____________

2) BSG Corrected for Water Bath Temperature ____________

3) % Air Voids _________
Bulk Specific Gravity and % Air Voids

Practice Problem # 2

Given the Following Test Results:

1) Calculate the Bulk Specific Gravity (BSG):

2) Adjust the BSG for Water Bath Temperature:

3) Calculate the % Air Voids:

Dry Weight in Air ---------------------------------------- 1151.5 Grams

S.S.D. Weight ------------------------------------------ 1152.7 Grams

Weight in Water ---------------------------------------- 652.0 Grams

Temperature of Water Bath ----------------------------- 21 Degrees C.

Maximum Theoretical Specific Gravity (MSG) -------- 2.396

(Show all Work)

Answers:

1) Bulk Specific Gravity (BSG) _____________

2) BSG Corrected for Water bath Temperature ______________

3) % Air Voids ___________
BULK SPECIFIC GRAVITY and % AIR VOID
(Practice Problem #3)

Problem (A)

<table>
<thead>
<tr>
<th>Compaction Temperature</th>
<th>Weight in Air (A)</th>
<th>SSD Weight (B)</th>
<th>Weight in Water (C)</th>
<th>Volume cc (D)</th>
<th>Actual Specific Gravity (E)</th>
<th>Max Theo. Specific Gravity (F)</th>
<th>% Air Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>290</td>
<td>1318.0</td>
<td>1319.5</td>
<td>755.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>290</td>
<td>1183.9</td>
<td>1184.9</td>
<td>679.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>290</td>
<td>1350.8</td>
<td>1351.7</td>
<td>775.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Water Temperature is 28 C

<table>
<thead>
<tr>
<th>Avg. Specific Gravity</th>
<th>Corrected Avg. B.S.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.443</td>
</tr>
</tbody>
</table>

Problem (B)

<table>
<thead>
<tr>
<th>Compaction Temperature</th>
<th>Weight in Air (A)</th>
<th>SSD Weight (B)</th>
<th>Weight in Water (C)</th>
<th>Volume cc (D)</th>
<th>Actual Specific Gravity (E)</th>
<th>Max Theo. Specific Gravity (F)</th>
<th>% Air Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>290</td>
<td>1232.5</td>
<td>1233.0</td>
<td>702.8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>290</td>
<td>1293.8</td>
<td>1294.8</td>
<td>735.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>290</td>
<td>1244.2</td>
<td>1244.8</td>
<td>707.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Water Temperature is 25 C

<table>
<thead>
<tr>
<th>Avg. Specific Gravity</th>
<th>Corrected Avg. B.S.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.405</td>
</tr>
</tbody>
</table>

Problem (C)

<table>
<thead>
<tr>
<th>Compaction Temperature</th>
<th>Weight in Air (A)</th>
<th>SSD Weight (B)</th>
<th>Weight in Water (C)</th>
<th>Volume cc (D)</th>
<th>Actual Specific Gravity (E)</th>
<th>Max Theo. Specific Gravity (F)</th>
<th>% Air Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>290</td>
<td>1202.2</td>
<td>1203.8</td>
<td>693.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>290</td>
<td>1201.3</td>
<td>1201.9</td>
<td>690.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>290</td>
<td>1205.8</td>
<td>1207.8</td>
<td>685.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Water Temperature is 19 C

<table>
<thead>
<tr>
<th>Avg. Specific Gravity</th>
<th>Corrected Avg. B.S.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.438</td>
</tr>
</tbody>
</table>
**BULK SPECIFIC GRAVITY and % AIR VOID**

(Practice Problem # 3 - Answer Sheet)

<table>
<thead>
<tr>
<th>Problem (A)</th>
<th>(B - C)</th>
<th>(A / D)</th>
<th>E/F*100-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction Temperature</td>
<td>Weight in Air (A)</td>
<td>SSD Weight (B)</td>
<td>Weight in Water (C)</td>
</tr>
<tr>
<td>290</td>
<td>1318.0</td>
<td>1319.5</td>
<td>755.5</td>
</tr>
<tr>
<td>290</td>
<td>1183.9</td>
<td>1184.9</td>
<td>679.5</td>
</tr>
<tr>
<td>290</td>
<td>1350.8</td>
<td>1351.7</td>
<td>775.3</td>
</tr>
<tr>
<td>Water Temperature – 28 C</td>
<td>Avg. Specific Gravity</td>
<td>2.341</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrected Avg. B.S.G.</td>
<td>2.339</td>
<td>2.443</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem (B)</th>
<th>(B - C)</th>
<th>(A / D)</th>
<th>E/F*100-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction Temperature</td>
<td>Weight in Air (A)</td>
<td>SSD Weight (B)</td>
<td>Weight in Water (C)</td>
</tr>
<tr>
<td>290</td>
<td>1232.5</td>
<td>1233.0</td>
<td>702.8</td>
</tr>
<tr>
<td>290</td>
<td>1293.8</td>
<td>1294.8</td>
<td>735.6</td>
</tr>
<tr>
<td>290</td>
<td>1244.2</td>
<td>1244.8</td>
<td>707.7</td>
</tr>
<tr>
<td>Water Temperature – 25 C</td>
<td>Avg. Specific Gravity</td>
<td>2.319</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrected Avg. B.S.G.</td>
<td>2.319</td>
<td>2.405</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem (C)</th>
<th>(B - C)</th>
<th>(A / D)</th>
<th>E/F*100-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction Temperature</td>
<td>Weight in Air (A)</td>
<td>SSD Weight (B)</td>
<td>Weight in Water (C)</td>
</tr>
<tr>
<td>290</td>
<td>1202.2</td>
<td>1203.8</td>
<td>693.9</td>
</tr>
<tr>
<td>290</td>
<td>1201.3</td>
<td>1201.9</td>
<td>690.8</td>
</tr>
<tr>
<td>290</td>
<td>1205.8</td>
<td>1207.8</td>
<td>685.9</td>
</tr>
<tr>
<td>Water Temperature – 19 C</td>
<td>Avg. Specific Gravity</td>
<td>2.339</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrected Avg. B.S.G.</td>
<td>2.342</td>
<td>2.438</td>
</tr>
</tbody>
</table>
# Field Test Worksheet

## Extraction, Dust Correction & Gradation

<table>
<thead>
<tr>
<th>SIEVE #</th>
<th>WEIGHT RETAINED</th>
<th>% PASSING</th>
<th>RICE TEST</th>
<th>(A) DRY WT. OF MIX</th>
<th>1561.1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(A*) SSD WT. OF MIX</td>
<td></td>
</tr>
<tr>
<td>2&quot;</td>
<td>SOLVENT</td>
<td>3040</td>
<td></td>
<td>(B) CONT. OF MIX &amp; WATER</td>
<td>8428.1</td>
</tr>
<tr>
<td>1.5&quot;</td>
<td>DISH &amp; ASH</td>
<td>85.50</td>
<td>(C) CONT. OF WATER (CONST)</td>
<td>7501.1</td>
<td></td>
</tr>
<tr>
<td>1.0&quot;</td>
<td>DISH</td>
<td>84.62</td>
<td>(B - C) = (D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>300</td>
<td></td>
<td>(A* - D) = (E)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>½&quot;</td>
<td>1220</td>
<td>MIN. in EFF.</td>
<td>(A + E) = (F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>1449</td>
<td>PAN WEIGHT</td>
<td>479.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>1514</td>
<td>ORIG. WT.</td>
<td>3000</td>
<td>TIME</td>
<td>WEIGHT</td>
</tr>
<tr>
<td>#8</td>
<td>1644</td>
<td>EXT. WT</td>
<td>2844</td>
<td>10:30</td>
<td>2045.0</td>
</tr>
<tr>
<td>#16</td>
<td>1793</td>
<td>NET WT.</td>
<td>10:45</td>
<td>2043.1</td>
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</tr>
<tr>
<td>#30</td>
<td>2024</td>
<td>BIT WT.</td>
<td>11:00</td>
<td>2041.3</td>
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<tr>
<td>#50</td>
<td>2343</td>
<td>% AC</td>
<td>11:15</td>
<td>2041.1</td>
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</tr>
<tr>
<td>#100</td>
<td>2748</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#200</td>
<td>2784</td>
<td>Uncorrected Gauge AC%</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAN</td>
<td>2843</td>
<td>% Moisture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corrected Gauge AC %</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MIX & PAN WT. __2986__  DRY MIX & PAN WT. __2979__

PAN WT. __483__  % MOISTURE

<table>
<thead>
<tr>
<th>PILLS</th>
<th>DRY WEIGHT (A)</th>
<th>SSD WEIGHT (B)</th>
<th>WT. IN WATER (C)</th>
<th>B - C (D)</th>
<th>A + D (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1208.7</td>
<td>1209.7</td>
<td>701.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1181.2</td>
<td>1182.4</td>
<td>681.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1216.0</td>
<td>1216.7</td>
<td>708.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WATER BATH TEMPERATURE = 26 C

AVG. BSG

CORR. BSG
# Field Test Worksheets (Answer Sheet)

## SIEVE #

<table>
<thead>
<tr>
<th>SIEVE #</th>
<th>WEIGHT RETAINED</th>
<th>% PASSING</th>
<th>(A) DRY WT.. OF MIX</th>
<th>(A*) SSD WT. OF MIX</th>
<th>(B) CONT. OF MIX &amp; WATER</th>
<th>(C) CONT. OF WATER (CONST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>½&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Mix & Pan WT.

<table>
<thead>
<tr>
<th>MIX &amp; PAN WT.</th>
<th>DRY MIX &amp; PAN WT.</th>
<th>PAN WT.</th>
<th>% MOISTURE</th>
<th>SSD Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2986</td>
<td>2979</td>
<td>483</td>
<td>0.3</td>
<td>1561.9</td>
</tr>
</tbody>
</table>

## Pills

<table>
<thead>
<tr>
<th>DRY WEIGHT (A)</th>
<th>SSD WEIGHT (B)</th>
<th>WT. IN WATER (C)</th>
<th>B - C (D)</th>
<th>A ÷ D (E)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1208.7</td>
<td>1209.7</td>
<td>701.0</td>
<td>508.7</td>
<td>2.376</td>
<td>MSG (RICE)</td>
</tr>
<tr>
<td>1181.2</td>
<td>1182.4</td>
<td>681.9</td>
<td>500.5</td>
<td>2.360</td>
<td></td>
</tr>
<tr>
<td>1216.0</td>
<td>1216.7</td>
<td>708.5</td>
<td>508.2</td>
<td>2.393</td>
<td>% AIR VOID</td>
</tr>
</tbody>
</table>

## Water Bath Temperature

<table>
<thead>
<tr>
<th>WATER BATH TEMPERATURE = 26 C</th>
<th>AVG. BSG</th>
<th>CORR. BSG</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.376</td>
<td>2.375</td>
<td>3.4</td>
</tr>
</tbody>
</table>
Section 3, Control Charts

441.10 .................................................................................................................. 2
441.10-1 Reference Table ....................................................................................... 3
Air Void Practice Problem ....................................................................................... 4
Asphalt Content Practice Problem ......................................................................... 5
Moving Range Example .......................................................................................... 6
441.10 Control Charts.

Maintain up to date control charts showing each individual test result and also the moving accumulative range as follows:

A. Plot tests showing the percent passing for the 1/2 inch (12.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), and No. 200 (75 μm) sieves the percent asphalt binder content, the MSG and the percent air voids. Round all percentages to the nearest whole percent; except, round asphalt binder content, the No. 200 (75 μm) sieve, and air voids to the nearest 0.1 percent.

B. Show the out of specification limits specified in Table 441.10-1 and QCP Warning Band Limits on the control charts.

C. Label each control chart to identify the project, mix type and producer.

D. Record the moving accumulative range for three tests under each test point on the chart for air voids and asphalt binder content. Accumulative range is defined as the positive total of the individual ranges of two consecutive tests in three consecutive tests regardless of the up or down direction tests take. If more than the minimum required testing (i.e. two tests per production day or night, 441.09 first paragraph) is performed do not include the result in accumulative range calculations.

Stop production and immediately notify the Monitoring Team when either A or B occurs:

A. Any two tests in a row or any two tests in two days are outside OF the specification limits of Table 441.10-1.

B. Any four consecutive moving accumulative ranges greater than specification limits of 2.50 percent for air voids or 0.60 percent for asphalt binder content occur. Any mixture sent to the paving site without stopping production and notifying the Monitoring Team when required by this specification will be considered non-specification material.

Do not restart production until an adequate correction to remedy problems is in place and the Monitoring Team is satisfied. Following a shutdown restart production in a manner acceptable to the DET. When production problems cannot be solved within one day after a plant shut down a Contractor’s representative holding a Level 3 Asphalt Department approval is required to be at the asphalt plant until a full production day is achieved with results satisfactory to the Monitoring Team.
<table>
<thead>
<tr>
<th>Mix Characteristic</th>
<th>Out of Specification Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Binder Content[1]</td>
<td>-0.3% to 0.3%</td>
</tr>
<tr>
<td>1/2 inch (12.5 mm) sieve[1]</td>
<td>-6.0% to 6.0%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm) sieve[1]</td>
<td>-5.0% to 5.0%</td>
</tr>
<tr>
<td>No. 8 (2.36 mm) sieve[1]</td>
<td>-4.0% to 4.0%</td>
</tr>
<tr>
<td>No. 200 (75 mm) sieve[1]</td>
<td>-2.0% to 2.0%</td>
</tr>
<tr>
<td>Air Voids[2]</td>
<td>2.5 to 4.5</td>
</tr>
<tr>
<td>Air Voids[3]</td>
<td>3.0 to 5.0</td>
</tr>
<tr>
<td>MSG[4]</td>
<td>-0.012 to 0.012</td>
</tr>
</tbody>
</table>

[1] deviation from the JMF
[2] for Design Air Voids of 3.5%
[3] for Design Air Voids of 4.0%
[4] deviation from the MTD
***When producing Asphalt Concrete Mix for an ODOT project which is governed under ODOT’s 441.10, you must plot each Individual Test Result and record the accumulative range (for AV and AC only) on a Control Chart.

Using the Test Results Provided below:
(1) Set up your control chart to include the Specification Band Limit and the QCP Warning Band Limit of (-3.2% to 4.8%) for plotting Air Void test results.

(2) After setting up your Control Chart, Plot each of the Individual Test Results and calculate the accumulative range results for the following Air Void Tests.

*This is a 4.0% Air Void Designed Mix:*

The First Air Void test result shows a 4.6%

The Second Air Void test result shows a 5.2%

The Third Air Void test result shows a 4.8%

The Fourth Air Void test result shows a 4.1%

The Fifth Air Void test result shows a 6.2%

The Sixth Air Void test result shows a 6.1%

<table>
<thead>
<tr>
<th>Test Result</th>
<th>Air Void (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>4.6</td>
</tr>
<tr>
<td>2nd</td>
<td>5.2</td>
</tr>
<tr>
<td>3rd</td>
<td>4.8</td>
</tr>
<tr>
<td>4th</td>
<td>4.1</td>
</tr>
<tr>
<td>5th</td>
<td>6.2</td>
</tr>
<tr>
<td>6th</td>
<td>6.1</td>
</tr>
</tbody>
</table>
***When producing Asphalt Concrete Mix for an ODOT project which is governed under ODOT’s 441.10, you must plot each Individual Test Result and record the accumulative range (for AV and AC only) on a Control Chart.

**Using the Test Results Provided below:**

1. Set up your control chart to include the Specification Band Limit and the QCP Warning Band Limit of (-0.2% to 0.2%) for plotting Asphalt Content test results.

2. After setting up your Control Chart, Plot each of the Individual Test Results and calculate the accumulative range results for the following Asphalt Content Tests.

_The JMF Asphalt Content is a 5.8%_

The First Asphalt Content test result shows a 6.1%

The Second Asphalt Content test result shows a 6.1%

The Third Asphalt Content test result shows a 5.8%

The Forth Asphalt Content test result shows a 5.6%

The Fifth Asphalt Content test result shows a 5.5%

The Sixth Asphalt Content test result shows a 5.9%
### MOVING RANGE EXAMPLE – AC%

<table>
<thead>
<tr>
<th>AC%</th>
<th>6.0</th>
<th>5.4</th>
<th>6.3</th>
<th>6.0</th>
<th>5.8</th>
<th>6.2</th>
<th>6.0</th>
<th>6.1</th>
<th>5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff.</td>
<td>-</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Range</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
<td>1.2</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

### MOVING RANGE LIMITS*

<table>
<thead>
<tr>
<th></th>
<th>2.50%</th>
<th>0.60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Voids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For four consecutive ranges

**Notes:**
- Used only for Air Voids and AC Graphs
- Only use the results obtained from the minimum, randomly selected, two QC tests/day

\[
\begin{align*}
\text{AC} &= 6.0-5.4=0.6 \\
&= 5.4-6.9=0.9 \\
&= 6.3-6.0=0.3 \\
&= 6.0-5.8=0.2 \\
&= 5.8-6.2=0.4 \\
&= 6.2-6.0=0.2 \\
&= 6.0-6.1=0.1 \\
&= 6.1-5.5=0.6
\end{align*}
\]

AC on two test and the difference

Range = 1\textsuperscript{st} Test=1.5 2\textsuperscript{nd} Test=1.2 3\textsuperscript{rd} Test=0.5 4\textsuperscript{th} Test=0.6 5\textsuperscript{th} Test=0.6 6\textsuperscript{th} Test=0.3 7\textsuperscript{th} Test=0.7
Section 4, Sampling Hot Mix Asphalt:

Sampling Procedure........................................................................................................3-8
Supplement 1035 (4-18-2008), .................................................................(3 pages)
Random Sampling Calculation ..........................................................................................13
Sampling Asphalt Concrete Mix

A. Sampling – General

1. Importance of Sampling

   a. Sampling helps determine quality of material accepted by ODOT

   b. Sampling helps determine proper payment to the contractor

      (1) Incentive pay above bid price
      (2) Full pay
      (3) Reduced pay

   c. Critical variables in construction

      (1) Materials
      (2) Production process
      (3) Sampling
      (4) Testing
      (5) Construction operations

   d. Deficiency in any of these is detrimental to achieving a quality pavement

2. Importance of Sampling Asphalt Concrete Mix

   a. Proper sampling of asphalt concrete mix is critical to determining specification compliance

   b. Correct procedure at all levels is essential

      (1) Components of the asphalt concrete mix are sampled or certified prior to production of the asphalt concrete mix
      (2) Asphalt concrete mix is sampled at production facility and at project
      (3) Sampling is performed by both contractor and ODOT personnel

The ODOT Sampling and Testing Manual provides guidance on sampling and testing requirements for ODOT personnel
B. Sampling Procedure

1. Concept of Sampling Procedure

   a. For many years, one sample was thought to be sufficient to represent a large quantity of material.

   b. In the late 1970s, ODOT introduced the emerging concept of statistically-oriented specifications, which used the principles of:

      (1) Random sampling
      (2) Using the average of multiple samples
      (3) Sampling from lots and sublots of material

2. Proper Sampling Procedure

   a. A sample is properly taken if it is....

      (1) Representative of the material
      (2) Properly randomized and in conformance with agency procedures

   b. An improperly taken sample can skew the results of the QC and acceptance procedure by indicating that....

      (1) Bad material is acceptable
      (2) Good material is not-approved

3. Value of Proper Sampling

   a. The material represented by a sample of the asphalt concrete mix can have a value of up to $50,000

   b. A sample taken improperly can result in....

      (1) ODOT accepting non-specification material
      (2) The contractor receiving reduced pay for material which meets specifications
      (3) The contractor having to remove and replace material which meets specifications
4. Sampling Before Production

a. Approvals are responsibility of ODOT Office of Materials Management (Central Lab) in cooperation with District Testing Offices

b. Coarse and fine aggregates are certified by producer and sampled by District Testing personnel at aggregate plants and asphalt concrete mix facilities

c. Asphalt binder is certified by producer and check sampled by ODOT Central Lab

5. Sampling During Production at the Asphalt Concrete Mix Plant

a. Most sampling at the asphalt concrete mix plant is performed by contractor's plant technician as part of quality control function

b. ODOT personnel (Monitoring Team) observe sampling and testing at the asphalt concrete mix plant and take samples as part of verification acceptance process

6. Sampling at the Project

a. ODOT personnel participate in acceptance sampling procedure at the project by determining location of random samples for 446 and taking samples of 448 when required

   (1) 446 sample core locations determined by random number calculation
   (2) 448 mix is sampled from road or hopper if construction or plant QC problems occur

C. Sampling Asphalt Concrete Mix Specification Items

1. Sampling 301 and 302

   a. Sampled at the asphalt concrete mix plant from truck selected at random by contractor's QC technician

   b. Monitoring team picks up "split samples" for testing by District Lab

2. Sampling 448

   a. Contractor's QC technician randomly selects truck, takes and tests samples for quality control at the asphalt concrete mix plant
b. Contractor's QC technician takes and splits sublot acceptance samples from truck selected at random by Monitoring Team

c. Monitoring Team picks up split samples for testing at District Lab

d. If problems arise placing mix at project, such as segregation, or if QC problems persist at the asphalt concrete mix plant, Monitoring Team may require that acceptance samples be taken from paver hopper or from behind paver at locations selected randomly by project personnel

3. Sampling 446

a. Contractor is responsible for cutting cores from completed pavement at random locations determined by ODOT personnel

b. ODOT personnel are responsible for calculating random sampling locations and for making information available to contractor in a timely manner

c. ODOT personnel are responsible for taking immediate possession of and carefully handling cores cut from pavement to prevent damage

d. Cores are to be delivered to District Lab for testing as soon as possible

D. Sampling Materials

1. Sampling Aggregate

a. Aggregate can be sampled at

   (1) Project
   (2) Asphalt Concrete Mix plant
   (3) Aggregate plant

b. Aggregate can be sampled from

   (1) Roadway
   (2) Stockpile
   (3) Bin
   (4) Belt

c. The proper sampling tools for taking an aggregate sample are:

   (1) A shovel with turned-up edges
   (2) A bag, bucket, or other suitable container
(3) Material for identifying the sample and attaching it to the container

2. Sampling Asphalt Binder

a. Asphalt binder can be sampled from
   (1) Asphalt Concrete Mix plant
   (2) Asphalt terminal

b. Proper equipment
   (1) Metal quart can
   (2) Gloves
   (3) Identification material

c. Proper procedure
   (1) Let material flow before filling sample container

3. Sampling Tack and Prime

a. Liquid asphalt for 407 Tack Coat and 408 Prime Coat shall be certified when delivered to project

b. One sample per project of each is required unless amount used is a "small quantity"

c. Sample from distributor or storage tank on project

   (1) One quart in plastic screw top container for tack (asphalt emulsion)

   (2) One quart in metal screw top container for prime (cutback asphalt)

4. Sampling Asphalt Concrete Mix

a. Asphalt concrete mix is usually sampled from trucks at the asphalt concrete mix plant selected randomly

b. Proper equipment
   (1) Shovel or scoop with turned-up edges
   (2) Sturdy metal container
   (3) Thermometer
   (4) Identification material
c. Asphalt concrete mix can be sampled at the project from the paver hopper or pavement behind the paver
d. It is sampled at random locations and in accordance with Supplement 1035
e. Proper equipment
   (1) Sampling tube for hopper
   (2) Plate sampler for pavement
   (3) Suitable metal container
   (4) Spatula, trowel, and nails
   (5) Identification material

E. Goal of Sampling

1. The goal of a sampling program is to provide a true representation of the materials used, and in that way contribute to building quality pavements

2. ODOT and contractor personnel can achieve this goal by the following
   a. Familiarity with construction materials
   b. Knowledge of sampling requirements
   c. Adherence to proper sampling methods
   d. Care in taking and processing samples
STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

SUPPLEMENT 1035
FIELD SAMPLING ASPHALT CONCRETE

April 18, 2008

1035.01 General. Field samples of asphalt concrete will be selected by a stratified random sampling procedure and taken from the mat behind the paver. If the mat thickness is less than 1.25 inch (32 mm) the samples will be taken from the paver hopper. A sample form for determining and documenting the location of material in each subplot to be sampled is attached.

1035.02 Equipment. The equipment required for taking samples includes:

1. Spatula or scraping device
2. Clean sample pan
3. Asphalt concrete mix sampling tube
4. Clean metal plates, Three 10" x 10" (250 mm x 250 mm) for mat thickness of 1.25 to 2 inches (32 to 50 mm)
5. Nails
6. Trowel or other form of lifting device

1035.03 Random Selection of Sample. Obtain four random samples, taken from within four sublots or partial lots, to represent each specified lot. Determine the particular location of material to be sampled by applying a random percent number, as obtained from the random number table, to the total tonnage in the sublot or partial lot. The location of production material selected shall be anticipated in its particular truck and in the first, second, or last third fraction of that load. When the approximate location of material is being placed, the sample shall be taken.

1035.04 Taking Samples

1. Mat - Place the plate in the path of the paver so the sample will be obtained when the desired ton is fed into the spreading screws. Determine where the plate will be located transversely from the edge of pavement by applying a second random percent number to the total width of the mat. If the transverse location selected is in imminent conflict with the paving equipment, the plate shall be moved laterally to the nearest suitable location within the mat width. Nails should be used to prevent the plate from sliding. Mark the location of the plate so that after the paver has passed, the plate may be found by probing the mat with a trowel. The trowel may then be used to lift the plate and sample from the mat. The plate and sample should be placed into the sample pan.
2. **Paver hopper** - Samples are taken alternately from over right and left flight feeders when the desired ton is in the hopper. With the loading interrupted and the truck pulled away from the paver, the correct size of sampler is sunk into the mix to collect a proper sample. Material is deposited from the sampler into the sample pan. Fine materials are scraped from inside the sampler, placed in the pan, and the spatula is scraped on the side of the pan. Sample size shall not be less than 22 lbs (10 kg).

**1035.05 Identification and Shipment**  The sample data card (TE-10) is completed, placed in an envelope and wrapped up with the pan. The sample no will also be created in CMS; the information completed in CMS; and a copy of the sample screen submitted with the sample. The wrapped sample shall be tagged and shipped to the District Testing Engineer.
# OHIO DEPARTMENT OF TRANSPORTATION
## RANDOM SELECTION OF ASPHALT CONCRETE FIELD SAMPLES

Project No. _________________  Item Type _________________
Reference No. _______________  Lot No. _________________

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUBLOT</strong></td>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
<td><strong>C</strong></td>
</tr>
<tr>
<td>1.</td>
<td>Initial accumulative total of weight laid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Sublot size or partial estimate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Random percentage number from table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Location in sublot to be sampled (2 X 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Accumulative weight at sample location (1 + 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Initial accumulative total for next sublot (1 + 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Station where sample taken</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*9.</td>
<td>Width of mat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*10.</td>
<td>Random percentage number from table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*11.</td>
<td>Distance from edge (right or left) or pavement (9 X 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Location of sublot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Dates Placed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Used when taking mat samples.*
Random Sampling Procedure

The Inspector in charge of sampling shall determine four (4), random two (2) digit numbers, from an approved table for each lot. These four (4), two (2) digit numbers shall be entered on the Bituminous Concrete Sampling Sheets. To determine the four (4) random numbers, start at a random point by placing a pencil aimlessly on the approved table of random digits.

**Example 1:** The pencil point picks digit 8, it’s in row 28 column 75. The digit 8 plus the next the next three (3) digits 541 gives row 85, column 41. In row 85 and column 41 find the digit 0 plus the next seven (7) digits to the right, they are 5405472.

These eight (8) digits give the four (4) random numbers 05, 40, 54, and 72.

Using these numbers as percentages, the random ton to be sampled is determined by multiplying the percentage number times the sub-lot or partial sub-lot size. If a lot is not a full lot and consists of maybe 2700 tons, then sublots A, B, & C would be 750 tons and sublot D (partial) would be 450 tons.

**Example Calculation of the Random Ton to be sampled for the Above Lot Size would be:**

- Sublot A = (.05 x 750) = 37.5 tons + 0 tons accumulative = 37.5 tons
- Sublot B = (.40 x 750) = 300 tons + 750 tons accumulative = 1050 tons
- Sublot C = (.54 x 750) = 405 tons + 1500 tons accumulative = 1905 tons
- Sublot D = (.72 x 450) = 324 tons + 2250 tons accumulative = 2574 tons

**If you needed a second set of random numbers for the width of the mat (see below)**

Get these numbers the same way as outlined in Example 1: New Numbers 09, 50, 67, and 75.

- Sublot A = (.09 x 12) = 1.0 foot from edge of mat
- Sublot B = (.50 x 12) = 6.0 feet from edge of mat
- Sublot C = (.67 x 12) = 8.0 feet from edge of mat
- Sublot D = (.75 x 12) = 9.0 feet from edge of mat

**Example 2:** If our pencil point picks the 3 at row 49, column 68, and our next 3 digits are 395. From here we go to row 33 column 95 and find the digit 3. To the right there are less than 7 digits on the table, so we must use the 7 digits to the left. They are 3205497. So the random numbers using this example would be 32, 05, 49, and 73.
Section 5, Supplemental Specifications and Supplements for Tests:

SS 800 – Asphalt Revisions to 2013 CMS (10-17-2014) ------------------ 23 pages
  Changes to 400 (18Jan2015) (11 pages)-----------------------------11 pages
  Changes to 442 (18Jan2015) (3 pages)-----------------------------3 pages
S 1036 – Determination of % Air Voids (Draft 1-16-2015) -------------- 4 pages
S 1037 – Determination of % Voids in VMA (4-18-2008) -------------- 2 pages
S 1038 – Quantitative Extraction VMA (4-18-2008) ----------------- 4 pages
S 1039 – Mechanical Analysis of Extracted Aggregate (4-18-2008) ------ 2 pages
S 1043 – Calibration/Test Procedures for Nuclear AC Gauge(1-18-2013) -- 8 pages
  Formula for Calculation of AC for Mixing .................................. 1 page
  Nuclear Gauge Offset Example Form ............................................ 1 page
S 1054 – Test Method for Ignition Oven(4-18-2008) ------------------- 7 pages
103.05
On page 17, Replace the subsection with the following:

**103.05 Requirement of Contract Bond.** Furnish Contract Bonds within 10 days after receiving notice of award. Furnish Contract Bonds to the Director on the prescribed form, in the amount of the contract, and according to ORC 5525.16.

105.17
On page 29, Replace the last paragraph with the following section:

Clean hard fill consisting of reinforced or non-reinforced concrete, asphalt concrete, brick, block, tile or stone that is free of all steel as per 703.16 shall be managed in one or more of the following ways:

1. Recycled into a usable construction material.
2. Disposed in licensed construction and demolition debris facility.
3. Used in legitimate fill operations on the site of generation according to 105.16.
4. Used in legitimate fill operations on a site other than the site of generation to bring a site up to grade on an existing roadbed or parking lot project.

A Beneficial Reuse Certification form needs to be properly executed by the Recipient prior to any material leaving the project.

106.09.E
On page 33, Replace the subsection with the following:

**E. Manufactured Products.** In order for a manufactured product to be subject to Federal requirements, the product must consist of at least 90% steel or iron content when it is delivered to the job site for installation.

Examples of products subject to Federal requirements include, but are not limited to, the following:

1. Steel or iron products used in pavements, bridges, tunnels or other structures, which include, but are not limited to, the following: fabricated structural steel, reinforcing steel, piling, high strength bolts, anchor bolts, dowel bars, permanently incorporated sheet piling, bridge bearings, cable wire/strand, prestressing/post-tensioning wire, motor/machinery brakes and other equipment for moveable structures;
2. Guardrail, guardrail posts, end sections, terminals, cable guardrail;
3. Steel fencing material, fence posts;
4. Steel or iron pipe, conduit, grates, manhole covers, risers;
5. Mast arms, poles, standards, trusses, or supporting structural members for signs, luminaires, or traffic control systems; and
6. Steel or iron components of precast concrete products, such as reinforcing steel, wire mesh and pre-stressing or post-tensioning strands or cables
255.07  **Wearing Course Replacement.** Replace the removed asphalt concrete overlay with Item 301 or 441 Type 2 material as shown on the plans. Compact these mixtures as approved by the Engineer using any of the roller types specified in 401.13. Apply Item 407 tack coat to the replacement surfaces.

255.07
On page 145, **Replace** the third paragraph with the following:
Seal the perimeter surface of the repaired areas by applying a 2 inch (50 mm) to 4 inch (100 mm) wide strip of approved 705.04 material or 702.01 approved PG binder.

255.08
On page 145, **Replace** the last paragraph with the following:
If maintaining traffic in adjacent lanes, schedule work in order to place the concrete in the prepared repair area within 48 hours after removing the existing pavement. In accordance with standard drawing MT-101.90, drums may be used as a separator to the adjacent traveled lane for repairs 60 feet or less in length. If unable to complete placement of the concrete in the exposed repair area by the end of the daily work shift, fill repair areas less than 4 feet from the traveled lane with a temporary patch material suitable to the Engineer or cover unfilled repair areas 10 feet (3 m) or less in length with a steel plate. Do not leave repair areas unfilled with concrete when work is suspended on weekends or holidays. If unable to complete placement of the concrete in the exposed repair area before suspending work for a weekend or holiday or within the time specified above, fill the excavation with an asphalt concrete mixture or other suitable temporary patch material with a durable surface as the Engineer directs. Maintain the temporary patches while they are in service.

255.10
On page 146, **Replace** the second paragraph with the following:
The Department will include tack coat in the cost of the asphalt concrete. The Department will pay for asphalt concrete according to Item 301 or Items 441.

256.08.
On page 148, **Replace** the entire section 256.08 with the following:
256.08  **Curing and Opening to Traffic.** Cure Type A patches according to 451.11, except allow the patch to attain a modulus of rupture of 400 pounds per square inch (2.8 MPa) before opening to traffic. Cure Types B and C patches according to the manufacturer’s recommendations.

301.02
On page 155, **Replace** the second paragraph of 301.02 with the following:
Submit for the Laboratory’s approval the desired percentage of the aggregate passing the No. 4 (4.75 mm) sieve and blend of individual components. The Contractor may use reclaimed asphalt concrete pavement according to 401.04. The Laboratory will establish the required binder content within a range of 4.7 to 7 percent. Do not make changes in these JMF values due to unsatisfactory results or other conditions except as authorized by the Laboratory. Obtain a new JMF approval for any desired change to an existing JMF.

301.04
On page 155, **Replace** 301.04 with the following:
301.04 Spreading and Finishing. Ensure that the maximum compacted depth of any one layer is 6 inches (150 mm). Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C). Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

302.02
On page 157, Replace the third, fourth and fifth paragraph of 302.02 with the following:

The Contractor may use reclaimed asphalt concrete pavement according to 401.04. Should problems with proper coating or other material issues related to the use of reclaimed asphalt concrete pavement or reclaimed asphalt shingles be evident, the Laboratory may restrict the allowable percentage of reclaimed asphalt concrete pavement to the reduced limits shown in tables 401.04-1 and 401.04-2 or may eliminate use of reclaimed asphalt shingles. In this case the virgin binder content will be adjusted by the Laboratory.

Add hydrated lime in the dry form at a rate of 0.75 percent by the dry weight of aggregate for asphalt concrete base, if antistrip additive is required and hydrated lime is used.

Design the asphalt concrete base to yield 4.0 percent air voids and the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Acceptable Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Binder Content, %</td>
<td>Note 1</td>
</tr>
<tr>
<td>Stability, lb (N), 70 blow</td>
<td>3000 (13,345)</td>
</tr>
<tr>
<td>Flow, 0.25 mm, 70 blow</td>
<td>--</td>
</tr>
<tr>
<td>Voids in Mineral Aggregate %</td>
<td>12.0</td>
</tr>
<tr>
<td>Note 1: See Tables in 401.04</td>
<td></td>
</tr>
</tbody>
</table>

302.04
On page 158, Replace 302.04 with the following:

302.04 Spreading and Finishing. Ensure that the compacted depth of any one layer is a minimum of 4 inches (100 mm) and a maximum of 7.75 inches (190 mm). Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C). Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

401.17
On page 181, Add the following after the 1st paragraph of 401.17:

Construct longitudinal joints using string line or other controls as a point of reference to provide a straight longitudinal joint. Prior to placing adjacent pavement, trim any locations along the longitudinal joint that deviate horizontally from the point of reference. Maintain a consistent overlap of 1 inch to 1 ½ inches on adjacent pavement when closing longitudinal joints.

402.03
On page 183, Replace the first two paragraphs with the following:

402.03 Polymer Binders. If an asphalt binder is modified by SBR at an asphalt concrete mixing plant, equip the plant with an automated SBR flow control and monitoring system. Obtain the Department’s approval of the system before operating and demonstrate the system calibration to the District. If the District waives the demonstration, provide a letter documenting calibration data for the
flow system to the DET for each project. Obtain written approval from the Laboratory for the use of SBR and ensure the QCP contains methods for properly controlling and sampling SBR binder blends.

For drum mix plants, introduce the SBR directly into the asphalt binder line through means of an in-line motionless blender or other device approved by the Laboratory which is able to provide a homogeneous blend. Ensure the in-line motionless blender design provides aggressive interaction of asphalt binder and SBR emulsion to provide a homogenous blend at the sampling port. Some blenders such as ‘swirl’ type blenders do not accomplish proper blending. The Astec in line SBR blender or similar design accomplishes proper blending. Locate a sampling valve between the in-line blender and the plant drum, at least 12 ft (3 m) downstream of the in-line blender and at least 5 ft (1 m) downstream of a piping elbow. Ensure the sampling valve port is at least 1 in. (2.54 cm) in diameter. Ensure the sampling valve can be opened quickly for maximizing sample flow for the purpose of obtaining a proper sample. In place of an in-line sampling valve, a sample may be taken from a 3-5 gallon (11-19 liter) surge tank as long as the tank is downstream of the required blender and the in-line flow can be quickly and directly diverted to the surge tank. Contents of the tank should be drained into a 5 gallon (19 liter) sampling bucket and stirred before filling the required sample container. Provide a sampling valve port that is in a position to safely obtain the required sample volume in the required 5 gallon (19 liter) sampling bucket. Provide a stable sampling rack to obtain a sample.

402.04
On page 184, Replace Item 2 in the first paragraph with the following:

2. Injection equipment has variable water injection control controlled by the plant operation rate and the water injection can never exceed 2.2 percent by weight of asphalt binder.

403.03
On page 185, Replace the entire subsection with the following:

403.03 Quality Control Program (QCP). Create and implement a Quality Control Program (QCP) for each paving season. The QCP will cover processes conducted to provide an asphalt mixture at the paving site that is uniform in composition, conforms to the specification requirements and that when placed is free of any defect (ex. segregation, lack of mixture and texture uniformity, raveling, rutting, holes, debris etc.) within the Contractor’s control at project completion. A minimum of 3 weeks before mix production, but no later than February 28, submit a hard copy of the proposed QCP to the Laboratory for review and approval. Send a hard copy and a digital copy (if available) of the approval letter and approved QCP to the DET in every District in which work is performed. Keep copies of the approval letter and the approved QCP in each Contractor plant laboratory and plant operation control room. Digital copies of the approved QCP and approval letter in pdf format are allowed in each Contractor plant laboratory and plant operation control room with the following requirements: The file icon must be appropriately labeled and be on the computer desktop of a computer in each area, the QCP must contain a Table Of Contents inside the front cover locating all sections by page number and the QCP must be page numbered, and out of date QCPs must be removed from the computer desktop. Failure to comply with the approved QCP may result in removal of personnel in accordance with Supplement 1041, removal from VA, and adversely affect the Contractor’s Prequalification rating. The QCP is a reflection of a Contractor’s sincerity and ability in producing a quality product. Development of this program beyond the minimum requirements specified below is encouraged and is taken into consideration by the QCQC when reviewing Contractor plant operation for qualification for VA.
Include in the program:

A. The assignment of quality control responsibilities. Quality control includes all efforts required to achieve a product meeting specifications. The QCP will list individuals as required below and note their designated responsibilities to meet QCP requirements. Provide a Quality Control Manager holding a Supplement 1041 Level 3 approval and who is a company employee. Assign Level 2 technicians for all Level 2 QC testing duties, and provide a list designating their responsibilities and expected actions. Ensure only approved personnel handle and test samples at all times. If Level 2 consultant technicians are used provide a document in the QCP and to them listing designated responsibilities and expected actions (if different from employee expectations). Define in the QCP who is responsible at plants and specific methods for assuring haul vehicles meet all requirements and proper bed release products are used. Provide a Field Quality Control Supervisor (FQCS), holding Supplement 1041 Field Quality Control Supervisor approval and who is a company employee, who is routinely and usually at the paving site during placement of any non-temporary asphalt concrete pavement. Ensure personnel obtaining and handling cores at the project site are approved Level 2 technicians, FQCS or personnel approved by the Laboratory.

B. Provisions to meet the Department mix specifications.

C. Procedures for extra testing (e.g., job start, responses to poor test results or field mix problems, aggregate stock testing, reclaimed asphalt concrete pavement checks, moistures) and any other testing necessary to control materials not already defined in these Specifications.

D. Methods to maintain all worksheets, including all handwritten records, and other test and sample records from the plant or project for the duration of the contract or 5 years, whichever is longer. Define the test record process. Define company records retention requirements. Provide copies of all test reports and forms used in the quality control process.

E. Procedures for equipment calibration and documentation for Level 2 lab equipment. Provide documentation that all Level 2 lab equipment has been calibrated at the time of the Level 2 lab approval inspection. Procedures for calibration record storage.

F. Method of Quick Calibration and documentation for each plant type.

G. Procedure for random sampling to be used at the plant and documentation method. Procedures for sample taking, tracking, handling and documentation method for all samples taken at the project paving site including taking of all cores used for density determination or density gauge correlation.

H. All procedures to meet the processing, testing and documentation requirements for RAP and RAS in 401.04 including test forms, record keeping, technician responsibilities, etc.

I. Procedure for ensuring that every Contractor employee involved in the testing of asphalt mix and operation of the asphalt plant facility has read the QCP and has on site access to all applicable Department specifications, proposals, policies, and the current approved JMF.

J. Means to meet the handling and storage requirements of 402.03 and asphalt binder suppliers for all asphalt binders.

K. Means to meet delivered mixture uniformity/coating and hauling/trucking requirements.

L. Define the roles and responsibilities of the Field Quality Control Supervisors. List approved Field Quality Control Supervisors.

M. Signature of the Quality Assurance Manager and, if different, the person in authority to enforce all operations covered by the QCP as outlined in this subsection.

N. Specify in the QCP warning bands to be used by technicians for all tests and give specific instruction how they will be used for tests in concert with Table 441.10-1 specification requirements.

403.05
On page 188, Replace the first three paragraphs with the following:

403.05 Quality Control Tests. Perform quality control tests to control the asphalt concrete mix within the appropriate specifications.

For items that use 448 acceptance, perform all mix testing and quality control according to 441.09. The Contractor may test a 448 Sublot sample instead of the required quality control test provided the sample is tested in the half day in which the Sublot sample mix was produced and is tested for all required quality control properties.

For mixes that do not use 448 acceptance (e.g. Items 301, 302, and Supplemental Specification 803), test the mix according to 441.09 for asphalt binder content and gradation (Basic). Other requirements of 441.09 and 441.10 do not apply. Control the Basic mixes as follows:

403.06 On page 188, Replace the first paragraph with the following:

The Department will perform VA. If the random Department sampling and testing verifies the accompanying Contractor tests, the average of the Contractor’s quality control tests for each day or night (for Basic mix), the average of the Contractor’s tests for each Lot (for 448 acceptance mix) or daily average MSG (446 acceptance mix) will be used to determine acceptance.

403.06.A On page 189, in the first full paragraph Replace “Item 448” with “448”

403.06.A On page 189, in the second full paragraph Replace “Item 448 mixes” with “448 acceptance mixes”

403.06.A On page 189, in the third full paragraph Replace “Item 446 mixes” with “446 acceptance mixes”

403.06.B On page 190, in the second full paragraph Replace “Item 448 mixes” with “448 acceptance mixes”

403.06.C On page 190, in the first full paragraph Replace “448 mixes” with “448 acceptance mixes”

403.06.C On page 191, in the first full paragraph Replace “446 mixes” with “446 acceptance mixes”

403.06-2 On page 192, in Table 403.06-2 Replace “448 Mixes” with “448 Acceptance Mixes” and Replace “446 Mixes” with “446 Acceptance Mixes”

403.07 On page 194, in the last paragraph Replace “Item 448 mixes” with “448 acceptance mixes”

421.02 On page 205, Replace the first three paragraphs of 421.02 with the following:
421.02 Materials. Use a polymer modified emulsified asphalt binder (Binder) consisting of the following:

Use a quick-traffic CSS-1hM (as defined below). Use only emulsion certified according to Supplement 1032. Do not use port addition of the polymer to the emulsified asphalt. Provide to the Engineer certified test data and a statement from the Binder manufacturer with each load of Binder that the Binder is the same formulation as used in the mix design.

Ensure the Binder meets one of the following:

<table>
<thead>
<tr>
<th>Tests on emulsion, AASHTO T 59, unless otherwise designated:</th>
<th>CSS-1hM</th>
<th>[1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 77 °F (25 °C) (SFS)</td>
<td>20 to 100</td>
<td></td>
</tr>
<tr>
<td>Storage Stability Tests, 24-hr (% difference), max.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td>Sieve Tests (%) (Distilled Water), max.</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Distillation to 177 °C, Residue % solids, min.</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tests on distillation residue:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration, 25 °C, 100 g, 5 sec (dmm) AASHTO T 49</td>
<td>40 to 90</td>
</tr>
<tr>
<td>Ductility, 25 °C, 5 cm/min, (cm), min. AASHTO T 51</td>
<td>40</td>
</tr>
<tr>
<td>Solubility in trichloroethylene, (%), min. AASHTO T 44 [2]</td>
<td>97.5</td>
</tr>
<tr>
<td>Elastic Recovery, 10 °C, 20 cm (%), min. AASHTO T 301 [3]</td>
<td>45</td>
</tr>
<tr>
<td>Softening Point, Ring &amp; Ball (°C), min. AASHTO T 53</td>
<td>60</td>
</tr>
</tbody>
</table>

[1] Pre-blend only: Use a minimum of 3.0% SBR solids based on weight of the asphalt binder. Use Natural SBR latex modifier or synthetic SBR latex modifier conforming to 702.14. Use only one type of latex. Mill or blend the SBR Emulsion into the emulsified solution prior to the emulsification process.

[2] See Supplement 1013. For natural latex, use the Oven Evaporation method in AASHTO T 59 in place of distillation and use this residue for further testing.


[4] Straight molds. Hold at test temperature for 90 minutes. Place in ductimeter and elongate 20 cm at 5 cm/min. Hold for 5 minutes and cut. After 1 hour retract the broken ends to touch and measure the elongation (X) in centimeters. Use the following formula to calculate the elastic recovery: Percent Recovery = ((20-X)/20) x 100.

Conform to 703.01 and 703.05 for aggregate, except as follows:

<table>
<thead>
<tr>
<th>Percent by weight of fractured pieces</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalence (ASTM D 2419)</td>
<td>45 minimum</td>
</tr>
</tbody>
</table>

Conform to Gradation A for the aggregate for leveling and surface courses and to Gradation B for the aggregate for rut fill courses according to the following:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Total Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>3/8 inch (9.50 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>85 to 100</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>50 to 80</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>40 to 65</td>
</tr>
<tr>
<td>No. 30 (600 µm)</td>
<td>25 to 45</td>
</tr>
<tr>
<td>No. 50 (300 µm)</td>
<td>13 to 25</td>
</tr>
<tr>
<td>No. 100 (150 µm)</td>
<td>7 to 18</td>
</tr>
<tr>
<td>No. 200 (75 µm)</td>
<td>5 to 15</td>
</tr>
</tbody>
</table>
Screen the aggregate for oversize material prior to use. For mineral filler, use Portland cement conforming to ASTM C 150, Type I. Use water conforming to 499.02. Use mix set additives as required.

421.04
On page 208, Replace 421.04 with the following:

421.04 Weather Limitations. Apply the mixture only when it is not raining and the existing pavement surface and atmospheric temperature is a minimum of 45 degrees and rising and there is no forecast of an atmospheric temperature below 32 degrees within 24 hours from the time the mixture is applied. Between September 30 and May 1, do not apply the mixture if the existing pavement surface temperature is less than 50 °F (10 °C).

421.08
On page 209, Replace the entire subsection with the following:

421.08 Surface Preparation. Before applying the mixture, thoroughly clean the surface. Remove raised pavement markers according to 621.08, when specified. The Contractor may fill the depression caused by the removal of the casting with material meeting this specification. Remove any existing pavement markings, except 740.02 (traffic paint), using an abrasion method conforming to 614.11 G. Apply a tack coat conforming to Item 407, consisting of one part asphalt emulsion and three parts water. Apply the tack coat at a rate of 0.06 to 0.12 gallon per square yard (0.25 to 0.45 L/m²). Protect drainage structures, monument boxes, water valve, etc. during material application.

421.10
On page 210, Replace the third and fourth paragraphs with the following:

If a leveling course and a surface course are specified, apply the paving mixture at 14 ± 2 pounds per square yard (7.6 ± 1.1 kg/m²) for the leveling course and 16 ± 1 pounds per square yard (8.7 ± 0.6 kg/m²) for the surface course. Apply the two courses at a minimum combined rate of 30 pounds per square yard (16.3 kg/m²), regardless of the above tolerances. If a surface course is specified and it is not placed on another Microsurfacing course, apply the paving mixture at a minimum of 18 pounds per square yard (9.8 kg/m²).

421.10
On page 210, Add the following to the end of the seventh paragraph:

Provide uniform appearance of the entire surface area regardless of the means used to spread material.

421.13
On page 211, Replace the second paragraph with the following:

The cost of any removal of any existing pavement markings according to 421.08 is incidental to Microsurfacing.

422.02
On page 212, Replace the first paragraph with the following:

Use polymer emulsified binder conforming to 702.16 Type A.
On page 214, **Replace** the entire section with the following:

**422.04 Weather Limitations.** Place the chip seal when the pavement temperature is between 60 °F (16 °C) and 140 °F (60 °C). Do not schedule the performance of this work for the time period before May 1 or after September 1. Do not place chip seal if any of the following conditions exist:

A. The atmospheric temperature is below 70 °F (21 °C).
B. Impending weather conditions do not allow for proper curing.
C. If temperatures are forecasted below 50 °F (10 °C) within 24 hours from the time of work.

On page 215, **Replace** the second paragraph with the following:

Remove all existing pavement markings, except 740.02 (traffic paint), using an abrasion method conforming to 614.11,G.

On page 217, **Replace** the first paragraph of 422.10, B, with the following:

**B. Binder.** Within one hour of start of production obtain and label a binder sample from the distributor truck and give the sample to the Engineer the same day. Provide and sample the binder in one quart plastic containers with plastic screw tops. Label and retain one sample per each additional day for the Department. Take more samples when requested by the Engineer.

On page 223, **Add** the following:

D. For projects with less than 1500 trucks use 50 blows, for projects with greater than or equal to 1500 trucks use 75 blows. If multiple traffic segments occur on a project use 75 blows for the project.

On page 224, **Replace** footnotes [3] and [4] with the following:

[3] Fine Aggregate - Use natural sand with at least 50 percent silicon dioxide by weight according to ASTM C 146. Include with a JMF submittal certified test data from an AASHTO accredited laboratory showing conformance to the 50 percent silicon dioxide requirement. Ensure data is no more than one year old at time of submittal. For 50 blow mixes, use no more than 20 percent limestone sand by weight of total aggregate. For 75 blow mixes, use 20 percent limestone sand or air cooled slag sand by weight of total aggregate. If 10 percent RAP is used the silicon dioxide content of the total natural sand blend must be at least 50 percent. Contact the Office of Materials Management, Asphalt Materials section for guidance on submitting RAP aggregate silicon dioxide data.

[4] Coarse Aggregate - For 50 blow mixes, for the final blend of all coarse aggregate use a minimum 10 percent two or more fractured faces aggregate. For 75 blow mixes, use 100 percent two or more fractured faces aggregate. Meet the two or more fractured faces aggregate criteria of ASTM D5821-01 (Reapproved 2006).
On page 224, Replace “60 °F” with “60 °F (15 °C)”

441  
On page 225, Replace the Item title with:  
**ITEM 441 ASPHALT CONCRETE - MIX DESIGN AND QUALITY CONTROL**

441  
On page 225, Add the following subsections:  
441.13 Acceptance  
441.14 Basis of Payment

441.01  
On page 225, in the first paragraph Add the following before the first sentence:  
This work consists of constructing a surface course or an intermediate course of aggregate and asphalt binder mixed in a central plant and compacted on a prepared surface.

441.02  
On page 226, in the second paragraph Add the following after the first sentence:  
The Laboratory may visit the Level 3 mix design lab for review.

441.02  
On page 226, in the second paragraph Replace the second to last sentence with:  
Unless otherwise directed submit a 5-pound (2500 g) minimum uncompacted sample (all mixes) representing the JMF.

441.02  
On page 226, in the fifth paragraph Replace the second sentence with:  
Calculate the effective asphalt binder content according to the Asphalt Institute Manual Series No. 2 or Superpave Series No. 2.

441.02  
On page 226, Delete the last paragraph on the page.

441.02  
On page 227, Replace the first paragraph with:  
Use a PG 64-22 for a Type 1 Intermediate course. Use a PG 64-22 for a Type 2 intermediate course unless RAP and/or RAS used per 401.04 require a virgin binder grade change. Use a PG 64-22 asphalt binder and Type 1 surface gradation for asphalt concrete for driveways and under guardrails.

441.02-1  
On pages 228-231, Replace the table 441.02-1 with:
TABLE 441.02-1

<table>
<thead>
<tr>
<th>Table 441.02 - Asphalt Mixture Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>1 1/2 inch (37.5 mm)</td>
</tr>
<tr>
<td>1 inch (25.0 mm)</td>
</tr>
<tr>
<td>3/4 inch (19.0 mm)</td>
</tr>
<tr>
<td>1/2 inch (12.5 mm)</td>
</tr>
<tr>
<td>3/8 inch (9.5 mm)</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
</tr>
<tr>
<td>No. 30 (600 µm)</td>
</tr>
<tr>
<td>No. 50 (300 µm)</td>
</tr>
<tr>
<td>No. 100 (150 µm)</td>
</tr>
<tr>
<td>No. 200 (75 µm)</td>
</tr>
<tr>
<td>Asphalt Binder</td>
</tr>
<tr>
<td>F/A Ratio, max.</td>
</tr>
<tr>
<td>F-T Value</td>
</tr>
<tr>
<td>Blows</td>
</tr>
<tr>
<td>Stability, min., pounds</td>
</tr>
<tr>
<td>(N)</td>
</tr>
<tr>
<td>Flow, 0.25 mm</td>
</tr>
<tr>
<td>Design Air Voids</td>
</tr>
<tr>
<td>VMA, min.</td>
</tr>
</tbody>
</table>

[1] Sieve, percent passing
[2] Percent of total mix
[3] Using effective asphalt binder content
[4] Percentage points maximum
[5] T 245
[6] Percent, Supplement 1036
[7] Percent, Supplement 1037

441.05
On page 232, Replace the first paragraph with:

**441.05 JMF Field Adjustments.** During production the Contractor may adjust the JMF gradation within the below limits without a redesign of the mixture. Limit adjustments of the JMF to conform to actual production, without a redesign of the mixture, to ±3 percent passing the 1/2 inch (12.5 mm), No. 4 (4.75 mm), and No. 8 (2.36 mm) sieves and ±1 percent passing the No. 200 (75µm) sieve. Do not exceed the limits in Table 441.02-1 in the adjusted JMF. The adjustment on the 1/2 inch (12.5 mm) sieve applies only to Type 2 mixes. Determine the need for any JMF gradation adjustments in the time specified. Should no adjustments be made, the Department will base acceptance on conformance to the original JMF. After the time period specified, the Department will allow no further adjustment of the JMF.

441.09
On page 233, Replace the second paragraph with:

Perform more sampling and testing than the minimum specified at the start of production. Additionally perform more sampling and testing than the minimum during production when the quality
control tests show the asphalt concrete being produced is outside the warning bands as shown in the Contractor’s approved QCP. Immediately resolve problems indicated by any test result exceeding the warning bands and immediately retest to validate corrections have returned the materials to within the warning band limits. The Contractor may determine the method of testing of the asphalt concrete beyond the minimum specified, and will detail the methods technicians will follow in the Contractor’s approved QCP.

441.09.A
On page 234, Replace the last sentence with:
Only take SBR PG-Modified Binder samples using a five gallon bucket. Take 1 gallon to clean the valve port and discard. Take 2 gallons again, stir its contents and transfer to the required sample containers.

441.12
On page 237, in the first paragraph, Replace the first sentence with:
Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in composition; within the specification requirements and limits; conforms to the JMF: and that the placed mixture is free of any defect (ex. segregation, tenderness, lack of mixture and/or texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor’s control.

441.13, 441.14
On page 238, Add the following two subsections:

**441.13 Acceptance.** The Department will base acceptance of the asphalt concrete mix on the item specified in the Contract item description. (i.e., Item 446, Item 448).

**441.14 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Surface</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 1, (448), PG64-22</td>
</tr>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Surface</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 1, (446), PG64-22</td>
</tr>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Surface</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 1, (448), PG70-22M</td>
</tr>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Surface</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 1, (446), PG70-22M</td>
</tr>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Intermediate</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 1, (448)</td>
</tr>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Intermediate</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 2, (448)</td>
</tr>
<tr>
<td>441</td>
<td>Cubic Yard</td>
<td>Asphalt Concrete Intermediate</td>
</tr>
<tr>
<td></td>
<td>(Cubic Meter)</td>
<td>Course, Type 2, (446)</td>
</tr>
</tbody>
</table>

442.02
On page 238, Replace the first paragraph of 442.02 with the following:
442.02 Type A Mix Design. Design the mixture composition for a Type A mix according to 441.02 and the most recent Asphalt Institute Superpave Mix Design Manual (SP-2) for design procedures and material properties except as modified by this subsection. Include in the JMF submittal the standard Department cover and summary page; all printouts from the gyratory compactor (all gyratory points not necessary); and analysis covering the required mix properties. Unless otherwise directed submit one compacted gyratory sample and loose mix for compaction of another sample, in addition to a 5-pound (2000 g) loose sample, for each JMF.

446

On page 246, Replace Item 446 with the following:

ITEM 446 ASPHALT CONCRETE CORE DENSITY ACCEPTANCE

446.01 Description
446.02 JMF Field Adjustments
446.03 Monitoring
446.04 Reports
446.05 Density Acceptance
446.06 Joints

446.01 Description. This specification describes the acceptance criteria for asphalt concrete surface and intermediate courses. The Department will base acceptance of the compacted mixture in place on the level of density attained as sampled by the Contractor and analyzed by the Department.

The requirements of Item 441 apply, except as modified by this specification.

446.02 JMF Field Adjustments. Determine the need for any JMF gradation adjustments, provided for in 441.05, in the first 3 days or first 3000 tons (3000 metric tons) of production, whichever comes last. Give the DET written notice of JMF adjustments no later than the end of the following day’s production.

For projects smaller than the above JMF field adjustment period give the DET written notice of any JMF gradation adjustments within 1 workday following the last day of production.

446.03 Monitoring. If there is poor comparison between the Department’s comparison samples and the Contractor’s quality control tests, the Monitoring Team may at any time disallow acceptance to continue under 446. In this case, accept per 448 and 446. The Department will notify the Contractor in writing to stop production.

446.04 Reports. Submit the Quality Control Report according to 441.11 on the workday following the production day of the material represented by the report.

446.05 Density Acceptance. The requirements of 401.13 do not apply. However, rollers must fully and satisfactorily provide the required compaction, be mechanically sound, and meet Asphalt industry standards. The Department retains the right to reject the use of rollers which are not in good repair, or are not designed to do the work required. A three-wheel roller according to 401.17 is not required.

Obtain ten, 4-inch cores for the Department to test to determine the in-place density of the compacted mixture as a percentage of the average QC Maximum Specific Gravity (MSG) for the production day the material was placed. If Department MSG VA tests show poor comparison to the
average QC MSG according to 403.06 use Department determined MSG results in the density calculation for each production day. Compact shoulders using the same equipment and procedures as used on the mainline pavement. The requirements of 401.16, except for the last four paragraphs, are waived.

Payment for compaction of the completed mainline pavement and ramps is by Lot, based upon the degree to which density is attained. Payment for shoulders depends on the degree to which the density is obtained on the adjacent mainline pavement lane or ramp. However, when a cold longitudinal joint is made between a mainline pavement lane and an adjoining shoulder, payment for the shoulder will be based on the degree to which the density is obtained on the shoulder.

A Lot consists of an area of pavement placed during a production day, including the shoulders. If less than 400 tons (400 metric tons) is produced in a production day, then that production day is combined with the next production day into a single Lot. If greater than 250 tons (250 metric tons) and less than 400 tons (400 metric tons) are produced on the last day of production for the project, then the day’s production is a separate Lot. If less than 250 tons (250 metric tons) is produced on the last production day for the project, it is part of the previous Lot for acceptance, provided the previous Lot was placed within 3 days; otherwise, it is a separate Lot.

Within 48 hours after the pavement is placed, obtain ten cores for each Lot at random locations the Engineer determines. Only obtain core samples in the presence of the Engineer and immediately surrender each core sample to the Engineer for testing. The Engineer will divide a Lot into five equal sublots and calculate two random core locations in each sublot as described below using ODOT TE-217 procedure. Both mainline pavement and ramps will be included in Lot determinations. The Engineer will not give the Contractor random core locations early in the Lot placement. The Engineer will tell the Contractor the method used to determine random locations as noted below before project start and will use the same method for all Lots.

Cores will be taken from each lot as follows. Three cores will be taken from cold longitudinal joints (joint cores) and seven cores will be taken from the mat (mat cores). If locations not according to this specification are given, immediately inform the Engineer. Do not take joint cores from ramps joints. Take joint cores from the first, last and randomly from one of the three remaining sublots. Determine by random number the longitudinal location of the joint core, and which pavement edge to be cored when the mat placed has both confined and unconfined edges. Except where notched wedge joints are used, take joint cores such that the core’s closest edge is 4 inches (100 mm) from the edge of the mat. Obtain the mat cores from at least twelve inches away from the longitudinal joint. Locate cores obtained for contractor quality control (QC sister core) longitudinally from and within four inches (100 mm) of the random core. In addition to the QC sister cores, three extra cores may be taken from the first lot of a JMF for testing to correlate density gauges. Do not take additional cores beyond what is noted above unless clearly identified in the approved Contractor’s QCP. Clearly label all cores with mat locations so that they may be readily identified. Any unlabeled cores may be destroyed by the Department. Notify the Laboratory if any questions arise. Do not store additional cores anywhere (project, in vehicles or at the plant) beyond those required to be taken for testing. Test all Contractor QC cores and maintain records of all tests (core tests and correlated gauge tests) per the QCP. Destroy all cores immediately after testing is complete.

Notched Wedge Joints: When notched wedge joint construction is used do not take cores on the sloped face of the wedge before the adjoining lane (matching pass) is placed. Take cores such that the core's closest edge is six inches (150 mm) from the edge of the joint upper notch. When a nine inch or wider wedge joint is used take the core three inches from the upper wedge joint notch.
The Department will determine the pay factor for each Lot cored by the pay schedule in Table 446.05-1 for Lots with three cold longitudinal joint cores and Table 446.05-2 for Lots with less than three cold longitudinal joint cores. The Department will verify the MTD if the MSG determination has a deviation from the MTD of less than or equal to 0.020. If the MTD is not verified, establish a new MTD according to the procedures established in 441.09. If less than 10 cores are available for determining the mean, the Laboratory will determine disposition of the Lot.

Fill core holes by the next workday with asphalt concrete. Before filling, ensure the holes are dry and tack them with asphalt material conforming to 407.02. Properly compact the asphalt concrete used for filling the hole and leave it flush with the pavement.

**TABLE 446.05-1 FOR LOTS WITH 3 COLD JOINT CORES**

<table>
<thead>
<tr>
<th>Mean of Cores</th>
<th>Pay Factor</th>
<th>Surface Course</th>
<th>Intermediate Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>98.0% or greater</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>97.0 to 97.9%</td>
<td>0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>96.0 to 96.9%</td>
<td>1.00</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>93.4 to 95.9%</td>
<td>1.04 [4]</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>92.4 to 93.3%</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>91.4 to 92.3%</td>
<td>0.98</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>90.4 to 91.3%</td>
<td>0.90</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>89.4 to 90.3%</td>
<td>0.80</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>88.4 to 89.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 88.4%</td>
<td>[2]</td>
<td>[2]</td>
<td></td>
</tr>
</tbody>
</table>

[1] Mean of cores as percent of average MSG for the production day.
[2] For surface courses, remove and replace. For other courses, the District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.60.
[3] The District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for such material allowed to remain in place is 0.70.
[4] No incentive will be paid if any single cold joint core is less than 91.0%.
### TABLE 446.05-2 FOR LOTS WITH LESS THAN 3 COLD JOINT CORES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>98.0% or greater</td>
<td>[2]</td>
<td>[2]</td>
</tr>
<tr>
<td>97.0 to 97.9%</td>
<td>0.94</td>
<td>[2]</td>
</tr>
<tr>
<td>96.0 to 96.9%</td>
<td>1.00</td>
<td>0.94</td>
</tr>
<tr>
<td>94.0 to 95.9%</td>
<td>1.04 [4]</td>
<td>1.00</td>
</tr>
<tr>
<td>93.0 to 93.9%</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>92.0 to 92.9%</td>
<td>0.98</td>
<td>1.00</td>
</tr>
<tr>
<td>91.0 to 91.9%</td>
<td>0.90</td>
<td>0.94</td>
</tr>
<tr>
<td>90.0 to 90.9%</td>
<td>0.80</td>
<td>0.88</td>
</tr>
<tr>
<td>89.0 to 89.9%</td>
<td>[3]</td>
<td>[3]</td>
</tr>
<tr>
<td>Less than 89.0%</td>
<td>[2]</td>
<td>[2]</td>
</tr>
</tbody>
</table>

[1] Mean of cores as percent of average MSG for the production day.
[2] For surface courses, remove and replace. For other courses, the District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.60.
[3] The District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for such material allowed to remain in place is 0.70.
[4] No incentive will be paid for lots where 3 joint cores are required to be taken but less than 3 cores are taken.

**446.06 Joints.** Construct joints according to 401.17. Make a hot longitudinal joint between the mainline pavement lane and the adjoining shoulder and all ramps and the adjoining shoulders. If a hot longitudinal joint is specified between the mainline pavement lanes, the Contractor may construct a cold longitudinal joint between the mainline pavement lanes and the adjoining shoulders. Cold longitudinal joints in mainline pavement will be tested according to 446.05.

**448**

On page 250, Replace Item title with:

**ITEM 448 ASPHALT CONCRETE ACCEPTANCE**

**448**

On page 250, Delete the following subsection:

**448.06 Basis of Payment**

**448.01**

On page 250, in the first paragraph Replace the first sentence with the following:

This specification describes the acceptance criteria for asphalt concrete surface and intermediate courses.
448.06
On page 251, **Delete** the entire subsection 448.06 Basis of Payment.

451.09
Starting on page 256, **Replace** the entire subsection 451.09 Joints with the following:

**451.09 Joints.** Unless otherwise directed, construct all transverse joints normal to the centerline of the pavement lane and of the type, dimensions, and at locations specified.

Determine contraction and longitudinal joint sawing time limits to protect the concrete from early cracking by using HIPERPAV software. Obtain the software according to Supplement 1033.

 Twenty four (24) hours before placing concrete pavement create a HIPERPAV project date file according to Supplement 1033.

 Provide the completed file and the printout to the Engineer. When HIPERPAV predicts early age slab cracking will occur, whether due to standard construction practices, joint sawing methods, mix design or curing, either do not start construction until modifications have been made to eliminate HIPERPAV’s predicted slab cracking or do not pave.

 Perform a HIPERPAV analysis for each pour.

 If software analysis determines joint sawing could exceed twenty four (24) hours, assure all joints are sawed by the 24th hour.

 A HIPERPAV analysis showing paving can proceed does not eliminate the requirements of 451.17.

 Accurately mark the correct locations of all joints that will be saw cut along both edges of the pavement. Ensure the method of marking remains clearly visible after the paver passes and until the joint saw cut is completed.

**A. Longitudinal Joint.** Construct longitudinal joints between simultaneously placed lanes by sawing.

 When a standard (water cooled diamond bladed) concrete saw is used to make the longitudinal joint between simultaneously placed lanes, saw the joint within the timeframe provided in the HIPERPAV output. For pavement less than or equal to 10 inches (255 mm), saw the joint to a minimum depth of one-fourth the specified pavement thickness. For pavements greater than 10 inches (255 mm) thick, saw the joint to a minimum depth of one-third the specified pavement thickness. Saw joints 1/4 ± 1/16 inch (6 ± 1.6 mm) wide measured at the time of sawing.

 When using early-entry (dry cut, light weight) saws to make the longitudinal joint between simultaneously placed lanes, only use saw blades and skid plates as recommended by the saw manufacturer for the coarse aggregate type being used in the concrete. Perform the early-entry sawing after initial set and before final set. Saw the joint 1/8 inch (3 mm) wide and 2 1/4 to 2 1/2 inches (56 to 63 mm) deep.

 Place deformed epoxy coated steel tiebars or the epoxy coated hook bolt alternate (wiggle bolt) with epoxy coated coupling, in longitudinal joints during consolidation of the concrete. Install them at mid-depth in the slab by approved mechanical equipment. As an alternate procedure, rigidly secure them on chairs or other approved supports to prevent displacement. Provide tie bars or wiggle bolts of the size and spaced as shown on the standard construction drawings. If used, securely fasten hook bolts or wiggle bolts with couplings to the form at the longitudinal construction joint as shown on the standard construction drawings.

**B. Transverse Joints**

 Unless otherwise directed, construct all transverse joints normal to the centerline of the pavement lane and of the type, dimensions, and at locations specified.
On page 617, Replace the second sentence in the first paragraph with the following: However, if applying thermoplastic to pavements that are older than six months, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 70 °F (21 °C) and rising.

648.05
On page 630, Replace the second sentence in the first paragraph with the following: However, if applying spray thermoplastic to pavements that are older than six months, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 70 °F (21 °C) and rising.

659.01
On page 638, Replace paragraphs one through four with the following:

659.01 Description. This work consists of placing topsoil, preparing the seed bed, and placing and incorporating seed, agricultural lime, commercial fertilizer, and placing mulching material used to achieve NPDES final stabilization.

Perform this work in areas shown on the plans for seeding and mulching.

Perform seeding and mulching after completing all work in the area and within 7 days of obtaining final grade. If it is anticipated that future work may disturb an area, place temporary NPDES compliant Best Management Practices as needed until final stabilization measures under this item can be installed. If the Contractor disturbs a final area, then the Contractor shall restore this area. With the Engineer’s approval, the Contractor may apply permanent seed between October 30 and March 1 on projects started and completed within the same calendar year.

659.05
On page 641, Replace the last sentence of the first paragraph with the following: Test topsoil according to AASHTO T 267.

700
On page 669, Replace the Post Inspection Instructions 701.01, 701.02, 701.04, 701.05, 701.07, 701.09, 701.10, 701.11 and 701.13 with:

<table>
<thead>
<tr>
<th>Spec No.</th>
<th>Material</th>
<th>Material only Inspection or Sampling Requirements</th>
<th>Post Inspection Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>701.01</td>
<td>Cement, Hydraulic</td>
<td>Verify manufacturer on Concrete Plant Batch Ticket is on CERTIFIED LIST for S 1028 maintained by OMM.</td>
<td>N/A</td>
</tr>
<tr>
<td>701.02</td>
<td>ASTM Types I, IA, II, III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spec No.</td>
<td>Material</td>
<td>Material only Inspection or Sampling Requirements</td>
<td>Post Inspection Instructions</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>701.04</td>
<td>Masonry</td>
<td>Verify material against bill of lading description.</td>
<td></td>
</tr>
<tr>
<td>701.05</td>
<td>Micro-Silica</td>
<td>Verify manufacturer on Concrete Plant Batch Ticket is on CERTIFIED LIST for S 1045 maintained by OMM.</td>
<td>N/A</td>
</tr>
<tr>
<td>701.07</td>
<td>Ground Granulated Blast Furnace (GGBF) Slag</td>
<td>Verify manufacturer on Concrete Plant Batch Ticket is on CERTIFIED LIST for S 1034 maintained by OMM.</td>
<td>N/A</td>
</tr>
<tr>
<td>701.09</td>
<td>Fly Ash</td>
<td>Verify manufacturer on Concrete Plant Batch Ticket is on CERTIFIED LIST for S 1026 maintained by OMM.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

702
On page 696, Replace the first paragraph of 702 with the following:

Acceptance. Asphalt binders 702.01 and liquid asphalts 702.02, 702.03, and 702.04 may be acceptable for shipment to and immediate use in construction projects. Acceptance is according to Supplement 1032. Material will meet specification requirements and no tolerances are given for material falling out of specification requirements.
On page 696, Replace the entire section 702.01 Asphalt Binders with the following:

**702.01 Asphalt Binders.**

General. According to AASHTO M 320-10 Table 1 except as follows.

Ensure PG 70-22M, PG 76-22M, PG 88-22M, and PG 64-28 meet the requirements of Table 702.01-1.

An independent laboratory will not be owned or operated, in whole or part, by the binder supplier, Contractor, or affiliates of either.

Materials and Manufacture. Replace the requirements of AASHTO M 320-10 Table 1 Section 5 “Materials and Manufacture” Section with the following:

5.1 Supply PG Binder from the refining of crude petroleum, or combination of asphalt binders from the refining of crude petroleum, or asphalt binders and suitable liquid from the refining of crude petroleum, and possible organic modifiers for performance enhancement. Material from the crude refining stream is considered neat. Liquid from crude refining may be used for adjustments, but do not used liquid from crude refining for the purpose of substitution of crude refined asphalt binder in a PG Binder. In the event of a failure investigation where asphalt binders exhibit unusual properties a supplier may be requested by the Laboratory to supply information about the makeup of a PG Binder. Failure to cooperate will mean removal from Supplement 1032 certification.

5.2 A modifier may be any approved material of suitable manufacture that is proven compatible with asphalt binder (does not separate appreciably in routine storage), and that is dissolved or reacted in asphalt binder to improve its performance. Performance enhancement is defined as a decrease in the temperature susceptibility of the asphalt binder while maintaining or improving desirable properties in a neat asphalt binder such as coat ability, adhesiveness and cohesiveness. Unless otherwise noted limit modifiers to no more than 6.0 percent by PG Binder weight.

5.3 The use of previously used materials in a PG Binder must be approved by the Department. Since no standard test procedures exist for reprocessed materials (and original tests were not developed with the use of such materials in mind), appropriate test methods may be chosen by the Department for review. Department approval does not relieve the binder supplier from full responsibility for content and use of any previously used material in a PG Binder nor guarantee suitable performance enhancement as defined above. The detected presence in a PG Binder sample of any unapproved previously used material will mean immediate removal from Supplement 1032 certification. Limit approved reprocessed materials to 6.0 percent by PG Binder weight.

5.4 Ensure the PG Binder is homogeneous, free from water and deleterious materials, and does not foam when heated to 350 °F (175 °C). Prove the asphalt binder (before modification or after modification if liquid modifier used) is fully compatible with a negative result by means of the Spot Test per AASHTO T 102 using standard naphtha solvent. If standard naphtha shows a positive result, a retest using reagent grade 35 percent Xylene/ 65 percent Heptane (volume) may be used.

5.5 Ensure the PG Binder is at least 99.0 percent soluble as determined by AASHTO T44. Ensure any insoluble component is free of fibers or discrete particles more than 75 µm.

5.6 Ensure flash point is 500 °F (260 °C) minimum. Ensure mass change on RTFO of the final PG Binder grade is 0.75 percent maximum.

5.7 Ensure that PG 64-22 has a Penetration (AASHTO T49) of no more than 75.

5.8 Direct Tension testing is not required, unless otherwise required in this specification.

**Requirements for PG Modified Binder.** Furnish PG Modified Binder according to the requirements of Table 702.01-1 by modifying a non-oxidized, non-air blown, neat asphalt binder by
using a styrene butadiene latex rubber compound (SBR polymer), a styrene butadiene styrene polymer block copolymer (SB, SBS polymer), an ethylene/ nbutyl acrylate/ glycidyl methacrylate copolymer (Elvaloy) as specified or Ground Tire Rubber (GTR) according to Supplemental Specification 887. For SB, SBS products the polymer supplier will certify to the refiner and Contractor that the polymer used meets a minimum 68 percent by weight butadiene content. Perform SB, SBS, Elvaloy or GTR modification prior to shipment to the asphalt concrete mixing plant (pre-blend). Perform SBR modification at the asphalt concrete mixing plant (post-blend) or prior to shipment to the asphalt concrete mixing plant (pre-blend) where allowed by specification.

Polyphosphoric acid (PPA) is allowed in PG binders as follows. PPA is a polymer of orthophosphoric acid. When using PPA ensure all the applicable requirements of the required PG binder in Table 702.01-1 are met. Ensure PPA does not contain water. To retain Supplement 1032 certification suppliers of PPA modified asphalt will provide a written certification to OMM that the amount of PPA used is less than 1.0% by weight of neat binder. Suppliers of PPA can have their Supplement 1032 certification removed for not following the above PPA requirements.

For each project, the PG Modified Binder supplier will give the Contractor a handling guide specifying temperature, circulation, shelf life, and other requirements for assuring the PG Modified Binder will perform as desired. Give this handling guide to the Monitoring Team and place a copy in the plant control room and plant laboratory.

If PG Modified Binder is retained at the asphalt concrete mixing plant for more than two weeks before use or beyond the supplier recommended shelf life, whichever is less, a top and bottom sample test (material property difference between samples taken from the top and bottom of the storage tank) will be performed by the Laboratory on samples retrieved by the Contractor at the District’s direction. Do not use material on hand until approved.

Table 702.01-1

<table>
<thead>
<tr>
<th>Test / Requirement</th>
<th>SBR Polymer</th>
<th>Pre Blended Binder</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final PG Binder Grade</td>
<td>70-22M a, b</td>
<td>64-28 (a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>64-28 (b)</td>
<td>70-22M (a,k)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76-22M (a,k)</td>
<td>88-22M (a,l)</td>
<td>c</td>
</tr>
<tr>
<td>Actual Pass Temperatures</td>
<td>Report</td>
<td></td>
<td>i</td>
</tr>
<tr>
<td>RTFO Mass Change, percent max</td>
<td>0.75</td>
<td></td>
<td>d</td>
</tr>
<tr>
<td>Phase Angle, max</td>
<td>78</td>
<td>78</td>
<td>74</td>
</tr>
<tr>
<td>Elastic Recovery, min</td>
<td>65</td>
<td>75</td>
<td>90 e</td>
</tr>
<tr>
<td>Toughness, in. lb</td>
<td>125</td>
<td>105</td>
<td>f, d</td>
</tr>
<tr>
<td>Tenacity, in lb.</td>
<td>70</td>
<td>80</td>
<td>f, d</td>
</tr>
<tr>
<td>Elongation, in. min</td>
<td>20</td>
<td>20</td>
<td>f, d</td>
</tr>
<tr>
<td>Ductility, in. min</td>
<td>28</td>
<td>28</td>
<td>j, d</td>
</tr>
<tr>
<td>Separation, F max</td>
<td>10</td>
<td></td>
<td>g, d</td>
</tr>
<tr>
<td>Homogeneity</td>
<td>None Visible</td>
<td></td>
<td>h, d</td>
</tr>
</tbody>
</table>

a. Pre-blended Binder. Use a base neat asphalt binder that is a -22 grade for 70-22M and 76-22M. Use a base neat asphalt binder that is a -28 grade for 64-28. 64-28 can be neat, PPA modified or modified with SB, SBS or Elvaloy. Ensure SB, SBS or Elvaloy modified 64-28 meets all requirements listed. The requirements of 3.0 Pa*s maximum for the rotational viscosity for 88-22M may be waived at the discretion of the Department if the supplier warrants that the asphalt
b. Post-blended Binder made from neat Supplement 1032 certified or preapproved standard PG Binder grade and SBR solids amount equal to or above 3.5 percent by weight of total binder to achieve the PG Binder grade. Ensure all listed properties are met.
c. Without Direct Tension, graded with actual pass temperatures
d. **PG Modified Binder**
e. AASHTO T301, 10cm @ 77 ºF (25 ºC), hold 5 min. before cutting, on RTFO material for SB, SBS, Elvaloy
f. ASTM D 5801, 50cm/min @ 77 ºF (25 ºC)
g. Softening point difference of top and bottom of tube sample conditioned at 340 ºF (171 ºC) for 48 hours. Compatibility of polymer and neat binder is sole responsibility of supplier. Formulate PG Modified Binder to retain dispersion for 3 days minimum.
h. Heat a minimum 400 gram sample at 350 ºF (177 ºC) for 2.5-3 hours. Pour entire sample over a hot No 50 (300 µm) sieve at 340ºF (171 ºC). Look for retained polymer lumps.
i. Actual high and low temperature achieved by PG Modified Binder beyond required grade, but will not grade out to the next standard PG Binder grade for low temperature.
j. AASHTO T51, @ 39 ºF (4 ºC), 1 cm/min
k. SB, SBS, Elvaloy or Supplemental Specification 887 GTR
l. SB, SBS, Elvaloy

**702.04**

On page 700, **Replace** the entire section 702.04 with the following:

**702.04 Emulsified Asphalts.** Provide emulsified asphalts according to AASHTO M 140 or AASHTO M 208 and specification limits will be producible for at least 30 days from project delivery. Use Saybolt Furol for viscosity.

**702.16**

On page 703, **Replace** the entire section 702.16 with the following:

**702.16 Polymer Emulsified Binder.** Material will meet specification requirements of the table below.
Table 702.16 Polymer Emulsified Binder

<table>
<thead>
<tr>
<th>Emulsion (AASHTO T 59)</th>
<th>Type A (b)</th>
<th>Type B (c,g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saybolt Furol Viscosity (g)</td>
<td>120-550 (50 ºC)</td>
<td>20-100 (25 ºC)</td>
</tr>
<tr>
<td>Storage stability, 24 hrs., % difference, max (a)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Demulsibility, 35 ml of 0.8% Dioctyl Sodium Sulph., min</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Demulsibility, 35 ml of 0.02N, CaCl₂, %, min</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Sieve test, (distilled water), %, max</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td>Distillation to 177 ºC, residue % solids (d)</td>
<td>66</td>
<td>63</td>
</tr>
<tr>
<td>Oil distillate, %, max</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Distillation Residue</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Penetration, 100g, 5 sec @77 ºF (25ºC) AASHTO T 49</td>
<td>70-125</td>
<td>90-150</td>
</tr>
<tr>
<td>Softening point, ºC, min AASHTO T 53</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>Solubility in TCE, %, min ASTM D 2042 or D 5546</td>
<td>97.5</td>
<td>97.5</td>
</tr>
<tr>
<td>Elastic Recovery, 50 ºF (10º C), %, min AASHTO T 301, (e),(f)</td>
<td>60</td>
<td>58</td>
</tr>
</tbody>
</table>

Notes:
(a) After standing undisturbed for 24 hours, the surface will show no white, milky colored substance, but will be a smooth homogeneous color throughout.
(b) CRS-2P, test within 20 days of project sampling. Limits for both certified source and project samples.
(c) CRS-1P and HFRS-1P, test within 20 days of project sampling. Limits for both certified source and project samples.
(d) See Supplement 1013.
(e) Straight molds. Hold at test temperature for 90 minutes. Place in ductilometer and elongate 20 cm at 5 cm/min. Hold for 5 minutes and cut. After 1 hour retract the broken ends to touch and note elongation in cm (X). Percent Recovery = ((20 - X)/20) x 100.
(f) SBR, SBS, & SB
(g) Minimum of 70 SFS for project acceptance.

703.11
On page 715, Replace the first paragraph with the following:

**703.11 Structural Backfill for 611 Bedding and Backfill.** Furnish structural backfill for 611 bedding and backfill consisting of CCS, gravel, natural sand, sand manufactured from stone, foundry sand, ACBFS, or RPCC.

On page 715, Delete the following:

Furnish granulated slag according to 703.08.
Do not use GS for Type 3 Structural Backfill.

703.11.B.1
On page 717, Replace the entire first subsection with the following:
401.01 Description
This specification is applicable to all types of asphalt concrete pavements irrespective of
gradation of aggregate, kind, and amount of asphalt binder, or pavement use. Deviations from these general requirements
are covered in the specific requirements for each type according to the appropriate contract item or items.

Work consists of one or more courses of asphalt concrete constructed on a prepared foundation. The asphalt concrete
consists of a mixture of uniformly graded aggregate and specified type and grade of asphalt binder.

Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in
composition, conforms to the specification requirements and that the placed mixture is free of any defect (ex. segregation,
tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor’s
control at project completion.

The asphalt concrete pavement thickness shown on the plans or stated in the Proposal is for the exclusive use in
calculating the weight required to be placed per unit of surface area.

401.02 Mix Design and Quality Control
Use an approved Job Mix Formula (JMF). The quality control and
acceptance requirements of Item 403 apply unless otherwise specified.

If required to perform the mix design or quality control, provide a laboratory and personnel meeting the requirements of
Supplement 1041 to perform mix design and quality control tests.

Calibrate asphalt content nuclear gauges according to Supplement 1043 using personnel with a minimum Level 2 rating
according to Supplement 1041. Mix and test the calibration verification sample with a Department employee present.

Provide and dispose of the solvent used for cleaning the asphalt content nuclear gauge pans.

401.03 Materials
Furnish materials conforming to:

Asphalt binder
(asphalt concrete, 401.14, 401.15) .......................... 702.01
Asphalt material (401.14, 401.18) ................................
..................................................SS875.02, 702.01, 702.04, or 702.13
Aggregates (base courses) ................................. 703.04
Aggregates (intermediate and surface courses)................................. 703.05
Mineral filler ................................................................. 703.07

Sample aggregate, asphalt binder, asphalt material, and mineral filler according to 106.01.

If 100 percent of coarse aggregate in an asphalt mix design is steel slag, the Contractor may include steel slag as a maximum of up to 50 percent of fine aggregate. If a steel slag source causes bulking (expansion resulting in flushing or material loss) in asphalt concrete courses, the Laboratory will place limits on the amount of steel slag allowed in a mix design. Bulking may occur when a large percentage of an asphalt mix design is steel slag aggregate. Bulking may be shown through testing, such as ASTM D 4792, or through field failure such as, but not limited to, flushing on newer pavement or apparent over-asphalting in production. The Department may require the steel slag processor at any time to perform additional testing to verify steel slag properties. Potential pavement performance problems due to poor control of steel slag aggregate include bulking, poor gradation and specific gravity control resulting in highly variable void properties, excess soft pieces resulting in pock marks, flushing, etc.

Take prompt corrective action if mixture delivered to the paving site is not uniform in composition, does not conform to the specification requirements or is not free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor’s control as determined by the Engineer. The Engineer will stop conditional acceptance of the asphalt concrete for failure to correct problems.

401.04 Reclaimed Asphalt Concrete Pavement and Reclaimed Asphalt Shingles. Provide reclaimed asphalt concrete pavement (RAP) and/or reclaimed asphalt shingles (RAS) according to the following requirements when choosing to use the in a mix. Failure to follow these requirements will result in a rejection of the Contractor QCP (403.03); restriction of any RAP or RAS use at the facility; and/or a change to Unconditional Acceptance at the facility.

Job Mix Formula. The Contractor may use a blend of new materials in combination with RAP obtained from verifiable Department or Ohio Turnpike Commission projects and/or RAS obtained from un-used manufactured shingle waste or used roofing tear-off shingles as listed in Tables 401.04-1 and 401.04-2 and as follows. If the RAP is not from the above sources or the source is unknown, process and blend the RAP into a single uniform stockpile, test according to Level 3 Asphalt Mix Design requirements and obtain District approval for use. Obtain written Laboratory approval for use of unusually large, old RAP stockpiles of unknown content and/or age. Include approved methods in the QCP for ongoing processing and testing of these piles. Ensure no foreign or deleterious material (703.04, 703.05) is present in RAP. All RAS suppliers must be approved and meet the requirements of Supplemental Specification 1116.

Ensure that the JMF falls within the specified limits of the required mix item. Ensure the JMF submittal includes the percentages of RAP, RAS, virgin aggregates, and virgin asphalt binder required for the mix item. Report all RAP and RAS test results, including binder blend analysis, in the JMF submittal. Identify the RAP in the JMF submittal as to project origin and mix type(s). Identify the manufactured shingle waste manufacturer source or the approved tear-off RAS processor in the JMF submittal.

Determine RAP properties and uniformity as follows. Determine the final RAP gradation and asphalt binder content on a minimum of four separate stockpile (or roadway for concurrent grinding) samples all agreeing within a range of 0.4 percent for asphalt binder content and 5 percent passing the No. 4 (4.75 mm) sieve. If fractionated RAP is used use a suitable sieve for determining gradation uniformity. Determine RAP binder content from a centrifuge extraction test. Do not use reflux extraction or oven burnoff.

Determine RAS properties and usage as follows. Use no more than 5.0 percent RAS by dry weight of mix. When using RAP and RAS in combination use no more than 3.0 percent RAS. For design assume 18.0 percent available RAS binder. Determine gradation and specific gravity according to AASHTO PP 78-14, Section 5 or subsequent AASHTO applicable standard. Provide the required certification forms in the JMF submittal documenting that the RAS meets AASHTO MP 23-14, section 4 and that RAS from roofing tearoffs conforms to the EPA’s NESHAP, 40 CFR 61 Subpart M, and other applicable agency requirements for asbestos.

RAP and RAS Usage Limits and Requirements. Process and use RAP and RAS as follows.

Process and use RAP by one of the following two methods. Note on the JMF submittal RAP page which of Method 1 or Method 2 methods described below apply to the RAP. Use PG64-28 virgin binder in all 442 intermediate courses regardless of the percentage of RAP used. If greater than 25 percent RAP is used in a JMF submittal use PG58-28 or PG64-28 virgin binder. If 25-30 percent RAP is used in the JMF submittal, the contractor may submit 3000 gram RAP sample along with a blend chart, according to Level 3 Mix Design procedures, to determine the grade of virgin asphalt binder to use. When using both 15% or greater RAP and 3% RAS in an intermediate or base course use PG58-28 or PG64-28. ODOT may request RAP and/or RAS samples or binder properties at any time.
1. **Method 1 Standard RAP.** Include RAP in a JMF submittal according to the Standard RAP/RAS Limits Table 401.04-1 unless specified differently in the applicable mix specification. For mixes that will contain up to 10 percent RAP and no RAS, the JMF submittal is not required to include the RAP except when a virgin polymer asphalt binder is used in a surface course. For surface course JMFs having polymer asphalt binder only submit at 0 or 10 percent RAP.

<table>
<thead>
<tr>
<th>Asphalt Mix Application</th>
<th>Percent RAP by Dry Weight of Mix Max.</th>
<th>RAS Usage (1)</th>
<th>Total Virgin Asphalt Binder Content, Min.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>442 Polymer Surface Course</td>
<td>10%</td>
<td>None</td>
<td>5.2</td>
<td>Polymerized binder is virgin. (For non-polymer virgin binder allow 20% max RAP and 5.0 min. virgin.)</td>
</tr>
<tr>
<td>441 Surface Course</td>
<td>20%</td>
<td>Manufacturing waste only</td>
<td>5.0</td>
<td>Polymer or non-polymer virgin.</td>
</tr>
<tr>
<td>441, 442 Intermediate Course</td>
<td>35%</td>
<td>Manufacturing waste and tear-offs</td>
<td>3.0</td>
<td>Any mix type used as an intermediate course.</td>
</tr>
<tr>
<td>301 Base Course</td>
<td>50%</td>
<td>Manufacturing waste and tear-offs</td>
<td>2.7</td>
<td>The Laboratory will establish the asphalt binder content.</td>
</tr>
<tr>
<td>302 Base Course</td>
<td>40% (30%)</td>
<td>Manufacturing waste and tear-offs</td>
<td>2.0</td>
<td>A lower RAP limit of 30 percent will be required if poor production mixing or coating is evident.</td>
</tr>
</tbody>
</table>

(1) No more than 5.0% RAS by dry weight of mix

**RAP Processing for Table 401.04-1 Method 1-Standard RAP.** For surface courses process RAP to less than 0.75 inch (19 mm) and place a 0.75 inch (19 mm) screen on the cold feed. For other courses place a 2-inch (50 mm) screen on the cold feed. Ensure that the RAP is the proper size to allow for complete breakdown in the plant. If mixing is incomplete, place a smaller screen on the cold feed.

2. **Method 2 Extended RAP.** Include RAP in a JMF submittal according to the Extended RAP/RAS Limits Table 401.04-2 unless specified differently in the applicable mix specification. Only use Method 2 with counter flow drum plants or mini-drum batch plant configurations meeting 402. For mixes that will contain up to 15 percent RAP and no RAS, the JMF submittal is not required to include the RAP unless a virgin polymer asphalt binder is used in a surface course. For JMFs having polymer asphalt binder do not submit at 1 through 9 percent RAP.
### TABLE 401.04-2 METHOD 2-EXTENDED RAP/RAS LIMITS

<table>
<thead>
<tr>
<th>Asphalt Mix Application</th>
<th>Percent RAP by Dry Weight of Mix Max.</th>
<th>RAS Usage [1]</th>
<th>Total Virgin Asphalt Binder Content, min.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>442 Polymer Surface Course</td>
<td>15%</td>
<td>None</td>
<td>5.0</td>
<td>Polymerized binder is virgin. (For non-polymer virgin binder allow 25% max RAP and 4.6 min virgin.)</td>
</tr>
<tr>
<td>441 Surface Course</td>
<td>25%</td>
<td>Manufacturing waste only</td>
<td>5.0</td>
<td>Polymer or non-polymer virgin.</td>
</tr>
<tr>
<td>441, 442 Intermediate Course</td>
<td>40%</td>
<td>Manufacturing waste and tear-offs</td>
<td>3.0</td>
<td>Any mix type used as an intermediate course.</td>
</tr>
<tr>
<td>301 Base Course</td>
<td>55%</td>
<td>Manufacturing waste and tear-offs</td>
<td>2.5</td>
<td>The Laboratory will establish the asphalt binder content.</td>
</tr>
<tr>
<td>302 Base Course</td>
<td>45% (35%)</td>
<td>Manufacturing waste and tear-offs</td>
<td>1.8</td>
<td>A lower limit of 35 percent will be required if poor coating is evident. The virgin requirement of 302.02 does not apply.</td>
</tr>
</tbody>
</table>

[1] No more than 5.0% RAS by dry weight of mix

**RAP Processing for Table 401.04-2 Method 2-Extended RAP.** Process RAP by means of fractionation or by additional in line processing. Include in the QCP additional methods and procedures to dictate how this is to be accomplished at plants. Specify documentation method for RAP measurement. Fractionation is the process of creating separate piles of RAP from one pile when split over a specific sieve or sieves. Test fractionated piles to show uniformity. For additional in line processing only process RAP from a uniform, tested and approved stockpile by passing the RAP over a double deck screen placed in-line between the RAP cold feed bin and the mixer. Use a 9/16 inch (14.3 mm) screen for surface and intermediate mixes and a 1.5 inch screen for base mixes. Do not use concurrent project RAP in a stream process.

**RAS Processing and Usage.** Include RAS in a JMF submittal according to the Standard RAP/RAS Limits Table 401.04-1 or Extended RAP/RAS Limits Table 401.04-2 unless specified differently in the applicable mix specification.

Ensure RAS is processed to have 100 percent passing the 1/2 inch sieve and at least 85 percent passing the No. 4 sieve. Ensure RAS has less than 1.0 percent deleterious materials and 0.1 percent metals by weight. Do not blend RAS from manufacturing waste and RAS from roofing tear-offs.

Ensure the approved QCP includes RAS usage methods before using RAS. Include in the contractor QCP what contractor requirements apply to the RAS processor.

Introduce and control RAS in asphalt plants in the same manner as RAP is introduced and controlled. RAS for base courses may be preblended with RAP if using rate control equipment to ensure uniformity of blending and if satisfactory blend and production is achieved. RAS may be preblended with a small amount of virgin aggregate meeting 703.05 to minimize stockpile agglomeration. Include in the contractor QCP blending equipment type and operation and uniformity testing requirements for preblended RAP and RAS or RAS and virgin aggregate. Other methods must be approved by the Laboratory.

**RAP and RAS QC and Management Requirements.** Maintain as part of the QC records the signed certification forms as required in Supplemental Specification 1116.

Always note on the daily quality control report how much RAP and RAS is actually being used. Apply a tolerance of ± 5.0 percent on the amount of RAP used if needed for a quality control adjustment but do not exceed the limits of Table 401.04-1 or Table 401.04-2, whichever applies. If this adjustment is not adequate for maintaining control of the mix submit a new JMF for approval. Do not apply this tolerance to RAS.

Include in the QCP methods to be used to meet Method 1 and Method 2 requirements above and the following requirements:

Provide enough space for meeting all RAP and RAS handling requirements at a hot mix facility. Provide a clean, graded base for stockpiles that does not collect water. Test blended RAP and RAS stockpiles to assure uniform gradation and asphalt binder content. Ensure uniform stockpile properties match the JMF submitted RAP and RAS properties unless the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing.
If the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing determine the processed RAP properties for use in the mix design. Record in the JMF submittal both the uniform stockpile and in line processed RAP properties.

If desired, when applying Method 1 Standard RAP requirements, use concurrent Department project RAP in a stream process in place of stockpiling and testing for uniformity but do so in the following manner. Concurrent project RAP must be taken from one existing mix type on the concurrent project or two existing mix types if both mix types are taken at the same time in one pass of the milling machine. Submit a new JMF for each existing mix type on the project (or each milling pass of two types) desired for use as concurrent project RAP. Include in the QCP methods of validating RAP properties when using concurrent project RAP. If these requirements are not met blend and test for uniformity and apply the stockpile requirements of this specification.

Maintain in the plant lab and control room an up to date and dated site map of all tested and untested RAP and RAS stockpiles. Give each stockpile a unique identification and identify if RAS piles are from un-used manufactured shingle waste or used roofing tear-off shingles. Provide in the plant lab RAP and RAS properties for each uniform, blended stockpile cross referenced with its identification. In addition, provide the date the stockpile processing was completed and the stockpile estimated size in tons. The DET may require RAP and RAS pile staking for failure to maintain the above. Do not add to a stockpile once it is tested for uniformity. Provide signage at all uniform stockpiles to inform haulers that uniform piles are not to be added to.

Stockpiles and processing methods are subject to inspection and approval by the DET at any time. Rejection of stockpiles can occur for the presence of foreign or deleterious materials, lack of uniformity, incomplete mixing in the asphalt mixture, adding to piles, or moving RAP or RAS in a way not traceable through the QCP records and methods. The Laboratory will resolve disputes over acceptability of RAP or RAS.

401.05 Mixing Plants. The Department will approve mixing plants before preparation of the mixtures. Schedule a date with the Department for approval inspection to be at least 1 week before mix production. Do not produce mixtures for projects from un-approved plants. General requirements for asphalt concrete mixing plants are specified in Item 402. Set the asphalt binder controls for the computerized plant at the virgin asphalt binder content of the JMF at all times unless change is authorized by the Laboratory.

Asphalt mixtures may be produced using the warm mix asphalt method according to 402.04 except as restricted by specification.

401.06 Weather Limitations. Place asphalt concrete only if the surface is dry and if weather conditions are such that proper handling, finishing, and compaction can be accomplished. Never place asphalt concrete if the surface temperature is below the minimum established in Table 401.06-1.

<table>
<thead>
<tr>
<th>Course Thickness</th>
<th>Minimum Surface Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 inches (75 mm) and over</td>
<td>36 °F [1] (2 °C [1])</td>
</tr>
<tr>
<td>1.5 to 2.9 inches (38 to 74 mm)</td>
<td>40 °F (5 °C)</td>
</tr>
<tr>
<td>1.0 to 1.4 inches (25 to 37 mm)</td>
<td>50 °F (10 °C)</td>
</tr>
<tr>
<td>Less than 1.0 inch (25 mm)</td>
<td>60 °F (16 °C)</td>
</tr>
<tr>
<td>Variable Intermediate, 0 to 3.0 inches (0 to 75 mm)</td>
<td>40 °F (5 °C)</td>
</tr>
</tbody>
</table>

[1] Instead of 36 °F (2 °C), use a minimum air temperature of 40 °F (5 °C) if paving on an aggregate base or subgrade.

In addition to the above surface temperature requirements, do not place surface courses if the air temperature is less than 40 °F (5 °C).

For any surface course with a polymer modified asphalt binder, ensure that the surface of the existing pavement is at least 50 °F (10 °C) and the air temperature is at least 50 °F (10 °C).

Do not schedule the placement of any surface course with a polymer modified asphalt binder after November 1, regardless of pavement or air temperature.

401.07 Notification. Notify the Engineer at least 24 hours before starting paving on a project. After starting paving, if paving operations are stopped for 1 week or more, notify the Engineer at least 24 hours before resuming paving on a project.

401.08 Asphalt Binder. Heat the asphalt binder and deliver it to the mixer within the temperature range specified in Table 702.00-1. Do not use asphalt binder while it is foaming in a storage tank. Take samples using correct new
containers from the binder line between the last piping ‘tee’ and inlet into the plant unless a different storage method requires a different sampling location.

401.09 **Aggregate Preparation.** Feed aggregates in their proper proportions and at a rate to permit correct and uniform control of heating and drying. Remove all aggregates in the plant that will produce a mix outside the temperature limits or that contain excessive moisture or expanding gases causing foaming in the mixture, and return them to the proper stockpiles.

401.10 **Mixing.** Maintain the temperature of the mix at the plant within the range set by the Laboratory for the JMF or according to the specification. The Engineer will determine the required temperature of the mixture on arrival at the project site based on the temperature range set for the mix design and heat losses in transit.

For batch plants, after all of the aggregate is in the mixer, add the asphalt binder in an evenly spread sheet over the full length of the mixer. The mixing time is defined as the interval between the start of application of the asphalt binder and the opening of the mixer gate. Discharge all asphalt binder required for one batch in not more than 30 seconds. After the asphalt binder is added, the Laboratory will establish a minimum mixing time, which will not be less than 30 seconds.

401.11 **Hauling.** Use trucks for hauling asphalt concrete that have tight, clean, smooth metal beds from which the entire quantity of mixture is discharged smoothly into the spreading equipment.

Before loading, apply a thin coating of an approved release agent to the inside surfaces of the truck bed to prevent adhesion of mixture to the bed surfaces. The Laboratory maintains a list of approved release agents. Do not use fuel oil for this purpose. Drain truck beds before loading.

Provide a place off the project for cleaning trucks when hauling polymer modified asphalt binder mixes or when excessive sticking of material in truck beds occurs. If the Contractor does not resolve excessive sticking of material in truck beds in a reasonable time and the sticking is in areas of the truck that would indicate excessive cooling of the mix (front corners, bottom, etc.) due to a long haul, the Engineer will require an insulated bed. The Contractor may only make changes in policy regarding release agents for beds or other procedure changes for better mix handling at the discretion of the Laboratory.

Equip each truck with a securely fastened, waterproof cover of suitable material to adequately protect the mixture from wind and weather. At the request of the Engineer, remove covers before dumping into the paver.

If transporting hot asphalt concrete at prevailing air temperatures below 50 °F (10 °C) or if the length of haul exceeds 20 miles (32 km), insulate all truck beds to maintain workable mix temperature, and ensure that all covers are fastened to exclude the wind. Do not exceed a distance of 50 miles (80 km) from the asphalt concrete plant to the paving site except by specific permission of the Department.

401.12 **Spreading Equipment.** Use self-contained spreading equipment of sufficient size, power, and stability to receive, distribute, and strike-off the asphalt concrete at rates and widths meeting the typical sections and other details shown on the plans. Use spreading equipment that has automatic control systems that maintain the screed in a constant position relative to profile and cross-slope references. Ensure control of the screed position is reasonably independent of irregularities in the underlying surface and of the spreader operation. Equip asphalt spreading equipment to prevent the segregation of coarse aggregate from the remainder of the asphalt concrete when the material moves from the hopper to the screed. Use means and methods approved by the asphalt spreader manufacturer consisting of but not limited to any combination of chain curtains, deflector plates, or other such devices.

For the following asphalt spreaders perform the listed modifications:

A. Equip Blaw-Knox asphalt spreaders with the Blaw-Knox Materials Management Kit (MMK) or an alternate equivalent kit. If an alternate kit is used provide documentation showing the Blaw Knox means and methods and that the alternate methods used are equivalent.

B. Only use Cedar Rapids asphalt spreaders manufactured after 1988.

C. Equip Caterpillar asphalt spreaders with deflector plates as identified in the Caterpillar December 2000 Service Magazine entitled “New Asphalt Deflector Kit (6630, 6631 or 6640)”.

Provide a letter to the Engineer identifying modified asphalt spreaders to be used and provide a certification statement and signature that the above modifications were implemented on the listed asphalt spreaders.

The Engineer will base final approval of spreading equipment on the demonstrated capability of the equipment to place the mixture to the required cross-section, profile and alignment in an acceptable, finished condition ready for compaction.

Where the use of standard full-scale spreading equipment is impractical due to the size or irregularity of the area to be paved, use specialized equipment or hand methods approved by the Engineer to spread the asphalt concrete.
**401.13 Rollers.** Use only steel wheel and pneumatic tire types of rollers meeting the minimum requirements of the following tables. Conform to manufacturer’s specifications for all ballasting.

<table>
<thead>
<tr>
<th>Roll Type</th>
<th>Maximum Capacity (square yards per hour (m²/hr))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandem 700 (600)</td>
<td></td>
</tr>
<tr>
<td>Three-Wheel 700 (600)</td>
<td></td>
</tr>
<tr>
<td>Trench 15 per inch width (13 per 25 mm width)</td>
<td>15</td>
</tr>
<tr>
<td>Pneumatic Tire, Type 1 1000 (850)</td>
<td></td>
</tr>
<tr>
<td>Pneumatic Tire, Type 2 700 (600)</td>
<td></td>
</tr>
<tr>
<td>Vibratory, Vibrating Roll 15 per inch width (13 per 25 mm width)</td>
<td>15</td>
</tr>
<tr>
<td>Vibratory, Static Roll (not vibrating) 3 per inch width (3 per 25 mm width)</td>
<td>3</td>
</tr>
</tbody>
</table>

**TABLE 401.13-2 STEEL WHEEL ROLLERS**

<table>
<thead>
<tr>
<th>Roller Type</th>
<th>Three-Wheel</th>
<th>Tandem</th>
<th>Vibratory</th>
<th>Trench</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total weight, tons (metric tons)</td>
<td>10</td>
<td>8 to 12</td>
<td>8 to 12</td>
<td></td>
</tr>
<tr>
<td>Compression rolls, pounds per inch width (kN/m), minimum</td>
<td>300</td>
<td>200</td>
<td>120</td>
<td>300</td>
</tr>
</tbody>
</table>

**TABLE 401.13-3 PNEUMATIC TIRE ROLLERS**

<table>
<thead>
<tr>
<th>Type I</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tire size, minimum</td>
<td>9.00 × 20 in (229 × 508 mm)</td>
<td></td>
</tr>
<tr>
<td>Wheel load, minimum</td>
<td>5000 lb. (2250 kg)</td>
<td></td>
</tr>
<tr>
<td>Average tire contact pressure, minimum</td>
<td>85 psi (590 kPa)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type II</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tire size, minimum</td>
<td>7.50 × 15 in (191 × 381 mm)</td>
<td></td>
</tr>
<tr>
<td>Wheel load, minimum</td>
<td>2000 lb. (900 kg)</td>
<td></td>
</tr>
<tr>
<td>Average tire contact pressure, minimum</td>
<td>55 psi (380 kPa)</td>
<td></td>
</tr>
</tbody>
</table>

For pneumatic tire rollers, use self-propelled, reversible units with vertical oscillation on all wheels on at least one axle. Determine the tire inflation pressure necessary to meet the specified minimum contact area and contact pressure requirements. Furnish the tire manufacturer’s charts or tabulations to the Engineer for verification of the required inflation pressure. Check tire inflation pressure as the Engineer directs and maintain it within 5 pounds per square inch (35 kPa) of the required pressure.

Provide rolls and wheels with the necessary accessories to prevent adhesion of the mixture, and keep them properly moistened with water, water containing a detergent, or water containing an approved additive. Do not use excess liquid.

**401.14 Conditioning Existing Surface.** Clean the surface on which the asphalt concrete is to be placed, and keep it free of accumulations of materials that would, in the judgment of the Engineer, contaminate the mixture, prevent bonding, or interfere with spreading operations. Where approved subgrade or pavement courses previously constructed under the Contract become loosened, rutted, or otherwise defective, correct the deficiency according to the contract item or items involved before the spreading of a subsequent pavement course.

If a quantity of asphalt concrete is specified for use in spot leveling or patching an existing pavement surface, spread and compact the material needed to effect the corrections as directed by the Engineer.

Paint contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of asphalt material before placing the asphalt concrete against them.

If placing asphalt concrete against the vertical face of an existing pavement structure, clean the vertical face of foreign material and apply asphalt material that results in a coating of approximately 0.25 gallon per square yard (1 L/m²).

Before placing a surface course onto an intermediate course, apply a tack coat to the intermediate course according to 407.06.

In areas where the surface is required to be feathered to meet an adjoining surface, coat the existing surface uniformly with a thin coat of asphalt binder.
401.15 Spreading, Finishing and Night Work

Spreading and Finishing. Spread the mixture at a rate calculated using the specified thickness and the compacted width of the pavement course being placed, and the weight-to-volume conversion factors established in 401.21. Maintain the actual rate of spreading the mixture equal to the required calculated rate within the tolerance specified in 401.19. For pavement courses specified for leveling an existing pavement surface, the actual rate of spreading the mixture may vary from the required calculated rate as approved by the Engineer to accomplish the intended purpose.

For intermediate courses, make the maximum compacted depth of any one layer 3 inches (75 mm).

Spread and finish the mixture using approved equipment or methods such that compaction can follow immediately. Preheat screeds and extensions before placing any asphalt concrete. Use side plates sufficient to contain the mixture laterally during spreading. Use only screed extensions, rigid or extendable, having the same features as the main screed including, but not limited to, vibration, heating, pre-strikeoffs, and tamping bars. When using front-mounted hydraulically extendable screeds at a fixed paving width use full width auger extensions and full tunnel extensions. When using fixed screed extensions use full width auger extensions and full tunnel extensions. Do not allow a buildup of excess material in front of any extended screed. Where excessive buildup of material is not controlled in front of the extended screed, the Engineer will require paver changes to correct the problem.

Ensure the paver operation, screed, screed extension, and, or, mix design provide a mat, prior to compaction, that is free of texture inconsistencies, shadowing, streaking, tearing, pulling, or other deficiencies. Take immediate action to correct the paver operation, screed, screed extensions, or, mix design. The Engineer may stop placement until corrections are completed.

Use strike-off plates/strike-off extensions only on irregular areas such as mailbox turnouts, driveway turnouts, and other irregular non-travelled roadway areas. The Engineer may approve the use of strike-off plates/extensions on variable width shoulders if the use of a standard extendable screed extension with the same features as the main screed is not practicable. Perform supplemental hand forming and tamping where irregularities develop and where placing the mixture by hand methods.

Take prompt corrective action if placed mixture is not free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor’s control and as determined by the Engineer. Remove and replace, or otherwise correct, any portion of the pavement course found to be defective in surface texture or composition before or after compaction in a manner satisfactory to the Engineer. Coordinate the spreading operation with the rate of production and delivery of the mixture to attain uniform, continuous progress. Avoid erratic spreader operation due to irregular contact with the hauling vehicle, surging in the feed and distribution of the mixture, or other cause. Maintain sufficient control of the spreading equipment with regard to line and grade references so that the pavement course, when compacted as specified, is in reasonable conformance with the Contract Documents.

Do not displace or damage bridge deck waterproofing membranes during spreading operations on the membranes.

Do not allow traffic on the compacted mixture until it has cooled sufficiently to prevent glazing as determined by the Engineer.

After completion of the surface course, seal gutters with asphalt binder as directed by the Engineer. Apply the material at a uniform width of approximately 4 inches (100 mm) and at a rate just sufficient to fill surface voids.

Night Work. Do not start night work or carry on day work into night work without operating an adequate and approved lighting system. Night work is defined as work performed from 30 minutes before sunset to 30 minutes after sunrise.

Operation of adequate lighting system consists of furnishing, installing, operating, maintaining, moving, and removing night time lighting to illuminate construction work areas for night work. Obtain the Engineer’s approval of the lighting at the beginning of the project and before starting the paving operation by measuring the luminance.

Provide an illuminated zone around all operating machinery. Provide an illuminated zone of at least 5 Foot-candles (55 lux) of lighting luminance in the immediate vicinity of pavers, rollers, grinding equipment, material transfer vehicles, etc., and at least 1 Foot-candle (10 lux) at 25 feet (7.6 m) from this equipment. Provide an illuminated zone of at least 5 Foot-candles (55 lux) of lighting luminance in the immediate vicinity of coring equipment and at least 1 Foot-candle (10 lux) at 10 feet (3m). Position the light sources so they don’t interfere with or impede traffic in any direction and do not cause glare for motorists or point onto adjacent properties. Provide a photometer capable of measuring the level of luminance on each night project. Take luminance measurements at a height of 20 inches (500 millimeters) above the roadway.

Obtain the luminance level any time requested by the Engineer. Test the illumination levels on the site each time a change in lighting configuration is made. Replace non-functioning lamps immediately. Check the luminaires aiming daily. Clean the luminaires regularly. Correct any deficient lighting within one hour or the Engineer will terminate construction activities.
When the total project includes more than one continuous lane mile (including bridges) of surface course paving in combination with night paving, provide a Material Transfer Vehicle (MTV) with paver hopper insert; a Material Transfer Device (MTD) with paver hopper insert; or a remixing paver specifically manufactured to eliminate segregation.

Provide equipment that:

A. Includes a mixer/agitator mechanism that consists of either segmented, anti-segregation, re-mixing augers or two full-length longitudinal paddle mixers specifically designed for the specific purpose of re-mixing. The longitudinal paddle mixers shall be located in the paver hopper insert.

B. Eliminates segregation, and provides a uniform temperature throughout the mixture;

C. Limits temperature differentials to less than 25 °F (14 °C);

Use the equipment on all mainline lanes of the traveled way including express lanes, collector-distributor lanes, continuous center turn lanes, acceleration/ deceleration lanes, and ramp lanes.

Use paver hopper inserts with a minimum capacity of 14 tons. Remixing may be done by the MTV or MTD, in the paver hopper insert, or by the remixing paver.

Demonstrate to the Engineer that the selected equipment eliminates physical segregation and limits the temperature differential of the mat surface measured transversely to 25 °F (14 °C). Provide a method before the start of paving that ensures non-segregation and thermal differential requirements are met, continuously during placement operations.

Remove equipment that does not consistently eliminate physical segregation and, or, does not meet the temperature differential requirement.

401.16 Compaction. Immediately after spreading the asphalt concrete and adjusting any surface irregularities, compact the mixture uniformly using rollers conforming to 401.13. Do not use a spreading rate that exceeds the total of the specified capacities of the rollers in use. However, if compacting a mixture spread as an intermediate or pre-leveling course less than 1-inch (25 mm) thick do not use a spreading rate that exceeds twice the total capacity of the rollers in use. Coordinate the spreading of the mixture with the required roller coverage, considering the rate of cooling of the mixture as affected by lift thickness and environmental conditions. Complete the required roller coverage during the period of time in which the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture. Compact base mixtures using a combination of both steel and Type I pneumatic tire rollers; however, in small areas, compact these mixtures as approved by the Engineer using any of the rollers specified in 401.13.

Compact intermediate and surface mixtures using a three-wheel roller in the breakdown position (roller immediately behind the paver) of the roller train; however, in small areas, compact these mixtures as approved by the Engineer using any of the roller types specified in 401.13.

Compact variable depth courses using a combination of both steel and pneumatic tire rollers; however, in small areas, compact these mixtures as approved by the Engineer using any of the roller types specified in 401.13.

For surface courses using a polymer modified asphalt binder give a copy of the JMF approval letter containing the design compaction temperature to the Engineer before any mix is placed. Unless otherwise specified ensure that the mix temperature immediately before rolling is not less than 290 °F (145 °C) if placing hot mix asphalt, and not less than 250 °F (121 °C) if placing warm mix asphalt according to 402.04. Do not compact polymer asphalt concrete surface courses with pneumatic tire rollers.

When using pneumatic tire rollers, ensure for any mix, that surface deviations and deformations caused by the tires are removed with steel wheel rollers. Do not use pneumatic tire rollers if any resultant surface deformations cannot be removed.

Do not use vibratory rollers on courses with a thickness under 1 1/2 inches (38 mm).

If using vibratory rollers, supplement them with three-wheel or pneumatic tire rollers.

Unless otherwise directed, begin rolling at the sides and proceed longitudinally parallel to the centerline at a slow, uniform speed. After each coverage or complete round trip, move the roller towards the crown of the road to begin its next pass, overlapping the previous pass by at least one-half the width of the previous pass. On superelevated curves, begin rolling at the low side and progress toward the high side. Where a longitudinal joint is being made, roll the joint then follow the applicable rolling procedure.

Continue rolling until full coverage of the course is complete and all roller marks are eliminated. Take care to prevent displacement of the edge line and grade. Where displacement occurs, correct the area immediately in a manner satisfactory to the Engineer.
Along curbs, headers, walls, and in other areas not accessible to rollers, thoroughly compact the mixture with hot, hand tampers or with mechanical tampers. On depressed areas, the Contractor may use trench rollers or rollers fitted with compression strips.

Replace mixture that becomes loose, broken, contaminated, or otherwise defective with fresh, hot mixture. Compact it to match with the surrounding area.

401.17 Joints. Place the asphalt concrete mixture as continuous as possible. Set up joints at the proper height above the adjacent construction to receive maximum compaction. Where the edge of the new pavement is significantly rounded, trim it to a vertical face before placing the adjacent pavement. On projects where traffic is allowed to cross the edge of the new pavement lane, complete the longitudinal joint of the adjacent lane or berm within 24 hours.

Construct longitudinal joints using string line or other controls as a point of reference to provide a straight longitudinal joint. Prior to placing adjacent pavement, trim any locations along the longitudinal joint that deviate horizontally from the point of reference. Maintain a consistent overlap of 1 inch to 1 ½ inches on adjacent pavement when closing longitudinal joints. Where phasing for maintenance of traffic will not allow lapping cold longitudinal joints per Standard Drawing BP3.1, provide a minimum of 6 inches offset between cold joints for each course placed. Form hot longitudinal joints using pavers operating in contiguous lanes, one just ahead of the other. Maintain the distance between pavers in adjacent lanes such that it does not exceed the distance that a normal size load of mixture will cover. Alternate loads of mixture between the pavers. Do not allow rollers performing the initial rolling operation in one lane closer than 12 inches (0.3 m) to the longitudinal joint until the adjacent lane is placed.

Instead of hot joint construction using multiple pavers, the Contractor may use full width construction with a single unit paver.

Compact all cold longitudinal joints on intermediate and surface courses using a three-wheel roller. For surface courses, form or cut all transverse construction joints to a vertical.

Seal all cold longitudinal construction joints by coating the entire face of the cold joint with a certified 702.01 PG binder or Supplemental Specification 875.02 Hot Applied Asphaltic Joint Adhesive to provide 100 percent coverage of the joint. Overlap the joint edges by at least 1/2 inch (13 mm). Seal all cold transverse construction joints with a certified 702.01 PG binder, 875.02 Hot Applied Asphaltic Joint Adhesive or 702.13 SBR Asphalt Emulsion to provide 100 percent coverage of the joint or with a certified 702.04 asphalt material applied at a rate of 0.25 gallon per square yard (1 L/m²).

401.18 Asphalt Binder Compatibility. If excess fat spots, regular random areas of flushing, or excess drain down occur on a project that are not attributable to over rolling, plant operation, or mix quality compared to the JMF, the Department will consider the asphalt binder incompatible. The Department will reject any on-hand asphalt binder because of incompatibility. The Department may use its discretion in determining if problem areas can be corrected, but if an unsafe condition exists, remove and replace the area in question. Demonstrate to the Laboratory through reporting actual testing analysis the compatibility of another asphalt binder and that proper equipment is in place in order to be allowed to resume.

401.19 Spreading and Surface Tolerances. If a uniform course is specified, make checks and adjustments to maintain the rate of spreading within a tolerance of ±5 percent of the required calculated weight per unit of area.

If a variable depth course is specified, place the mixture as shown on the plans.

If a longitudinal profile is specified by elevations on the plans, do not allow the completed pavement surface to deviate more than 1/2 inch (13 mm) at any point from parallel with the specified profile. Before placing the surface course, check the profile of the preceding course at 50-foot (15 m) intervals along the outside edge of each traffic lane and along any additional line described in superelevation tables, and submit a tabulation of all results that includes documentation of all deviations from the above tolerance to the Engineer. Perform corrective work necessary for compliance with the profile tolerance before placing the surface course. The requirements of this paragraph do not apply to small incidental areas of pavement less than 500 feet (150 m) in length.

Do not vary the transverse slope of the surface of the completed course from the specified slope by more than 3/8 inch in 10 feet (10 mm in 3 m).

Do not vary the surface of each completed intermediate or surface course from the testing edge of a 10-foot (3 m) rolling straightedge by more than 1/4 (6 mm). Furnish straightedges, straightedges equipped with levels, or other devices such as approved profilers conforming to S1058 and using ProVAL software. Equipment will be satisfactory to the Engineer.

Check the surface course for variations in slope or surface at locations where bumps are suspected when directed by the Engineer.
Correct variations in excess of slope or surface tolerance by removing mixture to neat lines and replacing, or by surface grinding in a manner satisfactory to the Engineer.

401.20 Asphalt Binder Price Adjustment. A contract item is eligible for a price adjustment when the contract’s proposal specifically includes an Asphalt Binder Price Adjustment note and the contract item meets the quantity limitations of the proposal note.

401.21 Method of Measurement. The Contractor is responsible for recording the net weight of each truckload of mixture to the nearest 100 pounds (50 kg) in triplicate on plant ticket forms approved by the Department. If the pay quantities are established by platform scales, provide a tare weight for each truck at the beginning of each day’s operation and a minimum of every 4 hours of operation each day. The Engineer may require additional tare weight measurements at any time. The Engineer will have the right to monitor all weighing operations and may require reweighing trucks at any time or location. Correct any discrepancies immediately. Continued non-compliance will result in the Department taking necessary and appropriate action, such as, but not limited to, assigning a Department ticket writer to the plant. Send one copy of the plant ticket with each load delivered to the paver and present it to the Engineer.

The Engineer will convert the total of the weights recorded on the plant tickets representing mixture finished according to contract requirements to cubic yards (cubic meters) using a conversion factor established by the Laboratory. The Laboratory will establish this conversion factor from the approved JMF. However, if a mix design is not available, the Laboratory will use the conversion factors in Table 401.21. If a uniform course is specified, the Department will not pay for a number of cubic yards (cubic meters) that exceeds the quantity calculated from plan lines and dimensions.

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>lb/yd³</th>
<th>(kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel and stone</td>
<td>4000</td>
<td>(2370)</td>
</tr>
<tr>
<td>Slag less than 90 lb/yd³ (less than 1450 kg/m³)</td>
<td>3600</td>
<td>(2135)</td>
</tr>
<tr>
<td>Slag 90 to 100 lb/yd³ (1450 to 1600 kg/m³)</td>
<td>4000</td>
<td>(2370)</td>
</tr>
<tr>
<td>Slag more than 100 lb/yd³ (more than 1600 kg/m³)</td>
<td>4300</td>
<td>(2550)</td>
</tr>
</tbody>
</table>

[1] Based on average dry rodded weight at the Laboratory.

401.22 Basis of Payment. The Department will pay for all work performed and measured as specified above according to the appropriate contract items for each type.

The cost of sealing the joints is included in the unit price bid for the asphalt concrete.

The Department will assess all costs against the Contractor that it incurs as a result of taking necessary and appropriate action due to the Contractor’s continued non-compliance.

If an unsafe condition exists, the Department will not pay for removing and replacing incompatible asphalt binder areas.
ITEM 442 SUPERPAVE ASPHALT CONCRETE REV. 1-18-2015

442.01 Description

This work consists of gyratory mix design, material, and quality control requirements for constructing a Superpave asphalt concrete pavement surface or intermediate course. The asphalt concrete pavement course consists of aggregate, and asphalt binder mixed in a central plant and spread and compacted on a prepared surface.

The requirements of Item 441 apply, except as modified by this specification.

442.02 Type A Mix Design

Design the mixture composition for a Type A mix according to 441.02 and the most recent Asphalt Institute Superpave Mix Design Manual (SP-2) for design procedures and material properties except as modified by this subsection. Include in the JMF submittal the standard Department cover and summary page; all printouts from the gyratory compactor (all gyratory points not necessary); and analysis covering the required mix properties. Submit one compacted gyratory sample and loose mix for compaction of another sample, in addition to a 5-pound (2000 g) loose sample, for each JMF.

The Contractor may use the Marshall flow test in design as an indicator of potential for excess tenderness.

Supply aggregate according to the lane current average daily truck traffic (Lane ADTT) as follows unless otherwise shown on the plans:

\[
\text{Lane ADTT} = \text{Current ADT} \times T_{24} \times 0.45
\]

Where:

- \( \text{Current ADT} \) = current average daily traffic count from the plans
- \( T_{24} \) = percent trucks per day from the plans

### TABLE 442.02-1 GYRATION LEVEL AND MATERIAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Lane ADTT</th>
<th>Nini</th>
<th>Ndes</th>
<th>Nmax</th>
<th>Coarse Aggregate Angularity</th>
<th>Fine Aggregate Angularity</th>
<th>Flat and Elongated Particles</th>
<th>Sand Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;4000</td>
<td>7</td>
<td>65</td>
<td>105</td>
<td>100 [1] / 100 [2]</td>
<td>44</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

[1] Percent fractured (one or more faces) according to ASTM D5821
[2] Percent fractured (two or more faces) according to ASTM D5821

Submit aggregate to be used to the Laboratory for approval a minimum of 3 weeks before submitting a JMF for approval.

If fine aggregate is from crushed carbonate stone or air-cooled blast furnace slag, the Department will not require the fine aggregate angularity (FAA) test. The Department will allow a blend of a material not meeting the FAA with a material that meets the FAA, but calculate the FAA result based on the individual Department FAA results and actual blend percentages. Obtain Department approval of any blends.

The restricted zone does not apply. Use control points according to SP-2, except as specified in Table 442.02-2.
Ensure that the F/A ratio is a maximum of 1.2. Use a 2-hour cure for the mix design.

If more than 15 percent fine aggregate not meeting FAA is used, perform a loaded wheel test (LWT) according to Supplement 1057. To estimate a LWT sample mix volume, use the bulk density from gyratory specimens at N$_{des}$. Results less than 0.20 inch (5.0 mm) at 120 °F (49 °C) are considered passing.

The Contractor may use reclaimed asphalt concrete pavement according to 401.04. Test design volumetric properties at N$_{des}$. Test N$_{max}$ for the required criteria. Ensure that the VMA is not less than the minimum values of Table 442.02-3.

### TABLE 442.02-3 VMA CRITERIA

<table>
<thead>
<tr>
<th>Mix</th>
<th>VMA (percent minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm</td>
<td>15</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>14</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>13</td>
</tr>
</tbody>
</table>

**442.03 Type B Mix Design.** Apply the mix design specified in 442.02 for a Type A mix except as modified by this subsection:

Modify the Coarse Aggregate Angularity of Table 442.02-1 according to Table 442.03-1.

### TABLE 442.03-1

<table>
<thead>
<tr>
<th>Lane ADTT</th>
<th>Coarse Aggregate Angularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;4000</td>
<td>65 [1]/65 [2]</td>
</tr>
<tr>
<td>&gt;4000</td>
<td>75 [1]/70 [2]</td>
</tr>
</tbody>
</table>

[1] Percent fractured (one or more faces) according to ASTM D5821
[2] Percent fractured (two or more faces) according to ASTM D5821

Ensure that at least 50 percent by weight of virgin fine aggregate is aggregate meeting FAA or is crushed carbonate stone or air-cooled blast furnace slag. Modify the No. 8 (2.36 mm) sieve requirement for a 12.5 mm mix in Table 442.02-2 to 34 to 40 percent. Apply an F-T value of +2 according to 441.02 and 441.09.

**442.04 Asphalt Binder.** Use a PG 70-22M asphalt binder for surface courses and a PG 64-28 asphalt binder for intermediate courses.

The minimum total asphalt binder content for a surface course is 5.7 percent.

**442.05 Quality Control.** Conform to 441.09, except as specified in this subsection. Ensure that plant operation and quality control testing conform to the Contractor’s Quality Control Program (QCP).

Use a gyratory compactor conforming to the requirements of Superpave. If the gyratory compactor was moved to the plant before production, calibrate it and present the results to the DET.

Determine bulk gravity for air voids determination on specimens compacted to N$_{des}$. For 12.5 mm mixes, compact one set of samples to N$_{max}$ a minimum of once each day for the first 3 production days. Ensure that density at N$_{max}$ is less than 98.0 percent of MSG. The Department will not allow production to continue if N$_{max}$ is greater than or equal to 98.0 percent of MSG unless acceptable corrections proven by resample and test are made.

If the design gradation requires an LWT test, take a sample sufficient to run a LWT test once each day for the first 3 days and test it according to Supplement 1057. The Contractor may perform the LWT test in the Contractor’s Level 2 laboratory, but must compact the sample the same day the sample was taken, cure it overnight, and test it the following day. Give the test result and sample density to the DET the day of the LWT test. Report the LWT data on the Quality Control Report.

**442.06 Compaction.** Cease production if compaction causes bumps in the mix or the mix is excessively tender.
442.07 **Acceptance.** The Department will base acceptance of the asphalt concrete mix on the method specified in the Contract line item description (i.e., 446, 448).

442.08 **Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Surface Course, 12.5 mm, Type A (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Surface Course, 12.5 mm, Type B (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Surface Course, 9.5 mm, Type A (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Surface Course, 9.5 mm, Type B (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Intermediate Course, 19 mm, Type A (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Intermediate Course, 19 mm, Type B (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Intermediate Course, 9.5 mm, Type A (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Intermediate Course, 9.5 mm, Type B (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Surface Course, 12.5 mm, Type A (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Surface Course, 9.5 mm, Type A (446)</td>
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<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Intermediate Course 19 mm, Type A (446)</td>
</tr>
<tr>
<td>442</td>
<td>Cubic Yard (Cubic Meter)</td>
<td>Asphalt Concrete Intermediate Course 19 mm, Type B (446)</td>
</tr>
</tbody>
</table>
1036.01 Procedure for Determining Theoretical Maximum Specific Gravity
1036.02 Procedure for Determining Bulk Specific Gravity
1036.03 Procedure for Determining Air Voids in Compacted Dense Asphalt Concrete

1036.01 Procedure for Determining Theoretical Maximum Specific Gravity

A. Condition the sample to be tested according to the specified requirement in ODOT C&MS. When determining the Maximum Theoretical Specific Gravity (MSG) in accordance with 441.09 or 442.05, this conditioning is not required when the mix is stored in a surge or storage bin for greater than one hour before sampling.

B. Determine the MSG per AASHTO T 209, Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures, (Rice Method). Do not use the “AASHTO T 209 Supplemental Procedure for Mixtures Containing Porous Aggregate” except as follows:

When creating a Job Mix Formula (JMF), if a 12.5 mm surface course has air-cooled blast furnace slag (No. 8 or larger) or a 19 mm or Type 2 intermediate course has dolomite, air-cooled blast furnace slag or limestone virgin coarse aggregate (No. 8 or larger) the Contractor may perform the ‘Supplemental Procedure for Mixtures Containing Porous Aggregate’ (SSD) per the method in section 4) to determine the amount of retained water. If the retained water in the JMF is greater than 0.18 percent water based on the dry weight of mix apply the SSD procedure for both the JMF testing and in quality control testing. Do not apply SSD to quality control if retained water is less than or equal to 0.18 percent water based on the dry weight of mix. Note on the JMF submittal and TE 199 that the SSD method is being used.

If during production it is believed an approved non-SSD 12.5 mm surface course having air-cooled blast furnace slag (No. 8 or larger size) or an approved non-SSD intermediate course JMF having dolomite, air-cooled blast furnace slag or limestone virgin coarse aggregate (No. 8 or larger) needs to have the SSD procedure performed apply the following requirements:

1. The amount of water retention in quality control must be greater than 0.18 percent water based on the dry weight of mix based on District confirmation testing.
2. The change must be approved by the District and the Laboratory.
3. Note the change on the TE 199.
4. Apply the SSD change to all subsequent MSG testing for the project.

C. Use the following equipment and procedures when performing the MSG test:

1. MSG Equipment:
   a. Metal pycnometer with a 1.06 gal (4000 mL) minimum volume.
   b. A table top mechanical vibration device designed specifically for the MSG test operating on 120-volts AC and capable of holding the above metal pycnometer. Ensure devices are approved by the Laboratory.
   c. The residual pressure manometer placed in the vacuum system per AASHTO T 209 may be a digital manometer. Obtain Laboratory approval of digital manometer models. Provide documentation for NIST traceability. Provide a connection near the vacuum pump for attaching a vacuum gauge as a check when needed. Immediately replace failed manometers with a functioning manometer before proceeding with testing.

2. MSG Procedure: Use only the submerged method. Calibrate the weight of the empty pycnometer in water weekly, or when a different technician begins testing, or when any changes to the water bath occur (changing/adding water, heating/cooling water, etc.).

D. When allowed by specification or the District and Laboratory, perform the SSD according to the following. No other SSD equipment and procedures are allowed.

1. MSG SSD Equipment: 12 inch (305 mm) diameter ‘full height’ sieve meeting the requirements of ASTM E11, " Specification for Wire-Cloth and Sieves for Testing Purposes", No. 50 (300 µm) or No. 100 (150 µm) mesh. Portable 120-volt AC fan that is at least 12 inch (305 mm) diameter.

2. MSG SSD Test Procedure:
   a. After the material has been removed from the water bath drain well.
   b. Obtain and record an empty weight of the sieve that the material will be placed in.
   c. Place the material in the sieve and pat/wipe the sieve underside with a dry towel to dry excess water. Place under the fan for 15 minutes. Ensure the fan axis is perpendicular to the sieve mesh with air flowing thru the sieve. Ensure the setup allows the air flow to readily escape the sieve bottom. Ensure the fan does not touch any sample being tested.
   d. After 15 minutes place the mix and sieve on a scale and record the weight. Subtract the weight of the empty sieve from the total weight to get the weight of the mix only. After weighing stir the entire contents of the mix by hand, especially at the corners and edges, ensuring all material is turned over to expose new surfaces to the air flow for drying. Place the mix and sieve under the operating fan for 15 minutes.
e. Repeat the process (15 minutes under the fan, weigh and subtract the sieve from total weight and record the weight, stir and dry again).
f. After obtaining the weight of the mix in each dry back period subtract the last two weights and record the difference. Divide the difference by the higher of the last two dry backs then multiply by 100. If the answer is 0.050 or below the material is considered SSD and the process is finished. Use the final SSD weight in the MSG calculation.

**1036.02 Procedure for Determining Bulk Specific Gravity.** Note: This method is for dense graded asphalt mixtures and is inappropriate for open graded mixtures.

Condition the sample to be compacted according to the specific requirement in ODOT C&MS. When determining the Bulk Specific Gravity (BSG) in accordance with 441.09 or 442.05, this conditioning is not required when the mix is stored in a surge or storage bin for greater than 1 hour before sampling.

Determine the BSG of a compacted mixture per AASHTO T166 Method A. When using vacuum drying per ASTM D7227 use a cycle period and number of cycles to ensure constant mass is achieved. This may vary depending on ‘as received’ condition of compacted specimens or cores. Document necessary cycle period and number of cycles dry back testing results for typical ‘as received’ specimens. Ensure a daily dry chamber and pressure test is performed. If the water bath for the specimens is not maintained at 77 °F (25 °C), use the correction factor (K) specified in Table 1036.02-1. Formula for correcting water temperature should be as follows:

\[
\text{Correction Factor (K)} \times \text{Avg. Specific Gravity} = \text{Corrected Avg. Specific Gravity}
\]

Do not exceed 350 °F (177 °C) in the destructive dry back of BSG samples. It is recommended for non-destructive purposes that the BSG dry back temperature be no more than 120 °F (49 °C).

**TABLE 1036.02-1**

<table>
<thead>
<tr>
<th>Temperature, °C</th>
<th>Correction Factor, K</th>
<th>Temperature, °C</th>
<th>Correction Factor, K</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.002661</td>
<td>21</td>
<td>1.000950</td>
</tr>
<tr>
<td>11</td>
<td>1.002567</td>
<td>22</td>
<td>1.000728</td>
</tr>
<tr>
<td>12</td>
<td>1.002458</td>
<td>23</td>
<td>1.000495</td>
</tr>
<tr>
<td>13</td>
<td>1.002338</td>
<td>24</td>
<td>1.000253</td>
</tr>
<tr>
<td>14</td>
<td>1.002204</td>
<td>25</td>
<td>1.000000</td>
</tr>
<tr>
<td>15</td>
<td>1.002060</td>
<td>26</td>
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</tr>
<tr>
<td>16</td>
<td>1.001903</td>
<td>27</td>
<td>0.999467</td>
</tr>
<tr>
<td>17</td>
<td>1.001734</td>
<td>28</td>
<td>0.999187</td>
</tr>
<tr>
<td>18</td>
<td>1.001555</td>
<td>29</td>
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</tr>
<tr>
<td>19</td>
<td>1.001364</td>
<td>30</td>
<td>0.998599</td>
</tr>
<tr>
<td>20</td>
<td>1.001162</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1036.03 Procedure for Determining Air Voids in Compacted Dense Asphalt Concrete.
Determine percent air voids in a compacted mixture by AASHTO T269 and the above procedures.
1037.01 SCOPE. This method covers the procedure for the determination of voids in the mineral aggregate (VMA) in a compacted mixture.

1037.02 DEFINITION. VMA is defined as the intergranular void space between the aggregate particles in a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume.

1037.03 SUMMARY OF METHOD. Determination of VMA is based on bulk specific gravity of the aggregate and is expressed as a percentage of the bulk volume of the compacted paving mixture. VMA is calculated by subtracting the volume of the aggregate determined by its bulk specific gravity from the bulk volume of the compacted paving mixture.

1037.04 CALCULATIONS. Determining VMA in mixtures containing:

1. 100% NEW MATERIAL (for mixtures incorporating recycled material, see 2. following).

\[
VMA = 100 - \frac{G_{mb}P_s}{G_{sb}}
\]

where
- \(VMA\) = Voids in mineral aggregate (percent of bulk volume)
- \(G_{mb}\) = bulk specific gravity of compacted mixture (ASTM D 2726)
- \(P_s\) = aggregate, percent by total weight of mixture
- \(G_{sb}\) = bulk specific gravity of total aggregate

\[
G_{sb} = \frac{P_1 + P_2 + \ldots + P_n}{G_1 + G_2 + \ldots + G_n}
\]

where
- \(P_1, P_2, \ldots, P_n\) = percentage by weight of aggregates 1, 2, …, n
- \(G_1, G_2, \ldots, G_n\) = bulk specific gravities of 1, 2, …, n (AASHTO T 84 and T 85)

2. Recycled materials.

\[
VMA = 100 - \frac{G_{mb}P_s}{G_{sb}}
\]

Where:
- \(VMA\) = voids in mineral aggregate (percent of bulk volume)
\[ G_{mb} = \text{bulk specific gravity of compacted mixture (ASTM D 2726) } \]
\[ P_s = \text{aggregate, percent by total weight of mixture} \]
\[ G_{sb} = \text{bulk specific gravity of total aggregate} \]

\[ G_{sb} = \frac{P_1 + P_2 + \ldots + P_n + P_{RAP}}{G_1 + G_2 + \ldots + G_n + G_{seRAP}} \]

where
\[ P_1, P_2, \ldots, P_n = \text{percentage by weight of aggregates 1, 2, \ldots, n} \]
\[ G_1, G_2, \ldots, G_n = \text{bulk specific gravities of 1, 2, \ldots, n (AASHTO T 84 and T 85)} \]
\[ P_{RAP} = \text{percentage by weight of recycled aggregate} \]
\[ G_{seRAP} = \text{effective specific gravity of the recycled aggregate} \]

\[ G_{seRAP} = \frac{100 - P_b}{100 - P_b} \frac{G_{mm} - G_b}{G_{mm} - G_b} \]

where
\[ P_b = \text{asphalt content of recycled material, percent by total weight} \]
\[ G_{mm} = \text{theoretical maximum specific gravity of recycled material (ASTM D 2041)} \]
\[ G_b = \text{specific gravity of the asphalt in recycled material} \]
1038.01 Scope. This method covers the procedure for the quantitative determination of asphalt binder in hot-mixed asphalt mixtures and pavement samples.

1. The aggregate remaining may be used for sieve analysis according to AASHTO T 30, Mechanical Analysis of Extracted Aggregate.

Note 1: Although asphalt binder, by definition, is material soluble in carbon disulfide, other solvents are used in this method for safety and environmental reasons.

1038.02 Summary of Method.

1. The mixture is extracted with a suitable solvent using the extraction equipment. The asphalt binder content is calculated by difference between the mass of the original sample and the mass of the extracted aggregate and ash from an aliquot of the extract.

1038.03 Apparatus.

1. Oven, capable of maintaining the temperature at 230 ± 9 °F (110 ± 5 °C).

2. Pan, flat, 14 inches (350mm) long, 10 inches (250mm) wide and 2.5 inches (65mm) deep.

3. Balance: A balance conforming to the requirements of AASHTO M 231, Class D shall be provided.

4. Balance: A balance conforming to the requirements of AASHTO M 231, Class E capacity 15 kg or more.
5. Hot Plate: Electric with adjustable heating rate.


7. Ignition Dish, 120 ml capacity.

8. Balance: A balance conforming to the requirements of AASHTO M 231, Class C.

9. Muffle furnace or gas burner capable of maintaining temperatures between 500 °C and 600 °C.

1038.04 Solvent.

1. For ODOT lab testing use trichloroethylene or alternate solvent approved by the Laboratory. Contractors may use any solvent that is determined to perform adequately.

1038.05 Preparation of Sample and General Requirements for weighing.

1. Place mixture in a large flat pan and dry to constant weight in an oven at a maximum temperature of 230 °F (110 °C).

2. The test sample consists of the entire sample or the end result of splitting or quartering a large sample conforming to AASHTO T 168. The size of the test sample is governed by the nominal maximum aggregate shown in the following table.

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size</th>
<th>Standard (mm)</th>
<th>Alternate</th>
<th>Minimum Mass of Sample (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75</td>
<td>No. 4</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>9.5</td>
<td>3/8&quot;</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>12.5</td>
<td>½&quot;</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>19.0</td>
<td>3/4&quot;</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>25.0</td>
<td>1&quot;</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>37.5</td>
<td>1 ½&quot;</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Note 2: When the mass of sample is greater than the maximum capacity of the extraction equipment, divide the sample into approximately equal portions for testing. The masses for calculations will then be the sum of like masses of the test portions.
3. Weigh extraction test apparatus and/or samples on a balance meeting the requirements of 1038.03 part 3 when the capacity is sufficient; otherwise, use a balance meeting the requirements of 1038.03 part 4.

1038.06 Apparatus

1. In addition to the apparatus listed in section 1038.03, apparatus similar to that shown in Figure 1, AASHTO T 164(76), Method A, is required.

1.1 Extraction Apparatus, consisting of a bowl approximately that shown in Figure 1 and an apparatus in which the bowl may be revolved at controlled variable speeds up to 3600 rpm. Provided a container for catching the solvent thrown from the bowl and a drain for removing the solvent.

Note 3: Similar apparatus of large size may be used.

1.2 Filter Ring: A smooth, white, medium fast filter paper of a diameter at least equal to the bowl sealing surfaces outside diameter and to internally exceed the bowl sealing surface width by at least 25.4 mm (1 inch).

1038.07 Procedure

1. Weigh a 1000 to 3000g sample into the bowl.

2. Cover the sample in the bowl with solvent and allow sufficient time for solvent to disintegrate the sample (not over 1 hour). Place the bowl containing the sample and the solvent in the extraction apparatus. Fit the filter ring around the edge of the bowl. Clamp the cover on the bowl tightly and place a graduated container under the drain to collect the extract.

3. Start the centrifuge revolving slowly and gradually increase the speed to a maximum of 3600rpm or until solvent ceases to flow from the drain. Allow the machine to stop, add 500 ml solvent and repeat the procedure. Use sufficient 500 ml solvent additions (not less than three) so that the extract is clear and near a light straw color. Collect the extract and the washings in a suitable graduate.

4. Remove as much of the mineral matter adhering to the ring as possible and add to the aggregate in the bowl. Dry the contents of the bowl to a constant mass in an oven at 110 ± 5 °C (230 ± 9 °F) or on a hot plate.

Note 4: Dry the sample until further drying at 110 ± 5 °C (230 ± 9 °F) does not alter the mass 0.1 percent.

5. Record the volume of the total extract in the graduate. Agitate the extract thoroughly and immediately measure approximately 100 ml into a previously weighed ignition dish. Dry on a hot plate. Burn the residue at a dull red heat (500 to 600 °C), cool, and weigh.
1038.08 Calculations

1. The mass of the mineral matter in the total volume of extract as follows:

   Total mineral value \[ G = \frac{V_1}{V_1 - V_2} \]

   where: \( G \) = mineral matter in grams
   \( V_1 \) = total volume in milliliters, and
   \( V_2 \) = volume after removing aliquot in milliliters.

2. Calculate the percentage of asphalt binder in the sample as follows:

   Binder content of dry sample, percent = \[ \frac{W_1 - (W_2 + W_3)}{W_1} \times 100 \]

   where: \( W_1 \) = mass of sample
   \( W_2 \) = mass of extracted mineral matter, and
   \( W_3 \) = mass of mineral matter in extract.

1038.09 Report

1. Report the asphalt binder content to the nearest 0.1 percent.
STATE OF OHIO  
DEPARTMENT OF TRANSPORTATION  
SUPPLEMENT 1039  
METHOD OF TEST FOR  
MECHANICAL ANALYSIS OF EXTRACTED AGGREGATE  

April 18, 2008

1039.01 SCOPE  This method of test covers a procedure for the determination of the particle size distribution of fine and coarse aggregates extracted from asphalt concrete mixtures, using sieves with square openings.

1039.02 APPARATUS  The apparatus consists of the following:

1. Balance: A balance conforming to AASHTO M 231, Class D for samples less than 5000 g, Class E for samples 5000 g or more.

2. Sieves: Sieves with square openings mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. Suitable sieve sizes selected to furnish the information required by the specifications covering the material to be tested. The woven wire cloth sieve conforming to the requirements of AASHTO M 92 for Sieves for Testing Purposes.

1039.03 PROCEDURE

1. Dry the sample until further drying at 230 + 9 °F(110 + 5 °C) does not alter the weight 0.1 percent. The total weight of aggregate in the asphalt concrete mixture being tested is the sum of the weights of the dried aggregates and the mineral matter contained in the extracted asphalt binder. The latter is to be taken as the weight of ash in the extract.

2. Sieve the aggregate over sieves of the various sizes required by the specification covering the mixture, including the 75 μm sieve. Sieve in accordance with AASHTO T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates. Commencing with the largest sieve, record an accumulated weight (consisting of the weight of material retained on a particular sieve plus the weight of material on all previous sieves) of material retained on each successive sieve and the pan. The total accumulated weight must check the total weight of the sample within 0.2 percent. Add the weight of dry material passing the 75 μm sieve by dry sieving to the weight of mineral matter in the extracted asphalt binder in order to obtain the total passing the 75 μm sieve. Determine the percent of material passing each sieve using the following formula:

\[
\% \text{ Passing} = 100 \left(1 - \frac{P_a}{P_t}\right)
\]

where:

- \(P_a\) = the accumulated weight for a particular sieve
- \(P_t\) = the total weight of aggregate in the asphalt concrete mixture from 3.1.
1039.04 REPORT Report percentages to the nearest whole number except for the percentage passing the 75 μm sieve which is reported to the nearest 0.1 percent.
1043.01 Scope. This supplement specifies the procedures for using an Asphalt Content Nuclear Gauge (AC Gauge) to correctly determine:

1. a background count.
2. a calibration.
3. a proper AC content offset amount.
4. the asphalt binder content of a sample of asphalt concrete.

Ensure the gauge meets the requirements of Supplement 1041.04. Ensure the manufacturer provided ‘reference voltage’ is properly entered into the gauge.

1043.02 General. Turn on the AC Gauge for a minimum of 10 minutes prior to performing any tests.

For QC and QA test reporting take AC Gauge readings at 16 minutes. For quick checks, readings may be taken at lesser times.

Ensure the AC Gauge operator or any other hydrogen sources are no closer than 5 feet (1.6m) to the AC Gauge when it is performing a test. If a hydrogen source moves closer than 5 feet (1.6m) to an AC Gauge during a test, retest the sample.

Calculate and record asphalt binder contents as percent of total mix.

1043.03 Background Count. Take two background counts before the start of each production day to make sure they are within 1.0 % of each other (also determines gauge
stability/gauge warm up). If the two counts are within 1.0 % save the second background count as the current count. Before each test run a background to check that it is within 1.0 % of the previous. If so save and use that current value for the test. If not investigate reasons for background variation. This may include changes in background (hydrogen) or gauge issues.

1043.04 Laboratory Produced Mixtures. This section describes the procedures for making laboratory mixes of asphalt concrete to calibrate an AC Gauge. Prepare mixes in an approved Level 3 laboratory.

Mix aggregate meeting the JMF with the specified percent asphalt binder and grade. Prior to mixing the samples for calibration, mix a sample of the asphalt concrete, at the minimum asphalt binder content to be mixed, to prime the mixing bowl. Discard this sample. Scrape the mixing bowl and mixer beater clean and weigh the mixing bowl.

Scrape the mixing bowl and mixer beater clean after mixing each batch of asphalt concrete so that the mixing bowl weighs the same before each batch is mixed. After all the batches are mixed clean all of the mixing equipment.

1043.05 Blank Sample. Prior to performing each calibration, prepare and weigh a blank sample to determine the weight of asphalt concrete to add to an AC Gauge pan for an AC Gauge test. Prepare a blank sample as follows:

1. Weigh an empty, clean AC Gauge pan.
2. Mix a sample of asphalt concrete, having an asphalt binder content at the JMF design asphalt binder content, in accordance with 1043.04. Use a mix temperature 25.0º F less than the JMF lab compaction temperature or 270º F (132º C), whichever is higher. Ensure this sample is of a sufficient size to completely fill an AC Gauge pan.
3. Fill an AC Gauge pan with the asphalt concrete in accordance with the first 3 steps of 1043.06.
4. Add additional asphalt concrete to just slightly over the top edge of the AC Gauge pan. Lightly press the top of the sample with a hot spoon or other instrument to settle the asphalt concrete into the edges and corners of the AC Gauge pan. Fill in any low spots and the corners with additional asphalt concrete as needed. Ensure the blank sample is level with the top edge of the AC Gauge pan. If not, redo the blank sample.

After the blank sample and pan is prepared weigh the sample and pan to the nearest gram. The weight of the blank sample is the difference between the sample and pan weight and the weight of the AC Gauge pan. Prepare a new blank sample for each JMF. The blank sample may be used as a calibration sample in accordance with 1043.07.

1043.06 Filling AC Gauge Pans. Fill the AC Gauge pans with laboratory or plant mixed asphalt concrete as follows:
1. Weigh an empty, clean AC Gauge pan.

2. Fill the AC Gauge pan about 1/3 full with the asphalt concrete and settle the contents by dropping it 3 to 4 inches (75 to 100 mm) onto a level surface 3 times.

3. Add additional asphalt concrete until the AC Gauge pan is about 2/3 full and settle the contents by again dropping it 3 to 4 inches (75 to 100 mm) onto a level surface 3 times.

4. Place the AC Gauge pan on a scale, tare the scale, and add additional asphalt concrete until the weight of the asphalt concrete in the AC Gauge pan equals the weight of the blank sample.

5. Remove the pan from the scale and lightly press the top of the sample with a hot spoon or other instrument to settle the asphalt concrete into the edges and corners of the AC Gauge pan. Note: For an accurate test it is essential that the corners are filled and that the mix surface is flush with the pan top.

6. Weigh the AC Gauge pan with the asphalt concrete to confirm the weight of the blank sample.

**1043.07 Calibration.** Calibrate the AC Gauge using a minimum of 3 separate calibration samples mixed in accordance with 1043.04. Ensure these samples have asphalt binder contents as follows:

1. Design asphalt binder content.
2. 1.0 percent above the design asphalt binder content.
3. 1.0 percent below the design asphalt binder content.

Perform the calibration of the AC Gauge in accordance with the AC Gauge manufacturer's instructions. Calibrate the AC Gauge such that the Fit Coefficient is 0.995 or above. If the Fit Coefficient is less than 0.995 calibrate the AC Gauge with new calibration samples.

To verify the calibration is properly working in the AC gauge mix a separate Verification sample at the JMF asphalt binder content. Contact the District for availability for witnessing the mixing and testing of the Verification sample. In place of witnessing the sample the District may opt to extract a Verification sample for Quality Assurance purposes and request a replacement Verification sample at any time. Determine the asphalt binder content of the Verification sample by the calibrated AC Gauge in accordance with 1043.09. The AC Gauge will be considered calibrated if the asphalt binder content determined by the AC Gauge is within 0.14 percent of the actual asphalt binder content of the sample. Retain and label the Verification sample above for District use.
If not full, store the calibration in the AC Gauge. Record the calibration so that it may be retrieved whenever a sample of asphalt concrete with the same design is to be tested for asphalt binder content.

Print out the following information for each calibration:

1. Date
2. Contractor's name
3. AC Gauge serial number
4. Calibration number (assigned by the Laboratory)
5. Type of asphalt concrete
6. Background count
7. Blank sample weight
8. Fit coefficient
9. Calibration constants
10. Programmed asphalt binder contents, corresponding measure counts and percent differences

Submit the printouts from the calibration and verification sample, along with the "Calibration Inspection Form", to the DET.

1043.08 Determining Plant and District AC Gauge Offset Amounts. Calculate an AC Gauge offset amount in accordance with procedures outlined in Appendix A. Do not use another procedure.

Every combination of aggregates and asphalt binder will have a unique offset amount. Before an offset amount is determined and applied to an AC Gauge the asphalt plant printout results for total asphalt binder content must be verified for accuracy. (Be sure to include SBR, if used, in this total asphalt binder content.) To accomplish this asphalt concrete samples are extracted with solvent to determine their asphalt content. Although extractions are not perfectly accurate they are critical in confirming the plant printout total asphalt content. Should extraction results appear out of line compared to the plant printout total asphalt content there may be an issue with the plant. Do not use the plant printout total asphalt content in determining an offset amount. Investigate the reason for the problem, correct the problem and record the investigation and findings on the TE-199 before proceeding with further extraction testing to verify the new plant printout total asphalt content used in determining the offset amount.

After determining an AC Gauge offset amount proceed with determining AC contents of production samples by the AC gauge according to 1043.09.

Correct sample test results that are tested by the AC Gauge prior to determining an offset amount by applying the offset amount to the previous AC Gauge determined AC contents by hand on the TE 199.
Only determine one AC Gauge offset amount per Job Mix Formula per project. For re-use of an offset on a new project if more than 30 days has lapsed since the JMF was last tested, re-do the offset procedure in Appendix A. If an AC Gauge offset amount is later determined, by an investigation of both the Contractor and the District, to be incorrect re-do the offset procedure in Appendix A.

1043.09  **Determining Asphalt Binder Content.** During initial production of asphalt concrete determine a proper AC Gauge offset amount in accordance with 1043.08. Enter the offset into the AC gauge in accordance with the manufacturer’s instruction. Determine the asphalt binder content of a sample of asphalt concrete in a properly offset AC gauge as follows:

1. Set the AC Gauge for the calibration that corresponds with the JMF of the asphalt concrete to be tested.
2. Place the AC Gauge pan containing the sample of asphalt concrete in the AC Gauge and test in accordance with the manufacturer's instructions.
3. Determine the moisture content of a 3.3 pound (1500-gram) sample in accordance with 1043.10 and record with each AC Gauge and test.
4. Print out the following information for each AC Gauge test:
   a. Date
   b. Time
   c. Contractor’s name
   d. AC Gauge serial number
   e. Calibration Number
   f. Measure count
   g. Background count
   h. Percent asphalt binder to the nearest 0.01 percent

1043.10  **Determining Moisture Content.** Determine the moisture content of a sample of asphalt concrete as follows:

1. Determine and record the combined weight of the empty sample pan and stirrer to the nearest 0.004 ounce (0.1 gram).
2. Place a 3.3 pound (1500-gram) sample of asphalt concrete and stirrer in the sample pan. Determine and record the weight of the filled sample pan to the nearest 0.1 gram (initial weight).
3. Place the filled sample pan in an oven for a minimum of 2 hours. Ensure the oven temperature is 355 +/- 20 °F (180 +/- 11 °C).
4. Remove the filled sample pan from the oven. Determine and record the weight of the filled pan to the nearest 0.1 gram. Stir the sample and place the filled sample pan back in the oven.

5. Repeat Step #4 every 15 minutes until the total mix weight loss between 2 consecutive 15 minute readings is less than 0.1 percent. The last 15 minute reading is the final weight. Subtract the empty sample pan and stirrer weight to determine the final sample weight.

6. Calculate the moisture content (expressed as a percent) as follows:

   \[
   \text{Moisture content} = \frac{(\text{initial sample weight} - \text{final sample weight})}{\text{final sample weight}} \times 100
   \]

7. Subtract the percent moisture content from the asphalt binder content as determined by the AC Gauge to determine the corrected asphalt binder content.
Appendix A, page 1

AC Gauge Verification and Offset Record

District ________ Date________

Project No. _____________________ Contractor _______________

JMF No. ________ Calibration No. _______ Type ___________

JMF AC ____________ P-4 ______________ %RAP ___________

Original Calibration Constants:

A1_____________A2_____________A3_____________

Blank Sample Weight ________g Background Count ___________ Fit Coef.___________

Verification Sample Gauge Correlation and Initial Offset:

Plant Gauge (1)__________(2)__________ Avg. ____________ Gauge Serial No. _____

District Gauge (1)_________(2)__________ Avg ____________ Gauge Serial No. _____

Initial Offset Plant = JMF AC-Plant Avg = +/- _____________

Initial Offset District=JMF AC-District Avg = +/- _____________

Initial Offset Calibration No. Plant _____________________ District __________________

Total Offset Determination for Plant Gauge:

Minimum four extractions at the plant required. Test results on page two.

Plant Offset Avg = +/- ________________

Total Offset Plant = Initial Offset Plant + Plant Offset =

Initial Offset Plant + Plant Offset Avg. = (+/- )_____+ (+/- )______= (+/- )_______

Total Offset Determination for District Gauge:

Total Offset District=

Initial Offset District + Plant Offset Avg = (+/- )_____+ (+/- )______= (+/- )_______

Note: Enter offsets using same plant sample before and after to verify correct entry.
AC Gauge Verification and Offset Record

Offsets Verification from Extraction and Plant Data
(Attach plant tickets and gauge printouts)

Extraction (plant, four minimum)

1) Date _____ Time _____ P-4 _____ AC _____
   Plant Ticket Avg AC _____ Plant Gauge _______ - Moisture ____ = Corrected Plant Gauge_____
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ______

2) Date _____ Time _____ P-4 _____ AC _____
   Plant Ticket Avg AC _____ Plant Gauge _______ - Moisture ____ = Corrected Plant Gauge_____
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ______

3) Date _____ Time _____ P-4 _____ AC _____
   Plant Ticket Avg AC _____ Plant Gauge _______ - Moisture ____ = Corrected Plant Gauge_____
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ______

4) Date _____ Time _____ P-4 _____ AC _____
   Plant Ticket Avg AC _____ Plant Gauge _______ - Moisture ____ = Corrected Plant Gauge_____
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ______

5) Date _____ Time _____ P-4 _____ AC _____
   Plant Ticket Avg AC _____ Plant Gauge _______ - Moisture ____ = Corrected Plant Gauge_____
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ______

**Plant Offset Avg** = Avg Difference (Plant Ticket AC - Corrected Plant Gauge) = +/- ______

Note: Is extraction sample P-4 +/- (6%) of JMF? Do not proceed until corrected. Does extraction data reasonably confirm plant data? If not, do not proceed with offset procedure and check plant operation / calibration. If so, calculate offset using plant ticket data. Calculating the plant offset average may require judgment on the part of the monitor if any one value appears to be out of place. If a single value is out of line but the rest are close then use the remaining data to calculate the average.

Level 2 Tech Sign. _________________________________ Date __________________

District Monitor Initials._____________________________ Date __________________
FORMULA for Calculating the Grams of PG Binder needed for an Asphalt Content Point:

Formula:

\[(C \times A) \div (100 - A)\]

A = Desired Asphalt Point
C = Weight of Dry Aggregates

Example:

Desired AC\% = 6.0\%
Weight of Dry Aggregates = 7000 Grams

\[(7000 \times 6.0) \div (100 - 6.0) = 42000 \div 94.0 = 446.80\]
Rounded = 447

According to this calculation, you need 447 grams of liquid asphalt (PG Binder) combined to the 7000 grams of Aggregate to give you a sample with a 6.0\% Asphalt Cement content.
AC GAUGE VERIFICATION AND OFFSET RECORD

District – 4
Project No. - 199-03
Contractor – Adam’s Paving

Date – 1/1/2008

JMF No.- B413060  Calibration No.- 3060  Type - 441-1

JMF AC - 5.6%  P-4 - 55%  %RAP - 20%

Original Calibration Constants:

A1) -6.133262  A2) +3.910774  A3) +0.00

Bland Sample Weight - 7000 grams

Verification Sample – Gauge Correlation and Initial Offset:

Plant Gauge - 5.67% & 5.63%  Avg. 5.65%  Gauge Serial No. - 1500
District Gauge - XXXX  Avg - XXXX  Gauge Serial No. - XXXX

Initial Offset Plant = JMF AC - Plant Avg = +/- 5.60% - 5.65% = -0.05%

Initial Offset District = JMF AC - District Avg = +/- XXXX

Initial Offset Calibration No. Plant - 3060 / 1  District - 4

Total Offset Determination for Plant Gauge:
Minimum three extractions at the plant required. Test results on page two. Plant Offset Avg = +/-

Plant Offset + Initial Offset = Total Plant Offset

(+/-) -0.39  (+/-) -0.05 = (+/-) -0.44

Plant Offset Calibration No. - 3060 / 2

Total Offset Determination for District Gauge:

Plant Offset + Initial Offset District = Total Offset District

(+/-) -0.00  (+/-) -0.00 = (+/-) -0.00
Extraction (Plant) (District split if used)

1) Date - 5/30 Time - 9:25 P-4 - 59 % AC - 5.06 % / P-4 - XX AC - XX
   (Plant Ticket Avg AC is 5.54 %) / (Plant Gauge 5.98 % – Moisture .05 %) = 5.93 %
   Difference (Plant Ticket AC - Corrected Plant Gauge) = 5.54% - 5.93% = - 0.39 %

2) Date - 6/3 Time - 9:41 P-4 - 52 % AC - 5.55 % / P-4 - XX AC - XX
   (Plant Ticket Avg AC is 5.54 %) / (Plant Gauge 6.00 % – Moisture .02 %) = 5.98 %
   Difference (Plant Ticket AC - Corrected Plant Gauge) = 5.54% - 5.98% = - 0.44 %

3) Date - 6/3 Time - 1:45 P-4 - 51 % AC - 5.20 % / P-4 - XX AC - XX
   (Plant Ticket Avg AC is 5.54 %) / (Plant Gauge 5.83 % – Moisture .01 %) = 5.82 %
   Difference (Plant Ticket AC - Corrected Plant Gauge) = 5.54% - 5.82% = - 0.28 %

4) Date - 6/4 Time - 10:18 P-4 - 51 % AC - 5.37 % / P-4 - XX AC - XX
   (Plant Ticket Avg AC is 5.54 %) / (Plant Gauge 6.17 % – Moisture .02 %) = 6.15 %
   Difference (Plant Ticket AC - Corrected Plant Gauge) = 5.54% - 6.15% = - 0.61 %

5) Date - 6/5 Time - 8:57 P-4 - 56 % AC - 5.50 % / P-4 - XX AC - XX
   (Plant Ticket Avg AC is 5.54 %) / (Plant Gauge 5.81 % – Moisture .02 %) = 5.79 %
   Difference (Plant Ticket AC - Corrected Plant Gauge) = 5.54% - 5.79% = - 0.25 %

---

Plant Offset Avg = 5.54% - 5.93%
Avg Difference (Plant Ticket AC - Corrected Plant Gauge) = - 0.39%

Notes: Is extraction sample P-4 +/- 6% of JMF? If not, resample and check plant. Does extraction data reasonably confirm plant data? If not, do not proceed with offset procedure and check plant operation/calibration. If so, calculate offset using plant ticket data.

Calculating the plant offset average may require judgment on the part of the monitor if any one value appears to be out of place. If a value is out but the rest are close then use the remaining data to calculate the average.

(Please Print)
State Monitor (Level 2 or 3) ___________________________ Date ____________

Contractor (Level 2 or 3) ___________________________ Date ____________
STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
SUPPLEMENT 1054
TEST METHOD FOR DETERMINATION
OF ASPHALT BINDER CONTENT BY
THE IGNITION METHOD

April 18, 2008

1054.1  Scope
This test method covers the determination of asphalt binder content of hot mixed paving mixtures by ignition of the asphalt binder in a furnace. The aggregate remaining can be used for sieve analysis.

1054.2  Safety
This standard may involve hazardous materials, operations, and equipment. This standard does not presume to address all of the safety problems associated with ignition oven’s use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Do not attempt to bypass the safety interlock on the oven door!!

1054.3  References
AASHTO Standards:
T 248  - Practice for Sampling Asphalt Paving Mixtures
T 30    - Mechanical Analysis of Extracted Aggregate
1054.4 Summary of Test Method

The asphalt binder in a sample of hot mixed paving material is burned by ignition at high temperature. The asphalt binder content is calculated from the mass of ignited aggregate, moisture content, and temperature compensation. The asphalt binder content is expressed as mass percentage of the moisture free mixture. This method may not be applicable to certain modified mixes. Contact the Laboratory if any question.

1054.5 Apparatus

A. A forced air ignition furnace capable of maintaining a temperature of 1100 °F (600 °C). The oven may or may not have an internal balance. If so it must be thermally isolated from the furnace chamber. The internal balance must be accurate to 0.1 g. Ensure the balance is capable of weighing a 3500 gram sample in addition to the sample baskets. Ensure the furnace calculates a temperature compensation factor for the change in weight of the sample baskets and provide for the input of a correction factor for aggregate loss. If the furnace has an internal balance provide a printed ticket with the initial specimen weight, specimen weight loss, temperature compensation, correction factor, corrected asphalt binder content (percent), test time and test temperature. As well ensure the furnace automatically determines weight loss and when weight is constant for two minutes signals the operator by an indicator light and audible alarm. Provide a method for reducing furnace emissions. Provide an automatic locking door.

B. Two or more tempered stainless steel 2.36mm (No. 8) mesh or similar perforated baskets nested into a catch pan. Provide screening on the legs to confine the aggregate. Ensure a minimum surface area of 265mm (10.5 inch) x 265mm (10.5 inch) for one basket.

C. One stainless steel catch pan.

D. Ovens, balance and miscellaneous equipment as outlined in Supplement 1041.

E. Safety equipment: safety glasses or face shield, high temperature gloves, and long sleeve jacket or heat resistant sleeves. A heat resistant surface capable of withstanding 1200 °F (650 °C) and a protective cage appropriately labeled and capable of surrounding the sample baskets.

F. Vent the furnace so no odors are noticeable in the laboratory. Ensure exhaust air moves by means of a fan on the furnace outlet. Ensure exhaust air movement is limited so as to not affect oven operation adversely.

1054.6 Sampling and Preparation

A. Obtain the test sample in accordance with the appropriate specification. Plant samples may need to be quartered (AASHTO T 248). Testing road samples after testing in an asphalt binder content nuclear gauge will require quartering as well.
B. Preparation of test specimens:

1. If the mix is too cold to separate, warm in an oven at less than 302 °F (150 °C) for sufficient time to soften.

2. The size of the test sample is governed by the type of asphalt concrete mix as shown in the table below. Conform to any existing requirements for sample size. Ensure no single oven test has a sample greater than 3000g. However, the test specimen may be divided into suitable increments, tested, and results recombined for calculation of the asphalt binder content (weighted average).

<table>
<thead>
<tr>
<th>Minimum Sample Size by Mix Type</th>
<th>448 Type 1&amp;2, 446 Type 1&amp;2</th>
<th>2000g</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>2000g</td>
<td></td>
</tr>
<tr>
<td>302</td>
<td>2500g</td>
<td></td>
</tr>
<tr>
<td>308</td>
<td>2500g</td>
<td></td>
</tr>
<tr>
<td>Open Graded Friction Course</td>
<td>2500g</td>
<td></td>
</tr>
<tr>
<td>All other mixes</td>
<td>2000g</td>
<td></td>
</tr>
</tbody>
</table>

3. A 1000g minimum sample is required for a moisture determination for each mix sample per 9.0. Do not use the specimen for moisture determination for asphalt binder content determination.

1054.7 Calibration (if required)

Test mixes containing any limestone coarse aggregate (including reclaimed asphalt concrete pavement) at 930 °F (500 °C) unless otherwise approved by the Laboratory. Test all other mixes at 1000 °F (540 °C) provided no indication of aggregate breakdown by erroneous data exists.

Obtain the asphalt binder content of reclaimed asphalt concrete pavement determinations by averaging results from ignition oven testing on three separate samples.

A. Three Sample Calibration

1 Prepare three calibration specimens conforming to 1054.6.B.2 at the design asphalt binder content and include the appropriate specification for cure time. Prepare a butter mix as above and discard prior to mixing calibration samples. Sample aggregate used for the calibration specimens from the most recently available aggregate source or pile. Batch and grade an additional blank sample to verify gradation meets the JMF.

2 Preheat the oven to the required test temperature. Record the oven temperature prior to the start of the test.
Enter a correction factor of 0.00 in the ignition oven if applicable.

Weigh the sample basket assembly.

With the sample in the baskets weigh and record the sample, baskets, catch pan, and basket guards. Calculate and record the initial weight of the sample specimen (total weight - the weight of the sample basket assembly).

Input the initial weight of the sample in whole grams into the oven if applicable. Verify that the correct weight has been entered.

Zero the balance if applicable. Place the sample in the oven. Verify that the sample weight (including baskets) equals the total weight in 1054.7.A.6 within 5 g. Differences greater than 5 grams or failure of the oven balance to stabilize may indicate that the sample basket assembly is touching the oven wall. Begin the test.

For internal balance ovens:

Allow the test to continue until the oven indicates the test is complete. Stop the test.

Remove the baskets to a safe location allowing to cool 20 minutes.

Record all data on the Mixture Calibration form.

For ovens with no internal balance:

Test the sample for 75 to 85 minutes for the 930 °F test and 60 minutes for the 1000 °F test. Stop the test and visually check the sample appearance. If any dark sooty ash remains on the aggregate or in the tray restart the test. Check the appearance every 5 minutes until no dark ash remains. Weigh the basket assembly recording the weight at 20 seconds. Restart the test and weigh again after 5 minutes recording the weight at 20 seconds. If the difference in hot weight is less than 1 gram the test is complete.

Calculate the difference in beginning weight and final hot weight.

Record all required data on the Mixture Calibration form.

B. Blank Aggregate Sample Calibration (if required)

Prepare two calibration samples conforming to 1054.6.B.2 in the lab or taken from the plant belt or hot bins. Any batching method may be used to prepare the samples. Grade one sample to verify the gradation conforms reasonably to the JMF. Extract reclaimed asphalt concrete pavement before incorporation into the blank sample.
Dry the blank sample before test. This can be done by drying in an oven (at least 230 °F (110 °C)) for 20 minutes (with some stirring).

Preheat the ignition oven to the required temperature. Record the oven temperature set point prior to the initiation of the test.

Enter a correction factor of 0.00 in the ignition oven if applicable.

Weigh the sample basket assembly.

With the sample in the basket assembly weigh and record the specimen and entire basket assembly. Calculate and record the initial weight of the sample (total weight - the weight of the sample basket assembly).

Input the initial weight of the sample in whole grams into the ignition oven, if applicable. Verify that the correct weight has been entered.

Zero the balance if applicable. Place the sample into the oven. Verify that the sample weight (including basket assembly) equals the total weight in 7B6 within 5 grams. Differences greater than this or failure of the scale to stabilize may indicate the basket assembly is touching the oven wall. Begin the test.

**For internal balance ovens:**

Allow the test to continue until the oven indicates the test is complete. Stop the test.

Remove the basket assembly to a safe location allowing to cool 20 minutes.

Record all required data on the Mixture Calibration form.

**For ovens with no internal balance:**

Test the sample for 75 minutes for the 930 °F test and 60 minutes for the 1000 °F test. Stop the test and visually check the sample appearance. If any dark sooty ash remains on the sample or in the tray restart the test. Check the sample every 5 minutes until no dark ash remains. Weigh the basket assembly recording the weight at 20 seconds. Restart the test and weigh again after 5 minutes recording the weight at 20 seconds. If the difference in hot weight is less than 1 gram the test is complete.

Calculate the difference in beginning weight and final hot weight.

Record all required data on the Mixture Calibration form.
1054.8 Oven Test Procedure

1  Preheat the ignition oven to the required temperature. Record the oven temperature prior to starting the test.

2  Perform a moisture correction test in accordance with 1054.6.B.3 and 1054.9

3  Weigh and record the weight of the sample basket assembly.

4  With the sample in the basket assembly weigh and record the weight of the sample and basket assembly. Calculate and record the initial weight of the sample (total weight - weight of the basket assembly).

5  Input the initial weight of the sample in whole grams into the oven, if applicable. Verify that the correct weight has been entered.

6  Place the sample and basket assembly into the oven. Verify that the sample and basket weight equals the sample and basket weight from 1054.8.4 within 5 grams. Differences greater than this or failure of the balance to stabilize may indicate that the sample is touching the oven wall. Begin the test.

**For internal balance ovens:**

7  Allow the test to continue until the oven indicates the test is complete. Stop the test.

8  Remove the sample and basket assembly to a safe location allowing to cool for 20 minutes.

**For ovens with no internal balance:**

7  Test the sample for 75 to 85 minutes for the 930 °F test and 60 minutes for the 1000 °F test. Stop the test and visually check the sample appearance. If any dark sooty ash remains on the sample or in the tray restart the test. Check the sample every 5 minutes until no dark ash remains. Weigh the basket assembly recording the weight at 20 seconds. Restart the test and weigh again after 5 minutes recording the weight at 20 seconds. If the difference in hot weight is less than 1 gram the test is complete.

8  Calculate the difference in beginning weight and final hot weight as percent total mix (percent).

1054.9 Determining Moisture Content

1  Determine and record the combined weight of the empty sample pan and stirrer to the nearest 0.1 gram (pan weight).
2. Place the sample of asphalt concrete and stirrer in the sample pan. Determine and record the weight of the filled sample pan to the nearest 0.1 gram (initial weight).

3. Place the filled sample pan in an oven for a minimum of 2 hours. Use an oven temperature of 355 °F (180 °C) ± 10 °F (6 °C).

4. Remove the filled sample pan from the oven. Determine and record the weight of the filled pan to the nearest 0.1 gram. Stir the sample and place the filled sample pan back in the oven.

5. Repeat step 1054.9.4 every 15 minutes until the total weight loss between 2 consecutive 15 minute readings is less than 0.1 percent. The last 15 minute reading is the final weight.

6. Calculate the moisture content (expressed as a percent) as follows:

\[
\begin{align*}
A &= \text{Initial weight} \\
B &= \text{Final weight} \\
C &= \text{Pan weight} \\
F &= \text{Moisture content (percent)} = \frac{(A - B) \times 100}{(B - C)}
\end{align*}
\]

1054.10 Final Calculations

The final asphalt binder content is a result of combining the oven test loss, correction factor and moisture content for the sample.

\[
\begin{align*}
D &= \text{Weight loss of ignition oven tested sample (percent)} \\
E &= \text{Correction factor from the Mixture Calibration form (percent)} \\
F &= \text{Moisture content from Section 9.6 (percent)} \\
\text{Final corrected asphalt binder content (percent)} &= D - E - F
\end{align*}
\]
Asphalt Materials District Testing and Monitoring Instructions and Guidelines

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   c) Small Quantity Asphalt
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3) Asphalt Binder Items
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1) General Plant and Testing Items

a) Plant Random Scale Checks
Random weighting of trucks for checking scales should be a minimum of once per day. Should questions come up, the District Engineer of Tests can check scales as often as necessary to solve the problem.

Should truck and plant scales be outside +/-1%, the first such load of mix is allowed to be placed. Adjustments should then be made by watching the plant operations. If the next load is also outside +/-1%, then that load is to be rejected.

b) Screen-less Batch Plants
Asphalt batch plants with the screen deck removed are allowed for production of 301, 302, and Type (2) (441) asphalt provided the following conditions are met and maintained. If uncontrolled and/or inconsistent material properties (AC, voids, segregation etc.) exist, screens will be required and no future screen-less operation of that plant will be allowed. Additional testing may be required by ODOT at the discretion of the central laboratory.

Requirements:
1) The modified plant must be inspected and approved by the Laboratory.
2) The material flow must be diverted into the center of one hot bin.
3) The plant must have extended dividers on cold bins.
4) A device to sample total flow with the belt in motion.
5) Lockable cold feeders.
6) Calibration of RAP and virgin belts.
7) Scalping screens on RAP and virgin belts. (2in)
8) Weight Bridges on RAP belts
9) Sensors on all cold feeders
10) Maximum of 30% RAP.
11) Give written approval.
12) This approval is subject to field verification.

Following is the procedure for the quality control and acceptance of small quantities of asphalt concrete. The contractor must have an approved Quality Control Plan (QCP) for producing under this procedure.

c) Small Quantity Asphalt Concrete Testing and Acceptance
This procedure is intended for the use of the contractor. However, small quantity acceptance is not permitted for JMF's that have not been verified by acceptable production under normal testing during the
current construction season. The use of new JMF's for small quantities must be approved by the District. The total seasonal production per project for each material type shall not exceed 1500 tons. The District can sample, test and/or reject any material received under this procedure. Material may be rejected by visual inspection by the project or rejected thru district comparison testing. Poor plant or mix control, poor mix performance, poor mix quality, failure to submit the required form as required or ongoing District sample failures can mean disallowing further use of this procedure on the project or future projects. This procedure may be disallowed by the District for any contractor when documented pre-mature small quantity mix failure in any application has occurred on the contractor's previous project(s).

When material is being produced under this procedure and has a quantity of less than 200 tons a day for each type, the acceptance is by contractor certification as outlined below. No quality control testing is required. A quick check plant calibration must have been performed in accordance with the contractor's QCP as outlined in 403. Computerized plant operation tickets, a copy of the dated and signed quick check calibration(s) and a TE 199 SMQ form (attached) must be submitted as outlined below.

If the daily production does not exceed 500 tons a day for each type, the acceptance shall be by contractor certification as outlined below. The contractor shall perform an asphalt binder content test for every two hours of production. The asphalt binder content shall be determined by a nuclear gauge that has been properly offset for the JMF being used. Computerized plant operation tickets and a TE-199 SMQ form must be submitted as outlined below. Contractor samples shall be held at the lab for three days.

The required certification (TE 199 SMQ form) and other required information must be submitted by the next working day to the District testing office unless otherwise notified by the District. The TE-199 SMQ form shall be signed by an employee of the contractor having authority to represent the contractor as outlined in the contractor's QCP. The TE 199 SMQ form shall be sent to the Project Engineer if desired by the district.
Ohio Department of Transportation

Small Quantities of Asphalt Concrete Form TE 199SMQ

Project No. _______________ JMF Number _______________

Producer _______________ Location/Plant _______________

Send to: Project Engineer or District Engineer of Tests as required by the district.

This is to notify you that small quantities of asphalt concrete have been produced.

<table>
<thead>
<tr>
<th>Production Date</th>
<th>Quantity (tons)</th>
<th>AC% 1</th>
<th>AC% 2</th>
<th>Ref No</th>
<th>ODOT Sample ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note 1 - To be provided by contractor

Attached are copies of worksheets (gauge printouts, gradation, etc.), plant printouts and our most recent quick check calibration. I certify that the material was produced in accordance with our approved QCP. The asphalt plant was operated at the approved JMF and the mix met specifications.

Signed: ____________________ Date: ____________________

Title: ____________________
d) Testing with the Nuclear Asphalt Content Gauge, Offset Form, Calibration Worksheet and Calibration

Testing

The following procedure will be followed when testing using the nuclear asphalt content gauge. The intent is to make use of the plant and (1) district nuclear gauges, (2) plant quality control testing and (3) computerized plant data for an accurate and consistent acceptance and monitoring test procedure.

Verification Sample

A minimum of (2) work days prior to the start of production, a JMF Calibration Verification Sample (Verification Sample) shall be made by the Contractor with a Department representative observing. The Contractor shall mix a sample of asphalt concrete meeting the JMF and fill an AC gauge pan with the sample in accordance with Supplemental Specification 1043.06. A verification sample shall be made for each JMF and held by the contractor as long as the JMF is active.

Initial Offset

Prior to the start of production, the asphalt binder content of the verification sample shall be determined by the Contractor's plant AC gauge in accordance with Supplement 1043. An initial offset, if needed, will be entered into the plant AC gauge so it will read the proper asphalt binder content of the verification sample. The AC gauge printout for this test shall be retained by the Department. For determining the asphalt binder content for 448 acceptance or 446 monitoring samples the District will also enter an initial offset, if needed, into their AC gauge to read the proper asphalt binder content of the verification sample. The Contractor's plant AC gauge is now correlated with the District's AC gauge. All of the data used to calculate the initial offsets shall be recorded on a form approve by the laboratory.

Total Offset

A total offset, if needed, for the plant gauge shall be determined by the Contractor and / or Department within the production of (2) lots or (3) production days, whichever comes sooner. For 441 mixes the total offset will also be applied to the District AC gauge. This offset shall be based on asphalt binder content data from the Computerized Plant System, verified by the extraction of samples of asphalt concrete obtained from the material represented by the plant data. This plant data shall consist of one of the following.

- The average of (5) consecutive readings from a drum mix plant.
- The average of (5) consecutive readings when a batch plant's asphalt concrete is loaded from a storage silo.
- The asphalt binder content from a single batch weight ticket when a batch plant's asphalt concrete is loaded directly in a truck.
A minimum of (3) sets of Computerized Plant System data verified by (3) corresponding extractions checked for gradation shall be used to establish the total offset. All of the data used to calculate the total offset shall be recorded on a form approved by OMM.

Prior to entering the total offset into an AC gauge, determine a plant sample's asphalt binder content with the AC gauge. Enter the total offset in the AC gauge and record the amount of the offset and the time it was performed on the Contractor's Quality Control Report (TE199). At this time, the asphalt binder content of the same plant sample as above will be determined by the plant AC gauge to verify the total offset was entered correctly. For 441 mixes, if the total offset is verified, this sample, still in the AC gauge pan, shall be held by a representative of the Department so it can be used to enter a total offset into the District's AC gauge using the same procedure described above.

Should discrepancies occur over the asphalt binder content between the district and plant after all of the above procedures are followed and no indication of any other correctable reasons are evident to the OMM, then 403 acceptance shall revert to full extraction testing, corrected for aggregate absorption. For 448 mixes the following testing procedure shall be followed:

For district testing at a minimum all nuclear gauge acceptance samples for lot one are to be extracted for gradation.

For lot two all four sub-lots are to be extracted for gradation but the sub-lot acceptance samples can be quartered and only one bowl run for asphalt binder determination.

For lots three and higher one randomly chosen sample will be extracted for gradation. This random sample can be quartered so that only one bowl is run for asphalt binder determination. Acceptance will be using a (4) test tolerance from 448 Table D or less if a partial lot. If not in tolerance samples for the entire lot will be run.

When quartering a sample the remaining portion of the sample must be retained until the extraction is complete. If the extracted sample meets the gradation tolerances as in the specification then that extraction result stands. If it is outside of the specification then the remaining portion of the original sample will be extracted and the results combined for a composite gradation. If the composite gradation is still out then the entire lot is to be run for lots three and higher.
AC GAUGE VERIFICATION AND OFFSET RECORD

District __________ Date__________
Project No. ________________ Contractor ________________
JMF No. __________ Calibration No. __________ Type __________
JMF AC __________ P-4 __________ %RAP __________

Original Calibration Constants:
A1 ___________ A2 ___________ A3 ___________
Blank Sample Weight ____________ g

Verification Sample Gauge correlation and Initial Offset:

Plant Gauge __________________________ Avg. ___________ Gauge Serial No. ______
District Gauge __________________________ Avg ___________ Gauge Serial No. ______

Initial Offset Plant = JMF AC-Plant Avg=+/__
Initial Offset District=JMF AC-District Avg=+/__
Initial Offset Calibration No. Plant __________ District __________

Total Offset Determination for Plant Gauge:
Minimum three extractions at the plant required. Test results on page two.

Plant Offset Avg=+/__
Total Offset Plant = Initial Offset Plant + Plant Offset =

Initial Offset Plant + Plant Offset= (+/__) + (+/__) = (+/__) 

Plant Offset Calibration No. __________

Total Offset Determination for District Gauge: Total Offset District=
Initial Offset District + Plant Offset= (+/__) + (+/__) = (+/__) 

District Offset Calibration No. ____________
Note: AC data to be two decimal places.
Enter offsets using same plant sample before and after.
Offsets Verification from Extraction and Plant Data (Attach plant tickets and gauge printouts)

**Extraction (plant)**

1. **Date** __________ **Time** P-4 AC __________
   
   Plant Ticket Avg AC ________ Plant Gauge ________ - Moisture ________ = Corrected Plant Gauge ________
   
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ________

2. **Date** __________ **Time** P-4 AC __________
   
   Plant Ticket Avg AC ________ Plant Gauge ________ - Moisture ________ = Corrected Plant Gauge ________
   
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ________

3. **Date** __________ **Time** P-4 AC __________
   
   Plant Ticket Avg AC ________ Plant Gauge ________ - Moisture ________ = Corrected Plant Gauge ________
   
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ________

4. **Date** __________ **Time** P-4 AC __________
   
   Plant Ticket Avg AC ________ Plant Gauge ________ - Moisture ________ = Corrected Plant Gauge ________
   
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ________

5. **Date** __________ **Time** P-4 AC __________
   
   Plant Ticket Avg AC ________ Plant Gauge ________ - Moisture ________ = Corrected Plant Gauge ________
   
   Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ________

Plant Offset Avg = Avg Difference (Plant Ticket AC-Corr. Plant Gauge) = +/- ________

Note: Is extraction sample P-4 +/- (5%) of JMF? If not, resample and check plant. Does extraction data reasonably confirm plant data? If not, do not proceed with offset procedure and check plant operation / calibration. If so, calculate offset using plant ticket data. Calculating the plant offset average may require judgment on the part of the monitor if any one value appears to be out of place. If a value is out but the rest are close then use the remaining data to calculate the average.

Level 2 Tech Sign. ___________________________ Date ___________________________
Office of Materials Management
Calibration Inspection Worksheet for A.C. Nuclear Gauge

Producer __________________ at ___________ Date: ______________

Coarse Aggregate #1 ______________ Coarse Aggregate #2 ______________

Fine Aggregate #1 ____________ Fine Aggregate #2 ____________

RAP Source ______________

Design(s) to be covered by this calibration:

<table>
<thead>
<tr>
<th>Mix</th>
<th>Calib</th>
<th>F4% A</th>
<th>C%</th>
<th>C.A. #1 %</th>
<th>C.A.#2 %</th>
<th>F.A. 1%</th>
<th>F.A. #2 %</th>
<th>RAP%</th>
</tr>
</thead>
</table>

Background count __________ Background verification count __________
Is Background verification within 1% of original? Yes/No

New Background count (if needed) ______________
Blank sample weight ______________ g.

Calibration Pan Counts:

<table>
<thead>
<tr>
<th>Pan #</th>
<th>AC %</th>
<th>Counts</th>
<th>Counts</th>
<th>Counts</th>
</tr>
</thead>
</table>

Fit Coefficient __________ Verification Sample:

Desired A.C. % (A) __________ Wt. of mixing bowl __________ g
Aggregate wt. (C) __________ g Wt. of A.C.(AxC)/(100-A) __________ g

Gauge Counts __________ Allowable A.C. Range __________ to __________

State Monitor ______________ District ______________

Note: Nuclear Asphalt Content Gauge Calibrations All nuclear gauge calibrations can be verified by the district at any time. This can be done either with an existing verification sample, a new verification sample or a new calibration if discrepancies cannot be resolved. The tolerance of +/- .14% still applies.
e) Asphalt Concrete Plant Auto Ticket Printer

Only those auto printer tickets generating the following minimum information will be permitted to be used in lieu of the TE-27

DATE, PROJECT NUMBER

PRODUCER NAME, PRODUCER LOCATION OR PLANT NUMBER

MATERIAL IDENTIFICATION, TIME LEFT PLANT

GROSS WEIGHT, NET WEIGHT, TARE WEIGHT

f) Determining Moisture Values for Asphalt Concrete Plant Computers

When a drum plant is used to produce HMA, the moisture content of each aggregate will be determined at the start of production, then at least once each day, and whenever conditions change the moisture content more than 1% from the previous determination. Enter into the plant computer the previous day’s moistures each morning until new moistures have been determined for that day. On the first day of production of any new aggregate or RAP the moisture content is to be set at 5% maximum for the total aggregate and RAP until new moisture tests have been completed, unless moistures were determined the previous day as follows. Samples may be taken in the late afternoon or evening and allowed to dry overnight to expedite the results for the following day. The District monitor may request a verification of any moisture value while present.

The moisture content of RAP will be taken at the start of production, then at least once every two weeks thereafter.

The moisture sample will be taken from the open working face of a stockpile or from the plant feeders if sampling thieves are installed on the plant. If a working face or a front end-loader is not available to obtain a representative moisture sample, hand dig into the area of the stockpile at least 3 feet from the bottom of the pile, and at least 1 foot into the pile to obtain the sample. Keep all surface dried stockpile material from entering the moisture sample.

Test the moisture content by drying to constant weight using a suitable heat source, such as a gas or electric oven (no ignition oven), hot plate, heat lamp, skillet, microwave oven, etc., that can effectively remove the water from the aggregate. Report the result to 0.1%. Report the moisture content of each individual aggregate, or the composite result (depending on the plant input), on the TE-125 or TE-199 form each day.
Maintain all worksheets and test data in the plant lab.
Alternate methods must be approved by the Laboratory.

The minimum mass of RAP and Aggregate to be obtained for test shall be based on the following table:

<table>
<thead>
<tr>
<th>Maximum Nominal Size</th>
<th>Minimum Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2” or greater</td>
<td>2000 grams</td>
</tr>
<tr>
<td>&lt; 1 1/2” – 3/4”</td>
<td>1200 grams</td>
</tr>
<tr>
<td>&lt;3/4 – 1/2”</td>
<td>1000 grams</td>
</tr>
<tr>
<td>&lt;1/2”</td>
<td>500 grams</td>
</tr>
</tbody>
</table>

Determine the mass of the wet material, dry to constant weight at a minimum of 230°F, cool, and determine the dry mass. The sample is thoroughly dry when further heating causes, or would cause, less than 0.1% additional loss in mass.

Calculate the % moisture to 0.1% as follows:

\[
\% \text{ Moisture} = 100 \times \frac{(\text{Wet Mass} - \text{Dry Mass})}{\text{Dry Mass}}
\]

g) Estimating RAP Pile Tonnages

Record all data for RAP piles per ODOT C&MS 401.04 requirements. Keep all worksheets and records in plant lab.

The initial estimated tonnage shall be established by either recording the plan quantity of RAP removed from a project, recording the quantity of RAP processed (if known from metering during the process), or by measurement. Note method used on worksheets used to determine RAP pile tonnages.

If the estimated quantity is established by measurement, one of the following procedures will be used depending on the type of pile:

<table>
<thead>
<tr>
<th>Rectangular RAP Piles</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average Width, ft x Average Length, ft x Average Height, ft) / 27 x 2.0 = tons</td>
</tr>
</tbody>
</table>

Example: A RAP pile 50 ft wide, 50 ft long and 25ft tall = (50ft x 50ft x 25ft) /27 x 2 = 4629.6 tons
For unique RAP pile shapes, define on the TE 199 how its size will be determined. All dimensions can be measured by using a tape, wheel, pacing, or surveying equipment. Note method used on worksheets.

Record the RAP quantity on the RAP control chart (example below) and site map.

If RAP is used at any time, update the control chart once each week for all ODOT projects. Re-estimate the quantity of RAP used by re-measuring the piles. Record this new quantity on the RAP control chart and site map.

<table>
<thead>
<tr>
<th>RAP Control Chart: Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date:</strong></td>
</tr>
<tr>
<td>11-20-13</td>
</tr>
</tbody>
</table>

h) Dust Correction Procedure for Centrifuge Extraction

Questions have been raised recently concerning the proper procedure for obtaining a 100 mL sample of effluent for determining a dust correction for a centrifuge extraction test. The questions have pertained to the use of a 100 mL ladle vs. pouring the sample out of a jug.

Accepted practice has been to use the 100 mL ladle and dip the sample from a bucket or wide mouthed container. This is how all the Level 2 Schools have taught the procedure.

The consensus of a state/industry group was to use the bucket and ladle method over the pouring method with the following caution. When stirring the effluent in the bucket clockwise and counter clock-wise care should be taken not to spin the effluent so fast that a deep vortex is formed. In doing this, some of the dust
can be forced to the outside edge. The proper method is to stir the effluent clockwise and counter clock-wise enough to lift settled dust off the bottom into suspension and then agitate the effluent several times across the diameter of the bucket. Dip the ladle 1/3 of the way across the diameter of the bucket for the 100 mL sample. If a wide mouthed container which can be sealed is used then the container can be shaken and then the ladle dipped for the 100 mL sample.

i) Non-approved Personnel in Testing

Concerns have been raised in the industry about the use of non-approved (Level 2) personnel working on jobs. Past practice has been to allow limited involvement of non-approved personnel at the plant provided they are under direct hands-on supervision of a Level 2 or level 3 person. This practice allowed for flexibility in the use of personnel by the contractor and also provided a training period for personnel intended to receive Level 2 status.

The following policy has been decided to maintain a level of flexibility in the use of personnel and provide a suitable training period. This policy will at the same time maintain ODOT’s need for clarity in quality control responsibilities at the plant for both the District’s and the technician’s benefit.

A three month period is allowed in which a non-approved person can work under the direct hands-on supervision of a Level 2 or Level 3 person at the plant. The intent is that this person will be receiving training and experience leading to Level 2 approval. A Level 2 test can be scheduled to accommodate those needing certification.

Any person not approved and who is involved in any manner in testing should have their name noted on the TE-199 each day of involvement. This way monitoring teams can have assurance as to the involvement of both Level 2 and non-Level 2 personnel.

2) 403 (301, 302, 448), 441, 442 Specific Items

a) 301 Blend Calculations

The 301 Blend shall be calculated from the gradations of the individual components and the blend percentages supplied by the Contractor. The following example demonstrates the procedure to be followed:

The blend is to be (85%) Sand and Gravel, (10%) No. 57 Gravel and (5%) Natural Sand. The amount passing the No. 4 shall be (45%).
### Laboratory Gradations:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Sand &amp; Gravel</th>
<th>No. #57</th>
<th>Natural Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;</td>
<td>100</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>1&quot;</td>
<td>99</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>¾&quot;</td>
<td>92</td>
<td>86</td>
<td>n/a</td>
</tr>
<tr>
<td>½&quot;</td>
<td>78</td>
<td>37</td>
<td>n/a</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>68</td>
<td>18</td>
<td>n/a</td>
</tr>
<tr>
<td>No.4</td>
<td>49</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>No.8</td>
<td>37</td>
<td>0</td>
<td>92</td>
</tr>
<tr>
<td>No.16</td>
<td>26</td>
<td>n/a</td>
<td>73</td>
</tr>
<tr>
<td>No.30</td>
<td>17</td>
<td>n/a</td>
<td>50</td>
</tr>
<tr>
<td>No.50</td>
<td>8</td>
<td>n/a</td>
<td>22</td>
</tr>
<tr>
<td>No.100</td>
<td>4</td>
<td>n/a</td>
<td>7</td>
</tr>
<tr>
<td>No.200</td>
<td>2.6</td>
<td>n/a</td>
<td>3.8</td>
</tr>
</tbody>
</table>

The final blend is arrived at by multiplying the percentage of that component in the Blend. The Sum of the products on each sieve is the blend percentage.

<table>
<thead>
<tr>
<th>Sand &amp; Gravel</th>
<th>#57</th>
<th>Natural Sand</th>
<th>Blend</th>
</tr>
</thead>
<tbody>
<tr>
<td>100x85=85</td>
<td>85</td>
<td>100x.10=10</td>
<td>100x.05=5</td>
</tr>
<tr>
<td>94x85=84</td>
<td>84</td>
<td>100x.10=10</td>
<td>100x.05=5</td>
</tr>
<tr>
<td>92x85=78</td>
<td>78</td>
<td>86x.10=9</td>
<td>100x.05=5</td>
</tr>
<tr>
<td>78x85=66</td>
<td>66</td>
<td>37x.10=4</td>
<td>100x.05=5</td>
</tr>
<tr>
<td>68x85=58</td>
<td>58</td>
<td>18x.10=2</td>
<td>100x.05=5</td>
</tr>
<tr>
<td>49x85=42</td>
<td>42</td>
<td>2x.10=0.2</td>
<td>100x5=5</td>
</tr>
<tr>
<td>37x85=31</td>
<td>31</td>
<td>n/a</td>
<td>92x.05=5</td>
</tr>
<tr>
<td>26x.85=22</td>
<td>22</td>
<td>n/a</td>
<td>73x.05=4</td>
</tr>
<tr>
<td>17x.85=14</td>
<td>14</td>
<td>n/a</td>
<td>50x.05=2</td>
</tr>
<tr>
<td>8x.85=7</td>
<td>7</td>
<td>n/a</td>
<td>22x.05=1</td>
</tr>
<tr>
<td>4x.85=3</td>
<td>3</td>
<td>n/a</td>
<td>7x.05=0.4</td>
</tr>
<tr>
<td>2.6x.85=2.2</td>
<td>2.2</td>
<td>n/a</td>
<td>3.8x.05=.19</td>
</tr>
</tbody>
</table>

* Note that these are included in the calculation since all sieves larger than the one passing 100% of the material also pass 100%.

** Note that the amount passing the No. 4 sieve is within the +/- 6% allowable.
**b) Testing Priorities for 441 Mixes**

Following are listed various asphalt samples in order of testing priority. In some case is difficult to say one sample type has priority over another, but you are already aware of this and judgments must be made. However, IN GENERAL and MOST OF THE TIME the following applies.

1. 403 Verification Samples: (Top priority for 3 samples from earliest production per project minimum and tested and reviewed within one day of receipt)
2. At least one set of Rice and Bulk samples from earliest production and tested and reviewed within one day of receipt. Investigate and document any comparison problems.
3. 446 lots 1,2: (tested and reviewed within 1 day of receipt)
4. Remaining 403 Verification samples (within 3 days) (Note: ALL 403 samples and contractor tests must be compared and recorded with responses.)
5. Remaining monitoring samples (within 3 days, reduce to 5 days after 3 consecutive good tests)
6. Remaining 446 lots (within 5 days)
7. Maintenance (purchase order) samples (within 20 days)

Important! As in the past, should you find yourself in a position of not keeping up testing at peak season please contact the Central Lab. In many cases in the past we have been able to help but if not we can find a district which may be a bit slow at that time to help out.

c) **Monitoring 403, 441, 442 projects**

Following is a discussion of the QC specification and also district monitoring procedures.

The QC specification places greater emphasis on the contractor to do what is necessary to maintain his mix rather than the district taking on the unnecessary burden of ensuring the technician follows some cookbook testing program. The district has the full authority and responsibility of assuring and satisfying itself that the mix is being made properly. This is accomplished thru monitoring procedures of split samples, plant lab visits, IAS testing and sometimes most importantly direct communication between the plant and the District Engineer of Tests or Asphalt Supervisor as to production progress or concerns. Lack of district satisfaction with mix quality or control should lead to reasonable problem resolution on the contractors part provided district monitoring provides evidence a problem exists. Lack of a reasonable response by the contractor or proper mix control is justification for production being stopped or going to a load and hold process. In the case of 403 projects removal from Verification Acceptance is always an option.
Official monitoring of a job is accomplished thru the testing of split samples and plant monitoring reviews. Any monitoring activity should only validate or invalidate particular contractor tests, technician procedures or plant operations. A response to invalid tests or procedures should be quick, decisive and documented. Reviews of test and procedures must also be documented. Reasonable response by the contractor to invalid tests or procedures is expected because of the terms of the contractor QC program and job contract. Responses to invalid tests can include additional testing, retests, load and hold tests, plant re-calibration, a different technician, scale checks or whatever legitimate action is necessary to achieve proper mix control.

The minimum monitoring requirements are as follows unless altered by 403. In event of conflicting results, the District should contact OMM to referee.

1) **446 Daily FHWA Sample**
   These samples have been required by the FHWA for some time for the purpose of monitoring the asphalt plant testing. The daily nuclear asphalt binder content on a properly offset gauge and only one extraction for gradation per week are necessary to meet FHWA requirements. In order to accomplish this, three plate samples will need to be taken per Supplement 1035 from the project or sufficient sample from the plant or hopper. Initial and final offsets may be determined as specified above. The intent of the sample is to compare the test result to the corresponding contractor test on the daily TE-199. Doing so will help check for possible poor contractor testing. In the past we looked for differences in AC of +/- 0.3 % two days in a row before investigating. This will still be a good starting point but with using the nuclear gauge the tolerance could become tighter.

2) **Run a minimum of (1) MSG split sample and (1) contractor AC Gauge sample each week.** (Rice comparisons to be within 0.012, 0.012 to 0.020 as an alarm and investigate and above 0.020 – confirm, stop production and/or investigate. If most comparisons are between 0.012 and 0.020 do not allow production to continue until resolved.)

3) **Run a minimum of (1) set of pills produced by the contractor to check for air void compliance each week.** (air voids within 0.2% are OK, between 0.2% and 0.3% OK if not consistently different over multiple tests and above 0.3% confirm, stop production and investigate.)

4) **Observe a minimum of (1) set of QC tests in the first 2 days of production.**

5) **Verify test procedures at least once a week.**

6) **Verify plant AC and moisture settings at least once a week. (monitor form)**
The specification discusses split sample retention. The AC Gauge sample does not have to be an actual split sample. Instead the contractor will hold all AC Gauge samples in the pan for two days. If an AC Gauge sample is not picked up after two days it can be dumped and the pan reused.

Besides more accurate air voids results because of the MSG testing other useful information can be derived from the MSG testing. However, a discussion of the MSG testing and control in detail is necessary so as to not confuse MSG test results and their indication of production quality versus AC tests, gradations and air voids and what they show about mix quality.

The Rice (MSG) test is an accurate test of the mix maximum specific gravity. A change in Rice values indicates primarily either an asphalt binder content change, abnormal gradation change, a blend change or an aggregate gravity change. Of course more than one of these things can change at the same time. Initially, for our purposes, the most important thing we can learn from all the extra Rice testing is the possibility of an asphalt binder content change. To accomplish using the test in a meaningful way it was decided to look at a band of +/- .012. This value, in general, could indicate a potential asphalt binder content change of +/- 0.3%.

However, the specification is misleading at this point as to the intent of using the +/- .012. The confusion is because blend, aggregate gravity, or even sample quality can make individual Rice results go outside of the +/- .012 and the asphalt binder content may still be OK. The +/- .012 is not a magical number. It is only useful in so far as indicating a potential asphalt binder content change.

A proper use of the Rice test in the revised QC specification should be as follows. If an individual Rice value goes outside the +/- 0.12 the contractor must contact the District Engineer of Tests. At that point the District Engineer of Tests will ask what corresponding AC gauge, gradation and air voids results are. If there is indication of an asphalt binder content change or other change thru the AC test or air voids test then corrective action must be taken. Regardless, the contractor should immediately test a new Rice sample and again report the results to the District Engineer of Tests. In many cases no asphalt binder content or air voids change will be indicated by the AC and voids testing.

This simply indicates that something else may have happened such as a poor sample, bad test or a trend
change in the aggregate specific gravities.

Should the District Engineer of Tests be satisfied that asphalt binder content, air voids and gradation are OK, but a trend toward the high or low side of the band is confirmed by several Rice test results the District Engineer of Tests can allow the contractor to re-establish an MTD. The MTD should be based upon test results representative of the new trend and proceed with the +/- 0.12 from that point.

Finally, if no other reasons can be found for a trend in Rice tests changing it can be reasonably assumed aggregate gravities are changing. Should this progress to an extreme the contractor will have difficulty controlling air voids. At some point the contractor will have to be told to correct the situation thru a stockpile change and / or redesign. Re-establishing the MTD is useless at this point until the mix properties are back in control.

d) Procedure for Establishing the MTD
By specification, the contractor shall determine the MSG by the rice method (corrected for moisture content) once per test series. Calculate the average of all the MSG determinations performed each production day and report this average on the Quality Control Report. When the range of three consecutive daily average MSG determinations is equal to or less than 0.020 average these three average MSG determinations to determine the Maximum Theoretical Density (MTD). After the MTD is established, compare all individual MSG determinations to the MTD.

The following must also be met on the Rice test, to be accepted for establishing the MTD.

- The pay sieves must be within the tolerances of (½ +/-6%, #4 +/-5% and #8 +/-4%)
- The Fines / Asphalt ratio shall be maintained so no F/A Ratio is less than 0.5 or greater than 1.1
- The asphalt binder content must be +/-0.5% (corrected for moisture) from the design.
- No Air void determination shall be less than 2.0% or greater than 6.0%

If any of the above requirements are not met, the Rice can be used for determining the air void content but not for establishing the MTD.

e) Use of Mineral Filler in JMF’s
It has been requested of ODOT to look into a policy for the use of mineral filler as an addition to asphalt concrete mixes for the purpose of controlling air voids or F/A ratio.
Mineral filler will be used in mixes in the following manner. A design in which it is desired to use mineral filler will be submitted to the OMM with the mineral filler incorporated into the mix up to 2% of blended aggregates. Calculation of the VMA will be done as if no mineral filler has been added to the mix. The percent mineral filler should be added to the percent of fine aggregate for calculation of VMA. In extreme cases this will cause a 0.1% change in VMA but will eliminate the question of specific gravity of the mineral filler.

Adjustment of the JMF to meet air voids or F/A ratio specified limits for production shall follow the 441.04 field adjustment procedures except for the following procedure:

After an attempt to adjust gradation to meet air voids or F/A ratio according to 441.04 it is found the mix is still out of the specified limits a mix that has approved incorporation of mineral filler may be adjusted by changing the amount of mineral filler up to +/- 1%. If this change does not solve the air voids or F/A ratio problem then JMF a re-design is required.

Following the mineral filler adjustment a rice test must be performed to show conformance to the MTD within .020 provided an MTD has been established. Mineral filler must be added to the mix separately from its own dry storage. Provision for accurate proportioning is required.

f) District Asphalt JMF Re-approval Process

1) Note received date.
2) Check plans and or proposal/supplemental spec 800 for any particular notes that may apply
3) Check MS for JMF validity and is within the 2 (3) year time frame.
4) Materials Codes checked to see if correct.
5) Aggregate Producers checked for 1069 program and any group list changes.
6) If 442, sample course gravel aggregate for crush count if not known, sample fine aggregate for FAA if not on the FAA web site. Only sample what you know will be used on the project.
7) Check for approved binder
8) If JMF is using RAP is the source listed in remarks and does RAP pile need checked?
9) Precursory review JMF aggregate percentages, liquid content percentages, voids etc
10) Looked at for problems that may have occurred on previous project
11) Update Project Bill of Material and enter conversion factor when enough detail of what is actually being used is known.

12) Send approval letter to contractor, copy project inspector and construction and others as district desires or use the contractor request letter, attach the JMF printout, send out and notify the contractor.

Additions to this list may be made as experience dictates is necessary.

g) Procedure for Isolating Causes of Test Comparison Problems

Apply this method if your normal evaluation of test discrepancies do not solve the issues!

This method will apply to any test where technician procedure or technique is key to an accurate test result. This method should be used when District comparison tests are outside acceptable tolerances when compared to the contractor QC test. Typically monitoring or QA samples split or obtained from QC samples are what are tested for comparison. The specification and this section of the S&T Manual will spell out requirements for sampling frequency and type. For sake of simplicity the MSG or Rice test will be used as an example. All testing must be documented!

1) When a comparison problem is noted first contact the QC Manager and plant technician. Most of the time this solves the problem. Immediately take a new comparison sample upon notification and test.

2) If a repeated history of poor comparison with a given project, technician or plant equipment exists take ALL monitor Rice samples from the QC lab to the District. Stopping or continuing mix production will depend on the circumstances. Run more than one sample to develop a record of the issue. It is also useful to have a different District technician run the same sample to verify results. Notify the QC Manager.

3) At this point a specific investigation should be conducted as follows:

   a. Do a cursory check of the District and Plant lab equipment: temperatures, pressures, hoses, and anything obvious. If problems are found correct and rerun samples on both equipment to verify. End the investigation and deal with future comparison issues (on this project or other projects with the same QC technician or plant) as below. If no problems are found use the below procedure to isolate the problem cause.

   b. Choose one of the Rice samples already run with known results from the District and
QC lab. Have the District and QC technicians (both technicians must be the same ones who ran the previous tests in question) run the same sample at the QC and District labs. This should be done together (all personnel present) at both labs and the District should have a third person present to help observe procedures. The contractor can have any additional person present they want. Record all results. Email the results to the Central Laboratory.

c. Several conclusions can be reached from this special testing: 1) Good comparison, 2) Differences between lab equipment but good technician comparison, or 3) Differences between technicians. Discuss with the Central Lab what constitutes good comparisons for technicians vs labs.

i) Good comparison between technicians and labs with the original District test result. This means the equipment is sound and the technicians are capable of good test technique. However, this also means the contractor QC technician incorrectly performed the original test. Please inform the QC manager and the technician in writing of the results and state in the letter that a copy of the letter will be placed in the technician file in Central Office. Send a letter copy to the Central Lab for filing in the technician certification file.

ii) Good comparison between technicians and labs but not with the original District test result. This means the equipment is sound and the technicians are capable of good test technique. However, this also means the District technician incorrectly performed the original test (unless an equipment problem was found previously). Review the technician procedure. Have the technician come to Columbus for retraining in the Central Lab if necessary.

iii) Differences between lab equipment. Contact the Central Lab to send someone to investigate the equipment.

iv) Differences between technicians. Send the same sample to the Central Lab to run. The Central Lab conclusion, after a review of available information, will be final. Send the QC technician or District technician to the Central Lab for a review of procedures and retraining.

v) There may be a rare possibility of both items iii. and iv. happening. If so carry out instruction for both items.
3) Asphalt Binder Items
   a) Asphalt Binder Sample Containers
   Compliance with AASHTO T 40 "SAMPLING BITUMINOUS MATERIALS" requires that the following materials be sampled into appropriate containers for shipment to the Laboratory.

   **Metal Quart (Friction Top)** - PG Binder, Asphalt Concrete Underseal (M-238), Waterproofing Asphalt (702.06), Bituminous Pipe Joint Filler, Polymer Modified Expansion Joint binder, Joint Adhesive

   **Plastic Quart (Screw Top)**
   SS-1, SS-1H, CRS-2, CSS-1H, RS-2, CMS-2, MS-2, CSS-1, MWS-90, MWS-150, MWS-300, HFRS-2, SBR Asphalt Emulsion, CRS-2P Type A, CRS-1P Type B, HFRS-1P Type B, Non-tracking Tack products, SBS Emulsion, CSS-1hM, any diluted emulsions (ex. Fog Seal)

   **Metal Quart (Screw Top)**
   MC-30, MC-70, MC-250, MC-800, MC-3000, Asphalt Primer (702.05), Primer-20

   Distribution of this requirement should include all personnel required to sample or observe sampling of the above items. It should also be noted that each container should be full and the lid be applied securely. All containers should be wiped clean of asphalt immediately after sampling.

   b) Sampling PG Binders
   Increased check sampling has brought out some issues with proper sampling procedures. Sample integrity is critical when deductions are to be incurred.
   It is common for monitors to hand a plant person cans for taking samples because of plant operational issues etc.. That is not a problem BUT here are the only ways this is acceptable.
   1) From this point forward TWO sample cans of each grade must be taken for each check sample desired and sent to Columbus. These will be under ONE sample ID. If we see a failure we will contact you to take new samples to determine the extent of the problem. We will also test the 1st sample again to verify a failure to meet the deduction policy.
   2) The cans must be labeled as to grade BEFORE the sample is taken. (Do your monitors have permanent markers for labeling?)
3) The monitor must witness the samples being taken from a tank or truck. (If you have new personnel who have no clue about how to take a tank sample then send them to us for training or train them yourself.)

4) The monitor must witness the handling and control of the samples until he takes possession. The monitor must take immediate possession of the samples.

5) If the monitor has any question about the proper labeling of a sample, handling of a sample or integrity of a sample throw it away and take another one.

6) The monitor must hand deliver the sample to the district lab ASAP for processing and sending to Columbus.

c) Taking a Liquid Binder Sample

There are four critical steps to having a legit sample.

1) Use only a clean container. Use only containers as described in Appendix J, Section 3a of the Sampling and Testing Manual at:

   http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/default.aspx

2) When sampling from a valve drain a minimum of 1 gallon of material into a separate container and have the contractor discard. The ASTM language below describes this for valve sampling. Dip sampling described below does not require the 1 gallon disposal. Take sample (s).

   a) From ASTM D140-01

   10. Sampling from Tank Cars, Vehicle Tanks, Distributor Trucks or Recirculating Storage Tanks

   10.1 The sample may be taken from the sample valve or tap if the tanks are provided with them. When such sampling devices are required, they are to be built into the tank itself. A sampling device of this type is shown in Fig. 1. Before the sample is taken, 4 L (1 gal) shall be drawn from the sample valve and discarded.

   10.2 Samples of liquid materials and materials made liquid by heating may be taken by the dip method using a clean wide-mouth or friction-top can in a suitable holder as shown in Fig. 4. A clean container must be used to take each sample, and the material sampled shall then be transferred to another new and clean container for retention or testing sample.
b) For SBR modified PG binders, sample after the injection of SBR for drum plants. For batch plants take a sample the SBR latex and a sample of the neat PG binder for batch plants. For drum plants, follow the steps below:

(i) Using a metal, 5-gallon bucket, a minimum of 1 gallon of material shall be drawn from the sample valve and discarded.

(ii) Using a clean, metal, 5-gallon bucket, draw out about 3 gallons of material but no more than two-thirds of a full bucket while the sample valve is fully open.

(iii) Stir the contents with a clean stirring rod or spoon.

(iv) Transfer material from bucket to required containers.

3) Properly label the side of the container with material type, amount represented, project number, and date sampled as well as any other information that may be need. If needed, all other required data on forms and required per this manual should be also labeled on container. Do NOT put label information on the lid of the containers.

4) Maintain custody of the sample(s) from beginning to end and send to OMM for test. Ensure sample(s) is stored from freezing and extreme heat between sampling and sending to OMM. Avoid shaking asphalt emulsion samples.
Section 6, AASHTO Standard test methods

T-30 Mechanical Analysis of Extracted Aggregate (2014) 5 pages
D5444 Mechanical Analysis of Extracted Aggregate (2008) 2 pages
T-209 Maximum Specific Gravity (2012), 15 pages
T-245 Mixing and Compacting a Marshall Specimen (2014), 11 pages
T-166 Bulk Specific Gravity Testing (2013), 6 pages
T-269 Air Void Calculation Procedure (2014), 4 pages

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