IOWA | DOT

HOT MIX ASPHALT
LEVEL I

INSTRUCTION MANUAL

2024-2025

TECHNICAL TRAINING AND
CERTIFICATION PROGRAM

TECHNICAL TRAINING AND CERTIFICATION PROGRAM
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1 INTRODUCTION

A BRIEF HISTORY – OF HOT MIX ASPHALT PAVING IN IOWA

The amount of hot mix asphalt (HMA) placed in a construction season has increased drastically over the past 30 years. Back then, a big day for a producer was 1000 tons per day. Today top end stationary drum mix facilities can produce 700 tons per hour, adding up to 7000 tons in a ten hour workday. Quick and accurate test data is required in order for the contractor to make changes to his mix as quickly as possible.

The taxpayer is the owner of all state projects. It is the taxpayer's money that funds the transportation program. The contractor and agency personnel have always served a vital role ensuring that the public gets the best quality road possible. The evolving of the process, as outlined below, helps everyone better utilize taxpayer money to build the best roads possible for the travelling public.

Historically, the state was the designer and inspector of hot mix asphalt mixes. The contractor's role back then was simple: to use a recipe given to them by the state, mix the materials in their plant and place it on the roadway. The Department of Transportation would do inspection and take samples of the mix for laboratory testing. The next day, or several days later, the results of the lab testing would indicate whether the mix met contract specifications. At that point in time, the roadway was already in place, leaving perhaps miles of deficient work.

Quality Management Asphalt (QMA):

During the 1980's and 1990's the construction industry and the Iowa Department of Transportation worked together to improve the quality of the HMA and the methods by which project testing was accomplished. In 1992 the Quality Management – Asphalt (QMA) program was implemented on all projects over 5000 tons.

Quality Management changed the way that HMA pavements were designed and placed. Components of QMA are still in place today.

Under QMA, the contractor's personnel develop the mix design using aggregate that keeps them competitive (often local sources), and creating a mix they believe will be economical and long lasting. The mix design is then submitted to the DOT for acceptance. During construction, the contractor's personnel are responsible for process control testing (with random samples done several times daily). If something unusual is occurring to the mix, it can be monitored instantly and changes can be made to ensure that poor quality mix does not get to the roadway. The morning test results are available to the quality control technician within hours of starting up the plant, giving the contractor information right away to effect the quality of mix being produced.

Under this agreement, the contractor retains controls of their product and process. The contractor does random sampling on their materials and tests them multiple times each day. The agency receives split samples of the materials, and tests them on a less frequent basis to verify the contractor's work. Verification is done by comparing the contractor's test results to the agency's test results (on the same sample) and assuring that it correlates. This quality assurance is an important check on the contractor's work.

QMA looks at individual test results to determine if they are in specification, and sometimes looks at running average's (an average of the last 4 tests) to determine if the trend in the test data is good. Under the old QMA system (1992-2010) contractors could incur penalties if their mix was not up to specification, but could not earn incentive pay for laboratory test results that were very good.

Percent Within Limits:

Beginning with the October 2010 letting, the Iowa DOT implemented the new Section 2303 of the Standard Specifications. This specification takes the next step beyond QMA, and provides incentives to the contractor to produce HMA that is consistently in spec and on target.

To accomplish this, methods were developed to analyze the test data and determine the amount of material that complies with the specifications. The result of the analysis is called the "Percent Within Limits" or PWL. The previous QMA specification did not provide for incentive payments to the contractor for providing a superior quality product, only disincentives for poor quality. The original PWL specification provided incentive payments for field voids up to a maximum of 4% and lab voids up to a maximum of 3%. In October 2023 the specification was changed to provide a maximum of 6% incentive for both lab voids and field voids. The contractor can earn these bonuses by controlling the production and construction operations to provide a consistent mixture on target – and a mat compaction that is both consistent and thorough. The goal is to "make quality pay" for those contractors that provide the best product.

Both incentive and disincentive are based on equations that provide a smooth and continuous payment schedule rather than the stepped price adjustment schedules used in the past. Field voids are analyzed daily, with eight core density values that are obtained each day. Lab voids require grouping of days or lots to obtain a minimum of eight test values before the PWL incentive/disincentive pay factors will be calculated. It is important that a minimum of 8 test results are used, because of the statistical formulas involved in PWL. Less than 8 test results is not sufficient to do a statistical analysis.

The HMA Plant Report Program and the Quality Control charting Program were modified from the existing QMA version to the new PWL version, to accumulate the needed test data and calculate the pay factors for the mix.

Average Absolute Deviation for Lab Voids:

Average Absolute Deviation is a statistical term meaning the average of the "deviation from target". It's a statistical average used only for the analysis of Lab voids. When there are not 8 test results (as mentioned above) to conduct PWL analysis, an AAD analysis is done instead on mainline paving. This was part of the PWL program initiated in 2010. In 2012 the specification changed so that AAD calculations and quality control is the method of analysis for all paving that is not mainline using what is called the "moving average". The moving average is simply the average of the last four deviations from the target value.

AAD allows the contractor to be penalized for poor mix, but does not give them incentive for superior quality work.

In Summary:

The industry continues to evolve. The test results have not changed much in the last 30 years, but the method of analyzing test data and reporting requirements have changed significantly over the past 15 years. Determination of pay factors changed significantly in the October 2023 specification revisions. Technicians involved in Hot Mix Asphalt projects need to be familiar with PWL, AAD, control charts, reporting, spec compliance, pay factors, etc……and the effect that these items will make to the contractor's operations and to contract administration. These topics will be discussed in this Level I HMA Course.

PRE-PROJECT PREP

Certified Technicians

CFR 641 requires all technicians that test materials for acceptance to be used in Federal Aid projects to be qualified.

*Knowledgeable
*Common Sense
*Observant
*Honest
*Organized

IM 213

Certified Materials

from Approved Sources
Aggregate, T-203
Binder, IM 437

Delivery Tickets are commonly used for acceptance

Approved Job Mix Formula

Standard Specification 2303

Qualified Laboratory

CFR 641 requires all laboratories that test materials for acceptance to be used in Federal Aid projects to be qualified.

IM 208

FEDERAL CODE 1020 and IOWA CODE 714.8

I.M. 213 discusses the Unsatisfactory Notice that Certified Technicians are given when they are not performing their job duties satisfactorily. This can be given for a number of reasons including, improper sampling and/or testing, not performing their duties and reporting in the time frame required, reporting incorrect information, etc. The technician is given one written notice, the second notice is three-month certification suspension, and the third notice is decertification. According to I.M. 213 the Certified Technician can automatically be decertified for false statements without going through the Unsatisfactory Notice procedure. The Certified Technician also needs to be aware of the false statement clause that is applicable to all federal-aid projects and the fraudulent practice clause that applies to all non-federal aid projects. **Certified Technicians need to read and be aware of U.S.C. 1020 and Iowa Code 714.8 since these do apply to them.** They read as follows:

FEDERAL AID PROJECTS

IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, the following notice shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID HIGHWAY PROJECTS
18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in

connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined not more than $10,000 or imprisoned not more than 5 years or both"

NON-FEDERAL AID PROJECTS

Iowa Code 714.8, subsection 3, defines fraudulent practices. "A person who does any of the following acts is guilty of a fraudulent practice. Subsection 3, Knowingly executes or tenders a false certification under penalty of perjury, false affidavit, or false certificate, if the certification, affidavit, or certificate is required by law or given in support of a claim for compensation, indemnification, restitution, or other payment." Depending on the amount of money claimed for payment, this could be a Class C or Class D felony, with potential fines and/or prison.

The above codes refer to the individual making the false statement. **Standard Specification Article 1102.03, paragraph C. section 5 refers to the Contractor.**

Article 1102.03, paragraph C, section 5 states, "A contractor may be disqualified from bidder qualification if or when: The contractor has falsified documents or certifications, or has knowingly provided false information to the Department or the Contracting Authority."

2 MATERIALS

Hot Mix Asphalt

Warning

Learning Objectives - Materials

- At the end of this section, you will be able to:
  - Understand basic HMA terminology
  - Identify the main ingredients in HMA
  - Explain the importance of Aggregate processing and handling
  - Explain the PG Grading System for Asphalt Binder
  - Understand the use of Recycled Materials and how they effect the mix

ASPHALT PAVEMENT STRUCTURE

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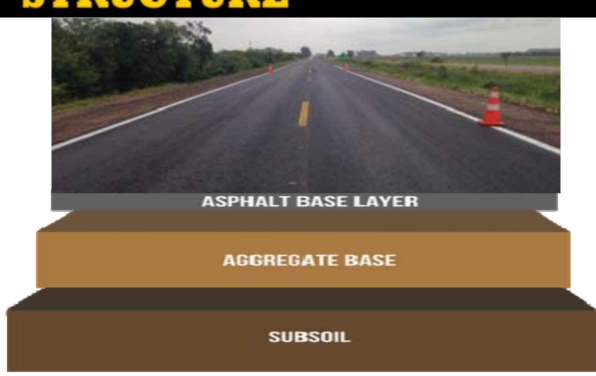

ASPHALT PAVEMENT STRUCTURE

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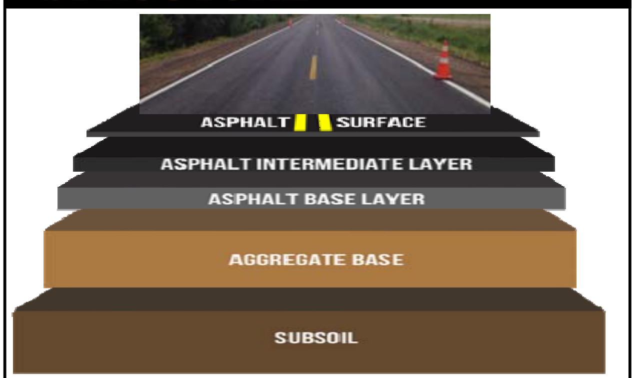
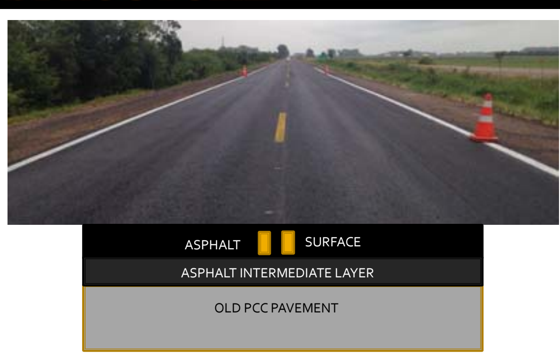


ASPHALT OVERLAY STRUCTURE



Some basic terminology

IM 500, Asphalt Terminology

- Liquid Asphalt Terminology
- Aggregate Terminology
- Mix Terminology
- Miscellaneous Terminology
- Construction Terminology

More basic terminology

Traffic Levels

- S = Standard Traffic
  < 1M ESALS
- H = High Traffic
  1-10M ESALS or
- V = Very High Traffic
  >10M ESALS or
- E = Extremely High Traffic
  >10M ESALS and

Hot Mix Asphalt

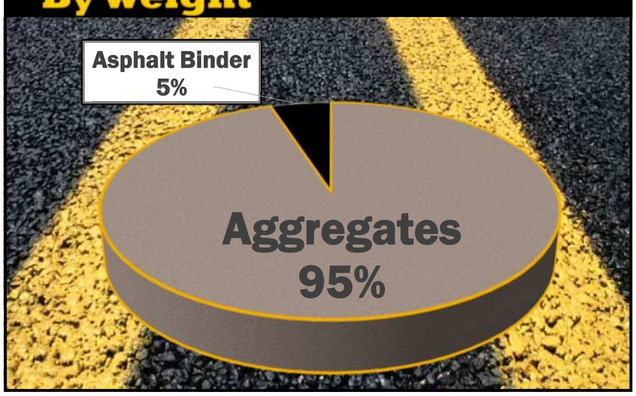
WHAT *is* HOT MIX ASPHALT (HMA)?

Hot Mix Asphalt

- In it's simplest form, HMA is nothing more than a combination of aggregate and asphalt binder.
  - Aggregates serve as the skeleton to provide strength to carry traffic
  - Asphalt binder serves as the glue to hold it together.
  - Air voids are necessary to provide flexibility and room for expansion and contraction

What is HOT MIX ASPHALT?

Hot Mix Asphalt By Weight



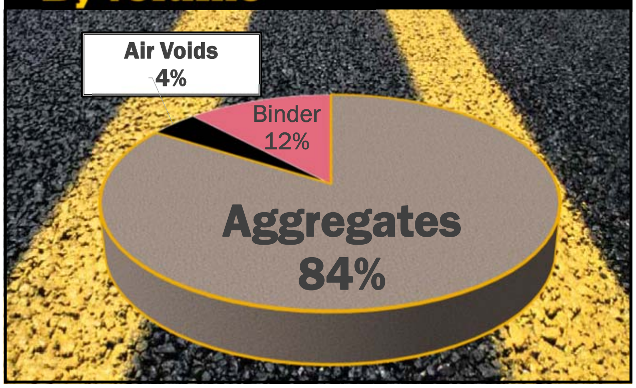
Air Voids

Air voids:

- Provide room for expansion
- Provide freeze / thaw resistance
- Provide flexibility
- Effects payment
- Controls the mix

- But how do we measure them?

Hot Mix Asphalt By Volume



Volumetrics

- The bridge between weight and volume is Specific Gravity

  Specific Gravity is essentially how many times heavier or lighter a material is as compared to an equal volume of water

Volumetrics

- In HMA analysis, several Specific Gravities will be needed.
  - Specific Gravity of the Binder
  - Specific Gravity of the Aggregate
  - Specific Gravity of the Mix

Volumetrics

- Why should you care?
  - Because of those darn Air Voids
  - Can't measure them, Can't weigh them
- In this class you will learn how to test Specific Gravity of the Mix and how to calculate air voids

Aggregates

- The ingredient that has the greatest effect on the mix is Aggregate
- 95%, by weight, of HMA is Aggregate

Aggregates

- Aggregate Must Meet Quality Requirements
  - Freeze/thaw
  - Abrasion
  - Shale
  - Clay
  - Absorption

Aggregates

- Aggregate is processed and sized to meet Mix Requirements
  - Gradation
  - Angularity
  - Crushed Content
  - Friction

Aggregates

Material we call "Aggregate"

-Natural Stone and Gravel

-Synthetic Stone (ex. Slag)

-Recycled Asphalt Pavement (RAP)

-Recycled Asphalt Shingles (RAS)

Aggregates

- Problems associated with aggregate
  - Segregation
  - Degradation
  - Contamination

Segregation

- What is Segregation?

Segregation

- Causes?
  - Source Problems
    - Segregated stockpile at the source
    - Loading from the crusher
  - Building the Stockpile at the Plant
    - Stacker Problems
    - Truck Dumping
  - End Loader Operator
    - Best friend or worst enemy?

Segregation

- Suggestions
  - If using a stacker, keep it low and moving (do not cone)
    - Build the stockpile in layers
  - If truck dumping, loader operator should push material up and blend along entire face
    - Push up to blend
    - Load side to side

Segregation

- https://www.youtube.com/watch?v=_KL82AnfNXI

Degradation

- In Iowa, most of coarse aggregates are limestone
  - Limestone tends to have higher abrasion loss than gravels or non-sedimentary aggregates
  - Handling limestone causes the generation of fines
  - How many times is aggregate handled before it becomes HMA?

Contamination

- Contamination can be the intermingling of different aggregates or the inclusion of foreign materials
  - Intermingling can occur if stockpiles are too close together or bins are overloaded
  - Foreign materials such as mud can be brought into the aggregate by the end-loader working to low or even from the tires picking up mud and dragging it into the stockpile

Cold Feed Bins with vertical dividers

Aggregate Acceptance

- Aggregate Acceptance
  - Certified Truck Tickets (if delivered to project)
  - Certified Producers Report

Recycled Asphalt Materials (RAM)

- Recycled Asphalt Pavement (RAP)
  - Comes from recycled pavements
  - Contains approx. 5% asphalt binder
- Recycled Asphalt Shingles (RAS)
  - Comes from roof tear-offs (in Iowa)
  - In other states, could be manufacturer waste
  - Contains 20-30% asphalt binder
  - Has fibers, fine aggregate and lime

RECYCLED ASPHALT PAVEMENT

RECYCLED ASPHALT PAVEMENT

- **Most recycled material in the world!**
- **Many forms**
  - **Hot mix asphalt**
  - **Cold in-place recycling**
  - **Hot in-place recycling**
- **Economical and does not compromise performance**

ASPHALT MILLING

RAP PROCESSING

RAP: Hot Mix Asphalt

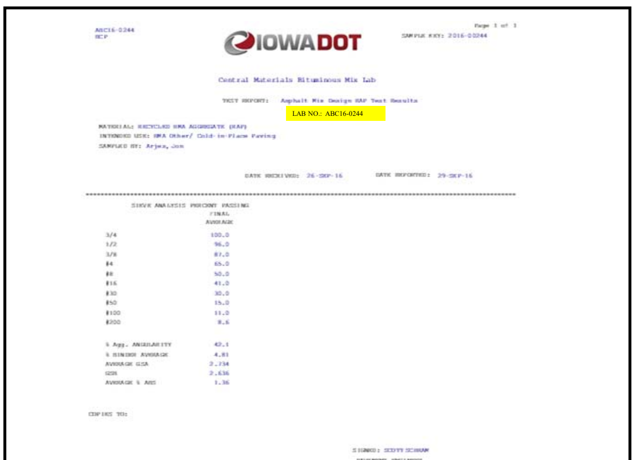
- Stockpiling RAP
  - You may truck dump the first lift for the base
  - The minimum stockpile height should be 8 ft
  - The remainder of the pile should be constructed with a loader, stacker, or similar equipment
  - Stacker placement should be in 4 ft layers
  - Track equipment may be allowed to operate on the stockpile during its construction.

RAP Properties

- Important "Properties" we want to know
  - Quality of the aggregate in the old pavement
  - Characteristics of the old asphalt binder
  - Percent of asphalt binder in the RAP
  - Gradation of the aggregate in the recycled product
  - Consistency

RAP Properties

- The Iowa DOT tests all RAP stockpiles for aggregate gradation and binder content before use.
- After the stockpile has been tested no material may be added to the stockpile during the project.
- The contractor may test RAP stockpiles for consistency and other properties



ABC16-0244
BCP

IOWA DOT

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SAMPLE KEY: 2016-00244

Central Materials Bituminous Mix Lab

TEST REPORT: Asphalt Mix Design RAP Test Results

LAB NO.: ABC16-0244

MATERIAL: RECYCLED HMA AGGREGATE (RAP)
INTENDED USE: HMA Other/ Cold-in-Place Paving
SAMPLED BY: Arjes, Jon

DATE RECEIVED: 26-SEP-16 DATE REPORTED: 29-SEP-16

SIEVE ANALYSIS PERCENT PASSING	FINAL AVERAGE
3/4	100.0
1/2	96.0
3/8	87.0
#4	65.0
#8	50.0
#16	41.0
#30	30.0
#50	15.0
#100	11.0
#200	8.6
% Agg. ANGULARITY	42.1
% BINDER AVERAGE	4.81
AVERAGE GSA	2.734
GSB	2.636
AVERAGE % ABS	1.36

COPIES TO:

SIGNED: SCOTT SCHRAM
PAVEMENT ENGINEER

RAP Specifications

- 2303.02
  - Types of RAP defined (Unclassified and Classified)
  - Crushed Content
  - Friction Credit
- IM 505
  - Processing
  - Stockpiling
  - Testing Requirements
- IM 510
  - Maximum Allowable Use

IM 510, Appendix C

Mix Designation	Aggregate Quality Type	Unclassified RAP	Classified RAP
HMA ST S	A	0%	Limited by binder replacement
HMA ST I	B	10%	No Limit
HMA ST B	B	10%	No Limit
HMA HT S	A	0%	Limited by binder replacement
HMA HT I	A	0%	No Limit
HMA HT B	B	10%	No Limit
HMA VT S	A	0%	Limited by binder replacement
HMA VT I	A	0%	No Limit
HMA VT B	B	10%	No Limit

*A contractor can obtain Classified RAP status on an Unclassified RAP pile by testing for gradation, binder content and aggregate quality. See IM 505 for requirements.

RAS

- The Specs allow up to 5% RAS to be used in any mix
- The % of RAS used is considered part of the maximum allowable RAP %
- IM 506
  - Requirements for approval of RAS
- MAPLE
  - List of approved suppliers

What is Asphalt Binder?

What is Asphalt Binder?

- Asphalt *Binder*
- Heavy Fraction from Crude Oil


Asphalt Binder


Asphalt for HMA

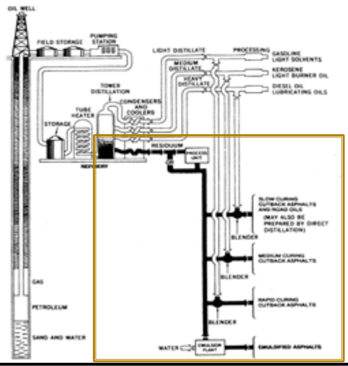

Asphalt Emulsion

What is Asphalt Binder?

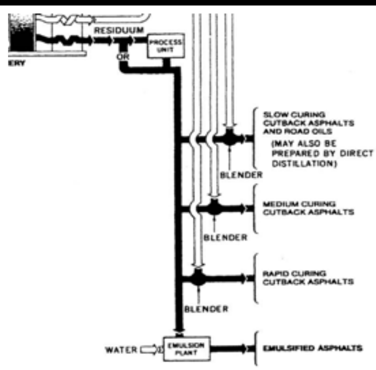
- SOURCES of ASPHALT *Binder*

NATURAL PRODUCTS	CRUDE PETROLEUM RESIDUES
	

What is Asphalt Binder?



What is Asphalt Binder?

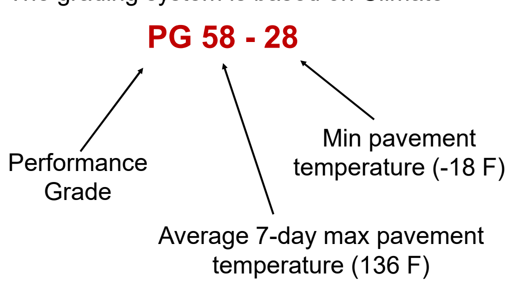


Binder Grading

1998

- **Performance Graded**

  The grading system is based on Climate



Binder Grading

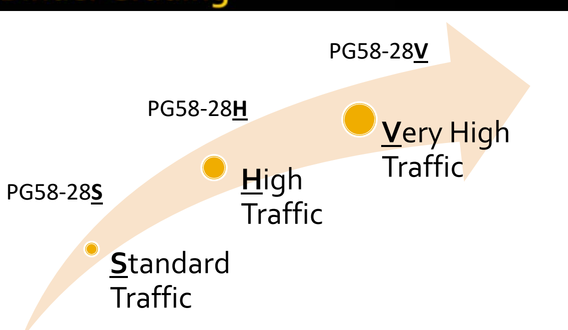
Example: PG 58-28

- Temps are in Degrees Celsius
- High Temp is to prevent rutting
- Low Temp is to prevent thermal cracking
- Grading is in 6^0 Celsius increments

Binder Grading

- Common Binder Grades in Iowa
  - PG58-28
  - PG58-34
  - PG64-22
  - Other Grades used for special purposes

The Influence of Traffic on Binder Grading



AASHTO Notations: PG 58S-28, PG 58H-28, PG58V-28

New Binder Designations Oct 2016

- S = Standard Traffic
  - < 1M ESALS <u>and</u>
  - >45 mph
- H = High Traffic
  - 1-10M ESALS <u>or</u>
  - 15-45 mph
- V = Very High Traffic
  - >10M ESALS <u>or</u>
  - ≤ 15 mph
- E = Extremely High Traffic
  - >10M ESALS <u>and</u>
  - ≤ 15 mph

Binder Grading

- The intended Binder Grade will be shown on the plans and the contract
  - BUT, RAM might change everything!!!!!
  - Contractor may need to "Bump" the grade.

100-1A
07-15-97

ESTIMATED PROJECT QUANTITIES
(1 DIVISION PROJECT)

Item No.	Item Code	Item	Unit	Total	As Built Qty.
1	2101-0850002	CLEARING AND GRUBBING	UNIT	352.2	
2	2102-0425070	SPECIAL BACKFILL	TON	10809.7	
3	2102-2710070	EXCAVATION CLASS 10 ROADWAY AND BORROW	CY	25823	
4	2102-2712015	EXCAVATION CLASS 12 BOULDERS OR ROCK FRAGMENTS	CY	50	
5	2102-2713070	EXCAVATION CLASS 13 ROADWAY AND BORROW	CY	2390	
6	2105-8425015	TOPSOIL STRIP, SALVAGE AND SPREAD	CY	11053	
7	2107-0875100	COMPACTION WITH MOISTURE CONTROL	CY	12523	
8	2113-0001100	SUBGRADE STABILIZATION MATERIAL POLYMER GRID	SY	74	
9	2115-0100000	MODIFIED SUBBASE	CY	10449.3	
10	2121-7425010	GRANULAR SHOULDERS, TYPE A	TON	57246	
11	2122-5500080	PAVED SHOULDER, HOT MIX ASPHALT MIXTURE 8 IN.	SY	8668.5	
12	2122-5500090	PAVED SHOULDER HOT MIX ASPHALT MIXTURE 9 IN.	SY	10401	
13	2123-7450000	SHOULDER CONSTRUCTION EARTH	STA	188.5	
14	2214-5145150	PAVEMENT SCARIFICATION	SY	431.4	
15	2214-7450050	BLADING AND SHAPING SHOULDER MATERIAL	STA	158.77	
16	2301-1033105	STANDARD OR SLIP FORM PORTLAND CEMENT CONCRETE PAVEMENT, CLASS C, CLASS 3 DURABILITY 10.5 IN.	SY	3900.4	
17	2301-6911722	PORTLAND CEMENT CONCRETE PAVEMENT SAMPLES	LS	1	
18	2303-1041500	HOT MIX ASPHALT HIGH TRAFFIC BASE COURSE 1/2 IN. MIX	TON	11535.84	
19	2303-1042500	HOT MIX ASPHALT HIGH TRAFFIC, INTERMEDIATE COURSE, 1/2 IN. MIX	TON	2598.88	
20	2303-1043502	HOT MIX ASPHALT HIGH TRAFFIC SURFACE COURSE. 1/2 IN. MIX FRICTION L-2	TON	2648.92	
21	2303-1258284	ASPHALT BINDER, PG 58-28H, HIGH TRAFFIC	TON	1007.02	
22	2303-6911000	HOT MIX ASPHALT PAVEMENT SAMPLES	LS	1	
23	2315-8275025	SURFACING DRIVEWAY CLASS A CRUSHED STONE	TON	642.7	
24	2402-0425040	FLOODED BACKFILL	CY	195	
25	2402-2720100	EXCAVATION CLASS 20 FOR ROADWAY PIPE CULVERT	CY	45,4 6	
26	2416-0100024	APRONS CONCRETE. 24 IN. DIA.	EACH	7	
27	2416-0100030	APRONS, CONCRETE, 30 IN. DIA.	EACH	3	
28	2416-0100036	APRONS, CONCRETE, 36 IN. DIA.	EACH	3	

Binder Grade Bumping

- IM510 states the following:
  - For mixtures <u>not</u> containing RAS
    - When the amount of recycled binder from RAP exceeds 20.0% of the total asphalt binder, the designated binder grade will be adjusted by lowering both the high and low temperature PG grade by 6°C while maintaining the AASHTO M332 traffic designation letter on the contract.
    - If the anticipated RAM binder percent exceeds 30% of the total, the selection of the binder grade shall be based on testing performed by the Contracting Authority.

Binder Grade Bumping

- IM510 states the following:
  - For mixtures containing RAS, adjust the contract binder grade as follows:
    - When the amount of recycled binder is inclusively between 15.0% and 25.0%, adjust the grade by lowering both the high and low temperature PG grade by 6°C while maintaining the AASHTO M332 traffic designation letter on the contract.
    - When the amount of recycled binder exceeds 25.0% of the total asphalt binder, the selection of the binder grade shall be based on testing performed by the Contracting Authority.

Binder Grade Bumping

- Example:
  - Contract and Plans call for a PG 58-28S
  - Contractor is using 25% RAP (that equates to 23% of the total asphalt binder in the mix)
  - What is the grade that the contractor will use?

____________________?

Binder Grade Bumping

- Example:
  - Contract and Plans call for a PG 58-28S
  - Contractor is using 25% RAP (that equates to 23% of the total asphalt binder in the mix)
  - What is the grade that the contractor will use?

PG52-34S

Binder Grade Bumping

- Confused Yet?
- The moral of the Binder Grading story:
  - Check the Job Mix Formula (JMF) for the grade of binder that will be used in the mix.
  - It MAY not be the grade of binder shown on the contract documents if RAM is being used.

Naming Convention

- IM 501, Page 1
  - "Tech Talk"
  - Identifies Material Specific Gravities
  - Identifies Material Percentages
  - Acronyms for everything related to Hot Mix Asphalt
  - Used in all the calculations
  - Helpful to make sure everyone is talking about the same thing

REVIEW QUESTIONS
HOT MIX ASPHALT MATERIALS

1. What are three major problems associated with aggregate? Briefly describe each.

2. Can unclassified RAP be used on a highway project on the surface lift?

3. Briefly describe what the numbers 64 and -22 mean in the asphalt binder grade: PG 64-22V.

4. What temperature must asphalt binder be at before being added to the mix? (See Specification 2303.03)

5. What binder grade will the contractor use if PG64-22H is indicated on the plans, but he is using RAP that contributes 22% of the total asphalt binder in the mix.

6. Is the contractor allowed to mix a PG58-28V grade binder with a PG64-22V grade binder in his storage tank?

THE "RECIPE"

(otherwise known as the job mix formula, form 956)

The job mix formula (JMF) is a form that the mix designer prepares before a project begins. This will list all the ingredients in the mix, the % of the ingredients, and the specification requirements. The JMF must comply with the mix design requirements found in IM510, Appendix A in order to be submitted for approval to the Iowa DOT. Once production begins, the job mix formula can be altered by the contractor to ensure that the mix produced meets the production tolerances (as spelled out in Spec Section 2303).

Along with the job mix formula is another form, form 955. This is a form that gives more information about the individual aggregates and binder that will be used on the project.

On the following pages you will see a JMF (form 956) and a form 955. It is important to understand the information that is on these forms, as they establish the materials that can be used on the project.

Form 956 ver. 11.22

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

HMA Gyratory Mix Design

Ndesign

			Letting Date :	10/17/2023
County : Polk		Project : IMX-35-5(97)121--02-77	Mix No. :	ABD23-1045
Mix Size (in.) : 1/2	Type A	Contractor : Quality Asphalt, Inc.	Contract #:	77-0355-097
Mix Type: VT	L - 2	Design Traffic : Very High Traffic	Date:	10/19/23
Intended Use : Surface		Location : MP 65 - 74.7	I-35 from Polk Co. line N. to I-80	

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
1/2" ACC Stone	33.0%	A85006	Martin Marietta Aggregates/Ames Mi	49-50	2.656	0.82	47.0	4
3/4" Washed Chips	7.0%	A85006	Martin Marietta Aggregates/Ames Mi	49-50	2.646	0.70	46.0	4
Man Sand	15.0%	ASD002	L G Everist Inc/Dell Rapids	ENTIRE LEDC	2.667	0.66	46.0	2
Sand	6.0%	A35522	Martin Marietta Aggregates/Mcdowel		2.569	1.62	38.0	4
1/2" Washed Chips	29.0%	ASD002	L G Everist Inc/Dell Rapids	ENTIRE LEDC	2.655	0.88	46.0	2
Classified RAP	10.0%	ABC16-66	10% ABC16-66 (4.8 % AC)		2.659	0.84	44.0	2

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	91	52	35		16			5.2
	100	**100**	**96**	**84**	**45**	**30**	**18**	**12**	**6.7**	**4.6**	**3.2**
Lower Tolerance	100	100	89	77	38	25		8			1.2

Asphalt Binder Source and Grade: TEXPAR DAVENPORT, IA PG 58-28V

Gyratory Data

% Asphalt Binder	4.91	**5.20**	5.26	5.70	6.20
Gmb @ N-Des.	2.383	**2.394**	2.397	2.410	2.411
Max. Sp.Gr. (Gmm)	2.495	**2.494**	2.494	2.462	2.442
% Gmm @ N- Initial	83.9	**83.8**	83.8	86.0	86.0
%Gmm @ N-Max		**96.1**			
% Air Voids	4.5	**4.0**	3.9	2.1	1.3
% VMA	14.6	**14.4**	14.4	14.3	14.7
% VFA	69.2	**72.3**	72.9	85.2	91.4
Film Thickness	12.42	**12.76**	12.85	14.84	16.38
Filler Bit. Ratio	0.73	**0.71**	0.71	0.61	0.56
Gse	2.692	**2.704**	2.707	2.688	2.685
Pbe	4.36	**4.48**	4.51	5.21	5.75
Pba	0.58	**0.75**	0.79	0.52	0.48
% New Asphalt Binder	90.7	**91.2**	91.3	92.0	92.7
Combined Gb @ 25°C	1.0309	**1.0309**	1.0309	1.0309	1.0309

Aggregate Type Used	A		Combined	Contribution From RAM
G_{sb}	2.652	% Friction Type 4 (+4)	50.5	6.8
G_{sa}	2.714	Or Better	99.3	9.2
% Water Abs	0.86	% Friction Type 3 (+4)	0	0
S.A. m^2 / Kg.	3.51	Or Better	49	2
Angularity-method A	46	% Friction Type 2 (+4)	49	2
% Flat & Elongated	1.9	% Friction Type 2 (-4)	42	1
Sand Equivalent	74	Type 2 Fineness Modulus	2.7	0.4
Virgin G_b @ 25°C	1.031	% Crushed	93.0	8.6

Anti-Strip Dose (%) 0.00

Stripping Inflection Point

Number of Gyrations
N-Initial
9
N-Design
95
N-Max

Gsb for Angularity Method A
2.638

Pba / %Abs Ratio
0.69

Slope of Compaction Curve

Mix Check
Fair

Pb Range Check
1.29

RAM Check
OK

Specification Check
Missing Hamburg

Hamburg Check
Required. Report results to DME
Please choose AS Dose/Type if req.

Disposition : An asphalt content of 5.2% is recommended to start this project.

Data shown in 5.20% column is interpolated from test data.

The % ADD AC to start project is 4.7%

0.00 % of binder

Comments :

Quality Asphalt, Inc.

Copies to : Quality Asphalt, Inc. CI-1234 Signed :

Mix Designer & Cert.# : Bob Anderson CI-1234 Signed :

Form 955 ver. 11.22

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County :	Polk	Project No.:	IMX-35-5(97)121--02-77	Date:	10/19/23
Project Location:	I-35 from Polk Co. line N. to I-80			Mix Design No.:	ABD23-1045
Contract Mix Tonnage:	25,906	Course:	Surface	Mix Size (in.):	1/2
Contractor:	Quality Asphalt, Inc.	Mix Type:	VT	Design Traffic:	Very High Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
1/2" ACC Stone	A85006	33.0%	Martin Marietta Aggregates/Ames Mine	A	4	49-50	2.656	0.82
3/4" Washed Chips	A85006	7.0%	Martin Marietta Aggregates/Ames Mine	A	4	49-50	2.646	0.70
Man Sand	ASD002	15.0%	L G Everist Inc/Dell Rapids	A	2	TIRE LED	2.667	0.66
Sand	A35522	6.0%	Martin Marietta Aggregates/Mcdowell San	A	4		2.569	1.62
1/2" Washed Chips	ASD002	29.0%	L G Everist Inc/Dell Rapids	A	2	TIRE LED	2.655	0.88
Classified RAP	ABC16-66	10.0%	10% ABC16-66 (4.8 % AC)	A	2		2.659	0.84
Type and Source of Asphalt Binder:			PG 58-28V TEXPAR DAVENPORT, IA					

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
1/2" ACC Stone	100	100	98	87	48	33	16	14	10	8.0	5.3
3/4" Washed Chips	100	100	63	34	5.0	1.8	1.7	1.6	1.5	1.2	1.0
Man Sand	100	100	100	100	95	67	37	20	7.0	3.0	2.2
Sand	100	100	100	100	98	85	67	40	12	1.8	1.1
1/2" Washed Chips	100	100	99	81	15	1.9	1.7	1.6	1.4	1.2	1.0
Classified RAP	100	99	95	85	47	32	21	14	11	9.5	7.1

Preliminary Job Mix Formula Target Gradation

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	91	52	35		16			5.2
Comb Grading	100	100	96	84	45	30	18	12	6.7	4.6	3.2
Lower Tolerance	100	100	89	77	38	25		8			1.2
S.A.sq. m/kg	Total	3.51		+0.41	0.19	0.25	0.29	0.34	0.41	0.56	1.05

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	33.0% of mix 1/2" ACC Stone		7.0% of mix 3/4" Washed Chips		15.0% of mix Man Sand		6.0% of mix Sand		29.0% of mix 1/2" Washed Chips		10.0% of mix Classified RAP	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	98.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0	98.0	100.0		
1/2"	91.0	100.0	56.0	70.0	100.0	100.0	100.0	100.0	92.0	100.0		
3/8"	80.0	94.0	27.0	41.0	98.0	100.0	98.0	100.0	74.0	88.0		
#4	41.0	55.0	0.0	12.0	88.0	100.0	91.0	100.0	8.0	22.0		
#8	28.0	38.0	0.0	6.8	62.0	72.0	80.0	90.0	0.0	6.9		
#30	10.0	18.0	0.0	5.6	16.0	24.0	36.0	44.0	0.0	5.6		
#200	3.3	7.3	0.0	3.0	0.2	4.2	0.0	3.1	0.0	3.0		

Comments:

Copies to: Quality Asphalt, Inc.

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Signed: ______________________

Producer Contractor

Form 956 ver. 11.22

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

HMA Gyratory Mix Design

Ndesign

					Letting Date :	10/17/2023
County :	Polk		Project :	IMX-35-5(97)121--02-77	Mix No. :	ABD23-1045
Mix Size (in.) :	1/2	Type A	Contractor :	Quality Asphalt, Inc.	Contract #:	77-0355-097
Mix Type:	VT	L - 2	Design Traffic :	Very High Traffic	Date:	10/19/23
Intended Use :	Surface		Location :	MP 65 - 74.7	I-35 from Polk Co. line N. to I-80	

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
1/2" ACC Stone	33.0%	A85006	Martin Marietta Aggregates/Ames Mi	49-50	2.656	0.82	47.0	4
3/4" Washed Chips	7.0%	A85006	Martin Marietta Aggregates/Ames Mi	49-50	2.646	0.70	46.0	4
Man Sand	15.0%	ASD002	L G Everist Inc/Dell Rapids	ENTIRE LEDC	2.667	0.66	46.0	2
Sand	6.0%	A35522	Martin Marietta Aggregates/Mcdowel		2.569	1.62	38.0	4
1/2" Washed Chips	29.0%	ASD002	L G Everist Inc/Dell Rapids	ENTIRE LEDC	2.655	0.88	46.0	2
Classified RAP	10.0%	ABC16-66	10% ABC16-66 (4.8 % AC)		2.659	0.84	44.0	2

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	91	52	35		16			5.2
	100	**100**	**96**	**84**	**45**	**30**	**18**	**12**	**6.7**	**4.6**	**3.2**
Lower Tolerance	100	100	89	77	38	25		8			1.2

Asphalt Binder Source and Grade: TEXPAR DAVENPORT, IA PG 58-28V

Gyratory Data

% Asphalt Binder	4.91	**5.20**	5.26	5.70	6.20
Gmb @ N-Des.	2.383	**2.394**	2.397	2.410	2.411
Max. Sp.Gr. (Gmm)	2.495	**2.494**	2.494	2.462	2.442
% Gmm @ N- Initial	83.9	**83.8**	83.8	86.0	86.0
%Gmm @ N-Max		**96.1**			
% Air Voids	4.5	**4.0**	3.9	2.1	1.3
% VMA	14.6	**14.4**	14.4	14.3	14.7
% VFA	69.2	**72.3**	72.9	85.2	91.4
Film Thickness	12.42	**12.76**	12.85	14.84	16.38
Filler Bit. Ratio	0.73	**0.71**	0.71	0.61	0.56
Gse	2.692	**2.704**	2.707	2.688	2.685
Pbe	4.36	**4.48**	4.51	5.21	5.75
Pba	0.58	**0.75**	0.79	0.52	0.48
% New Asphalt Binder	90.7	**91.2**	91.3	92.0	92.7
Combined Gb @ 25°C	1.0309	**1.0309**	1.0309	1.0309	1.0309

Aggregate Type Used	A		Combined	Contribution From RAM
G_{sb}	2.652	% Friction Type 4 (+4)	50.5	6.8
G_{sa}	2.714	Or Better	99.3	9.2
% Water Abs	0.86	% Friction Type 3 (+4)	0	0
S.A. m^2 / Kg.	3.51	Or Better	49	2
Angularity-method A	46	% Friction Type 2 (+4)	49	2
% Flat & Elongated	1.9	% Friction Type 2 (-4)	42	1
Sand Equivalent	74	Type 2 Fineness Modulus	2.7	0.4
Virgin G_b @ 25°C	1.031	% Crushed	93.0	8.6

Anti-Strip Dose (%) 0.00

Stripping Inflection Point

Number of Gyrations
N-Initial
9
N-Design
95
N-Max

Gsb for Angularity
Method A
2.638

Pba / %Abs Ratio
0.69

Slope of Compaction Curve

Mix Check
Fair

Pb Range Check
1.29

RAM Check
OK

Specification Check
Missing Hamburg

Hamburg Check
Required. Report results to DME
Please choose AS Dose/Type if req.

Disposition : An asphalt content of 5.2% is recommended to start this project.

Data shown in 5.20% column is interpolated from test data.

The % ADD AC to start project is 4.7%

0.00 % of binder

Comments :

Quality Asphalt, Inc.

Copies to : Quality Asphalt, Inc. CI-1234 Signed :

Mix Designer & Cert.# : Bob Anderson CI-1234 Signed :

Form 955 ver. 11.22

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Polk Project No.: IMX-35-5(97)121--02-77 Date: 10/19/23

Project Location: I-35 from Polk Co. line N. to I-80 Mix Design No.: ABD23-1045

Contract Mix Tonnage: 25,906 Course: Surface Mix Size (in.): 1/2

Contractor: Quality Asphalt, Inc. Mix Type: VT Design Traffic: Very High Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
1/2" ACC Stone	A85006	33.0%	Martin Marietta Aggregates/Ames Mine	A	4	49-50	2.656	0.82
3/4" Washed Chips	A85006	7.0%	Martin Marietta Aggregates/Ames Mine	A	4	49-50	2.646	0.70
Man Sand	ASD002	15.0%	L G Everist Inc/Dell Rapids	A	2	TIRE LED	2.667	0.66
Sand	A35522	6.0%	Martin Marietta Aggregates/Mcdowell San	A	4		2.569	1.62
1/2" Washed Chips	ASD002	29.0%	L G Everist Inc/Dell Rapids	A	2	TIRE LED	2.655	0.88
Classified RAP	ABC16-66	10.0%	10% ABC16-66 (4.8 % AC)	A	2		2.659	0.84

Type and Source of Asphalt Binder: PG 58-28V TEXPAR DAVENPORT, IA

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
1/2" ACC Stone	100	100	98	87	48	33	16	14	10	8.0	5.3
3/4" Washed Chips	100	100	63	34	5.0	1.8	1.7	1.6	1.5	1.2	1.0
Man Sand	100	100	100	100	95	67	37	20	7.0	3.0	2.2
Sand	100	100	100	100	98	85	67	40	12	1.8	1.1
1/2" Washed Chips	100	100	99	81	15	1.9	1.7	1.6	1.4	1.2	1.0
Classified RAP	100	99	95	85	47	32	21	14	11	9.5	7.1

Preliminary Job Mix Formula Target Gradation

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	91	52	35		16			5.2
Comb Grading	100	100	96	84	45	30	18	12	6.7	4.6	3.2
Lower Tolerance	100	100	89	77	38	25		8			1.2
S.A.sq. m/kg	Total	3.51		+0.41	0.19	0.25	0.29	0.34	0.41	0.56	1.05

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	33.0% of mix 1/2" ACC Stone Min	Max	7.0% of mix 3/4" Washed Chips Min	Max	15.0% of mix Man Sand Min	Max	6.0% of mix Sand Min	Max	29.0% of mix 1/2" Washed Chips Min	Max	10.0% of mix Classified RAP Min	Max
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	98.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0	98.0	100.0		
1/2"	91.0	100.0	56.0	70.0	100.0	100.0	100.0	100.0	92.0	100.0		
3/8"	80.0	94.0	27.0	41.0	98.0	100.0	98.0	100.0	74.0	88.0		
#4	41.0	55.0	0.0	12.0	88.0	100.0	91.0	100.0	8.0	22.0		
#8	28.0	38.0	0.0	6.8	62.0	72.0	80.0	90.0	0.0	6.9		
#30	10.0	18.0	0.0	5.6	16.0	24.0	36.0	44.0	0.0	5.6		
#200	3.3	7.3	0.0	3.0	0.2	4.2	0.0	3.1	0.0	3.0		

Comments:

Copies to: Quality Asphalt, Inc.

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Signed: ______________________

Producer Contractor

3 PLANTS

ASPHALT PLANTS

Covered in this section:

-Asphalt Plant Types
-Basic operation of each plant type
-Mix Storage
-Pollution Control
-Mix Segregation
-Plant Calibration
-Weighing equipment requirements

ASPHALT PLANT TYPES

- Batch Plants
- Drum Mix Plants

There are two types of plants used in the production of asphalt mixes, batch plants and drum mix plants. An inspector has many jobs to perform when visiting an asphalt plant. Each plant operates differently, so it is important that an inspector becomes familiar with the plant they are inspecting.

GOOD INSPECTORS KNOW

- Why things happen
- How they happen
- What can be done to correct the problem.

The purpose of an asphalt plant is to combine aggregates and asphalt binder in such a way as to produce a mixture that meets job requirements. The production process involves proportioning aggregates of various sizes into the proper mix gradation, drying and heating the aggregate particles, adding the right amount of heated binder, mixing these materials together, and storing the finished mix before depositing it into trucks for delivery to the job site.

Asphalt binder and aggregate are delivered to the plant before and during production. Asphalt binder is stored in heated storage tanks. Aggregates are stockpiled in a way that avoids segregation and contamination.

Each aggregate stockpile contains particles of a specific size or range of sizes. Separation of stockpiles prevents the different sized aggregates from mingling.

From stockpiles, the aggregates are fed directly into underground conveyor tunnels or loaded into cold bins from which they are drawn as needed. During production, it's important that stockpiles and bins are well supplied. An aggregate shortage could cause an interruption of plant operations.

Cold aggregates are drawn from stockpiles and bins through cold feed gates. Each gate is calibrated and set to control the flow rate of a certain size of aggregate. If all gate openings are properly coordinated, the combined flow of materials from the different bins or stockpiles will contain the right amount of each size of aggregate required for the finished mix.

The accuracy of cold feed operation is especially important in drum mix plants because, unlike batch plants, they have no secondary proportioning system. The aggregate gradation leaving the cold feed system becomes the gradation of the mix. For this reason, the gradation of the aggregates, stockpiles, and the function of the cold feed system should be checked frequently during operation.

From the cold feed system, a conveyor belt carries the materials to a secondary conveyor.

Two features of the conveyor system are particularly important to the inspector. The first is the aggregate weighing device called a weigh bridge, usually located midway along the length of the belt.

A typical weigh bridge consists of a series of conveyor idlers. One of these, the weight idler, is mounted on a scale allowing it to weigh the aggregate passing over it.

A visual display in the plant control room gives continuous weight readings in tons per hour. The weigh bridge is interlocked with the asphalt binder metering system so that the proportions of aggregates and binder used in the mix remains correct.

The second feature of the conveyor system is the aggregate sampling device, usually located where the primary conveyor empties onto the secondary conveyor. The location allows personnel to capture a stream flow sample without interrupting plant operations. This gives the inspector and the laboratory a means of checking that aggregates entering the drum meet gradation requirements.

DRUM MIX PLANTS

In a drum mix plant, the aggregates are carried from the conveyor system to the drum mixer. The drum mixer, also referred to as the drying drum mixer, is the central component of a drum mix plant. Within the drum mixer, the aggregates are heated, dried, and combined with the proper proportion of asphalt binder.

Binder is introduced away from the direct heat of the burner flame.

The inside wall of the drum mixer is lined with lifters called flights. Two or more flights are used in most drum mixers to lift and direct the aggregate in different ways as it moves through the drum.

Within the drum mixer, operations occur in two phases. In the preliminary phase, aggregates enter and are dropped in a veil pattern through the burner flame. Aggregate temperature increases dramatically and most of the moisture is driven off.

The secondary phase occurs where binder is introduced. As asphalt binder sprays into the drum it meets the moisture that has been driven off the aggregates. The combination of binder and moisture causes the binder to foam.

The foamed binder literally engulfs the aggregate particles, rapidly coating them and providing uniform coverage.

The system that delivers binder to the drum mixer includes a heated storage tank, a metering pump and a visual display for monitoring binder flow. The accuracy of this system is critical for successful production of hot mix asphalt.

To ensure that aggregates and binder are always mixed in proper proportion, the aggregate weight system and the binder metering system are interlocked. When the flow of aggregate into the drum mixer either decreases or increases, the flow of binder into the drum automatically adapts to the change.

During plant operation, the inspector will notice the visual display of the two systems do not give the same reading. Why the discrepancy? Very simple. The weigh bridge measures the combined weights of both the aggregates and the moisture the aggregates contain. The proportion of asphalt binder introduced into the mix, however, must be based on the weight of the aggregate alone. For this reason, it is important to know the moisture content of the aggregate being used. This moisture content is input into the asphalt plant and the computer adjusts the weights accordingly.

In addition to the other features, most drum mixers are mounted on adjustable jacks that are used to control the drum’s angle of tilt. A steep tilt forces the aggregates to pass through the drum mixer more quickly than a gentle tilt. Jack adjustments are one of the ways in which the length of time for heating, drying and mixing can be controlled.

Another important component of the drum mixer is the dust collection system. There are several types of dust collection systems used in HMA plants, however all of them have the same purpose: to capture as much of the dust as possible in the drum exhaust. One common method of dust collection system is a bag house, which gets its name from the hundreds of fabric bags inside it. Dust collected in the bottom of the bag house can be piped back into the drum as needed for the mix.

When the drum mixer finishes its work, it discharges the hot mix asphalt from an outlet at its lower end into an elevator, which carries the fresh mixture to the top of one or more storage silos. The silos keep the mix hot until it is hauled to the job site.

Gates located at the bottom of the silo discharge measure amounts of material into trucks for delivery.

Because a drum mix plant produces a steady stream of HMA, it is important that enough trucks and pavers are employed to use the volume of mix that the plant produces. Too few operational trucks or pavers can force the plant to halt operations, interfering with smooth flow of production needed to maintain mix quality.

The nerve center for plant monitoring is the control room. It houses a full range of equipment needed to keep an eye on everything from aggregate and binder feed rates to mixture temperature and surge bin weights. Having monitors and controls in a central location is an advantage of plant automation. It is an advantage that makes the inspector’s job easier and allows plant personnel to react quickly to malfunctions and imbalances.

Computer readouts and visual displays, however, are no replacement for a sharp pair of eyes and a solid knowledge of plant functions and conditions. In short, automation can never replace a competent plant inspector.

Drum Plants in review:

An HMA drum plant consists of several coordinated components, stockpiles and cold bins that store the aggregate; a cold feed system that proportions the aggregate onto a conveyor and a weigh bridge that monitors the rate of aggregate feed.

The conveyor feeds the aggregates into a drum mixer where they are heated, dried, combined with binder, and mixed together into a uniform paving mixture. A dust collection system reclaims mineral dust from the drum exhaust. From the discharge of the drum, a conveyor carries the finished hot mix to the top of a storage silo.

Plant systems and material conditions are monitored from a central location, ensuring balanced and uniform plant operations.

Drum plants vary in size and configuration, but their functions are essentially the same. With little modifications, the points presented here will be applicable to almost any plant you inspect.

BATCH PLANTS

The second type of plant is a batch plant. The general functions of a batch plant are the same as a drum mix plant. Inspection responsibilities are very similar, but the process of putting the binder and aggregate together is different. This affects the drying, adding binder, and mixing parts of operation.

Aggregate is fed to the dryer by means of the cold feed belt, similar to that of a drum plant. The dryer is the first major difference between a batch and drum plant. In the batch plant, no binder is added at the dryer

The heated aggregate is discharged into an elevator which takes the hot aggregates up into the overhead “hot bins”. A batch plant has similar pollution control equipment as a drum plant.

Batch plants are designed with a screening unit at the top where the hot aggregates can be screened into various sizes and put into the hot aggregate bins. One of the benefits of this screening is that the batch plant operator can now batch out whatever mix is called for since each batch can be different. This can be very useful at a plant doing commercial work. If this is occurring, you need to be aware of what is happening so you can keep track of the materials you are getting on your project. **In Iowa, most batch plants remove the screens and use the aggregate as it is proportioned and comes out of the dryer**. It is already proportioned at the cold feed and comes all the way through the plant in a single line. When mix is ready to be made, the aggregate will leave the hot bin and be weighed in the chamber called the weigh hopper, and then will travel into the pugmill for mixing.

We are now ready for the asphalt binder to be brought into the batch.

Heated asphalt binder is piped from the binder storage tank into the asphalt binder weigh bucket. One batch worth of binder is weighed out and at the proper time in the batched sequence, will be pumped into the pugmill where it will be mixed with the aggregate. The asphalt binder is proportioned by a scale weight for each batch.

As the pugmill is mixing the aggregate, asphalt binder is sprayed into the chamber. As the batch is in its mixing cycle, the plant is filing the weigh hopper with aggregate for the next batch.

There are specifications governing pugmills. These requirements include twin shafts, a paddle-to-side clearance not more than ¾', and others. You need to review current specifications for the equipment requirements.

MIX STORAGE

Mix storage may or may not be necessary for batch plants. Some batch plants only make the number of batches required for truck delivery. The mix is batched and deposited directly into the truck.

Drum plants, on the other hand, have a continuous flow of mix. If a truck is not available for immediate delivery, the mix must be placed in hot storage. This is accomplished by means of a hot elevator and storage silo.

Hot mix from the drum or batch plant is raised by means of the hot elevator to the top of the storage silo. At the top of the silo is a small storage unit called a "gob hopper". This stores small quantities of hot mix so that it can be dropped into the storage silo in a "gob". This helps cut down the segregation that might occur if there was a steady stream of mix falling into the silo.

Many problems of segregation on the roadway can be traced back to the elevator and storage silo. Many silos have internal baffles that direct the flow of mix as it passes through. This is another way to cut down the segregation of the mix.

Part of the plant inspectors' job is to know what equipment is being used, whether it complies to specifications, how it is supposed to work, how it is working and where to look for problems. Most of this should be checked out before paving begins.

POLLUTION CONTROL

Pollution control equipment is necessary to eliminate exhaust dust and smoke from the operation.

Baghouses and wet scrubbers are examples of pollution control equipment. Whatever process or equipment is used at the plant to remove the waste matter from the exhaust, the intent is the same. Fines created in the drying process are removed from the plant so they are not dispersed into the air. In most cases a plant is equipped to meter the dust back into the mixer to ensure that the mix being produced meets specifications.

MIX SEGREGATION

One of the foremost problems in HMA paving is segregation of the mix. Every point in the hot mix handling process can be a point of segregation. If the road inspector discovers a segregation problem, check the plant from stockpile to exit gate for possible problems and solutions. Some of the causes are from the paver, but many segregation problems can be tracked back to the plant. There are many locations at a plant where mix segregation can occur. Some of these locations will be discussed here.

Leaving the drum discharge chute at a drum plant: If the drum does not center in the chute, segregation may occur. This can be detected by watching the discharge from the drum. It can also be seen by checking the mix going up the hot elevator. Generally any segregation from the drum discharge will be evident as the material is carried to the silo. Some of the elevators are enclosed but there is generally an access area near the bottom that can be opened to observe the mix.

Above the silo at the gob hopper: Mix coming up the hot elevator is temporarily stored in the gob hopper so that it can be discharged into the silo in "gobs". If the gates do not function properly, material dribbles into the silo and may tend to segregate as a cone of mix develops in the silo. With close inspection, you can see the gate cylinders working. On computerized plants, the gob hopper function is shown on the video screen.

Gob Hopper gates: On some silos, the direction the gates open on the gob hopper is the same as the discharge gate opening direction on the bottom of the silo. This may be a source of a segregation problem. If the mix is segregated at the time of delivery into the silo, it will probably be segregated when discharged into the truck.

Low Bin Discharge: All silos must be equipped with low bin indicators. Mixes should not be pulled down below the level indicator as segregation may occur in the lower discharge cone of the bin.

Truck Loading: If the truck is left in one spot to fill, excessive coning of the mix occurs, and segregation is likely. It is important that the truck driver moves the truck between dumps from the silo. This spreads the mix more uniformly over the truck box. The truck should be loaded using a 3 dump system, with the 3rd dump always occurring in the middle. Front, back, middle or Back, front, middle is the recommended loading procedure.

ASPHALT PLANTS

1

Objectives

- Describe how aggregate gradation and asphalt content are controlled in Asphalt plants
- Detail the calibration and operation of Drum Mix Plants

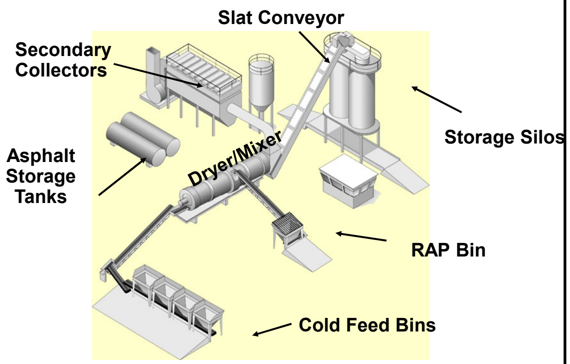
2

Types of Facilities

- Drum Mix Plants (continuous)
  - –Single drum
  - –Double drum

3

Drum-Mix Plant Elements



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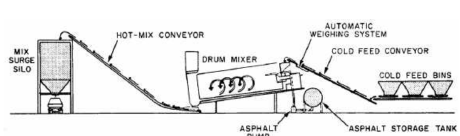
Parallel-Flow Drum-Mix Plant

5

Material Flow – Drum Mix Plan



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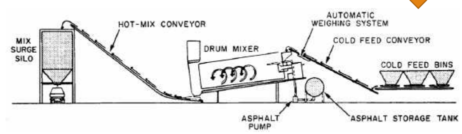
Material Flow – Drum Mix Plan

AGGREGATE CONTROL



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Cold Feed Bins with vertical dividers

8

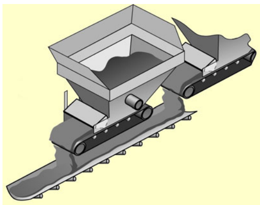
Aggregate Feeders

Typically Belt

Calibration

9

Cold Feed Bin Showing Strike-off Gate



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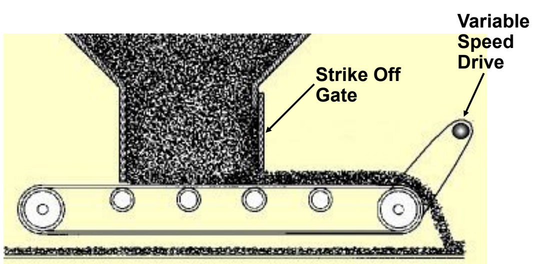
Continuous Belt Feeder



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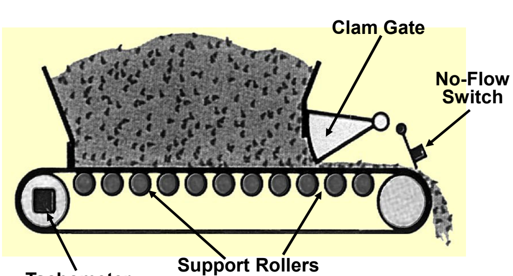
Clam Gate Feeder



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Belt Feeder and Bin Wall Vibrator

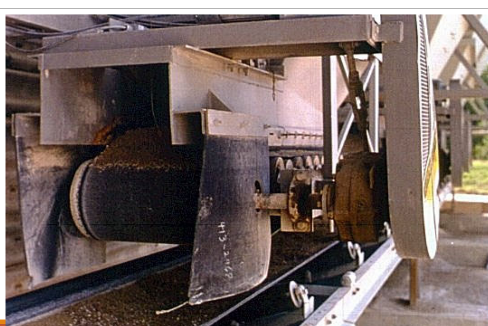
13

Collecting Conveyors

Collects material from each feeder and transfers to dryer

14

Collecting Conveyor Under Cold Feed Bins



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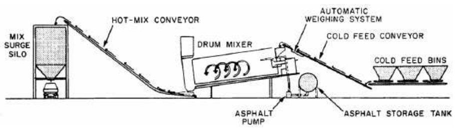
Single Deck Scalping Screen on Drum-Mix Plant

16

Material Flow – Drum Mix Plan

WEIGH BELT AND ASPHALT FLOW METER



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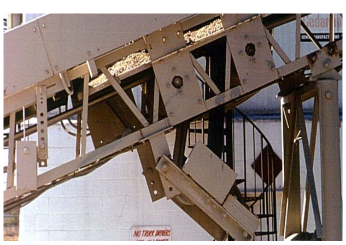
Weigh Belt weighs Agg and Moisture



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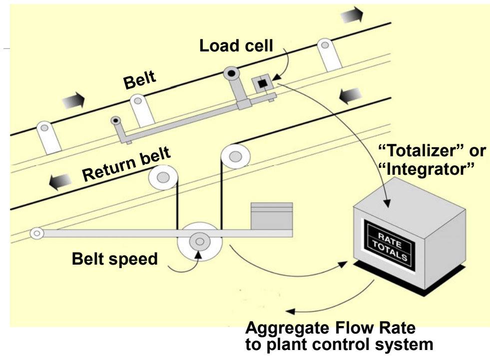
How a Belt Scale Works



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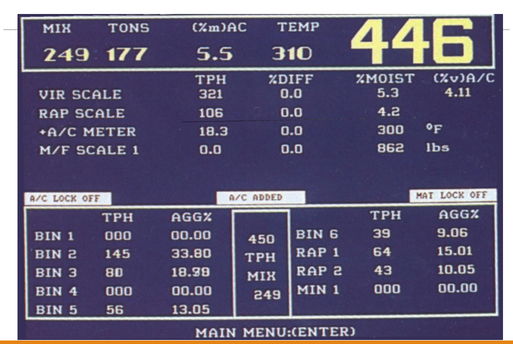
Moisture Compensation

20

Main Control Screen on Computerized Control System



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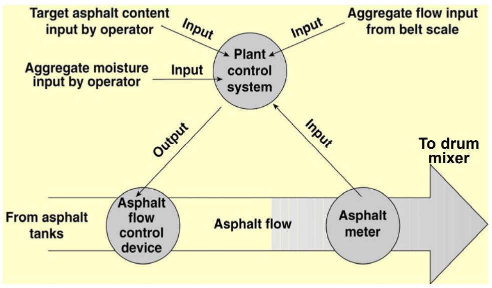
Asphalt Flow Regulated in Drum-Mixer Plant



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Asphalt Flow Control

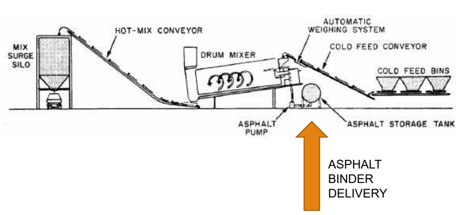
Flow is measured

Flow reported to control system

Control system regulates flow

23

Material Flow – Drum Mix Plan



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Multiple Horizontal Tanks

25

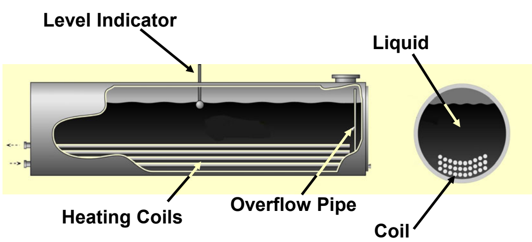
Hot Oil Heater to Heat Asphalt Tanks

26

Hot Oil Pipes for Asphalt Tanks

27

Horizontal Asphalt Tank Showing Hot Oil Pipes



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"Touch Screen" Control System with Manual Backup

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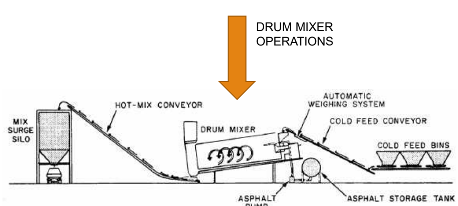
Material Flow – Drum Mix Plan



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Fixed Chute Entry to Dryer with Vibrator on Chute

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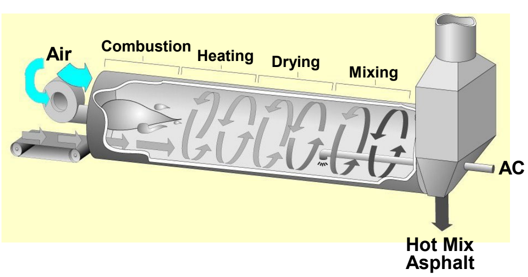
Slinger Feed Entry to Counter-Flow Drum-Mixer

32

Parallel-Flow Drum-mixers Zones



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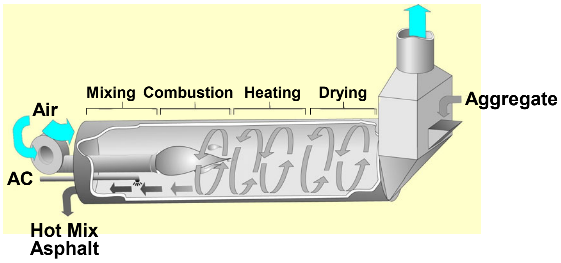
Counter-Flow Drum-mixer Zones



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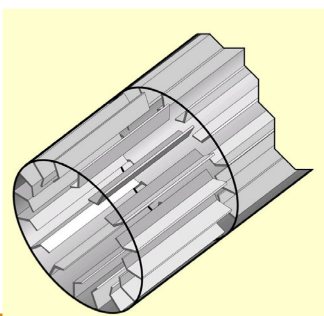
Staggered Rows of Flights



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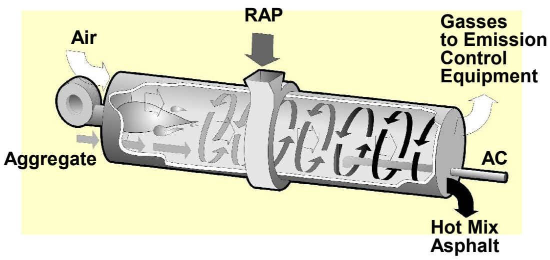
Where does RAP get incorporated?

36

RAP Collar on Parallel-flow Drum-mixer



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HMA LEAVING THE DRUM

Inspection Point…..what should you be looking for?

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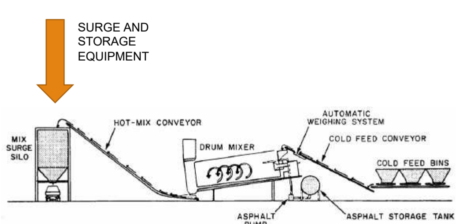
Material Flow – Drum Mix Plan



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Portable Self-Erecting Silo

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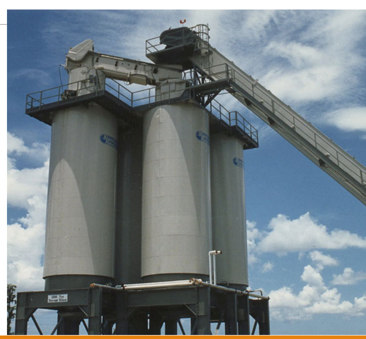
Stationary Five Bin Silo System



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Slat Conveyor Feeding Silos

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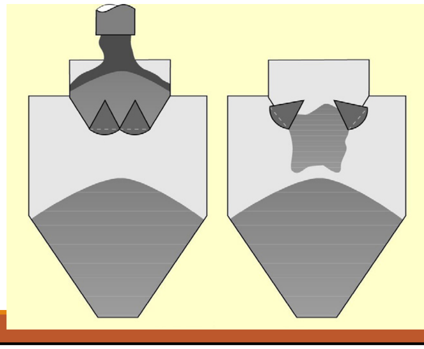
Center Drop Batcher



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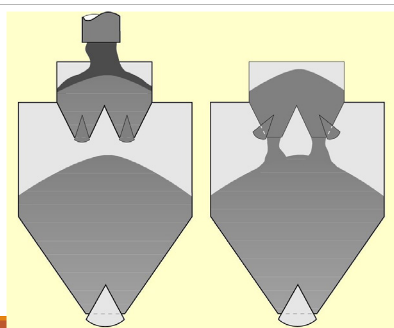
Split Feed Batcher



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Modern Silo Control Screen

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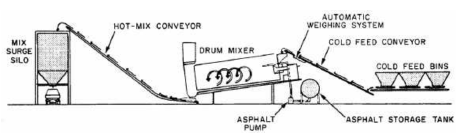
Storage Concerns

- **Temperature**
- **Segregation**
- **Moisture**

46

Material Flow – Drum Mix Plan

Not shown, but very important. Pollution control



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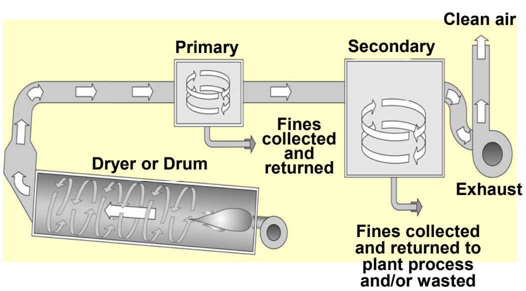
Primary and Secondary Emission Control Equipment



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Primary Collector

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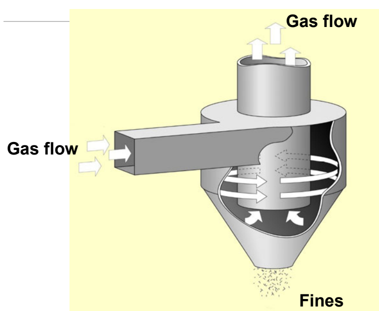
How a Single Cyclone Works



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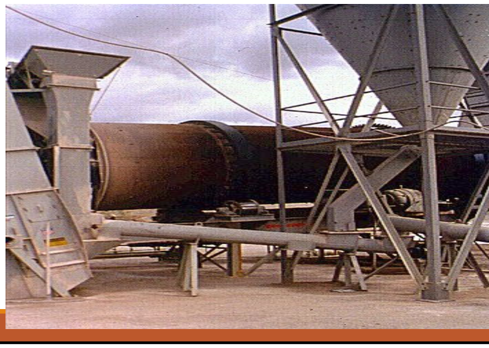
Vertical Cyclone

51

Dust Return from Cyclone to Elevator with Screw Conveyor



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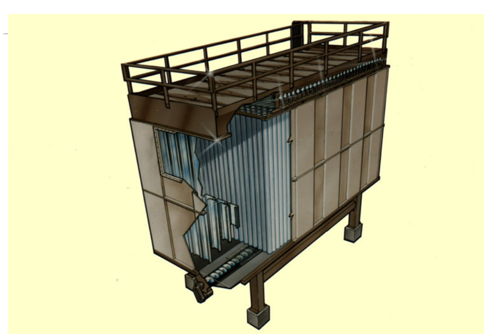
Secondary Collector

53

Cutaway Drawing of Typical Baghouse



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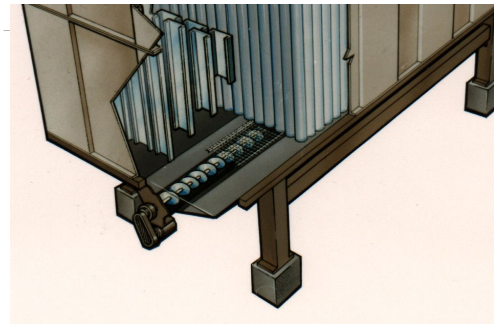
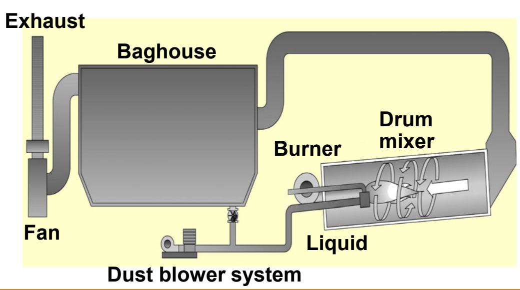
Collecting and reusing Baghouse Fines



55

Baghouse Fines Being Blown into Mixing Area of Drum Mixer



56

Pulse Jet Baghouse

57

Mix Segregation

58

Mix Segregation

- Every point in the hot mix handling process can be a point of segregation
- Some of the cause are from the paver, but many segregation problems can be tracked back to the plant.

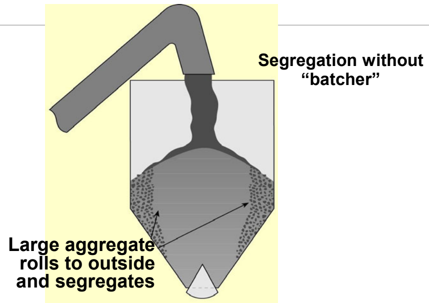
59

Example Segregation Locations

- **Above the silo at the gob hopper**
  - If gates don't function properly, material can dribble into the silo
- **Truck Loading**
  - Depositing into large truck bodies, causing the mixture to cone and roll.
    - If truck is left in one spot to fill, segregation is likely

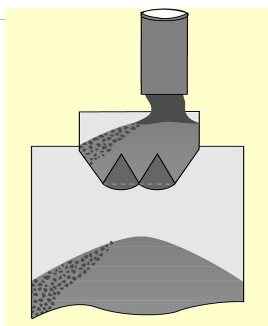
60

Segregation Occurring in Silo w/o a Batcher or Gob-Hopper



61

Off Center Batcher feeding causes segregation



62

TRUCK LOADING

Three-drop Method

- 1st Drop at Front
- 2nd Drop at Rear
- 3rd Drop in Center

Reduce aggregate roll-down
Important when paving with large stone mixes

63

Other Example Segregation Locations

- Leaving the drum discharge chute at a drum plant
- Gob Hopper Gates
- Low Bin Discharge
- Inadequate mixing

64

Truck Beds

- Release Agents
- Diesel Fuel?

65

REVIEW QUESTIONS
HOT MIX ASPHALT PLANT OPERATIONS

1. What are the two types of hot mix asphalt plants.

2. How is RAP fed into a Drum-Mix plant?

Answer the following Spec Questions using Section 2303.03 of the asphalt specification.

3. What is the maximum temperature hot mix asphalt can be when it leaves the plant?

4. What is the maximum temperature for warm mix asphalt (WMA) before October 1^{st}?

5. If WMA has a target production temperature of 260°, what is the lowest temperature that mix can be produced without getting approval from the engineer.

6. What is the minimum temperature HMA can be at the job site and still be placed?
   a. If the lift is 1 ½” or less_______________
   b. If the lift is more than 1 ½” _____________

ASPHALT PLANT CALIBRATION

Before the job starts, all material proportioning equipment at the plant must be calibrated and checked for accuracy.

The calibration is the responsibility of the contractor and will be witnessed by the District Materials Office. **The contractor must furnish:**

1. The people to calibrate the HMA plant
2. The scales
3. The test weights
4. All equipment required to calibrate

The contractor conducts the calibration and prepares the paperwork. The contractor also runs the moisture contents on each aggregate.

The plant monitor should be present during the calibration:

1. To become familiar with the contractor's equipment
2. To learn how all the settings are made
3. It is also a good time to discuss the job mix or any other items

Prior to the calibration, the following items should be checked, particularly for portable setups:

1. Is there adequate footing for equipment such as the storage silo, the binder tanks, and the cold feed bins?
2. Is the equipment level? Binder storage tanks that are not level can give inaccurate tankstick readings.
3. Is there unequal settlement around the bin footings? Rain and heavy truck traffic may have an effect on this throughout the job.
4. Are all the bins in good shape? Make sure all the parts are in place that are required.
5. Are there ground rods where they are needed?
6. Do all the stairways have handrails where necessary?
7. Are there covers or other protection on pulleys, belts, and drive mechanisms? Make sure they are in place.

If something doesn't appear right, discuss it with the contractor. For the inspector, it is important that they feel safe around the equipment and with the work they must do around it.

The equipment that must be calibrated is:

1. Aggregate cold feed bins
2. Asphalt binder meter
3. Weigh belts
4. Batch scales (at a batch plant)
5. Storage silo weighing equipment

Modern asphalt plants calibrate themselves, and each one is different in how that calibration occurs. With experience you can become familiar with the plant you are working with and understand the plant calibration process.

WEIGH FOR PAY

In Iowa, two methods of payment are used.

1) For mainline paving, contractors are paid on a weight basis for Asphalt Binder and Mix. Both materials are paid by the ton.

2) Other mixture bid items such as shoulders are paid by the square yard (sy). When a contractor is paid by the square yard asphalt binder is considered incidental and is not paid for separately.

HMA mixtures can be weighed over platform scales, in silos on load cells, in weigh hoppers, or by counting batches. Weight tickets are typically required for each load to quantify HMA mixture.

Binder is quantified by in-line flow meter, or by totaling batch tickets. In-line flow meter must be accurate to plus or minus 0.2% as demonstrated through the calibrations process. Use a certified truck scale or a calibration tank in the calibration of flow meters.

At least once per year a Certified Scale Company shall verify the load cells on the calibration tank. When the tank is moved certified weights shall be used to test the load cells. Use a minimum of 200 pounds to check for accuracy, sensitivity and that the tank is free floating and level on the load cells.

Binder quantity is required to be verified by conducting Yield checks. Yield checks shall be performed on a weekly basis by comparing delivery quantities or by tankstick.

It is very important that the equipment used to determine pay quantities is accurate.

- The specification requires that scales for weighing trucks must meet the requirements and be inspected by the Iowa Department of Agriculture.
- The scales must be certified by a bonded scale repairman.

Three items are utilized during HMA production to ensure proper operations of scales:

- **SCALE ACCURACY**
- **SCALE SENSITIVITY**
- **VERIFICATION WEIGHING**

It is very important to understand these requirements.

WEIGHING EQUIPMENT REQUIREMENTS

1. **SCALE ACCURACY:** A measure of how close the registered weight is to the actual weight.

Requirements at time of plant calibration:

± 0.2%	For scales and binder meters used to determine pay quantity (platform scale, silo discharge weigh hopper or batch plant proportioning scales when counting batches for pay quantity)
± 0.5%	For proportioning scales (aggregate weigh hopper or binder weigh bucket on batch plants when not counting batches for pay quantity)
± 1.5%	For all weigh belt and binder meters not used for pay quantities (drum mix plants)

Requirements during use:

Check weighing is used to confirm the accuracy of all types of weighing equipment. Check weighing is defined as a second weighing of the same load on another certified truck platform scale. A reasonable adjustment for fuel consumption is allowed. The engineer may require check weighing at any time. The construction manual recommends one check weighing the first day of production and one additional random check for projects exceeding 5,000 tons as a minimum. The Contracting Agency may monitor check weighing. Check weighing must agree with the following tolerances:

± 0.3%	For truck platform scales
± 100 lbs	For all other weighing equipment

*Note regarding binder quantity accuracy: Yield checks shall be performed on a weekly basis by comparing delivery quantities or by tankstick. The complete tankstick guidelines can be found in IM 509.

2. SCALE SENSITIVITY: How sensitive the scale is to a change in weight as indicated by the scale reaction to a small weight variation.

All types of weighing equipment, except weight belts, must be checked at least once per day for proper sensitivity by placing a small weight on the fully loaded scale and observing the dial or readout for movement. The weight used for the sensitivity check is normally ± 0.1% of the quantity being weighed, however it cannot be less than one of the minimum graduations of the scale or more than 20 lb.

3. VERIFICATION WEIGHING: A second weighing of the same load on the same platform scale.

When using a truck platform scale for pay quantities, there is an additional check that must be performed daily. The purpose of the verification weighing is to check the load cell distribution. A verification weighing involves weighing a loaded truck, driving the truck off the scale then back on the scale, and weighing it again. The verification weight should not be different from the initial weight by more than 0.1 %.

*For more information on weighing equipment and procedures see:

A. Construction Manual (3.50), Weighing Equipment for Determination of Pay Quantities
B. Iowa Standard Specifications 2001.07, Weighing Equipment and Procedures

YEAR	2015	CALIBRATION OF HMA PLANT EQUIPMENT	
Contractor:	Mathy Portable Plant # 23	Date of Plant Calibration:	10/19/2015
Plant Type:	400 tph Drum Plant	Date of Platform Scale Calibration:	Spring 2015
Plant Location:	Preston Redimix (Preston Quarry)	Scale Company:	Derlein Scale Co
Project #:	FM-CO23(97)--55-23	Binder Type & Grade:	PG 58-28 During Calibration
Pollution Control:	Baghouse	Mix Size:	1/2"
Calibrated By:	Pat Cherney	Date of Asphalt Tank Calibration:	N/A
Witnessed by:	Mark Dutra (I.D.O.T.)	Asphalt Tank Calibrated By:	N/A
Mix Design:	ABD15-6055	Plant Phone #:	

AGGREGATE BELT SCALES Spec: +/- 1.5% Error

	Operating Range @ (300) TPH											
Belt Weight	11,832	11,268	11,254									
Truck Gross	34,500	34,220	34,280									
Truck Tare	22,940	22,940	22,940									
Truck Net	11,560	11,280	11,340									
Difference	272	12	86									
% Error	2.4	0.1	0.76									
Scale Factor	3.334 / 9078											
Comments:	All aggregate bins were calibrated under 1.5% Error											

ASPHALT CEMENT PUMP Spec: +/- 0.2% For Pay By Meter or +/- 1.5% Not For Pay (Tank Stick Only)

	Operating Range @ (15) TPH											
Metered Gal. or Lbs.	15,004	14,996										
Corrected Gal. or Lbs												
Calibrated Tank Lbs.												
Truck Gross	45,640	60,660										
Truck Tare	30,640	45,640										
Truck Net	15,000	15,020										
Difference	4	24										
% Error	0.03	0.16										
Scale Factor	2008.2											
Comments:												

RAP BELT SCALES Spec: +/- 1.5% Error												
	Operating Range @ (60) TPH											
Belt Weight	11,476	11,648	11,583									
Truck Gross	34,700	34,680	34,500									
Truck Tare	22,940	22,940	22,940									
Truck Net	11,760	11,740	11,560									
Difference	284	92	23									
% Error	2.4	0.78	0.2									
Scale Factor	2.220 / 5766											
Comments:	All RAP bins were calibrated under 1.5% Error.											

RAS BELT SCALES Spec: +/- 1.5% Error												
	High Range @ ( ) TPH			Medium Range @ ( ) TPH			Low Range @ ( ) TPH					
Belt Weight												
Truck Gross												
Truck Tare		RAP AND RAS USE THE SAME BELT SCALE										
Truck Net												
Difference												
% Error												
Scale Factor												
Comments:	All RAS bins were calibrated under 1.5% Error.											

SILO HOPPER SCALES Spec: +/- 0.2% Error												
	Silo #1			Silo #2			Silo #3					
Hopper Scale	30,200											
Truck Gross	53,200											
Truck Tare	22,940											
Truck Net	30,260											
Difference	60											
% Error	0.2											
Comments:												

PLATFORM SCALES Spec: +/- 0.2% Error												
Test Weight's												
Truck Gross												
Truck Tare			SEE COMMENTS									
Truck Net												
Difference												
% Error												
Comments:	Calibrated By Derlein Scale Inc.											
Additional Information:												

PORTABLE SCALE REPORT

Owner ____ **Date** ___/___/_____

Address____
(Street)

____ **ZIP** _________
(City) (State)

Scale Make _______________________ **Model** _____________________________

Capacity _______________________ **Platform Size** _______________________

Location ____
(County) (Township) (Section)

Quarry Name ____

Remarks: Was scale found to meet the specifications and tolerance set by the Iowa Department of Agriculture? ____

If the answer to above is "no," did you make necessary repairs to bring it into specification and tolerance of the Iowa Department of Agriculture? ______

AFFIDAVIT

The undersigned registered scale technician certifies that the above described Portable scale has been inspected and found to be within weight specifications and tolerance specified under the laws, rules and regulations of the State of Iowa.

Signed: ____
(Scale Technician) (Registration Number)

Company: ____

Instructions

1. **Materials producers will forward one signed copy of this report to Chief, Weights and Measures Bureau, Iowa Department of Agriculture, Wallace Building, Des Moines, Iowa 50319.**
2. **One signed copy of this report must be conspicuously posted in the scale house.**
3. **Portable scales, not installed permanently, are not intended to be used at any location for more than 90 days.**

4 SPECS

SOME MORE HMA DEFINITIONS

SEE IM 500 & 501 IN YOUR MANUAL

P_a

$P_{b(Added)}$

$P_{b(RAP)}$

$P_{b(Total)}$

P_{ba}

P_{be}

Film Thickness

Gyratory Compactor

N_{des}

G_{mb}

G_{mm}

% of G_{mm}

Small Quantity

THE END-PRODUCT

HOT MIX ASPHALT

When the finished product is complete it will be hot mix asphalt. How do you know if this mix is good or bad? There are many specifications, tolerance limits and performance characteristics that must be met. The contractor will be paid for mix that meets specifications, and may be penalized for mix that does not meet specifications.

The following locations are where specific requirements of the mix may be found.

IM 510, Appendix A

Specification 2303.03.D.3&4

Other Asphalt Specification References

ASPHALT BINDER
AASHTO M 332
Combined State Binder Group Document
Specification 4137

MIXTURE
General Specification Section 2303

EQUIPMENT
Specification 2001
Test equipment is specified in each test method.

AGGREGATE
Specification 4127

EMULSION
Specification 4140
AASHTO M 140
AASHTO M 208

CUT-BACK ASPHALT
Specification 4138
AASHTO M 81
AASHTO M 82

REVIEW QUESTIONS

SPECIFICATIONS

Use IM 510, Appendix A to answer the following questions:

1. What is the film thickness requirement for a ST Surface mix?

2. What is the target air void requirement for a mix designated as HT Intermediate?

3. How many times will the gyratory compactor “gyrate” a VT Surface mix?

Use Spec Section 2303.03.D.3 to answer the following questions:

4. What is the allowed tolerance (+/-) for asphalt binder in hot mix asphalt?

5. What is the allowed tolerance (+/-) for laboratory air voids under the PWL Spec?

6. What is the specification range for field voids under the PWL Spec?

7. Whose job is it to make changes to the mix to produce HMA mix that meets specifications? The contractor or the agency?

Form 830245
09-20

NONCOMPLIANCE NOTICE

Contractor ______________________________ Project No. ______________________________

County ____________________ Contract ID ____________________ Date __________ Time __________

To: ____________________ ____________________ ____________________
(Name) (Title) (Signature)

You are hereby notified that the following observation and/or test noted

and is a violation of Article

The test data value is

and the specification limits are

- Additional tests may be performed.
- The violation identified in this notice shall be ceased and/or corrected. This may require a modification of current practices or removal and replacement of materials, including labor, at no cost to the Contracting Authority.
- You are to determine corrective action necessary.
- You are to determine if you wish to discontinue operations until the violation is corrected or additional tests confirm or refute this failing test.

Remarks:

Correction:

____
Inspector's Signature

Distribution: Contractor, Project Engineer, Inspector

LIST OF COMMON NONCOMPLIANCES

AGGREGATE

Gradation
Stockpile Contamination
Stockpile Segregation
Stockpile Intermingling
Feeder Bin Intermingling

BINDER

Binder Quality - *PA*
Storage Temperature

MIXTURE

VMA
Film Thickness - *PA*
Temperature
Segregation - *PA*
Lab Voids PWL - *PA*

PAVEMENT CORES

Field Voids PWL - *PA*

PLANT OPERATIONS

Unsafe Sampling Locations
Diesel Fuel in Truck Boxes

**PA = Pay Adjustment*

ACTION STEPS TO BE TAKEN WHEN NONCOMPLIANCE OCCURS

Check calculations for correctness.

Check test equipment for proper operation.

Check control charts for trends.

Check plant equipment for proper settings.

Check plant equipment for proper operation.

Check the individual materials for changes.

Notify the contractor.

Notify the Contracting Authority.

THE PLANT IS READY TO BEGIN OPERATIONS….

ONE OF YOUR JOBS, AS A TECHNICIAN (QC OR QA) IS TO BE AWARE OF SAFETY REQUIREMENTS AND CHECK DAILY TO ENSURE THE PLANT SITE IS SAFE

VIEW PLANT SITE SAFETY VIDEO

<u>LIST SOME ITEMS TO CHECK FOR</u>

5 SAMPLING

SAMPLING MATERIALS AT A HOT MIX ASPHALT PLANT

WHO is involved?	WHAT is sampled?	WHERE is the sample taken?	WHEN how often?	HOW explain	SECURITY what type?
	AGGREGATE				
	BINDER				
	TACK				
	UNCOMPACTED HMA				
	COMPACTED HMA				

AGGREGATE SAMPLING AT THE PLANT

Belt Sampling Technique

Streamflow Sampling Technique

Current specification calls for the certified Aggregate Technician to run a gradation test on the combined aggregate each day or lot. **You must be Aggregate Sampler certified or Aggregate Technician certified to sample aggregate at the asphalt plant.**

Good position, good equipment, and good techniques will result in a good sample.

The standard belt template used in cold feed sampling is quite narrow. If you want to keep your hands clean, you can make a scoop to use with the template. This makes the sampling much easier.

Proper streamflow sampling requires the proper good body position, and a minimum of three good cuts of the stream. Increments should be spread out to represent as much production as possible.

”A safe and convenient” sampling location should mean that a platform is built so the technician is not handling the sampler in an awkward position.

The contractor’s certified technician takes the sample and the monitor for the agency directs and witnesses the sampling and the splitting of the sample. The monitor must then secure one half of the split and completes a sample ID before returning it to the contractor for delivery to the District Lab. If the monitor takes possession of the sample and is running the gradation tests for the agency, securing the sample is not necessary. On projects using the PWL specification, the monitor will need to direct and witness the aggregate sample daily. IM 301 explains the proper sampling procedure for aggregate.

IOWADOT
Form 820193
(03-17)

Highway Division
Office of Construction and Materials
Ames, Iowa

Central
Lab No.: ____________

IDENTIFICATION OF SAMPLE TEST

Material: Cold Feed Combined Aggregate 1/2"

Barcode Security ID No.: D1-000121

Intended Use: HMA VT Surface

Sender's Sample No.: CF10-25A

County: Polk

Contract ID No.: 77-0355-097

Project: IMX-35-5(97)121--02-77

Mix Design No.: ABD23-1045

Contractor: Quality Asphalt Inc. (Name) ____________ (Address)

Supplier: ____________ Source: ____________

Producer: Quality Asphalt Inc.

Brand: ____________

Lot No./Heat No.: ____________

Location of Producing Plant: US Highway 6 Altoona

Quantity Represented: 1/2 split of 40 Lb daily plant sample

Sample by: John Rayson witnessed by Bob Anderson (Name) ____________ (Address)

Date Sampled: 10-25-2023

Date Received: ____________

Report to District Materials *[Check appropriate box(es)]* Dist 1 ☒ Dist 2 ☐ Dist 3 ☐ Dist 4 ☐ Dist 5 ☐ Dist 6 ☐

Report to Residency *(Write appropriate residency number)* ☐☐ ☐☐ ☐☐ ☐☐ ☐☐

(Last two digits of Cost Center)

Report to Counties *(Write appropriate county number)* ☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Report to Other: Quality Asphalt Inc.

Report to Other: ____________

Report to Other: ____________

Results need by: Date: ____________

Additional Detailed information:

Check Sample Type		
☒	V	Verification
☐	PN	Project Information
☐	MD	Mix Design
☐	DI	Dept. Information
☐	WH	Warehouse Stock
☐	IA	Independent Assurance

(NOTE: A representative of the Department of Transportation shall select the sample.)

Distribution: One copy - with the sample; One copy - File

ASPHALT BINDER SAMPLING AT THE PLANT

Asphalt Binder is required to be sampled at the plant by the Contractor. The sample is then submitted to the Iowa DOT so that tests can be run to verify the PG Binder Grade.

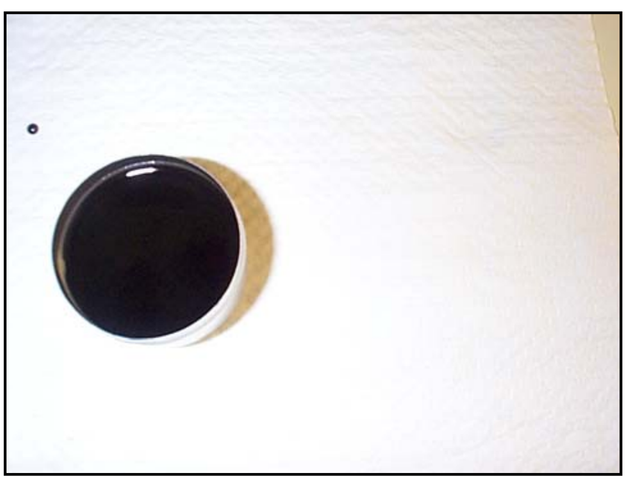
Asphalt Binder samples need to be representative of the binder being incorporated into the mix. It must be taken from sampling valves located in the pumping line, between the storage tank and the mixer. For quality control, samples cannot be taken from the delivery tanker.

It's very important that the sampling location is accessible and safe. A poor setup is an accident waiting to happen. It is important to wear proper safety apparel to prevent burns from spills or "burps" in the line.

Care should be taken to ensure the sample is not contaminated.

IM 323 explains the proper sampling procedure for Asphalt Binder.

*This sample must be directed and witnessed by the Agency's Inspector. The contractor can take as many samples as they'd like for their own Quality Control, but only the directed and witnessed samples are used for Acceptance. The Agency's Inspector will supply the security items and complete the Form 193.




SUPPLY CO.
WEST DES MOINES, IOWA
THIS VEHICLE STOPS AT ALL RR CROSSINGS
RM 6991

IOWADOT
Form 820193
(03-17)

Highway Division
Office of Construction and Materials
Ames, Iowa

Central Lab No.: ____________

IDENTIFICATION OF SAMPLE TEST

Material: Asphalt Binder PG58-28V

Barcode Security ID No.: D1-000101

Intended Use: HMA VT Surface

Sender's Sample No.: BIN10-25A

County: POLK

Contract ID No.: 77-0355-097

Project: IMX-35-5(97)121--02-77

Mix Design No.: ABD23-1045

Contractor: Quality Asphalt Inc. (Name) ____________ (Address)

Supplier: Texpar Energy LLC

Source: Texpar Davenport

Producer: Texpar Davenport

Brand: PG58-28V

Lot No./Heat No.: ____________

Location of Producing Plant: Texpar Davenport

Quantity Represented: One 4oz tin per days run

Sample by: John Rayson witnessed by Bob Anderson (Name) ____________ (Address)

Date Sampled: 10-25-2023

Date Received: ____________

Report to District Materials *[Check appropriate box(es)]*

Dist 1	Dist 2	Dist 3	Dist 4	Dist 5	Dist 6
☒	☐	☐	☐	☐	☐

Report to Residency *(Write appropriate residency number)* ☐☐ ☐☐ ☐☐ ☐☐ ☐☐

(Last two digits of Cost Center)

Report to Counties *(Write appropriate county number)* ☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Report to Other: Quality Asphalt Inc.

Report to Other: ____________

Report to Other: ____________

Results need by: Date: ASAP

Additional Detailed information:

Check Sample Type		
☐	V	Verification
☒	PN	Project Information
☐	MD	Mix Design
☐	DI	Dept. Information
☐	WH	Warehouse Stock
☐	IA	Independent Assurance

(NOTE: A representative of the Department of Transportation shall select the sample.)

Distribution: One copy - with the sample; One copy - File

UNCOMPACTED MIX SAMPLING

IM 322 requires HMA and WMA mixtures to be sampled at the grade for testing to determine laboratory air voids and possibly aggregate gradation. For ST, HT, and VT mixtures placed by a paver, it is usually sampled from the last point in the construction process, after it's been placed and before it's been rolled. Special circumstances and special mixtures such as the High Performance Thin Lift (HiPro) and the Interlayer allow other sampling methods. Sampling from the windrow in front of the paver or from the paver hopper is required for the special mixtures. The DME may approve windrow sampling for special circumstances. When placing mix in a widening trench or other circumstances where the thickness is greater than three inches, a square point shovel may be used to sample. It must be a representative sample of the mix being placed.

Proper safety precautions must be taken. Gloves, work boots, eye protection, vests and hard hats are required. Make sure you use proper safety procedures and are aware of the construction traffic and travelling public while on the grade.

The number of hot mix asphalt samples needed each day is based on the tonnage being produced. The sampling rate is 1 / sublot and the number of sublots can be found in the Specifications.

Table 2303.03-5: Uncompacted Mixture Sampling

Estimated Daily Production, Tons	Number of Samples
101-500	1
501-1250	2
1251-2000	3
2001-4500	4
Over 4500	5

The Agency technician will determine the location within each sublot by using the random number generator spreadsheet provided by the Iowa DOT. This can be found at: http://www.iowadot.gov/Construction_Materials/hma.html

IM 322 explains the proper sampling procedure for hot mix asphalt. Do not vary from this procedure unless directed to do so, and if you do vary, document why and how. **The technician CANNOT vary from the IM unless directed to do so by the DME. This includes windrow sampling.**

*This sample must be directed and witnessed by the Agency's Inspector. The contractor can take as many samples as they'd like for their own Quality Control, but only the directed and witnessed samples are used for Acceptance. The Agency's Inspector will supply the security items and complete the Form 193.

Date:	10/26/2012			
Expected Tons Produced For The Day:	4,900.00			
First Hot Box Sample Tons:	281.00	--	980.00	First Sublot (tons):
Second Hot Box Sample Tons:	1,114.00	--	980.00	Second Sublot (tons)
Third Hot Box Sample Tons:	2,257.00	--	980.00	Third Sublot (tons)
Fourth Hot Box Sample Tons:	3,147.00	--	980.00	Fourth Sublot (tons)
Fifth Hot Box Sample Tons:	4,860.00	--	980.00	Fifth Sublot (tons)

Approved Increased Sampling Plan based on Today's Production			# of Sublots
Production, tons			# of Sublots
101	to	500	1
501	to	1250	2
1251	to	2000	3
2001	to	4500	4
>		4500	5

Expected tons from Silo storage

Plant Production Tons per Hour:	450
Laydown Start Time:	7:00 AM
Approximate First Sample Time:	7:37 AM
Approximate Second Sample Time:	9:28 AM
Approximate Third Sample Time:	12:00 PM
Approximate Fourth Sample Time:	1:59 PM
Approximate Fifth Sample Time:	5:48 PM

Press F9 to Calculate

To use this spreadsheet to select random samples of uncompacted HMA you must provide the tonnage the contractor expects to lay.
If only the expected tonnage is provided the program will provide sample locations based on the running total of tonnage delivered when you press F9.
If you want the sample locations expressed as time you must also provide the tons per hour at which the plant is operating and the time when the laydown operation started then press F9.

Any changes in expected tonnage or plant production such as breakdowns, weather interruptions or other delays may require recalculation of sample locations if the interrruption causes the sample time to fall during a period when no mix is being laid or fall in the same sublot as a previous sample.

Every attempt should be made to keep the sampling random, however if, for example, rain-out is eminent or plant production ceases prematurely and the sample for the sublot has not been obtained a sample should be taken immediately if possible.

Sample locations must not be provided to the contractor in advance except for the time needed to prepare for sampling.
The contractor should be prepared to sample as directed at any time.

This program works best if it is the only file loaded in Excel. Automatic recalculation has been turned off in this file so that the program will only calculate once when you press F9.
If other files have been loaded into Excel that allow automatic recalculation this file may change sample locations whenever any data is changed.
If this occurs, exit Excel then reload it and open this file and complete the sample locations before loading any other Excel files.

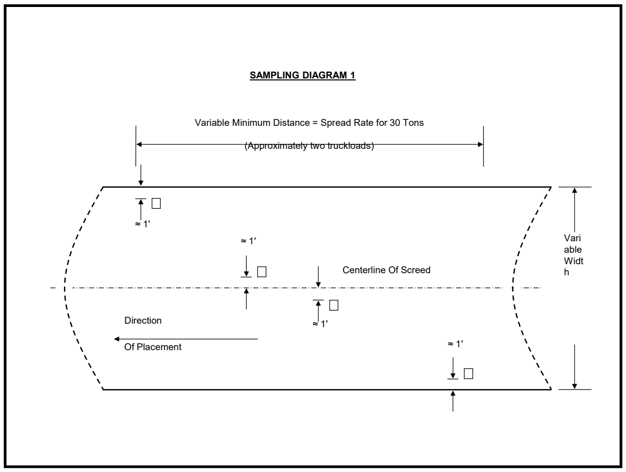
Hot Mix Asphalt Sampling

- Paired Samples, one box for the Contractor, one for the Agency, each containing at least 40 Lbs.
- Can use a single template, or a double template
  - The use of a double template can speed up the sampling since it requires only one placement for each increment.
  - If using a double template, you can eliminate scraping the template between each increment if you pair the samples correctly

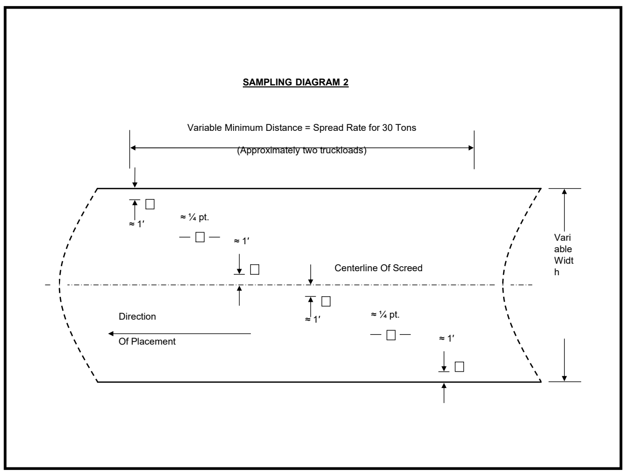
1

2

3


SAMPLING DIAGRAM 1
Variable Minimum Distance = Spread Rate for 30 Tons
(Approximately two truckloads)
≈ 1'
≈ 1'
Centerline Of Screed
≈ 1'
Direction
Of Placement
≈ 1'
Vari
able
Widt
h

4


SAMPLING DIAGRAM 2
Variable Minimum Distance = Spread Rate for 30 Tons
(Approximately two truckloads)
≈ 1'
≈ ¼ pt.
≈ 1'
Centerline Of Screed
≈ 1'
≈ ¼ pt.
≈ 1'
Direction
Of Placement
Vari
able
Widt
h

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13

Thick Lifts greater than 3” can be sampled using a square point shovel instead of the template. Use the shovel to delineate an area and carefully remove all material from within the area.

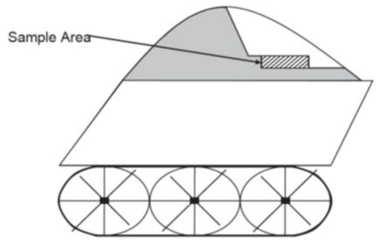
14

Sampling from Hopper

- Sampling of special mixes like High Performance Thin Lift and Interlayer is not performed behind the paver due to the high polymer content of the binder. One of the methods specified for these mixes is sampling from the paver hopper.

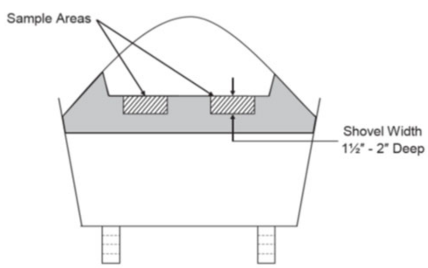
15

Sampling from Hopper



16

Sampling from Hopper



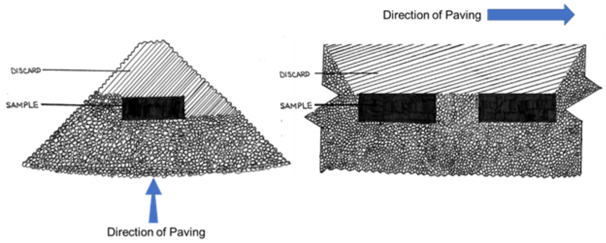
17

Sampling from Windrow

- The other method used for sampling special mixes is to obtain samples from the windrow if the contractor is using that method of placement.
- Windrow sampling may also be used for standard mixes with the approval of the DME.

18

Sampling from Windrow



19

20

SAMPLE IDENTIFICATION

Sampling identification is very important. The box that is sent to the agency must have all the necessary information written on it. The Sample Identification Form #193 must be filled out completely and sent along with the box, or, filled out electronically and sent with the bar code identification.

It is always better to include more information than necessary. At a minimum, include the following:

21

Sample identification written on the box

- Date and time the sample was obtained
- Station and Direction (NB, SB, EB, or WB)
- Tonnage at which the sample was taken (if known)
- Lift (Surface, Intermediate, Base)
- Project Number
- **Mix Design Number**
- Sample ID #

22

Sample identification written on the Form #193

- Mix Type
- Lift (Surface, Intermediate, Base)
- Project Number
- **Mix Design Number**
- Contractor
- The person who took the sample
- Sample ID #
- Who the report is being sent to

23

Explanation of Sample ID

Sender Sample No. IN 10-25A

IN stands for Intermediate lift (BA is base, SU is surface)

10-25 stands for October 25th, the date the sample was taken using a month/day format

A stands for the first box of the day (A, B, C, D, E….first box, second box, etc.)

24

Explanation of Sample ID#

- Other sample identification methods may be used, including bar codes.
- Always check with the District Lab before submitting samples to find out what method of identification is required.

25

IOWADOT
Form 820193
(03-17)

Highway Division
Office of Construction and Materials
Ames, Iowa

Central Lab No.: ____________

IDENTIFICATION OF SAMPLE TEST

Material: HMA VT Surface 1/2" @ 5.2% Asphalt Binder

Barcode Security ID No.: D1-000144

Intended Use: HMA VT Surface

Sender's Sample No.: SU10-25A

County: Polk

Contract ID No.: 77-0355-097

Project: IMX-35-5(97)121--02-77

Mix Design No.: ABD23-1045

Contractor: Quality Asphalt Inc. (Name) ____________ (Address)

Supplier: ____________ Source: ____________

Producer: Quality Asphalt Inc.

Brand: ____________

Lot No./Heat No.: ____________

Location of Producing Plant: US Highway 6 Altoona

Quantity Represented: 1 40 Lb box from first sublot of Approx. 750 tons

Sample by: John Rayson witnessed by Bob Anderson (Name) ____________ (Address)

Date Sampled: 10-25-2023

Date Received: ____________

Report to District Materials *[Check appropriate box(es)]*

Dist 1	Dist 2	Dist 3	Dist 4	Dist 5	Dist 6
☒	☐	☐	☐	☐	☐

Report to Residency *(Write appropriate residency number)* ☐☐ ☐☐ ☐☐ ☐☐ ☐☐

(Last two digits of Cost Center)

Report to Counties *(Write appropriate county number)* ☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Report to Other: Quality Asphalt Inc.

Report to Other: ____________

Report to Other: ____________

Results need by: Date: ____________

Additional Detailed information:

Check Sample Type		
☒	V	Verification
☐	PN	Project Information
☐	MD	Mix Design
☐	DI	Dept. Information
☐	WH	Warehouse Stock
☐	IA	Independent Assurance

(NOTE: A representative of the Department of Transportation shall select the sample.)

Distribution: One copy - with the sample; One copy - File

COMPACTED FLEXIBLE PAVEMENT SAMPLING
(CORES)

Cores are required to be sampled from the completed pavement for testing to determine thickness, density, and air voids. The core being sampled must represent the pavement layer as placed. (Base, Intermediate, Surface).

The proper procedure involves cutting samples from the completed pavement. Specifications require the cores to be cut as promptly as practical. Cores should be sampled no later than the following workday. Proper safety precautions must be taken.

The number of core samples needed each LOT is determined by specification. For a PWL project there will always be 8 cores/lot cut from the travelling portion of the road, and 3 cores/lot cut from the joint (if it's a surface course and a qualifying joint is built).

A LOT is one layer of one mixture bid item placed during one day's operation

The Agency's inspector will determine the location within each lot by using the random number generator spreadsheet provided by the Iowa DOT. This can be found at:
http://www.iowadot.gov/Construction_Materials/hma.html

Once the locations are determined, the Agency's inspector will mark out the location on the pavement, and the contractor will cut the core from that location. The contractor must take care when cutting the cores to avoid damaging them. Cores will then be safely transported to the Contractors lab for testing.

Spec 2303 explains the thickness requirement for cores.

IM 320 explains the proper sampling procedure for sampling compacted asphalt mixtures.

*This sample must be directed and witnessed by the Agency's Inspector. The contractor can take as many samples as they'd like for their own Quality Control, but only the directed and witnessed samples are used for Acceptance. The Agency's Inspector will supply the security items and complete the Form 193 if necessary.

Station | Select

RANDOM CORE SAMPLES version 2.00

*Use for PWL lots and test strips under PWL

For Class I Compaction, only the quantity within the 12.0 ft area is included for a PWL field voids lot

PROJECT	123	MAT THICKNESS	2.00	IN.
COURSE LAID	Surface	TRAVEL LANE(S) WIDTH	12.0	FT. <REQUIRED
		WIDTH OF PAVER UNIT	14.0	FT. <REQUIRED
DATE LAID		DATE CUT		

MAT					JOINT				
From STATION	To STATION	Length (L.F.)	Direction/ Lane	# MAT Cores	Longitudinal Joint Created? (None/Full/Partial)	From STATION	To STATION	Length (L.F.)	# JOINT Cores
1.00	5.00	400.00	NB	2	No Joint Created				0
400.00	410.00	1,000.00	SB	6	Partial (<1,000 ft) Joint Created	402.00	410.00	800.00	3
		0.00			No Joint Created				0
		0.00			No Joint Created				0
			Total Mat Cores =	8				Total Joint Cores =	3
			Total Length =	1,400.00				Total Length =	800.00
			Avg Sublot Size =	**175.000**				**Avg Sublot Size =**	**266.667**

<Enter this value in the coreworksheet_201

***If a joint is created today, the random locations will be marked for coring below.**

CORE # 1:	200.000	X	0.917	=	183.355	+ STA.	1.00	=	**STATION**	**2.83**	NB	
	12.0	X	0.712	=	**8.5**	**FT.**	(Offset)					
CORE # 2:	200.000	X	0.208	=	41.681	+ STA.	3.00	=	**STATION**	**3.42**	NB	
	12.0	X	0.494	=	**5.9**	**FT.**	(Offset)					
CORE # 3:	166.667	X	0.531	=	88.464	+ STA.	400.00	=	**STATION**	**400.88**	SB	
	12.0	X	0.488	=	**5.9**	**FT.**	(Offset)					
CORE # 4:	166.667	X	0.148	=	24.637	+ STA.	401.67	=	**STATION**	**401.91**	SB	
	12.0	X	0.970	=	**11.0**	**FT.**	(Offset)		11.0 FT. max			
CORE # 5:	166.667	X	0.424	=	70.699	+ STA.	403.33	=	**STATION**	**404.04**	SB	Joint Core # 1
	12.0	X	0.049	=	**1.0**	**FT.**	(Offset)		1 FT. min			
CORE # 6:	166.667	X	0.805	=	134.207	+ STA.	405.00	=	**STATION**	**406.34**	SB	Joint Core # 2
	12.0	X	0.474	=	**5.7**	**FT.**	(Offset)					
CORE # 7:	166.667	X	0.514	=	85.637	+ STA.	406.67	=	**STATION**	**407.52**	SB	
	12.0	X	0.359	=	**4.3**	**FT.**	(Offset)					
CORE # 8:	166.667	X	0.095	=	15.778	+ STA.	408.33	=	**STATION**	**408.49**	SB	Joint Core # 3
	12.0	X	0.532	=	**6.4**	**FT.**	(Offset)					

Sampling Compacted Pavement

Cutting cores

Agency's Inspector will use a template and mark out a 16" circle on the finished pavement.

A Density Gauge is not to be used to find the best place to cut a core! The core locations must be random.

Core Diameter

Specifications require the cores to have a 4” minimum diameter for cores taken from the travelling portion of the pavement, and a 6” minimum diameter for joint cores.

CUTTING AND CARE

- Core bits should be kept sharp
- Truck Mounted Core Drill typically used
- Water injection
- Take care not to damage when removing
- Drill will drill down to the tack coat, and then the core can generally be removed with a hard knock.

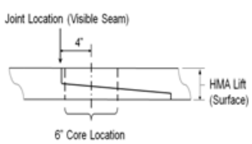
Cutting Joint Cores

- Place the drill in the proper location over the joint
- Location depends on the type of joint created
  - Notched Wedge Joint
  - Vertical (BUTT) Joint

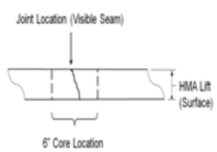
Proper placement ensures core contains approximately 50% of each side

Joint Core: Notched Wedge or Butt Joint?

NOTCHED WEDGE



BUTT JOINT



Cutting and Care

- If core cannot be removed with a hard knock, drill full-depth and the underlying layers will be removed in the lab
- Measure cores before trimming, to determine the thickness of the representative layer

Core Thickness Requirements

- Specifications Requires the cores cut from the travelling lane to be between 70% and 150% of the intended mat thickness in order to be valid samples.
  - Example: The plans call for a 2" lift
    Cores cut for that lift must be between 1.4" and 3"

Core Thickness Requirements

If core is too thick or too thin a replacement core must be cut. In this case do not cut from within the circle template, move away to an alternate location determined by the engineer (agency inspector).

Core Thickness Requirements for Joint Cores

- The thickness spec does not apply to joint cores.
- Joint cores are measured and tested regardless of their thickness.

Check the core for damage

- Damaged cores cannot be tested
- Typical damage
  - Cracks
  - A piece that has broken or fallen off
  - Denting or distortion caused by prying out of the hole

Damaged Cores

- If a core is damaged, a replacement core must be cut. If the thickness is okay, cut the replacement core from an alternate location (within the 16" circle if possible)
- Both the Contractor and Agency's inspector must agree that a core is a "good" core

Core Transportation

- Monitor will transport the cores to the contractor's lab
- Or, the monitor will secure the cores in a core box for the contractor to take to the lab
  - Transport on a hard, flat surface
  - If possible, use a core box obtained from the Central DOT offices
  - Cores should not be placed in a pail of water
  - Cores should not be placed in a cardboard box
  - Cores should NEVER be kept in a freezer
  - If it's a long trip, cores can be put in plastic bags and placed in a cooler with some ice to prevent them from getting too hot and falling apart

Back at the Lab

- Cores should be placed in front of fans and allowed to “air dry” before testing
- If the core has part of the old road or the lower lift still attached, the contractor will saw off the underlying layers (remember to measure thickness before doing that)
- Remove the tack coat. Only saw the tack coat off if necessary (sawing seals the surface of the core approximately 60%)
- Once dry and prepped, cores can be tested.

In Summary

- Must have “test-able” cores
  - Proper diameter
  - Proper thickness
  - No damage present
- Once cores are tested, the results stand. A core cannot be determined “damaged” after the fact just because the answer is off.
- Incentive / Disincentive payment is attached to the results of core testing. VERY important to ensure cores are treated VERY carefully.

6 TECHNICIAN DUTIES

TECHNICIAN DUTIES

The certified technician does not have the authority to modify the plans or specifications, to accept the work, or to act as any part of the contractor's regular production chain.

The duties of the technician depends upon who they work for, and what type of project they're on. For example, a Federal Aid project will have many more technician duties than a Local Project.

Being aware of your responsibilities requires:

-knowledge of the contract documents

-experience

-communication

The following table directs you to the appropriate IM's depending on who you work for.

Contractor	Agency
IM 511, App. A	IM 511, App. A
IM 508	IM 507
IM 213, App. D	CM App 3-4

Daily Check List (HMA)

Project No.: ______________________ Contract ID.: ______________________

	Stockpiles				Plant Equipment					Scale Sensitivity		Mix Control										
Date	Procedure	Intermingling	Contamination	Segregatlon	Interlocks	Delivery System	Storage Tanks	Screens	Weigh Belts	A M	P M	Aggr. Coatlng	Mixing Time	Temperatures	Truck Boxes	Truck Loading	Silo Operations	Hopper Gates	Silo Gates	Gate Settings	Aggr. Proportion	By:

HMA PLANT MONITOR CHECKLIST
Plant Calibration - Initial Startup

Project Number ____________________
Contractor ____________________
Plant Monitor ____________________
Date ____________________

#	Item	YES	NO
1	**HMA plant calibrated with supporting documentation** *Articles 2001.07, 2001.22; IM 508; C.M. 3.50*	☐	☐
2	**Contarctor Lab qualified with supporting documentation** *Articles 2520, 2521; IM 208*	☐	☐
3	**Contractor QMA Technicians possess proper certifications** *IM's 213, 511, C.M. Appendix 3-4*	☐	☐
4	**Contractor QM-A Technicians currentin IAP program** *IM 207*	☐	☐
5	**Contractor Lab using current version of SHADES/Plant Book software** *IM 511, Iowa DOT Website*	☐	☐
6	**Project Information (Project No., Mix Design, etc.) correct in Plant Book**	☐	☐
7	**Contractor Lab equipped to send reports electronically** *Articles 2520, 2521; IM 511*	☐	☐
8	**Agency Monitor has sample security supplies** *IM 205*	☐	☐
9	**Aggregate/RAM stockpiles properly identified** *IM 508*	☐	☐
10	**Aggregate/RAM stockpile locations stable and drainable** *IM 508*	☐	☐
11	**Bin Dividers installed to prevent aggregate intermingling** *IM 508*	☐	☐
12	**Each RAM source has separate totalizer** *Articles 2520, 2521; IM 511*	☐	☐

COMMENTS AND OBSERVATIONS

____

Project Monitor

HMA PLANT MONITOR CHECKLIST
Daily Plant Monitoring

Project Number ____________________
Contractor ____________________
Plant Monitor ____________________
Date ____________________

		YES	NO
1	Aggregate tickets indicate correct materials being used in mix design		
2	Asphalt binder tickets indicate proper source and correct PG grade		
3	Asphalt binder has correct anti-strip additive and dosage, if required		
4	QM-A Technician performing moisture tests on RAM products		
5	QM-A Technician providing daily dry RAM totalizer quantities		
6	Plant scales, gate settings checked/monitored		
7	Aggregate Stockpiles free of contamination, segregation, degradation		
8	Aggregate deliveries to correct stockpiles		
9	Loader operator working entire face of stockpile		
10	Loader tires/tracks not tracking mud into stockpile area		
11	Loader operator avoiding getting base material in load		
12	Loader operator assuring proper aggregate loadout into proper bin		
13	No contamination of aggregate on belt		
14	Proper loading of HMA trucks (multiple dump)		
15	Approved release agent used - NO DIESEL used as release agent		
16	Daily field cores sampled, secured, and tested		
17	Daily binder sampling witnessed and sample secured		
18	Cold feed aggregate sampling witnessed and secured (if required)		
19	Tank stick/flow meter witnessed periodically as required		
20	Daily plant report received and reviewed promptly		

COMMENTS AND OBSERVATIONS

____

Project Monitor

7 TESTING

TESTING MATERIALS ON A HOT MIX ASPHALT PROJECT

MATERIAL SAMPLED	TEST TO BE PERFORMED	MINIMUM TESTS / DAY RUN AT THE CONTRACTOR'S LAB
AGGREGATE		
BINDER		
UNCOMPACTED HMA		
COMPACTED HMA		

AGGREGATE TESTING

The cold-feed aggregate is normally tested once per day for gradation. In drum mix plants, both the aggregate and the RAP must also be tested every half day for moisture content.

The results of the moisture content test should be relayed to the plant operator immediately so that the plants setttings may be adjusted.

After running the aggregate gradation test, you should advise the contractor's Quality Control Manager of the results and record them in the plant report program. Compare results to the target gradation and to results from previous tests to see if there are inconsistent results that may mean a problem. The best way to compare test results is to transfer the test results to the charts. Both sudden changes and trends can be easily detected by observing the charts. Charting test results will be covered in detail in the reporting section of this training.

Lab No.:	grad 1-A
Original Dry Mass:	2,555.0
Dry Mass Washed:	2,451.0
Total Minus #4 (W1):	
Reduced Minus #4 (W2):	
Conversion Factor:	

Only use green colored cells when (Using Box & 8 in. Sieves).

Sieve Size	**Reduced Minus #4**	**Total or Calc Mass Retd.**	**% Retd.**	**% Passing**	**Reported Final**	**Composite % Psg.**	**Reported Final**	**Specs.**
1 ½ in.				100.0	100			
1 in.				100.0	100			100
¾ in.		15.4	0.6	99.4	99			90-100
½ in.		275.6	10.8	88.6	89			83-90
3/8 in.		325.5	12.7	75.9	76			76-90
#4		740.0	29.0	46.9	47			43-57
#8		456.0	17.8	29.1	29			23-35
#16		255.4	10.0	19.1	19			
#30		163.3	6.4	12.7	13			7-15
#50		130.5	5.1	7.6	7.6			
#100		55.7	2.2	5.4	5.4			
#200		30.5	1.2	4.2	4.2			2.0-5.3
Pan		3.3	4.2					
Wash		104.0						
Totals		2,555.2	100.0					
Tolerances		100.0						

Plant Moistures (Pan Dry)

Project No.: IMX-35-5(97)121--02-77 **Contract ID.:** 77-0355-097

Date	Material Type	Wet Wt. (Grams)	Dry Wt. (Grams)	Difference (Grams)	Moisture (%)	Remarks	By
10/21/13	cold-feed	2,105.2	2,025.5	79.7	**3.93%**		AW
10/21/13	RAP	1,262.3	1,198.5	63.8	**5.32%**		AW
10/22/13	cold-feed	2,256.0	2,159.5	96.5	**4.47%**		AW
10/22/13	RAP	1,212.3	1,135.2	77.1	**6.79%**		AW
10/22/13	cold-feed	2,098.3	2,010.2	88.1	**4.38%**		AW
10/22/13	RAP	1,129.5	1,058.9	70.6	**6.67%**		AW
10/23/13	cold-feed	2,323.6	2,248.5	75.1	**3.34%**		AW
10/23/13	RAP	1,258.3	1,185.2	73.1	**6.17%**		AW
10/24/13	cold-feed	2,121.5	2,055.6	65.9	**3.21%**		AW
10/24/13	RAP	1,188.1	1,119.5	68.6	**6.13%**		AW
10/24/13	cold-feed	2,255.2	2,202.0	53.2	**2.42%**		AW
10/24/13	RAP	1,098.0	1,031.0	67.0	**6.50%**		AW
10/25/13	cold-feed	2,316.4	2,265.2	51.2	**2.26%**		AW
10/25/13	RAP	1,144.5	1,088.2	56.3	**5.17%**		AW
10/25/13	cold-feed	2,289.1	2,232.3	56.8	**2.54%**		AW
10/25/13	RAP	1,215.2	1,155.2	60.0	**5.19%**		AW

BINDER TESTING

The samples of asphalt binder are not tested by the contractor. The equipment required to test asphalt binders is very expensive and delicate and is not well suited to a QC laboratory. The Iowa DOT has invested in the equipment and laboratory space to perform the testing on asphalt binders. The Dynamic Shear Rheometer (DSR) is used to test the stiffness of the asphalt binder samples in the District Lab. It is important that the correct grade of asphalt be used on the project to assure the best performance from the pavement.

SPECIFIC GRAVITY TESTING

On a hot mix asphalt project, several specific gravities will be measured or calculated: Gmm, Gmb, Core Densities

Before beginning to discuss the test procedures for specific gravity, let's explain exactly what specific gravity is.

Definition

- Ratio of mass/volume (density) of an object to the mass/volume (density) of water at the same temperature
- Unitless (units cancel)
- Essentially, how many times heavier or lighter than water is the object
- Used as a bridge between mass and volume of objects

Types

- Specific Gravity of Binder (1.00 to 1.05)
- Specific Gravity of Aggregate
- Specific Gravity of Mix

WHAT TO DO WITH THE HOT BOX SAMPLE?

The uncompacted HMA sample (the Hot Box) is brought in from the field, and will be used to determine maximum specific (G_{mm}) and bulk specific gravity (G_{mb}) through test procedures. The results of these test procedures will be put into calculations to determine air voids (P_a).

Before any testing of this hot box sample material can be done, the hot mix asphalt must be split and prepared for testing according to the following IM's.

SPLITTING

IM 357

SAMPLE PREPARATION

↙ ↓ ↘

G_{mm}	Gmb	Ignition Oven
IM 350	IM325G IM 321	IM 338

TESTING CORES

Cores drilled from the roadway are tested the same way as gyratory specimens. The Agency Inspector selects the locations and directs and witnesses the drilling of the cores. If a core appears to be too thin or too thick, it should be measured and if it is out of spec a replacement core should be drilled at a nearby location. If the core is damaged a replacement core should be drilled from the same location. The cores need to be carefully handled and transported to avoid any distortion or damage that may affect test results.

The Agency Inspector will test the cores individually in the contractor’s lab by obtaining the required three weights for each core before testing the next core. A copy of the results will be provided to the contractor’s certified technician to report on the Daily Plant Report. Sometimes cores must have lower lifts trimmed off by the contractor before testing. Cores should be measured, surface dried and examined for damage again before being tested.

The Daily Plant Report will analyze the test results and determine a Quality Index (Q.I.) for the core data set. If the QI produces a PWL that results in less than 100% pay, the computer will check for outliers (as per IM 501). Only one core may be considered an outlier in a single lot. If an outlier is identified, the Plant Report will recalculate the PWL with the results of the remaining cores and determine whether the PWL is improved. The Plant Report will then use the larger of the original and recalculated PWL to determine the pay factor.

At least once per project a set of cores needs to be submitted to the District Lab for Independent Assurance.

Flexible Paving Mixture Core Sampling and Testing Worksheet (version 1.02)

Plant Report Number: 5

Project Number: IMX-35-5(97)121--02-77 **Contract ID Number:** 77-0355-097 **Mix Design Number:** ABD23-1045

Lift: Surface **Intended Thickness:** 2.0 **Field Voids Limits** 3.5 - 8.5

Date Laid: 10/25/2023 **Date Tested:** 10/26/2023 **Sampled By:** Anderson (Jenkins) (Witness)

**As needed*

	Core # 1	Core # 2	Core # 3	Core # 4	Core # 5	Core # 6	Core # 7	Core # 8	*Core # 9	*Core # 10	*Core # 11	*Core # 12
Lane:	N\E Pass	N\E Pass	N\E Pass	N\E Pass	N\E Pass	N\E Pass	N\E Pass	N\E Pass				
Station:	295+55	325+62	362+45	388+66	400+25	428+32	455+89	480+55				
CL Offset:	1.00	5.10	6.40	10.30	4.60	2.60	10.30	5.10				
Dry Weight:	1091.70	882.90	949.70	956.30	912.20	881.50	916.30	1071.50				
Weight in Water:	620.10	505.90	547.50	552.10	530.20	509.40	525.60	612.40				
SSD Weight:	1092.30	883.70	950.50	956.70	912.90	882.00	917.00	1072.10				
Density	**2.312**	**2.337**	**2.357**	**2.364**	**2.384**	**2.366**	**2.341**	**2.331**				
Thickness:	2.250	1.875	2.125	2.125	2.000	1.875	2.000	2.250				

70% of Intended Thickness = 1.4 **150% of Intended Thickness =** 3.0

Comments:

Tested By: Mike Jenkins **Contractor:** Bob Anderson, Quality Asphalt Inc.

Flexible Paving Mixture Joint Core Sampling and Testing Worksheet (version 1.02)

Plant Report Number: 5

Project Number: IMX-35-5(97)121--02-77

Contract ID Number: 77-0355-097

Mix Design Number: ABD23-1045

*Only required on Surface Mainline

Lift: Surface

Intended Thickness: 2.00

Date Laid: 10/25/2023

Date Tested: 10/26/2023

Sampled By: \nderson (Jenkins) (Witness)

	Joint Core # 1	Joint Core # 2	Joint Core # 3
Sublot Length (From Random Core Sheet)	6,317	6,317	6,317
Joint ID:	4L-NB\EB Centerline	4L-NB\EB Centerline	4L-NB\EB Centerline
Station:	325+62	388+66	455+89+
Joint Geometry (Butt/Wedge):	Notch	Notch	Notch

Dry Weight:	1025.00	950.00	910.00
Weight in Water:	555.00	525.00	501.00
SSD Weight:	1026.00	951.00	911.00
	2.176	2.230	2.220
Thickness:	2.13	2.25	2.25

70% of Intended Thickness = 1.4

150% of Intended Thickness = 3

Comments:

Tested By:

Contractor:

VALIDATION OF TEST RESULTS

Validating the contractor’s test results is a very important part of the QC/QA process. On a daily basis the contractors (QC) are running several tests on their material. These test results are submitted to the engineer on a daily basis. On a less frequent basis, sometimes weekly or more, the project owner (city, county, state: QA) is running tests on split or paired verification samples. These are tests on the same material that the contractor has tested. In a perfect situation, the QC and QA test will produce the exact same result. Since it is not a perfect situation, tolerances are allowed between the test results. If the QC test and the QA test are within this tolerance, everything is good and the contractor’s quality control processes are assumed to be working. If the two tests do not correlate, something must be done to determine what went wrong. If the owner is unable to validate the contractor’s test results, then the contractor’s results cannot be used to accept the material. When this happens, only the owners test results are used to judge the quality and determine payment.

IM 216

IM 511, VALIDATION

HMA Chart 11-01 Rpt4 - Excel

AV36 =IF(ISERROR(MATCH(B36,Data!$BM$3:$BM$500,0)),"",LEFT(OFFSET(Data!$LC$2,MATCH(B36,Data!$BM$3:$BM$500,0),0),SEARCH("/",OFFSET(Data!$LC$2,MATCH(

				LAB DENSITY (G_{mb})									RICE (G_{mm})										LAB
Lot	Rpt #	ID/Station	Date	Correction Factor (DME Use Only)	DOT G_{mb}	CON G_{mb}	Diff	IM 216 (± 0.02)	IM 511 5,C,1,a &b	IM 511 5,C,1,c	Daily Result Used	Prevail G_{mb}	Correction Factor (DME Use Only)	DOT G_{mm}	CON G_{mm}	Diff	IM 216 (± 0.01)	IM 511 5,C,1, a&b	IM 511 5,C,1,c	Daily Result Used	Prevail G_{mm}	Contractor Gyratory Serial	DOT Pa
1	1	IN10-21A/74+15/D	10/21/16		2.439	2.422	-0.017	In	In	In	CON	2.422		2.515	2.508	-0.007	In	In	In	CON	2.508	SP1-0234	3.0
1	1	IN10-21B/77+45/D	10/21/16			2.432			In	In	CON	2.432			2.521			In	In	CON	2.521	SP1-0234	
1	1	IN10-21C/81+10/D	10/21/16			2.439			In	In	CON	2.439			2.504			In	In	CON	2.504	SP1-0234	
2	2	IN10-22A/228+15/	10/22/16			2.416			In	In	CON	2.416			2.513			In	In	CON	2.513	SP1-0234	
2	2	IN10-22B/241+00/	10/22/16			2.416			In	In	CON	2.416			2.516			In	In	CON	2.516	SP1-0234	
2	2	IN10-22C/275+00/	10/22/16			2.421			In	In	CON	2.421			2.506			In	In	CON	2.506	SP1-0234	
2	2	IN10-22D/315+00/	10/22/16		2.422	2.424	0.002	In	In	In	CON	2.424		2.516	2.510	-0.006	In	In	In	CON	2.510	SP1-0234	3.7
2	3	IN10-23A/325+00/	10/23/16			2.415			In	In	CON	2.415			2.509			In	In	CON	2.509	SP1-0234	
2	3	IN10-23B/363+00/	10/23/16		2.437	2.421	-0.016	In	In	In	CON	2.421		2.513	2.511	-0.002	In	In	In	CON	2.511	SP1-0234	3.0
2	3	IN10-23C/395+00/	10/23/16			2.424			In	In	CON	2.424			2.509			In	In	CON	2.509	SP1-0234	
2	3	IN10-23D/447+00/	10/23/16			2.419			In	In	CON	2.419			2.513			In	In	CON	2.513	SP1-0234	
2	4	IN10-24A/78+00/N	10/24/16			2.422			In	In	CON	2.422			2.522			In	In	CON	2.522	SP1-0234	
2	4	IN10-24B/159+00/	10/24/16		2.433	2.436	0.003	In	In	In	CON	2.436		2.533	2.522	-0.011	Out	In	In	CON	2.522	SP1-0234	3.9
2	4	IN10-24C/228+00/	10/24/16			2.420			In	In	CON	2.420			2.528			In	In	CON	2.528	SP1-0234	
2	4	IN10-24D/276+00/	10/24/16			2.423			In	In	CON	2.423			2.515			In	In	CON	2.515	SP1-0234	

INDEPENDENT ASSURANCE

Independent Assurance (IA) is another requirement that is part of the HMA sampling and testing program. IA is a check on sampling and testing procedures that is performed by personnel and equipment not used in the QC/Verification testing. There are several ways that IA can be accomplished to satisfy the FHWA requirements. Proficiency samples are one common method. Proficiency samples are a group of samples as nearly identical as possible that are distributed to the testing labs on a regular basis for testing. The test results from all the labs testing the same material are then grouped together and analyzed statistically. The Iowa DOT has used an internal proficiency sample testing program for many years to satisfy our IA requirements. This program has been extended to include contractors for HMA and gradation testing.

IM 205, 207 and 208 contain the details of the Independent Assurance Program. Basically, it requires certified technicians who perform QM-A testing to obtain a proficiency sample from the District Materials Office in April or when they begin their first project of the year. Additional proficiency samples should be obtained approximately every three months after that. The intent is that all contractor's technicians involved in QM-A testing for the entire season will test three proficiency samples per year. Those involved in only one project or just part of the season will need to test only one or two proficiency samples per year. **All technicians performing testing on projects must test at least one proficiency sample per year.** Those certified HMA Level I technicians who do not perform any QM-A testing do not need to participate in the proficiency sample testing program.

Instructions will accompany the samples, and an Excel spreadsheet has been programmed to gather and report the test data. The Excel file or a copy of the report needs to be sent to the Central Materials Laboratory, where the data will be analyzed and reported back to the participating technicians. Each technician will be graded on their performance based on either how close their results were to the overall average or, if there are only a few results or the standard deviation is unusually small, how close their results were to the Central Lab results. Technicians will receive a failing grade if their results are more than three standard deviations from the mean or if their results on two consecutive samples are more than two standard deviations from the mean. Failing results indicate that the technician should review equipment calibrations and test procedures. If the technician receives two failing results in a row the District Materials Office will review the technicians work. If the technician receives more than three failing test results in a row an unsatisfactory performance letter will be issued and placed in the technicians file. It is highly unlikely that a technician who follows the test procedures and has properly calibrated equipment will receive consecutive failing grades.

Failure to test and report proficiency sample test results as required may also result in an unsatisfactory performance letter being placed in the certified technicians file.

The agency's technician who tests the cores must also be included in the independent assurance program. This will be handled simply by submitting one set of cores per project to the District Lab for correlation. Agency labs that test aggregate (RCE, County or consultant) will be checked on aggregate split samples.

Sampling of mixtures, binders and aggregates is also covered by the independent assurance program. The District Materials Office will observe the mixture sampling procedures on all projects over 5000 tons and may also observe the binder and aggregate sampling. A checklist is available for use when observing sampling procedures and is filed with the IAP report.

Iowa Department of Transportation
Office of Materials

HMA Independent Assurance Program
Data Report Form

Return this form to Central Materials

Certification Number: ______________________

Sample Number: ______________________

Employer: ______________________

Lab Location: ______________________

Technician: ______________________

Home Address: ______________________

____

Phone: ______________________

Date Received: ______________________

Gyratory Information:

Manufacturer: ______________________

Model: ______________________

Serial Number: ______________________

Years in Service: ______________________

Date of last Full Calibration[1]: ____________

Method of Angle Verification, check applicable.

☐ Internal ☐ External

Test Results:

Date of Testing:

Gmm: ____________________

Gmb: ____________________

Measured Value:

Gmm: ____________________

Gmb[2]:

@ N = _____:____________________

@ N = _____:____________________

@ N = _____:____________________

Gradation: ____________________

Gradation (% Passing)

37.5mm	25.0mm	19.0mm	12.5mm	9.50mm	4.75mm	2.36mm	1.18mm	600µm	300µm	150µm	75µm

Comments: ____

____

____

____

[1]Full calibration includes height, angle, and pressure.
[2]Mean of results.

A Copy of this Worksheet should be retained by the technician for their records.

Sample No.	
Certification No.	
Tech. Name:	
Gmm Test Date	
Gmb Test Date	
Grad. Test Date	

Only yellow cells need to be filled in.

RICE (G_{mm}):	
Pycnometer #	
Water Temp. (°F)	
Sample Wt. (g)	
Wt. pyc & H_2O (g)	
Wt. pyc & H_2O & Sample (g)	
Gmm:	

Bulk Density (G_{mb})		
	Specimen # 1	Specimen # 2
Water Temp. (°F)		
Dry Weight (g)		
Weight under water (g)		
SSD Weight (g)		
G_{mb} @ N_{max}:		
Average:		

Gyratory						
	N_{inital}	N_{design}	N_{max}	Sample Weight (g)	Gmb @ Ninitial	Gmb @ Ndesign
Gyrations						
	Specimen # 1					
Height (mm)»»						
	Specimen # 2					
Height (mm)»»						
				Average:		

Gradation	
Orig. Dry Mass:	
Dry Mass Washed:	
Total Minus 4.75mm (W1):	
Reduced Minus 4.75mm (W2):	
Conversion Factor:	

Only use light blue colored cells when using Box & 203mm (8in.) Sieves.

Sieve Size		Reduced Minus 4.75	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final
1 1/2"	37.5mm					
1.0"	25.0mm					
3/4"	19.0mm					
1/2"	12.5mm					
3/8"	9.50mm					
# 4	4.75mm					
# 8	2.36mm					
# 16	1.18mm					
# 30	600 µm					
# 50	300 µm					
# 100	150 µm					
# 200	75 µm					
Pan						
Wash						
Totals						
Tolerances						

A Copy of this Worksheet should be retained by the technician for their records.

HMA Paving Independent Assurance Worksheet

☐ Surface ☐ Intermediate ☐ Base ☐ Shoulders ☐ Base Widening

Project #: ______________________ **Page #** ________

County: ______________________ **Contract ID:** ________

Contractor: ______________________

Plant Location: ______________________

Date	Lift Type	Mix ID	Approx. Job Totals	Notes

Witnessed Lab Testing Procedures of the Contractor

Gyratory	Rice	Gradation

Comments: ______________________

HMA Sample **IAP by:** ____________ Cert# ________ **Contractor IAP Sample #**

Contractor ____________ Cert # ________

Monitor ____________ Cert # ________

Binder Sample **IAP by:** ____________ Cert# ________ **Contractor IAP Sample #**

Contractor ____________ Cert # ________

Monitor ____________ Cert # ________

Gradation Sample **IAP by:** ____________ Cert# ________ **Contractor IAP Sample #**

Contractor ____________ Cert# ________

Monitor ____________ Cert# ________

Core Densities **IAP by:** ____________ Cert# ________ **Comments**

Contractor ____________ Cert# ________

Monitor ____________ Cert# ________

	Aggregate Type	Source	Beds	Sample ID	Sample Date
1					
2					
3					
4					
5					

	Binder Source	Binder Grade	Sample ID	Sample Date
1				
2				
3				
4				
5				

8 CALCULATIONS

CALCULATIONS

Remember there are several important specification items that are needed to ensure that the hot mix asphalt produced is "good". Some of these are tested, such as G_{mm} and G_{mb}. Some of these are calculated using information about the mix and the project. Many of these calculations cannot be completed until the end of the day after the plant shuts down.

ITEMS THAT NEED TO BE CALCULATED…………………….

Related to Asphalt Binder

P_b (added)

Total P_b

Related to the mix:

Laboratory Air Voids (P_a)

Film Thickness

% of Gmm

Field Voids (P_a)

Statistical Functions on a PWL Project:

Quality Index (QI)

→Percent Within Limits (PWL)

→Pay Factor

Statistical Functions on a PWL project with less than 8 test results:

Average Absolute Deviation (AAD)

Statistical Functions on a PWL project, non-mainline paving:

Moving Average Absolute Deviation (Moving AAD)

HOT MIX ASPHALT BASIC CALCULATIONS

1 Calculate the asphalt binder content P_b given the following:

Aggregate = 4536.87 tons
Asphalt Binder = 224.59 tons
Total Mix = 4761.46 tons

2 For a mix with RAP, calculate the total asphalt binder content (Total P_b) given the following:

P_b added = 4.72%
% RAP in the mix = 9.27%
P_b(rap) = 5.62%

3 Calculate % of G_{mm} for Core #1 given the following:

G_{mb} (lot avg for lab specimens)= 2.388
G_{mb} (Core #1) = 2.315
G_{mm} = 2.477 (lot avg)
G_{sb} = 2.598

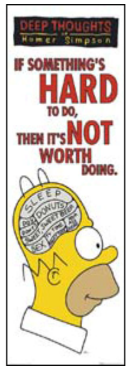
4 Calculate the Percent Field Voids for Core #1 in problem 3:

5 Calculate the Film Thickness given the following:

P_{be} = 3.98 %
SA = 4.2

Statistically Based Specifications

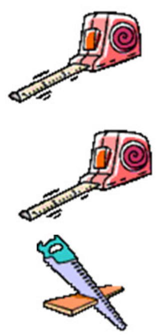
- Statistics are a Tool
- Right Tool for the Job



1

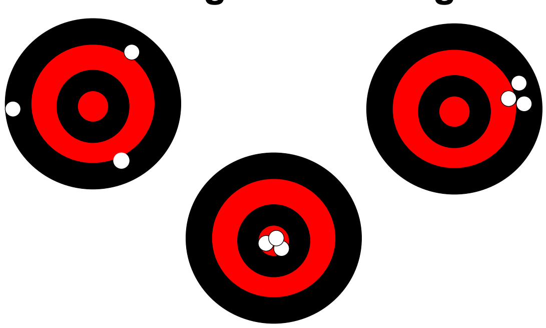
What is a Statistically Based Specification

- Statistic is a Measurement
  - Length
  - Width
  - Weight
- Carpenters are Believers of Statistics
  - Measure 2, Cut 1
- Decisions Based on Measurements



2

Average vs On Target



3

STATISTICS

- Mean & Standard Deviation
- Mean is the Average of the Measurements
- Standard Deviation is a Measurement of the Spread of the Data

4

MEAN - AVERAGE

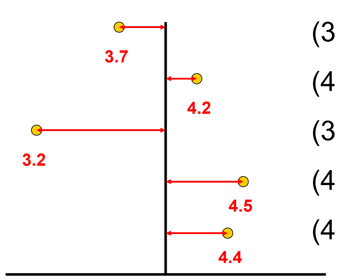
$$\bar{X} = \frac{\Sigma X_i}{n}$$

$$\bar{X} = \frac{3.7+4.2+3.2+4.5+4.4}{5}$$

$$\bar{X} = 4.0$$

5

STANDARD DEVIATION



$(3.7 - 4.0)^2 = 0.09$

$(4.2 – 4.0)^2 = 0.04$

$(3.2 – 4.0)^2 = 0.64$

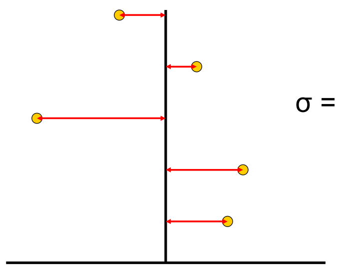
$(4.5 – 4.0)^2 = 0.25$

$(4.4 – 4.0)^2 = 0.16$

$\bar{X} = 4.0$ Σ 1.18

6

STANDARD DEVIATION



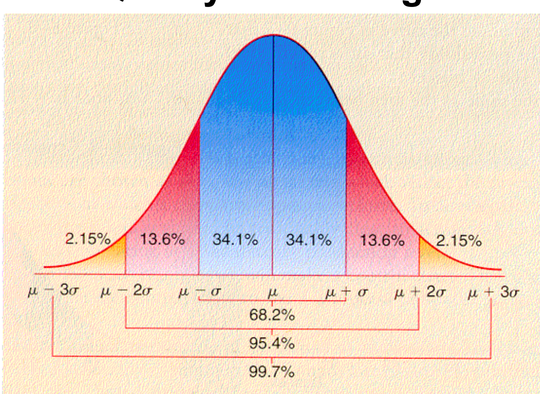
$$\sigma = \sqrt{\frac{1.18}{5-1}}$$

$\sigma = 0.54$

$\overline{X} = 4.0$

7

σ = Quality Measuring Stick



8

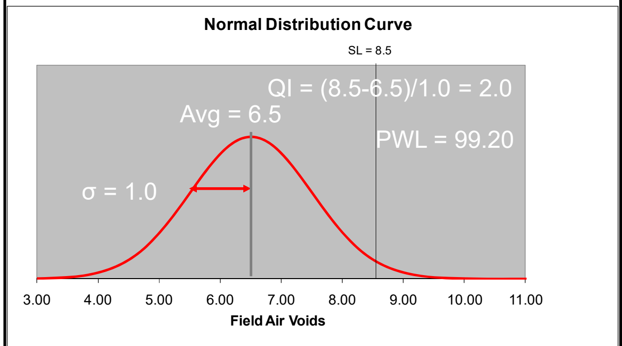
PWL & QI

$$QI = \frac{\text{Average} - \text{Specification Limit}}{\text{Standard Deviation}}$$

Percent Within Limits (PWL) uses the properties of the distribution curve to estimate the percent of the material within the specifications from the QI (Quality Index)

9

PWL



10

What does this have to do with HMA Sampling & Testing???

- Quality of Product
  - Does it meet customers expectations
- Measurable Quality
  - Meet desired engineering properties
- Measure Average and Variation
  - Recognize variation part of the real world

11

What Can Be Done

- Measure what we want – Voids
  - Base Field Voids On Gmm
- PWL Acceptance
- Incentive & Disincentive
  - Make Quality Pay
- Use Historic Data to Establish Limits
- Target a Fair Pay Factor

12

Example PWL & Pay Factor

- Determine the Statistics of the Lot
  - Mean, Standard Deviation
- Determine the QI
- Determine the PWL
- Determine the Pay Factor for the Lot

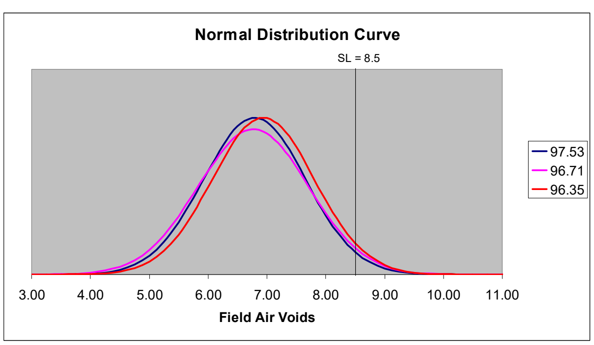
13

Field Voids PWL

- Based on %Gmm
- PWL of 90 = 100% Pay
- Incentive if over 90 PWL
- Disincentive if less than 90 PWL
- Maximum of 106% Pay Factor – Mix Price
- Lot Size
  - A Lot still a Day
  - 8 Cores in Day
  - May request more cores

14

Industry Average for Field Voids



15

Lab Voids PWL

- PWL of 90 = 100% Pay
- Incentive over 90% PWL
- Maximum of 106% Pay Factor- Mix Price
- Lot Size
  - Minimum lot size of 8
  - Start new lot after 15 tests
  - Do not break lots in the middle of a day

16

Acceptance Methods

	0 – 1000 Tons	If Less Than 8 Total Tests or Intermittent Placement	If 8 or More Total Tests
Lab Voids	Small Quantity	AAD*	>90 PWL* 106% Max
Field Voids	Small Quantity	>90 PWL 106% Max	>90 PWL* 106% Max
Film Thickness	Small Quantity	No Change 8.0 Min	No Change 8.0 Min

* Special Rules for Test Strip and Low Tonnage

17

Hot Mix Asphalt Statistical Calculations

1. Calculate the Lab Voids pay factor given a PWL of 96.5

2. Calculate the Field Voids pay factor given a PWL of 78.8

3. Given five lab voids (Pa) for an entire bid item as follows: 3.5%, 3.2%, 3.9%, 4.2%, 3.4% and a target voids of 3.5%, what is the Average Absolute Deviation from target (AAD):

4. Calculate the latest moving AAD given the following individual deviations from target: 0.2, 0.5, 0.4, 0.5, 0.3, 0.4

PAY FACTORS

The Specifications now contain several methods for determining payment to the contractor based on the type of work, the quantity and the number of tests performed. PWL is the method used when significant quantities of main-line paving are evaluated. For other types of placement and small quantities other methods of determining payment are used.

For bid items of 1000 tons (Mg) or less, all patching bid items, detour pavements and temporary pavements, payment is made at the contract unit price for all work that is properly certified by the Contractor and accepted by the Engineer. This is called the “Small Quantities” specification and is found in Section 2303.03,E. For all other bid items with contract quantities greater than 1000 tons (Mg), payment is determined by several possible methods.

Field Voids Pay Factors

Section 2303.03,D,6,b,1),d),(1) defines several types of bid items that are not suitable for PWL analysis. For those bid items, The Engineer has the option to accept the field voids based on 8% maximum field voids or the Engineer may approve an established effective rolling pattern for the Contractor to use. If the Engineer requires cores and applies the 8% maximum field voids specification, payment is based on the schedule in Section 2303.05,A,3,b,3. If the approved rolling pattern is used or Class II compaction is specified, payment is made at the contract unit price provided the compaction is thorough and effective.

For all other bid items, PWL is used to determine payment for field voids except for approved test strips. The specifications require test strips for certain mixtures on Primary and Interstate highways. The Contractor may request test strips for other mixtures and placements. Test strips are accepted based on the average field voids. The pay schedule for test strips is found in section 2303.05,A,3,b,2.

When the placement is not a test strip, PWL is determined for each lot based on the percent of Gmm determined from cores. Payment is based on the schedule in Section 2303.05,A,3,b,1 or the pay schedule in the Local Systems Specification. If the determined pay factor is less than 1, the core data is examined to determine if there is an outlier. If an outlier is identified, the outlier core is eliminated from the PWL analysis and payment is based on the PWL calculated from the remaining cores.

Lab Voids Pay Factors

Section 2303.03,D,6,a,1),a) identifies several types of bid items that are not suitable for Lab Voids PWL analysis. There are specific bid items identified in the specification, however the basic rule is that bid items that are not placed in the travel lanes of a permanent pavement are excluded from PWL analysis. Local System projects that do not use Federal funding may also be excluded from Lab Voids PWL in the contract documents. For these types of bid items, a moving AAD is calculated but payment is based on the contract unit price. The moving AAD is used as a quality control tool but does not affect payment. If the moving AAD value exceeds 1, the Contractor must cease operations and consult with the Engineer about adjustments to bring the mixture into compliance before any more placement is allowed.

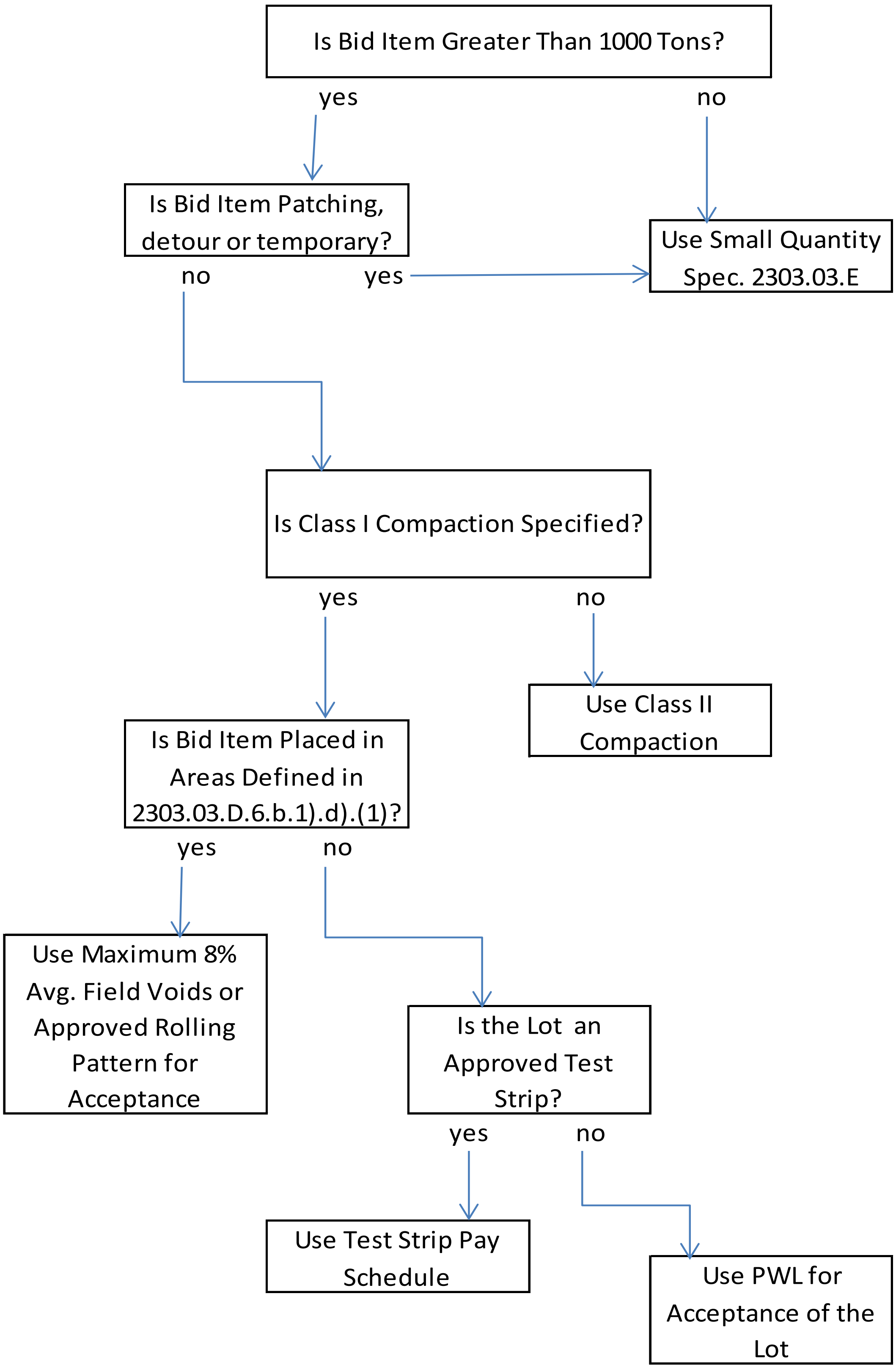
For all other bid items, PWL is used to determine payment for Lab Voids with three exceptions. Just like field voids, test strips have their own pay schedule for lab voids. Section 2303.05,A,3,a,3 contains the Lab Voids pay factors for test strips based on the calculated AAD of the Lab Voids from all the tests performed on the test strip lot.

The other two situations where PWL is not used even though the bid item requires it are irregular production and placement and insufficient test data. Section 2303.03,D,6,a,2) defines what is considered irregular production and placement. Any lot that meets that definition is paid for based on the AAD calculated for that lot. The AAD is also used to determine the pay factors for lots that do not have the minimum of eight test results. When AAD is used to determine pay factors, the schedule in 2303.05,A,3,a,2 is used.

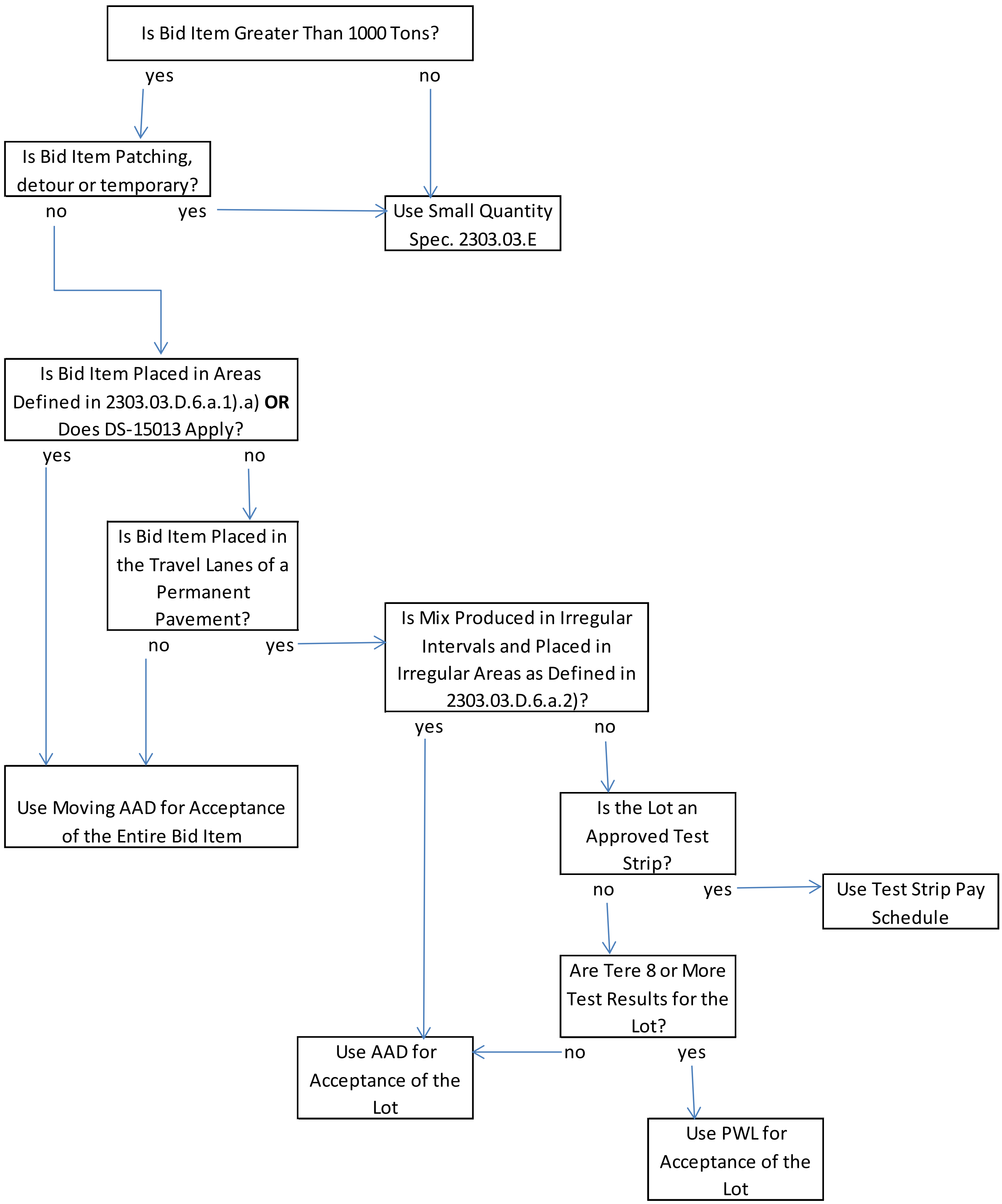
For all other lots, PWL is calculated based on eight to fifteen test results grouped together. The pay schedule in Section 2303.05,A,3,a,1 is used to calculate the pay factor for Lab Voids when PWL applies.

The Plant Report and Charting software will calculate the correct pay factors for both Field Voids and Lab Voids provided that the bid items and lots are identified correctly.

FIELD VOIDS ACCEPTANCE FLOW-CHART
FOR INTERSTATE, PRIMARY AND OTHER PROJECTS



LAB VOIDS ACCEPTANCE FLOW-CHART
FOR INTERSTATE, PRIMARY AND OTHER PROJECTS



HOT MIX ASPHALT CALCULATIONS
extra practice problems

Answers

1 Calculate G_{mm} given the following:

W = 2019.4 grams

W_1 = 6064.5 grams

W_2 = 7246.5 grams

R = 1.000

G_{mm} =2.412

2 Calculate Gmb given the following:

W1 = 4804.2 grams

W2 = 2734.5 grams

W3 = 4807.6 grams

G_{mb} = 2.317

3 Calculate P_a (lab voids) given the following:

G_{mm} = 2.425

G_{mb} = 2.314

P_a = 4.6%

4 Calculate the asphalt binder content P_b given the following:

Aggregate = 13,200 tons

Asphalt Binder = 800 tons

Total Mix = 14,000 tons

P_b = 5.71%

5 Calculate % of G_{mm} for Core #1 given the following:

G_{mb} (lot avg for lab specimens = 2.405

G_{mb} (Core #1) = 2.355

G_{mm} = 2.466 (lot avg)

G_{sb} = 2.435

%G_{mm} = 95.5

6 Calculate the Percent Field Voids for Core #1 in problem 5:

% Field Voids = 4.5%

7 Calculate the Film Thickness given the following:
P_{be} = 3.95 %
SA = 4.2

Film Thickness = 9.40

8 Calculate the Field Voids pay factor given a PWL of 96.6 *PF = 1.040*

9 Calculate the Lab Voids pay factor given a PWL of 78.0 *PF = 0.925*

10 Given five lab voids (Pa) for an entire bid item as follows: 3.5%, 4.1%, 4.5%, 3.8%, 4.0% and a target voids of 4.0%, what is the Average Absolute Deviation from target (AAD):

AAD = 0.3

11 Calculate the latest moving AAD given the following individual deviations from target:
0.2, 0.4, 0.4, 0.5, 0.3, 0.2

Moving AAD = 0.4

9 COMPUTER PROGRAMS

HMA COMPUTER PROGRAM OUTLINE

HMA Plant Report	The HMA Plant Report is an Excel file that has been designed to gather daily test data, calculate test results, and produce a daily report of the project data. This daily report is then available to provide data to other Excel files, such as the Charting Program, where the data is accumulated and the pay is calculated. The Plant Report is kept and filled out by the **Contractor.**
HMA Daily Field Report	The Daily Field Report (DFR) is an Excel file that has been designed to gather field data, such as stationing, sample locations, and quantities. The DFR is kept and filled out by the **Agency Inspector.** The DFR is intended to be emailed to the contractor in a timely manner, so that the contractor can import the file into the Daily Plant Report.
HMA Chart	The HMA Chart is an Excel spreadsheet program designed to accumulate all the data generated from the Plant Report and the Daily Field Report programs. Incentive and disincentive for field voids, lab voids, joint density and film thickness are calculated whenever a Plant Report is imported. Comparison of contractor's to DOT test results is also performed for validation and verification purposes. The HMA Chart is kept and filled out by the **Contractor.** The Agency Engineer will also keep and fill out a copy of the HMA Chart for their records and for comparison/verification of the Contractor's Chart.

THE PLANT REPORT PROGRAM

The daily record of what is happening on the project goes on the Daily HMA Plant Report, which is kept and filled out by the contractor. The plant report must be on the computer-generated form provided by the Central Materials Office. It is important that the contractor is using the current version of the daily plant report. It can be found at:

http://www.iowadot.gov/Construction_Materials/hma.html

The Iowa DOT Plant Report Program is an Excel file that has been designed to gather daily test data, calculate test results and produce a daily report of the project data. This daily report is then available to provide data to other Excel files, such as the Charting Program where the data is accumulated and the pay is calculated.

This report is seen by the District Materials Engineer, the Resident Engineer, and the Central Offices to keep them aware of what is happening on a daily basis.

A copy of the daily file must be-mailed to the District Materials Office and the Resident Engineer within four hours after the start-up of the plant on the next working day. If DOC Express is being used on the project, the completed file must be placed in the appropriate drawer within this same 4 hour requirement. When a project is completed, the plant inspector shall check all documentation for accuracy and completion. Furnish copies of all required documentation to the RCE and DME.

Setting Up the "Shell" File

To use the Plant Report Program, the first thing normally done is to import the mix design file from the program called SHADES. SHADES is another Excel file that the mix designer uses to document the job mix formula (JMF). The mix design information such as the aggregates and target percentages as well as some basic project information is automatically populated on the input tab screen. The RAM information appears on the RAM tab. If necessary, the JMF data can be entered manually, but it is easier to import the data.

Once the basic JMA data has been imported the rest of the project data must be entered. The input tab screen requires that the route type and the letting date be entered so the correct specifications will be applied. If SUDAS or Local System specifications are to be used they are also selected on this screen. Complete as much as possible on the input screen. Only the date and expected tonnage for the day are entries that will change daily. If the information is provided on the plans, the mileage summary on the Placement Record tab should also be completed. Save this file as a generic "Shell" file, that can be opened each day of the project.

Entering the Daily Data

Each day of the project the "Shell" file can be opened and saved under a unique name, usually the mix and date or report number. Daily data will be entered in that daily file. Once all the project data has been entered the file can be "checked" to look for errors. Click the "check" button on the Report tab. If the check is successful the Charting program can then input the daily data and calculate pay.

The first thing a Contractor's certified technician would do before beginning a project is prepare the computer program to input daily data. This is called the **HMA Plant Report** (an excel file).

Step 1) Open up the HMA Plant Report on your computer

Step 2) Enable macros if necessary

Step 3) Import Data. We are going to import from SHADES, not from a prior plant report. The Import from Shades button is ½ way down on the right side, in the section called Mixture Information.

Step 4) As you can see, not all of the data came in from the mix design. Some is based on the plans or contract, and some is regarding personnel. You'll have to type in the information in the red blanks that didn't get imported. Some of these blanks will have drop down arrows that you will use.

Todays Date:	Please leave this blank for now
Expected Tonnage:	Please leave this blank for now
Lane Dir:	Both
Route:	Select 35
Ending Mile Post	74.70
Begin Sta:	70+00
End Sta:	582+00
Route Type:	Select interstate
Letting Date:	Select 10/17/23
Plant Type	Pull down menu – select Portable
Plant Location	Hallett's NDM Pit
Expected Tons from Silo:	Please leave this blank for now
Certified Technicians Name	*put your name here*
Cert No.	CI123
Certified Technicians Name	*There are always 2 people in an HMA lab, the 2nd persons info goes here.*
Cert No.	SW123
Cold Feed Sampled by:	Select one
Cold Feed Tested by:	Select one
Cold Feed Sampling Location:	Streamflow
Gyratory Compactor Serial #:	12345ABCDE
Design Gyrations:	95
Binder Grade Used Today:	Select 58-28V
Mix Being Produced	HMA VT Surface, L-2, 1/2

Tank Tab:

Scroll down to the section called "Distribution of Today's mix".
Select Bid Item using the drop down arrow: 2303-1053502 (HMA VT SURF, ½", FRIC L-2)
Now scroll across this line and enter the plant report number. This is the 5th day of the project, so the plant report number is 5.

Placement Record Tab:

Scroll down to the section called Mileage Summary. Input the following information (which comes off the plans):

MILEAGE SUMMARY (FOUND ON PLANS TAB 105-1) map)

Entry #	Division	From/Back Station	To/Ahead Station	Description	Lin. Ft.	Mile Post
1	1	70+00	336+12	Mainline	26,612.00	65.00
2	1	336+12	337+55	Bridge	143.00	70.0402
3	1	337+55	582+00	Mainline	24,445.00	70.0672
4					0.00	
5					0.00	

Report Tab: This is the one page summary of all the information that will get turned in daily to the engineer. On the top of the report, in red:

Select the active project # IMX-35-5(97)121—02-77
Select the active bid item 2303-1053502 VT SURF ½ IN L-2 (HMA)

Congratulations! You've now completed what we call the "Shell file". This is the general project information that does not change from day to day. The contactor would save this "Shell File" and pull it up every day, rename it, and put in the days project information.

We are now working on day 5 of this Project, and need to start putting in daily data on our shell file. Input the following information.

Input Tab:

Date: 10/25/2023
Expected Tons Produced Today 4900

Today the contractor is changing the target binder content. They're having a problem with air voids. Change the following values to reflect the new target:

Intended added % binder Change to 4.55
% Total Binder Change to 5.00

Stop, Take a Break, Wait for Further Instruction

Grad 1 Tab Input the following Test Data:

Lab No.	CF10-25A	← don't forget sample ID
Orig. Dry Mass:		1,921.5
Dry Mass Washed:		1,825.2
Total Minus #4 (W1):		
Reduced Minus #4 (W2):		
Conversion Factor:		
Sieve Size	Reduced Minus #4	Total or Calc Mass Retd.
1 1/2 in.		
1 in.		
3/4 in.		
1/2 in.		95.5
3/8 in.		216.3
#4		715.1
#8		297.6
#16		201.6
#30		132.8
#50		104.2
#100		50.8
#200		15.2
Pan		2.1

Fill in the remaining two blanks on this page with the following:

Tons when sampled	250
Sample Type:	Cold Feed

Questions:

Does it appear that the gradation meets specifications? ______________

You can't tell yet if it really meets gradation specs because the cold feed has not been combined with the gradation from the RAP. You'll need to look at this again later to see how the RAP modifies the resultant gradation.

Gyratory Tab: This is the tab for all of the G_{mm} and G_{mb} lab data. Today there are 5 sublots, so there are 5 hotboxes to be tested. We have already put in the data for the first 4 boxes today, it is your job to put in the data for box #5.

G_{mb} Data			
		Test E	
		SU10-25E	
	Compaction Temp	275	275
	Specimen ID No.	I	J
	W1, Mass in Air	4725.2	4728.9
	W2, Mass in Water	2775.3	2777.4
	W3, Mass SSD	4728.2	4730.2
	Gyratory Height, Nde	115.4	115.9

G_{mm} Data		
	Mass, Container & Sample	5345.5
	Mass, Container	3258.4
	W, Sample Mass	2087.1
	W1, Mass Pyc & H_20 @ Test Temp	7483.5
	W2, Mass Pyc & Water & Sample	8740.9
	Test Temperature of Water	77
	R Multiplier (chart)	1

Questions:

What are the values calculated for each sublot air voids (Pa)? You can find these right below the $G_{mm's}$ of each hotbox.

First Sublot Pa __________

2nd Sublot Pa __________

3rd Sublot Pa __________

4th Sublot Pa __________

5th Sublot Pa __________

Do any of these air voids fall outside of the allowed specification range?

Yes or No __________

Cores Tab: The Agency tested the cores and has filled out the electronic core worksheet. Import this worksheet into the Daily Plant Report by selecting "Import from Core Worksheet"

You will be asked to find the file, it is in the HMA Level I Folder on the desktop, called "10-25-2023 Core Worksheet Complete"

Select the Project Number/Bid Item for all 8 mat cores and the 3 joint cores.

Questions:

Do all of the cores meet the thickness requirement? ________________

Stop, Take a Break, Wait for Further Instruction

THE DAILY FIELD REPORT (DFR) PROGRAM

The daily record of field operations is recorded on the Daily Field Report (DFR), which is **kept and filled out by the Agency inspector**. Information such as stationing, uncompacted sample locations, compacted sample location and quantities are recorded on this report. The DFR also generates the random locations for the location of field cores.

The Daily Field Report must be on the computer generated form provided by the Central Materials Office. It is important that the inspector is using the current version of the Daily Field Report. It can be found at:

https://iowadot.gov/construction_materials/Hot-mix-asphalt-HMA

The DFR is an excel file that has been designed to gather field data. The DFR is intended to be emailed to the contractor in a timely matter, so that the contractor can import the file into the Daily Plant Report.

HMA HANDOUT #3	DAILY FIELD REPORT	SAMPLING AND FIELD INFO

The Daily Field report is filled out by the Agency Inspector. This report contains information about daily placement, sampling locations, field waste and payment quantities. At the end of the day, or the beginning of the next day, the Inspector will send this report to the Contractor, and they will import the information info the Daily Plant Report.

Input tab:	Enter the following information:	
	Residency	Grimes
	Contractor	Quality Asphalt Inc.
	Contract ID	77-0355-097
	Bid Items on Contract	2303-1053502 (HMA VT SURF, 1/2", FRIC L-2)
	Bid Item Plan Quantity	25906
	Plan Thickness (inches)	2
	Contract Mix Price	$45
	Contract Binder Price	$550
	Project Number	IMX-35-5(97)121--02-77
	Mix Design No.	ABD23-1045

Email Addresses Tab	This page is where you would enter the email addresses for everyone who needs to receive this report. For class just put your email in this box.

Tab 5	There is a page in this program for every day of placement. Enter the following:	
This is day 5 of the project	Date	10/25/2023
	Item No.	1
	From Station	292+50
	To Station	482+00
	Lane	NB/EB Pass Ln
	ML or Widening Placement Width	12
	Additional Width (ft)	6
	Thickness (in)	2
	Placed Density Thickness	2
	Placed tons	4440.51
	Select Mix Design Number:	ABD23-1045
	Go to the far left of the page now and put in the following:	
	Bid item, in order of placement	Select the bid item, there is only one there
	Today's Placement	Surface (Travel Lane)
	Select Project Number	IMX-35-5(97)121--02-77
	Mix on Road (tons)	4440.51
	Waste on Road (tons)	2
	Now jump back up and select the bid item that's currently red	

(more to go, see the back side of this handout)

Enter the Hot Box Sample Information. You can see we've already put in Tests A, B and C. You just need to put in Test E information.

	Test A	Test B	Test C	Test D	Test E
Hot Box ID Number	SU10-25A	SU10-25B	SU10-25C	SU10-25D	SU10-25E
Hot Box Sample Tons	166.23	1287.45	2513.15	3455.98	4299.01
Time	7:30 AM	10:10 AM	1:30 PM	3:50 PM	5:00 PM
Station/MP	295+25	325+65	395+22	436+12	478+66
Bar Code ID	D1-000013	D1-000014	D1-000015	D1-000016	D1-000017
Compaction Temp, °F	275	275	275	275	275

Enter the Mat Temperatures as follows:

Time	Temp	
7:00	290	
9:00	285	
11:00	275	
1:00	276	
3:00	281	
5:00	277	
7:00		Leave blank, the contractor finished at 5:30 p.m.

Random Core Locator Tab

At the end of the day it's the inspector's job to determine the location of the cores.
Enter the following information:

Lay Down Date	10/25/2023
Mat Thickness	2
Travel Lane Width	12
Width of paver unit	18

*the paver is paving the 12' lane and the 6' shoulder at the same time in this scenario

Mat: From Station	292.5
Mat: To Station	482
Direction/Lane	NB/EB Pass Ln
# Mat Cores	8
Longitudinal Joint Created?	Full

Click on "calculate"

*the random generator has now created the location for the 8 mat cores
Click "calculate" again and you'll get locations for the 3 joint cores

Click on the macro button on the top left that says "Assign to a DFR"
You'll notice that the day 5 tab is still selected because that's the page that you're working on. The program knows to assign these sample locations to the day 5 Daily Field Report.

*The computer will ask "do you want to generate new random locations". Select no (they're already created) and the core locations will be transferred to your DFR

Field Report is done! Save the file.

Stop, Take a Break, Wait for Further Instruction

Input the remaining project information from the day into the computer:

Input Tab The agency personnel has filled out the electronic Daily Field report with the information collected in the field. The contractor can inport this Daily Field Report into their Daily Plant Report.

Find the macro button on the top left of the input tab that says "import from daily field report". You will be asked where the file is. It's on the desktop in the Level I HMA Folder, called "10-25 DFR Complete"

If you browse through the plant report you'll now see that all of the information from the DFR has been added to the Plant Report. Gyratory Sample Information, Sublots, Road Waste on the Tank Tab, Placement Record, Mat Temps, etc.

RAM tab: Enter the total tons of dry RAM used today in the RED box: **401.55 tons**

Tank Tab: Input the supplier tank: A123
Input the asphalt binder specific gravity, Gb, given to you by the asphalt supplier: 1.0369

Today the contractor is doing a yield check to verify the flowmeter. They do that by comparing a tankstick result to the daily flowmeter. Input the following tankstick data:

Starting Time	7:00 AM
Tank Capacity (Gallons)	21000
Direct Reading (Gallons)	3582
Beginning Temp	300
Total Pounds Binder Added During Day	476589
Pounds/Gallon	8.634
Ending Time	5:00 PM
Direct Reading (Gallons)	12400
Ending Temp	300

Payment for binder is by Flowmeter. Enter the following:
Total Pounds of Binder used by Flowmeter 406187 lbs

What is the yield difference? ________________________________
Is that within specification? ___________________________________
Hint: what is the accuracy requirement for a pay scale?

Today the plant received a delivery of binder. Enter the following information in the binder shipment log:

Delivery Date	10/25/2023
Ticket Number	A1253
Weight per Gallon	8.634
Pounds Delivered	476,589

Under the section called Mix Production, enter the following:
Total Pounds of Mix Made Today 8,901,020
Do not put anything in the silo information boxes. No silo'd mix today

Under the section called Distribution of Today's Mix, enter the following:
Quantity Not Placed (Pounds):
This is where quantities go that did not end up on your project.

Wasted on road (came from DFR)	4000
Wasted on other jobs	20000

Now mathematically we can figure out the quantity placed (Total mix made - wasted on road - wasted on other jobs)

Quantity Placed (Pounds) 8,877,020
Today's Placement: Select Surface

Total Usage:
What is the "net tons of mix used on road" (pay quantity): ___________
What is the "net tons of virgin binder used on road": ___________
How many tons of binder will the contractor be paid for today? _____________
hint: they get paid for the virgin binder plus the binder in the RAP

Temp Tab Each day temperatures must be taken at the plant every 2 hours. These temperatures are Air, Binder, and Mix. In the field mat temperatures are taken as well, and those will come in from the inspector. Enter the following temperatures:

Time	7:00	9:00	11:00	1:00	3:00	5:00
Air Temp. °F	72	77	81	85	86	85
Binder Temp	300	295	300	295	295	300
Mix Temp. °F	290	285	275	276	281	277
Mat Temp. °F						

Placement Record Tab A few red boxes need to be filled out:

From Mileage Summary Entry # 1
To Mileage Summary Entry # 3
Select Bid Item, there should only be one to select.

Report Tab There are some items that need to be input to finalize the days work. These blanks are currently red or yellow.

Input the date the cores were tested (test date for cores) 10/26/2023

On the bottom right of the report there's a section called Mix Change Information
Report here any mix changes the contractor plans to make before starting up the plant on the next working day. The contractor is going to make the following changes to lower his amount of dust (-200)

Report that 1/2" ACC Stone will change to New % of 25
Report that Man Sand will change to New % of 18
Report that 1/2" washed chips will change to New % of 34

Enter the district hotbox results. They tested the 3rd box of material, sample ID SU10-25C

Gmb	2.435
Gmm	2.518
Pa	3.3 should be automatically calculated.

Enter the District gradation result as follows:

1/2"	99
3/8"	88
#4	50
#8	35
#16	24
#30	16
#50	9.5
#100	7.8
#200	5.9

Is your pay factor correct? For this data the pay factor should be 1.053
If it's correct, click on the "check" button on the upper right portion of the report tab. If you are missing any data the computer will tell you.
If you get the message "This can now be charted" you're good! Save your file.

THE CHARTING PROGRAM

HMAChart is an Excel spreadsheet program designed to accumulate all the data generated from the Daily Plant Report and the Daily Field Report programs. Once the Daily Plant Report is completed, including the Daily Field Report information, the final data is imported into the Charting Program, where the test data is analyzed and pay factors and quantities are determined. Because pay is calculated here, a separate Charting Program spreadsheet is required for each HMA bid item.

When the first plant report is imported, the project information, specifications, bid item quantities and contract unit prices will appear in the Charting Program. This information should be checked for accuracy before proceeding. The Contractor will maintain a Charting Program for each bid item and the Contracting Authority will normally maintain a duplicate for project records.

Incentive and disincentive for field voids, lab voids, joint density and film thickness are calculated whenever a Daily Plant is imported. Field voids, joint density and film thickness pay adjustments are calculated on a daily lot basis, however lab voids PWL pay adjustments are based on data from multiple days of eight to fifteen or more test results. Comparison of Contractor's to DOT test results is also performed for validation and verification purposes.

Always use the latest version of the Excel spreadsheet. The latest version can be found on the DOT website at:

https://iowadot.gov/construction_materials/Hot-mix-asphalt-HMA

COMPUTER PROGRAMS - REVIEW QUESTIONS

1. Who fills out the Daily Field Report?

2. Who fills out the Plant Report?

3. Which excel report determines random core locations?

4. Which excel report summarizes total incentive/disincentive pay?

5. Which excel report is used to input gyratory test data and calculate test results?

6. Any changes to the mix need to be reported on the ____________________________?

IM 204
SAMPLING & TESTING

INSPECTION OF CONSTRUCTION PROJECT SAMPLING & TESTING

INTRODUCTION

The Iowa Department of Transportation (DOT) has established a Quality Assurance Program (IM 205) to assure that the quality of materials and construction workmanship incorporated into all highway construction projects is in reasonable conformity with the requirements of the approved plans and Specifications, including approved changes. It consists of an Acceptance Program and an Independent Assurance Program (IAP), both of which are based on test results obtained by qualified persons and equipment.

The acceptance portion of the program covers quality control (QC) sampling and testing and verification sampling and testing. The IAP portion of the program covers the evaluation of all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (includes contractor, contracting agency, and consultant).

ACCEPTANCE PROGRAM FOR MATERIALS

To fulfill the materials acceptance requirements, several methods are used by the DOT.

Sampling & Testing (Test Report)
Certification
Approved Brands
Approved Sources
Approved Shop Drawings
Approved Catalog Cut
Inspection Report
Visual Approval by the Engineer

The Instructional Memorandum IM 204 Appendices A through W contain the material acceptance information for the type of work being done. ~~If there is a conflict in wording between the appendix and another Instructional Memorandum or appendix Z, the appendix A through W will supersede the others.~~ If there is a conflict in wording between the appendix A through Z and another Instructional Memorandum, the Instructional Memorandum will supersede the appendix A through Z.

In many cases more than one method may be required for acceptance in the 204 Appendices and tables in the back of this guide. For some new or special materials, the District Materials Engineer may need to determine the most appropriate acceptance requirements.

In order to provide the Contractor the opportunity to construct a project with minimal sampling and testing delays, inspection is performed at the source for many materials. Source inspection may consist of inspecting process control, sampling for laboratory testing or a combination of these procedures. All source-inspected or certified materials are subject to inspection at the project site prior to being incorporated into the work. Project site inspections are for identification of materials with test reports and for any unusual alterations of the characteristics of the material due to handling or other causes. Verification samples secured by project agency personnel of source-inspected, certified, or project processed materials are also required for some materials in order to secure satisfactory validation for acceptance.

When certification procedures are required, the Contractor may, on the Contractor's own responsibility and at the Contractor's risk, incorporate these materials into the work. Acceptance will be based on satisfactory certification and compliance of the test results of any verification samples. When verification samples are not taken, acceptance will be based on satisfactory certification.

A. SAMPLING & TESTING (TEST REPORT)

When a material is sampled and tested, the results will be documented on a construction form or a test report. There is quality control sampling and testing done by the Contractor or producer and verification sampling testing done by the Project Engineer, the District Materials Engineer, the Central Materials Laboratory, or an independent laboratory.

In many cases, in addition to sampling and testing, some other type of acceptance method will also be required. Sampling and testing may be done at the project, supplier, or source depending on which is the most appropriate.

B. CERTIFICATION OF COMPLIANCE

For many materials, a fabricator, manufacturer, or supplier is required to provide the Project Engineer with a certification document stating that the material meets the requirements of the plans and specifications. In most cases, the fabricator, manufacturer, or supplier must also be on an approved list in the Materials Approved Products Listing Enterprise (MAPLE). For some of these materials, sampling and testing is also required before final acceptance. The certification comes in a variety of forms:

- Stamped or preprinted on truck tickets as with aggregates,
- Stamped or preprinted on invoices as with Portland Cement and asphalt binder,
- Stamped or printed on the Mill Analysis as with reinforcing steel, structural steel, and other metals,
- Furnished as a separate document with each shipment as with zinc-silicate paint, engineering fabrics, epoxy coatings, and dowel baskets,
- Stamped or printed on a list of materials for each shipment as with CMP, concrete pipe, and corrugated plastic subdrain,

The inspector will verify that the certification has been entered into DocExpress.

C. APPROVED SOURCE

(May also be referred to as "Approved Producer, Approved Supplier, Approved Fabricator, or Approved Brand") The source, producer, and the material must be evaluated and approved by the Office of Construction and Materials according to the appropriate Materials IM in order to be used on a project. Once a letter of approval is issued, the source or producer is approved for use on projects (with the exception of steel fabricators and precast concrete plants). Approved products, sources, and producers are listed in the Materials Approved Products Listing Enterprise (MAPLE). Approval for a source or producer may be rescinded at any time if it no longer meets the requirements of the IM. The plans, developmental specifications, and special provisions may also contain lists of approved sources.

The project inspector will document information about this material such as product name, source, date, producer, and lot number in the project files.

Most approved sources also require a certification.

D. **APPROVED WAREHOUSE STOCK**
For some items made up of miscellaneous materials, inspection and approval will be done by the District Materials Engineer at the supplier's warehouse.

E. **APPROVED SHOP DRAWING & APPROVED CATALOG CUT**
This information must be submitted to, and reviewed by the Iowa DOT Design Office or Bridges and Structures Office, before the material can be incorporated in the project.

F. **INSPECTION REPORT**
The project inspector must have a copy of the final inspection report prior to incorporating the item into the project. The report will vary depending on the Materials IM requirements for the item fabricated. Final acceptance is by construction personnel at the project site, and is based on the proper documentation and the condition of the component.

G. **VISUAL APPROVAL BY PROJECT ENGINEER**
(May also be referred to as "As Per Plan, Approved By RCE, or Manufacturer Recommendations") The project inspector must document information about this material such as product name, source, producer, lot number and date produced in the project files. The inspector will make sure the material meets the requirements of the plans, the Engineer, or the manufacturer before the material is used. Visual approval requires construction personnel to visually inspect the material to determine if it complies with the specifications. Visual approval is appropriate for non-critical items such as sod stakes, where compliance can be readily determined by visual means. If there are questions on specification compliance, samples will be taken for testing.

INDEPENDENT ASSURANCE PROGRAM

The IAP evaluates all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (Includes Contractor, Contracting Agency, and consultant). Independent assurance includes evaluation based on:

Calibration checks
Split samples
Proficiency samples
Observation of sampling and testing performance

The test method and the frequency of test are in the Appendices. Calibration checks and proficiency samples testing is covered in IM 208.

SMALL QUANTITIES

The FHWA allows and encourages alternative acceptance methods for small quantities of non-critical materials. Appendix X contains a list of those materials and maximum quantities for which alternative acceptance methods may be appropriate. The Project Engineer or District Materials Engineer may still require the normal acceptance method for a material when it is considered critical in the intended application.

IM 204 APPENDIXES

Appendix A	Roadway & Borrow Excavation & Embankments
Appendix B	Soil Aggregate Subbase
Appendix C	Modified Subbase
Appendix D	Granular Subbase
Appendix E	Portland Cement Concrete Pavement, Pavement Widening, Base Widening, Curb & Gutter & Paved Shoulders
Appendix F	Asphalt Mixtures
Appendix H	Structural Concrete, Reinforcement, Foundations & Substructures, Concrete Structures, Concrete Floors, & Concrete Box, Arch & Circular Culverts
Appendix I	Concrete Drilled Shaft Foundations
Appendix K	Cold-In-Place Recycled Asphalt Pavement
Appendix L	Granular Surfacing/Driveway Surfacing
Appendix M	Concrete Bridge Floor Repair & Overlay & Surfacing
Appendix P	Surface Treatment (Seal Coat, Microsurfacing, Slurry, Joint Repair, Crack Filling & Fog Seal)
Appendix T	Base Repair, Pavement Repair
Appendix U	Granular Shoulders
Appendix V	Subdrains
Appendix W	Water Pollution Control, Erosion Control
Appendix X	Acceptance of Small Quantities of Materials
Appendix Z	Supplemental Guide, Basis of Acceptance

Sampling & Testing Guide-Minimum Frequency
ASPHALT MIXTURES
Section 2303 & 2213

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Coarse (4127)		AS 209												
Aggregates-Fine (4127)		AS 209												
Hydrated Lime (4127)		AS 491.04												
Asphalt Binder		AS 437												
Emulsions & Cutbacks		AS 437												
Release Agent		AB 491.15												
Recycled Asphalt Shingles		AS 506												
PLANT INSPECTION														
Aggregates (2303)	Quality							V	DME	1/20,000 Ton	50 lb.	CTRL		
Combined Aggregate (4127)	Gradation	302, 306, 336	RCE/ CONTR	1/lot	IM 301	CONTR		V IA	RCE/ CONTR	Sample 1/day, Test 1st day + 20% Systems Approach*	IM 301	DME/ RCE	IM 216 IM 216	
	Moisture		CONTR	1 / half day	1000 gm	CONTR								Drum Mix Plants Only
Asphalt Binder	DSR Quality	AS Cert 323						V V IA	RCE/ CONTR DME	Sample 1/day Test 1st 1/week 1/20,000 T of Mix Systems Approach	4 oz tin 1 qt	DME CTRL		Log all shipments ** Interlayer
Cutback		AS Cert												Log all shipments
Emulsion	Residue	AS 360						V	RCE	1/project	1 qt	DME		Plastic bottle required

AB-Approved Brand
AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert- Certification Statement

CONTR-Contractor
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Laboratory

IA-Independent Assurance
V-Verification

*A project approach may be applied at the discretion of the DME at the frequency 1/project.

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Uncompacted Mixture:	Lab Density & Lab Voids	321,322, 350 325G, 357, 338	RCE/ CONTR	As per 2303	40 lb	CONTR		V IA	RCE/ CONTR	As per 2303 Test 1/day Systems Approach	40 lb	DME		***Interlayer
	Moisture Sensitivity	319, 322, 325G Article 2303.02, E.2						V	RCE/ CONTR	Test 1st Sample at 500 tons then sample 1/10,000 tons per 2303 until 1st sample accepted (test as needed)	70 lb	CTRL		
Compacted Mixture	Mat Density, Thickness & Voids	320, 321 337						V IA	RCE/ CONTR DME	Lot 1 lot/project*	Min 8/lot	RCE DME		
	Joint Density	SS-15004 Or DS-15036						V	RCE/ CONTR	Lot	3/lot	RCE		6-inch core
	Smoothness	341	CONTR	100%	100%	CONTR		V	DME	10%		DME		

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*** A system approach may be applied at the discretion of the DME.**
NOTE: A Verification sample for asphalt binder quality and aggregate quality not required under 2000 tons of mix.
NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.
****NOTE: For interlayer construction, as a minimum, sample 1 Qt. each day, and perform the MSCR test on the first and last day's binder sample of interlayer placement.**
***** NOTE: For interlayer construction, in addition to the required uncompacted mix sample(s) tested by the contractor and district lab, sample and retain at least one additional box of uncompacted mix each day of interlayer placement.**
NOTE: For Local agency projects with no Federal Funds Independent Assurance, IA, tests are not required.
NOTE: For Local agency projects with no Federal funding, verification samples or monitor samples sampled by the DME are not required. These samples may be sampled by the contracting authority. With prior approval, these samples may be tested by the Iowa Department of Transportation Central Laboratory.
NOTE: For Local agency projects with no Federal funding, smoothness verification testing may be tested and evaluated by the DME.

ASPHALT MIXTURES

Section 2303 & 2213

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
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	Moisture		CONTR	1 / half day	1000 gm	CONTR								Drum Mix Plants Only
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NOTE: For Local agency projects with no Federal Funds Independent Assurance, IA, tests are not required.
NOTE: For Local agency projects with no Federal funding, verification samples or monitor samples sampled by the DME are not required. These samples may be sampled by the contracting authority. With prior approval, these samples may be tested by the Iowa Department of Transportation Central Laboratory.
NOTE: For Local agency projects with no Federal funding, smoothness verification testing may be tested and evaluated by the DME.

IM 205
QUALITY ASSURANCE

QUALITY ASSURANCE PROGRAM FOR CONSTRUCTION
OVERVIEW & DESCRIPTION

INTRODUCTION
The Iowa Department of Transportation (DOT) has established the following Quality Assurance Program to assure that the quality of materials and construction in all highway construction projects is in reasonable conformity with the requirements of the approved plans and Specifications, including approved changes. The program reflects conformance with the criteria contained in the regulation for Quality Assurance Procedures for Construction, published as 23CFR 637(B) on June 29, 1995. It consists of an Acceptance Program and an Independent Assurance Program (IAP), both of which are based on test results obtained by qualified persons and equipment.

This Quality Assurance Program allows for the use of the Contractor's test results as part of the acceptance decision if satisfactory validation is achieved by the Agency in accordance with IM 216, IM 511, and IM 530. The IAP, as presently structured, is conducted exclusively by the Contracting Agency. The acceptance of all materials and workmanship is the responsibility of the Engineer.

In order to avoid an appearance of a conflict of interest, any qualified non-DOT laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IAP testing, or dispute resolution testing.

ACCEPTANCE PROGRAM
Materials incorporated into highway construction projects shall be subject to sampling and testing, including Quality Control (QC) sampling and testing when required by specification. Sampling and testing shall be performed in accordance with location, frequency and procedures identified in IM 204.

A. Quality Control Sampling & Testing

Contractor-performed QC sampling and testing may be used as part of an acceptance decision when required or allowed by specifications. Contractor QC sampling and testing personnel, laboratories, and equipment shall be qualified in accordance with the Iowa DOT Technical Training & Certification Program (IM 213) and the Materials Laboratory Qualification Program (IM 208), and shall be evaluated under the Independent Assurance Program.

If the Contracting Authority eliminates contractor quality control testing from the contract documents, the Contracting Authority shall perform the quality control testing at the frequencies identified in IM 204. Validation of these test results is not required.

B. Verification Sampling & Testing

Verification of quality is performed on critical materials, through independent sampling and testing, at a frequency identified in IM 204. Verification sampling and testing is done by Agency personnel or personnel hired by the Agency excluding the Contractor or vendor.

Agency sampling and testing personnel, laboratories, and equipment will be qualified in accordance with the Iowa DOT Technical Training & Certification Program (IM 213) and the Materials Laboratory Qualification Program (IM 208), and will be evaluated under the Independent Assurance Program.

Verification samples will be obtained by agency sampling. For some sampling identified in IM 204, the Contractor shall assist with sampling as directed and witnessed by certified Agency personnel. The sample location and time will be randomly selected by the Agency (except when noted elsewhere) and will only be given to the Contractor immediately prior to sampling. To maintain the integrity of the sample, it will either be transported by Agency personnel or secured by a tamper proof method and transported by the Contractor. See IM 205 Appendix A for information on securing samples.

QC test results to be used as part of the acceptance decision will be validated by verification test results. Validation of Contractor test results will be done in accordance with IM 216, IM 511, and IM 530. Contractor test results that fail the lot validation shall not be used for acceptance of that lot unless the dispute resolution system resolves the discrepancy. Verification test results will be used for lot acceptance pending the dispute resolution.

C. Quality Control Plans

When required by the Specifications, a Quality Control Plan (QCP) must be developed by the Contractor or producer and submitted to the Engineer for review. Minimum requirements for the QCP will be provided in an IM or specification.

D. Dispute Resolution System

When QC test results are used as part of the acceptance decision, testing disputes arising between the Contracting Agency and the Contractor shall be resolved in a reliable, unbiased manner or an evaluation performed by the Iowa DOT Central Materials Laboratory. Resolution decisions by the Iowa DOT Central Materials Laboratory will be final.

Unless specified elsewhere, the District Materials Engineer will select some or all of the following steps for the dispute resolution:

1. Check all numbers and calculations.
2. Review past proficiency and validation data.
3. Review sampling and testing procedures.
4. Check equipment operation, calibrations and tolerances.
5. Perform tests on split samples or reference samples.
6. Involve the Central Materials Laboratory.

If the discrepancy cannot be resolved using the steps listed above, or if it is determined that the Contractor's testing is in error, then the Agency test results will be used for the acceptance decision for that lot.

INDEPENDENT ASSURANCE PROGRAM

The Independent Assurance Program (IAP) will evaluate all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (Includes Contractor, Contracting Agency, and consultant). Testing performed by the Central Materials Laboratory is not subject to IAP. The Central Materials Laboratory maintains accreditation through the AASHTO Materials Reference Laboratory (AMRL) Program. The goal of the IAP program is to check each active tester at least once per calendar year.

The IAP includes both system- and project-based approaches defined as follows:

- Project Approach. The frequency of IAP activities is based primarily on quantities of materials being tested and requires minimums (as per IM 204) on every project.

- System Approach. The frequency of IAP activities is based on time intervals, regardless of the number of tests, quantities of materials, or numbers of projects being tested by the individual and equipment being evaluated.

The systems approach for IAP was implemented statewide in 1999 for evaluation of Contractor, consultant, city, county, and state equipment, procedures, and personnel involved with project acceptance. Within implementation of the systems approach, the District Materials Engineer may find it more appropriate to retain use of the project approach for IAP on specific projects when the systems approach cannot be effectively applied.

Independent assurance includes evaluation based on:

Calibration checks
Split samples
Proficiency samples
Observation of sampling and testing procedures

A. IAP Personnel & Equipment

IAP testing equipment must not be the same equipment that was used by the project QC or verification personnel. IAP personnel must not be involved in the project verification testing or QC testing for the sampling and testing procedure they are evaluating on that project.

B. Comparison of Test Results

A prompt comparison of the test results obtained by the individual being evaluated and the IAP tester will be performed by the Engineer. If results of the comparisons do not comply with tolerances provided in IM 216 or criteria in IM 208, Appendix C, a review of the test procedures and equipment shall be performed immediately to determine the source of the discrepancy. Corrective actions must be identified, incorporated as appropriate and followed by additional IAP testing. Test results from all the samples involved in the IAP will be documented and reported in the appropriate District or project files.

C. Annual Report of IAP Results

The Central Construction and Materials Office will compose and submit an annual report to the FHWA Division Administrator summarizing the results of the Iowa DOT's systems approach IA Program. This report will identify the number of sampling and testing personnel evaluated by systems approach IA testing, the number of evaluations found to be acceptable and unacceptable, as well as a summary of any significant system-wide corrective actions taken.

SIGNIFICANT DIGITS IN TEST DATA

When comparing test data to the specification limit, a uniform method is used to round the data. When a rounding method is not specified elsewhere for the test data, the method to be used is the Rounding Method in ASTM E29 except that the rounding procedure in section 6.4.3 is replaced as below and 6.4.4 is eliminated.

> 6.4.3 When the digit next beyond the last place to be retained is 5, and there are no digits beyond this 5, or only zeros, increase by 1 the digit in the last place retained.

When the Iowa DOT provides a computer program or spreadsheet for reporting test results, the rounding method will be as reported by the computer software.

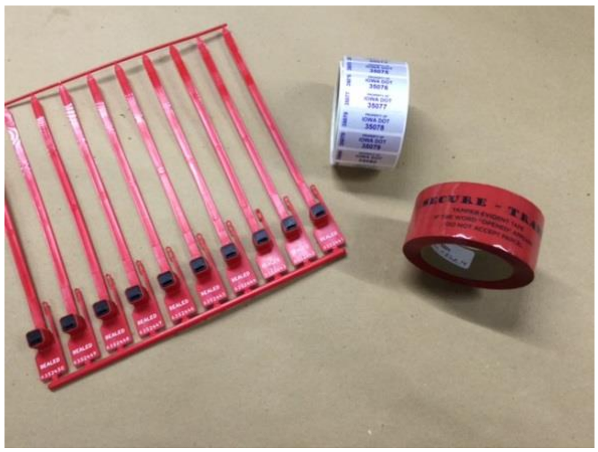
SECURING SAMPLES

INTRODUCTION

This IM is intended to provide instructions on how to secure verification samples. Verification samples can be transported by the contracting authority without additional security measures. Verification samples not transported by the contracting authority must make use of the following procedures unless directed otherwise by the District Materials Engineer (DME). For materials not able to be secured through one of the following methods, contact your local DME for additional guidance.

PROCEDURES

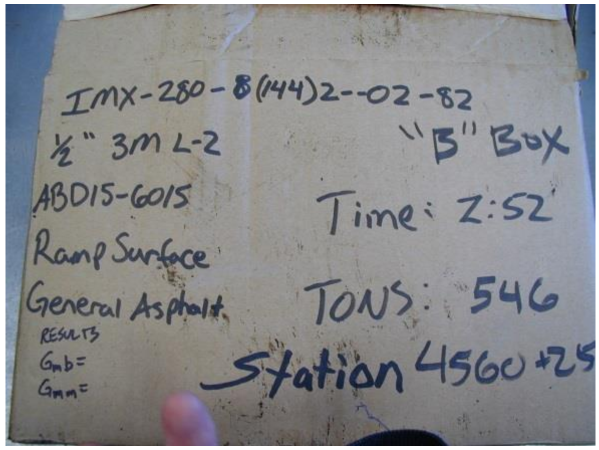
To obtain the required security supplies, contact your local District Materials Office. These are examples of the security supplies available.



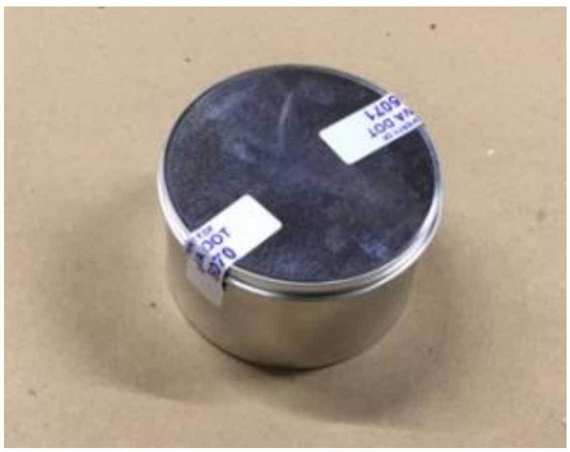
TAMPER PROOF TAPES

Tamper proof tapes can be used to secure boxes, binder tins, and other similar containers.

Here are some examples of how the tamper proof tape can be utilized.



Standard practice is to place the 193 form inside the box prior to securing the box. For loose asphalt mix, on the outside of the box several pieces of information are recorded including the date, mix design number, sender's number, project number and sample number.



When using the numbered security tape the number is recorded on the 193. The paper 193 (if used) must accompany the sample. The secured binder tin should be placed inside the secured cold feed bag. Should an ignition oven sample be utilized to determine gradation compliance, the secured binder tin may be placed inside the secured box of loose mix. The secured binder tin may be placed inside the box of loose mix.

TAMPER PROOF TAGS

Tamper proof tags are used to secure bags. Examples of the tamper proof tags and how they are applied to the bags are as follows:

The security number on the tag is recorded on the 193 form and the paper 193 (if used) placed inside the bag prior securing the bag for delivery.

DOCUMENTATION

The identification number on the tamper proof tag is recorded on the 193 form and the paper 193 (if used) is then secured with the sample prior to submitting to the District Materials Office. Arrangements can be made to submit the 193s electronically with notification to the DME.

IM 213
CERTIFICATION

TECHNICAL TRAINING & CERTIFICATION PROGRAM

GENERAL

The purpose of the Technical Training & Certification Program is to ensure Quality Control (QC)/Quality Assurance (QA) and Acceptance of Aggregates, Hot Mix Asphalt (HMA), Portland Cement Concrete (PCC), Soils, Erosion Control, Precast and Prestressed Concrete, and Pavement Profiles and to ensure proper documentation of quality control/quality assurance and acceptance procedures and test results by industry and Contracting Authority personnel.

This Instructional Memorandum (IM) explains the requirements to become certified and to remain certified to perform inspection and testing in the State of Iowa. This IM also describes the duties, responsibilities and the authority of persons assigned the position of Certified Technician in any of the above areas for construction or maintenance projects. Appendix C of this IM lists what tests and procedures the technician is qualified to perform for each level of certification they obtain.

Through a cooperative program of training, study, and examination, personnel of the construction industry, State DOT, and other Contracting Authorities will be able to provide quality management and certified inspection. Quality control/quality assurance and acceptance sampling, testing and inspection will be performed by certified personnel and documented in accordance with the IMs.

A technician who is qualified and holds a valid certification(s) shall perform quality control/quality assurance and acceptance at a production site, proportioning plant, or project site. Responsibilities cannot be delegated to non-certified technicians. The duties of a Certified Technician may be assigned to one or more additional Certified Technicians.

The Technical Training & Certification Program will be carried out in accordance with general policy guidelines established or approved by the Highway Division Director. A Board of Certification composed of the following members will advise the Director:

Director – Construction and Materials Bureau
Representative of District Materials Engineers**
Representative of District Construction Engineers**
Representative of Associated General Contractors (AGC of Iowa)
Representative of Iowa Concrete Paving Association (ICPA)
Representative of Asphalt Paving Association of Iowa (APAI)
Representative of Iowa Ready Mixed Concrete Association (IRMCA)
Representative of Iowa Limestone Producers Association (ILPA)
Representative of County Engineers
Representative of American Council of Engineering Companies (ACEC-Iowa)
Coordinator of Technical Training & Certification Program**

** Appointed by Program Director

The Director of the Construction and Materials Bureau will be the Program Director. Coordinators will be appointed by the Program Director to assist in administration of the program and to handle such planning, administration, and coordinating functions as may be needed.

TRAINING
The Iowa DOT will provide the training necessary to become certified. Producers/Contractors are encouraged to conduct their own pretraining program. A complete listing of training opportunities is available at the Technical Training & Certification Program website, https://iowadot.gov/training/technical-training-and-certification-program.

CERTIFICATION REQUIREMENTS
1. A candidate must attend Iowa DOT course instruction and pass the examination(s) for all levels of certification prepared and presented by the Program Director or someone designated by the Program Director. If the new candidate fails the examination, they will have one opportunity to retake the examination. The retake must be completed within six months of the original exam. If they fail the retake of the examination, they will need to attend the training again before taking the examination the third time. If an individual is recertifying they will have only one opportunity to take the examination. If they fail the examination they must take the applicable training before retaking the examination.

2. All prerequisites shall be met before the applicant may attend the next level of training for the certification desired. A listing of certification levels and prerequisites is located in Appendix A.

3. Once the candidate has met all the criteria and has received certification, it is recommended the Certified Technician work under the supervision of an experienced technician until they become efficient in the inspection and testing methods they will be performing.

   An individual requesting to become certified as a Precast/Prestress Concrete Technician is required to obtain forty hours of experience assisting in quality control inspection at an approved plant before certification will be issued. The experience must be documented and shall be approved by the District Materials Engineer. This experience must be completed within two years from the date the individual attended the training.

4. Registered Professional Engineers, engineering graduates, and geology graduates from accredited institutions will be exempt from the training requirement in the areas they have had instruction. It is, however, strongly recommended that they attend the certification classes. In order to obtain certification for any technical level, these persons must pass all applicable written examinations for the level of certification they wish to obtain. If the written examination attempt does not meet the required score, the candidate must take the certification class before another attempt can be made. All certificates issued in accordance with these requirements will be subject to the same regulations concerning expiration, recertification, etc., as applies to certificates obtained via training and examinations.

5. Technicians will be issued certifications by reciprocity when the following criteria are met:

   a. The applicant must be certified in another state or certification program determined equivalent by the Program Director or someone designated by the Program Director, in each level of certification they are requesting.

   b. The applicant must pass an examination for each level of certification desired, which will be administered by the Iowa Department of Transportation. Failure of the examination shall require the applicant to take the full certification class before they can retake the exam.

c. The applicant must follow the prerequisite requirements of the Technical Training & Certification Program.

Reciprocity requests should be made through the Technical Training and Certification office in Ames. Copies of all the applicant's certifications will be required.

CERTIFICATION

Upon successfully completing the requirements for certification, the Program Director will issue a pocket certification card. The certification is not transferable. A certification earned in a training season shall be valid until March 31st of the fifth succeeding training season. A training season is defined as October 1st, XXXX to September 30th, XXXX+1.

CERTIFICATION IDENTIFICATION

The certification card will identify the certificate holder, their certification number, the level(s) of certification, and the expiration date of each level.

RENEWAL OF CERTIFICATION

A certification shall be valid through March 31st of the fifth succeeding training season. If the individual has not renewed their certification by the certification expiration date, they are automatically decertified.

All certified technicians will be required to pass an examination before recertification will be issued. Failure of the examination shall require the applicant to retake the full certification class and pass the examination. If the individual does not take the examination within one year after their certification(s) expire-they must retake the full certification class and pass the examination.

If an applicant becomes decertified in any level of certification and that certification is a prerequisite for other levels of certification the applicant will also be decertified in those related levels of certification until the prerequisite certification has once again been obtained.

The certificate holder shall be responsible for applying for certification renewal and for maintaining a current address on file.

PROVISIONAL CERTIFICATION

Provisional certification will be allowed through a special request to the TTCP Director. The request can be mailed or emailed to the TTCP Director and must include the need for a provisional certification, such as, company technician quit and they need to replace, an unforeseen workload, etc. Provisional certifications will only be granted to contractors. If the request is granted the following requirements will apply.

1. The provisional certification applicant must work under the direct supervision of a certified technician until such time that the applicant is competent in the required skills of the certification and has taken the written exam. The applicant must also take the web based review offered by the TTCP in the area they are seeking provisional certification.
2. The applicant must take and pass the written exam for the provisional certification they are requesting. There will be a testing fee in the amount of the TTCP recertification fee due at the time of the exam. CIT funds may not be used for provisional certification testing. The exams will be offered at the District Materials offices or the TTCP office in Ames.
3. The technician must demonstrate proficiency to an Iowa DOT certified technician at the first available opportunity.

4. After the provisional certification applicant has successfully completed the steps in 1 and 2, they will become provisionally certified until the end of the calendar year in which they obtained certification.
5. If the provisional certified technician wishes to keep their certification they must attend the full class at the full class cost for the certification during the training season immediately following their provisional certification.
6. A provisional certification is not intended to be an annual request. The provisional certification will only be allowed for one construction season. Repeated requests for provisional certifications for the technician will be denied.
7. Any prerequisites for the certification must be met prior to number 2 above.
8. HMA Basic Tester is a new certification that may only be used as a provisional certification. This certification follows all the requirements previously listed and the technician will be required to take Level I HMA at the first available opportunity after the provisional expires.
9. Provisional Certification will be offered for:
    a. Aggregate Sampler
    b. Aggregate Technician
    c. Level I PCC
    d. HMA Sampler
    e. HMA Basic Tester

UNSATISFACTORY PERFORMANCE NOTICE

A certified technician failing to perform the required specified duties or inadequately performing these duties, will receive an Unsatisfactory Notice (Materials IM 213, Appendix B). The notice will be from the District Materials Engineer in the District where the failure occurred. This notice and all supporting documentation will be placed in the technician's record with the Iowa Department of Transportation's Technical Training & Certification Program (TTCP). The notice will remain in their file for five years. The notice may be removed prior to the five years upon the recommendation of the District Materials Engineer.

SUSPENSION

A technician receiving two Unsatisfactory Work Performance Notices for work performed under a specific certification will be given a three-month suspension of the applicable certification. Suspended technicians shall not perform any duties governed by the suspended certification, including any duties which require the suspended certification as a prerequisite.

Technicians are eligible to be reinstated after the three-month suspension and successful completion of the applicable recertification test(s).

Technicians are subject to decertification when they receive a third Unsatisfactory Performance Notice.

The suspension will be effective on the date the Program Director issues the suspension.

DECERTIFICATION

Certified Technicians will be decertified for any of the following reasons:

Certifications will be revoked for the following reasons:

1. Failure of the certificate holder to renew the certificate prior to regular expiration as described above.

2. Use of false or fraudulent information to secure or renew a certificate.
3. Use of false or fraudulent documentation by the certificate holder.
4. Use of misleading, deceptive, untrue or fraudulent representations by the certificate holder.
5. Cheating on certification exams or performance evaluations. This includes removing, or attempts to remove, exam questions, answers, or other exam materials from the testing location.
6. Receipt of 3 Unsatisfactory Performance notifications, as stated above under suspension.

The Program Director, or designee, will notify an individual in writing of the intent to suspend or revoke the individual's certification(s). Notice will also be sent to the technician's last known employer. For DOT employees, notice will also be sent to their immediate supervisor.

An individual's certifications will be suspended during the appeal process, and the individual can't perform any duties governed by the certification during this time, until the first day following the end of the appeal process described below.

Technicians that are decertified shall not perform any duties requiring certification.

APPEALS & REINSTATEMENT REQUESTS

An individual has 10 business days to respond to the revocation notice. If the individual fails to respond with an appeal within 10 days of receipt of the original revocation notice, the suspension or revocation becomes effective on the 10^{th} day.

Appeal step 1: First step appeals will be heard by the program director and a representative panel. The individual will have an opportunity to present information to support their continued certification to the panel. The Program Director and representative panel will then render a written decision, taking into account the technician's actions or omissions, the existence of past infractions, and any mitigating factors. This step 1 appeal will become final if further action is not taken as described in appeal step 2 and the suspension or revocation will become effective on the day the decision is issued by the panel.

Appeal step 2: If the individual is not satisfied with the decision of the Program Director and representative panel, the individual shall, within 10 days of receipt of the written decision, submit a request for further review to the Program Director. This appeals request will be considered by the entire Certification Board. The decision of the Certification Board will be the final decision on behalf of Technical Training & Certification Program.

Any violation will remain on the violator's record for five years, at which time the violation will be removed from their record.

A technician may request reinstatement after one year of being decertified unless the Program Director authorized a shorter period of time, which shall not be less than three months. If a reinstatement is authorized, the individual must attend and successfully complete the applicable certification courses.

FUNCTIONS & RESPONSIBILITES

A certificate holder at each production site, project site, proportioning plant, or laboratory will perform duties. The certified technician shall perform quality control testing in accordance with specified frequencies and submit designated reports and records.

The specification requirement for materials testing by a certified technician does not change the supplier's responsibilities to furnish materials compliant with the specification requirements.

The District Materials Engineer and/or Project Engineer will be responsible for monitoring the sampling, testing, production inspection activities and quality control performed by the contractor. A monitor shall have satisfactorily completed the training and be certified for the level of technician they are monitoring.

The District Materials Engineer and/or Project Engineer will have authority and responsibility to question and, where necessary, require changes in operations and quality control to ensure specification requirements are met.

QUALITY CONTROL, TESTING, & DOCUMENTATION

The QC Technician shall be present whenever construction work related to production activity, such as stockpiling or other preparatory work, requires record development and/or documentation is in progress. The QC Technician's presence is normally required on a continuing basis beginning one or more days before plant operation begins and ending after plant shut down at the completion of the project. The work shall be performed in a timely manner and at the established frequencies.

The QC Technician's presence is not normally required during temporary plant shut downs caused by conditions, such as material shortages, equipment failures, or inclement weather.

All quality control activities and records shall be available and open for observation and review by representatives of the contracting authority.

Reports, records, and diaries developed during progress of construction activities will be filed as directed by the Contracting Authority and will become the property of the Contracting Authority.

Quality control activities, testing, and records will be monitored regularly by Contracting Authority representatives. The Project Engineer or District Materials Engineer will assign personnel for this function.

Monitor activities will be reported and filed at prescribed intervals with the Project Engineer, District Materials Engineer, producer, contractor, and the contractor's designated producer.

At no time will the monitor inspector issue directions to the contractor, or to the QC Technician. However, the monitor inspector will have the authority and responsibility to question, and where necessary, reject any operation or completed product, which is not in compliance with contract requirements.

ACCEPTANCE

Completed work will be accepted on the basis of specification compliance documented by acceptance test records, and monitor inspection records. Specification noncompliance will require corrective action by the producer, contractor, or by the contractor's designated producer, and review of events and results associated with noncompliance by the Project Engineer.

CERTIFICATION LEVELS

CERTIFICATION LEVEL	TITLE	PRE-REQUISITES
	AGGREGATE	
Aggregate Sampler	Certified Sampling Technician	None
Aggregate Technician	Certified Aggregate Technician	None
	EROSION CONTROL	
Erosion Control	Erosion Control Technician	None
	HOT MIX ASPHALT	
HMA Sampler	HMA Sampler	None
Level I HMA	HMA Technician	Aggregate Technician
Level II HMA	HMA Mix Design Technician	Level I HMA
	PORTLAND CEMENT CONCRETE	
Level I PCC**	PCC Testing Technician	None
Level II PCC	PCC Plant Technician	Agg. Technician & Level I PCC
Level III PCC	PCC Mix Design Technician	Level II PCC

**American Concrete Institute (ACI) Grade I certification will be acceptable as a portion of the Level I PCC training.

CERTIFICATION LEVEL	TITLE	PRE-REQUISITES
	PRESTRESS	
Prestress	Prestress Technician	Level I PCC or ACI Grade I If the technician will be performing gradations, they will need to be Aggregate Technician certified.
	RIDE QUALITY	
Ride Quality	Ride Quality Technician	None
	SOILS	
Soils	Soils Technician	None

UNSATISFACTORY PERFORMANCE NOTICE

Issued To: ____________________________ Date: ____________________

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This notice is to inform you that your performance as a Certified Inspector/Technician was unsatisfactory for the reason(s) listed below.

This notice and all supporting documentation will be placed in your record with the Iowa Department of Transportation's Technical Training & Certification Program (TTCP).

The goal of the Technical Training and Certification Program (TTCP) is to work with contractors, producers, cities, counties, and consultants to continually improve the quality of Iowa's construction projects. We hope you will work with us to achieve this goal.

Unsatisfactory Performance:

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District Materials Engineer

cc: Program Director –Construction and Materials Engineer, Ames
TTCP Coordinator
Resident Construction Engineer

CERTIFIED TECHNICIANS QUALIFICATIONS

Tests and Procedures the Certified Technician is qualified to perform for each level of certification.

AGGREGATE SAMPLER

- IM 204 - Inspection of Construction Project Sampling & Testing (when material is incorporated)
- IM 209, App. C - Aggregate Specification Limits & Sampling & Testing Guide (when material is produced)
- IM 301 - Aggregate Sampling Methods
- IM 336 – Methods of Reducing Aggregate Field Samples to Test Samples

AGGREGATE TECHNICIAN

- IM 204 - Inspection of Construction Project Sampling & Testing (when material is incorporated)
- IM 209, App. C - Aggregate Specification Limits & Sampling & Testing Guide (when material is produced)
- IM 210 – Production of Certified Aggregate From Reclaimed Roadways
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 301 - Aggregate Sampling Methods
- IM 302 - Sieve Analysis of Aggregates
- IM 306 - Determining the Amount of Material Finer Than #200 (75µm) Sieve in Aggregate
- IM 307 - Determining Specific Gravity of Aggregate
- IM 308 - Determining Free Moisture & Absorption of Aggregate
- IM 336 - Methods of Reducing Aggregate Field Samples to Test Samples
- IM 344 - Determining the Amount of Shale in Fine Aggregate
- IM 345 - Determining the Amount of Shale in Coarse Aggregate
- IM 368 – Determining the Amount of Clay Lumps & Friable Particles in Coarse Aggregate
- IM 409 – Source Approvals for Aggregate

HMA BASIC TESTER (This is for Provisional Certification Only)

- IM 321 - Method of Test for Compacted Density of Hot Mix Asphalt (HMA) (Displacement Method)
- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt
- IM 323 - Method of Sampling Asphaltic Materials
- IM 325G - Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
- IM 350 - Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
- IM 357 - Preparation of Hot Mix Asphalt (HMA) Mix Samples for Test Specimens
- All forms must be signed by an HMA I or HMA II certified technician

HMA SAMPLER

- IM 320 – Method of Sampling Compacted Asphalt Mixtures
- IM 321 – Method of Test for Compacted Density of Hot Mix Asphalt (HMA) (Displacement Method)
- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt

- IM 323 - Method of Sampling Asphaltic Materials

LEVEL I HMA
- IM 204 - Inspection of Construction Project Sampling & Testing
- IM 208 - Materials Laboratory Qualification Program
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 320 - Method of Sampling Compacted Asphalt Mixtures
- IM 321 - Method of Test for Compacted Density of Hot Mix Asphalt (HMA) (Displacement Method)
- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt
- IM 323 - Method of Sampling Asphaltic Materials
- IM 325G - Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
- IM 337 - Determining Thickness of Completed Courses of Base, Subbase, & Hot Mix Asphalt
- IM 350 - Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
- IM 357 - Preparation of Hot Mix Asphalt (HMA) Mix Samples for Test Specimens
- IM 501 - Asphaltic Terminology, Equations & Example Calculations
- IM 508 - Hot Mix Asphalt (HMA) Plant Inspection
- IM 509 - Tank Measurement & Asphalt Cement Content Determination
- IM 511 - Control of Hot Mix Asphalt (HMA) Mixtures

LEVEL II HMA
- IM 380 - Vacuum-Saturated Specific Gravity & Absorption of Combined or Individual Aggregate Sources
- IM 510 - Method of Design of Hot Mix Asphalt (HMA) Mixes
- AASHTO T176 - Plastic Fines in Graded Aggregate & Soils by use of Sand Equivalent Test
- AASHTO T304 - Uncompacted Void Content of Fine Aggregate
- ASTM D 4791 - Flat Particles, Elongated Particles, or Flat & Elongated Particles in Coarse Aggregate
- AASHTO T283 Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage

LEVEL I PCC
- IM 204 - Inspection of Construction Project Sampling & Testing
- IM 208 - Materials Laboratory Qualification Program
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 315 - Method of Protecting, Curing, Making & Testing Concrete Cylinders
- IM 316 - Flexural Strength of Concrete
- IM 317 - Slump of Hydraulic Cement Concrete
- IM 318 - Air Content of Freshly-Mixed Concrete by Pressure
- IM 327 - Sampling Freshly-Mixed Concrete
- IM 328 - Making, Protecting, and Curing Concrete Flexural Specimens
- IM 340 - Weight Per Cubic Foot, Yield, & Air Content (Gravimetric) of Concrete
- IM 347 – Measuring Length of Drilled Concrete Cores
- IM 383 - Testing the Strength of PCC Using the Maturity Method
- IM 385 - Temperature of Freshly-Mixed Concrete

- IM 525 - Designing Flowable Mortar
- AASHTO T97 - Third Point Loading

LEVEL II PCC
- IM 527 - Paving Plant Inspection
- IM 528 - Structural Concrete Plant Inspection
- IM 529 - PC Concrete Proportions

LEVEL III PCC
- IM 530 - Quality Management & Acceptance of PC Concrete Pavement
- IM 531 - Test Method for Combining Aggregate Gradations
- IM 532 - Aggregate Proportioning Guide for Portland Cement Concrete Pavement

PRESTRESS
- IM 570 - Precast & Prestressed Concrete Bridge Units

RIDE QUALITY
- IM 341 - Determining Pavement & Bridge Ride Quality

SOILS
- IM 309 – Determining Standard Proctor Moisture Density Relationship of Soils
- IM 312 – Sampling of Soils for Construction Project
- IM 335 – Determining Moisture Content of Soils
- ASTM D-2937 – Field density by drive-cylinder method

AGGREGATE SAMPLING TECHNICIAN DUTIES

Duties of the Aggregate Sampling Technician are detailed in IM 209 and the IM 300 Series and consist of, but are not limited to the following:

A. Sampling

1. Obtain representative samples by approved method(s).
2. Sample at required frequencies.
3. Identify samples with pertinent information such as:
    a. Type of material
    b. Intended use
    c. Production beds working depth
    d. Sampling method
4. Reduce samples by approved method(s).

AGGREGATE TECHNICIAN DUTIES

Duties of the Aggregate Technician are detailed in IM 209 and the IM 300 Series and consist of, but are not limited to the following:

A. Sampling

1. Obtain representative samples by approved method(s).

2. Sample at required frequencies.

3. Identify samples with pertinent information such as:

    a. Type of material

    b. Intended use

    c. Production beds working depth

    d. Sampling method

4. Reduce samples by approved method(s).

B. Gradation Testing

1. Follow appropriate testing methods.

2. Maintain current applicable specifications.

3. Post test results within 24 hours of sampling.

C. Other Testing as required (specific gravity, moisture, deleterious material, etc.)

1. Follow appropriate testing methods.

2. Maintain current applicable specifications.

3. Complete required reports.

D. Sampling & Testing Equipment

1. Clean and check testing sieves for defects.

2. Assure scale accuracy.

3. Maintain sampling and testing equipment.

E. Communication

1. Notify the District Materials office for production start-up or changes.

2. Relay test results to appropriate production or supervisory personnel.

3. Report failing test results immediately to appropriate personnel (including District Materials office) and assure remedial actions are taken.

F. General

1. Monitor stockpiling procedures to avoid contamination and excess segregation.

2. Assure proper identification of stockpiles.

3. Assure specification requirements for intended use are met before shipment.

4. Assure sampling locations are safe.

5. Assure proper bedding planes or production depths are maintained.

G. Documentation

1. Report all production test results of certified aggregates on Form #821278 and distribute as required.

2. Assure “plant production log” is maintained.

EROSION CONTROL TECHNICIAN DUTIES

Duties of the Erosion Control Technician consist of, but are not limited to the following:

A. Carefully review and be familiar with the details in the contract documents.

B. Assign erosion and sediment control monitoring responsibilities to Erosion & Sediment Control (ESC) Basics trained field staff.

C. Review copies of storm water inspection reports.

D. Provide input on initial Erosion Control Implementation Plan (ECIP) submittal and ECIP updates.

E. Provide onsite reviews when requested by Contracting Authority or Contractor field staff.

HOT MIX ASPHALT (HMA) SAMPLING TECHNICIAN INSPECTION DUTIES

Duties of the Hot Mix Asphalt Sampling Technician consist of, but are not limited to the following:

A. Plant Sampling. (Article 2303.04, IM 204 & 511)

1. Obtain asphalt binder samples as directed by Contracting Authority personnel per IM 323 and IM 204.

B. Field Sampling (Article 2303.04, IM 204 & 511)

1. Obtain uncompacted mix random samples as directed by Contracting Authority personnel, and identify time, station, lift and side.

2. Obtain compacted mix core random samples as directed by Contracting Authority personnel.

HOT MIX ASPHALT (HMA) TECHNICIAN INSPECTION DUTIES

The following is a list of the duties that must be performed by the Certified Level I HMA Technicians doing quality control work for the Contractor on all projects where the Quality Management-Asphalt (QM-A) specification applies. The Quality Control Technician shall have no other duties while performing certified inspection duties.

These duties consist of, but are not limited to, the following:

A. Aggregate Stockpiles.

1. Assure proper stockpiling of aggregate deliveries. (stockpile build & additions) (IM 508)
   a. Prevent intermingling of aggregates.
   b. Check for and prevent contamination.
   c. Prevent segregation.
   d. Check for oversize material.

2. Document certified aggregate deliveries. (each delivery) (IM 508). When the aggregate supplier can provide a summary document of all deliveries, do not enter into Plant Book.

   a. Obtain truck tickets.
   b. Check for proper certification.
   c. Check for proper approved source.
   d. Enter deliveries in Plant Book Program when other documentation cannot be provided, Aggregate Certification page.

3. Observe loader operation. (daily) (IM 508)

   a. Check for proper stockpile to bin match-up.
   b. Check that loader does not get stockpile base material in load.
   c. Check that loader does not intermingle aggregate by overloading bins.

B. Asphalt Binder Delivery. (each delivery) (IM 508 & 509)

1. Check that material is pumped into correct tank.

2. Document Deliveries.

   a. Obtain truck tickets.
   b. Check for proper approved source.
   c. Check for proper certification.
   d. Check for proper grade.
   e. Check for addition of liquid anti-strip if required.
   f. Check if weight per gallon or specific gravity has changed.
   g. Enter deliveries into Plant Report Program.

C. Plant Operations. (daily)

1. Prepare Plant Report Program for daily entries. (IM 511)

   a. Enter Date.
   b. Enter Report Number.
   c. Enter expected tonnage for the day.
   d. Enter any proportion or target changes that apply.

2. Aggregate Delivery System. (IM 508)

   a. Check for proper cold feed gate settings.
   b. Check for proper cold feed belt speed settings.
   c. Check for proper moisture setting (drum plants).
   d. Monitor RAP proportions.

3. Mixing System. (Article 2303.03, IM 508)

   a. Check for proper asphalt binder delivery setting.
   b. Check for proper interlock operation.
   c. Monitor coating of aggregates.
   d. Monitor mixing time (batch plants).

4. Loading System. (Article 2303.03 & 2001.01, IM 508)

   a. Check hopper/silo gates for proper open/close
   b. Check trucks for proper loading and possible segregation.
   c. Check trucks for diesel fuel contamination in box and remove contaminated trucks from service (5 hrs with box raised).

5. Asphalt Binder Quantity Determination.

   a. Obtain totalizer printout readings and periodically check against tank stick readings.
   b. If using batch count for quantity, obtain printouts of each batch and add up the asphalt binder used for total quantity.

D. Plant Operations. (2 hour intervals) (IM 508)

1. Temperatures.

   a. Monitor and record mix temperature at discharge into truck box.
   b. Monitor and record asphalt binder temperature.
   c. Monitor and record air temperature.

2. Observe plant operation for any irregularities.

E. Weighing Equipment.

1. Proportioning scales (batch plants). (min. 1/day) (Articles 2001.07 & 2001.20) (IM 508)
    a. Perform sensitivity checks of scales.
    b. Check for interference at scale pivot points.

2. Pay Quantity Scales. (min. 1/day) (Articles 2001.07 & 2001.20, IM 508)
    a. Regularly perform check weighing comparisons with a certified scale as necessary. (min. 1st day and one additional if >5000 tons, and as directed by Engineer)
    b. Perform sensitivity checks of scales.
    c. Check for interference at scale pivot points.
    d. Perform verification weighing (truck platform scales).

3. Weigh Belts. (daily)

    a. Check weigh belt for excess clinging fines that effects speed reading.
    b. Check weigh belt for interference at bridge pivot points.
    c. Check for proper span setting.

4. Enter scale checks in Plant Report Program. (daily)

F. Plant Sampling. (daily) (Article 2303.04, IM 204 & 511)

1. Obtain cold-feed gradation samples as directed by Contracting Authority personnel per IM 301 and IM 204.

2. Obtain asphalt binder samples as directed by Contracting Authority personnel per IM 323 and IM 204.

3. Obtain cold-feed moisture samples at a minimum of every ½ day (drum mix plants).

G. Field Sampling (if not performed by others). (daily) (Article 2303.04, IM 204 & 511)

1. Obtain uncompacted mix random samples as directed by Contracting Authority personnel, and identify time, station, lift and side.

2. Obtain compacted mix core random samples as directed by Contracting Authority personnel.

H. Testing. (daily) (Article 2303.04, IM 204 & 511)

1. Field cores.

    a. Provide properly calibrated equipment for Contracting Authority technician's use.
    b. Obtain and record core location station and offset information.

c. Obtain copy of core thickness measurements from Contracting Authority Technician.
d. Obtain copy of core weights from Contracting Authority technician.
e. Record weights and thickness in Plant Report Program.

2. Uncompacted mix.

a. Properly store Contracting Authority secured portion of paired sample.
b. Split Contractor half of paired sample into test portions as per IM 357.
c. Perform gyratory compaction as per IM 325G.
d. Perform bulk specific gravity test of laboratory-compacted specimen as per IM 321.
e. Perform maximum specific gravity test as per IM 350.
f. Enter test data into Plant Report Program.
g. Submit secured samples to DOT District Lab.

3. Aggregate.

a. Split one sample each day as directed by Contracting Authority personnel and provide half for testing by Contracting Authority.
b. Perform gradation analysis as per IM 302 and enter weights into Plant Report Program.
c. Perform moisture tests and produce results upon request.

4. Testing Lab Qualification. (as needed) (IM 208 & 511)

a. Record all HMA sample validations with DOT on form 235.
b. Document corrective actions taken when not correlating.
c. Document all test equipment calibrations.
d. Update IM's, test procedures and specs as required.

I. Documentation. (daily) (Article 2303.04, IM 204, 511 & 508)
The Plant Report, Chart, Plant Book, and other HMA worksheets are available on the following website: https://iowadot.gov/construction_materials/Hot-mix-asphalt-HMA

1. Prepare computerized Daily Plant Report.
   a. Check that all data is correct.
   b. Check that all data is complete.
   c. Compute tons of mix used to date.
   d. Enter mix adjustment data on report.
   e. Check for spec compliance.
   f. Immediately report non-complying results.
   g. Obtain and record mat temperatures and stationing.
   h. Provide electronic daily Plant Report to DME.

2. Maintain a daily diary of work activity in Plant Report Program.

a. Record weather conditions.

b. Record daily high and low temperatures.
c. Record sunrise and sunset times.
d. Record any interruptions to plant production.
e. Record any other significant events.

3. Import daily data into charting program.

4. Enter tack shipment quantities in Plant Report Program.

5. Total all truck tickets delivered to project and deduct any waste to determine HMA pay quantity.

6. Complete Daily Check List

J. Miscellaneous. (daily) (IM 208 & 511)

1. Clean lab.

2. Back-up computer files.

3. Dispose of samples as directed by District Lab.

4. Clean and maintain lab equipment.

K. Independent Assurance Duties. (Every 3 months) (IM 205 & 216)

1. Pick up HMA and aggregate proficiency sample from District Lab.

2. Test aggregate proficiency sample for gradation per IM 302.

3. Test HMA proficiency sample per IM 357, 325G, 321 & 350.

4. Report test results on proficiency samples to Construction Materials Bureau per IM 205.

L. Project Duties. (1/project) (IM 508 & 511)

1. Be in possession of appropriate mix design.

2. Be present during plant calibration.

3. Observe scale calibrations.

4. Perform plant site and set-up inspection and fill out Plant Site Inspection List.

5. Set up Plant Report Program and enter all project information to create Project Master files at beginning of project.

6. Check that release agents used in truck boxes are on the approved list in MAPLE.

7. Copy all computer files and provide to the Contracting Authority at completion of project.

8. Copy all paperwork and control charts and provide to the Contracting Authority at completion of project.

PORTLAND CEMENT CONCRETE (PCC) TECHNICIAN DUTIES
PAVING & STRUCTURAL CONCRETE

The Quality Control Technician shall have no other duties while performing certified inspection duties. Refer to IM 528 for exceptions. The District Materials Engineer may approve all quality control activities be performed by a single certified technician for low production situations.

Many of the duties of the PCC Level II Technician are detailed in IM 527 (Paving) and IM 528 (Structural) and consist of, but are not limited to the following:

A. Stockpiles

  1. Assure proper stockpiling procedures.
  2. Prevent intermingling of aggregates.
  3. Prevent contamination.
  4. Prevent segregation.

B. Plant Facilities

  1. Assure safe sampling locations.
  2. Check for equipment compliance.
  3. Assure proper laboratory location and facilities.

C. Calibration

  1. Be present during calibration (paving).
  2. Check plant calibration (structural).
  3. Assure proper batch weights.

D. Cement (Fly Ash) & Aggregate Delivery

  1. Check for proper sources and certification.
  2. Document quantities delivered.
  3. Monitor condition of shipments.

E. Plant Sampling

  1. Check aggregate gradations by obtaining, splitting, and testing samples.

2. Check aggregate moistures and specific gravity.

F. Proportion Control

1. Check scale weights and operation.
2. Check admixture dispensers.
3. Check mixing time and revolutions.
4. Check cement yield. (Paving plant only, unless over 10,000 cu. yds.)

G. Concrete Tests

1. Cure flexural test specimens.
2. Test flexural specimens (Contract agency will perform test in structural plant).
3. Conduct maturity testing.

H. Test Equipment

1. Clean and maintain scales, screens, pycnometers and beam molds, and laboratory facility.

I. Documentation

1. Prepare daily plant reports (paving), weekly plant reports (structures).
2. Document all checks and test results in the field book.
3. Maintain daily diary of work activity.

PRESTRESS TECHNICIAN DUTIES

Duties of the Prestress Technician are detailed in IM 570 and consist of, but are not limited to the following:

A. Pre-pour

1. Identify and document materials requiring outside fabrication inspection.
2. Identify potential fabrication or production problems and notify Iowa DOT inspectors.
3. Verify that all materials incorporated meet the requirements of the contract documents.
4. Review concrete placement documents for strand locations.
5. Check tension calculations.
6. Measure elongation and gauge pressure during tensioning.
7. Check hold down and insert locations.
8. Check stress distributions.
9. Check steel reinforcement and placement.
10. Check strand position.
11. Check condition of pallet.
    a. Level
    b. Holes
    c. Gaps
    d. Other deformities
12. Determine moisture of aggregates.
13. Check form condition and placement.
    a. Oil
    b. Line alignment level
    c. Tightness

B. Concrete Placement

1. Check on use of an approved mix design and batching operations (sequence).
2. Assure appropriate placement and proper vibration techniques.
3. Measure and record concrete temperature.
4. Assure test cylinders are properly made.
5. Assure appropriate finish.
6. Assure appropriate curing operations.

C. Post-pour

1. Check temperature and record during curing process.
2. Assure concrete strength has been met prior to releasing the line.
3. Assure proper detensioning procedure.
4. Check unit for defects and obtain approval for repairs.
5. Identify and store cylinders with the respective units.
6. Check beam ends for fabrication in accordance with the plans.
7. Assure exterior sides of facia beams are grouted.
8. Inspect after patching and desired surfacing.
9. Measure and record overall dimensions of beam.
10. Measure and record camber at release and compare to design camber.
11. Check and/or measure and record lateral sweep before shipping.
12. Assure proper cylinder cure.

RIDE QUALITY TECHNICIAN DUTIES

Duties of the Ride Quality Technician are detailed in IM 341 and consist of, but are not limited to the following:

A. Test pavement and bridge surfaces for ride quality.

B. Evaluate the test data.

   1. Indentify bumps and dips.

   2. Summarize the roughness into segments and sections.

   3. Identify the segments for incentive, disincentive, or grind.

   4. Retest and evaluate bumps, dips, and must grid segments for specification compliance.

C. Documentation

   1. Document the evaluation on a test report. A copy is sent to the Project Engineer, District Materials Engineer, and Central Materials.

   2. Notify the Project Engineer if the daily average profile index exceeds the specification tolerance.

   3. Submit the profilograms to the Project Engineer for all areas tested.

SOILS TECHNICIAN DUTIES

A certified Soils Technician is required for all projects with Compaction with Moisture Control, Compaction with Moisture and Density Control, or Special Compaction of Subgrade (including for Recreation Trails). Refer to contract documents for Contractor QC testing requirements. Duties of the Soils Technician consist of, but are not limited to the following:

A. Sampling: Obtain samples at required frequencies per IM 204.

B. Proctor Testing

C. Other Testing as Required

1. For projects with Compaction with Moisture Control: Determine moisture content per frequencies in IM 204.

2. For projects with Compaction with Moisture and Density Control or Special Compaction of Subgrade: Determine moisture content and in-place density per frequencies in IM 204.

D. Sampling & Testing Equipment

1. Clean and check testing sieves for defects.

2. Assure scale accuracy.

3. Check and maintain other testing equipment.

E. Evaluate the test data.

1. For projects with Compaction with Moisture Control: Confirm soils are being placed within required moisture content range.

2. For projects with Compaction with Moisture and Density Control or Special Compaction of Subgrade: Confirm soils are being placed within required moisture content range and soil is compacted to density equal to or greater than density requirement.

F. Documentation and Communication

1. Document test data. A copy is sent to the Project Engineer.

2. Relay test results to appropriate supervisory personnel.

3. Notify the Project Engineer if any test results do not meet contract requirements and assure corrective actions are taken.

IM 216
VALIDATING RESULTS

GUIDELINES FOR DETERMINING THE ACCEPTABILITY OF TEST RESULTS

GENERAL

Criteria for determining the acceptability of test results is an integral part of the Quality Assurance Program. The comparison between two different operator's results is used in the independent assurance program and sometimes in the validation process. The tolerances in this IM are for comparing individual test results except in the case of the profile index where averages are used. When criteria for comparing test results is not established in this IM or any other IM, use of the AASHTO or ASTM test procedure precision criteria is appropriate for determining acceptability of test results.

When the tolerances are exceeded, an immediate investigation must be made to determine possible cause so that any necessary corrections can be made. Below are some steps that may be used to identify the possible cause:

1. Check all numbers and calculations.
2. Review past proficiency and validation data.
3. Review sampling and testing procedures.
4. Check equipment operation, calibrations and tolerances.
5. Perform tests on split samples or reference samples.
6. Involve the Central Materials Laboratory.

TOLERANCES

TEST NAME	TEST METHOD	TOLERANCE
Slump of PC Concrete		
1" or less on IA or Verification	IM 317	1/4 in.
More than 1" on IA or Verification		3/4 in.
Air Content of PC Concrete	IM 318	0.4% 0.5% for air >8%
Length of Concrete Cores	IM 347	0.10 in.)
NDT Pavement Thickness (MIT)		<=0.15 in.
Free Moisture in Aggregate, by Pycnometer	IM 308	0.2%
Specific Gravity of Aggregate, by Pycnometer	IM 307	0.02
Moisture in Aggregate, by Hot Plate		0.3%
Moisture in Soil	IM 335, IM 334	1.5%
Proctor Optimum Moisture Content	IM 309	2.0%
Proctor Maximum Dry Density	IM 309	5.0 lb./ft^3

In-Place Wet Density, Soils & Bases	IM 334, 326, other approved	2.0 lb./ft³
G_{mm} Maximum Specific Gravity	IM 350	0.010
G_{mb} Density of HMA Concrete, by Displacement	IM 321	0.020
G*/Sin Delta	T315	17% of mean
% Binder, Ignition Oven	IM 338	0.33%
G_{sa} Apparent Specific Gravity	IM 380	0.010
G_{sb} Bulk Specific Gravity	IM 380	0.028
Percent Absorption	IM 380	0.37%
Fine Aggregate Angularity	T304	2.0%
Sand Equivalency	T176	10 % of mean
Pavement Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile		
6.0 or less		1.0 in./mi.
6.1 to 20.0		2.0 in./mi.
20.1 to 40.0		3.0 in./mi.
More than 40.0		5.0 in./mi.
Pavement Profile Index (0.0" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile		
25.0 or less		3.0 in./mi.
25.1 to 40.0		4.0 in./mi.
More than 40.0		5.0 in./mi.
Bridge Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile		
6.0 or less		2.0 in./mi.
6.1 to 20.0		3.0 in./mi.
20.1 to 40.0		4.0 in./mi.
More than 40.0		6.0 in./mi.
Pavement International Roughness Index (IRI)	IM 341	
Verification IRI Test Result		
Inches/mile		
50.0 or less		10.0% of mean
50.1 to 150.0		8.0% of mean

More than 150.0	7.0% of mean

TOLERANCES FOR AGGREGATE GRADATIONS

Determining the precision of an aggregate sieve analysis presents a special problem because the result obtained with a sieve is affected by the quantity of material retained on the sieve and by results obtained on sieves coarser than the sieve in question. Tolerances are, therefore, given for different ranges of percentage of aggregate passing one sieve and retained on the next finer sieve used.

Comparisons of test results are made on each fraction of the sample, expressed in percent that occurs between consecutive sieves.

NOTE: Unless otherwise noted, tolerances for aggregate gradations are only valid if the two tests were made on a split sample. Experience has shown that improper sample reduction, as well as differences in test procedures can contribute to results being out of tolerance. When a comparison exceeds the tolerance limits, a review of the test procedures and equipment will be performed. Where practical, additional comparisons will be done with similar equipment and methods.

Table 1 Tolerances for All Aggregates Except HMA-Combined Aggregate

	Size Fraction Between Consecutive Sieves, %*	Tolerance, %
Coarse Portion:	0.0 to 3.0	2
#4 Sieve and larger	3.1 to 10.0	3
	10.1 to 20.0	5
	20.1 to 30.0	6
	30.1 to 40.0	7
	40.1 to 50.0	9
Fine portion:	0.0 to 3.0	1
#8 Sieve and smaller	3.1 to 10.0	2
	10.1 to 20.0	3
	20.1 to 30.0	4
	30.1 to 40.0	4

Table 2 Tolerances for All HMA-Combined Aggregate

Size Fraction Between Consecutive Sieves, %*	Tolerances(1)
0.0 to 3.0	2
3.1 to 10.0	3
10.1 to 20.0	5
20.1 to 30.0	6
30.1 to 40.0	7
40.1 to 50.0	9

(1) Minimum tolerance of 5% is applied to all size fractions coarser than the #4 sieve when comparing cold feed to ignition oven as shown on page 3 of Appendix A.

*The verification test analysis fraction is used to find the proper tolerance.

COMPARISON OF AGGREGATE GRADATIONS

Use of these tolerances is explained in the following examples. Computer spreadsheets to perform the analysis are available on the Iowa DOT Materials Office website. Use of the spreadsheets is preferred when possible. Appendix A contains a copy of the printouts from the spreadsheets.

Example 1 - PC Concrete Coarse Aggregate

Sieve Size	DOT Coarse Aggr Percent Passing	Prod./CPI Coarse Aggr Percent Passing	DOT Coarse Aggr Percent Retained	Prod./CPI Coarse Aggr Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5"	100.0	100.0	0.0	0.0	0.0	2	Yes
1"	97.1	99.1	2.9	0.9	2.0	2	Yes
3/4"	72.2	65.1	24.9	34.0	9.1	6	No
1/2"	38.1	34.9	34.1	30.2	3.9	7	Yes
3/8"	12.0	8.8	26.1	26.1	0.0	6	Yes
#4	0.6	0.2	11.4	8.6	2.8	5	Yes
#8	0.5	0.2	0.1	0.0	0.1	1	Yes
Minus #200	0.3	0.2	0.3	0.2	0.1	1	Yes

The size fraction between consecutive sieves is found by calculating the difference between the percent passing reported for the two sieves. For example, the fraction between the 1.5 in. and 1 in. sieves for the above verification test is 100.0 - 97.1 = 2.9%. Between the 1/2 in. and 3/8 in. sieves it is 38.1 – 12.0 = 26.1%. Since nothing passes the pan, the size fraction between the #200 sieve and the pan is equal to the percent passing the #200.

The example shows the fraction between each pair of consecutive sieve sizes for both tests and the difference between these fractions for both tests. The difference is compared with the applicable tolerance to determine a disposition. In this example, a suspect result is found in the fraction between the 1 in. and 3/4 in. sieves. Since the suspect difference is due primarily to the percent passing results on the 3/4 in. sieves, it is these results that should at least be investigated first. Only further investigation can determine which 3/4 in. sieve, if any is faulty.

NOTE: The applicable tolerance changes between #4 and #8 size fractions.

Example 2 - PC Concrete Fine Aggregate

Sieve Size	DOT Fine Aggregate Percent Passing	Prod./CPI Fine Aggregate Percent Passing	DOT Fine Aggregate Percent Retained	Prod./CPI Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8"	100.0	100.0	0.0	0.0	0.0	2	Yes
#4	95.0	95.0	5.0	5.0	0.0	3	Yes
#8	87.8	86.3	7.2	8.7	1.5	2	Yes
#16	72.0	71.5	15.8	14.8	1.0	3	Yes
#30	44.0	43.8	28.0	27.7	0.3	4	Yes
#50	12.2	13.0	31.8	30.8	1.0	4	Yes
#100	1.5	1.3	10.7	11.7	1.0	3	Yes
Minus #200	0.4	0.4	0.4	0.4	0.0	1	Yes

Example 3 - HMA Combined Aggregate

		Sieve Sizes										
		1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200
	Specs.											
	D.O.T.		100	99.1	87.3	68.8	54.2	41.4	28.2	15.5	9.1	6.9
	Prod./C.P.I.		100	98.8	86.1	74.9	56.1	41.9	28.7	15.1	10.9	8.6

D.O.T. FBR: _______

D.O.T. % Retained	Prod./C.P.I. % Retained	Diff.	Tol. %	Comply (Y/N)
NA	NA	0.0	2	Y
0.9	1.2	0.3	2	Y
11.8	12.7	0.9	5	Y
18.5	11.2	7.3	5	N
14.6	18.8	4.2	5	Y
12.8	14.2	1.4	5	Y
13.2	13.2	0.0	5	Y
12.7	13.6	0.9	5	Y
6.4	4.2	2.2	3	Y
2.2	2.3	0.1	2	Y
6.9	8.6	1.7	3	Y

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9

NOTE: The applicable tolerance for this combined aggregate sample is from Table 2. In this example, the suspect fractions would indicate a possible problem for two pairs of consecutive sieve sizes involving the #4 sieves. This evidence and the difference in the test values found for the #4 sieves, strongly point to an error in one of the #4 sieve results.

When RAP mixes are used, the comparison data is of the composite gradation results and not of the cold feed.

Example 4 HMA Cold-Feed to Ignition Oven Comparison

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		Specs.	**100**	100	100	90-100	76-90	50-64	30-40		20-28			3.0-7.0
Sample ID		Ign. Oven	100.0	100.0	100.0	92.0	82.0	62.0	40.0	30.0	20.0	15.0	9.0	5.0
Sample ID		Cold-Feed	100.0	100.0	100.0	90.0	80.0	60.0	35.0	27.0	22.0	13.0	7.0	3.0
	Correction Factor		0.0	0.0	0.0	0.0	-0.3	-0.5	-0.5	-0.3	-0.3	-0.2	-0.3	-0.3

Sieves	Ign. Oven % Retained	Cold-Feed % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	0.0	0.0	0.0	2	Y
1 - 3/4	0.0	0.0	0.0	2	Y
3/4 - 1/2	8.0	10.0	2.0	3	Y
1/2 - 3/8	10.3	10.0	0.3	5	Y
3/8 - 4	20.2	20.0	0.2	6	Y
4 - 8	22.0	25.0	3.0	6	Y
8 - 16	9.8	8.0	1.8	3	Y
16 - 30	10.0	5.0	5.0	3	N
30 - 50	4.9	9.0	4.1	3	N
50 - 100	6.1	6.0	0.1	3	Y
100 - 200	4.0	4.0	0.0	3	Y
200	4.7	3.0	1.7	3	Y

Corrected Ign. Oven SA:	5.6	Film Thickness:	7.3
Cold-Feed Surface Area:	4.7	Film Thickness:	8.7
Correction Factor:	-0.1		

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9
+#4 sieves minimum tolerance =			5

When comparing an ignition oven extracted gradation to a cold-feed gradation a correction factor must be applied to the ignition oven extracted gradation before comparing it to the cold-feed gradation. The correction factor is determined by calculating the difference between a cold-feed gradation and an ignition oven gradation on the first day of HMA production according to IM 501. The correction factor is then applied to all subsequent comparisons. In the example above, the correction factor was determined on a previous sample. The District Materials Engineer may establish new or average correction factors when needed.

PC CONCRETE GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

Rev 05/03

Iowa Department Of Transportation

Form 200

Reported Gradation & IM 216 Comparison Report

Project No.:_______________

Contract ID:_______________

County:_______________

Contractor/Producer:_______________

Design No.:_______________

Coarse Agg. T203 A No.: ___________

Fine Agg. T203 A No.: ___________

Proper Equipment:___________

Applicable Specs.:___________

Intended Use: _______________
(Paving, Structure, Patching, Incidental

	Good	Fair	Poor
Care of Equipment:	______	______	______
Sampling Procedure:	______	______	______
Splitting Procedure:	______	______	______
Sieving to Completion:	______	______	______
Computations:	______	______	______
Reporting:	______	______	______

DOT Tested By: _______________ Cert. No.:____________ Date:____________

Contr./Prod. Tested By:_______________ Cert. No.:____________ Date:____________

Grad No.	Sample ID	Specs	Sieve Sizes - Percent Passing 1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		DOT												
		Contr./Prod.												

Grad No.	Sample ID					Specs								
		DOT												
		Contr./Prod.												

Sieves	DOT % Retained	Contr./Prod. % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	2	Y
1 - 3/4	NA	NA	0.0	2	Y
3/4 - 1/2	0.0	0.0	0.0	2	Y
1/2 - 3/8	0.0	0.0	0.0	2	Y
3/8 - 4	0.0	0.0	0.0	2	Y
4 - 8	0.0	0.0	0.0	1	Y
8 - 200	0.0	0.0	0.0	1	Y
200	0.0	0.0	0.0	1	Y

	Size Fraction Between Consecutive Sieves, %			Tolerance, %
Coarse Aggregate:				
	0.0	to	3.0	2
	3.1	to	10.0	3
	10.1	to	20.0	5
	20.1	to	30.0	6
	30.1	to	40.0	7
	40.1	to	50.0	9

3/8 - 4	0.0	0.0	0.0	2	Y
4 - 8	0.0	0.0	0.0	1	Y
8 - 16	0.0	0.0	0.0	1	Y
16 - 30	0.0	0.0	0.0	1	Y
30 - 50	0.0	0.0	0.0	1	Y
50 - 100	0.0	0.0	0.0	1	Y
100 - 200	0.0	0.0	0.0	1	Y
200	0.0	0.0	0.0	1	Y

Fine Aggregate:				
	0.0	to	3.0	1
	3.1	to	10.0	2
	10.1	to	20.0	3
	20.1	to	30.0	4
	30.1	to	40.0	4

Remarks:____

Distribution________ Central Materials________ Dist. Materials________ Contr./Producer________ Proj. Engineer________ Technician________

HMA GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

Rev 05/03

Iowa Department Of Transportation

Form 201

Reported Gradation & IM 216 Comparison Report

Project No.: ____________________

Contract ID: ____________________ Intended Use: ____________________

County: ____________________

Contractor/Producer: ____________________

Mix Design No.: ____________________

Mix Change (Y/N): __________

Date of Change: __________

Total, % Asphalt (Pb): __________

Effective % Asphalt (Pbe): __________

Proper Equipment: __________

Applicable Specs.: __________

	Good	Fair	Poor
Care of Equipment:	______	______	______
Sampling Procedure:	______	______	______
Splitting Procedure:	______	______	______
Sieving to Completion:	______	______	______
Computations:	______	______	______
Reporting:	______	______	______

DOT Tested By: ____________________ Cert. No.: __________ Date: __________

Contr./Prod. Tested By: ____________________ Cert. No.: __________ Date: __________

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		Specs.												
Sample ID		DOT												
Sample ID		Contr./Prod.												

Sieves	DOT % Retained	Contr./Prod. % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	2	Y
1 - 3/4	NA	NA	0.0	2	Y
3/4 - 1/2	NA	NA	0.0	2	Y
1/2 - 3/8	NA	NA	0.0	2	Y
3/8 - 4	NA	NA	0.0	2	Y
4 - 8	NA	NA	0.0	2	Y
8 - 16	NA	NA	0.0	2	Y
16 - 30	NA	NA	0.0	2	Y
30 - 50	NA	NA	0.0	2	Y
50 - 100	NA	NA	0.0	2	Y
100 - 200	NA	NA	0.0	2	Y
200	NA	NA	0.0	2	Y

DOT Gyratory Filler/Bitumen Ratio

0.00

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9

Remarks: ____

Distribution________ Central Materials________ Dist Materials________ Contr./Producer________ Proj. Engineer________ Technician________

Rev 05/08

Iowa Department Of Transportation

Form 201 Modified

Cold-Feed & Ignition Oven Gradation & I.M. 216 Comparison Report

Project No.: ____________________

Contract ID: ____________________ Intended Use: ____________________

County: ____________________

Contractor/Producer: ____________________

Mix Design No.: ____________________

Mix Change (Y/N): __________

Date of Change: __________

Total, % Asphalt (Pb): __________

Effective % Asphalt (Pbe): __________

Proper Equipment: __________

Applicable Specs.: __________

	Good	Fair	Poor
Care of Equipment:	______	______	______
Sampling Procedure:	______	______	______
Splitting Procedure:	______	______	______
Sieving to Completion:	______	______	______
Computations:	______	______	______
Reporting:	______	______	______

Ignition Oven Tested By: ____________________ Cert. No.: __________ Date: __________

Cold-Feed Tested By: ____________________ Cert. No.: __________ Date: __________

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		Specs.												
Sample ID		Ign. Oven												
Sample ID		Cold-Feed												
	Correction Factor		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sieves	Ign. Oven % Retained	Cold-Feed % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	5	Y
1 - 3/4	NA	NA	0.0	5	Y
3/4 - 1/2	NA	NA	0.0	5	Y
1/2 - 3/8	NA	NA	0.0	5	Y
3/8 - 4	NA	NA	0.0	5	Y
4 - 8	NA	NA	0.0	2	Y
8 - 16	NA	NA	0.0	2	Y
16 - 30	NA	NA	0.0	2	Y
30 - 50	NA	NA	0.0	2	Y
50 - 100	NA	NA	0.0	2	Y
100 - 200	NA	NA	0.0	2	Y
200	NA	NA	0.0	2	Y

Corrected Ign. Oven SA:		Film Thickness:	
Cold-Feed Surface Area:		Film Thickness:	
Correction Factor:			

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9
+#4 sieves minimum tolerance =			5

Remarks: ____

____

____

Distribution________ Central Materials________ Dist Materials________ Contr./Producer________ Proj. Engineer________ Technician________

QMC GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

QMC Gradation Correlation I.M. 216

Project No.: ______________________

Plant Name: ______________________

Contractor: ______________________

Coarse Agg. Source: ______________

Monitor: ______________

C.P.I.: ______________

Contract ID: ______________

County: ______________

Mix Design Number: ______________

Intermediate Agg. Source: ______________

Cert. No.: ______________

Cert. No.: ______________

Date Sampled: ______________

Gradation Date: ______________

Design No.: ______________

Fine Agg. Source: ______________

Proper Equipment: ______________

Specification: ______________

Sieve Size	D.O.T. Coarse Agg Percent Passing	Prod. / C. P. I. Coarse Agg Percent Passing	D.O.T. Coarse Agg Percent Retained	Prod. / C. P. I. Coarse Agg Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5" / 37.5mm							
1" / 25.0mm							
3/4" / 19.0mm							
1/2" / 12.5mm							
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
Minus #200							

Sieve Size			D.O.T. Intermediate Aggregate Percent Retained	Prod. / C. P. I. Intermediate Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5" / 37.5mm							
1" / 25.0mm							
3/4" / 19.0mm							
1/2" / 12.5mm							
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
Minus #200							

Sieve Size	D.O.T. Fine Aggregate Percent Passing	Prod. / C. P. I. Fine Aggregate Percent Passing	D.O.T. Fine Aggregate Percent Retained	Prod. / C. P. I. Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
#16 / 1.18mm							
#30 / 600um							
#50 / 300um							
#100 / 150um							
Minus #200							

Care of Equipment	☐ GOOD	☐ FAIR	☐ POOR
Sampling Procedure	☐ GOOD	☐ FAIR	☐ POOR
Splitting Procedure	☐ GOOD	☐ FAIR	☐ POOR
Sieving to Completion	☐ GOOD	☐ FAIR	☐ POOR
Computations	☐ GOOD	☐ FAIR	☐ POOR
Reporting	☐ GOOD	☐ FAIR	☐ POOR

Comments: ______________________

cc: ______________________

IM 320
CORE SAMPLING

METHOD OF SAMPLING
COMPACTED ASPHALT MIXTURES

SCOPE
This IM provides the procedures used for sampling compacted asphalt mixtures.

REFERENCED DOCUMENTS

IM 204, Inspection of Construction Project Sampling & Testing

APPARATUS

- Core drill suitable for cutting a sample from the mat with a minimum 4” nominal diameter bit. Note: 6” nominal diameter is needed for joint coring.
- Core tongs if a core drill is used to cut the sample
- Hammer
- Steel plate 4 in. wide, 4 in. long, 1/8 in. thick and curved to fit firmly around the core being taken. A piece of core bit will serve this purpose.
- Wedge – A small cold chisel makes a suitable wedge.

PROCEDURE

1. Unless otherwise specified, sampling frequency shall comply with IM 204 and applicable IM 204 appendixes. ~~and s~~Sample sites shall be randomly located by the Engineer.

> **NOTE:** Exercise care during sampling, handling, transporting and testing to minimize possibility of damaging the specimens.

2. Drill completely through the layer being sampled.

> **NOTE:** If samples are to be cut from compacted mixtures that are still warm, it may be necessary to subject the sample site to artificial cooling equivalent to surface contact with ice for approximately 20 minutes.

3. Use the curved steel plate for protection of sample. Then place the wedge behind the plate and strike it with a sharp blow from the hammer. This will snap the sample loose.

4. If a layer being sampled adheres to a lower layer such that it is necessary to remove two or more layers during the sampling process, cool the composite sample and remove the extraneous material before testing by sawing or other suitable methods.

> **NOTE:** Under no circumstances shall the cores be submerged in water before testing.

5. All samples shall be carefully inspected for damage before testing. Samples that are damaged shall be replaced by additional samples obtained as outlined above.

6. Mark the core for later identification.

DOCUMENTATION

Assign a number to each core and record the core number, date sampled, station, and transverse position on the appropriate form.

IM 321
Gmb

METHOD OF TEST FOR COMPACTED DENSITY OF ASPHALT MIXTURES (DISPLACEMENT METHOD)

SCOPE

This IM provides the method of test used in determining the bulk specific gravity (G_{mb}), bulk density, of laboratory-compacted specimens of asphalt or cores takes from compacted asphalt pavements.

APPARATUS

- A balance having a capacity of 5000 grams or more and accurate to 0.5 gram.
- Water container of sufficient size to allow a submerged sample to not touch the sides or bottom.
- Suspension apparatus (sample holder) – "wire suspending the container shall be the smallest practical size to minimize any possible effects of a variable immersed length. The suspension apparatus shall be constructed to enable the container to be immersed to a depth sufficient to cover it and the test sample during weighing. Care should be taken to ensure no trapped air bubbles exist under the specimen" (AASHTO T166-00).
- Spatula or putty knife
- Clean cloth

Balance, Sample Holder, and Water Container

PROCEDURE

SAMPLE PREPARATION

Field Cores

1. Allow the core to attain laboratory room temperature prior to testing. Cores stored in refrigerated units must be removed and allowed to stand at least 2 hours at room temperature prior to testing. Under no circumstances shall the cores be submerged in water prior to testing.

2. Clean off all loose particles, base materials, and prime oils that are stuck to the sample. The portion of the sample that needs to be cleaned may be lightly warmed and scraped with a putty knife.

3. If water was used in cutting the sample, the specimen shall be surface-dried before testing.

Laboratory Compacted Specimens

1. Cool lab-compacted specimens to laboratory room temperature before testing.

2. Clean off all loose particles that are stuck to the specimen.

TEST PROCEDURE FOR DENSITY

1. Fill the water container with water at approximately 77°F to a depth sufficient to ensure that the sample holder and sample are completely submerged during testing.

2. Connect the wire to the balance at the point provided on the balance.

3. Connect the holder to the wire and place in the water bath filled with water and tare the balance.

4. Weigh the sample in air (W_1).

5. Weigh the suspended sample completely submerged in water targeted at 77° ± 5°F (W_2). The reading must be taken when the balance stabilizes.

> **NOTE:** The balance will normally be considered to have stabilized when the weight reading doesn't change by more than 0.1 gram over a 10 to 30 second time span.

6. Remove the sample from the water and immediately, with a damp cloth, blot the free water from the surface of the sample. Then, immediately weigh the sample again in air (W_3).

> **NOTE:** Care should be taken not to rub any particles from the edges or corners when blotting the free water.

7. Calculate the G_{mb} bulk density and report the result to three decimal places.

CALCULATIONS

The calculation for determining G_{mb} is as follows:

$$G_{mb} = \frac{W_1}{W_3 - W_2}$$

IM 322
SAMP. UNCOMP. HMA

SAMPLING UNCOMPACTED ASPHALT

SCOPE
Three methods are used for sampling asphalt mix to be submitted for laboratory tests.

REFERENCED DOCUMENTS
Standard Specification 2303 Flexible Pavement
Standard Specification 2309 Surface Recycling by Heater Scarification
IM 336 Reducing Aggregate Field Samples to Test Samples
IM 357 Preparation of Asphalt Mix Samples for Test Specimens

APPARATUS

- Metal Sampling Template, with a minimum area of 64 in.^{2} & 4 in. deep.
- Laboratory Sampling Scoop (Square Pointed)
- Putty Knife
- 2-gallon capacity cardboard box, heat resistant buckets or insulated containers
- Sampling Container
- Ruler
- Quartermaster (Optional)
- Square-pointed Shovel or for sampling from the hopper and windrow sampling: A square-pointed shovel of a size easily handled with built-up sides and back (approximately 1 ½" [37.5mm]) to facilitate the retention of material on the shovel when sampling.

Equipment used for sampling purposes must be clean and free of any materials, which may alter the material properties of the mixture. Extra care should be used when using petroleum distillates or other solvents to clean equipment. If petroleum distillates or other solvents are used to clean equipment, the equipment must be dry prior to use.

PROCEDURE

Sample Size

Samples submitted to both laboratories for testing shall be 40 pounds to run each of the required tests (G_{mm}, G_{mb} and extracted gradation). Samples taken from thick layers will be proportionately larger.

Paired Samples
Field sampling (side-by-side sampling) to obtain paired samples as required providing Agency verification samples and Contractor quality control samples. The Contractor shall obtain asphalt samples in accordance with the procedures outlined in the required sampling method that follow and obtain two boxes of at least 40 pounds from each sample site as directed and witnessed by the Engineer.

When paired samples are required, but a template is not used to delineate the sample such as for base widening, thick lifts or heater scarification, the Engineer will provide direction on the sampling procedures to be used. Adjacent locations for paired samples will be used whenever practical.

After obtaining paired samples, Agency personnel will immediately take possession of one of the two boxes, secure it according to IM 205 Appendix A and fill out sample identification (Form #193) before returning the sample to the Contractor for transport to the Agency's testing lab.

Sampling Methods

The District Materials Engineer may approve an alternate sampling method to sampling behind the paver (Section A. Pavement Sampling) when field conditions warrant. Sampling safety and materials aspects of the project should be considered when selecting the sampling method.

NOTE: Extreme care shall be taken to minimize segregation of coarse and fine particles while the sample is being taken. **NOTE:** Extreme care shall be taken so as not to contaminate the sample with any foreign matter (Fuel oil, dust, etc.).

A. Pavement Sampling

This method of sampling asphalt mixture is not to be used in situations involving Heater Scarification Work as stated in Standard Specification 2309.

1. Samples shall always be taken behind the laydown machine before the material receives any compaction. Sampling shall be distributed over at least 30 tons of mix placed (approximately two different truckloads).

2. The template shall be placed on the mat and forced straight down through the entire depth of the mat being laid. All material inside the template shall be scooped out and placed uniformly in the sample container(s). The scoop is used to remove the material from the inside of the template. All the material, which has stuck to both the inside and outside of the scoop, shall be scraped off and added to the sample. The engineer may adjust the details of this procedure when samples are obtained from courses placed on earth subgrades, untreated subbases, and bases to prevent contamination. **NOTE:** Any material adhering to the inside of the template shall be scraped off and added to each template sample.

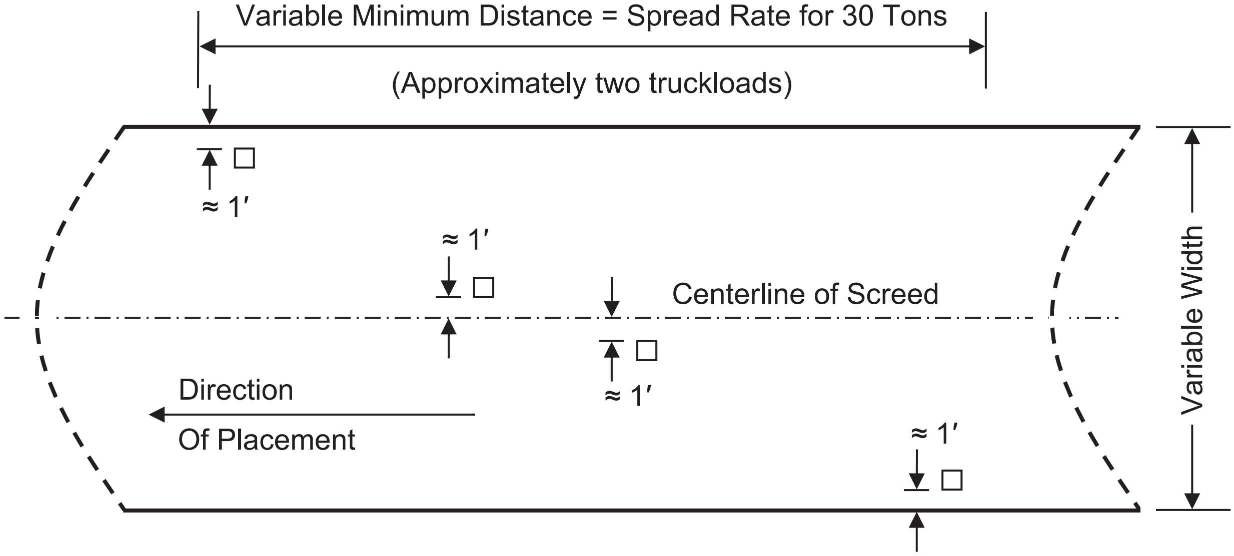
3. For paired samples, after obtaining each template sample for the first box, the template shall be moved longitudinally so that the second template sample site shares a common edge (not more than 4 inches apart) with the first. A double template with a divider in the middle may be used to expedite the paired sampling. When using a double template, scraping the material from the inside of the template needs to be done only once at the completion of sampling.

   Perform the same procedures as stated in step 2 to remove all materials from the adjacent location and place this material in the second box.

4. Samples shall be taken to represent a cross-section of the mat as follows:

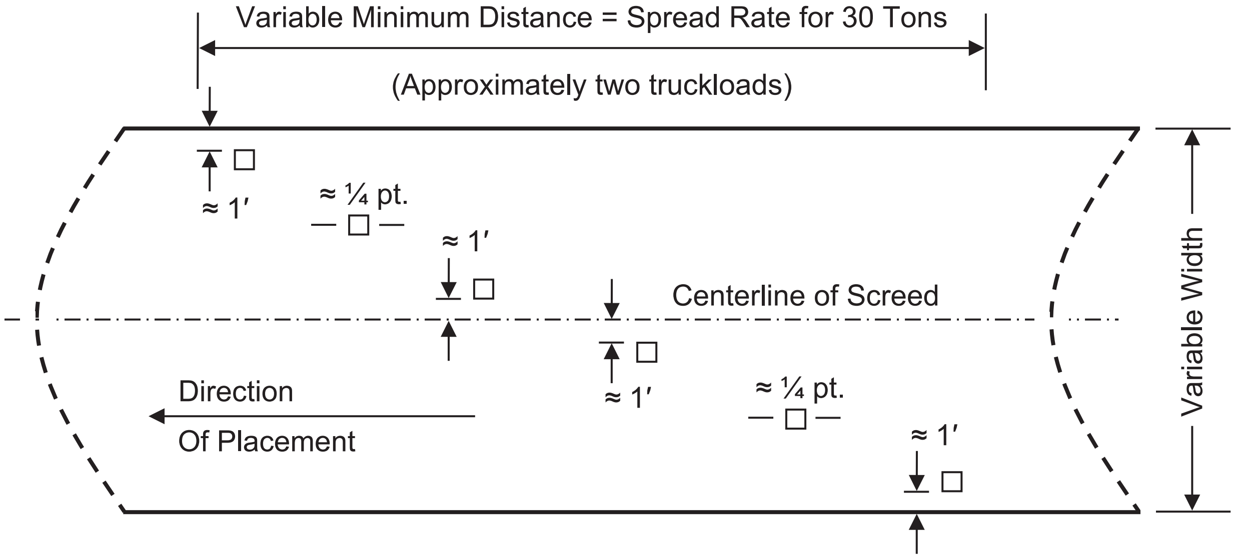
   a. A minimum of four template samples shall be taken. One approximately 1 foot in from the left edge of the mat, one approximately 1 foot left of the center of the screed, one approximately 1 foot right of the center of the screed, and one approximately 1 foot in from the right edge of the mat. (See Diagram 1.)

DIAGRAM 1



b. If six template samples are needed to yield a sample of sufficient size, an additional template sample shall be taken approximately on each quarter point. (See Diagram 2.) If eight or more template samples are needed to yield a sample of sufficient size, two or more repetitions of four or six template samples may be required.

DIAGRAM 2



5. When sampling from thick lifts (generally greater than 3 inches in thickness), obtain the sample in increments as outlined above except a metal straight edge or a square point shovel may be used to delineate the sample sites in lieu of the template. When using the shovel to sample thick lifts, the shovel is first used to delineate the sample area and remove the material that is not part of the sample by creating a vertical face and pulling

the shovel and excess material away from the sample area. Then the shovel can be used to remove the sample. The scoop can be used to finish the sampling to be sure that all mix within the delineated area is included in the sample increment. If the four segments required in section 3a result in excess mixture, the additional mixture shall be forwarded to the appropriate laboratory. Large samples shall be carefully combined and reduced at the laboratory prior to testing.

6. When mix is placed in narrow widths such as base widening where the above sampling pattern will not work, a sample shall be obtained in a minimum of two increments from near the center of the placement and spread out over at least 30 tons or approximately two truckloads.

B. Hopper Sampling

This method of sampling asphalt mixture shall be limited to projects using HMA Interlayer and High Performance Thin Lift Overlay mixes, as well as the Heater Scarification Process as stated in Standard Specification 2309.

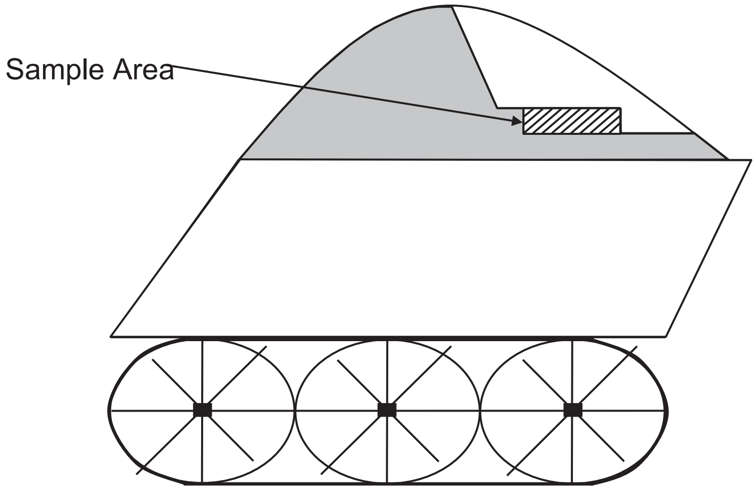
1. The sample shall always be taken from the paver hopper for the Heater Scarification Process.

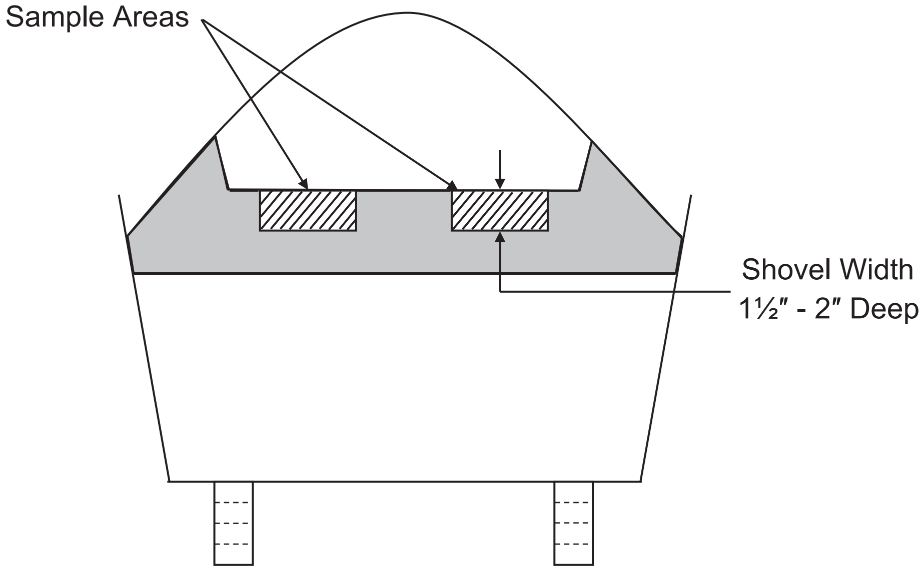
2. A square pointed shovel shall be used to prepare the sampling area and to take the sample.

3. The sample shall be built up from a minimum of 30 tons of mixture placed (approximately two different truckloads).

4. The sample shall be taken from a location, which is as near the center of the mass of a nearly full hopper as practically possible. A flat surface shall be prepared by removing mix downward from the peak until the desired benched area is reached. Just prior to taking the sample, all foreign material shall be scraped from the shovel. The sample shall be removed from the benched area in a manner that will assure collection of sample material over an area, which is of uniform dimension. Paired sampling requires two samples be taken from the same benched area in the hopper. Space the sampling pairs so each sample is obtained from a uniform, undisturbed portion of the benched material. Do not locate a paired sample in material disturbed from taking the first sample.

5. Any material adhering to the inside of the shovel shall be scraped off and added to each sample. Scrape the leftover HMA material on the inside of the shovel only. If taking paired sample, equally distribute scrapped material into both sample containers.





C. Windrow Sampling

This method covers sampling asphalt material from the windrow at the jobsite. These samples may be utilized when sampling behind the paver is not practical, and the hopper is not accessible.

When sampling from the windrow, use a square-pointed shovel with built-up sides and back (approximately 1 ½") to facilitate the retention of material, especially coarse aggregates, during the sampling process.

1. Obtain sample at a minimum of three locations along the windrow. Choose locations along the windrow that appears uniform; avoid the beginning or the end of the

windrow section. Each sample is obtained in at least three increments at a minimum of three locations along the windrow. Sample increments must be located a minimum of 6 feet apart as shown in diagram below. Illustration shows paired samples “A” and “B”.

2. Remove approximately 1 foot from the top of the windrow. See windrow cross section diagram below.

3. Bench out a section at intermediate height on one side of the windrow, as shown in cross section diagram below. For paired samples, bench out a section that is large enough for sampling side-by-side paired samples, as shown in the illustration.

4. Just prior to taking the sample, all foreign material shall be scraped from the shovel. Use the square-pointed shovel with built up sides to obtain one increment of the sample from the benched section. The sample shall be removed from the benched area in a manner that will assure collection of sample material over an area, which is of uniform dimension. Insert the shovel horizontally into the benched section of the windrow (labeled “sample” in the diagram below). The illustration’s “sample” dimensions are a shovel width wide and approximately 1.5”-2” deep. Paired sampling requires two samples be taken from the same benched area of the windrow. Space the sampling pairs so each sample is obtained from a uniform, undisturbed portion of the benched material. Do not locate the paired sample in material disturbed from taking the first sample.

5. Obtain a minimum of two additional sample increments per sample at additional locations (minimum of three) along the windrow.

6. Any material adhering to the inside of the shovel shall be scraped off and added to each sample. Scrape the leftover HMA material on the inside of the shovel only. If taking paired sample, equally distribute scrapped material into both sample containers.

7. Deposit bituminous material in suitable container; prevent contamination and segregation of material.

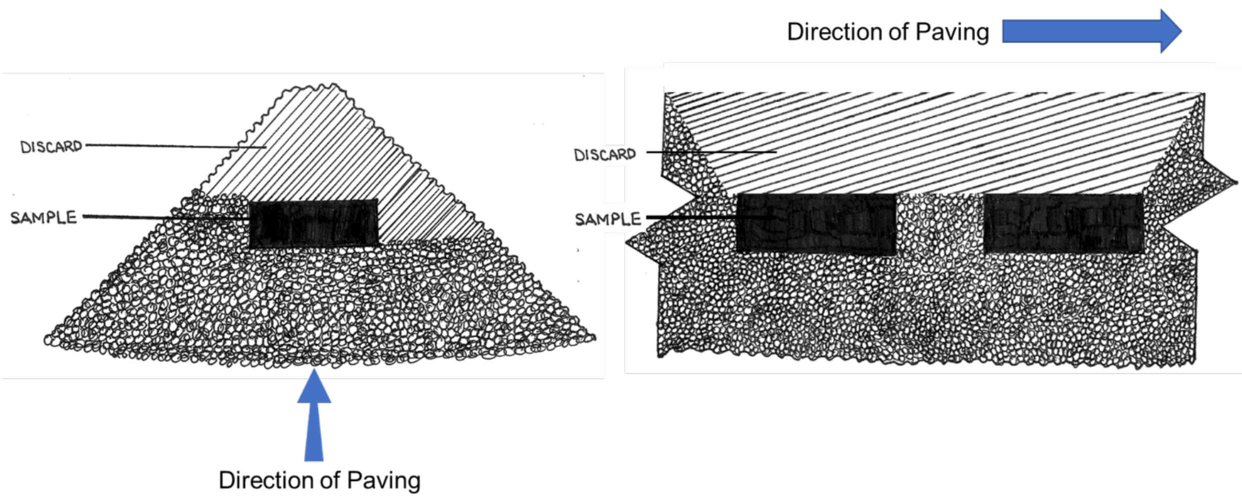


Illustration of windrow cross section and one paired-sample increment.

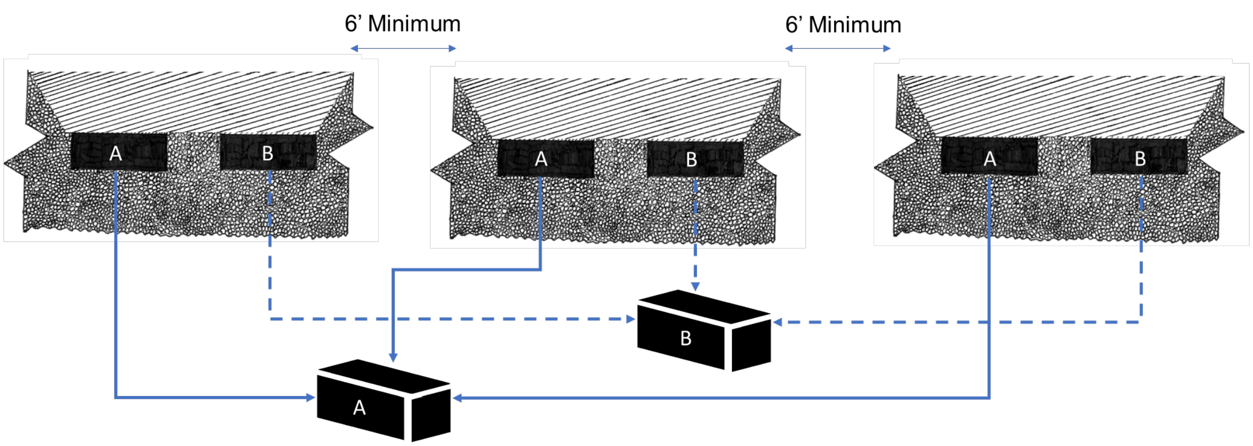


Illustration of paired sampling along the windrow. Repeat sampling increments as needed.

Sample Splitting

These splitting methods are to be used for reducing large field samples to lab sample size and to provide split samples for testing in multiple labs. To reduce samples to test sample size see IM 357.

The order of preference of sample splitting is as follows:

A. Quartermaster (Or Similar Quartering Device)

1. Place the entire sample in the Quartermaster. **NOTE:** Take care to avoid segregation when placing material in the Quartermaster.

2. Release the gate to split the sample into four smaller samples.

3. Take the split material from opposite corners and recombine to obtain two boxes of material.

B. Riffle Splitter

Follow procedure I, Splitting Method, in IM 336 with the following exceptions:

1. Only one cycle of this process is performed to obtain the desired sample size for both labs.

C. Manual Splitting

Follow procedure IV, Quartering Method, in IM 336 with the following exceptions:

1. Only one cycle of this process is performed to obtain the desired sample size for both labs.

Sample Delivery & Retention

1. Each sample shall be carefully labeled by the Agency Inspector.

2. The Contractor will transport the boxes to the Contractor's QMA laboratory.

3. The Contractor's certified technician will test the unsecured box of the paired sample at the Contractor's QMA laboratory for testing.

4. The secured box of each paired sample will be retained at the Contractor's QMA laboratory until delivered by the Contractor to the testing lab designated by the Engineer.

5. The Contractor shall retain all samples and test specimens for a lot until the Contracting Authority accepts the lot. **NOTE:** The Contractor should retain all samples until notified by the Contracting Authority that the material is no longer required.

IM 323
BINDER SAMPLING

METHOD OF SAMPLING ASPHALTIC MATERIALS

SCOPE

This IM provides the procedure used in the sampling of asphaltic materials (asphalt binder, asphalt emulsions, and cutback asphalts) to be submitted for laboratory tests. The necessary sample containers are available for purchase by the contractor from the Iowa Department of Transportation, Ames warehouse.

APPARATUS

- Disposable, unlined, one-quart capacity cardboard sample catching containers.
- 3 oz. or 4 oz. ointment tin for asphalt binder.
- One-quart capacity wide-mouth cans with lids for cutback asphalts and complete analysis binder samples.
- One-quart and one gallon plastic bottles for asphalt emulsion.
- Clean, dry cloth.
- 1 pair insulated gloves.

PROCEDURE

1. Single samples as follows:

    a. Binder for DSR stiffness – 3 oz. or 4 oz. tin

    b. Binder complete analysis – 1 quart metal can

    c. Cutback asphalts – 1 quart metal can

    d. Asphalt emulsion – partial analysis 1 quart– must be a plastic bottle
    – complete analysis – 1 gallon– must be a plastic bottle

SAMPLING PROCEDURE

The various materials shall be drawn from plants, distributors, and storage tanks as required in a safe and reliable manner. Single samples shall be taken at the rate prescribed and by the following methods:

1. Sampling from Mixing Plants

    Samples shall be taken from sampling valves located in the pumping line, (line from tank to mixer). A minimum of one-gallon of material must be drawn and wasted from the sampling valve before the actual sample is drawn. The plant should be operated a minimum of one hour before samples are taken.

Sample material shall be drawn into the appropriate containers provided for that purpose. DSR samples shall be prepared by pouring the material from the sample catching container into the ointment tins; the tins shall be filled to a depth 1/4" from the top. Material should not be spilled over the sides and edges of the tins. The tins should be covered and allowed to cool in air to handling temperature. The tins should then be capped and marked for shipment. When cutback asphalt or asphalt emulsion samples are obtained from mixing plants, the sample shall be one quart or one gallon size and may be placed directly in the shipping containers provided.

Prior to use, the "uncoated" sample-catching containers and sample storage containers should be inspected and wiped clean of dust and manufacturing residue with a clean, dry cloth. If the containers, which are to be used for shipment, are spattered during the pouring operation, they should be wiped clean with a clean, dry cloth. In case the tins are over filled or otherwise made unusable, they should be disposed of and new tins filled as required. Under no circumstances should any volatile material or contaminants of any kind be allowed to come in contact with the samples, containers, and cleaning cloths.

In the event that it is necessary to sample storage tanks by dipping through the dome or top opening of a tank, care should be taken so that the container is not filled entirely with the materials from the top portion of material in storage.

2. Samples from Distributors

Samples should be drawn from the spray bar after heating and recirculation has been completed. The spray bar should be opened and cleared of old or foreign material before the sample is taken. Asphalt emulsion samples should be taken from the spray bar after it has been adjusted to gravity feed. Samples may be drawn directly into sample containers furnished for this purpose.

NOTE:: The test results of asphalt emulsion samples can be greatly affected when samples are obtained from the spray bar, under pressure.

NOTE: When asphalt emulsions are diluted for tack coat material, the addition of the water changes the manufacturer's formula. Due to this, very rapid settlement occurs. To obtain a representative sample of the diluted asphalt emulsion, it is essential to obtain the sample immediately after circulating the material.

The precautions listed in the previous section should be observed in this procedure as well. Refer to Section No. 1 for size of samples.

3. Samples from Transports, Rail Cars, Terminal Storage

When samples are to be obtained from hauling units or terminal facilities, sampling methods listed in Section No. 1 above are to apply. Samples shall be drawn from sampling valves located in tank walls or bulkhead, and/or transfer lines when possible. When sampling valves are not provided, samples are to be obtained by inverting sample containers substantially below the surface of the stored material.

IM 324
MOIST. CONT. OF RAP

****THIS IS A NEW IM. – PLEASE READ CAREFULLY.****

DETERMINING THE MOISTURE CONTENT OF RAP FOR USE IN HMA

GENERAL

This test method is used to determine the percent of moisture in RAP stockpiles being used in the production of HMA. The moisture contents determined are used to correct the weight of material being fed into mixing plants that measure the weight of RAP prior to drying.

Apparatus:
Oven capable of maintaining a temperature of 275 ± 5 degrees F.
Balance capable of weighing a minimum of 1000g and accurate to 0.1g.
Sample pans
Spatula or spoon for stirring sample

PROCEDURE

Obtain a representative sample of the RAP as per IM 301. Immediately reduce the sample to the test sample size, minimum of 500g, by splitting or quartering as per IM 336. Record the empty weight of the sample pan and the spatula or spoon. Tare the sample pan on the scale. Place the test sample in the pan and record the original weight of the sample to the nearest 0.1g. Place the sample in the oven maintained at 275 ± 5 degrees F. Stir the sample occasionally. Dry the sample to a constant weight defined as no change in weight exceeding 0.1% of the sample weight in 15 minutes of oven heating. Weigh the sample, pan and spatula or spoon together to avoid any loss of material.

> Note: Samples must be split and weighed as quickly as possible to avoid loss of moisture. If the splitting and test sample weight determination cannot be accomplished quickly, the sample should be sealed in a plastic bag until the test sample preparation can be done.

Once the sample has achieved a constant weight, cool the sample to room temperature. Weigh the sample, pan and spatula or spoon together to the nearest 0.1g. Subtract the weight of the pan and the spatula or spoon from the total weight to obtain the final dry weight of the sample. Calculate the percent moisture by determining the difference between the original weight of the test sample and the final dry weight of the sample and dividing the result by the final dry weight. Multiply the result by 100 to convert to a percentage. Report the moisture content to the nearest 0.1%.

IM 325G
GYRATORY COMPACTION

METHOD OF TEST FOR DETERMINING THE DENSITY OF ASPHALT USING THE SUPERPAVE GYRATORY COMPACTOR (SGC)

SCOPE

This method describes the procedures for compacting asphalt samples using the SGC and determining their percent compaction. This method consolidates the provisions of AASHTO T312 and makes the following exceptions:

- Compaction temp

REFERENCED DOCUMENTS

Standard Specification 2303 Flexible Pavement
AASHTO T312 Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
IM 321 Compacted Density of Asphalt Concrete
IM 357 Preparation of Bituminous Samples for Test

APPARATUS

- SGC, including a device for measuring and recording the height of the specimen throughout the compaction process. The compactor may also include a printer or a computer and software for collecting and printing the data.
- Specimen molds per AASHTO T312
- Thermometer with a range of 38 to 200°C (100 to 400°F).
- Balance with a minimum capacity of 6,000 gram and readable to at least 1 gram.
- Forced Draft Oven capable of maintaining a constant temperature of 177 ± 3°C (350 ± 5°F) and large enough to hold 2 molds and mix pans.
- Pan between approximately 200 in.^{2} and 300 in.^{2} in size.
- Safety equipment: insulated gloves, long sleeves, apron, etc.

General Equipment:

- Calibration equipment recommended by compactor manufacturer
- Paper discs with a diameter of 150 mm (6 in.).
- Lubricating materials recommended by compactor manufacturer
- Scoop or trowel for moving mixture
- Funnel or other device for ease of loading mixture into mold.

PROCEDURE

CALIBRATION

The means of calibrating the gyratory vary with different manufacturers. Refer to the operation manual and manufacturer's recommendations of the particular brand and model of gyratory available for use. Calibration of the following items should be verified at the noted intervals unless manufacturer's recommendations are more stringent:

Item	Tolerance	Calibration Interval
Height	Record to nearest 0.1 mm, Compact to 115 $\pm$ 5 mm	Daily
Angle (Internal)	1.16° ± 0.02°	See IM 208
Pressure	600 $\pm$ 18 kPa	See IM 208
Speed of Rotation	30.0 $\pm$ 0.5 gyrations per minute	See IM 208
Mold dimension	149.90 to 150.00 mm[1]	See IM 208
Platen dimension	149.50 to 149.75 mm	See IM 208

1. Molds with inside diameters up to 150.20 mm, measured according to AASHTO T312 may be used.

COMPACTOR PREPARATION

1. Turn the compactor on and allow for warm-up before proceeding.
2. Lubricate the mold or gyratory parts as recommended by the manufacturer.
3. Perform the height calibration per manufacturer's recommendations.
4. Set the specified number of gyrations, N_{des}.

TESTING

1. Obtain the material for the test specimen by following the procedure in IM 357.
2. Weigh into separate pans for each specimen the amount of asphalt mixture required which will result in a compacted specimen 115 ± 5 mm in height. Spread the material uniformly in the pan to between 1 to 2 in. of thickness.

   This will normally be about 4700 grams.

3. Heat the pans of loose asphalt mixture in the oven to a temperature of 135 ± 2°C (275 ± 5°F) as checked by a thermometer with the bulb in the center of the mixture sample. The oven temperature may not exceed 143°C (290°F).

   Heat WMA mixtures to 240 ± 5°F.

   a. Heat the mold, base plate, top plate (if used) and funnel (if used) in the oven for each specimen compacted for a minimum of 30 minutes. In between tests, a minimum of 5 minutes reheating should be used.

4. Place a paper disc in the bottom of the mold. Place the mixture into the mold in one lift. A funnel or other device may be used to place the mixture into the mold. Take care to avoid segregating the mix in the mold, but work quickly so that the mixture does not cool excessively during loading. Level the mix in the mold and place a paper disc on top.
5. Place the mold in the gyratory.

6. If the desired number of gyrations (N_{des}) has not been entered into the gyratory, do that now. The number of gyrations to apply is determined from the Job Mix Formula (JMF).

> **NOTE:** Some gyratories allow charging the mold with mix after the mold has been positioned in the compactor.

7. Apply the load to the mixture in the mold.

8. Apply the gyratory angle to the specimen.

9. Compact to N_{des}.

10. After compaction is complete, remove the angle from the specimen, and raise the loading ram if needed (this is done automatically on some gyratories).

11. Extrude the specimen from the mold. Take care not to distort the specimen when removing the specimen from the mold. Remove the paper discs while the specimen is still warm to avoid excessive sticking.

12. Record or print the height data for each specimen compacted.

> **NOTE:** A cooling period of 5 to 10 minutes before extruding the specimen may be necessary with some mixtures; a fan may help speed the cooling process.

13. After the specimens have cooled, they may be tested for bulk specific gravity, G_{mb} per IM 321.

IM 337
COURSE THICKNESS

METHOD TO DETERMINE THE THICKNESS OF COMPLETED COURSES OF BASE, SUBBASE & HOT MIX ASPHALT

SCOPE

This method covers the sampling and measurement procedures for determining the thickness of completed courses of pavement.

REFERENCED DOCUMENTS:

IM 320, Method of Sampling Compacted Asphalt Mixtures

APPARATUS

1. Complete core drilling apparatus as required in IM 320 or as furnished by the contractor.
2. Straightedge at least 18 in. long
3. Ruler with graduations of 1/16 in.
4. Tape measure

PROCEDURES

Specifications and instructions require that the thickness of the completed pavement courses be measured to the nearest 1/8 in. by means of cores, measurement of hole depth or measurement of the side of the trench, as directed by the engineer. Sample sites shall be randomly located.

A – THICKNESS DETERMINATION BY CORE MEASUREMENT

A-1 If the compacted material has sufficient cohesion and strength to permit the drilling and handling required to obtain an undisturbed core, this method should be used.

A-2 Drill through the course and remove the core. Perform thickness measurements before trimming core. Refer to IM 320 for drilling and removal procedures.

A-3 Measure with a ruler, to the nearest 1/8 in., the thickness of the pavement course. Make four measurements, along the edge of the core at 90° intervals.

A-4 Assign a number to the core and record the core number, date drilled, station, transverse position (distance from centerline) and core measurements.

A-5 Retain all samples obtained from lots of construction that are determined to be deficient until final disposition of the lot is made as provided for by the specifications.

B – THICKNESS MEASUREMENTS BY HOLE MEASUREMENT

B-1 If the core breaks, while drilling or handling, or if it crumbles or disintegrates in the hole while drilling, the hole may be measured.

B-2 Place a straightedge at least 18 in. long, flat on the surface so as to establish the plane of the surface surrounding the hole.

B-3 Measure with a ruler, to the nearest 1/8 in., the distance perpendicular from the straightedge, laid across the center of the hole, to the bottom of the hole.

B-4 Take two measurements along the edges on opposite sides of the hole with the straightedge parallel to the centerline of the road, and two with it perpendicular to the centerline.

B-5 If the core breaks, but the portion in contact with the subgrade remains intact, remove it and measure to the nearest 1/8 in. the amount of the subgrade material adhering to it at four points on the edge of the core at 90° intervals. Subtract the average depth of subgrade material for the average depth measurement of the entire depth of the hole as made in B-1 to arrive at the average thickness.

B-6 Record the station, lateral position, date measured, and the depth of hole measurements.

C – THICKNESS DETERMINATION BY SIDE OF TRENCH MEASUREMENT

C-1 If accurate measurements cannot be obtained as outlined in Section A or B, the engineer, at his/her discretion may require the course to be dug open with any hand or mechanical means which will produce an opening large enough, and of sufficient depth, to permit viewing of the pavement course profile and the subgrade immediately under it. Obtain at least four measurements from the surface to the bottom of the course as viewed in the trench as described in Section B.

CALCULATIONS

Average the individual measurements for each core or hole to the nearest 1/8 in., and record in the appropriate field book and report form.

EXAMPLE DETERMINATION OF QUALITY INDEX (QI)

Design thickness 4 in.

Individual core averages as determined and recorded per this IM.

4.50 in.
3.75 in.
4.00 in.
4.12 in.
3.50 in.
3.88 in.
4.12 in.

Average = 3.982 in.

Range = (high value - low value) = 1 in.

$$QI = \frac{\text{Average - (Design - 0.5)}}{\text{Range}}$$

$$QI = \frac{3.982 - (4.00 - 0.5)}{1.00}$$

$$QI = 0.48$$

Report QI upon completion of each lot. Refer to applicable specifications for specific details and disposition for each type of construction.

IM 338
IGNITION METHOD

DETERMINING ASPHALT BINDER CONTENT & GRADATION OF HOT MIX ASPHALT (HMA) BY THE IGNITION METHOD

SCOPE

This test method covers the procedures used for the determination of the asphalt binder content and gradation of HMA mixtures by ignition of the asphalt binder in an oven. The aggregate remaining after ignition can be used for sieve analysis using IM 331.

REFERENCED DOCUMENTS

AASHTO T308 Determining Asphalt Binder Content of Hot Mix Asphalt (HMA) by Ignition Method
IM 301 Aggregate Sampling & Minimum Size of Samples for Sieve Analysis
IM 322 Sampling Uncompacted Hot Mix Asphalt
IM 323 Sampling Asphaltic Materials
IM 331 Mechanical Analysis of Extracted Aggregate
IM 336 Reducing Aggregate Field Samples to Test Samples
IM 357 Preparation of Hot Mix Asphalt Mix Samples for Test Specimens
IM 510 Design of Hot Mix Asphalt Mixtures

APPARATUS

- Ignition oven – Meeting the requirements of AASHTO T308 Method A or Method B.
- Sample basket(s) – Meeting the requirements of AASHTO T308 Method A or Method B.
- Catch pan of sufficient size to hold the sample basket(s) so that aggregate particles and melting binder falling through the screen mesh are caught.
- Spatula or trowel
- Pan of sufficient size to hold the HMA.
- Oven capable of maintaining 275 ± 5°F (135 ± 3°C).
- Balance: 10,000-gram minimum capacity and readable to 0.1 grams.
- Safety Equipment – safety glasses or face shield, high temperature gloves, long sleeve jacket, a heat resistant surface capable of withstanding 1202°F (650°C) and a protective cage capable of surrounding the sample baskets during the cooling period.
- Miscellaneous Equipment – a pan larger than the sample basket(s) for transferring sample after ignition, spatulas, bowls, and wire brushes.
- Mixer: capable of mixing samples of HMA of at least 2000 grams.

PROCEDURE

Sampling

1. Obtain samples of aggregate in accordance with IM 301.

2. Obtain samples of asphalt binder in accordance with IM 323.

3. Obtain samples of freshly produced hot mix asphalt in accordance with IM 322.

Establishing a Mixture-Specific Calibration Factor

This method may be affected by the type of aggregate in the mixture. Accordingly, to optimize accuracy, a calibration factor will be established with the testing of a calibration sample for each mix to be tested. The calibration factor shall be established using the ignition oven intended for quality control.

The calibration process should be repeated each time there is a significant change in the mix.

Calibrate the ignition oven components per the manufacturer's recommendations.

If using an ignition oven with a built in scale, set the ignition oven to test until either the change in weight does not exceed 0.01 percent of the total sample weight for three consecutive minutes or until the sample weight loss does not exceed 0.2 g for three consecutive minutes.

1. Prepare a calibration sample according to Table 1 at the target binder content. Aggregate used for the calibration specimen shall be sampled from stockpiled material produced in the current construction season and designated for use on the candidate project. A sample of the cold feed from the plant is preferred. The aggregates shall be in the proportions needed to obtain the target aggregate gradation. Combine the aggregates and binder by following the procedure in the Mixture Batching, Curing & Testing Section of IM 510. The aggregates and binder may be combined by hand mixing, such that the aggregates are fully coated with binder prior to curing.

Table 1

Sieve Size	Sample Size, g
1 in.	3000-3100
3/4 in.	2000-2100
1/2 in.	1500-1600
3/8 in.	1200-1300

NOTE: If the Hobart 20 quart mixer is used, a minimum sample size of 6000 grams is required. The extra material may be used to check the calibration factor obtained with the first sample.

2. Oven-cure the freshly mixed sample for 2 hours, per IM 510, prior to testing. 1 hour into curing, remove the sample, thoroughly stir and place back into the oven for the remainder of

the curing time.

3. After oven curing, test the specimen using the same procedure as outlined in the Testing Section.

4. Once the calibration specimen has been burned, determine the measured asphalt binder content for the calibration sample by calculation and/or from the printed tickets.

5. The difference between the target binder content and the binder content determined from the ignition oven is the calibration factor for that mix (see Example A for an example calculation).

Testing

1. Preheat the ignition oven to 1000°F (538°C). Manually record the oven temperature (set point) prior to the initiation of the test if the oven does not record automatically.

   NOTE: If the calibration factor for a given mixture is determined at any temperature other than 1000°F (538°C), production samples for that mixture must be tested at that sample temperature.

2. If using an ignition oven with a built in scale, enter the calibration factor for the specific mix to be tested, as determined in the Establishing a Mixture-Specific Calibration Factor Section, in the ignition oven, if desired.

3. Split out a test sample according to Table 1 using the procedure in IM 357. If the mixture is not sufficiently soft to separate with a spatula or trowel, place it in a large flat pan in an oven at 275°F ± 5°F (135°C ± 3°C) until it is workable.

   NOTE: Care should be taken with production samples suspected of containing moisture. Samples with moisture can cause variations in the P_b obtained from the ignition oven. If the sample may contain moisture, split out an additional sample (min. 500g) and determine and record the moisture content by drying to a constant weight in an oven at 275°F.

4. Evenly distribute this sample in the sample basket(s) that have been placed in the catch pan, taking care to keep the material away from the edges of the basket. Use a spatula or trowel to level the specimen to an even depth.

5. Weigh and record the initial weight of the sample to the nearest 0.1 g and the total weight of the sample and basket to the nearest 0.1 g.

6. If using an ignition oven with a built in scale, input the initial weight of the sample in whole grams into the ignition oven controller. Verify that the correct weight has been entered.

7. Open the chamber door, and place the sample basket(s) in the oven. Close the chamber door. If using an ignition oven with a built in scale, verify that the weight displayed on the oven scale equals the total weight recorded in #6 above within ± 5 g. Differences greater than 5 g or failure of the oven scale to stabilize may indicate that the sample basket(s) are

contacting the oven wall. Immediately initiate the test by pressing the start/stop button. This will lock the sample chamber and start the combustion blower.

NOTE: The oven temperature will drop below the setpoint when the door is opened, but will recover when the door is closed and when ignition occurs. Sample ignition typically increases the temperature well above the setpoint, depending on sample size and binder content.

8. If using an ignition oven with a built in scale, allow the test to continue until the stable light and audible stable indicator indicates the test is complete. If the ignition oven does not indicate that testing is complete when 1 hr ± 2 min has elapsed, stop the test. If using an ignition oven without a built in scale, stop the test when 1 hr ± 2 min has elapsed.

9. Press the start/stop button. This will unlock the sample chamber and, if using an ignition oven with a built in scale, will cause the printer to print out the test results.

   NOTE: Testing **must** be completed within 1 hr. Testing performed after this time can cause the material to breakdown.

10. Open the chamber door, remove the sample basket(s), and allow them to cool to room temperature (approximately 30 minutes).

11. If the aggregate calibration factor had been entered into the ignition oven prior to testing, use the corrected asphalt binder content (percent) from the printed ticket. If the aggregate calibration factor had not been entered into the ignition oven prior to testing, adjust the production sample binder content as shown in Example B and report the corrected binder content. Correct for moisture if needed.

Gradation

1. After allowing the sample to cool to room temperature in the sample baskets, empty the contents of the basket(s) into a clean, dry flat pan. Use a small wire sieve brush to ensure that any residual fines are removed from the basket(s).

2. Perform the gradation analysis according to IM 331.

DOCUMENTATION

Report the following information to the appropriate laboratory:

- Target binder content
- Corrected binder content
- Ignition oven binder content
- Target aggregate gradation
- Ignition oven aggregate gradation
- Calibration Factor
- Duration of test
- Total Percent loss

- Initial weight
- Test Temperature
- Temperature compensation factor

EXAMPLE A

Determine the Calibration Factor for a mix.

Given: Target binder content = 5.50%
Ignition oven binder content (calibration sample) = 5.72%

Calibration Factor = Target binder content - Ignition oven binder content (calibration sample)

Calibration Factor = 5.50 - 5.72 = -0.22%

NOTE: The Calibration Factor is normally a negative number.

EXAMPLE B

Determine the corrected binder content for a production sample.

Given: Ignition oven binder content (production sample) = 5.75%
Calibration Factor = -0.22%

Corrected binder content = Ignition oven binder content (production sample) + Calibration Factor

Corrected binder content = 5.75 + (-0.22) = 5.75 - 0.22 = 5.53%

IM 350
Gmm

DETERMINING MAXIMUM SPECIFIC GRAVITY OF ASPHALT MIXTURES

SCOPE

This test method is intended to determine the maximum specific gravity (G_{mm}) of asphalt paving mixtures, commonly referred to as Rice specific gravity. This method uses a flask pycnometer and is based on Iowa Test Method 510 and AASHTO procedure T209. Instructions for the use of a metal bowl type pycnometer are also included.

REFERENCED DOCUMENTS

AASHTO T209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

IM 357 Preparation of Bituminous Mix Sample for Test Specimens

Iowa Test Method 510 Method of Test for Determining Maximum Specific Gravity of Bituminous Paving Mixtures Using a Flask Pycnometer

APPARATUS

- Balance 10,000-gram minimum capacity and capable of weighing to the nearest 0.1 gram
- Pycnometer (four-liter, thick-walled glass Erlenmeyer flask without side discharge nozzle, with top surface of opening ground plane and smooth, and with rubber stopper hose connection)
- Mechanical vibratory device designed to firmly hold the pycnometer while vibrating.
- Vacuum pump or water aspirator for evacuating air from the pycnometer
- Manometer for measuring absolute pressure - **NOTE:** The manometer must not be connected to the vacuum tube coming from the pump, but is to be connected to the pycnometer through a separate tube.
- Thermometers, ASTM 15F (30 to 180°F) [ASTM 15C (-2 to 80°C)], softening point and a general purpose – of suitable range – with graduations every 0.5°F (0.2°C). Electronic thermometric devices meeting or exceeding these requirements may also be used.
- Large, flat, weighing pan about 16 in. x 24 in. x 2 3/4 in. (400 mm x 600 mm x 70 mm) with one end formed in the shape of a chute, for cooling and weighing the sample and for transferring the sample into the pycnometer.
- Glass 4 in. x 4 in. (100 mm x 100 mm) cover plate for accurate filling of pycnometer flask
- Scoop, spatula or trowel, and bulb syringe
- Elevated water container, with gravity discharge valve and tubing, of sufficient capacity to conduct a complete test
- Funnel for transferring sample from weighing pan into the pycnometer

- Equipment meeting AASHTO T209 will also be considered acceptable.

PROCEDURE

Pycnometer Calibration

Calibration of the pycnometer will be performed prior to being put in service. Pycnometer calibration will be performed by accurately determining the weight of water at 77 ± 0.5°F (25 ± 0.2°C) required to fill it. Accurate filling of the flask pycnometer may be ensured by the use of the cover plate. A calibration table may be produced by filling the pycnometer with water at 72°F and at 82°F (22.2°C and 27.8°C).

The following notes apply to both the Erlenmeyer flask apparatus and the alternate equipment meeting AASHTO T209.

NOTE: It is recommended that the calibration of the pycnometer be confirmed at least once a week or when a correlation problem exists.

NOTE: Cover plate and flask pycnometer combinations are not interchangeable. The cover plate used for calibration should also be used for routine testing. If a different cover plate is used, however, the calibrated weight used in G_{mm} determinations must be appropriately adjusted by the difference in weight between the original cover plate and its replacement.

Test Procedure

1. Obtain and transfer to the large, flat pan a test sample weighing between 2,000 and 2,500 grams by following the procedure in IM 357.

2. The ignition oven and G_{mm} sample portions of the field sample are normally taken first and the gyratory density samples obtained from the remainder. When there is insufficient material in the sample for all the required tests, additional material may be obtained by re-heating and re-mixing density specimens, or the sample may be obtained solely from density specimens. Results obtained with density specimen material must be so identified on the report.

   NOTE: Heat the density specimens only long enough to allow the specimens to be broken up and thoroughly mixed, using care not to overheat.

3. Separate the particles of the warmed sample so that the conglomerates of fine aggregate particles are not larger than 1/4 in. (6 mm). Use care not to fracture the aggregate particles. Discard any fractured particles found. Allow to cool to room temperature.

4. If using the flask pycnometer, add about 2 1/2 in. (60 mm) of water at about the same temperature as the sample to the calibrated pycnometer. Tare the pycnometer and water. Transfer the sample into the pycnometer. Determine the sample weight by weighing the pycnometer to the nearest 0.1 gram. Alternately, the sample weight may be determined by weighing the large, flat pan and sample contents to the nearest 0.1 gram, transferring the sample to the calibrated pycnometer, then weighing the empty pan and determining the difference.

If using the metal bowl type pycnometer, it is not required that water be added to the pycnometer prior to placing the sample in the pycnometer and the sample weight may be determined by weighing the pycnometer empty and weighing it again after the sample has been added and determining the difference.

5. If necessary, add water to cover the sample. Remove any loosely trapped air by stirring, being sure to avoid the loss of any sample.

6. Fill the flask pycnometer to about 6 in. (150 mm) from the top with water at the same temperature as that already present.

   NOTE: Water may be pulled into the vacuum pump if the pycnometer is filled too high.

   NOTE: The general-purpose thermometer or thermometric device, which has been calibrated with the ASTM 15F (15C) thermometer, may be used to determine temperatures for routine testing. The ASTM 15F (15C) thermometer must be used for determining temperatures when calibrating the pycnometer and for referee testing. If the thermometric device is calibrated and traceable to NIST standards it may be used in place of the ASTM thermometer.

7. Insert rubber stopper, or, if using a metal bowl type pycnometer, place the transparent plastic lid on the bowl, assure a proper seal and connect vacuum hose. Apply the vacuum necessary to attain between 1.0 in. and 1.2 in. (25 mm and 30 mm) of mercury (H_g) absolute pressure, as measured by a manometer, to the pycnometer contents for 15 minutes. During the vacuum period agitate the pycnometer and contents using a mechanical vibratory device. This will facilitate the removal of gas bubbles trapped in the mix and on the interior surface of the pycnometer.

8. Slowly release the vacuum and remove the vacuum apparatus from the pycnometer and fill with water to the top of the pycnometer. Allow the water filled pycnometer to stand 10 minutes

9. Tip the flask pycnometer slightly and use a glass cover plate and bulb syringe to add water until the pycnometer is completely full and no air bubbles are present. If using a metal bowl type pycnometer, place the vented metal lid on the bowl and assure that water escapes through the vent indicating that all air bubbles have been expelled.

10. Dry the outside of the pycnometer and glass plate or top with a clean cloth, chamois or paper towel, and weigh to the nearest 0.1 gram. Immediately after weighing, remove the glass plate or top and determine the temperature of the water to the nearest 0.5°F (0.2°C) with the general purpose thermometer or thermometric device.

11. Pour off water and dispose of sample.

CALCULATIONS

$$G_{mm} = \frac{W \times R}{W + W_1 - W_2}$$

Where: W = Weight of sample, g

W_1 = Weight of pycnometer filled with water at test temperature, g. (This value must be determined anytime the test temperature changes from the calibration temperature by more than ± 0.5°F (0.2°C).

W_2 = Weight of pycnometer filled with water and sample, g

R = Correction multiplier obtained from Table 2

$$R = \frac{d_t}{0.99707}$$

Where: d_t = density of water at test temperature, g/cc

0.99707 = density of water at 77°F (25°C), g/cc

Note: If the temperature of the water in the pycnometer at the completion of the test is less than 72°F (22.2°C) or greater than 82°F (27.8°C) compensation for the expansion of the asphalt must be included in the calculations as shown in AASHTO T209.

CORRECTION MULTIPLIER FOR SPECIFIC GRAVITY DETERMINATION

TABLE 1 – DENSITY OF WATER (°C)

°C	0	1	2	3	4	5	6	7	8	9
10	0.99973	0.999633	0.999525	0.999404	0.999271	0.999127	0.998971	0.998803	0.998624	0.998435
20	0.99823	0.998023	0.997802	0.997570	0.997329	0.997077	0.996816	0.996545	0.996265	0.995976
30	0.99568	0.995371	0.995056	0.994733	0.994400	0.994061	0.993714	0.993359	0.992996	0.992626
40	0.99225	0.99187	0.99147	0.99107	0.99066	0.99025	0.98982	0.98940	0.98896	0.98852
50	0.98807	0.98762	0.98715	0.98669	0.98621	0.98573				

TABLE 2 – R CORRECTION MULTIPLIER (Correction to 25°C)

°C	0	1	2	3	4	5	6	7	8	9
10	1.0027	1.0026	1.0025	1.0023	1.0022	1.0021	1.0019	1.0017	1.0016	1.0014
20	1.0012	1.0009	1.0007	1.0005	1.0003	1.0000	0.9997	0.9995	0.9992	0.9989
30	0.9986	0.9983	0.9980	0.9976	0.9973	0.9970	0.9966	0.9963	0.9959	0.9955
40	0.9952	0.9948	0.9944	0.9940	0.9936	0.9932	0.9927	0.9923	0.9919	0.9914
50	0.9910	0.9905	0.9900	0.9896	0.9891	0.9886				

TABLE 3 – DENSITY OF WATER (°F)

°F	0	1	2	3	4	5	6	7	8	9
60	0.999040	0.998982	0.998859	0.998764	0.998664	0.998562	0.998455	0.998346	0.998232	0.998115
70	0.997997	0.997874	0.997749	0.997619	0.997489	0.997353	0.997216	0.997074	0.996929	0.996783
80	0.996632	0.996481	0.996325	0.996168	0.996006	0.995844	0.995676	0.995505	0.995335	0.995159
90	0.994984	0.994802	0.994622	0.994436	0.994251	0.994059	0.993866	0.993673	0.993475	0.993277
100	0.993074	0.992872	0.992664	0.992458	0.992246	0.992030	0.99182	0.99160	0.99138	0.99116
110	0.99093	0.99071	0.99048	0.99025	0.99001	0.98977	0.98954	0.98930	0.98906	0.98881
120	0.98857	0.98832	0.98807	0.98782	0.98757	0.98731	0.98705	0.98679	0.98653	0.98626
130	0.98606									

TABLE 4 – R CORRECTION MULTIPLIER (Correction to 77°F)

°F	0	1	2	3	4	5	6	7	8	9
60	1.0020	1.0019	1.0018	1.0017	1.0016	1.0015	1.0014	1.0013	1.0012	1.0010
70	1.0009	1.0008	1.0007	1.0005	1.0004	1.0003	1.0001	1.0000	0.9999	0.9997
80	0.9996	0.9994	0.9992	0.9991	0.9989	0.9988	0.9986	0.9984	0.9983	0.9981
90	0.9979	0.9977	0.9975	0.9974	0.9972	0.9970	0.9968	0.9966	0.9964	0.9962
100	0.9960	0.9958	0.9956	0.9954	0.9952	0.9949	0.9947	0.9945	0.9943	0.9941
110	0.9938	0.9936	0.9934	0.9932	0.9929	0.9927	0.9924	0.9922	0.9920	0.9917
120	0.9915	0.9912	0.9910	0.9907	0.9905	0.9902	0.9899	0.9897	0.9894	0.9892
130	0.9890									

IM 357
SAMPLE PREP.

PREPARATION OF ASPHALT MIX SAMPLES FOR TEST SPECIMENS

SCOPE

This IM is intended to provide the procedure for obtaining representative split samples and representative test specimens from a sample of asphalt mix.

APPARATUS

- Ventilated oven capable of maintaining the specified temperature within ± 5°F (± 3°C)
- Masonry trowel
- Balance. (Refer to the appropriate test procedure for the required capacity and accuracy.)
- Pan, not less than 24 in. x 24 in. x 3 in. for approximately 40 lb. Large samples, approximately 80 lb., will require the use of a pan size not less than 27 in. x 36 in. x 4 in.
- Asphalt mix sampling scoop (scoop with vertical sides)

PROCEDURE

1. Without removing the sample from the cardboard container, heat it and the trowel in the oven at 275°F ± 5°F (135°C ± 3°C) until the mixture is soft enough to be easily worked with and capable of being thoroughly mixed. Heat WMA mixtures to 240 ± 5°F. Then remove the sample from its container and place in the pan. Samples received in insulated boxes may be placed in the pan without heating providing the material is soft enough to be thoroughly mixed.

2. Using the trowel, mix, spread, and flatten the sample to a uniform thickness of approximately 1 1/2 in. Then carefully fold the edges of the sample toward the center and press flat with the trowel, so that large particles will not segregate to the edges. Fold and press one trowel load at a time. With a spatula, scrape the fine material off the trowel distributing it over the surface of the sample. Work around the sample in one direction, overlapping each trowel load until all edges have been folded and a truncated cone has been formed. Spread and re-flatten the sample to a uniform thickness as before. If the sample doesn't appear uniform repeat this process until the sample, when flattened to the uniform thickness of approximately 1 1/2 in., presents a homogeneous appearance.

> **NOTE:** The above technique will produce a truncated cone. Extreme care must be used to keep the sides of this cone as flat as possible and not allow particles to segregate to the edges.

3. To obtain material for the test specimen, start at the center of the sample and remove a strip with the sampling scoop. This strip should be taken from the center towards the outer edge of the pan and full depth of the sample. Make certain that all material is removed down to the bottom of the pan. (Refer to the appropriate test procedure to determine the amount of material taken, as described above, for the test specimen.)

Alternate Procedures for Large Samples Contained in Two or More Boxes

1. The identical procedure is followed, except a large pan is used.

2. Each box of material making up the sample is regarded as a separate sample. The identical regular procedure is followed on each box of material through Step 2 in the regular procedure. Step 3 of the regular procedure is replaced with the following:

   The material contained in the first box is reduced to about half by removing strips of material with the sampling scoop. The strips are taken by removing the material all the way across and full depth of the sample. Make certain that all the material is removed down to the bottom of the pan. Place the strips of material in another container and continue removing strips of material in the above manner until the proper amount is obtained. Repeat the above procedure for each additional box of mix, adding the strips of material taken to the container holding the material obtained from the first box of mix. The mixture accumulated from the original boxes is now regarded as one sample, and the regular procedure is followed.

IM 500
TERMINOLOGY

****THIS IS A NEW IM. – PLEASE READ CAREFULLY.****

ASPHALTIC TERMINOLOGY

SCOPE

This IM describes the terminology associated with asphaltic materials.

LIQUID ASPHALT TERMINOLOGY

Asphalt Cement – See **Binder**

Binder – A dark brown to black cementitious material, which occurs in nature or is obtained in petroleum processing. Also commonly referred to Asphalt Cement (AC).

Bitumen – See **Binder**

Cutback Asphalt – Liquid asphalt composed of asphalt binder and a petroleum solvent. Cutback asphalts have three types (Rapid Curing (RC), Medium Curing (MC), and Slow Curing (SC)). The petroleum solvent, also called diluents, can have high volatility (RC) to low volatility (SC).

Emulsified Asphalt – Composed of asphalt binder and water, and a small quantity of emulsifying agent, which is similar to detergent. They may be of either the Anionic, electro-negatively-charged asphalt globules, or Cationic, electro-positively-charged asphalt globules types, depending upon the emulsifying agent. Emulsified asphalt is produced in three grades (Rapid-Setting (RS), Medium-Setting (MS), and Slow-Setting (SS)).

Flux or Flux Oil – A thick, relatively nonvolatile fraction of petroleum, which may be used to soften asphalt binder to a desired consistency.

Foamed Asphalt – A combination of high temperature asphalt binder and water to produce foaming.

Gilsonite – A form of natural asphalt, hard and brittle, which is mined.

Modified Binder – These are asphalt binders, which have been physically- and/or chemically-altered (usually with an additive) to bring the characteristics of the binder to what is desired for the application. This process includes polymer modification.

Performance Graded Asphalt (PG) – The identification associated with the grading of the binder. Prior identification methods have been penetration and viscosity grading. For example, a PG 64-22 would indicate a performance-graded binder with a high temperature confidence of 64°C and a low temperature confidence of -22°C.

Viscosity – The property of a fluid or semifluid that enables it to resist flow. The higher the viscosity, the greater the resistance to flow.

AGGREGATE TERMINOLOGY

Absorption – The property of an aggregate particle to take in and hold a fluid. For our purposes usually asphalt binder or water.

Aggregate – Any hard, inert, mineral material used for mixing in graduated fragments. It includes sand, gravel, crushed stone, and slag.

Coarse Aggregate – The aggregate particles retained on the #4 (4.75 mm) sieve.

Coarse-Graded Aggregate – A blend of aggregate particles having a continuous grading in sizes of particles from coarse through fine with a predominance of coarse sizes. A gradation below the maximum density line.

Cold-Feed Gradation – The aggregate proportioning system employing calibrated bins to deliver aggregate to the dryer (see IM 508 for additional information).

Fine Aggregate – Aggregate particles passing the #4 (4.75 mm) sieve.

Fine-Graded Aggregate – A blend of aggregate particles having a continuous grading in sizes of particles from coarse through fine with a predominance of fine sizes. A gradation above the maximum density line.

Gradation – The description given to the proportions of aggregate on a series of sieves. Usually defined in terms of the % passing successive sieve sizes.

Lime – A product used to enhance the bond between aggregate and asphalt binder. It is composed of dust from crushed limestone. Hydrated lime is often specified for surface mixes.

Manufactured Sand –The predominately minus #4 (4.75 mm) material produced from crushing ledge rock or gravel.

Mineral Filler – A finely divided mineral product at least 70 percent of which will pass a #200 (75 µm) sieve. Pulverized limestone is the most commonly manufactured filler, although other stone dust, hydrated lime, Portland cement, fly ash and certain natural deposits of finely divided mineral matter are also used.

Natural Sand – A loose, granular material found in natural deposits.

Open-Graded Aggregate – A blend of aggregate particles containing little or no fine aggregate and mineral filler and the void spaces in the compacted aggregate are relatively large.

Slag – A byproduct of steel production.

Well-Graded Aggregate – Aggregate that is uniformly graded from coarse to fine.

MIX TERMINOLOGY

Asphalt Cement Concrete – See **Hot Mix Asphalt**

Asphalt Leveling Course – Lift(s) of HMA of variable thickness used to eliminate irregularities in the contour of an existing surface prior to overlay.

Asphalt Overlay – One or more lifts of HMA constructed on an existing pavement. The overlay may include a leveling course to correct the contour of the old pavement, followed by uniform course or courses to provide needed thickness.

Base Course – Lift(s) of HMA pavement placed on the subgrade or subbase on which successive layers are placed.

Binder Course – See **Intermediate Course**

Full-Depth® Asphalt Pavement – The term Full-Depth® certifies that the pavement is one in which asphalt mixtures are employed for all courses above the subgrade or improved subgrade. A Full-Depth® asphalt pavement is laid directly on the prepared subgrade.

Hot Mix Asphalt (HMA) – Asphalt binder/aggregate mixture produced at a batch or drum-mixing facility that must be spread and compacted while at an elevated temperature. To dry the aggregate and obtain sufficient fluidity of the binder, both must be heated prior to mixing – giving origin to the term “hot mix.”

Intermediate Course – An HMA pavement course between a base course and a surface course.

Job Mix Formula (JMF) – The JMF is the mix design used to begin a HMA project. It is also used as the basis for the control of plant produced mixture. It sets the proportions of the aggregate and amount of asphalt binder.

Mixed-In-Place (Road Mix) – An HMA course produced by mixing mineral aggregate and cutback or emulsified asphalt at the road site by means of travel plants, motor graders, or special road-mixing equipment.

Plant Mix – A mixture, produced in an asphalt mixing facility that consists of mineral aggregate uniformly coated with asphalt binder, emulsified asphalt or cutback asphalt.

Sand Asphalt – A mixture of sand and asphalt binder, cutback or emulsified asphalt. It may be prepared with or without special control of aggregate grading and may or may not contain mineral filler. Either mixed-in-place or plant-mix construction may be employed.

Sheet Asphalt – A hot mixture of binder with clean angular, graded sand and mineral filler.

Surface Course – The top lift(s) of HMA pavement, sometimes called asphalt wearing course.

Warm-Mix Asphalt (WMA) – Similar to HMA but produced by using additives that allow the mix to be produced, placed and compacted at lower temperatures.

****THIS IS A NEW IM. – PLEASE READ CAREFULLY.****

ASPHALTIC TERMINOLOGY

SCOPE

This IM describes the terminology associated with asphaltic materials.

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Bitumen – See **Binder**

Cutback Asphalt – Liquid asphalt composed of asphalt binder and a petroleum solvent. Cutback asphalts have three types (Rapid Curing (RC), Medium Curing (MC), and Slow Curing (SC)). The petroleum solvent, also called diluents, can have high volatility (RC) to low volatility (SC).

Emulsified Asphalt – Composed of asphalt binder and water, and a small quantity of emulsifying agent, which is similar to detergent. They may be of either the Anionic, electro-negatively-charged asphalt globules, or Cationic, electro-positively-charged asphalt globules types, depending upon the emulsifying agent. Emulsified asphalt is produced in three grades (Rapid-Setting (RS), Medium-Setting (MS), and Slow-Setting (SS)).

Flux or Flux Oil – A thick, relatively nonvolatile fraction of petroleum, which may be used to soften asphalt binder to a desired consistency.

Foamed Asphalt – A combination of high temperature asphalt binder and water to produce foaming.

Gilsonite – A form of natural asphalt, hard and brittle, which is mined.

Modified Binder – These are asphalt binders, which have been physically- and/or chemically-altered (usually with an additive) to bring the characteristics of the binder to what is desired for the application. This process includes polymer modification.

Performance Graded Asphalt (PG) – The identification associated with the grading of the binder. Prior identification methods have been penetration and viscosity grading. For example, a PG 64-22 would indicate a performance-graded binder with a high temperature confidence of 64°C and a low temperature confidence of -22°C.

Viscosity – The property of a fluid or semifluid that enables it to resist flow. The higher the viscosity, the greater the resistance to flow.

AGGREGATE TERMINOLOGY

Absorption – The property of an aggregate particle to take in and hold a fluid. For our purposes usually asphalt binder or water.

Aggregate – Any hard, inert, mineral material used for mixing in graduated fragments. It includes sand, gravel, crushed stone, and slag.

Coarse Aggregate – The aggregate particles retained on the #4 (4.75 mm) sieve.

Coarse-Graded Aggregate – A blend of aggregate particles having a continuous grading in sizes of particles from coarse through fine with a predominance of coarse sizes. A gradation below the maximum density line.

Cold-Feed Gradation – The aggregate proportioning system employing calibrated bins to deliver aggregate to the dryer (see IM 508 for additional information).

Fine Aggregate – Aggregate particles passing the #4 (4.75 mm) sieve.

Fine-Graded Aggregate – A blend of aggregate particles having a continuous grading in sizes of particles from coarse through fine with a predominance of fine sizes. A gradation above the maximum density line.

Gradation – The description given to the proportions of aggregate on a series of sieves. Usually defined in terms of the % passing successive sieve sizes.

Lime – A product used to enhance the bond between aggregate and asphalt binder. It is composed of dust from crushed limestone. Hydrated lime is often specified for surface mixes.

Manufactured Sand –The predominately minus #4 (4.75 mm) material produced from crushing ledge rock or gravel.

Mineral Filler – A finely divided mineral product at least 70 percent of which will pass a #200 (75 μm) sieve. Pulverized limestone is the most commonly manufactured filler, although other stone dust, hydrated lime, Portland cement, fly ash and certain natural deposits of finely divided mineral matter are also used.

Natural Sand – A loose, granular material found in natural deposits.

Open-Graded Aggregate – A blend of aggregate particles containing little or no fine aggregate and mineral filler and the void spaces in the compacted aggregate are relatively large.

Slag – A byproduct of steel production.

Well-Graded Aggregate – Aggregate that is uniformly graded from coarse to fine.

MIX TERMINOLOGY

Asphalt Cement Concrete – See **Hot Mix Asphalt**

Asphalt Leveling Course – Lift(s) of HMA of variable thickness used to eliminate irregularities in the contour of an existing surface prior to overlay.

Asphalt Overlay – One or more lifts of HMA constructed on an existing pavement. The overlay may include a leveling course to correct the contour of the old pavement, followed by uniform course or courses to provide needed thickness.

Base Course – Lift(s) of HMA pavement placed on the subgrade or subbase on which successive layers are placed.

Binder Course – See **Intermediate Course**

Full-Depth® Asphalt Pavement – The term Full-Depth® certifies that the pavement is one in which asphalt mixtures are employed for all courses above the subgrade or improved subgrade. A Full-Depth® asphalt pavement is laid directly on the prepared subgrade.

Hot Mix Asphalt (HMA) – Asphalt binder/aggregate mixture produced at a batch or drum-mixing facility that must be spread and compacted while at an elevated temperature. To dry the aggregate and obtain sufficient fluidity of the binder, both must be heated prior to mixing – giving origin to the term "hot mix."

Intermediate Course – An HMA pavement course between a base course and a surface course.

Job Mix Formula (JMF) – The JMF is the mix design used to begin a HMA project. It is also used as the basis for the control of plant produced mixture. It sets the proportions of the aggregate and amount of asphalt binder.

Mixed-In-Place (Road Mix) – An HMA course produced by mixing mineral aggregate and cutback or emulsified asphalt at the road site by means of travel plants, motor graders, or special road-mixing equipment.

Plant Mix – A mixture, produced in an asphalt mixing facility that consists of mineral aggregate uniformly coated with asphalt binder, emulsified asphalt or cutback asphalt.

Sand Asphalt – A mixture of sand and asphalt binder, cutback or emulsified asphalt. It may be prepared with or without special control of aggregate grading and may or may not contain mineral filler. Either mixed-in-place or plant-mix construction may be employed.

Sheet Asphalt – A hot mixture of binder with clean angular, graded sand and mineral filler.

Surface Course – The top lift(s) of HMA pavement, sometimes called asphalt wearing course.

Warm-Mix Asphalt (WMA) – Similar to HMA but produced by using additives that allow the mix to be produced, placed and compacted at lower temperatures.

MISCELLANEOUS TERMINOLOGY

Asphalt Joint Sealer – An asphalt product used for sealing cracks and joints in pavements and other structures.

Average Absolute Deviation (AAD) – The absolute value of the difference of a test result from a specified value, averaged for a specified set of values.

Cold-In-Place Recycling – A method of rehabilitating the HMA surface by milling, adding a stabilizing agent, relaying and compacting in a continuous operation (see IM 504 for additional information).

Durability – The property of an asphalt paving mixture that describes its ability to resist the detrimental effects of air, water and temperature. Included under weathering are changes in the characteristics of asphalt, such as oxidation and volatilization, and changes in the pavement and aggregate due to the action of water, including freezing and thawing.

Fatigue Resistance – The ability of asphalt pavement to withstand repeated flexing caused by the passage of wheel loads.

Field Density – The density ($G_{mb\ (field)}$) of HMA based on field roller compaction.

Field Voids – The percent by volume of air voids in cores cut from the finished pavement.

Flexibility – The ability of an asphalt paving mixture to be able to bend slightly, without cracking, and to conform to gradual settlements and movements of the base and subgrade.

Fog Seal – A light application of emulsion diluted with water that is applied without mineral aggregate cover.

Lab Density – The density ($G_{mb\ (lab)}$) of HMA based on laboratory compaction.

Lab Voids – The percent by volume of air voids in laboratory compacted specimens.

Pay Factor – A calculated multiplier used to determine adjustments to payment to the contractor. Pay factors greater than 1.000 are referred to as “incentive” and pay factors less than 1.000 are referred to as “disincentive” or “penalties”

Percent Within Limits (PWL) – A statistical estimation of the percentage of a material that falls between specified limits based on sampling and testing of the material. PWL is used to calculate the pay factor.

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

Recycled Asphalt Pavement (RAP) – HMA removed and processed, generally by milling. This material may be stored and used in mixtures in addition to virgin aggregate and binder. This is also referred to as Reclaimed Asphalt Pavement.

Recycled Asphalt Shingles (RAS) – Roofing shingles, either waste from a shingle manufacturer or tear off shingles from reroofing operations. Shingles contain a high percentage of asphalt as well as fibers and fine aggregate. Shingles are processed into a fine material and handled similar to RAP.

Seal Coat – A thin asphalt surface treatment used to waterproof and improve the texture of an asphalt wearing surface. Depending on the purpose, seal coats may or may not be covered with aggregate. The main types of seal coats are aggregate seals, fog seals, emulsion slurry seals and sand seals.

Skid Resistance – The ability of asphalt paving surface, particularly when wet, to offer friction against the tire surface.

Slurry Seal – A mixture of emulsified asphalt, fine aggregate and mineral filler, with water added to produce flowing consistency.

Specific Gravity – The weight to volume relationship of material in relation to water.

Stability – The ability of asphalt paving mixtures to resist deformation from imposed loads. Unstable pavements are marked by channeling (ruts), and corrugations (washboarding).

Surface Treatments – A broad term embracing several types of asphalt or asphalt-aggregate applications, usually less than 1 in. (25 mm) thick, to a road surface. The types range from a light application of emulsified or cutback asphalt (Fog seal) to a single or multiple surface layers made up of alternating applications of asphalt and aggregate (chip seal).

Tack Coat – A very light application of asphalt, usually asphalt emulsion diluted with water. It is used to ensure a bond between the existing pavement surface and the overlay.

CONSTRUCTION TERMINOLOGY

Batch Plant – This type of HMA production plant is used to produce individual batches of mix by making use of a pugmill (see IM 508 for additional information).

Certified Plant Inspection (CPI) – A specified method of quality control using a Certified Plant Inspector (see Section 2521 of the Standard Specification for additional information).

Cold-Feed – The device used to combine the various aggregates, in the correct proportions.

Drum Plant – This type of HMA production plant is a continuously operating plant, which mixes the aggregate, asphalt binder and RAP (if used) in the drum (See IM 508 for additional information).

Quality Management of Asphalt (QMA) – A specified quality control procedure where the contractor is responsible for the mix design and the control of the mix properties during production (see IM 511 for additional information). The agency is responsible for quality assurance and verification.

Workability – The ease with which paving mixtures may be placed and compacted.

IM 501
CALCULATIONS

ASPHALTIC EQUATIONS
& EXAMPLE CALCULATIONS

SCOPE

This IM describes the equations associated with asphaltic materials. In addition, there are a number of example calculations showing how to determine various properties.

NAMING CONVENTION

G_{sb}

Volumetric Property	*Material*	*Type*
		b = bulk
	s = stone	e = effective
G = Specific Gravity	b = binder	m = maximum theoretical
V = Volume	m = mix	a = apparent (for G) or
P = Percent	a = air	a = absorbed (for V and P)

DEFINITIONS

P_a	=	% of air voids in compacted hot mix asphalt mixture (percent of total volume) **Lab Voids** for gyratory specimens or **Field Voids** for cores
P_b	=	% of asphalt binder in the hot mix asphalt mixture
$P_{b(RAP)}$	=	% of asphalt binder in RAP material
$P_{b(add)}$	=	% of virgin asphalt binder needed to add to the mix to achieve the total intended binder content
$P_{b(added)}$	=	% of virgin asphalt binder in the hot mix asphalt mixture. Does not include the asphalt binder from the RAP
P_s	=	% of combined aggregate in the hot mix asphalt mixture
	=	100 – P_b - other non-aggregate components
P_{ba}	=	% of asphalt binder absorbed by aggregate, aggregate basis
$P_{ba\ (mix)}$	=	% of asphalt binder absorbed by aggregate, mix basis
P_{be}	=	effective asphalt binder, %, mixture basis
% Abs	=	% water absorption of the individual or combined aggregate
ABS	=	fraction of water absorption of the individual or combined aggregate

	=	% Abs/100 ABS is always used in the calculations rather than % Abs.
G_{sa}	=	apparent specific gravity of the aggregate
G_{se}	=	effective specific gravity of the combined aggregate
G_{sb}	=	bulk specific gravity of the aggregate (dry basis)
$G_{sb(SSD)}$	=	bulk specific gravity of the aggregate (SSD basis) Used for Portland Cement Concrete **NOT ASPHALT!!!**
G_b	=	specific gravity of the asphalt binder at 25°C (77°F)
$G_{b\ (effective)}$	=	effective specific gravity of the combined new and recycled asphalt binder at 25°C (77°F)
% New AC	=	percentage of the total binder that is virgin (not from RAM)
G_{mm}	=	maximum specific gravity of the hot mix asphalt mixture. Often referred to as the Rice specific gravity, solid specific gravity or solid density.
G_{mb}	=	bulk specific gravity of compacted hot mix asphalt mixture
$G_{mb(measured)}$	=	G_{mb} of gyratory specimen as determined from test procedure in IM 321
$G_{mb(corrected)}$	=	corrected G_{mb} of gyratory specimen at N_{des}, also called **Lab Density**. $G_{mb(corrected)}$ and $G_{mb(measured)}$ will be the same when compacting to N_{des} so no correction is necessary.
$G_{mb(field\ core)}$	=	bulk specific gravity of pavement cores (also **$G_{mb(field)}$** or **Field Density**)
VMA	=	% voids in mineral aggregate, (percent of bulk volume), compacted mix
V_t	=	design target air voids, %
VFA	=	% voids filled with asphalt binder
N_{ini}	=	Number of gyrations used to measure initial compaction.
N_{des}	=	Number of gyrations used to measure design compaction. G_{mb} for Lab Density is determined at N_{des}.
N_{max}	=	Number of gyrations used to measure maximum compaction.
N_x	=	Level of compaction, where x is the number of gyrations.
R	=	temperature correction multiplier obtained from IM 350 Table 2 App. A

d_t	=	density of water at test temperature, g/cc
h_{max}	=	the height of the specimen at N_{max}, mm
h_{des}	=	the height of the specimen at N_{des}, mm
h_x	=	the height of the specimen at any gyration level N_x, mm
C_x	=	percent of compaction expressed as a percentage of G_{mm} Where x is the number of gyrations (this is normally N_{ini} or N_{max})
S	=	slope of the compaction curve
FT	=	Film Thickness, microns
SA	=	Surface Area, m^2/kg
F/B	=	Filler/Bitumen Ratio also called Fines/Bitumen Ratio
σ_{n-1}	=	Sample Standard Deviation
$\bar{X}$	=	sample average

FORMULAS

All calculations shown have been rounded for ease of presentation. Normally calculations will involve maintaining more significant figures throughout the intermediate calculations and only rounding the final result. The values generated by the software specified by the DOT will be the accepted results for reporting purposes.

All specific gravity calculations will be reported to 3 decimal places. Binder content is reported to 2 decimal places. Percent voids, VMA and VFA are reported to 1 decimal place.

Unless noted as otherwise, the following information is given to perform the calculations for a mix not containing RAS. Any additional needed information will be provided with the sample calculation.

$P_b = 5.75\%$	$G_{sa} = 2.667$	$G_{mb\ (field)} = 2.215$
$P_s = 100 – 5.75 = 94.25\%$	$G_{se} = 2.659$	$G_{mb\ (measured)} = 2.310$
% Abs = 1.39	$G_{sb} = 2.572$	$G_{mb\ (corrected)} = 2.273$
ABS = 1.39/100 = 0.0139	$G_{sb(SSD)} = 2.608$	% RAP = 10.0%
$G_b = 1.031$	$G_{mm} = 2.438$	$P_{b(RAP)} = 5.00\%$
% minus #200 (75 µm) sieve = 5.0%		

VOLUMETRIC EQUATIONS

To convert the specific gravity of asphalt binder from one temperature to another, the following two equations are used.

G_b (at 60°F) $= \frac{G_b \text{ (at } 77^\circ\text{F)}}{0.9961} = \frac{1.031}{0.9961} = 1.035$

G_b (at 77°F) $= 0.9961 \times G_b \text{ (at } 60^\circ\text{F)} = 0.9961 \times (1.035) = 1.031$

$G_{b\ (effective)}$ with RAM

$$= \frac{100}{\frac{\%\ New\ AC}{G_b} + \frac{100 - \%\ New\ AC}{1.030}}$$

% Abs

$$= \frac{W_a + W_b - W_c}{W_c} \times 100$$

$$= \frac{1315.7 + 690.3 - 2000.0}{2000.0} \times 100 = 0.30\%$$

Where:
W_a = Saturated-Surface-Dry (SSD) weight of coarse portion, 1315.7 g
W_b = Saturated-Surface-Dry (SSD) weight of fine portion, 690.3 g
W_c = Combined dry weight of coarse and fine portion, 2000.0 g

% $Abs_{(combined)}$

$$= [\%\ Abs_1 \times (P_{s1})] + [\%\ Abs_2 \times (P_{s2})] + [\%\ Abs_3 \times (P_{s3})] + \ldots$$

$$= 0.67(0.50) + 1.23(0.05) + 2.21(0.45) = 1.39\%$$

Where:
% Abs_1 = 0.67% P_{s1} = 50%
% Abs_2 = 1.23% P_{s2} = 5%
% Abs_3 = 2.21% P_{s3} = 45%

G_{sa}

$$= \frac{W \times R}{W + W_1 - W_2} = \frac{(2000.0)(1.0000)}{2000.0 + 6048.0 - 7298.1} = 2.667$$

Where:
W = Weight of dry sample, 2000.0 g
W_1 = Sample weight of pycnometer filled with water at test temperature, 6048.0 g
W_2 = Sample weight of pycnometer filled with water and sample, 7298.1 g

R = Multiplier to correct temperature to 77°F = 1.0000 @ 77°F

G_{sb}

$$= \frac{G_{sa}}{1 + (ABS) \times (G_{sa})} \qquad = \frac{2.667}{1 + (0.0139)(2.667)} = 2.572$$

$G_{sb\ (combined)}$

$$= \frac{100}{\frac{P_{s1}}{G_{sb1}} + \frac{P_{s2}}{G_{sb2}} + \frac{P_{s3}}{G_{sb3}} + ..} \qquad = \frac{100}{\frac{50.0}{2.657} + \frac{5.0}{2.642} + \frac{45.0}{2.640}} = 2.649$$

Where: P_{s1} = 50.0% G_{sb1} = 2.657
P_{s2} = 5.0% G_{sb2} = 2.642
P_{s3} = 45.0% G_{sb3} = 2.640

G_{se}

$$= \frac{P_s}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}} \qquad = \frac{100 - 5.75}{\frac{100}{2.438} - \frac{5.75}{1.031}} = 2.659$$

G_{mm}

$$= \frac{W \times R}{W + W_1 - W_2} \qquad = \frac{(2020.0)(1.0000)}{2020.0 + 6048.0 - 7239.5} = 2.438$$

Where: W = Sample weight of sample, 2020.0 g
W1 = Sample weight of pycnometer filled w/water at test temperature, 6048.0 g
W_2 = Sample weight of pycnometer filled w/water and sample, 7239.5 g
R = Multiplier to correct temperature to 77°F = 1.0000 @ 77°F

To correct the density of water to 77°F the R multiplier is used. The value of R is given in the tables in IM's 350 and 380 for temperatures from 60 to 130°F. R is calculated as follows:

R

$$= \frac{d_t}{0.99707} \qquad = \frac{0.99707}{0.99707} = 1.0000$$

Where: d_t = density of water at temperature t = 0.99707 g/cc at 77°F.

G_{mb} (or $G_{mb\ (measured)}$)

$$= \frac{W_1}{W_3 - W_2} \qquad = \frac{4800.0}{4805.6 - 2727.7} = 2.310$$

Where: W_1 = Sample Dry weight, 4800.0 g
W_2 = Sample weight in water, 2727.7 g
W_3 = Sample weight in air, SSD, 4805.6 g

P_a (lab voids)

$$= \frac{G_{mm} - G_{mb}}{G_{mm}} \times 100 \qquad = \frac{2.438 - 2.310}{2.438} \times 100 = 5.3\%$$

$\%G_{mm}$ (field core)

$$= \frac{G_{mb(field\ core)}}{G_{mm(lot\ avg.)}} \times 100 \qquad = \frac{2.215}{2.438} \times 100 = 90.9\%$$

P_a (field voids)

$$= 100 - \%G_{mm} \qquad = 100 - 90.9 = 9.1\%$$

VMA

$$= 100 - \left[\frac{G_{mb} \times P_s}{G_{sb}}\right] \qquad = 100 - \frac{(2.310)(94.25)}{2.572} = 15.4\%$$

VFA

$$= \frac{VMA - P_a}{VMA} \times 100 \qquad = \frac{15.4 - 5.3}{15.4} \times 100 = 65.6\%$$

P_{ba}

$$= \frac{(G_{se} - G_{sb})}{(G_{se} \times G_{sb})} \times G_b \times 100 \qquad = \frac{2.659 - 2.572}{(2.659)(2.572)} \times 1.031 \times 100 = 1.31\%$$

P_{be}

$$= P_b - \left[\frac{P_{ba} \times P_s}{100}\right] \qquad = 5.75 - \frac{(1.31)(94.25)}{100} = 4.52\%$$

$P_{ba\ (mix)}$ $= P_b - P_{be}$

F/B (fines/bitumen)

$$= \frac{\text{Total \% of minus \#200 material}}{P_{be}} \qquad = \frac{5.00}{4.52} = 1.11$$

Where: Total % of minus #200 (75 µm) includes both virgin aggregate and RAM when used

GYRATORY EQUATIONS

If compacting to N_{max} a correction to the measured G_{mb} must be performed. The corrected G_{mb} (**$G_{mb\ (corrected)}$**) is then used in the calculations for **P_a** (lab voids) and **VMA.**

To correct G_{mb} from the measured value at N_{max} to the corrected value at N_{des}:

$G_{mb\ (corrected)}$ (lab density)

$$= (G_{mb\ (measured)}) \times \frac{h_{max}}{h_{des}} \qquad = (2.310)\frac{117.5}{119.4} = 2.273$$

Where: h_{max} = 117.5 mm (the height at N_{max}) and h_{des} = 119.4 (the height at N_{des})

To find the percent of maximum specific gravity ($\%G_{mm}$) at a specific gyration (N_x):

C_x ($\%G_{mm}$)

$$= \frac{(G_{mb(measured)}) \times (h_{max})}{(G_{mm}) \times (h_x)} \text{ x } 100$$

Given:
N_{ini} = 8 gyrations h_8 = 135.4 mm
N_{des} = 109 gyrations h_{109} = 119.4 mm
N_{max} = 174 gyrations h_{174} = 117.5 mm

C_8

$$= \left(\frac{(2.310) \text{ x } (117.5\text{mm})}{(2.438) \text{ x } (135.4\text{mm})}\right) \text{x } 100 = 82.2\%$$

C_{109}

$$= \left(\frac{(2.310) \text{ x } (117.5\text{mm})}{(2.438) \text{ x } (119.4\text{mm})}\right) \text{x } 100 = 93.2\%$$

C_{174}

$$= \left(\frac{(2.310) \text{ x } (117.5\text{mm})}{(2.438) \text{ x } (117.5\text{mm})}\right) \text{x } 100 = 94.7\%$$

To find the slope of the gyratory compaction curve:

S

$$= \frac{(\log(N_{max}) - \log(N_{ini}))}{C_{max} - C_{ini}} \qquad = \frac{(\log(174) - \log(8))}{0.947 - 0.822} = 10.7$$

Where: C_{max} and C_{ini} are expressed as decimals.

RAP FORMULAS

To determine the percent of asphalt binder to add to a mix containing RAP (**$P_{b(add)}$**) to achieve the total intended P_b shown on the JMF (this the value to which the plant controls are set):

$P_{b(add)}$

$$= \frac{[(100) \times (\text{total intended } P_b)] - [(\%\,\text{RAP}) \times (P_{b(RAP)})]}{100 - [(\%\,\text{RAP}) \times (P_{b(RAP)}) \times (0.01)]}$$

$$= \frac{(100)(5.75) - (10.0)(5.00)}{100 - (10.0)(5.00)(0.01)} = 5.28\%$$

To determine the percent of aggregate contributed by the RAP in the total aggregate blend:

$\%\,RAP_{(aggregate)}$

$$= \frac{(\%\,\text{RAP}) \times [1.00 - (P_{b(RAP)} \times 0.01)]}{\%\,\text{virgin agg.} + [(\%\,\text{RAP}) \times (1.00 - (P_{b(RAP)} \times 0.01))]} \text{ x } 100$$

$$= \frac{(10.0)(1.00 - (5.00)(0.01))}{90.0 + (10.0)(1.00 - (5.00)(0.01))} \text{ x } 100 = 9.55\%$$

To determine the actual percent virgin aggregate in the total aggregate blend containing RAP:

% virgin agg.

$$= \frac{\%\,\text{virgin agg.}}{\%\,\text{virgin agg.} + [(\%\,\text{RAP}) \times (1.00 - (P_{b(RAP)} \times 0.01))]} \text{ x } 100$$

$$= \frac{90.0}{90.0 + (10.0)(1.00 - (5.00)(0.01))} \text{ x } 100 = 90.45\%$$

To determine the total percent asphalt binder in a mix containing RAP:

Total P_b $= P_{b(added)} + [(\%\,\text{RAP}) \times (P_{b(RAP)}) \times (0.01)] - [(P_{b(added)}) \times (\%\,\text{RAP}) \times (P_{b(RAP)}) \times (0.0001)]$

$$= 5.28 + (10.0)(5.00)(0.01) - (5.28)(10.0)(5.00)(0.0001) = 5.75\%$$

Where: $P_{b(added)}$ is the actual percent of virgin asphalt binder added to the mix from the tank stick, flow meter or batch weights - **not the $P_{b(add)}$ determined above which is the original determination on the JMF**.

FRICTION AGGREGATE CALCULATIONS

Percent Retained on #4 Sieve:

$$\textbf{\% +\#4 Frictional aggregate} = \frac{(\text{\% frictional agg. retained on \#4 }) \times (\text{\% frictional agg. in total blend})}{(\text{\% retained on \#4 of total blend})}$$

Example: The aggregate blend contains 20% quartzite as the Type 2 friction class aggregate, the quartzite gradation shows 90% **retained** on the #4 sieve, and the combined gradation of the blend shows 60% **retained** on the #4 sieve:

% +#4 frictional aggr. in total blend = +#4 Type 2 $= \frac{(90)(20)}{60} = 30\%$

Percent Passing the #4 Sieve:

$$\textbf{\% −\#4 Type 2 aggregate} = \frac{(\text{\% passing \#4 of Type 2 aggr, }) \times (\text{\% Type 2 agg. in total blend})}{(\text{\% passing \#4 of total blend})}$$

Example: For a single Type 2 aggregate:
Quartzite Type 2 aggregate is 20% of the total blend and has 58% passing the #4 sieve. The combined gradation of the total blend has 65% passing the #4 sieve.

% −#4 Type 2 in the total blend $= \frac{(58) \times (20)}{65} = 17.8\%$

If more than one Type 2 aggregate is included in the blend the gradations of the Type 2 aggregates must be combined first in the numerator to determine the percent passing the #4 sieve for the Type 2 aggregate as shown in the following example.

Example: For multiple Type 2 aggregates:
Three quartzite aggregates are included in the total blend. The graded quartzite aggregate is 20% of the total blend and has 58% passing the #4 sieve. The quartzite

man sand is 10% of the total blend and has 100% passing the #4 sieve. The quartzite chip is 5% of the total blend and has 5% passing the #4 sieve. The combined gradation of the total blend has 65% passing the #4 sieve.

The % Type 2 in the total blend combined −#4 is:

% −#4 Type 2 in the total blend $= \frac{[(58 \times 20) + (100 \times 10) + (5 \times 5)]}{65} = 33.6\%$

Fineness Modulus

The fineness modulus of the Type 2 (FM_{Type2}) material is expressed as 600 minus the total of the percents passing each of the six sieves from the #4 to the #100 sieves divided by 100 and then multiplied by the percentage of Type 2 aggregate in the total blend expressed as a decimal.

$$FM_{Type2} = \frac{[600 - (P_4 + P_8 + P_{16} + P_{30} + P_{50} + P_{100})]}{100} \times P_{Type\ 2}$$

Where:

P_x is the percent passing sieve #x (x = #4, #8, #16, #30, #50, and #100)

$P_{Type\ 2}$ is the percent of Type 2 aggregate in the total blend expressed as a decimal

When more than one Type 2 aggregate is included in the total blend the gradations of the Type 2 aggregates must be combined first to determine the percent passing each of the six sieves for the total Type 2 aggregate as shown in the following example.

Example:

Given: The following gradations of the three Type 2 aggregates and the percentages in the total blend:

Percent Passing	3/4	1/2	3/8	#4	#8	#16	#30	#50	#100	#200
20% Graded Quartzite	100	98	78	58	48	38	28	18	8.0	4.0
10% Quartzite Man Sand				100	75	52	33	22	7.0	2.0
5% Quartzite Chip	100	95	35	5.0	4.5	4.0	3.5	3.0	2.0	1.0

The total percent Type 2 quartzite in the total blend is 20+10+5=35%

To combine the gradations of the Type 2 aggregates, multiply the percent passing each sieve (#4 to #100) for each aggregate by the percent of that aggregate in the total blend, sum the results individually for each sieve then divide the sum by the total percent Type 2 in the total blend as shown below. Express the result to two significant figures.

Combined gradation of the Type 2 for the #4 sieve: $= \frac{(58 \times 20) + (100 \times 10) + (5 \times 5)}{35} = 62$

Perform this same calculation for each of the other five sieves, #8, #16, #30, #50 and #100

Percent Passing	3/4	½	3/8	#4	#8	#16	#30	#50	#100	#200
Total Type 2 Combined				62	50	37	26	17	6.9	

$$FM_{Type2} = \frac{[600 - (62 + 50 + 37 + 26 + 17 + 6.9)]}{100} \times 0.35 = 1.40$$

FILM THICKNESS EXAMPLE:

SIEVE ANALYSIS % PASSING													
Sieve	in.	1	3/4	1/2	3/8	#4	#8	#16	#30	#50	#100	#200	
	(mm)	(25.0)	(19.0)	(12.5)	(9.5)	(4.75)	(2.36)	(1.18)	(0.600)	(0.300)	(0.150)	(0.075)	
Combined Grading		100	100	95	86	68	47	38	26	10	5.4	3.9	
Surface Area Coefficient						0.0041	0.0082	0.0164	0.0287	0.0614	0.1229	0.3277	TOTAL
Surface Area	(m^2/kg)	0.41				0.28	0.39	0.62	0.75	0.61	0.66	1.28	5.00

The surface area (**SA**) is found by taking the % Passing times the Surface Area Coefficient. The Surface Area for the material above the #4 sieve is a constant 0.41. The total surface area is found by adding all of the individual surface area values.

SA (for each sieve) $= (\%\ \text{Passing}) \times (\text{Surface Area Coefficient})$

$= (38)(0.0164) = 0.62$ (for the #16 sieve above)

Where: The Surface Area Coefficients are constants.

FT (Film Thickness) $= \frac{P_{be}}{SA} \times 10$ $= \frac{4.52}{5.00} \times 10 = 9.0$

MISCELLANEOUS

Optimum P_b

$$= \frac{(\text{high voids} - \text{target voids})}{(\text{high voids} - \text{low voids})} \times (\text{high } P_b - \text{low } P_b) + \text{low } P_b$$

Where: Target voids = 4.0

	P_b	P_a	
(low P_b =)	4.75	5.5	(= high voids)
(high P_b =)	5.75	3.0	(= low voids)
	6.75	1.2	

Since the target voids of 4.0% falls between 5.5 and 3.0 they are the high voids and low voids respectively. The asphalt contents associated with those voids are used as the low P_b and high P_b respectively.

$$= \frac{(5.5 - 4.0)}{(5.5 - 3.0)} \text{ x } (5.75 - 4.75) + 4.75 = 5.35\%$$

% Moisture

$$= \frac{\text{Wet Wt. Sample - Dry Wt. Sample}}{\text{Dry Wt. Sample}} \text{ x } 100$$

Where: Wet Wt. Sample = 2100.0 g
Dry Wt. Sample = 2000.0 g

$$= \frac{2100.0 - 2000.0}{2000.0} \text{ x } 100 = 5.0\%$$

To adjust the height of a G_{mb} specimen to reach the intended height, the following equation is used.

Adjusted sample weight

$$= \frac{(\text{trial sample weight}) \times (\text{intended height})}{\text{trial sample height}}$$

$$= \frac{(4775.0)(115.0)}{109.5} = 5014.8$$

G_{sb} (from $G_{sb(SSD)}$)

$$= \frac{G_{sb(SSD)}}{1 + ABS} \qquad = \frac{2.608}{1 + 0.0139} = 2.572$$

Percent of Lab Density

$$= \frac{G_{mb(\text{field core})}}{G_{mb}} \text{ x } 100 \qquad = \frac{2.215}{2.273} \text{ x } 100 = 97.4\%$$

Min. P_b

$$= \frac{[(G_b)(G_{se})(VMA - V_t) + (G_b)(100 - VMA)(G_{se} - G_{sb})]}{(G_b)(G_{se})(VMA - V_t) + (G_b)(100 - VMA)(G_{se} - G_{sb}) + (G_{se})(G_{sb})(100 - VMA)} \text{ x } 100$$

$$= \frac{[(1.031)(2.659)(15.4 - 4.0) + (1.031)(100 - 15.4)(2.659 - 2.572)]}{(1.031)(2.659)(15.4 - 4.0) + (1.031)(100 - 15.4)(2.659 - 2.572) + (2.659)(2.572)(100 - 15.4)} \text{ x } 100 = 6.29\%$$

You have 13,000 grams of aggregate and 650 grams of asphalt binder. Determine the asphalt binder content (P_b) of the mixture.

P_b

$$= \frac{W_b}{W_s + W_b} \text{ x } 100 \qquad = \frac{650}{13000 + 650} \text{ x } 100 = 4.76\%$$

Where: W_b = Weight of the asphalt binder, g
W_s = Weight of the aggregate, g
P_b = Percent binder of the mix, mix basis

You have 13,000 grams of aggregate. You want to prepare a mixture having 5.5% asphalt binder content based on the total mix. Determine the weight of the asphalt binder you need to add to the aggregate.

W_b

$$= \frac{(P_b) \times (W_s)}{(P_s)} \qquad = \frac{(5.5)(13000)}{100 - (5.5)} = 756.6$$

Where: W_b = Weight of the added binder, mix basis, g
W_s = Weight of the aggregate, g

<u>QUALITY INDEX (QI) EXAMPLE %G_{mb} Method</u>:
(This example is applicable for calculating outliers for G_{mb} and gradation)

For use on projects not using the PWL specifications

Given: lab. lot average $G_{mb(corrected)}$ = 2.408
field G_{mb} of individual cores: 2.319, 2.316, 2.310, 2.298, 2.242, 2.340, and 2.345.
% of lab density = 94%, 95%, or 96%. For this example 95% is used.

Determine the average field density (G_{mb}) of the seven cores.

x^-

$$= \frac{2.319 + 2.316 + 2.310 + 2.298 + 2.242 + 2.340 + 2.345}{7} = 2.310$$

The sample standard deviation is determined as follows:

σ_{n-1} $= \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$ $= \sqrt{\frac{0.007}{7 - 1}} = 0.034$

Where: x = individual sample value
n = number of samples
$\bar{x}$ = average of all samples

The Quality Index for density shall be determined according to the following calculation:

Q.I. (Density)

$$= \frac{(\text{Avg. } G_{mb})_{\text{FIELD LOT}} - ((\%\text{ Density})_{\text{SPECIFIED}} \times (\text{Avg. } G_{mb})_{\text{LAB LOT}})}{(\text{Std. Dev. } G_{mb})_{\text{FIELD LOT}}}$$

QI

$$= \frac{2.310 - (0.95)(2.408)}{0.034} = 0.66$$

The QI is less than 0.72. Check for outliers. To test for a suspected outlier result, apply the appropriate formula.

Suspected High Outlier $= \frac{\text{Highest } G_{mb} - \text{Avg. } G_{mb}}{\sigma_{n-1}}$ $= \frac{2.345 - 2.310}{0.034} = 1.03$

Suspected Low Outlier $= \frac{\text{Avg. } G_{mb} - \text{Lowest } G_{mb}}{\sigma_{n-1}}$ $= \frac{2.310 - 2.242}{0.034} = 1.99$

The highest density or lowest density shall not be included if the suspected outlier result is more than 1.80 for seven samples. The quality index shall then be recalculated for the remaining six samples.

The suspected low outlier result is greater than 1.80 for seven samples, therefore the core with the lowest density, 2.242, is an outlier.

Recalculate the QI for the remaining six densities (excluding the outlier).

Avg. $G_{mb\ (field\ lot)(new)}$ = 2.321 = **$\sigma_{n-1\ (new)}$** = 0.018

$QI_{(new)}$

$$= \frac{2.321 - (0.95)(2.408)}{0.018} = 1.88$$

<u>GRADATION EXAMPLE (Combined Gradation)</u>:

Assume the proportions of the individual aggregates are as follows: 50% ¾" Minus, 5% ⅜" Chips, and 45% Nat. Sand. Then using the following gradations for the individual aggregates, determine the combined gradation.

% Passing										
Sieve Size	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/4" Minus	100	90	75	43	21	17	15	12	9.8	7.4
3/8" Chip	100	100	70	32	5	1.8	1.5	1.1	0.9	0.7
Nat. Sand	100	100	100	100	80	65	40	9	1.0	0.5
combined	_______	_______	_______	_______	_______	_______	_______	_______	_______	_______

To determine the combined gradation, take each individual material % Passing times the percentage of that material in the blend. For example, take the 50% of the 3/4" Minus material times the % Passing for that material.

3/4" Minus Portion % Passing #200 sieve: $= 7.4 \times \frac{50}{100} = 3.7$

Do the same thing with each of the other aggregates and sieve sizes to obtain the following:

3/4" Minus	50.0	45.0	37.5	21.5	10.5	8.5	7.5	6.0	4.9	3.7
3/8" Chip	5.0	5.0	3.5	1.6	0.3	0.1	0.1	0.1	0.0	0.0
Nat. Sand	45.0	45.0	45.0	45.0	36.0	29.3	18.0	4.1	0.5	0.2

Next, sum the individual sieve sizes to get the combined gradation. This will result in the following combined gradation.

Combined	100.0	95.0	86.0	68.1	46.8	37.9	25.6	10.2	5.4	3.9

BATCHING EXAMPLE:

You have been directed to prepare a 13,000-gram batch of aggregate composed of the aggregates used above with the same proportions. The ¾" Minus has been split into four size fractions by sieving on the 12.5 mm, 9.5 mm and 4.75 mm sieves. The ⅜" Chip has been split into three size fractions by sieving on the 9.5 mm and 4.75 mm sieves. The Nat. Sand is one size fractions passing the 4.75 mm sieve. Complete the following batching sheet by determining the mass of each aggregate needed, the percentage of each size fraction and the weight of each size fraction.

Weight ¾" Minus @ 50% = __________ grams

Sieve	% Passing	Size Fraction	% In Size Fraction	Weight Needed Each Fraction	Cumulative Weight
19 mm	100				
12.5 mm	90	-19 + 12.5	________	________	________
9.5 mm	75	-12.5 + 9.5	________	________	________
4.75 mm	43	-9.5 + 4.75	________	________	________
		-4.75	________	________	________
			________		

Weight ⅜" Chip @ 5% = __________grams

Sieve	% Passing	Size Fraction	% In Size Fraction	Weight Needed Each Fraction	Cumulative Weight
12.5 mm	100				
9.5 mm	70	-12.5 + 9.5	________	________	________
4.75 mm	32	-9.5 + 4.75	________	________	________
		-4.75	________	________	________
			________		

Weight Nat. Sand @ 45% = __________grams

Sieve	% Passing	Size Fraction	% In Size Fraction	Weight Needed Each Fraction	Cumulative Weight
4.75 mm	100	-4.75	________	________	________
			________		

The weight of each material is found by taking the percentage of the blend each material is times the total batch weight. For example, the weight of the ¾" Minus is found by taking 50% of the 13,000 gram batch, or 6,500 grams.

The % In Size Fraction column is found by subtracting the % Passing from one size by the previous size % Passing. For example, the % In Size Fraction for the –19 + 12.5 Size Fraction is found by subtracting 90% Passing the 12.5 mm sieve from 100% Passing the 19 mm sieve. This process is repeated for each size fraction. The last line in the % In Size Fraction column is found by adding each of the individual values above it. The total should be 100.0%.

The Weight Needed Each Fraction is found by taking the % In Size Fraction value and multiplying it by the total mass of that aggregate. For example, for the ¾" Minus material, there is 10% in the –19 + 12.5 size fraction. Take this 10% times the mass of 6,500 grams to get the Weight Needed value of 650 grams.

The Cumulative Weight is found by taking the first value in the Weight Needed column and placing it in the first spot for the Cumulative Weight column. For example, there was 650 grams needed in the previous example. This value would go on the first line of the Cumulative Weight column.

Each successive line requires adding the corresponding Weight Needed value with the previous Cumulative Weight value. Below are the solutions for the example shown above.

Weight ¾” Minus @ 50% = 6500.0 grams

Sieve	% Passing	Size Fraction	% In Size Fraction	Weight Needed Each Fraction	Cumulative Weight
19 mm	100				
12.5 mm	90	-19 + 12.5	10.0	650.0	650.0
9.5 mm	75	-12.5 + 9.5	15.0	975.0	1625.0
4.75 mm	43	-9.5 + 4.75	32.0	2080.0	3705.0
		-4.75	43.0	2795.0	6500.0
			100.0		

Weight ⅜” Chip @ 5% = 650.0 grams

Sieve	% Passing	Size Fraction	% In Size Fraction	Weight Needed Each Fraction	Cumulative Weight
12.5 mm	100				
9.5 mm	70	-12.5 + 9.5	30.0	195.0	6695.0
4.75 mm	32	-9.5 + 4.75	38.0	247.0	6942.0
		-4.75	32.0	208.0	7150.0
			100.0		

Weight Nat. Sand @ 45% = 5850.0 grams

Sieve	% Passing	Size Fraction	% In Size Fraction	Weight Needed Each Fraction	Cumulative Weight
4.75 mm	100	-4.75	100.0	5850.0	13000.0
			100.0		

The Cumulative Weight at the end of the batching should always equal the desired total batch weight.

Determination of Tons of Asphalt Binder Used

Determine the tons of asphalt binder used in the mix for a given day using the following information:

Weights of all Binder @ 60°F = 8.67 lbs./gal.
Beginning tank stick 18,000 gal. @ 296°F
28.0 tons Binder hauled in during the day’s run
Ending tank stick 16,000 gal. @ 296°F
Volume correction factor for correcting Binder @ 296°F to Binder @ 60°F = 0.9200

The difference between the beginning and ending tank stick readings is the first place to start. There were 2,000 gal. of binder used plus all of the binder hauled in during the day.

To combine these quantities, they must be converted to tons. First the gallons used must be corrected to 60°F. Since the temperature is the same for the beginning and ending tank stick readings the correction can be done on the difference between the two readings. If the temperatures were different for the two readings, the temperature correction would need to be done on the individual readings before the difference is determined.

2,000 gal binder @ 296°F $= (2000 \text{ gal @ } 296°F) \times 0.9200 = 1840 \text{ gal @ } 60°F$

This value must then be converted to the tons of binder.

1840 gal @ 60°F $= \frac{(1840 \text{ gal}) \times (8.67 \text{ lbs./gal.})}{2000 \text{ lbs./ton}} = 7.98 \text{ tons}$

This value in addition to the 28.0 tons of binder hauled in during the day is the amount used in the mix that day.

Tons of binder used in mix $= 28.0 \text{ tons} + 7.98 \text{ tons} = 35.98 \text{ tons binder}$

DETERMINING CORRECTION FACTORS FOR COLD FEED VS. IGNITION OVEN

		Sieve Sizes - Percent Passing												Surface
		1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200	Area
SU4-30D	Ign. Oven	100.0	100.0	99.0	89.0	77.0	47.0	31.0	20.0	14.0	8.6	6.4	5.2	4.60534
4-A	Cold-Feed	100.0	100.0	99.0	89.0	76.0	47.0	29.0	19.0	13.0	7.8	5.6	4.4	4.13424
Correction Factor		0.0	0.0	0.0	0.0	-1.0	0.0	-2.0	-1.0	-1.0	-0.8	-0.8	-0.8	-0.5

The correction factor is determined by taking the percent passing an ignition oven sieve and subtracting it from the percent passing of the corresponding cold-feed sieve. For example, there is 31 percent passing the number #8 sieve for the ignition oven and 29 percent passing the #8 sieve for the cold-feed. The correction factor for this sieve size is -2.0. The correction factor is applied to the ignition oven test results for I.M. 216 comparison.

This same procedure is used regardless of using a single gradation or multiple gradations to determine the correction factors. If multiple gradations are used, the correction factor is determined for each individual result and the resulting correction factors averaged for each sieve.

QUALITY INDEX (QI) FIELD VOIDS EXAMPLE %G_{mm} Method:

For use on projects using the PWL specifications

Given: Field G_{mb} of individual cores: 2.319, 2.316, 2.310, 2.298, 2.242, 2.340, 2.345, 2.310.
Lot Average G_{mm} = 2.501

Determine the average field density {(Avg G_{mb})$_{(FIELD\ LOT)}$} of the eight cores.

$\bar{x}$

$$= \frac{2.319 + 2.316 + 2.310 + 2.298 + 2.242 + 2.340 + 2.345 + 2.310}{8} = 2.310$$

The sample standard deviation (**σ_{n-1}**) of G_{mb} for the field lot {(Std. Dev. $G_{mb})_{FIELD\ LOT}$} is determined as follows:

σ_{n-1}

$$= \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}} \qquad = \sqrt{\frac{0.007}{8-1}} = 0.032$$

Where: x = individual sample value
n = number of samples
$\bar{x}$ = average of all samples

The Lower and Upper Quality Indexes for field voids shall be determined according to the following calculations:

QI_U (Field Voids)

$$= \frac{(\text{Avg. } G_{mb})_{\text{FIELD LOT}} - (0.915 \text{ x Lot Avg. } G_{mm})}{(\text{Std. Dev. } G_{mb})_{\text{FIELD LOT}}}$$

QI_L (Field Voids)

$$= \frac{(0.965 \text{ x Lot Avg. } G_{mm}) - (\text{Avg. } G_{mb})_{\text{FIELD LOT}}}{(\text{Std. Dev. } G_{mb})_{\text{FIELD LOT}}}$$

Example:

QI_U (Field Voids)

$$= \frac{2.310 - (0.915 \text{ x } 2.501)}{0.032} = 0.67$$

QI_L (Field Voids)

$$= \frac{(0.965 \text{ x } 2.501) - 2.310}{0.032} = 3.23$$

If the QI produces a PWL that results in less than 100% pay, check for outliers. To test for a suspected outlier result, apply the appropriate formula.

Suspected High Outlier $= \dfrac{\text{Highest } G_{mb} - \text{Avg. } G_{mb}}{\sigma_{n-1}}$ $= \dfrac{2.345 - 2.310}{0.032} = 1.09$

Suspected Low Outlier $= \dfrac{\text{Avg. } G_{mb} - \text{Lowest } G_{mb}}{\sigma_{n-1}}$ $= \dfrac{2.310 - 2.242}{0.032} = 2.13$

The highest density or lowest density shall not be included if the suspected outlier result is more than 1.80 for eight samples. The quality index shall then be recalculated for the remaining seven samples.

The suspected low outlier result is greater than 1.80 for eight samples, therefore the core with the lowest density, 2.242, is an outlier.

Recalculate the upper and lower QI for the remaining seven densities (excluding the outlier).

Avg. $G_{mb\ (field\ lot)(new)}$ = 2.320 **$\sigma_{n-1\ (new)}$** = 0.020

$QI_{U\ (new)}$ $= \dfrac{2.320 - (0.915) \times (2.501)}{0.020} = 1.58$

$QI_{L\ (new)}$ $= \dfrac{(0.965) \times (2.501) - 2.320}{0.020} = 4.67$

<u>DETERMINATION OF PERCENT WITHIN LIMITS (PWL)</u>

Field Voids

Calculate the upper and lower QI for field voids. Using Table 6 in AASHTO R 9-97 Appendix C and the QI value, the PWL can be determined using a sample size of N=8. A sample size of N=8 is always used regardless of the actual number of samples. The program provided by the Iowa DOT will calculate the PWL automatically using a best fit equation between QI values.

The PWL used for pay factor determination is based on a combination of the upper and lower PWLs calculated from the QI_U and QI_L. In this case the PWLs determined by the best fit equation for the QI_U (1.58) and QI_L (4.67) are 95.6 and 100.0 respectively.

Example:

PWL = (PWL_U + PWL_L) – 100 = (95.6 + 100.0) – 100 = 95.6

PWL Table for N=8 (from AASHTO R 9-97 Appendix C Table 6)

QI	PWL	QI	PWL	QI	PWL	QI	PWL	QI	PWL
0.00	50.00	0.50	68.43	1.00	83.96	1.50	94.44	2.00	99.24
0.05	51.89	0.55	70.16	1.05	85.26	1.55	95.17	2.05	99.45
0.10	53.78	0.60	71.85	1.10	86.51	1.60	95.84	2.10	99.61
0.15	55.67	0.65	73.51	1.15	87.70	1.65	96.45	2.15	99.74
0.20	57.54	0.70	75.14	1.20	88.83	1.70	97.01	2.20	99.84
0.25	59.41	0.75	76.72	1.25	89.91	1.75	97.51	2.25	99.91
0.30	61.25	0.80	78.26	1.30	90.94	1.80	97.96	2.30	99.96
0.35	63.08	0.85	79.76	1.35	91.90	1.85	98.35	2.35	99.98
0.40	64.89	0.90	81.21	1.40	92.81	1.90	98.69	2.40	100.00
0.45	66.67	0.95	82.61	1.45	93.65	1.95	98.99	2.45	100.00

Note: For QI values less than zero, subtract the table value from 100.

The best fit equation used in the spreadsheet software to calculate the upper or lower PWL is:

PWL = $3E-10x^6+0.2019x^5-3E-09x^4-4.123x^3-2E\text{-}08x^2+37.881x+50$

Where: x = QI_U or QI_L

QUALITY INDEX (QI) LAB VOIDS EXAMPLE:

Based on the weekly lot of HMA produced with a minimum of eight test values, determine the average and standard deviation for the air voids.

Quality Index for Air Voids Upper Limit (QI_U)

$$\mathbf{QI_U} = \frac{(\text{Target } P_a + 1) - \text{Avg. } P_a}{\text{Std. Dev. } P_a}$$

Quality Index for Air Voids Lower Limit (QI_L)

$$\mathbf{QI_L} = \frac{\text{Avg. } P_a - (\text{Target } P_a - 1)}{\text{Std. Dev. } P_a}$$

Using Table 6 in AASHTO R 9-97 Appendix C and a sample size of N=8 determine the upper and lower QI limits. A sample size of N=8 is always used regardless of the actual number of samples. The program provided by the Iowa DOT will calculate the PWL automatically using a best fit equation between QI values. No rounding is done until the final PWL is determined.

Example:

Given the following weekly lot air void information and a target air void of 4.0% determine the upper and lower limits for the QI for air voids: 3.1, 3.9, 4.2, 4.5, 4.5, 4.1, 4.3, 4.5

$P_{a(avg)}$

$$= \frac{3.1 + 3.9 + 4.2 + 4.5 + 4.5 + 4.1 + 4.3 + 4.5}{8} = 4.1375$$

Std. Dev. P_a

$$= \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}} \qquad = \sqrt{\frac{1.55875}{8-1}} = 0.471888$$

QI_U

$$= \frac{(4.0 + 1) - 4.1375}{0.471888} = 1.827763$$

QI_L

$$= \frac{4.1375 - (4.0 - 1)}{0.471888} = 2.410528$$

DETERMINATION OF PERCENT WITHIN LIMITS (PWL)

Lab Voids

After calculating the quality indices for the Lab Voids for a particular lot, the PWL values can be obtained from tables provided in FHWA Technical Advisory T 5080.12, June 23, 1989. The direct calculation with an example is provided herein. (Equations taken from: *Belz, M.H., Statistical Methods for the Process Industries. John Wiley & Sons. New York. 1973.* Explanation presentation taken from: *Freeman & Grogan, Statistical Acceptance Plan for Asphalt Pavement Construction Appendix B. U.S. Army Corps of Engineers Technical Report GL-98-7.1998.*)

Cacluating PWL involves the use of the beta probability distribution defined over the interval 0≤ x ≤1. The shape of the beta distribution is a function of two parameters: α and β.

$$f(x) = \begin{cases} \frac{1}{B(\alpha,\beta)} x^{\alpha-1}(1-x)^{\beta-1} & (0 \le x \le 1) \\ 0 & (x < 0,\ x > 1) \end{cases}$$

Where α and β are greater than -1, also α and β are not restricted to assuming integer values. The value B(α, β) is defined as:

$$B(\alpha,\beta) = \frac{\Gamma(\alpha)\Gamma(\beta)}{\Gamma(\alpha+\beta)}$$

Where Γ is the gamma function and can be calculated using the GAMMA function in Microsoft Excel. In Excel, GAMMA uses the following equation:

$$\Gamma(M) = \int_0^\infty t^{M-1} e^{-t} dt$$

NOTE: The gamma function extends the factoral to non-integer values and Γ(M+1)=M*Γ(M).

The shape of the beta distribution is dependent on sample size (designated as n). The parameters, α and β, for the beta distribution are calculated as:

$$\alpha = \beta = \frac{n}{2} - 1 \quad for \quad n \geq 3$$

After calculating a quality index for the lot, QI_U or QI_L (designated generically as Q in the following equation) is transformed into x(β) by:

$$x(\beta) = \frac{1}{2}(1 - \frac{Q\sqrt{n}}{n-1})$$

Example. Results for thirteen laboratory void measurements for a lot of HMA are shown below in the table. The value "n" represents the number of observations, 13. The target laboratory air voids is 4.0% with limits ± 1%.First, the sample mean and sample standard deviation are calculated.

Lab air voids (%)	Average Air Voids (%)	Sample Standard Deviation
2.3	3.444	0.58
3.0		
3.0		
3.2		
3.1		
4.0		
4.1		
3.8		
3.0		
3.4		
3.4		
3.9		
4.4		

Next, the QI_U and QI_L are calculated. The upper quality limit is 5.0% and the lower quality limit is 3.0%.

$$QI_L = \frac{\bar{X} - Lower\ Quality\ Limit}{s} = \frac{3.444 - 3.0}{0.5839} = 0.7605$$

$$QI_U = \frac{Upper\ Quality\ Limit - \bar{X}}{s} = \frac{5.0 - 3.444}{0.5839} = 2.6646$$

Where:
QI_L = quality index relative to the lower specification limit
QI_U = quality index relative to the upper specification limit
$\bar{X}$ = sample mean or average for the lot
s = sample standard deviation for the lot

The quality index value represents the distance in sample standard deviation units that the sample mean is offset from the specification limit. A positive quality index value represents the number of sample standard deviation units that the sample mean falls inside the specification limit. Conversely, a negative quality index value represents the number of sample standard deviation units that the sample mean falls outside the specification limit.

Next, the percent of non-conforming for the upper and lower specification limit must be calculated. The percent non-conforming is calculated by transforming quality index into x(β), a value "x" within the beta distribution. The lower quality index is transformed to $x(\beta)_L$ by:

$$x(\beta)_L = \frac{1}{2}\left(1 - \frac{QI_L\sqrt{n}}{n-1}\right) = \frac{1}{2}\left(1 - \frac{0.7605\sqrt{13}}{13-1}\right) = 0.3857$$

The upper quality index is transformed to $x(\beta)_U$ by:

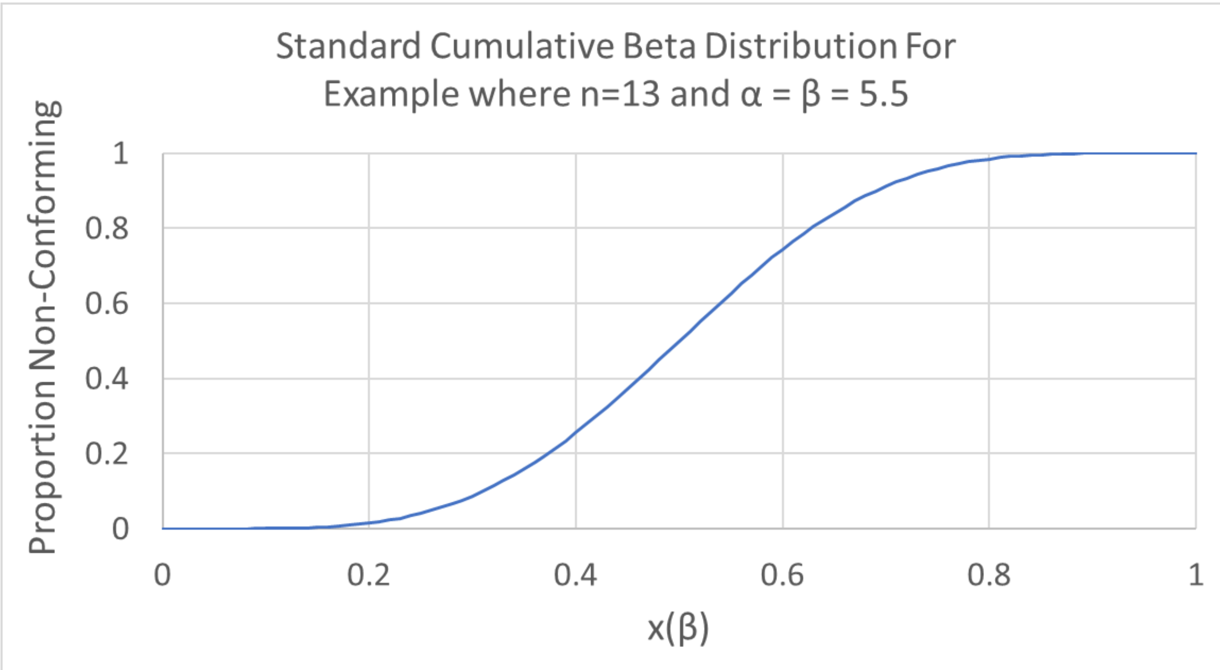
$$x(\beta)_U = \frac{1}{2}\left(1 - \frac{QI_U\sqrt{n}}{n-1}\right) = \frac{1}{2}\left(1 - \frac{2.6646\sqrt{13}}{13-1}\right) = 0.0997$$

The probability of obtaining air voids less than the lower limit (3.0%) is equal to the probability of finding an x(β) less than 0.3857 within the beta distribution defined by the following α and β.

$$\alpha = \beta = \frac{n}{2} - 1 = \frac{13}{2} - 1 = 5.5$$

The beta probability can be obtained from most commercial spreadsheet software using built-in functions that can be included in user-generated equations. For example, the built-in function in Microsoft Excel include BETADIST(x, α, β, A, B), where x is the value at which to evaluate the function (shown as $x(\beta)_L$ or $x(\beta)_U$ above); α and β are the beta distribution parameters; and A and B are the lower and upper beta distribution boundaries, respectively. Plugging both the known A and B (0 and 1, respectively) and the calculated x, α, and β into the function, BETADIST(0.3857, 5.5, 5.5, 0, 1) produces 0.226347 which represents 22.6% as non-conforming for the lower specification limit. The lower PWL is 77.37%. The upper specification limit for x, α, and β into the function, BETADIST(0.099678, 5.5, 5.5, 0, 1) produces 0.000504 which represents 0.05% non-conforming. The upper PWL is 100%.

This figure represents the cumulative Beta Distribution function for the example. NOTE: This distribution will change for lots with different sample sizes.



The PWL used for pay factor determination is based on a combination of the PWLs calculated from the QI_U and QI_L.

PWL = $(PWL_U + PWL_L) - 100$ = (100 + 77.37) – 100 = 77.37

DETERMINATION OF PAY FACTOR

The pay factor is determined from the tables in the Basis of Payment section 2303.05 BASIS OF PAYMENT of the specification. A PWL of 90.0 results in a pay factor of 1.000. Equations are used to determine the pay factor for other PWL values.

Example:

Using the PWL determined above for Lab Voids of 77.37 and the specified equation for a Lab Voids PWL of 50.0-89.9:

Lab Voids:

PF **(Pay Factor)** = 0.00625 × 77.37 + 0.4375 = 0.921

Using the PWL determined above for Field Voids of 95.6 and the specified equation for a Field Voids PWL of 90.1-99.9:

Field Voids:

PF **(Pay Factor)** = 0.006000 × 95.6 + 0.4600 = 1.034

DETERMINING AVERAGE ABSOLUTE DEVIATION (AAD) FOR LAB VOIDS

AAD is calculated by determining the absolute difference between the target and the individual test results and then averaging those values.

Example:

Target Voids P_a = 4.0
Individual P_a = 3.8, 4.2, 4.1, 3.7, 3.5

Sample	Difference	Deviation from Target	Absolute Deviation from Target
1	(4.0 - 3.8)	0.2	0.2
2	(4.0 - 4.1)	-0.1	0.1
3	(4.0 - 4.2)	-0.2	0.2
4	(4.0 - 3.7)	0.3	0.3
5	(4.0 - 3.5)	0.5	0.5

AAD (Lab Voids) $= \dfrac{0.2 + 0.1 + 0.2 + 0.3 + 0.5}{5} = 0.3$

DETERMINING MOVING AVERAGE ABSOLUTE DEVIATION (AAD) FOR LAB VOIDS

Calculate the absolute deviation from target (ADT_i) for sample, *i,* using the following equation:

$$ADT_i = |Pa_i - Target\ Pa|$$

Where,
i = Sequential production sample, *i*
ADT_i = Absolute deviation from target for sample, *i*
Pa_i = Laboratory air voids test result for sample, *i*
Target Pa = Target laboratory air voids for mixture
| | = Absolute value

Calculate the moving average ADT for *i* ≥ 4 using the following equation:

$$\left|\frac{ADT_i + ADT_{i-1} + ADT_{i-2} + ADT_{i-3}}{4}\right|$$

Where,
i = Sequential production sample, *i*
ADT_i = Absolute deviation from target for sample *i*
| | = Absolute value

IM 505
RAM

INSTRUCTIONS FOR RAM IN ASPHALT MIXTURES

GENERAL

This IM describes requirements for processing, storing, documenting, and sampling & testing of Recycled Asphalt Materials (RAM) intended for use in asphalt mixtures. RAM shall apply to Recycled Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS).
All notifications and documentation shall be submitted to the District Materials Engineer (DME) based on the District responsible for the location of the initial RAM stockpile.

PROCESSING

A) RAP

RAP suitable for asphalt mixtures shall be processed by milling and/or crushing up to a maximum particle size of 1.5 inches. The Contractor shall notify the Engineer and DME 48 hours before processing begins.

Additional screening or blending may be done to achieve a more uniform stockpile. This processing may be done as the stockpile is built or as part of the asphalt plant production. Additional actions that may improve the consistency of the RAP include further crushing to reduce top size, screening into coarse and fine fractions, or blending by proportioning through a calibrated two-bin cold feed. Each individual RAP stockpile being incorporated into asphalt mixtures must have a dedicated totalizer for measuring quantities during production. When using multiple RAP stockpiles for a single mix, if the required number of totalizers are not available pre-blend the piles to the JMF proportions under the direction of the DME.

B) RAS

End users of RAS which also receive raw, unprocessed shingles and process the material for incorporation into an asphalt mixture, shall be considered a shingle Supplier and must adhere to Materials IM 506.

STORAGE

A) RAP

Place stockpiles on a base with adequate drainage, sufficient to prevent contamination, constructed in layers to minimize RAP segregation and ensure a workable face. Track equipment may operate on the stockpile during its construction.

To meet Classified RAP criteria, separate stockpiles shall be constructed for each source of RAP based on the quality of aggregate, type and quantity of asphalt binder, and size of processed material. Notify the Engineer and DME 48 hours prior to blending Classified RAP materials of the same aggregate quality to retain Classified status.

B) RAS

Place stockpiles on a base with adequate drainage sufficient to prevent contamination.

Separately stockpile pre-consumer RAS from post-consumer (tear-off) RAS. RAS may be pre-blended with RAP under the direction of the Engineer. Notify the Engineer and DME 48 hours prior to blending RAS materials with other materials or adding to a RAS stockpile. Equipment must be calibrated to ensure proper proportioning of blended piles. The Engineer may require verification testing for asphalt content, gradation, aggregate specific gravity, aggregate absorption, and fine aggregate angularity before the pile may be used.

DOCUMENTATION OF RAM STOCKPILES

A) RAP

Stockpiled RAP material will only retain its Classified status when the following documentation requirements are met. No documentation is required when the RAP is used on the project it came from, or a tied project.

- Identification of the project from which the material was removed.
- Mix data from the original project including mixture type.
- Aggregate classification.
- Location and depth in the pavement structure.
- Extracted gradation information, if available.
- Description of stockpile location and quantity.
- Form 820009r (see Appendix A) is completed by the RAP owner and a copy is forwarded to the DME within 10 calendar days of completing the stockpile.
- Any special handling, treatment or conditions of the RAP or its use should be described on this form.
- Maps shall provide details that depict the stockpile site, including adjacent stockpiles of RAP or aggregates, permanent plant equipment, and landmarks.

Maps and signs shall identify the stockpile by RAP Identification Number.
The DME will review Form 820009r for accuracy. Portions of the form including assigning the RAP identification number, aggregate quality type, crushed particle and friction type credit, average values for extracted aggregate gradation, aggregate bulk specific gravity, aggregate absorption and asphalt binder content will be furnished by the DME.

Notify the DME at least 48 hours before relocating or reprocessing a Classified RAP stockpile for future use (not intended for a specific project). The notification shall include the estimated quantity of RAP being relocated or reprocessed and the new location of the stockpile. Relocation of RAP shall be reported on the appropriate Form (820009r) and submitted to the DME within 10 calendar days of completing the relocation. Reprocessing a Classified RAP stockpile may require additional sampling, testing, and a new Form (820009r) with reassignment of a RAP Identification Number.

Before January 1st of each year, the Contractor shall update Form 820009r on the status of each RAP stockpile. Report the estimated quantity of RAP removed for the construction season completed and the available RAP in each stockpile for future use.

B) RAS

The following documentation is required for owners of stockpiled RAS:

- Form 820009ras (see Appendix B) is completed by the stockpile owner and a copy is forwarded to the DME within 10 calendar days of completing the stockpile.
- Any special handling, treatment or conditions of the RAS should be described on this form.
- A record of addition and consumption of the RAS stockpile should be documented on this form.

- Maps shall provide details that depict the stockpile site, including adjacent stockpiles of RAP or aggregates, permanent plant equipment, and landmarks.
- Maps and signs shall identify the stockpile by RAS Identification Number.

The DME will review forms for accuracy. Portions of the form including assigning the stockpile identification number, average values for extracted aggregate gradation, and asphalt binder content will be completed by the DME.

Notify the DME at least 48 hours before relocating or reprocessing a RAS stockpile for future use (not intended for a specific project). The notification shall include the estimated quantity of RAS being relocated or reprocessed and the new location of the stockpile. Relocation of RAS shall be reported on the appropriate Form (820009ras) and submitted to the DME within 10 calendar days of completing the relocation. Reprocessing a RAS stockpile may require additional sampling, testing, and a new Form (820009ras) with reassignment of a RAS Identification Number.

Before January 1st of each year, the Contractor shall update Form 820009ras on the status of each RAS stockpile. Report the estimated quantity of RAS removed for the construction season completed and the available RAS in each stockpile for future use.

SAMPLING & TESTING

1. Mix Design

A) RAP

A certified Level I Aggregate Technician shall obtain the samples. Significant mixture differences in the pavement to be recycled may require separate stockpiles and samples. A sampling plan shall be developed by the Contractor and approved by the DME prior to sampling.

Samples for mix design obtained from the RAP stockpile are preferred, but not always available when the mix designs are performed. Samples shall be obtained from at least 3 locations. When stockpile samples are not available, RAP samples shall be obtained by milling a minimum of 50 feet of project length at each sample location. Other methods of sampling for mix design may only be used with the approval of the DME.

Obtain sufficient material for contractor mix design testing and owner agency RAP extraction testing as recommended in Materials I.M. 510. A representative 30 pound sample split from the total sample shall be delivered to the District Materials Laboratory for extraction testing. Results of the extraction test will be provided to the Contractor within 4 weeks of sample delivery.

B) RAS

When RAS is to be used on an existing contract, the DOT will perform mix design testing on samples from the certified stockpile dedicated to the project at the plant. Samples may also be collected at an in-state source. For out-of-state sources, the DME may approve mix design sampling and testing to be coordinated by the Contractor and Supplier at a qualified lab for preliminary information. Mix designs may then be given conditional approval pending DOT results. When the Contractor retains possession of the RAS, the DOT will sample and test. DOT results shall be available prior to start-up. Adjustments to the mix design may be required.

When mix design development needs to be expedited for an active DOT contract and the Supplier has not had sufficient time to certify the pile's quality (gradation and deleterious content), extraction samples may be taken by the District directly at the Supplier's site provided the material is certified free of asbestos containing materials (ACM). Provide a certification letter to the DME using guidelines in Materials IM 506 Appendix E. The Central lab will run extraction and material quality (gradation and deleterious content) testing on the sample. In the event of a failing quality test, the District may sample and test (gradation and deleterious) again after the Supplier has certified the material quality.

A certified Level I Aggregate Technician shall obtain the samples. RAS shall be sampled using methods similar to those for fine aggregate. Samples for mix design testing shall be obtained from at least 3 locations. A sampling plan shall be developed by the Contractor and approved by the DME prior to sampling.

Obtain sufficient material for contractor mix design testing and owner agency extraction testing as recommended in Materials I.M. 510. Samples shall be witnessed and secured. A representative 30 pound sample split from the total sample shall be delivered to the District Materials Laboratory for extraction testing. Results of the extraction test will be provided to the Contractor within 4 weeks of sample delivery.

Include extracted asphalt content and dry RAS gradation in testing.

In lieu of a sieve analysis on the extracted aggregate, the following gradation may be assumed for the RAS aggregate:

Shingle Aggregate Gradation	
Sieve Size	Percent Passing by Weight
3/8 in.	100
No. 4	95
No. 8	85
No. 16	70
No. 30	50
No. 50	45
No. 100	35
No. 200	25

2. Classified RAP Quality Control

When the contractor elects to perform RAP quality control, use one of the following quality control sampling programs. A certified Level I Aggregate Technician shall obtain the samples.

- Stockpiles – The Contractor shall obtain a representative sample of RAP from the stockpile for each 1000 tons of RAP placed in the stockpile.
- Asphalt Plant – The Contractor shall obtain a representative sample of RAP from the RAP feed belt for each 7000 tons of mixture produced.

The Contractor shall use the ignition oven (Materials I.M. 338) or chemical extraction (AASHTO T 164) to extract the aggregate from the RAP sample. Calibration of the asphalt binder content from the ignition oven extraction is not required for the RAP quality control program. The gradation of the extracted RAP aggregate and the un-calibrated asphalt binder content shall be logged and charted within 24 hours of sampling. Report results to the DME upon completion of testing.

3. Undocumented RAP Stockpiles

To retain Classified RAP status for undocumented sources, the stockpile shall be uniform in gradation and binder content. The contractor shall perform ignition oven (Materials IM 338) testing for aggregate gradation and binder content at 1/1000 tons as the stockpile is built or during processing of the stockpile. Regardless of tonnage, a minimum of three tests shall be required. Interior samples from the stockpile cross section shall be included in quality control testing. The contractor shall perform and report aggregate specific gravity and absorption testing at the above frequencies. Retain a split portion of each sample for testing by the Iowa DOT. The District may, at their discretion, select any of the samples to test a burn-off gradation for verification and validate the contractor's testing based on IM 216 tolerances. If tolerances are not met, the District may deem the pile as unclassified or perform additional testing to determine if the Contractor's test results are satisfactory.

Gradation and asphalt content uniformity will be based on the standard deviation requirements listed in Table 1. If the Contractor results satisfy the requirements in Table 1, ~~the District will select a sample to test a burn-off gradation for verification. If the tolerances in IM 216 are met, the Contractor's results will be validated and~~ the pile will be classified. ~~Asphalt content need not be verified with IM 216 tolerances.~~ Log, chart, and report all test results to the DME using the spreadsheet (*http://www.iowadot.gov/Construction_Materials/hma/CertifiedRAPWorksheet.xlsx*). The procedure outlined in Materials I.M. 501 will be used to identify an outlier on each sieve size and binder content.

Table 1: Variability requirements for Classified RAP from Undocumented Source

Property	Maximum Standard Deviation
1 ½ (% Passing)	5.0
1 (% Passing)	5.0
¾ (% Passing)	5.0
⅜ (% Passing)	5.0
#4 (% Passing)	5.0
#8 (% Passing)	5.0
#30 (% Passing)	5.0
#200 (% Passing)	1.5
Asphalt Content (%)	0.50

The DME will provide notification of Classified status when the above requirements are satisfied.

Only when the owner of the stockpile of a RAP material is an asphalt contractor, the Iowa Department of Transportation or a local agency, should RAP samples be submitted to the Office of Construction & Materials for Vacuum Extraction of Bitumen and Mechanical Analysis of Extracted Aggregate. Ownership of the RAP should be verified so the test results are provided to the rightful owner.

These tests on samples representing stockpiles of any RAP not owned by one of the owners described in the preceding paragraph, shall not be submitted to Office of Construction &

Materials for testing, unless directed by the DME. Until it is certain that these RAP materials will be used in Department projects, the owner may be advised to seek a qualified commercial testing lab to perform these tests.

CREDIT FOR FRICTION AND CRUSHED PARTICLES

The Engineer will use the following guidelines to determine credit for friction and crushed particles when blending multiple piles or milling multiple lifts:

- Credit will be weighted based on paving histories and lift thickness obtained from the historical records where possible
- When no documentation exists, but the year of paving is known, the Engineer may assign credit according to the specification requirement at the time of original paving.

Example:

Your firm is milling 3" of existing pavement using 1 pass of the mill. Of that 3", 2" is from a surface mix, 1" was from a base mix.
From the paving records you determine the base mix had:

A. 20% crushed clean 3/4" type 4 limestone with 15% passing the number 4 sieve.
B. 20% crushed 3/4" type 4 limestone with 36% passing the number 4 sieve.
C. 10% crushed 1/2" type 4 limestone with 42% passing the number 4 sieve.
D. 25% crushed type 4 limestone manufactured sand with 97% passing the number 4 sieve.
E. 25% type 5 washed sand with 98% passing the number 4 sieve.

From the paving records you determine the surface mix had:

F. 17% crushed 3/4" type 3 gravel with 6% passing the number 4 sieve.
G. 16% crushed 3/8" type 4 limestone with 57% passing the number 4 sieve.
H. 11% crushed 1/2" type 4 limestone with 42% passing the number 4 sieve.
I. 32% crushed limestone manufactured sand with 95% passing the number 4 sieve.
J. 24% type 5 washed sand with 98% passing the number 4 sieve.

The base lift is 1"/ 3" or 33.33% of the rap.
The surface lift is 2"/ 3" or 66.67% of the rap.
Aggregate A from above was 20% of the original base mix aggregate. The base was 33 1/3% of the total rap milled. 85% was retained on the 4. 15% passed the 4. For this rap blend:

- Aggregate A contributed (20%)*(33 1/3%)*(85%) or 5.67% (see below) Type 4 plus 4 sieve material to the aggregate total.
- Aggregate A contributed (20%)*(33 1/3%)*(15%) or 1% (see below) Type 4 minus 4 sieve material to the aggregate total.

This can be done with every aggregate (as shown below).

	Base					Surface							
A number	Axxxxx	Axxxxx	Axxxxx	Axxxxx	Axxxxx	Axxxxx	Axxxxx	Axxxxx	Axxxxx	Axxxxx			
Common name	¾" C.L.	¾" - L.S.	½" - L.S.	Man. Sand	W. Sand	¾" Cr. Gr	3/8" - L.S.	½" - L.S.	Man Sand	W. Sand			
Percent of original mix	20	20	10	25	25	17	16	11	32	24			
Volumetric % (Ratio of lift compared to total lift milled)	33%	33%	33%	33%	33%	67%	67%	67%	67%	67%	0%	0%	
% (percent of total mix)	6.67	6.67	3.33	8.33	8.33	11.33	10.67	7.33	21.33	16.00	0	0	
Retained (+4)	85	64	58	3	2	94	43	58	5	2	100	100	
Passing (-4)	15	36	42	97	98	6	57	42	95	98	0	0	
Aggregate percentage as a decimal	0.066667	0.066667	0.033333	0.083333	0.083333	0.113333	0.106667	0.073333	0.213333	0.16	0	0	
Aggregate Type	4	4	4	4	5	3	4	4	4	5	0	0	
Type 2 or better	No	No	No	No	No	No	No	No	No	No	No	No	
Type 3 or better	No	No	No	No	No	Yes	No	No	No	No	No	No	
Type 4 or better	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	
Crushed y-yes n-no	Y	Y	Y	Y	N	Y	Y	Y	Y	n			
Type___ or better	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	Total
Plus 4 type 4 credit =	5.67	4.27	1.93	0.25	0.00	10.65	4.59	4.25	1.07	0.00	0.00	0.00	32.68
Plus 4 type 3 credit =	0.00	0.00	0.00	0.00	0.00	10.65	0.00	0.00	0.00	0.00	0.00	0.00	10.65
Plus 4 type 2 credit =	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minus 4 type 4 credit =	1.00	2.40	1.40	8.08	0.00	0.68	6.08	3.08	20.27	0.00	0.00	0.00	42.99
Minus 4 type 3 credit =	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.68
Minus 4 type 2 credit =	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plus 4	5.667	4.267	1.933	0.250	0.167	10.653	4.587	4.253	1.067	0.320	0.000	0.000	33.16
Minus 4	1.000	2.400	1.400	8.083	8.167	0.680	6.080	3.080	20.267	15.680	0.000	0.000	66.84

% plus 4 type 4 **or Better**=32.68/33.16=	98.5%
% plus 4 type 3 **or Better**=10.65/33.16=	32.1%
% plus 4 type 2 **or Better**=0/33.16=	0.0%
% minus 4 type 2 **or Better**=0/66.84=	0.0%
% minus 4 type 3 **or Better**=.68/66.84=	1.0%
% minus 4 type 4 **or Better**=42.99/66.84=	64.3%

Type 5 aggregate	13.00%
Type 4 aggregate	75.67%
Type 3 aggregate	11.33%
Type 2 aggregate	0.00%

Crushed credit in %= 75.67

% plus 4 type 4 =(32.68-10.65)/33.16=	66.4%
% plus 4 type 3 =10.65/33.16=	32.1%
% plus 4 type 2 =0/33.16=	0.0%
% minus 4 type 4 = (42.9-68)/66.84=	63.3%

% minus 4 type 3 =.68/66.84=	1.0%
% minus 4 type 2 =42.99/66.84=	0.0%

Note: Type three or two aggregate is shown as type four or better. When sorting by type this material cannot be counted more than once.

*****GENERAL REWRITE – PLEASE READ CAREFULLY.*****

RAP STOCKPILE REPORT (Form 820009r)

820009r (January 2010)

RAP Stockpile Report		RAP Stockpile ID #
□ **Classified**	□ **Certified**	
Stockpile Owner:		

SOURCE OF RAP (Classified only)	Project No.	Dates of Removal

Route No.	From Milepost	To Milepost

Removal Depth	JMF No(s)	Mix Type / Size	Crushed Particle %		

LOCATION OF RAP STOCKPILE:

County	Section	Township	Range

Description of stockpile base:

Processing remarks:

STOCKPILE QUANTITY INVENTORY LOG

Date	Quantity	Disposition (Project No. and use)
		Total initial stockpile quantity

Average EXTRACTION TEST RESULTS		**Aggregate Characteristics**
Gradation	Lab Report nos.	
3 / 4	Moisture % =	Aggregate Type
1 / 2	Pb =	
3 / 8	Gsb =	Crushed Particles %
No. 4	Abs% =	
No. 8	FAA =	Aggr Friction Type 2 %
No. 16	XRF Results	
No. 30	Al_2O_3 =	Aggr Friction Type 3 %
No. 50	MgO =	
No. 100	Deleterious=	Aggr Friction Type 4 %
No. 200	Recycled PCC =	

Shaded boxes to be completed by the District Materials Engineer

Stockpile Owner Representative		Date
District Materials Representative		Date

*****NEW – PLEASE READ CAREFULLY.*****

RAS STOCKPILE REPORT (Form 820009ras)

820009ras (October 2011)

RAS Stockpile Report	**RAS Stockpile ID #**
Stockpile Owner:	

SOURCE OF RAS

☐ **Post Consumer Scrap (Tear-offs)** ☐ **Post Manufactured Scrap**

LOCATION OF RAS STOCKPILE:

County	Section	Township	Range

Description of stockpile base:

Processing remarks:

STOCKPILE INVENTORY LOG					
RAS Addition			RAS Consumption		
Date	Quantity	Supplier	Date	Quantity	Disposition (Project No. and use)
					Total initial stockpile quantity

Average EXTRACTION TEST RESULTS		
Dry RAS Gradation		Lab Report nos.
3 / 4		Moisture % =
1 / 2		
3 / 8		Pb =
No. 4		
No. 8		
No. 16		
No. 30		
No. 50		
No. 100		
No. 200		

Shaded boxes to be completed by the District Materials Engineer

Stockpile Owner Representative		Date
District Materials Representative		Date

IM 507
HMA PLANT MONITOR

ASPHALT PLANT MONITORING

GENERAL

The following instruction is to be used when monitoring the operation of an asphalt plant. The plant monitor is responsible for monitoring the plant operation, quality control procedures performed by the certified plant inspector, and ensure that proper mix is being produced and delivered.

DUTIES

The following duties are performed by the plant monitor for asphalt paving.

Duty	Task	Minimum Frequency
1. Inspect stockpiles	• Observe stockpiling procedures. • Check for segregation. • Check for contamination. • Check for degradation. • Check for proper storage and handling of aggregates per Article 2303.03 C 3. • Check that the stockpiles being loaded into the bins match the mix design.	Observe during startup and during visits
2. Mix Design	• Verify that a valid mix design exists and has been signed by the DME. • Check that any changes to the mix design are properly documented. • Verify that the mix design being produced matches the bid item being placed.	At start up and before each new design.
3. Test Equipment	• Inspect test equipment to ensure it is in good working order and lab has been qualified.	During startup and when problems arise
4. Material certifications	• Check certifications for binder, aggregates, and RAM. Verify that the material delivered meets the mix design and materials requirements of 2303.02.	During visits
5. Observe aggregate and mixture sampling and testing.	• Observe tests are performed in accordance with Materials IM's and at the frequency listed in IM 204. • Direct and witness binder and aggregate samples for verification testing. • Fill out form 193 for binder aggregate and mixture samples and secure for transport per IM 205 Appendix A.	During daily visits
6. Plant proportion control	• Observe delivery tolerances. • Observe scale check and verification weights per 2001.07 A 7.	

	• Check that mix proportions settings in the control house match the approved mix design.	
7. Compacted mixture density.	• Witness or verify that agency personal direct and witness coring. •Transport or verify that sample security has been maintained. • Check cores for damage with the CPI before testing. • Test cores, record and furnish the results to the CPI.	During visits
8. Audit Daily Diary	• Review for proper recording of events.	During visits
9. Plant Reports	• Check for proper project bid item and mix identification. • Check for dates and report number. • Check for proper placement records (stations, widths for PWL & non-PWL) • Check for recorded air, binder, mix and mat temperatures. • Check binder quantities against totalizer in the control house. • Check for locations on hot boxes. • Check for proper documentation of mix changes. • For small quantities 2303.03 E., check that the certification statement is in the remarks. • Review test results and aggregate gradations. • Check materials sources. • Check for correct binder, aggregate and RAM totals (daily, weekly, and to date). • Check for appropriate Plant Inspector signature or initials. • Sign report after review. • Check for hard copy or electronic backup of files	Daily / Weekly
10. Monitor dump trucks	• Check for properly cleaned dump box. • Check release agents. • Watch for inappropriate use of solvents per 2001.01 D.	During visits
11. Inspect plant facility	• When available observe plant calibration to assure compliance with Materials IM 514. • Check for calibration report. • Check lab qualifications. • Inspect test equipment.	At start of project

A monitor checklist is available at: https://iowadot.gov/construction_materials/Hot-mix-asphalt-HMA

SAMPLING

A Non-compliance Notice (Form #225) shall be immediately delivered to the acting representative of the contractor for the area of construction involved whenever procedures or tests results on acceptance samples representing material to be incorporated or incorporated in the work indicate non-compliance with the specifications and plans. Appropriate action in accordance with the applicable specifications and Instructional Memorandums shall be taken.

Identification of Sample for Test (Form #193)

This form must accompany all samples submitted to the Central Laboratory and District Laboratories. Examples of completed forms have been included in this instruction. A copy of the 193 form may be found at: https://iowadot.gov/construction_materials/Hot-mix-asphalt-HMA

IM 508
PLANT INSPECTION

GENERAL REWRITE
ASPHALT PLANT INSPECTION

GENERAL

The overall responsibility for plant inspection remains with the Contractor. The Contractor's Certified Technician should witness the contractor operations. Any deficiencies, which are observed with regard to specification compliance or safety, shall be reported to the contractor and the engineer.

INSPECTION

Refer to IM 213 Appendix D for a list of the duties of a Certified Plant Inspector.

A. Preliminary Inspection
The first phase of the contractor operations consists of preparing the plant site and building stockpiles.

Stockpiles should be inspected for segregation, contamination and intermingling. If evidence of segregate and/or contamination is found, report to the contractor's quality control manager. Inspect Plant Site for safe working conditions.

> **NOTE:** All aggregate must be properly certified before being placed in the stockpile.

B. Job Mix Formula (JMF)
The plant inspector must be thoroughly familiar with the information provided by the Job Mix Formula Report (Form #956 & 955). Sample mix design documentation can be found in IM 510 Appendix B.

Aggregate production and inspection are covered in detail by IM 204 and IM 209.

C. Sampling and Testing
The Contractor's Laboratory Technician is responsible for meeting all sampling, testing, and documentation requirements as set forth by Specification 2303 and IM 511. Sampling frequencies are provided for in IM 204 and the Standard Specifications. Sampling and testing methods are provided for in IM 300 series.

D. Plant Equipment
Items of equipment to be checked for specification compliance prior to beginning operations are listed below:

1. Truck Scales or weigh hoppers
2. Aggregate Bins and Belts
3. Dryer
4. Dust Collector
5. Revolution Counters, and/or Scales
6. Thermometer Equipment

7. Equipment for Heating, Storing and Measuring Asphalt Binder (Asphalt Pump, Surge Tank, and/or Scales)
8. Testing Laboratory
9. Safety Requirements

See IM 514 for plant calibration.

E. Production Inspection Duties
1. Temperature Control
Observe and control the temperature of the various material components to document specification compliance, to prevent damage to the material, and to produce uniform workable mixtures. The specifications contain the ranges and tolerances for each type and class of mixture. The specification limits for mix temperature are the same for all plant types. Production above or below these limits must be approved in advance by the Engineer, and documented as set out in Section 1108.04 of the Standard Specifications.

	Point of Test (Temperature)
• Asphalt Binder	Delivery units and storage tanks
• Aggregate	Dryer Pyrometer
• Final Mixture	Point of Discharge from mixer (May be obtained from the internal instrumentation providing real-time information to the control house)
• Final Mixture (on road)	Behind Paver

2. Gradation Control
Aggregate proportioning will be monitored and verified as part of the overall plant inspection activity. When the sieve analysis test indicates the combined material does not comply with the gradation requirements, the plant inspector shall take the following steps:
a. Recheck test procedures and computations.
b. Check gate settings and feeder operations.
c. Check the materials and material handling procedures.
d. Notify the RCE, the DME and the contractor of the results.
e. Obtain a second sample and test promptly.

If the gradation tests and/or inspection observations indicate that proportioning irregularities are occurring, the contractor is required to take corrective action immediately. Adjustments in proportions and other job mix formula changes must be documented, in accordance with IM 511.

3. Asphalt Content Control
IM 509 provides the detailed procedure for determining asphalt content and IM 509 Appendix A for making tank measurements. Refer to IM 511 Appendix D for troubleshooting. Separate check systems are used for drum-mix and batch plants as follows:

a. Drum Mixing Type Plants
At start-up and during periods when asphalt or aggregate delivery is questionable, it is advisable to perform proportioning checks in addition to the measurements required in IM 204. The specifications require drum-mixing plants to be equipped with totalizing

asphalt meters and aggregate scales.

This equipment and information should be utilized for making continuous checks. Total asphalt delivered as indicated by the meter should be periodically compared with quantities used as determined by tank measurements.

(1) Compare asphalt delivered by metering pump or scale with outage shown by 2 or 4 hour tank measurement (compare by pounds, gallons, or percent).

(2) Compare total mix produced, including waste, to asphalt and aggregate delivered by plant for a given period of time.

b. Batch Type Plants
The operation of batch type plants should also be verified when work begins on a project. This is done by checking the operation and sensitivity of the scale equipment.

F. Checking Scales
1. Batch Scales
Batch scale sensitivity shall be checked once per day during a normal working day by placing a weight equal to 1/10 percent of the batch weight but not greater than 20 lbs. on the fully loaded scales and observing the movement of the indicator. A properly sensitive scale will exhibit a visible indicator movement when so tested. If no indicator movement is visible, immediate corrective action must be taken by the contractor.

The specified scale delivery tolerance limits should be checked by periodically witnessing the batch weighing operations. Each scale indicator should consistently indicate the required weight within the specified delivery tolerance, and return to zero when unloaded within the specified 0.5 percent tolerance.

When automatic batch weighing equipment is used, the interlock system shall be set at the 1.0 percent limit as specified. They may be manually overridden to continue plant operation if the specified delivery tolerance is not exceeded. When the delivery tolerances are exceeded, the asphalt or aggregate batch sizes shall be adjusted manually to bring the batch into compliance, or it shall be wasted.

The plant superintendent or other authorized contractor representative must make all necessary scale and equipment settings and/or adjustments. Before the plant operation begins or resumes the plant inspector will independently determine for himself that the settings and/or adjustments are accurate and that the weights of material being delivered to the batch are correct.

Normal plant operation causes vibration, which tends to change these adjustments. Accumulation of material clinging to the inside of the weighing hopper can also cause these adjustments to drift. If the amount exceeds one percent of the material batch weight it must be removed and the empty weight readjusted to indicate a zero load.

2. Truck Scales
Truck scales shall be checked as provided in Standard Specification 2001.07.

G. Specification Compliance

All materials shall be inspected prior to being incorporated in a pavement structure. Some materials are being shipped to projects under certification programs and others must have a report. In either case it is necessary to check and file the reports or certifications such that each final product component is properly identified and incorporated with the proper documentation. This is accomplished by obtaining the documents for each lot of material before incorporation. All shipments of all materials incorporated shall be logged as they are received.

H. Reporting Requirements

1. Computer programs are provided to document what is required.
   Daily Plant Report. This form is submitted daily to document plant operations, job control testing, and material placement.
   (http://www.iowadot.gov/Construction_Materials/hma/HMAplantreport.xlsm)

2. Testing Worksheets. All worksheets and other original documents used by inspection personnel are to include identification of:
   a. Individuals associated with sampling and testing,
   b. County and Project No.,
   c. Material and sampling point,
   d. Date and time of sampling and testing and,
   e. Source, producer or contractor.

   All documents other than field notebooks are to be filed with the appropriate report and retained per the file retention schedule.

I. Mixture Segregation

Segregation of the mix results in non-uniform distribution of the material in the pavement. Coarse, lean mixtures are more subject to segregation than fine-rich mixtures; therefore more care must be exercised when coarse mixtures are being produced. Segregation at the plant may be caused by:

1. Pugmill discharge being too high above the truck bodies.

2. Depositing into very large truck bodies, causing the mixture to cone and roll. In this case trucks should be moved back and forth during loading.

3. Pugmill or storage gates opening improperly. They may not open or close quickly or to the full extent of the opening.

4. Inadequate mixing. This may be caused by short mixing cycle, improper mixer paddle positioning, worn paddles, or low level in the mixing chamber.

5. Improperly designed, maintained, and operated surge and storage bins and conveyors. Example - material discharge into conveyor must be centered into the bucket or belt.

6. Failure to provide near level truck charging platform.

J. Asphalt Binder Contamination

Alert inspection and proper supervision can prevent contamination by the contractor since most of the problems are associated with the use of cleaning fluids and improper material combination. Contamination may be caused by:

1. Allowing fuel oil used for cleaning pumps and lines to enter the storage tanks.

2. Accepting delivery of non-specification material or material of a different grade.

3. Leakage of plant heating oil into the storage tanks.

4. Contaminated delivery tanks.

5. Improper sampling, and sample catching container, refer to IM 323.

6. Residual products left in the tank.

K. Completed Project
When a project is completed, the plant inspector shall check all documentation for accuracy and completeness. It is also necessary to determine at this time the net quantity of materials incorporated in the project. The field records and plant records should be compared and final determinations made. Furnish copies of all required documentation to the RCE and DME.

ASPHALTIC CONCRETE EQUIPMENT

MFG. CODE	STOCK NO.	QUANTITY NEEDED	DESCRIPTION
	*	1 each	Box Sieves - 1½ in. (3.75 mm), 1.0 in. (25.0 mm), 3/4 in. (19 mm), 1/2 in. (12.5 mm), 3/8 in. (9.5 mm), #4 (4.75 mm)
		1 each	8 in. Round Sieves - #4 (4.75 mm), #8 (2.36 mm), #16 (1.18 mm), #30 (600 µm), #50 (300 µm), #100 (150 µm), #200 (75 µm), #200 (75 µm) Wash, Pan and Cover.
	*	1	Box Shaker With Pans
		1	Splitter (With Pans, Scoop & Brush)
		1	Balance With Pan & Weights
		1	Surface Checker With Parts Box
003	318990	24	Paper Cup, Bituminous Sampling
003	059500	25	Cardboard Box (14 in. x 9 in. x 6 in.)
012	733100	24	4-oz. Ointment Tins, Style 22
		3	12-qt. Pails
		6	Round Pans (Approximately 4-qt.)
		6	Round Pans (Approximately 6-qt.)
		1	Short Handle Round Point Shovel
		1	Pointing Trowel
		1	Candy Scoop
		1	Large Spoon
012	530155	6	1-qt. Cans With Lids

MFG. CODE	STOCK NO.	QUANTITY NEEDED	DESCRIPTION
		1	-30°F to 120°F General Purpose Thermometer
		2	200°F to 400°F Maximum Registering Thermometers
		2	100°F to 400°F Asphalt Thermometers
		1	Electric Sieve Shaker
		1	Electric Sieve Shaker Timer (Switch)
		1	Putty Knife
		1	Sieve Cleaning Brush (Cropped Paint Brush)

The Office Supply Storeroom stocks the following items:

370	820193	1 Pad	Form #193
000	319200	1 Box	Tag Envelopes
000	480300	1 Box	Shipping Tags G-5

Items Not Coded Are Commercially Available
Coded Items Are Available Through the Ames Storeroom
*Available to Contractors through the Central Materials Laboratory

WEIGHING EQUIPMENT

GENERAL

Section 2001.07 of the Standard Specifications covers weighing equipment and procedures. Under certain conditions equipment used to determine true net weight must be fully automatic or semiautomatic. Fully automatic systems are those that perform all required functions and print them on a ticket automatically. Semiautomatic systems must, as a minimum, be capable of determining the gross weight and printing it on a ticket automatically. The remaining functions must be entered on the ticket manually by a weighmaster.

Except for asphalt batch type plants, each load ticket is to contain all weight calculations necessary to arrive at a true net weight. This includes a printed gross weight, a printed or manually entered tare weight and a resultant printed or manually entered net weight.

Quantities for batch plants may be determined from batch counts and individual batch weights provided the batching scales have been calibrated to the accuracy required for pay quantity determination. The ticket shall indicate the batch weight, the number of batches and a net weight of the batches in each load. The ticket information may be entered by automatic printers or by a weighmaster. No tare weight is required when batch plant scales are used.

Automatic or semi-automatic printing is required when contract quantities of 10,000 tons (10,000 Mg) or more of HMA is furnished.

Scale tickets, as a minimum, shall identify project number, date, truck number and type of material (for hot mix asphalt materials, this is the mix design number). Additional requirements for specific systems are listed below.

TYPES OF SYSTEMS

A. Batch Plants:

Tickets automatically printed in a batch plant must contain, as a minimum, the total weight of material used in each batch, the number of batches and a total weight of material in each load. Most printing systems will show the aggregates and asphalt separately.

B. Storage Silo with Separate Weigh Hopper:

Tickets prepared automatically for this system shall contain, as a minimum, the gross weight of each drop weighed, a tare weight as a measure of any material left in the weigh hopper and a net weight of the material dropped. Also included shall be a true net weight of the total number of drops in each load.

C. Storage Silo/Weigh Hopper Combination:

Tickets prepared automatically for this system shall contain, as a minimum, the gross weight of material in the bin at the beginning of each weighing increment, the weight of material remaining in the bin at the end of each weighing increment as a tare weight and a resultant net weight of each increment. If weighing is in more than one increment, the ticket shall show the total net weight of all increments included in the load.

D. Truck Scales:

For Automatic Truck Scales - The scale must print the gross weight, tare weight of the truck, and net weight of the load. The tare weight of the truck is to be stored in the system, and not necessarily determined each trip. The operator must identify the truck to the recorder.

For Semiautomatic Truck Scales - The scale must print the gross weight. The tare weight and net weight shall be on the ticket, and may be added by the weighmaster by hand.

Many of the automatic systems are capable of printing much more information than the specified minimum. These are good features that may be beneficial to the contracting authority and the contractor; however, no features may be substituted for those specified.

IM 509
TANK STICKING

GENERAL REWRITE

ASPHALT BINDER CONTENT DETERMINATION

GENERAL

This Instructional Memorandum covers the procedures used by the contracting authority to determine: (1). The quantity of asphalt binder incorporated in a project, and (2) the asphalt binder content of individual production runs of asphalt mixtures. Measure asphalt binder with a calibrated in-line flow meter. The plant inspector is referred to the applicable specifications and instructions for the specified tolerances and measurement frequencies.

YIELD CHECKS

Perform yield checks using either Tank Stick or by comparing the quantity of material delivered with the quantity used. Yield checks shall be performed a minimum of once per week unless otherwise required by the Engineer. See Appendix A for measurement by tank stick.

TANK NO., TANK IDENTIFICATION

Each asphalt binder storage tank shall be identified by a number or letter and listed on the form. If a separate working tank or surge tank is provided, it will be necessary to establish a uniform procedure for determining the quantity or level or material in the tank. It is recommended that the plant inspector arrange with the contractor to maintain a uniform storage level in the surge tank.

Enter the tank number for each tank being used each day of production.

THIS IS A NEW APPENDIX

ASPHALT BINDER MEASUREMENT BY TANK STICK

GENERAL

Tables are furnished for computing quantities of materials stored in standard horizontal cylindrical tanks, and for correcting volumes to standard temperature. The plant inspector is responsible for checking to see that appropriate gauging tables and calibrated sticks are available prior to beginning work on a project. The contractor is required to furnish the calibrated measuring sticks, and gauging tables, for all storage tanks.

PROCEDURES

Refer to example, Form #E216

PROJECT NO.

Enter the project number listed on the project plans.

CONTRACT ID

Enter the county listed on the project plans.

DATE

Enter the date the tank measurement is recorded.

REPORT NO.

Enter the report number of the Daily HMA Plant Report, which reflects the daily virgin asphalt binder tank stick information.

START OF PERIOD

TANK NO., TANK IDENTIFICATION

Four tanks may be used on a given day and recorded on a single sheet.

TIME

Enter the beginning time for each tank that is measured each day of production.

TANK CAPACITY (A)

The capacity of each tank depends upon its dimensions. The capacity of standard cylindrical tanks may be computed by determining the length and radius from actual measurements. All dimensions must be inside measurements. The volume of a cylindrical tank is obtained by multiplying the length of the tank (L), by the radius of the tank (½ the diameter) squared, by the constant pi (3.141592). That is, volume (V) = L(pi)r^2. When measurements are obtained in feet, convert $ft.^3$ to gallons by multiplying by 7.48 $gal./ft.^3$. The contractor is required to furnish the manufacturer's data for nonstandard tanks. The contractor should not be permitted to allow the level of the asphalt cement to drop below the level of the heating coils, because accurate measurements cannot be made when the cross section of the storage area varies.

Enter the tank capacity in gallons for each tank being used each day of production.

OUTAGE (PERCENT OF DIAMETER) (B)
The number entered in this row is obtained from the actual tank measurement using the calibrated stick provided for each tank. The measurement is made by placing the stick through the designated tank hatch down to the level of the stored material. The percent outage is read from the stick at the reference elevation, which is normally the inside shell wall. The reference elevation can be checked by placing the stick at the full elevation and checking to see that the zero percentage line and the top of the tank coincide. When the tank shell is full, the outage percentage is zero, and when the tank is empty the outage is 100%.

When non-standard tanks are used, the manufacturer's tables, measuring sticks, and instructions must be followed.

Enter the outage tank stick reading for each tank when the T104 tables are used. If a direct reading measurement is made for a tank stick reading, leave this row blank.

INNAGE (PERCENT OF CAPACITY) (C)
Enter the FILLED PERCENT OF CAPACITY figure from the T104 tables, which coincides with the Outage (Percent of Diameter) (B) figure listed above for each tank used. If a direct reading measurement is made for a tank stick reading, leave this row blank. Refer to the manufacturer tables for non-standard tanks.

DIRECT READING (D)
Enter the direct reading measurement figure that is calculated for each tank being used. If you do not use a direct reading tank measurement stick, leave this row blank.

TEMPERATURE (E)
The temperature of the asphalt binder in each tank must be determined at the time the measurements are made. This is done by lowering a maximum registering thermometer to the approximate center of the asphalt cement stored. The thermometer must be shook down to a temperature less than that of the asphalt cement in the storage tank and must be allowed to adjust to the temperature of the stored material. From 3 to 5 minutes should be allowed for this adjustment. Thermometers mounted permanently in the storage tanks by the manufacturers may be used if they agree with the thermometers checked by the Central Laboratory.

Enter the Fahrenheit temperature at the time each tank is measured.

T102 TEMPERATURE CORRECTION FACTOR (F)
The volume of asphalt in the tank at the time of measurement must be corrected to 60°F. Refer to tables T102 or T103 to obtain the appropriate four-digit correction factor which corresponds to the Fahrenheit temperature recorded for each tank used.

CORRECTED GALLONS (G)
Enter the corrected gallons at 60°F for each tank being used by multiplying rows A, C, & F or D & F, depending on which method is used to measure the asphalt. Divide result by 100 when C is expressed as a whole number percent. This is the standard temperature at which pay quantities are determined.

TOTAL CORRECTED GALLONS (H)
Enter the total corrected gallons by adding the corrected gallons figures for each tank being used.

TOTAL ASPHALT BINDER ADDED

TOTAL POUNDS (I)

This space provides for entering the total quantity of asphalt added during the production run. Care must be exercised to ensure that weight tickets are obtained for each load placed in the storage tank during the production run. Each shipment ticket should be logged in the plant report, with the appropriate date and unloading time. The weight is converted to corrected gallons at 60°F by dividing by the weight per gallons coefficient provided by the supplier. Quantities added shall be certified or determined at the job site.

Enter the total pounds added to each tank being used.

WEIGHT PER GALLON (J)

The asphalt binder supplier provides the average weight per gallon. If asphalt binder from different sources has been used during the production run, it is necessary to compute a weighted average weight per gallon for the total quantity used. If emulsified asphalt or cutback asphalt is being used, it is necessary to reduce the weight of the diluted material to asphalt residue. The quantity of asphalt residue incorporated is determined by multiplying the total weight of emulsion or cutback by the percent residue value furnished by the supplier.

Enter the weight per gallon listed on the shipment tickets. The weight per gallon cannot change on a given day of production.

TOTAL CORRECTED GALLONS (K)

Enter the total corrected gallons added during the day by adding the (I) row figures together and dividing by the (J) figure.

END OF PERIOD

TIME

Enter the ending time for each tank that is measured each day of production.

TANK CAPACITY (L)

Enter the tank capacity in gallons for each tank being used each day of production.

OUTAGE (PERCENT OF DIAMETER) (M)

Enter the outage tank stick reading for each tank when the T104 tables are used. If a direct reading measurement is made for a tank stick reading, leave this row blank.

INNAGE (PERCENT OF CAPACITY) (N)

Enter the FILLED PERCENT OF CAPACITY figure from the T104 tables which coincides with the Outage (Percent of Diameter) (B) figure listed above for each tank used. If a direct reading measurement is made for a tank stick reading, leave this row blank.

DIRECT READING (O)

Enter the direct reading measurement figure that is calculated for each tank being used. If you do not use a direct reading tank measurement stick, leave this row blank.

TEMPERATURE (P)

Enter the Fahrenheit temperature at the time each tank is measured.

T102 TEMPERATURE CORRECTION FACTOR (Q)
The volume of asphalt in the tank at the time of measurement must be corrected to 60°F. Refer to tables T102 or T103 to obtain the appropriate four-digit correction factor which corresponds to the Fahrenheit temperature recorded for each tank used.

CORRECTED GALLONS (R)
Enter the corrected gallons at 60°F for each tank being used by multiplying rows L, N, & Q or O & Q, depending which method is used to measure the asphalt content. Divide result by 100 when C is expressed as a whole number percent. This is the standard temperature at which pay quantities are determined.

TOTAL CORRECTED GALLONS (S)
Enter the total corrected gallons by adding the corrected gallons figures for each tank being used.

CALCULATIONS

TOTAL CORRECTED GALLONS USED (T)
Enter the total corrected gallons used each day of production by adding (H) and (K), then subtracting (S).

WEIGHT PER GALLON (U)
Enter the four-digit figure listed in the (J) row from above.

TOTAL POUNDS OF BINDER USED (V)

This number is obtained by multiplying (T) by (U).

TOTAL POUNDS OF MIX PRODUCED (W)
Enter the total pounds of mix produced by the plant each day.

The total pounds of mixture are determined by adding the net weight of all the scale tickets. This total includes all mixture produced, including rejected, wasted, or commercial loads. Mixtures, such as cold mixes, which contain moisture, must be corrected for the moisture content.

TOTAL POUNDS OF MIX WASTED (X)
Enter the total pounds of mix wasted during the day. This figure includes road waste, plant waste and other mix, which was wasted, sold rejected or otherwise disposed of. All mix so wasted should be weighed, if at all possible. It may be necessary to estimate small quantities of waste in some cases.

TOTAL POUNDS OF BINDER WASTED (Y)
This number is determined by multiplying the percent asphalt (Z) by the total pounds of mix wasted (X). This quantity will not be included in the project pay quantity total.

NET TONS OF ASPHALT BINDER INCORPORATED IN THE PROJECT
This is the net quantity of asphalt binder for which the contractor is eligible to receive pay.

This number is obtained by subtracting (Y) from (V) and then dividing by 2000. **THIS FIGURE SHALL BE GIVEN TO THE ROAD INSPECTOR EACH DAY.**

<u>NET TONS OF MIX INCORPORATED IN THE PROJECT</u>
This number is obtained by subtracting (X) from (W) and then dividing by 2000. This is the net quantity eligible for payment. **THIS FIGURE SHALL CORRELATE WITH THE ROAD FIGURE EACH DAY.**

<u>PERCENT VIRGIN ASPHALT BINDER, BY TANK MEASUREMENT (Z)</u>
This percent virgin binder is obtained by dividing (V) by (W) and multiplying by 100.

This percentage is obtained by dividing the total net pounds of asphalt binder incorporated (V) by the total net pounds of mix produced (W). The plant inspector is, at this point, directed to refer to appropriate specifications to determine if this percentage is within the allowable tolerance.

<u>COMMENTS</u>
All computations should be checked thoroughly and promptly; any corrections should be reported to the contractor and recorded on the daily report forms. Upon completion of the project the completed form shall be incorporated in the resident or county engineer project file.

Rev 11/07

Form E216

DAILY VIRGIN ASPHALT BINDER TANK MEASUREMENT SHEET

Project No.: ____________ Date: ____________

Contract ID.: ____________ Report No.: ____________

Start Of Period

Tank No.:				
Time:				
Tank Capacity (Gallons) (A):				
Outage (% of Diameter) (B):				
T-104 Innage (% of Capacity) (C):				
Direct Reading (Gallons) (D):				
Temp. °F (E):				
T-102 Temp. Corr. Factor (F):				
Corrected Gallons = (A*C/100*F)or(D*F) (G):				
Total Corrected Gallons = (G+G+G+G) (H):				

Total Asphalt Binder Added

Total Pounds (I):				
Weight Per Gallon (J):				
Total Corrected Gallons = (I+I+I+I/J) (K):				

End Of Period

Time:				
Tank Capacity (Gallons) (L):				
Outage (% of Diameter) (M):				
T-104 Innage (% of Capacity) (N):				
Direct Reading (Gallons) (O):				
Temp. °F (P):				
T-102 Temp. Corr. Factor (Q):				
Corrected Gallons = (L*N/100*Q)or(O*Q) (R):				
Total Corrected Gallons = (R+R+R+R) (S):				

Calculations

Total Corrected Gallons Used = (H+K-S) (T): ____________

Average Weight Per Gallon (U): ____________

Total Pounds Of Binder Used = (T*U) (V): ____________

Total Pounds Of Mix Made (W): ____________

Total Pounds Of Mix Wasted (X): ____________

Total Pounds Of Binder Wasted = (X*Z / 100) (Y): ____________

Net Tons Of Binder Used On Road = ((V-Y) / 2000): ____________

Net Tons Of Mix Used On Road = ((W-X) / 2000): ____________

Percent Virgin Binder by Tank Stick = ((V / W) * 100) (Z): ____________

Comments: ____

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DAILY VIRGIN ASPHALT BINDER TANK MEASUREMENT SHEET

Project No.: NHSN-63-9(19)--2R-45 | Date: 9/8/2007

Contract ID.: 45-0639-019 | Report No.: 5

Start Of Period

Tank No.:	1			
Time:	6:47 AM			
Tank Capacity (Gallons) (A):	25,000			
Outage (% of Diameter) (B):	15.6			
T-104 Innage (% of Capacity) (C):	90.0440			
Direct Reading (Gallons) (D):				
Temp. °F (E):	300			
T-102 Temp. Corr. Factor (F):	0.9187			
Corrected Gallons = (A*C/100*F)or(D*F) (G):	20,681			
Total Corrected Gallons = (G+G+G+G) (H):	**20,681**			

Total Asphalt Binder Added

Total Pounds (I):	103,066			
Weight Per Gallon (J):	8.5641			
Total Corrected Gallons = (I+I+I+I/J) (K):	12,035			

End Of Period

Time:	6:58 PM			
Tank Capacity (Gallons) (L):	25,000			
Outage (% of Diameter) (M):	69.4			
T-104 Innage (% of Capacity) (N):	25.9350			
Direct Reading (Gallons) (O):				
Temp. °F (P):	295			
T-102 Temp. Corr. Factor (Q):	0.9204			
Corrected Gallons = (L*N/100*Q)or(O*Q) (R):	5,968			
Total Corrected Gallons = (R+R+R+R) (S):	5,968			

Calculations

Total Corrected Gallons Used = (H+K-S) (T):	26,748
Average Weight Per Gallon (U):	8.5641
Total Pounds Of Binder Used = (T*U) (V):	229,073
Total Pounds Of Mix Made (W):	4,001,650
Total Pounds Of Mix Wasted (X):	
Total Pounds Of Binder Wasted = (X*Z / 100) (Y):	
Net Tons Of Binder Used On Road = ((V-Y) / 2000):	**114.54**
Net Tons Of Mix Used On Road = ((W-X) / 2000):	**2,000.83**
Percent Virgin Binder by Tank Stick = ((V / W) * 100) (Z):	**5.72**

Comments: Example using T-104 Tables

Rev 11/07

Form E216

DAILY VIRGIN ASPHALT BINDER TANK MEASUREMENT SHEET

Project No.: NHSN-63-9(19)--2R-45   Date: 9/8/2006

Contract ID.: 45-0639-019   Report No.: 5

Start Of Period

Tank No.:	1	2		
Time:	6:47 AM	10:05 AM		
Tank Capacity (Gallons) (A):	25,000	25,000		
Outage (% of Diameter) (B):				
T-104 Innage (% of Capacity) (C):				
Direct Reading (Gallons) (D):	23,450	21,075		
Temp. °F (E):	300	300		
T-102 Temp. Corr. Factor (F):	0.9187	0.9187		
Corrected Gallons = (A*C/100*F)or(D*F) (G):	21,544	19,362		
Total Corrected Gallons = (G+G+G+G) (H):	**40,906**			

Total Asphalt Binder Added

Total Pounds (I):	103,066			
Weight Per Gallon (J):	8.5641			
Total Corrected Gallons = (I+I+I+I/J) (K):	12,035			

End Of Period

Time:	6:58 PM	2:25 PM		
Tank Capacity (Gallons) (L):	25,000	25,000		
Outage (% of Diameter) (M):				
T-104 Innage (% of Capacity) (N):				
Direct Reading (Gallons) (O):	9,750	23,560		
Temp. °F (P):	295	300		
T-102 Temp. Corr. Factor (Q):	0.9204	0.9187		
Corrected Gallons = (L*N/100*Q)or(O*Q) (R):	8,974	21,645		
Total Corrected Gallons = (R+R+R+R) (S):	30,619			

Calculations

Total Corrected Gallons Used = (H+K-S) (T):	22,322
Average Weight Per Gallon (U):	8.5641
Total Pounds Of Binder Used = (T*U) (V):	191,168
Total Pounds Of Mix Made (W):	3,207,523
Total Pounds Of Mix Wasted (X):	10,000
Total Pounds Of Binder Wasted = (X*Z / 100) (Y):	596
Net Tons Of Binder Used On Road = ((V-Y) / 2000):	**95.29**
Net Tons Of Mix Used On Road = ((W-X) / 2000):	**1,598.76**
Percent Virgin Binder by Tank Stick = ((V / W) * 100) (Z):	**5.96**

Comments: Example using Direct Reading

8/96

Form M216

DAILY VIRGIN AC TANK MEASUREMENT SHEET

Project No.: ____________________ Date: __________

Contract ID.: ____________________ Report No.: __________

Start Of Period

Tank No.:				
Time:				
Tank Capacity (Liters) (A):				
Outage (% of Diameter) (B):				
T-104 Innage (% of Capacity) (C):				
Direct Reading (Liters) (D):				
Temp. °C (E):				
T-102 Temp. Corr. Factor (F):				
Corrected Liters (G)= (A*C*F)or(D*F):				
Total Corrected Liters (H)= (G+G+G+G):				

Total AC Added

Total Kilograms (I):				
Mass Per Liter (J):				
Total Corrected Liters (K)= (I+I+I+I/J):				

End Of Period

Time:				
Tank Capacity (Liters) (L):				
Outage (% of Diameter) (M):				
T-104 Innage (% of Capacity) (N):				
Direct Reading (Liters) (O):				
Temp. °C (P):				
T-102 Temp. Corr. Factor (Q):				
Corrected Liters (R)= (L*N*Q)or(O*Q):				
Total Corrected Liters (S)= (R+R+R+R):				

Calculations

Total Corrected Liters Used (T)= (H+K-S):	
Mass Per Liter (U):	
Total Kilograms Of AC Used (V)= (T*U):	
Total Kilograms Of Mix Made (W):	
Total Kilograms Of Mix Wasted (X):	
Total Kilograms Of AC Wasted (Y)= (X*Z):	
Net Mg. Of AC Used On Road = ((V-Y) / 1000):	
Net Mg. Of Mix Used On Road = ((W-X) / 1000):	
Percent Virgin AC by Tank Stick (Z)= ((V / W) * 100):	

Comments: ____

8/96

Form M216

DAILY VIRGIN AC TANK MEASUREMENT SHEET

Project No.: NHSN-63-9(19)--2R-45

Date: 09/09/96

Contract ID.: 45-0639-019

Report No.: 1

Start Of Period

Tank No.:	1			
Time:	06:30			
Tank Capacity (Liters) (A):	94,635			
Outage (% of Diameter) (B):	10.0			
T-104 Innage (% of Capacity) (C):	94.7960			
Direct Reading (Liters) (D):				
Temp. °C (E):	149			
T-102 Temp. Corr. Factor (F):	0.9183			
Corrected Liters (G)= (A*C*F)or(D*F):	82,381			
Total Corrected Liters (H)= (G+G+G+G):	82,381			

Total AC Added

Total Kilograms (I):	46,750			
Mass Per Liter (J):	1.0262			
Total Corrected Liters (K)= (I+I+I+I/J):	45,556			

End Of Period

Time:	06:35			
Tank Capacity (Liters) (L):	94,635			
Outage (% of Diameter) (M):	80.0			
T-104 Innage (% of Capacity) (N):	14.2380			
Direct Reading (Liters) (O):				
Temp. °C (P):	149			
T-102 Temp. Corr. Factor (Q):	0.9183			
Corrected Liters (R)= (L*N*Q)or(O*Q):	12,373			
Total Corrected Liters (S)= (R+R+R+R):	12,373			

Calculations

Total Corrected Liters Used (T)= (H+K-S):	115,564
Mass Per Liter (U):	1.0262
Total Kilograms Of AC Used (V)= (T*U):	118,592
Total Kilograms Of Mix Made (W):	2,014,080
Total Kilograms Of Mix Wasted (X):	12,000
Total Kilograms Of AC Wasted (Y)= (X*Z):	707
Net Mg. Of AC Used On Road = ((V-Y) / 1000):	**117.89**
Net Mg. Of Mix Used On Road = ((W-X) / 1000):	**2,002.08**
Percent Virgin AC by Tank Stick (Z)= ((V / W) * 100):	**5.89**

Comments: Example using T-104 tables.

8/96

Form M216

DAILY VIRGIN AC TANK MEASUREMENT SHEET

Project No.: NHSN-63-9(19)--2R-45

Date: 09/09/96

Contract ID.: 45-0639-019

Report No.: 1

Start Of Period

Tank No.:	1	2		
Time:	06:30	08:00		
Tank Capacity (Liters) (A):	94,635	94,635		
Outage (% of Diameter) (B):				
T-104 Innage (% of Capacity) (C):				
Direct Reading (Liters) (D):	34,629	74,898		
Temp. °C (E):	149	149		
T-102 Temp. Corr. Factor (F):	0.9183	0.9183		
Corrected Liters (G)= (A*C*F)or(D*F):	31,800	68,779		
Total Corrected Liters (H)= (G+G+G+G):	100,579			

Total AC Added

Total Kilograms (I):	116,782			
Mass Per Liter (J):	1.0262			
Total Corrected Liters (K)= (I+I+I+I/J):	113,800			

End Of Period

Time:	06:35	05:00		
Tank Capacity (Liters) (L):	94,635	94,635		
Outage (% of Diameter) (M):				
T-104 Innage (% of Capacity) (N):				
Direct Reading (Liters) (O):	53,016	59,105		
Temp. °C (P):	149	149		
T-102 Temp. Corr. Factor (Q):	0.9183	0.9183		
Corrected Liters (R)= (L*N*Q)or(O*Q):	48,685	54,276		
Total Corrected Liters (S)= (R+R+R+R):	102,961			

Calculations

Total Corrected Liters Used (T)= (H+K-S):	111,418
Mass Per Liter (U):	1.0262
Total Kilograms Of AC Used (V)= (T*U):	114,337
Total Kilograms Of Mix Made (W):	2,014,080
Total Kilograms Of Mix Wasted (X):	12,000
Total Kilograms Of AC Wasted (Y)= (X*Z):	682
Net Mg. Of AC Used On Road = ((V-Y) / 1000):	**113.66**
Net Mg. Of Mix Used On Road = ((W-X) / 1000):	**2,002.08**
Percent Virgin AC by Tank Stick (Z)= ((V / W) * 100):	**5.68**

Comments: Example using Direct Reading.

IM 510
MIX DESIGN

METHOD OF DESIGN OF ASPHALT MIXTURES

SCOPE

The design of asphalt mixtures involves determining an economical blend of aggregates that provides a combined gradation within the limits of the specifications and a determination of the percent of asphalt binder to mix with the aggregate blend, which provides a mix, which meets volumetric specifications. Trial mixes prepared with different binder contents are tested for mix properties and the results are analyzed to select the binder content that is judged to be most satisfactory for the intended use of the mix.

This IM will cover the sample preparation procedure, aggregate blend selection, binder content selection and the evaluation of the test results. Individual test method IMs are referenced for measuring the properties of individual mixes.

> **NOTE:** The aggregate variable and asphalt binder variable blends are important tools needed by the production control technician for field adjustment of the Job Mix Formula (JMF).

Appendix A of this IM contains the criteria for Gyratory mix design.

REFERENCED DOCUMENTS:

Standard Specification 4127 Aggregate for Flexible Paving Mixtures
AASHTO R-35 Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)
ASTM D7313 Standard Test Method for Determining Fracture Energy of Asphalt-Aggregate Mixtures Using the Disk-Shaped Compact Tension Geometry
IM 302 Sieve Analysis of Aggregates
IM 306 Determining the Amount of Material Finer than the #200 (75 µm) Sieve in Aggregate
IM 336 Methods of Reducing Aggregate Field Samples to Test Samples
IM 321 Method of Test for Compacted Density of Asphalt Mixtures (Displacement)
IM 319 Moisture Sensitivity Testing of Asphalt Mixtures
IM 325G Method of Test for Determining the Density of Asphalt Using the Superpave Gyratory Compactor (SGC)
IM 350 Determining Maximum Specific Gravity of Asphalt Mixtures
IM 357 Preparation of Asphalt Mix Samples for Test Specimens
IM 369 Determining Specific Gravity of Asphalt Binder
IM 380 Vacuum-Saturated Specific Gravity & Absorption of Combined or Individual Aggregate Sources
IM 501 Equations & Example Calculations

APPARATUS

- Thermometers: Armored-glass, dial type or digital thermometer with metal stems is recommended. A range of 50° to 400°F (10° to 200°C) with graduations of 5°F (2°C) is required.

- Balances: 20,000-gram capacity, 0.1 gram resolution for mix design and production testing.

- Forced Draft Oven, 350°F (177°C) minimum with controls sensitive to ± 5°F (3°C), minimum size, 7 cu. ft. for production testing or mix design.

> **NOTE:** Experience has shown that a 15 cu. ft. or larger oven may be desirable.

- Mixer: Hobart 19 liters with Dough Hook, Model A-200, or equivalent for Mix Design.
- Safety equipment: insulated gloves, long sleeves, apron, etc.
- Pans of sufficient size for splitting and curing of samples.

General Equipment:

- Scoop or trowel for moving mixture.

PROCEDURE

A. MATERIALS SELECTION

The Contractor selects the aggregate and Recycled Asphalt Materials (RAM) sources and the source of asphalt binder. Aggregate sources and types, individual gradations, crushed particle amount, aggregate friction type, binder grade, and other specific requirements should be checked prior to submitting materials and the 955 form to the laboratory. The gradation of the combined aggregate submitted for trial mix testing shall meet the requirements of the Contract Documents.

The Contractor must notify the District Materials Engineer prior to sampling aggregate stockpiles and RAM. A stockpile of at least 500 tons must be produced so that representative samples of the processed material can be obtained. The target gradation, for each source, to be reported on the 955 form is the average gradation for the stockpile as determined by using the Quality Control and Monitor samples. Enter the target gradation for each source into the SHADES Mix Design program.

Representative RAM samples shall be sent into the laboratory designated by the Engineer for material classification (for State work this is the Central Materials Laboratory). The laboratory will report the results of the tests normally within 15 working days. The following information will be provided for RAP: Fine Aggregate Angularity, Extracted P_b, gradation, and specific gravity of aggregate. The % friction aggregate, % crushed, and types of aggregate will be provided if available. Extracted binder content of RAS samples will be provided.

Binder Bumping

For mixtures not containing RAS

When the amount of recycled binder from RAP exceeds 20.0% of the total asphalt binder, the designated binder grade will be adjusted by lowering both the high and low temperature PG grade by 6°C while maintaining the AASHTO M332 traffic designation letter on the contract. The MSCR test temperature shall be the new adjusted high temperature PG grade (i.e. PG 58-28H becomes PG 52-34H with a test temperature of 52°C). If the anticipated RAM binder percent exceeds 30.0% of the total, the selection of the binder grade shall be based on testing performed by the Contracting Authority.

For mixtures containing RAS, adjust the contract binder grade as follows:

a. When the amount of recycled binder is inclusively between 15.0% and 25.0%, adjust the grade by lowering both the high and low temperature PG grade by 6°C while maintaining the AASHTO M332 traffic designation letter on the contract. The MSCR test temperature shall be the new adjusted high temperature PG grade (i.e. PG 58-28H becomes PG 52-34H with a test temperature of 52°C).

b. When the amount of recycled binder exceeds 25.0% of the total asphalt binder, the selection of the binder grade shall be based on testing performed by the Contracting Authority.

When binder replacement exceeds 30.0% (25.0% for mixtures containing RAS), grade selection is based on fracture energy as measured by the Disk-Shaped Compact Tension Test (DCT) (ASTM D7313-07a) at no additional cost to the contracting authority. The average of two specimens shall meet the following minimum fracture energy requirements tested at 10°C warmer than the low climatic temperature (normally specified as the low temperature PG grade on the contract):

- Very High Traffic (VT) 690 J/m^2
- High Traffic (HT) 460 J/m^2
- Standard Traffic (ST) 400 J/m^2

The adjusted grade shall meet the same MSCR recovery requirements as the contract binder grade. No adjustments will be made to the contract unit price for required changes to the asphalt binder grade.

Warm Mix Asphalt (WMA)

1. WMA Process Selection

a. **WMA Technology**

Select the WMA process that will be used in consultation with the specifying agency and technical assistance personnel from the WMA suppliers. Consideration should be given to a number of factors including: (1) available performance data, (2) the cost of the warm mix additives, (3) planned production and compaction temperatures, (4) planned production rates, (5) plant capabilities, and (6) modifications required to successfully use the WMA process with available field and laboratory equipment.

b. **WMA Temperatures**

Determine the temperatures that will be used for plant mixing (production) and field compaction. Binder grade selection depends on the plant production temperature. See Table 1 for production temperatures below which the high temperature grade of the binder should be increased one level.

2. Binder Grade Selection for WMA

Increase the high temperature performance grade based on the proposed production temperature. Increase the high temperature performance grade by one grade when the plant discharge temperature is less than that specified in Table 1.

RAM: If more than 20.0% but less than 30.0% of the total binder contribution is from a recycled source, the designated high temperature binder grade will remain unchanged if the production temperature falls below that indicated in Table 1.

Table 1 - Production Temperatures below which the High Temperature Grade Should be Increased One Grade.

Specified PG High Temperature Grade	Aging Index (AI)[1]											
	1.4	**1.6**	**1.8**	**2.0**	**2.2**	**2.4**	**2.6**	**2.8**	**3.0**	**3.2**	**3.4**	**3.6**
	Minimum WMA Mixing Temperature Not Requiring PG Grade Increase, °F											
52	<215	<215	<215	<215	<215	<215	220	220	225	225	230	230
58	<215	<215	<215	220	225	230	235	235	240	240	245	245
64	<215	<215	220	230	235	235	240	245	245	250	250	250
70	<215	220	230	240	245	245	250	255	255	260	260	260

Note: 1. $AI = \frac{(G^*/\sin\delta)_{RTFOT}}{(G^*/\sin\delta)_{Tank}}$ at the high temperature performance grade temperature.

3. **WMA Additives**
   Use additives as required by the proposed WMA process or to obtain acceptable coating, workability, compactibility, and moisture susceptibility.

B. JOB MIX FORMULA (JMF)

The JMF together with the specifications provides the initial basis for setting up and starting the job.

To avoid possible delays in the approval of the JMF, the District Materials Engineer should be notified that the Contractor is preparing a JMF. The District Materials Engineer will normally review the complete trial JMF within five working days. The District Materials Engineer may approve a laboratory mix design outside of the gradation control points, provided the plant produced mixture meets the specifications in all respects. It is expected that this would be considered only when the anticipated aggregate gradation is expected to result in a plant produced mixture within specifications.

C. MATERIAL PREPARATION

Approximately 250 lbs. of the combined aggregate will normally be required for the design work. If aggregate variable blends are to be tested prior to the asphalt variable design work, approximately 500 lbs. of aggregate may be necessary. This will allow enough material for the following:

1. Four mix samples of a minimum 13,000-gram batch.

> **<u>NOTE</u>:** If a 2nd Rice sample is desired, a minimum of 14,000 grams is recommended.

2. One sample of each individual aggregate for vacuum saturated specific gravity and absorption (IM 380).

3. Approximately 50 lbs. of material will be used for mix design verification when required.

To prepare the aggregate and RAM samples the following steps should be followed:

4. Obtain samples of each individual source material by following the procedure in IM 336. Perform a sieve analysis on each of the individual materials according to IM 302 and IM 306. Weigh the retained and passing portions of the aggregate, and calculate the percent retained on each sieve split by the following equation:

$$Z = \frac{X}{X + Y} \text{ x } 100$$

Where: "X" = weight of the retained portion, g
"Y" = weight of the passing portion, g
"Z" = percent of the total sample retained

5. Aggregates and RAM must be air dried to a surface dried condition prior to further preparation.

6. Review aggregate gradations as indicated on the 955 form. If the gradation result, for each individual aggregate, found in Step C.4 is within the production tolerance of the gradation indicated on the 955 form, an initial split is made by sieving on the screen size that will most nearly result in a 50-50 percent split. When the screen size selected for the initial split is coarser than the #4 sieve, additional splits shall be made on all sieves down to and including the #4 which retain at least 10% of the material. If the gradation result is outside the production tolerance of the gradation indicated on the 955 form, sieving on each sieve size down to an including the #8 sieve is performed. All sieving must be done to completion.

> **<u>NOTE</u>:** Sieving on each sieve size down to and including the #8 sieve is always an option even if the gradation results found in Step C.4 are within the production tolerances.

7. In no case shall any sample or sample portion be split on a #16 or smaller size sieve.

8. After sample splitting is complete, dry the individual portions of the aggregate for a minimum of 6 hours in an oven at a temperature of 275° ± 10°F (135° ± 6°C) for HMA mixtures, or until the aggregates reach a constant weight when weighed at 30 minute intervals. Use 60°F (15°C) above the proposed production temperature for WMA mixtures.

> **<u>NOTE:</u>** RAM is not oven-dried.

9 Prior to aggregate blend selection, the aggregate source properties, the bulk dry specific gravity and absorption of the individual aggregate samples as well as the specific gravity of the binder at 77°F (25°C) must be determined. In addition, the consensus properties of the individual aggregates may be determined to estimate the combined aggregate properties. Properties of RAM sources are as provided by the Contracting Authority.

> **<u>NOTE</u>:** G_b at 77°F (25°C) may be obtained from certifying documents or test reports (IM 369). Certifying documents may report G_b at 60°F (15°C).

D. AGGREGATE BLEND SELECTION

This section explains the selection of an aggregate blend determined to be the most appropriate blend that will meet the design criteria. The mix designer may establish an aggregate blend based on past experience or by evaluating multiple blends. The shape of the gradation plotted on the 0.45 power gradation chart generally reflects the void space available for asphalt. Gradations that closely follow the maximum density line generally have minimal void space.

1. Select a minimum of three blends, which cover a broad range of aggregate properties (shape, texture, gradation, etc…).

2. Check the aggregate consensus properties of each blend as specified in Appendix A.

3. Select a trial asphalt binder content for each of the proposed blends by one of the five methods below. The asphalt binder used for trial mixes shall be of the same grade as indicated on the 955 form and shall be from the same source when possible.

   a. Experience
   b. SHADES Mix Design Program
   c. AASHTO R-35
   d. Calculated surface area of the aggregate (See Note.)

   > **<u>NOTE</u>:** The asphalt film thickness obtained at a given binder content is related to the surface area and asphalt absorption of the aggregate. Higher surface areas will generally, but not always, require higher binder content.

   e. Table 2303.02-2 in Standard Specification 2303 for Basic Asphalt Binder Content.
4. Check that the trial asphalt binder content selected for each aggregate blend could meet the film thickness criteria specified in Appendix A.

5. Use the procedure in the "Mixture Batching, Curing & Testing" section to batch, cure and test trial blends.

6. Evaluate the mixture properties of each trial blend as specified in Appendix A.

Mixes that meet the design criteria may proceed to asphalt binder variable design. Aggregate blend selection should take into consideration the source availability, ability to adjust field production and source cost.

E. ASPHALT BINDER CONTENT SELECTION

Normal trial mixes are prepared at a minimum of three different asphalt binder contents to assure close bracketing of the final recommended design binder content. The final recommended binder content must be bracketed by trial binder contents above and below, unless the air voids are within 0.25% of the design target, in which case no additional points are needed. Contractor prepared mix designs may require a mixture prepared at the recommended design binder content for DOT mix design verification.

Select an initial trial asphalt binder content by one of the five methods below. The binder used for trial mixes shall be of the same grade as indicated on the 955 form and shall be from the same source when possible.

a. Experience
b. SHADES Mix Design Program
c. AASHTO R-35
d. Calculated surface area of the aggregate (See Note.)

> **NOTE:** The asphalt film thickness obtained at a given binder content is related to the surface area and asphalt absorption of the aggregate. Higher surface areas will generally, but not always, require higher binder content.

e. The basic asphalt binder content table from Step D.3

> **NOTE:** To avoid wasted effort in the laboratory when using unfamiliar materials, the mix designer is encouraged to perform a single point analysis of the volumetric properties prior to performing the complete (multi point or bracketing) analysis. For the purposes of adjusting the trial binder content to the proper void level, the following general rule applies: A 0.2% change in asphalt binder content is approximately a 0.5% change in air voids.

Anti-stripping Agents

See Article 2303.02, E, 2, g for allowed use. For HMA designs which use a liquid anti-stripping agent, if the agent also acts as a compaction aid then after the optimum binder content has been selected, compact an additional specimen (with binder that has been dosed with the agent) to ensure the target air void content is met. If air voids have changed by more than 0.5% then adjust the binder content accordingly to achieve target voids prior to production.

F. MIXTURE BATCHING, CURING & TESTING

The following procedures should be used for the batching, curing and testing of mixes. These procedures are to be used for both the “aggregate blend selection” and “asphalt binder content selection” phases of mix design. For WMA mixtures not utilizing a water-injection system, the WMA technology should be used in fabricating specimens in the mixture design phase. Methods for WMA specimen preparation are process specific. Consult the manufacturer for detailed WMA specimen fabrication procedures

1. Accurately batch the aggregates in the correct proportions to obtain the desired batch weight. The desired amount of RAM plus an additional 100 grams, to compensate for moisture loss, will be weighed in a separate pan. The individual aggregate split sample batch weight is determined by the following equation:

   Split sample aggregate batch weight = (A)(B)(C)

   Where: A = total aggregate batch weight desired
   B = individual aggregate in total aggregate batch weight, %
   C = split portion of individual aggregate, %

   > **<u>NOTE</u>:** If RAM is included in the mix, the aggregate proportions must be adjusted for the purpose of determining the combined aggregate gradation and combined specific gravity. Use the formulas in IM 501.

2. Determine the amount of asphalt binder needed for each trial mix batch as follows:

$$\text{Binder Weight} = \frac{(\text{aggregate batch weight}) \times (\text{Target } P_b)}{(100 - \text{Target } P_b)}$$

   > **<u>NOTE</u>:** If RAM is included in the mix, the $P_{b\ (added)}$ content must be determined. Use the formulas in IM 501.

3. For HMA mixtures, separately heat the combined aggregate batch and binder to 275° ± 5°F (135° ± 3°C) as checked by a thermometer in the pan of aggregate. For WMA mixtures, heat the combined aggregate batch and binder containing the WMA technology (at the dosage recommended by the manufacturer) to the proposed production temperature ± 5°F (± 3°C). The mixing bowl and utensils shall also be heated before mixing operations begin. Always keep the mixing bowl buttered.

   > **<u>NOTE</u>:** It generally takes 4 hours to bring aggregates & binder to

mixing temperature. RAM will be heated in a separate pan for a maximum of 2 hours to minimize binder aging.

4. Weigh the required amount of RAM into the mixing bowl; pour the heated aggregate into the bowl and dry mix for 15 seconds on speed 1. Stop mixer.

5. Add the required amount of binder and mix for 15 seconds on speed 1. Stop mixer, shift to speed 2 and continue to mix for 45 seconds. Stop mixer.

6. Lower the mixing bowl and clean the dough hook and the bottom and side of the bowl by scraping with a spatula. Incorporate any adhering mixture or binder back into the sample within 2 minutes from the start of the cleaning operation.

7. Raise the bowl and continue mixing for 15 seconds on speed 2. Then repeat Step F.6 and again stir any adhering mix or binder back into the sample with the spatula.

8. Break the samples down according to IM 357.

   a. Take 2 samples of approximately 5000 gram each for gyratory compaction.

   b. Take a sample of a minimum of 2000 gram for G_{mm} determination.

9. Spread the material into a pan such that the material is 1 to 2 in. (25 to 50 mm) thick.

10. For HMA mixtures, cure all samples for 2 hours at 275°F (135°C). For WMA mixtures, cure all samples for 2 hours at the proposed field compaction temperature. 1 hour into curing, all samples are removed, thoroughly stirred and placed back into the oven for remainder of curing time.

11. Place approximately 4700 grams of material into the mold for gyratory specimens. Compact HMA specimens at 275°F (135°C) and WMA specimens at the proposed field compaction temperature per IM 325G.

    a. If necessary, adjust the weight of the sample to achieve the required test specimen height.

$$\text{Adjusted sample weight} = \frac{\text{(trial sample weight)(intended height)}}{\text{trial sample height}}$$

    b. Adjust the weight of the sample 1.25% for every 1% change in binder content.

12. Test loose mix at each binder content for maximum specific gravity per IM 350.

13. Measure the density (G_{mb}) of the compacted specimens per IM 321.

G. MIXTURE PERFORMANCE EVALUATION

A binder content is selected that will produce percent air voids in the compacted specimens equal to the target air void value. The test data and calculated results at the selected binder content are compared to the criteria specified in Appendix A. Interpolation may be necessary. Mixture designs may also be tested using IM 319 when required by the specifications.

DOCUMENTATION

The link to SHADES is provided here:
http://www.iowadot.gov/Construction_Materials/hma/SHADES.xlsm
A copy of the SHADES computer file containing all the test data must be submitted to the DME for approval of the JMF. For WMA mixture designs, report proposed production temperature, compaction temperature, WMA technology, additional equipment requirements from the manufacturer, manufacturer name, proposed dosage rate, and any manufacturer recommendations on the 956 form. The signed JMF report (956) (including economic justification when required) shall be required prior to paving. See Appendix B for more information.

Distribution of the documents:

District Materials Engineer
Project Engineer

ASPHALT MIXTURE DESIGN CRITERIA

Overview of the Asphalt Mixture Design Criteria Chart (Table 1)

The Asphalt Mixture Criteria chart identifies the aggregate, mixture volumetric, and laboratory density requirements for mixtures designed under the gyratory mix design system. The chart is formatted to correspond with the bid item designations. The bid item designations classify each mixture by the maximum 20-year traffic load (ST-Standard Traffic, HT-High Traffic, VT-Very High Traffic), the intended pavement layer (surface, intermediate, base), the mixture size (based on nominal maximum aggregate size), and the surface layer friction requirement. A designation of "**HMA HT Surface ½ L-3**" describes the HMA mixture for high traffic, surface layer, ½-inch mixture size, with level 3 friction aggregate. Frictional aggregate requirements can be found in Standard Specification 2303.

The column to the right of the mixture designation define the required level of compaction (N value) and the target density (expressed as percent of G_{mm}) associated with each level of compaction. Note that the required density of a given level of compaction varies for different traffic levels and pavement layers. For example, the ST surface/intermediate, N_{des}=50, mixture requires 96 percent of G_{mm} (4.0% air voids). The N_{des}=50 base mixture for ST requires 97.0 percent of G_{mm} (3.0% air voids).

The middle column identifies the film thickness requirement.

The aggregate properties are defined in the right columns. The quality of the aggregate (Type A or B) is further specified in Standard Specification 4127. The crush value specifies the minimum amount of crushed aggregate required. The Fine Aggregate Angularity and Sand Equivalent values are consensus properties of the fine aggregate portion of the mix. Table Note 1 defines the allowable quantity of flat and elongated aggregate for all mixtures.

For any specified asphalt mixture, the mix design criteria are found by reading across the table. The asphalt mixtures are grouped by traffic levels.

Gradation Requirements

The individual aggregate gradation requirements for HMA mix designers are contained on Form 955.

The combined aggregate shall meet the gradation requirements on Table 2.

Table 1

Mix Designation		**Gyratory Density**		**Film Thickness**	**Aggregate [1]**			
		N_{des}	**Design (Target) % G_{mm}**		**Quality Type**	**Crush (min)**	**FAA**	**Sand Equivalent**
ST	Surface	50	96.0	8.0-15.0	A	60	40	40
	Intermediate				B	45		
	Base		97.0				--	
HT	Surface	75	96.0	8.0-15.0	A	75	43	45
	Intermediate					60		
	Base		96.5		B		40	
VT	Surface	95	96.0	8.0-15.0	A	85	45	45
	Intermediate							
	Base		96.5		B	75	40	
	HMA Interlayer [2]	50	98.0	≥8.0	A	45	40	50
	HMA Thin Lift [3]	50	≥98.0	≥8.0	A	50	40	50

(1) Flat & Elongated 10% maximum at a 5:1 ratio.
(2) See Table 3 for additional requirements.
(3) See Table 4 for additional requirements.

Table 2

Aggregate Gradation Control Points												
Sieve Size	Mix Size – Control Points (% Passing)											
	1 inch		3/4 inch		1/2 inch		3/8 inch		HMA Interlayer		HMA Thin Lift	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
1 1/2 inch	100											
1 inch	90	100	100									
3/4 inch		90	90	100	100							
1/2 inch				90	90	100	100					
3/8 inch						90	90	100	100		91	100
No. 4								90	80	100		90
No. 8	19	45	23	49	28	58	32	67	60	85	27	63
No. 16 (1)				28		32			40	70		
No. 30 (2)				24		25			25	55		
No. 50									15	35		
No. 100									8	20		
No. 200	1	7	2	8	2	10	2	10	6	14	2	10

(1) Only applies to surface and intermediate mixtures for HMA VT designs.
(2) Only applies to surface and intermediate mixtures for HMA HT designs.

Table 3

Performance Requirements for HMA Interlayer (2)		
Test	Requirement	Notes
AASHTO T-321	Minimum 100,000 cycles to failure	1

(1) Failure criterion at 2,000 microstrain shall be 50% of the initial flexural stress measured at the 200th load cycle.
(2) Use a PG 58-34E binder. Testing may be verified by the Engineer on field produced mix. Do not open to traffic until mat has cooled to below 150°F.

Table 4

Performance Requirements for High Performance Thin Lift [(1)]		
Test	Requirement	Notes
AASHTO T-324	At the 8,000th wheel pass, the rut depth must be less than or equal to 4.00 mm	1

(1) Use a PG 64-34E+ binder with a minimum 90% MSCR recovery. Do not open to traffic until mat has cooled to below 150°F.

MIX DESIGN DOCUMENTATION

GENERAL

Assign a mix design number with the following format: ABDYY-D000
Where "YY" is the two-digit year, "D" is the district number, and "000" is a 3-digit number identifying the JMF number.

When a significant change (as defined in 2303) is made to the original JMF, amend the mix design number with an "RX". For example ABD14-6017 is the 17th JMF in 2014 for District 6. When a significant mix change is made, the new mix design number would be ABD14-6017R1. Subsequent changes from the original design would require "R2, R3, etc".

For mix designs transferred from one project to another a new mix design number will be required when the following have occurred.

- There have been two or more aggregate or RAP source changes.
- The blend percentage has varied more than 10% from the original design for any individual aggregate or RAM.
- Recycled shingles have been added or removed from the design.

The new design may be validated by testing a single point or by evaluating current production test results.

A typical Mix Design Report and a Proportion/Production Limits Form is shown below.

Form 956 ver. 10.14

Iowa Department of Transportation

Highway Division - Office of Materials
HMA Gyratory Mix Design

Mix Data

Nmax

County :	Jones		Project : HSIPX-151-4(125)--3L-53	Letting Date :	7/16/2013
Mix Size (in.) :	1/2	Type A	Contractor : Mathy d/b/a R.C.Paving	Mix No. :	ABD14-6017
Mix Type:	HMA 1M	No Frictn Req	Design Life ESAL's : 1,000,000	Contract #:	53-1514-125
Intended Use :	Shoulder		Location : MP 63.05 - 92.31	Date:	04/29/14

On US 151 from Monticello to Jct. US 61 29.26 mi.

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
5/8" x3/8"	30.0%	A31066	River City Stone/Fillmore	2-4	2.696	1.37	48.0	4
3/8" x 3/16"	20.0%	A31066	River City Stone/Fillmore	2-4	2.695	1.31	48.0	4
Natural Sand	35.0%	A31514	River City Stone/Fillmore		2.593	1.20	40.0	5
Classified RAP	15.0%	ABC12-15	15% ABC12-15 (5.56 % AC)		2.578	2.29	43.1	4

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	87	60	45		26			5.8
	100	**100**	**97**	**80**	**53**	**40**	**33**	**22**	**9.0**	**4.6**	**3.8**
Lower Tolerance	100	100	90	73	46	35		18			1.8

Home

Asphalt Binder Source and Grade: . Paul Park Refinery Co. LLC (St. Paul Park, M PG 58-28

Gyratory Data

% Asphalt Binder	4.70	**4.86**	5.20	5.70	
Corrected Gmb @ N-Des.	2.404	**2.412**	2.428	2.432	
Max. Sp.Gr. (Gmm)	2.491	**2.486**	2.477	2.460	
% Gmm @ N- Initial	90.3	**90.9**	92.0	92.7	
%Gmm @ N-Max	96.5	**97.0**	98.0	98.8	
% Air Voids	3.5	**3.0**	2.0	1.1	
% VMA	13.3	**13.1**	12.8	13.2	
% VFA	73.6	**77.1**	84.6	91.4	
Film Thickness	9.33	**9.67**	10.29	11.38	
Filler Bit. Ratio	0.91	**0.88**	0.82	0.74	
Gse	2.677	**2.679**	2.683	2.684	
Pbe	4.19	**4.34**	4.62	5.11	
Pba	0.53	**0.55**	0.61	0.63	
% New Asphalt Binder	82.9	**83.5**	84.7	86.1	
Combined Gb @ 25°C	1.0330	**1.0330**	1.0330	1.0331	

			Combined	Contribution From RAM
Aggregate Type Used	A	% Friction Type 4 (+4)	93.1	3.8
G_{sb}	2.641	Or Better	93.1	3.8
G_{sa}	2.745	% Friction Type 3 (+4)	0.0	0.0
% Water Abs	1.44	Or Better	0.0	0.0
S.A. m^2 / Kg.	4.49	% Friction Type 2 (+4)	0.0	0.0
Angularity-method A	41	% Friction Type 2 (-4)	0.0	0.0
% Flat & Elongated	0.2	Type 2 Fineness Modulus	0.0	0.0
Sand Equivalent	89	% Crushed	59.0	8.6
Virgin G_b @ 25°C	1.0336			
Anti-Strip Dose (%)	0.00			
Stripping Inflection Point				

Number of Gyrations
N-Initial
7
N-Design
68
N-Max
104
Gsb for Angularity
Method A
2.593
Pba / %Abs Ratio
0.41
Slope of Compaction
Curve

Mix Check
Good
Pb Range Check
1.00
RAM Check
OK

Specification Check
Comply
Moisture Sensitivity Check
Not Required

Disposition : An asphalt content of 4.9% is recommended to start this project.
Data shown in 4.86% column is interpolated from test data.
The % ADD AC to start project is 4.1%

Comments :

Copies to :	Mathy d/b/a R.C.Paving	Roger Boulet	Manchester Const.	Dist. 6 Lab.
	Producer	Area Inspector		HMA Tech.

Mix Designer & Cert.# : C. Morgan & D.Lohrer EC-347 & EC-177 Signed : C. Morgan & D. Lohrer

Form 955 ver. 10.14

Iowa Department of Transportation

Highway Division-Office of Materials
Proportion & Production Limits For Aggregates

Production Limits

County : Jones Project No.: HSIPX-151-4(125)--3L-53 Date: 04/29/14
Project Location: On US 151 from Monticello to Jct. US 61 29.26 mi. Mix Design No.: ABD14-6017
Contract Mix Tonnage: 70,000 Course: Shoulder Mix Size (in.): 1/2
Contractor: Mathy d/b/a R.C.Paving Mix Type: HMA 1M Design Life ESAL's: 1,000,000

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
5/8" x3/8"	A31066	30.0%	River City Stone/Fillmore	A	4	2-4	2.696	1.37
3/8" x 3/16"	A31066	20.0%	River City Stone/Fillmore	A	4	2-4	2.695	1.31
Natural Sand	A31514	35.0%	River City Stone/Fillmore	A	5		2.593	1.20
Classified RAP	ABC12-15	15.0%	15% ABC12-15 (5.56 % AC)	A	4		2.578	2.29

Type and Source of Asphalt Binder: PG 58-28 St. Paul Park Refinery Co. LLC (St. Pau

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
5/8" x3/8"	100	100	90	35	6.0	5.5	5.0	4.5	4.0	3.5	3.0
3/8" x 3/16"	100	100	100	100	33	6.5	6.0	5.5	5.0	4.5	4.0
Natural Sand	100	100	100	100	93	80	65	40	10	1.5	1.0
Classified RAP	100	100	99	97	79	62	49	37	23	15	12

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	100	87	60	45		26			5.8
Comb Grading	100	100	97	80	53	40	33	22	9.0	4.6	3.8
Lower Tolerance	100	100	90	73	46	35		18			1.8
S.A.sq. m/kg	Total	4.49		+0.41	0.22	0.33	0.54	0.63	0.55	0.57	1.25

Clear | Add Limits | Production Limits for Aggregates Approved by the Contractor & Producer. | Home

Sieve Size in.	30.0% of mix 5/8" x3/8" Min	Max	20.0% of mix 3/8" x 3/16" Min	Max	35.0% of mix Natural Sand Min	Max	15.0% of mix Classified RAP Min	Max		
1"	100.0	100.0	100.0	100.0	100.0	100.0				
3/4"	100.0	100.0	100.0	100.0	100.0	100.0				
1/2"	80.0	100.0	100.0	100.0	100.0	100.0				
3/8"	28.0	42.0	98.0	100.0	100.0	100.0				
#4	0.0	13.0	23.0	37.0	90.0	100.0				
#8	0.0	10.0	0.0	11.0	75.0	85.0				
#30	0.0	8.0	0.0	9.0	36.0	44.0				
#200	0.0	4.0	0.0	4.0	0.0	1.5				

Comments:

Copies to: Mathy d/b/a R.C.Paving (Producer's), Roger Boulet (Area Inspector), Manchester R.C.E. (HMA Tech.), Dist. 6 Lab

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Signed: ______________________
Producer Contractor

GENERAL REWRITE
ALLOWABLE RAP USAGE BY WEIGHT

Mix Designation	Aggregate Quality Type	Unclassified RAP	Classified RAP
HMA ST S	A	0%	Limited by binder replacement
HMA ST I	B	10%	No Limit
HMA ST B	B	10%	No Limit
HMA HT S	A	0%	Limited by binder replacement
HMA HT I	A	0%	No Limit
HMA HT B	B	10%	No Limit
HMA VT S	A	0%	Limited by binder replacement
HMA VT I	A	0%	No Limit
HMA VT B	B	10%	No Limit

IM 511
MIX CONTROL

CONTROL OF ASPHALT MIXTURES

SCOPE

This IM describes the Quality Control/Quality Assurance (QC/QA) procedures for monitoring and controlling plant-produced asphalt concrete mixtures on Quality Management of Asphalt (QMA) projects.

REFERENCE DOCUMENTS

Standard Specification 2303 Flexible Pavement
IM 204 Inspection of Construction Project Sampling & Testing
IM 205A Securing Samples
IM 208 Materials Laboratory Qualification Program
IM 213 Technical Training and Certification Program
IM 216 Guidelines for Validating Test Results
IM 301 Aggregate Sampling & Minimum Size of Samples for Sieve Analysis
IM 302 Sieve Analysis of Aggregates
IM 319 Moisture Sensitivity Testing of Asphalt Mixtures
IM 320 Method of Sampling Compacted Asphalt Mixtures
IM 321 Method of Test for Compacted Density of Hot Mix Asphalt (HMA)(Displacement)
IM 322 Sampling Uncompacted Hot Mix Asphalt
IM 323 Method of Sampling Asphaltic Materials
IM 325 Compacting Asphalt Concrete by the Marshall Method
IM 325G Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
IM 336 Reducing Aggregate Field Samples to Test Samples
IM 337 Method to Determine Thickness of Completed Courses of Base, Subbase & Hot Mix Asphalt
IM 338 Method of Test to Determine Asphalt Binder Content & Gradation of Hot Mix Asphalt (HMA) by the Ignition Method
IM 350 Method of Test for Determining the Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
IM 357 Hot Mix Asphalt (HMA) Mix Sample for Test Specimens
IM 501 Equations and Example Calculations
IM 510 Method of Design of Hot Mix Asphalt Mixes

RESPONSIBILITIES

Appendix A contains an outline of the responsibilities required for all parties. Refer to IM 213 Appendix C for individual certification requirements.

SAMPLING & TESTING

Sample and test according to Section 2303. Only the information obtained from random samples as directed and witnessed by the Engineer and validated by comparison to one or more of the paired samples tested by the Contracting Authority will be used for specification compliance. Additional samples of aggregate and uncompacted asphalt mixture may be taken by the contractor to provide better quality control. The results of testing done on additional samples will be for informational purposes only and do not need to be reported.

All testing done by the Contractor that is used as part of the acceptance decision shall be performed in qualified labs by certified technicians. Gyratory compactors not utilized in the independent assurance testing (IM 208 Appendix C) will not be allowed on QMA projects without permission from the District Materials Engineer (DME).

Retain samples taken for acceptance purposes until the contractor's results have been validated.

A. UNCOMPACTED ASPHALT MIXTURE

The specific ton or truckload to begin sampling will be determined by the Engineer using the spreadsheet (https://iowadot.gov/Construction_Materials/hma/hmarandomsamples.xlsx). The total estimated daily production is divided into equal sublots based on the number of samples determined from Table 2303.03-5.

EXAMPLE
Estimated production = 4,501 tons
Number of Samples = 5
Approximate sublot size = 4501/5 = 900 tons

When production of a bid item is expected to exceed three production days (small quantities excluded) and conditions/resources reasonably allow, test samples immediately "hot-to-hot" (without allowing the sample to cool) for at least one day at the beginning of production to aid in any future investigation of non-correlation that may arise throughout production.

Calibrate the Rice pycnometer at the beginning of a project and anytime that a correlation problem occurs.

B. COMPACTED ASPHALT MIXTURE

1. For class I compaction, the width subjected to the random sampling shall coincide with the width eligible for PWL incentive/disincentive. This width shall be the nominal width of the travelled lane unless otherwise determined by the Engineer. Take samples from no less than 1 foot from the unconfined edge of a given pass of the placing equipment, except when the width of a single pass of the paver exceeds the width eligible for random sampling by more than 1 foot (i.e. For a 14-foot paving width on a 12-foot wide lane, a core location could randomly fall exactly 12 feet from centerline, assuming a two lane roadway. The outside 2 feet would then be deducted from the field voids lot quantity).

2. The Engineer will provide inspection staff to direct and witness the sampling and perform G_{mb} measurement during a time agreed between the Engineer and the Contractor. The Engineer should make every effort to meet the Contractor's schedule.

3. The Engineer will transport the cores in accordance with IM 320, or secure the cores for transport by the contractor. The Engineer and Contractor will determine that cores are not damaged. The Engineer will decide if a core is damaged prior to testing.

C. ASPHALT BINDER
Sample and test according to IM 204. For DSR verification tests performed at the District laboratory, if the G*/sinδ falls below 1.0, obtain a quart sample for full analysis and test all remaining 4 oz. samples until the area of noncompliance is isolated.
The Engineer may price adjust the asphalt binder for the following quality characteristics

- G*/sinδ (un-aged)
- Percent Recovery
- M-value

VALIDATION

A. Defined
Validation is defined as the ability of two labs to achieve similar (statistically equivalent) test values on split or paired samples.

B. Aggregate Gradation Correction Factor
When comparing the cold-feed gradation to the ignition oven extracted gradation, a correction factor to adjust the extracted gradation must be determined in accordance with IM 501. Validation of the cold-feed gradation will be determined by comparing the cold-feed gradation and the corrected extracted gradation as shown on the comparison report for Cold-Feed & Ignition Oven in IM 216 Appendix A. The correction factors will be established by comparing an Agency cold-feed sample to an Agency ignition oven extracted sample. The Engineer may witness and secure a split cold-feed sample according to IM 205 Appendix A for validation in lieu of an ignition oven sample, in which case a correction factor is not needed.

C. Validation Requirements

1. When any of the following events occur, validation has not been achieved or maintained:
   a. The difference between test results on each of two consecutive split/paired samples exceeds the IM 216 tolerance.
   b. The difference between test results on any two of three consecutive split/paired samples exceeds the IM 216 tolerance.
2. Consecutive samples may be either validation samples tested sequentially with another lab or mix specific samples when other mixes are being tested for validation between the two labs. It may be necessary to examine validation of test results on consecutive samples **of the same mix** if more than one mix is being tested between the two labs. Validation problems sometimes only occur during testing of specific mix samples.
3. When validation for a particular test has not been achieved, all results for that day are considered invalid for that test.
4. To achieve or reestablish validation, a minimum of two consecutive test results must meet IM 216 tolerances.
5. When noncomplying material has been removed, the test results corresponding with the material will remain in the validation decision.

DISPUTE RESOLUTION

A. Investigation
When validation is not achieved or maintained, the DME will act as appropriate to

resolve split/paired test result differences by choosing among the strategies below. The DME shall report the results of the investigation to the Contractor upon its conclusion. The DME may consider results from the Independent Assurance Program in the investigation. When non-validation of test results cannot be explained by an assignable cause as determined by the DME, the Engineer's results will be used for acceptance.

1. Retest the same sample
2. The District labs will test additional verification samples.
3. The DME will review the sampling and testing procedures of both labs
4. The DME will immediately test samples sent in by the Contractor without allowing cool down and reheating (hot-to-hot testing).
5. Both labs will test samples using comparable reheat periods.
6. The DME will establish a correction factor based on the reheat evaluation outlined in Appendix B.
7. Both labs will test a sample that was taken and split by the Engineer.
8. Both labs and a third laboratory designated by the Contracting Authority will test a sample split three ways. The 3rd lab for state projects will normally be the Central Materials Lab.
9. The DME will establish a correction factor for the Contractor's gyratory compactor based on the procedure described in Appendix C. The correction factor for G_{mb} should not exceed 0.030.
10. Verify both labs are compacting to the number of gyrations specified in the contract documents.

B. Quality Assurance Protocol
   1. Resolution decisions by the Iowa DOT Central Materials Laboratory will be final.
   2. During the period of production when validation cannot be achieved, the Engineer's test results will be used for acceptance of the lot. The use of the Engineer's test values for acceptance will be retroactive to the time when the first sample exceeded the validation tolerance. Similarly, when validation is regained, the use of the Contractor's test results for acceptance is retroactive to the first test used to reestablish validation.
      a. Over the period which validation cannot be achieved for aggregate gradation, the Engineer's test results will be used for the entire gradation and applied to any calculations involving the gradation for the entire lot.
      b. If validation cannot be achieved between the ignition oven extracted gradation and the Contractor's cold-feed gradation, the Agency will run cold-feed gradations for validation in place of the ignition oven.
      c. Over the period which validation cannot be achieved on-uncompacted asphalt mixture tests for G_{mm} or G_{mb}, the Engineer's test results will be used as follows:
         i. For lots under the PWL acceptance plan,
         The Engineer's results and any other valid contractor's results for the lot will be used in the calculations for field voids and lab voids.
         ii. For all other lots, the Engineer's results will be used for any calculations involving that particular test value.
         iii. Use a maximum lot pay factor of 1.000 for lab voids and field voids when the Engineer's results are used for any portion of the lot.

PRODUCTION TOLERANCES

Production tolerances are listed in the Section 2303.

Investigate variations between two consecutive test results in G_{mb} or G_{mm} of more than 0.030 promptly since these tests reflect significant changes in binder content, aggregate properties and/or gradation. In some cases variations may be attributed to segregation, thoroughness of mixing, sampling procedure, and changes in aggregate production.

If the test results in a series of split/paired samples (minimum of 3 samples) are not variable and random (results are consistently higher or results are consistently lower) and the difference between each split/paired test result is greater than half of the IM 216 tolerance, the DME may establish a correction factor for the Contractor's gyratory compactor based on the procedure described in Appendix C. The correction factor for G_{mb} should not exceed 0.030.

REPORTING

For each production sample of loose asphalt mixture the Contractor will determine, report, and plot G_{mb}, G_{mm} and P_a. Binder content measurement by an approved method will be determined, reported, and plotted daily. Gradation will be determined, reported and plotted daily. Make the inter lab correlation reports available.

Test results are to be recorded and plotted in the computer programs provided by the Iowa DOT (https://iowadot.gov/construction_materials/Hot-mix-asphalt-HMA). The computer programs act as a tool for documenting project data and applying the specification. The specification and IMs will always govern when errors are encountered in the software. Microsoft Excel 2007 (or newer) is required (or equivalent spreadsheet software capable of reading and writing *.xlsm and *.xlsx file types). The recommended minimum system requirements include a 2.3 Ghz processor or higher with at least 2 GB of physical memory and a wireless network adapter with internet access. Copies of the electronic spreadsheet file containing the completed Daily HMA Plant Report shall be provided to the DME and the Engineer within 4 hours of beginning operations on the next working day. The Engineer may extend this time on days when longitudinal joint cores are sampled and tested. Alternatively in these cases, the Engineer may accept partially completed reports until results are available. Use electronic mail (or DocExpress®) as the method of delivery unless otherwise approved by the Engineer. Copies of computer files containing the project information shall be furnished to the Engineer on a CD or portable memory device upon project completion. An additional copy of the files shall be furnished to the DME on a CD or portable memory device.

Keep the charts current and available showing both individual sample results and moving average values for both lab voids and absolute deviation from target. Base moving average values on four consecutive sample results.

MIXTURE AND BINDER SUBSTITUTIONS

At no additional cost to the Contracting Authority, the Engineer may approve the substitution of any mix design which meets or exceeds the requirements of the original mix. Mixture substitutions shall be gyrated to the same level as the original mix requirements. Binder substitutions have an equal or better low temperature PG grade and MSCR designation.

EXAMPLE

Original Mix

ST Intermediate with a PG 58-28S

Requested Substitution

HT L-2 Surface with a PG 58-28H

The request would be approved provided the HT Surface mix is gyrated to the same level as a ST Intermediate with lab voids within the target range. The binder substitution would be approved since it meets or exceeds the low and high temperature grade and has an equal or better letter designation. The aggregate quality of a HT Surface also meets or exceeds that of a ST Intermediate. The Engineer may approve an alternate maximum aggregate size.

A polymer modified binder may be substituted into the JMF provided the original PG grade and temperature spread is met or exceeded. In this case, verify the JMF target air voids are met at the design binder content. If the original JMF required moisture susceptibility testing and has consistently demonstrated acceptable SIP values in the field, the original anti-strip agent (if needed) and dosage rate may be used in lieu of IM 319 re-evaluation. Plant produced mix will still be tested for moisture susceptibility.

ADJUSTING (TROUBLESHOOTING)

The Contractor is responsible for making changes, as necessary, to achieve target values specified on the JMF. These changes can include adjusting the proportions of aggregate and asphalt binder necessary to meet the JMF. If a change in the target gradation is desired, obtain approval of a new JMF from the DME. Changes in the target gradation cannot be set outside of the control points. The Contractor may change the target binder content to maintain the required mixture characteristics, provided the appropriate documentation and reporting is performed. The Contractor may change binder sources provided the Engineer receives written notification (or e-mail) prior to the substitution. Report all changes in proportions on the Daily HMA Plant Report.

The addition of new materials to the JMF may be approved by the Engineer without evaluating mix volumetrics in the laboratory if the materials are produced from geologically comparable sources, do not constitute more than 15 % of the total aggregate, meet quality requirements, and produce mixes that meet design criteria. When aggregates are introduced from sources that are not geologically comparable or otherwise differ significantly, complete laboratory mix design testing and approval is required.

When a stockpile of recycled asphalt materials (RAM) constitutes less than 15% of the JMF, it may be substituted by another source of equivalent classification and quality (Classified or Unclassified) to finish the project. In this case, update the JMF by entering the new RAM binder content, specific gravity, gradation, and absorption into SHADES. Verify the volumetrics remain compliant with the specifications by testing a lab compacted sample.

Moving averages and the gyratory compaction slope assist in identifying potential problems before they arise. Watch the trends in the moving averages (approaching a specification limit) and the slope of the compaction curve. The slope of the compaction curve of plant-produced material shall be monitored and variations in excess of ± 0.40 of the mixture design gyratory compaction curve slope may indicate potential problems with uniformity of the mixture.

TABLE OF RESPONSIBILITY

QUALITY ACTION	CPI & QMA	SMALL QTY.
General		
Use of Qualified Labs & Certified Technicians	CONTR/RCE	CONTR
Use of Certified Labs & Qualified Technicians	DME/CTRL	DME/CTRL
Preparation of the Job Mix Formula (JMF)	CONTR(2)	CONTR(2)
Approval of the JMF	DME	DME
Calibration of the Plant	CONTR	CONTR
Monitoring of Plant Operations	DME/RCE(1)	DME/RCE(1)
Inspection of Plant Operations	CONTR(1)	CONTR(1)
Asphalt Binder		
Direct & Witness Verification Sample of Asphalt Binder	RCE/DME(3)	NA
Sample Asphalt Binder	CONTR(3)	NA
Secure Verification Sample of Asphalt Binder	RCE/DME	NA
Transport Verification Sample of Asphalt Binder	CONTR/RCE	NA
Run & Report Verification Sample of Asphalt Binder	DME/CTRL	NA
Aggregate		
Direct & Witness Verification Sample of Combined Aggregate	RCE(4)	NA
Sample Combined Aggregate	CONTR(4)	CONTR(4)
Direct & Witness Splitting of Combined Aggregate Sample	RCE(5)	NA
Secure Verification Sample of Combined Aggregate	RCE	NA
Transport Verification Sample of Combined Aggregate	CONTR/RCE	NA
Run & Report QC Tests on Combined Aggregate Gradation	CONTR(5)	CONTR(5)
Run & Report Verification Tests on Combined Aggregate Gradation	DME/RCE(5)	NA
Report Validation per IM 216 on Combined Aggregate Gradation	DME/RCE	NA
Obtain & Transport Verification Samples of Coarse Aggregate Quality	DME(4)	NA
Run & Report Verification Tests on Coarse Aggregate Quality	CTRL	NA
Loose Hot Mix		
Determine Loose Hot Mix Paired Sample Frequency/Location	RCE(3)	CONTR
Direct & Witness Verification Sample of Loose Hot Mix	RCE(3)	NA
Sample Loose Hot Mix Paired Samples	CONTR(3)	CONTR(3)
Secure Verification Sample of Loose Hot Mix	RCE	NA
Transport Verification Sample of Loose Hot Mix	CONTR/RCE	NA
Run & Report QC Tests on Loose Hot Mix Samples	CONTR(1)	CONTR(1)
Run & Report Verification Tests on Loose Hot Mix Samples	DME(1)	NA
Report Validation of Hot Mix Tests	CONTR(1)	NA
Evaluate Test Results/Take Action when Validation Fails	DME	NA
Compacted Hot Mix		
Determine Density Coring Frequency/Location	RCE(3)	RCE(3)
Direct & Witness Coring & Transport to QC Lab	RCE(3)	RCE(3)
Obtain Core Samples & Prepare Samples at the QC Lab	CONTR	CONTR
Run Density Testing on Cores	RCE(3)	RCE(3)
Record Density Testing Measurements on Cores	RCE(3)	RCE(3)
Report Density Testing Results on Cores	CONTR(1)	CONTR(1)
Revisions		
Adjust Production to Maintain JMF Targets	CONTR	CONTR
Report Plant Adjustments	CONTR(1)	CONTR(1)
Approve Revisions to JMF Targets	DME	DME
Shut Down Production when Required	CONTR	CONTR

NOTES:

(1) Must be done by Certified Level I HMA Technician
(2) Must be done by Certified Level II HMA Technician
(3) Must be done by Certified HMA Sampler
(4) Must be done by Certified Aggregate Sampler-Technician
(5) Must be done by Certified Aggregate. Technician

ABBREVIATIONS:

CPI = Certified Plant Inspection
QMA = Quality Mgmt. of Asphalt
RCE = Project Engineer
CONTR = Contractor
DME = District Materials
CTRL = Central Materials

REHEAT EVALUATION

The contractor's QMA laboratory technician shall split the sample selected for correlation. The split will provide material for 3 individual maximum specific gravity, G_{mm}, test samples and material for 3 sets of laboratory density, G_{mb}, specimens.

The contractor's technician will split and retain sufficient material for 2 G_{mm} test samples and 2 sets of laboratory density specimens. The remainder of the field sample will be submitted to the DOT laboratory. From this portion the DOT laboratory will split and test an additional G_{mm} sample and an additional set of laboratory density specimens, after reheating.

Immediately after splitting, the contractor's technician will return one set of laboratory density samples to the oven and heat to compaction temperature. Once compaction temperature is reached, this set is removed from the oven, compacted as per IM 325 or IM 325G, cooled to ambient temperature and G_{mb} determined. The second set of samples is cooled to ambient temperature, reheated to compaction temperature then compacted as per IM 325 or IM 325G, cooled to ambient temperature and G_{mb} determined. This dual testing is intended to indicate the differences in test results, which can be expected, between samples tested on the original heat of the mixture and those tested at a later time (hot-to-cold testing).

The contractor's technician will cool and separate both G_{mm} samples. The contractor's technician will test one G_{mm} sample. The second G_{mm} sample will be sealed in a plastic bag and submitted to the appropriate DOT laboratory for testing. The DOT laboratory will test the sample without any significant reheating (not more than 5 minutes oven reheating to facilitate breaking up sample).

Interlaboratory correlation, as specified in IM 208, will be determined by comparing G_{mm} results obtained by the contractor to those obtained by the DOT laboratory on the G_{mm} samples split by the contractor. The laboratory density obtained by the contractor on the G_{mb} specimens prepared from the reheated portion will be compared to the G_{mb} determined by the DOT laboratory on G_{mb} specimens prepared from the reheated portion of the original split sample. If the test results compared are within the tolerances specified in IM 208, then the reheat procedure shall be performed when required by the District Materials Engineer. If the test results are not within the tolerances specified in IM 208, additional testing on the same or subsequent samples will be required.

The District Materials Engineer may waive the reheat testing if the test results indicate no significant difference caused by reheating of samples. Additional correlation testing may be performed at any time at the request of the contractor or the District Materials Engineer. The information obtained by the dual testing described above may be used when monitoring the daily comparison of contractor's test results to DOT laboratory test results when reheating of samples is involved. All samples shall be retained until permission to discard them is obtained from the DOT laboratory.

This outline is to serve only as a guide to the steps in the correlation procedure. All tests noted in this outline must be performed in accordance with the applicable IM.

1. Contractor Testing Responsibilities

   A. Obtain field sample and split to obtain 2 sets of laboratory density, G_{mb}, specimens and 2 Maximum specific gravity, G_{mm}, specimens and submit the remainder of field sample to DOT laboratory for testing.

   B. Bulk Density Testing

      1) Set #1 – Immediately after splitting, return specimens to the oven, reheat to compaction temperature, compact specimens as per IM 325 or IM 325G, cool to ambient temperature and test for density.

      2) Set #2 – Cool to ambient temperature, return to oven, reheat to compaction temperature, compact as per IM 325 or IM 325G, cool to ambient temperature and test for density.

      3) Compare values obtained in #1 and #2 to determine possible reheat factor.

   C. Maximum Density Testing

      1) Sample #1 – Cool sample and perform Rice Test.

      2) Sample #2 – Cool sample, place in plastic bag and submit to the DOT laboratory for testing.

   D. Submit remainder of field sample to DOT laboratory for testing.

2. DOT Laboratory Testing Responsibilities

   A. Bulk Density Testing

      1) From the field sample supplied by the contractor, split one set of G_{mb} specimens, place in oven, heat to compaction temperature, compact as per IM 325 or IM 325G, cool to ambient temperature and test for density.

   B. Maximum Density Testing

      1) From the field sample supplied by the contractor, split one G_{mm} specimen and perform Rice Test.

      2) Test the G_{mm} sample supplied by the contractor.

      3) Compare values obtained in #1 and #2 to determine possible deviation in G_{mm} results that might occur between the Contractor's split G_{mm} sample and the DOT G_{mm} sample split from a field sample.

PROCEDURE FOR ESTABLISHING A CORRECTION FACTOR FOR G_{mb}

The procedure used for establishing a correction factor is as follows:

PROCEDURE A

1. Obtain one sample of sufficient plant produced material for 12 G_{mb} specimens and split per IM 357 into 6 specimens each between the contractor and engineer. This should provide enough material that 6 gyratory specimens may be compacted at both labs. The sample should be representative, but sampling procedure IM 322 is not required.

2. The material must be handled and compacted in the same manner by the contractor and engineer (hot-to-hot or cold-to-cold).

3. Compact the specimens per IM 325G.

4. Perform density testing on the compacted specimens per IM 321.

5. Average the 6 G_{mb} results for each lab.

The difference between the average G_{mb} results from the two labs will be considered the correction factor. **NOTE:** Unless otherwise decided on by the Engineer, only 1 correction factor will be established for a given mix design.

PROCEDURE B

The engineer may use the results of 3 consecutive QC/QA split tests in lieu of a single 12 split sample. There can be no significant change to the mix between the 3 tests and no adjustments to the gyratory compactors. The material must be handled and compacted in the same manner by the contractor and engineer (hot-to-hot or cold-to-cold). The contractor’s QC results will be averaged and the engineer’s QA results will be averaged with the difference being the correction factor to be applied.

****THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.****
TROUBLESHOOTING FLEXIBLE PAVING MIXTURES

PLANT TROUBLESHOOTING

Asphalt Binder

If Computed Percent Binder is High:

a. Check tank stick readings and computations.
b. Check to be sure that all mix produced was included in the computations.
c. Check for spilled, wasted, or otherwise used asphalt cement.
d. Check to be sure all asphalt listed as **added** during the period should be included.
e. Check truck scales and total mix made.
f. Check cold-feed and pump setting.
g. Check aggregate delivery level for uniformity.

If Computed Percent Binder is Low:

a. Check tank stick readings and computations.
b. Check total mix made.
c. Check to be sure that all asphalt added during the period is included.
d. Check cold-feed and pump setting.
e. Check for plugged nozzle.
f. Check pumping pressures.
g. Check strainer screen.
h. Check truck scales.

Gradation

Non-compliant cold-feed gradation and other production mix irregularities may result from the following causes:

- Sample not representative of lot (Multiple hot bins)
- Improper bin balance
- Test errors, weights, calculations, etc.
- Incorrect cold-feed settings
- Non-uniform cold-feed delivery
- Stockpile segregation
- Stockpile contamination
- Storage bin segregation
- Intermingling of aggregates in stockpiles and/or feeders
- Wet, non-uniform stockpiles
- Degradation

MIX TROUBLESHOOTING

The tables below are intended to provide guidance on dealing with the most common problems, which arise during the production of asphalt concrete mixture. The first table deals with problems, which can show up in the laboratory setting and the second table deals with problems, which can appear in the field.

The following example explains how to read the tables. Both tables are read downward. The shaded regions are the items to be considered for adjusting purposes.

<u>Lab Problem Table</u>
The first step is to identify which lab problem is occurring. If “Low Voids” is the identified problem, move down the column to the “Step 1 Check”. Assuming the first check is to be made on the “Binder Content”, move down the column to “Step 2 If”. If the Binder Content is high proceed to “Step 3 Verify”. Each of the shaded items identified in the “Step 3 Verify” should be looked at before proceeding further. Assuming that the items in “Step 3 Verify” are on target, go to “Step 4 Do”. In this case, the action to be taken in “Step 4 Do” is to “Lower Binder” in the mix. In <u>all</u> cases, the items in the “Step 3 Verify” are assumed to be within the allowable tolerances and won’t fall outside of allowable tolerances if the action in “Step 4 Do” is taken.

LAB PROBLEM		Low Voids			High Voids			Low Film Thickness			High Film Thickness			Low VMA			High VMA		
Step 1-Check	Binder Content	■			■			■			■								
	Gradation		■			■			■			■		■	■		■	■	
	Agg. SG (Gsb)			■			■									■			■
	Agg. Abs.									■			■						
Step 2-If	Low Binder				■			■											
	High Binder	■									■								
	Low -200					■						■					■		
	High -200		■						■					■					
	Off JMF Target			■			■			■			■		■	■		■	■
Step 3-Verify	Filler Bitumen Ratio	■	■		■	■		■	■		■	■		■	■		■	■	
	Film Thickness	■	■		■	■								■	■		■	■	
	VMA	■	■		■	■													
	Field Compaction	■	■			■		■	■	■	■	■	■						
	Voids							■	■		■	■		■	■		■	■	
	Individual Agg. Sources			■			■			■			■			■			■
Step 4-Do	Decrease Binder	■									■								
	Increase Binder				■			■											
	Lower -200		■						■					■					
	Increase -200					■						■					■		
	Adjust Agg. Proportions		■	■		■	■		■	■		■	■	■	■	■	■	■	■
	Recompute Volumetrics			■			■			■			■			■			■

<u>Field Problem Table</u>
The first step is to identify which field problem is occurring. If “High Field Voids” is the identified problem, move down the column to the “Step 1 Check”. Assuming the first check is to be made on the “Lab Voids”, move down the column to “Step 2 If”. If the Lab Voids are high proceed to “Step 3 Verify”. Each of the shaded items identified in the “Step 3 Verify” should be looked at

before proceeding further. Assuming that the items in “Step 3 Verify” are on target, go to “Step 4 Do”. In this case the process of looking at the “Step 3 Verify” would lead to the Lab Problem Table and cause one of the actions for High Lab Voids to be used.

In <u>all</u> cases, the items in the “Step 3 Verify” are assumed to be within allowable tolerances and won’t fall outside of allowable tolerances if the action in “Step 4 Do” is taken.

FIELD PROBLEM		Low Field Voids		High Field Voids		Tender Mix				Low Density Q.I.		Agglomerates	Uncoated Aggr.		Brown Rock			Stripping
Step 1 - Check	Stockpiles											■						
	Aggr. Absorption														■			
	Binder Content												■			■		
	Lab Voids	■		■		■				■								
	Film Thickness						■											
	Mixing Time													■				
	Moisture in Mix							■										■
	Mix Temp at Plant		■		■												■	
	Mat Temp								■		■							
Step - 2	Low	■			■	■					■		■	■		■		
	High		■	■			■		■						■		■	
	Yes							■				■						■
Step 3 -Verify	Filler/Bitumen Ratio												■			■		
	Film Thickness												■			■		
	Voids												■			■		
	Field Compaction																■	
	Aggr. Breakdown		■		■													
	Individual Aggr. Sources		■		■										■			
	Moisture		■		■												■	
	Amount of Clay binder											■						
	Go to Lab Problem Table	■		■		■	■			■								
Step 4 - Do	Increase Binder												■			■		
	Lower Temp		■						■								■	
	Increase Temp				■						■							
	Cover Loads				■													
	Increase Aggr. Dryer Time							■										■
	Screen											■						
	Adjust Aggr. Proportions														■			
	Increase Wet Mixing Time													■				

IM 514
PLANT CALIBRATION

******THIS IS A NEW IM – PLEASE READ CAREFULLY.******

ASPHALT PLANT CALIBRATION

GENERAL

The specifications require that all material proportioning equipment be calibrated and checked for accuracy. Refer to Section 2001 of the Standard Specifications for calibration tolerances. The job mix formula provides the basis for the calibrations.

The District Materials Engineer shall be afforded the opportunity to witness the calibration. The plant calibration may be monitored by and is subject to the approval of the District Materials Engineer or authorized representative. A copy of the calibration report shall be available at the plant site.

CALIBRATION

The contractor is responsible for plant calibration. The specifications require the contractor to provide personnel, scales, test weights, and equipment for calibrating each delivery component.

Scales may be calibrated by a certified scale company. Check weighing may be used to validate the calibration.

Equipment that needs to be calibrated may include these items.

1. Cold Aggregate Bins
2. RAM Bins
3. Conveyor Scales
4. Asphalt Pump/ inline flow meter
5. Hot Aggregate Bins on Batch Plants
6. Batch Plant Scales
7. Initial Plant Settings
8. Mixing Rate

Where possible it is good practice to calibrate at high, medium, and low production rates. This will help insure that the plant is in calibration when the production rate changes during the project.

The calibration tolerances for proportioning and weighing equipment are as follows:

+/– 0.2% for scales and binder meters used to determine pay quantity (platform scale, silo discharge weigh hopper or batch plant proportioning scales when counting batches).

+/- 0.5% for proportioning scales (aggregate weigh hopper or binder weigh bucket on batch plants when not counting batches for pay quantity).

+/- 1.5% for all weigh belts and binder meters not used for pay quantities (drum mix plants).

Calibration can be considered to have been achieved after two consecutive runs within tolerance.

REPORTING

See the following website for a plant calibration worksheet:
http://www.iowadot.gov/Construction_Materials/hma.html

See Appendix B for plant calibration worksheet example.

Plant Equipment and Calibration Examples

PLANT EQUIPMENT

1. Cold Aggregate Bins

The first step in calibrating a proportioning plant is the calibration of the cold aggregate bins. These units determine the final gradation of the mixture.

a. Fixed Speed-Variable Gate Opening Bins

These bins are controlled by gates, which meter the flow volumetrically. They are calibrated by weighing the quantity of material, which passes through a given gate opening during a measured time interval. The interval is determined by counting the number of revolutions that the belt makes while the material is delivered. From the RPM of the belt and the weight of the material, the delivery rate in pounds per minute is calculated (corrected for moisture). The calibration is graphed by plotting the pounds of dry aggregate delivered per minute at the gate openings used in the calibration.

b. Fixed Gate Opening-Variable Speed Bins

With this system, a gate opening is selected for each bin. This gate opening must be maintained throughout the calibration and the job. They are calibrated by weighing the amount of material delivered at several different speeds of the cold-feeder motor over a measured time interval.

The calibration is graphed by plotting the pounds of dry aggregate delivered per minute at the speeds of the belt motor used in the calibration.

These bins are equipped with a master control, which may be used to adjust the production rate. Changing the master control setting changes the speed of all the belts proportionately.

c. With either type of bin, the gate setting is very important and should be checked regularly.

2. Conveyor Scales

The specifications require Dryer Drum Mixing Plants be equipped with continuous weighing central conveyor scales that are interlocked with the asphalt delivery system. These scales are checked for accuracy by two methods as follows:

a. The scale is first zeroed while the conveyor is operating at normal operating speed, but unloaded. It is then adjusted to readout a predetermined total weight using the special

scale beam weights and a standard operating time interval. Both of the foregoing procedures are to be performed in accordance with the scale manufacturer's instructions.

b. The second accuracy check requires the comparison of the weight shown on the totalizing meter, with the weight actually delivered as determined by running material over the conveyor into a tared truck. The truck tare and loaded weights must be obtained by weighing over certified commercial truck scales, or plant scales that have been checked against certified scales and approved by the Engineer. The conveyor scales should be checked at several delivery rates representing the proposed operating range. The contractor shall adjust the weighing system so that when the plant is operating, the final mixture is uniform and consistently within the specified job mix formula tolerances.

3. Asphalt Pump

Some batch plants, and all drum mixing plants deliver asphalt material to the mixer through volumetric pumps. These volumetric systems must be calibrated throughout the proposed operating range at the normal operating temperature. Totalizing meters must be adjusted to readout the quantity delivered within the specified delivery tolerance.

In-line flow meter must be accurate to plus or minus 0.2% as demonstrated through the calibrations process. Use a certified truck scale or a calibration tank in the calibration of flow meters. Perform yield checks.

At least once per year a Certified Scale Company shall verify the load cells on the calibration tank. When the tank is moved certified weights shall be used to test the load cells. Use a minimum of 200 pounds to check for accuracy, sensitivity and that the tank is free floating and level on the load cells.

When troubleshooting asphalt binder measurement:

a. Check capacity of storage tanks.
b. Check tank sticks.
    i. Be sure they fit the tanks.
    ii. Determine proper use. (touch stick or dipstick, percent of diameter or inches, etc.)
    iii. Be sure tanks are level.
c. Check piping and type of pumping system.
d. Check the truck scales.

4. Hot Aggregate Bins on Batch Plants

After the various aggregates have been proportioned and dried, they are fed to the mixer unit.

a. On batch plants the hot aggregates are weighed in batches over calibrated scales as described in the following paragraphs and examples.

The dust collected by the dust collector is fed from a calibrated bin or returned directly to the hot aggregate, depending on the type of plant equipment and the specification

requirements. If the dust is returned separately, the feeder should be calibrated to feed the required quantity of dust in a uniform manner. If the dust is returned directly to the hot aggregate the weight or volume of dust collected and returned is taken into account automatically in the calibration of the hot aggregate delivery system or batch weights.

When gradation control is by cold-feed samples, and the batch plant is equipped with hot aggregate screening units, they should be removed or covered so that the gradation is not altered by the balance of the hot bin delivery settings. If the Contractor would like to use the hot aggregate screening process, the approval of the DME is required before beginning. If this process is used, the gradation control will be based on samples obtained from the hot aggregate delivery or on the extracted gradation from samples of the hot mix. When hot aggregate screening is used, the delivery of each hot bin must be calibrated similarly to the cold feed bins.

5. Batch Plant Scales

Calibration of batch plant scales as required by the specifications is performed by incrementally loading the scales with standard test weights and partial batches through the operating range of the scales. As each increment of load is applied, the actual observed weight and the required weight are compared. The differences, plus or minus, are determined and converted to percentages of the required weight. If the percentage deviations are less than the tolerance allowed by the specifications and the scales are sensitive to the test loads, the scales will be considered in calibration. If the scales do not meet the various requirements, the contractor is required to make the necessary repairs or adjustments. Recalibration may be ordered by the engineer if the scale equipment malfunctions or if required material quantities do not agree with actual material quantities. If the batch plant scales are to be used for the determination of pay quantity, a scale calibration to the proper accuracy is required.

6. Initial Plant Settings

Three examples of initial plant settings have been provided: one for a drum mix plant, one for a 3000-pound batch plant with a volumetric asphalt measurement, and one for a continuous plant with a sprocket type asphalt pump.

7. Mixing Rate

The specifications contain requirements regarding the quality and duration of mixing for the various types of mixes and plants. The design, condition, speed and loading of the mixer unit together with the characteristics of the materials being mixed will vary from job to job and need to be taken into account when evaluations are made.

Mixing times are determined in the following manner:

b. Batch Plants. The mixing rate of batch plants is controlled by the batch size and the dry and wet mixing timer settings. The batch size should not exceed the manufacturers rated capacity and the timer should be set to provide the specified mixing time unless more or less time is authorized by the engineer. The accuracy of the timer may be checked with a stopwatch if necessary.

PLANT CALIBRATION EXAMPLE

TYPICAL PLANT COLD-FEED SETTINGS

The following example is based on initial plant output of 70 TPH of mix. See example.

Set for 70 TPH total cold-feed aggregate (Dry Weight):

$$\frac{70 \text{ TPH} \times 2000 \text{ lbs./ton}}{60 \text{ min./hr.}} = 2333 \text{ lbs./min. of mix}$$

Material	% in Mix	lbs./min.	Gate Setting
1/2 in. (12.5 mm) Cr. Stone	60%	1400	Approx. 3 5/8
Sand	40%	933	Approx. 2 1/8

DRUM MIXING PLANT

The following example is based on initial plant output of 300 TPH. See example.

Set aggregate delivery controls on plant control console to deliver 300 TPH of dry aggregate.

Master control set on maximum.

TPH		TPH
300 x 58% 3/4 inch crushed limestone	=	174
300)x 30% Sand	=	90
300 x12% RAP	=	36
100%		300

BATCH PLANT SETTINGS

After the aggregate scale and asphalt scale has been checked for accuracy, the batch weights are set and mixing operations are begun. The scales are checked by adding weights to the hopper and observing the scale dial indicators (see examples). Some batch plants are equipped with volumetric asphalt pumps rather than scale buckets; these devices are calibrated the same way that asphalt pumps are calibrated on drum-mix plants, but operated on a batch basis:

Assume 3000 lb. batch plant, cold-feeds as cited previously and 5.5% binder content.

SCALE SETTING

Binder: 5.5% x 3000 lbs. = 165 lbs. per batch (see example)

Combined Hot Agg.: 3000 lbs.– 165 lbs.= 2835 lbs. per batch

Asphalt pump (volumetric) = 165 lbs. per batch = 23 counts per batch (see example)

If the dust is returned directly to the hot aggregate, separate computations are not required for the dust being fed since it is automatically included in the hot aggregate delivery.

All gate and scale settings and weighing controls shall be set to target on the required quantities. Offsetting shall not be permitted, except to correct calibration errors.

ASPHALT PUMP

Example of flow meter calibration intervals:
Production Range = 100-300 TPH
JMF Binder Content = 6.0 % (virgin)
Asphalt Weight/Volume = 8.57 lb/gal
Tank Capacity = 24 Tons (5600 gallons)
Asphalt Binder Range = 6 – 18 TPH (1400 – 4200 gallon/hr)
The lower portion of the range may include an interval starting from 1400 gallons. Intervals should be sufficient to ensure that the tolerance and scale break requirements are met on a platform scale.

CALIBRATION OF HMA PLANT EQUIPMENT

YEAR	2015		
Contractor:	Mathy Portable Plant # 23	Date of Plant Calibration:	10/19/2015
Plant Type:	400 tph Drum Plant	Date of Platform Scale Calibration:	Spring 2015
Plant Location:	Preston Redimix (Preston Quarry)	Scale Company:	Derlein Scale Co
Project #:	FM-CO23(97)--55-23	Binder Type & Grade:	PG 58-28 During Calibration
Pollution Control:	Baghouse	Mix Size:	1/2"
Calibrated By:	Pat Cherney	Date of Asphalt Tank Calibration:	N/A
Witnessed by:	Mark Dutra (I.D.O.T.)	Asphalt Tank Calibrated By:	N/A
Mix Design:	**ABD15-6055**	Plant Phone #:	

AGGREGATE BELT SCALES Spec: +/- 1.5% Error

	Operating Range @ (300) TPH											
Belt Weight	11,832	11,268	11,254									
Truck Gross	34,500	34,220	34,280									
Truck Tare	22,940	22,940	22,940									
Truck Net	11,560	11,280	11,340									
Difference	272	12	86									
% Error	2.4	0.1	0.76									
Scale Factor	3.334 / 9078											
Comments:	All aggregate bins were calibrated under 1.5% Error											

ASPHALT CEMENT PUMP Spec: +/- 0.2% For Pay By Meter or +/- 1.5% Not For Pay (Tank Stick Only)

	Operating Range @ (15) TPH											
Metered Gal. or Lbs.	15,004	14,996										
Corrected Gal. or Lbs												
Calibrated Tank Lbs.												
Truck Gross	45,640	60,660										
Truck Tare	30,640	45,640										
Truck Net	15,000	15,020										
Difference	4	24										
% Error	0.03	0.16										
Scale Factor	2008.2											
Comments:												

RAP BELT SCALES Spec: +/- 1.5% Error

	Operating Range @ (60) TPH											
Belt Weight	11,476	11,648	11,583									
Truck Gross	34,700	34,680	34,500									
Truck Tare	22,940	22,940	22,940									
Truck Net	11,760	11,740	11,560									
Difference	284	92	23									
% Error	2.4	0.78	0.2									
Scale Factor	2.220 / 5766											
Comments:	All RAP bins were calibrated under 1.5% Error.											

RAS BELT SCALES Spec: +/- 1.5% Error

	High Range @ ( ) TPH			Medium Range @ ( ) TPH			Low Range @ ( ) TPH					
Belt Weight												
Truck Gross												
Truck Tare		RAP AND RAS USE THE SAME BELT SCALE										
Truck Net												
Difference												
% Error												
Scale Factor												
Comments:	All RAS bins were calibrated under 1.5% Error.											

SILO HOPPER SCALES Spec: +/- 0.2% Error												
	Silo #1			Silo #2			Silo #3					
Hopper Scale	30,200											
Truck Gross	53,200											
Truck Tare	22,940											
Truck Net	30,260											
Difference	60											
% Error	0.2											
Comments:												

PLATFORM SCALES Spec: +/- 0.2% Error												
Test Weight's												
Truck Gross												
Truck Tare			SEE COMMENTS									
Truck Net												
Difference												
% Error												
Comments:	Calibrated By Derlein Scale Inc.											
Additional Information:												

SPEC 2001
EQUIPMENT

Section 2001. General Equipment Requirements

2001.01 GENERAL.

A. Obtain Engineer's approval for equipment. Maintain equipment in working condition.

B. Except as provided in Article 1105.11, G, do not operate equipment that exceeds the legal axle load, as defined herein, on pavement or on primed or unprimed subgrade, subbase, or base course.

C. Do not use tractors with lugs for manipulating or spreading subbase or base material except when traveling on uncompacted material deposited by spreaders or spreader boxes.

D. Keep equipment that comes in contact with bituminous materials or bituminous mixtures clean by heating, scraping, or by the use of an approved release agent described in Materials I.M. 491.15. When kerosene, distillates, or other solvents are used, allow the equipment to drain for a minimum of 5 hours after cleaning. Collect the cleaning agents and dispose of according to Federal and State regulations.

E. Do not mix, transport, or place concrete using equipment or forms with aluminum that will come in contact with the concrete.

2001.02 FIELD LABORATORY.
Comply with requirements of Section 2520.

2001.03 TRUCKS FOR TRANSPORTING BITUMINOUS MIXTURES.

A. Transport bituminous mixtures using motor trucks with tight metal or metal lined dump bodies. For hot mixes on unusually long hauls or for work after October 1, the Engineer may require the truck bodies to be insulated adequately to retain heat in the mixture.

B. Transport hot mixes in trucks having a cover of canvas or other suitable material. Covering normally will not be required between May 15 and October 1.

2001.04 MECHANICAL TAMPERS.

A. In areas inaccessible to rollers where compaction is required and hand tamping is not permitted, use a suitably sized mechanical tamper.

B. Do not operate pneumatic tampers at pressures lower than the manufacturer's recommendations.

2001.05 ROLLERS.
Use rollers that comply with the restrictions imposed in the specifications for the various types of construction. Use rollers in good repair and designed to do the work required. Use rollers that are approved by the Engineer and comply with the following requirements:

A. Soil Compaction Rollers.

1. Use sheepsfoot type rollers consisting of one or more drums having studs or feet projecting no less than 6 1/2 inches from the surface of the drum.

2. Load the roller so that no less than 200 psi is exerted on a single row of feet parallel to the axle of the drum.

B. Self Propelled, Smooth, Steel Tired Rollers.

1. Self propelled, smooth, steel tired rollers may be of the 3 wheel type, 2 axle tandem type, or 3 axle tandem type.

2. For natural subgrade, use rollers no less than the 3 ton weight class.

3. For hot asphalt mixtures, use a driving drum no less than 60 inches in diameter.

4. On tandem type rollers used for hot asphalt mixtures, use a driving drum capable of being filled with liquid ballast. The Engineer may require that it be partially or entirely filled.

5. For all other types of work, use rollers of a weight class no less than 8 tons. Load the driving drum to produce a compactive effort not less than 200 pounds per inch of width of the roller. When the Engineer requires, weight the steering drum to 200 pounds per inch of width of the steering drum.

C. Self Propelled, Pneumatic Tired Rollers.

1. Use tires no smaller than a 7.50 by 15 size.

2. For hot asphalt mixtures, use rollers capable of producing contact pressures of 80 psi. Operate when specified or directed by the Engineer. Ensure the 80 psi contact pressure is obtainable with a legal axle load.

3. For all other types of work, use rollers loaded to produce a compactive effort no less than 200 pounds per inch of width of the roller, based on the maximum ground contact width. Use a tire inflation pressure no less than 60 psi. Rollers complying with the requirements for HMA may also be used.

4. Ensure tire pressures vary no more than 5 psi.

5. Attach an information plate to each roller showing the tire size and ply and the correlation of wheel load and tire pressure with contact pressure. Equip the roller with wheel sprinklers, scrapers, or mats, and during cooler weather, protective skirting around the tires.

D. Pull Type, Pneumatic Tired Rollers.

1. Use tires no smaller than a 7.50 by 15 size.

2. Load the rollers to produce a compactive effort no less than 200 pounds per inch of width of the roller, based on the maximum ground contact width.

3. Use a tire inflation pressure no less than 60 psi.

E. Trench Rollers.

1. For trench operations, use trench rollers with a compacting roller of a width no less than 15 inches. Equip the rollers with a leveling mechanism to maintain the compacting surface of the roller in the desired plane while compacting surfaces below the edge of the old pavement. If used only to compact the bottom of a trench for widening, the leveling mechanism will not be required, provided the roller is built to fit the slope of the trench bottom.

2. The Engineer may require the roller loaded to produce the compactive effort best adapted to the work, to a maximum of 250 pounds per inch of width of the tire.

3. Operate pneumatic tired rollers at an inflation pressure no less than 60 psi.

F. Self Propelled Vibratory Rollers.

1. Use self propelled vibratory rollers suitable for the use intended. The manufacturer's handbook shall be available to the operator.

2. Control the speed of the roller so there is a minimum of 10 impacts per linear foot.

3. The Engineer will consider other types of rollers for approval.

2001.06 MATERIAL BINS.

A. For the purpose of this article, the word "bin" is defined as any structure in which materials are stored. The requirements apply to any bin that an inspector, while performing sampling or inspection duties, might work upon or beneath.

B. Ensure each part of each bin, including foundations and connections, has adequate strength to withstand any stress to which it might be subjected while in use.

C. The Engineer may inspect each portable bin each time it is erected. The Engineer may reject the use of any bin that does not perform as intended, or otherwise exhibits any unsafe condition.

2001.07 WEIGHING EQUIPMENT AND PROCEDURES.

This article describes equipment capability and procedures to be used when payment for an item is based on weight.

A. Weighing Equipment.

1. Use weighing equipment meeting the requirements of the Iowa Department of Agriculture for measuring pay items. Ensure truck weighing equipment is of sufficient length to weigh, at one time, the maximum truck and trailer combination, or situate separate equipment so that both truck and trailer can be weighed at the same time. Make available upon request, at least ten standard 50 pound test weights and suitable cradles and platforms for the purpose of testing weighing equipment.

2. Ensure weighing equipment is:

- Accurate to 2 pounds per 1000 pounds of weight, and
- Sensitive to a weight equal to 0.1% of the quantity being weighed but not more than 20 pounds and no less than a weight equal to one of the minimum graduations on a beam or dial scale.

3. When electronic devices such as load cells, computers, and printers are a part of the weighing equipment, ensure they are sealed or otherwise protected to prevent any unauthorized adjustment. Weighing systems which have been tampered with may be rejected from further use until the system has been checked and/or recalibrated. Furnish a copy of the manufacturer's detailed step by step instructions for adjusting and/or checking for accuracy, sensitivity, and tolerance of the equipment.

4. Tare all trucks to be weighed before loading. Tare these trucks daily thereafter, preferably on a random time basis. Use the previous day's tare until a new tare is determined.

5. Provide a scale ticket to the Engineer with each load. Also, provide a scale ticket when tares are determined for verification and check weighing. "Verification weighing" is a second weighing of the same load on the same equipment. "Check weighing" is a second weighing of the same load on different weighing equipment. Perform check weighing on a certified truck scale. Ensure scale tickets, as a minimum, identify project number, date, truck number, type of material, and total net weight.

6. Except for automatic weighing, use a weighmaster, as defined in Iowa Code 214, to weigh all loads or load increments. Ensure the weighmaster, or operator for automatic weighing, signs the first scale ticket of each day and initials all subsequent tickets, or prints them using automatic equipment.

7. Check weighing and verification weighing may be made at any time as directed by the Engineer. The Engineer may check the operation of the equipment at any time. The verification weight shall not be different from the initial weight by more than 0.1%. When check weighing on a platform scale, the check weight shall not be different from the initial weight by more than 0.3%.

8. When the material is not weighed in the truck, (for example, weighing in a weigh hopper or determining weight from initial and final weighing of a weigh silo) perform check weighing on a certified truck scale. The net check weight shall not be different from the initial net weight (mass) by more than 100 pounds. A suitable fuel adjustment may be made.

9. If the weight is not within the tolerances stated above, the Engineer may adjust the weight of loads previously weighed on the weighing equipment that day, and the previous day, by the difference greater than the specified tolerance. Perform verification and check weighings at no additional cost to the Contracting Authority.

B. Special Procedures for Asphalt Mixtures, Aggregates, and Binders.

1. Use automatic or semi automatic weighing on projects with contract quantities of asphalt mixtures totaling 10,000 tons or more, or aggregates totaling 10,000 tons or more from a single source.

a. Automatic Weighing.
Use weighing equipment that is self balancing and includes an automatic weight recorder. Have all tickets printed automatically with net weight and all weights needed to determine total net weight.

b. Semi Automatic Weighing.

1) The weighing equipment may be self balancing or manually balanced. Use equipment that includes an automatic weight recorder that:

- Will not print until the equipment is balanced, and
- Prints the gross weight or the batch weights and number of batches.

2) For weigh hoppers, ensure the printout includes the empty weight after each discharge.

2. For measurement of asphalt binders by tank stick or in-line flow meter, meet the requirements of Materials I.M. 509 for calibration and measurement.

3. For asphalt mixtures, provide daily totals to the Engineer for all mixture quantities produced and used in the project. Provide daily totals to the Engineer for all mixture quantities produced and not incorporated into the project. Ensure this total identifies the quantity of asphalt binder used, but not incorporated.

2001.08 EQUIPMENT FOR PREWETTING AGGREGATES AND AGGREGATE MIXTURES.

Use equipment complying with one of the following:

A. Standard Mixer.

Use equipment that provides accurate control of the proportions of water and aggregate, as well as positive, thorough mixing of the materials. Dow boxes will be approved as a Standard Mixer.

B. Pugmill Mixer.

1. When this equipment is specified, ensure it:

- Provides accurate control of the proportions of water and aggregate, and
- Is designed so that the material can be retained in the mixing chamber under vigorous mixing action for at least 15 seconds.

2. If using continuous flow type mixers, use ones that:

- Have twin mixing shafts, and
- Are equipped with a hopper or bin at the discharge end of the mixer designed to minimize segregation of the mixed materials.

2001.09 WATER DISTRIBUTORS.

A. To apply water to the roadway, use a distributor mounted on a truck or trailer equipped with pneumatic tires.

B. Use a distributor equipped with an adequate pressure pump and spray bars to distribute water evenly over the intended area.

C. Use distributors that have a:

- Spray bar with correct size and pattern of nozzles,
- Means to maintain uniform nozzle pressure,
- Means to control application rates between 0.05 to 0.50 gallon per square yard, and
- Positive sprayer shutoff mechanism.

D. For trench operations, use distributors that have an offset spray bar with replaceable nozzles so the width to which water is applied can be adjusted to the work.

2001.10 WATER SUPPLY EQUIPMENT.

A. Use water supply equipment, including pipe lines and water trucks, of a capacity and nature to ensure an ample supply and sufficient pressure for all the requirements of the work.

B. When pumping is necessary, backup pumping equipment may be required.

2001.11 EQUIPMENT FOR HEATING BITUMINOUS MATERIALS.

A. Use equipment for heating bituminous material that:

- Has adequate capacity to heat the material to the temperatures specified,
- Is equipped with an accurate thermometer which will indicate the temperature of the bituminous material in the unit in which heat is being applied,
- Will not damage the bituminous material by local overheating or by contamination with the material used for the transfer of heat, and
- Will ensure continuous circulation between the storage tank and the mixer during the operating period.

B. Heat the material under control by:
- Using circulating steam or a liquid through coils in the car or tank,
- Electric heat,
- Circulating the bituminous material through a separate heating unit, or
- Other means so that no flame is applied to metal with which the bituminous material comes in contact.

C. Jacket or insulate all pipe lines to prevent heat loss.

2001.12 EQUIPMENT FOR DISTRIBUTING BITUMEN.

A. Mount distributors on motor trucks or trailers. Ensure distributors comply with the restrictions imposed in the specifications for the various types of construction. Use only those distributors which are in good repair and are designed to do the work. Use distributors and trucks that are approved by the Engineer.

B. Equip distributors with adequately sized burners and flues for heating the bituminous material. Ensure they have a means for circulating the material in the tank when the burners are in operation. Equip distributors with adequate and safe catwalks or ladders for use in making stick measurements.

C. Equip each unit with the following:

1. An accurate thermometer for indicating the temperature of the bitumen in the tank.

2. A tachometer operated by a wheel independent of the truck wheels.

3. A calibrated or verified measuring stick.

4. A quick opening gate in the dome of the distributor tank.

5. Quick cutoff valves at the nozzles or other means for reversing the direction of flow through the nozzles.

D. Use separate power supplies for the pressure pump and the distributor drive train. Pressure equipment which depends on the drive train power for the distributor may be approved provided special devices are installed to ensure that variation from the designated rates of application will not exceed 0.02 gallon per square yard. Use a pressure system with sufficient capacity to produce a uniform, fine, even spray from all the nozzles for the maximum width of the spray bar used. Ensure it is capable of distributing bitumen at rates varying from 0.03 to 0.50 gallon per square yard. Use nozzles of a size such that bitumen may be spread in a uniform coating without the forward speed exceeding 20 mph.

E. Use spray bars that are adjustable for the widths of application required by the work. Equip them with a means of shifting at least 6 inches laterally from the center position during bitumen application. Use spray bars that are also adjustable vertically to ensure uniform transverse application of the bitumen. Equip distributors used for applying bituminous seal coat binder bitumen with a positive means for maintaining a constant nozzle height (within ± 1/2 inch) during discharge of the load. If dollies are used for maintaining the constant nozzle height, use a spray bar mounting that adjusts vertically.

F. With each distributor, provide the manufacturer's instructions for use, including specific recommendations for the following:

1. Spray bar height above road surface.

2. Nozzle size and angle of spray fan with spray bar axis.

3. Tables showing rates of distribution in gallons per square yard for tachometer readings, spray bar pressure, or pump revolutions, and for various widths of spray bars.

G. Calibrate or verify the tanks of all distributors that have not been previously checked:
- Before being initially used, and
- After any damage or alteration which may affect the calibration.
- Provide a manufacturer produced tank stick.

2001.13 SPREADERS.

This article applies to equipment used for distribution of certain materials, other than liquids, where it is required that the material be distributed on a roadbed at a specified uniform rate.

A. Non-Self-Propelled Cover Aggregate Spreaders.
Comply with the following:

1. Equipped with a mechanical feed of a length at least equal to the width to which aggregate is spread with a single pass of the spreader.

2. Capable of depositing aggregate from the transporting vehicle directly upon freshly applied bitumen in a smooth, uniform layer, at the rate required and in a manner that equipment will not come in contact with the bitumen until the bitumen is covered with a layer of aggregate.

3. Equipped so that they may be filled and moved without discharging aggregate.

B. Self-Propelled Cover Aggregate Spreaders.
Comply with the requirements of Article 2001.13, A, and the following:

1. Are mounted on pneumatic tires.

2. Have a width of spread no less than 13 feet.

3. Provide cutoff plates to permit the width of spread to be reduced in increments of 1 foot from the maximum to 4 feet.

4. Are capable of spreading aggregate of 1 inch maximum size at any rate desired from 3 to 50 pounds per square yard of surface covered.

5. Provide a hopper with the following qualifications (conveyers are suitable for conveying the aggregate from the hopper to the spreading element):
   a. Has a capacity of no less than 5 tons.
   b. Is integral with the spreader unit.
   c. Can receive aggregate from transporting vehicles without the wheels of such vehicles coming in contact with uncovered bitumen on the road surface.
   d. Augers or agitators distribute aggregate uniformly to the spreading element without segregating aggregate particles.

6. Have adequate power to propel the spreader at uniform speed on gradients up to 6%.

C. Sand Spreader.
For spreading sand cover for tack and seal coat, use a spreader that has one (or more) horizontal rotating disk fed by a conveyor and driven by power takeoff or by a separate unit.

D. Materials Spreader for Base Widening Work.

1. Place the material used in base widening by machine without dumping on the pavement.

2. Use a machine that will spread the base materials in a uniform layer of the desired thickness and width in a uniformly loose condition.

3. Locate the wheels of the spreader so they do not operate on the 1 foot width of pavement adjacent to the edge of the base widening.

2001.14 BROOMS.

Use a rotary type broom driven by an auxiliary motor or by a power takeoff from the power plant of the unit propelling the broom.

2001.15 MOTOR GRADERS.

Equip motor graders used in trimming edges of subbases or bases with an offset blade with supplementary cutting edge designed so the wheels of the motor grader will be operated entirely on the surface of the base or subbase.

2001.16 SCARIFYING EQUIPMENT.

Use scarifying equipment designed and operated to loosen the material to the depth specified.

2001.17 PULVERIZING EQUIPMENT.

Use pulverizing equipment designed and operated to pulverize the material to the degree specified.

2001.18 TRENCH EXCAVATING MACHINES.

A. Use a machine designed for the required purpose.

B. Use equipment capable of excavating the material to the full, normal design depth and suitable width.

2001.19 ASPHALT MIXTURE PAVING MACHINE.

A. Spread all asphalt mixtures to be placed 8 feet wide or more in width using a self- propelled finishing machine which will receive the hot mixture and spread the mixture in a layer of uniform density to the desired thickness.

B. Use a finishing machine consisting of a tractor unit and a screed unit.

1. Use a tractor unit with dual controls to permit operation of the finishing machine from either side. The tractor unit will provide the motive power and may be mounted on crawler treads or pneumatic tires. If mounted on pneumatic tires, maintain sufficient inflation pressure to keep vertical movement to a minimum. Ensure the length of crawler treads or distance between axles, if mounted on pneumatic tires, is sufficient to allow the tractor unit to pass over small irregularities in the base without abrupt vertical movement.

2. Attach the screed unit to the tractor unit so that it is free floating on the mixtures being placed. Equip the screed with vibrators or tampers for giving the initial consolidation to the material. Operate this equipment at the frequency the manufacturer recommends. Ensure the screed unit operation produces a smooth surface, free from surface tears or voids, and within the permissible variation specified for the type of work involved.

3. Use a screed unit that is adjustable to the crown of the finished surface. Ensure it is equipped with an approved device which will indicate the slope of crown. Provide a minimum 2 foot long straightedge for checking the installation of screed extensions.

4. A screed extension may be used, provided it has a screed plate with vibration. Other extensions will be allowed only for use in placing fillets or short or irregular tapers.

a. Flush-mounted Screed Extension.
If the extension exceeds 1 foot, extend the auger as well.

b. Offset-mounted Screed Extension.
Operate screed unit to produce a uniform distribution of mixture ahead of the extension.

c. Other extensions will be allowed for placing fillets or short or irregular tapers.

C. Do not use finishing machines which operate with rollers on the freshly placed mixture.

D. Unless otherwise specified, use a finishing machine that has automatic screed controls, except for the following uses:

1. Wedge courses.

2. Curb fill resurfacing.

3. Urban type sections containing fixtures or other permanent grade control features.

4. Surface layers 1 inch or less in thickness.

5. Special leveling course (scratch course) in which the screed rests entirely on the high spots of the underlying base during the paving procedure.

6. Single course resurfacing on Secondary projects.

E. Ensure automatic controls:

1. Have grade and slope control systems which operate with an approved grade reference system.

2. Work in conjunction with a ski type device, traveling stringline, or other approved, self contained grade referencing system.

F. Use a self contained grade referencing system no less than 30 feet long. Verify both the grade and slope controls are adequately sensitive and in proper working order at all times. During malfunctions the Engineer may permit the completion of the day's work using manual controls.

G. A special commercial joint matching shoe may be used when constructing longitudinal joints on surface courses:
- When placing a single lift only, with a thickness of 1 1/2 inches or less, or
- For placement in conjunction with heater scarification work.

H. For placing the final lift of paved shoulders, use finishing machines or pavement widening machines that have an automatic grade and slope control system approved by the Engineer. The joint matching shoe may be used when placing any paved shoulder.

I. Obtain the Engineer's approval for machines used for spreading mixtures on areas less than 8 feet wide. Do not use machines which are less than standard size for highway work without the Engineer's permission.

J. Obtain the Engineer's approval for use of material transfer vehicles. The Engineer will base approval on bridge and pavement structural evaluation of resultant axle and wheel loads.

K. When using a windrow pick-up process, control the process to produce a windrow that is uniform and does not extend more than two truck dumps ahead of the paver. Pick up all hot mix material from the windrow and deposit it in the paver. Balance windrow placement to maintain a uniform quantity of material in the paver hopper.

2001.20 EQUIPMENT FOR WEIGHING AND PROPORTIONING PORTLAND CEMENT CONCRETE MATERIALS.

A. General.

1. Use weighing and proportioning equipment that meets the requirements of this article. Allow the Engineer every opportunity to witness calibration of the equipment during the Engineer's normal working hours, or at a mutually agreeable time. This schedule limitation will be modified, if necessary, for work to be done according to an accelerated work schedule. The Engineer may consider a report concerning equipment and its calibration certified by a Professional Engineer licensed in the State of Iowa in lieu of this calibration. The Engineer may, at any time, perform such tests or checks as necessary to verify a report or to assure continued compliance.

2. Coarse aggregate sampling facilities which permit collecting representative portions of a ribbon or stream will be required at the proportioning plant site. The Engineer will designate a sampling point:
- Prior to individual material identity loss in the proportioning mixing process, and
- After delivery to the plant or after delivery to a site stockpile, whichever is nearest the mixer.

3. Furnish personnel, test weights, and equipment for calibration of the plant and for verifying accuracy of proportions. Arrange for weighing water to calibrate the water meter.

B. Proportioning Equipment.

1. Use proportioning equipment complying with the following requirements:
a. Accurate to 0.5% of the batch weight.
b. Sufficiently sensitive so that 0.1% of the batch weight or 2 pounds, whichever is greater, will be detectable.
c. Weighs each individual material within ± 1.0% of the batch weight and returns to zero within ± 0.5% of the batch weight.
d. Is protected from air currents, vibration, and so forth which may affect the accuracy of weighing. Keep all fulcrums, clevises, and similar working parts clean and in proper working condition.
e. Has available upon request, at the plant site, standard test weights for calibrating weight equipment according to Table 2001.20-1. Have suitable devices available for conveniently applying test loads.

Table 2001.20-1: Standard Test Weights

Nominal Scale Capacity lb	Minimum Test Weights Required Total lb
0 to 500	2 @ 50 lbs. ea.
Over 500 to 5000	500
Over 5000 to 10,000	1000
Over 10,000	2000

- **f.** Weighs cement in an independent hopper.
  - **1)** Use a weigh hopper that has:
    - **a)** A dust tight seal between the charging mechanism and the batching hopper which will not affect the accuracy of weighing.
    - **b)** A discharge hose or device which will prevent the loss of cement during discharge.
  - **2)** Do not allow any part of the discharge device which comes in contact with the receiving equipment to be supported by the weigh hopper. Ensure cement hoppers are equipped with a vibrator and with a vent which will adequately release air pressure which may affect weighing.
- **g.** Will weigh fly ash and GGBFS according to the requirements of weighing cement. Fly ash and GGBFS may be weighed in the same hopper as the cement, provided the cement is introduced into and weighed in the hopper first.
- **h.** Sets and operates automatic weighing equipment, if used, with the following interlocks:
  - **1)** The charging mechanism cannot be opened until the equipment has returned to zero balance within ± 0.5% of the batch weight.
  - **2)** The charging mechanism cannot be opened if the discharge mechanism is open.
  - **3)** The discharge mechanism cannot be opened if the amount in the hopper is over or under by more than 1.0% of the batch weight.

2. When automatic weighing equipment is required:
- **a.** Manual controls may be used for emergencies. Manual controls will not be permitted longer than 1 working day after automatic batching equipment failure.
- **b.** Weigh fly ash according to the requirements for cement.

C. Water Measuring Equipment.

1. Measure water using equipment that will clearly indicate the volume or weight being measured with an accuracy of 2 pounds or ± 1.0%, whichever is greater. Arrange the equipment so the accuracy of the measurement will not be affected by variations in pressure of the water supply line. Unless water is measured by weight, provide containers in which the entire quantity of water required for one batch of concrete may be weighed for calibration purposes.

2. Equipment that measures moisture in the fine aggregate and adjusts the batch amounts of fine aggregate and batch water on a continuous basis will be allowed provided satisfactory calibration and correlation procedures are met.

D. Equipment for Admixtures.

1. Use equipment for dispensing liquid admixtures that is accurate within ± 3.0% of the quantity required. The visual inspecting chamber requirement may be waived in lieu of admixture dispensing systems using positive electronic flow metering and computer controlled delivery that prevents improper admixture incorporation into the mix. Ensure dispensing equipment has a means for routine diversion of a measured quantity into a suitable vessel for calibration and for periodic verification of the batch quantity.

2. When liquid admixtures are proportioned and introduced into the mix, use equipment and procedures that meet the following requirements:
- **a.** Measures and automatically introduces separately each individual admixture into the mixer with the mixing water.
- **b.** Uses a dispenser equipped with a measuring chamber which provides a means of determining the batch quantity by visual inspection.

E. Equipment for Volumetric Proportioning.

1. Use volumetric proportioning equipment meeting the applicable requirements of ASTM C 685, Sections 5, 6, 7, and 8 and the applicable requirements of Article 2413.03, A, 3.

2. Calibrate each time, when in the Engineer’s opinion, material or condition changes may affect the calibration.

3. It is not intended that this equipment be used in place of conventional drum mixing equipment normally used for structures and paving applications.

4. This equipment may be used on miscellaneous pours, described in Materials I.M. 534, less than 50 cubic yards per day.

5. Equipment used on miscellaneous pours shall be equipped with a batch ticket printer to include the cement, coarse and fine aggregate, and water count. Equipment used in accordance with Section 2413 shall be equipped with a batch ticket printer for the cement count.

2001.21 PORTLAND CEMENT CONCRETE MIXING EQUIPMENT.

A. General.

1. Use mixing equipment that meets the requirements of this article for the type specified.

2. Allow the Engineer every opportunity to witness the calibration of the equipment during the Engineer's normal working hours, or at a mutually agreeable time. This schedule limitation will be modified, if necessary, for work to be done under an accelerated work schedule.

B. Construction or Stationary Mixer.

1. Use only batch type mixers.

2. Do not allow the total volume of the batch to exceed the designated size of the mixer or the rated capacity as shown on the manufacturer's rating plate.

3. After all solid materials are assembled in the drum, mix for a minimum of 60 seconds and a maximum of 5 minutes. The Engineer may increase the mixing if the mixer efficiency tests show that the concrete is not satisfactory for uniformity or strength. Use an accurate timing device that:
   - **a.** Indicates minimum mixing time.
   - **b.** Starts automatically when the mixer is fully charged.
   - **c.** When applicable, locks the discharge chute until the expiration of the required time.

4. Operate mixers at the manufacturer’s recommended mixing speed. Charge the batch into the mixer so that:
   - Some water will enter in advance of cement and aggregates, and
   - All water is in the mixing chamber by the end of the first 25% of the specified mixing time.

5. Operate mixing drums of tilting drum mixers at an angle no steeper than the mixer manufacturer’s recommendation. Do not use a mixer if the drum is not clean or if the mixing blades are damaged or badly worn.

6. When a construction or stationary mixer is used for mixing pavement concrete, have the quantities of fine aggregate, coarse aggregate, cement, mineral admixture, liquid admixture and water for each batch automatically documented on individual batch tickets or on a daily summary. Have the time of discharge for each batch recorded automatically as well. These proportioning documents will become property of the Contracting Authority.

C. Truck Mixer and Agitator.

1. The equipment shall have a metal plate or plates attached with the following information:
   - Gross volume of the drum
   - Mixed concrete capacity
   - Maximum and minimum mixing speed

   The plate may be issued by the Truck Mixer Manufacturers Bureau, if not, have an independent laboratory meeting the requirements of ASTM C 1077 perform the proof tests described in Annex A1 of ASTM C 94. The test report of the proof test results may be required.

2. Do not exceed mixer or agitator capacity. Keep mixing and agitator speeds within the designated limits. Equip truck mixers with reliable reset revolution counters. If truck mixers are used for mixing while in transit, the revolution counter is to register the number of revolutions at mixing speed.

3. Have an authorized representative of the concrete producer certify that:
   - **a.** The interior of the mixer drum is clean and free of hardened concrete,
   - **b.** The fins or paddles are not broken or worn excessively,
   - **c.** The other parts are in proper working order,
   - **d.** The unit has been checked by the representative within the previous 30 calendar day period to substantiate this certification.

4. Keep the current, signed certification with the unit at all times.

5. For bridge floor concrete, ensure mixing is between 70 and 90 revolutions. For other structural concrete and pavement concrete, ensure mixing is between 60 and 90 revolutions with satisfactory preblending of the materials, or between 70 and 90 revolutions without preblending. Use the manufacturer’s designated mixing rate. Keep the mixing rate duration between the limits stated above to produce uniform, thoroughly mixed concrete.

6. The Engineer may inspect mixer units at any time to assure compliance with certification requirements. Removal of inspection ports may be required. Should the Engineer question the quality of mixing, the Engineer may check the slump variation within the batch. Should the slump variation between two samples taken, one after approximately 20% discharge and one after approximately 90% discharge of the batch, show a variation greater than 3/4 inch or 25% of the average of the two, whichever is greater, the Engineer may require:
   - The mixing to be increased,
   - The batch size reduced, or
   - The unit removed from the work.

D. Continuous Mixer.
A continuous mixer used in conjunction with volumetric proportioning may be approved as provided in Article 2001.20, E.

2001.22 PLANT EQUIPMENT FOR HOT MIX ASPHALT MIXTURES.

Ensure plant equipment will proportion each aggregate, dry and heat the aggregate (except mineral filler), proportion the aggregate and hot asphalt, and mix all materials. The plant may be of a batch type, continuous type, or drum mixing type. Ensure the plant is equipped to produce uniform mixtures of required composition, heated to the desired temperature.

A. Aggregate Feeders for Dryer Drum or Drum Mixer.

1. Ensure the following:

- **a.** The feeder uses mechanical means to accurately feed each aggregate (except for mineral filler added without heating) to a central elevator or conveyor in the proportion prescribed by the approved design mix.
- **b.** The feeders are belt type feeders equipped with adjustable gates or adjustable drive systems that can be calibrated and controlled.
- **c.** The feeder throats are of sufficient size to ensure positive and continuous flow.
- **d.** All feeders mechanically or electronically interlocked during operation.
- **e.** On some types of feeders, revolution counters capable of registering to a tenth of a revolution may be necessary (and may be required) for accurate calibration and control.

2. When drum mixing plants are used, ensure:

- **a.** The central conveyor is equipped with a continuous weighing system with a recorder that can be monitored by the plant operator.
- **b.** The aggregate weighing system interlocks with the asphalt control unit.

3. If a drum mixing plant is adding RAP, ensure the following:

- **a.** A system of weigh belts is used to control delivery of virgin aggregates and recycled material to the dryer.
- **b.** The belt system is equipped with interlocking control mechanisms in a manner that will assure positive and accurate delivery of recycled and virgin materials in proper proportions at all times.
- **c.** The belt system includes recorders that will record the total amount of material being delivered by each belt system separately.
- **d.** The belt weighing controls are connected to a totalizer which is interlocked with the asphalt delivery system in a manner which will ensure that asphalt delivered to the mix is at all times within ± 0.3% of the intended amount. Obtain the Engineer’s approval for the system.
- **e.** The Engineer is provided a schematic diagram of the control system prior to plant calibration.
- **f.** Calibrated bins are dedicated to deliver each recycled asphalt material to the drum unless materials are pre-blended under the direction of the Engineer.

B. Dryer Drum and Drum Mixer.
Ensure the following:

1. The plant is equipped with means for drying and heating the aggregate and/or mixture.

2. Heating is controlled to avoid damage to the aggregate and asphalt.

3. Operation of the equipment is controlled so the specified temperature is maintained.

C. Screens.
Ensure the plant is equipped with adequate means to remove objectionable oversize and foreign material from the aggregate before entering into the hot aggregate bin dryer drum, or drum mixer.

D. Aggregate Bins.
Ensure the following:

1. The plant has aggregate bins of sufficient capacity to ensure uniform and continuous operation.

2. The heated aggregate storage is provided with sufficient ventilation by means of a stack or connection to the dust collection system so that moisture from the hot aggregate will be removed before condensing in the aggregate storage.

3. When mineral filler is added without heating, adequate additional dry storage is provided for the mineral filler, and provisions are made for proportioning the filler uniformly in the desired proportion for the mixture.

4. The plant has a dedicated bin for each virgin aggregate product used in the job mix formula.

E. Equipment for Heating and Storing Asphalt Binder.
Apply Article 2001.11 for heating asphalt binder. Comply with the following:

1. Provide duplicate storage facilities of sufficient capacity to permit complete unloading of a tank car or truck transport in a single operation, unless the asphalt binder is supplied to the project from transports measured by weight.

2. Fill and withdraw storage material from each tank as a separate, definite operation which will permit the Engineer to measure the quantity of asphalt binder used from each storage tank.

3. Install and maintain each storage tank in a level position.

4. Furnish measurement devices and gauging tables so accurate determinations of quantities used and stored can be made at regular intervals.

5. Provide suitable means for maintaining the specified temperature of the asphalt binder in the pipe lines, meters, weighing buckets, spray bars, and other containers and flow lines.

6. Include a spigot for removing asphalt samples from the delivery line to the mixer before the asphalt binder is metered into the mixer or weighed.

F. Asphalt Binder Control Unit.
Provide satisfactory means, by weighing, metering, or volumetric measurements, to add the proper amount of asphalt binder to the aggregate. Operate all measuring devices within a delivery tolerance of 1.5% by weight of binder.

1. **Batch Plants.**
   a. Measure the quantity of asphalt binder for each batch on equipment meeting the appropriate requirements of Article 2001.07, A, or by an approved automatic batch metering system.
   b. When used for proportioning only, meet the appropriate equipment requirements of Article 2001.20.
   c. Use a sufficiently flexible means of heating that will not affect the weighing.
   d. Arrange the container so that it will deliver the asphalt binder in a thin, uniform sheet or in multiple streams the full width of the mixer, except in the case of a mixer into which the asphalt binder is sprayed. If the binder is deposited on a flow or spreader sheet, use a heated sheet with sufficient slope to discharge promptly into the mixer.

2. **Continuous Plants.**
   a. Comply with the following:
      1) To supply asphalt binder to the mixer, use a pump constructed to be under a positive pressure sufficient to maintain uniform delivery from the pump. The pressure is to be maintained within ± 0.5 psi of the recommended operating pressure.
      2) Install accurate pressure gauges in readily accessible locations in lines feeding the metering pump and the mixer spray bars. Install gauges of such size that the normal operating pressure can be easily read to the nearest 1.0 psi.
   b. For the mixer unit, comply with the following:
      1) Equip with a surge tank or a deaeration chamber for supplying a constant pressure flow of asphalt binder to the metering pump.
      2) The surge tank or the deaeration chamber is to be of dimensions and capacity to provide the pressure specified. The capacity is to be at least a 6 minute supply of asphalt binder at the normal mixing rate of the mixer unit.
      3) The surge tank or the deaeration chamber is to be fitted with baffles and other appurtenances necessary to prevent the incorporation of air bubbles into the asphalt binder as the tank is being filled.
      4) When the surge tank system is used, the pressure at the spray bar is to be no greater than 20 psi.

5) When a deaeration chamber system is used, the pressure difference between the return line and the spray bar is to be no greater than 20 psi.
6) Separate return lines are to be provided for each tank.
7) Obtain the Engineer's approval for the surge tank or the deaeration chamber.

3. Drum Mixing Plants.
Ensure the following:
- **a.** The plant uses a pump to supply asphalt binder to the mixer, which is constructed to be under positive pressure sufficient to maintain uniform delivery from the pump.
- **b.** A totalizing flow meter is placed in the line between the metering pump and mixer unit.
- **c.** The asphalt control unit is interlocked with the aggregate weighing system specified in Article 2001.22, A, and is equipped to automatically adjust for variation in aggregate delivery.
- **d.** The plant is operated with automatic controls, except when approved by the Engineer.
- **e.** The asphalt control unit is equipped so the plant operator can monitor and adjust the flow rate of aggregate or asphalt binder.

G. Thermometer Equipment.
Install an accurate, registering pyrometer or other approved thermometric instrument in the discharge chute of the dryer drum or drum mixer in a manner so the temperature of the heated aggregate or mixture is continuously measured. Locate this instrument where it is in clear view of the plant or dryer operator and readily accessible to the Engineer.

H. Control of Mixer Capacity and Mixing Time.
Equip the plant with positive means to govern and maintain mixing time.

I. Dust Collector.

1. Install and properly maintain proper housings, mixer covers, and dust collecting systems and returns.

2. Obtain the Engineer's approval for the method of returning dust collected by dry type collection systems to the hot aggregate mixture. If not required in the mixture, remove the bag house fines from the project and plant site.

3. When wet type collection systems are used, remove all wet material from the project and plant site.

J. Hot Aggregate Proportioning.
Apply the requirements of this article only to batch plants.

1. Accurately weigh the mineral filler and dried aggregate from each bin in a weighing hopper that is of ample size to hold a full batch without hand raking or running over.

2. Support the weighing hopper so it will not be easily thrown out of alignment or adjustment.

3. Construct gates on bins and hoppers to prevent leakage when closed.

4. Separately proportion mineral filler which is added cold from a hopper and feed uniformly into the heated aggregate before delivery to the pugmill.

5. Weigh the quantity of aggregate for each batch on equipment meeting the appropriate requirements of Article 2001.07, A. When this equipment is used for proportioning only, meet the appropriate requirements of Article 2001.20.

K. Mixer.

1. Batch Mixer.
- **a.** Use twin shaft pugmills capable of producing a uniform mixture within the job mix or other specified limits.
- **b.** Do not exceed 3/4 inch clearance of the blades from all fixed and moving parts. Orient the blades according to the manufacturer's recommendation.
- **c.** If the pugmill is not enclosed, equip it with a dust hood to prevent loss of dust by dispersion.
- **d.** Construct the mixer to prevent leakage of contents until the batch is to be discharged.
- **e.** Use an accurate time lock to control the operation of a complete mixing cycle by:
  1) Locking the weighing hopper gate when the mixer is charged and until the mixer gate is closed at the completion of the cycle.
  2) Locking the outlet of the asphalt binder delivery system throughout the dry mixing period.
  3) Locking the mixer gate throughout the dry and wet mixing periods.

- **f.** The dry mixing period is the interval of time between the opening of the weighing hopper gate and the application of asphalt binder. The wet mixing period is the interval of time between the application of asphalt binder and the opening of the mixer gate. Ensure control of the timing is flexible and capable of being set at intervals of no more than 5 seconds. Install a mechanical batch counter as part of the timing device and design it to register only completely mixed batches.
- **g.** When adding RAP:
  - **1)** Modify batch plant equipment to provide for accurate proportioning of the recycled material and for adding it directly into the weigh hopper, with weighing as a separate increment of the total batch.
  - **2)** The RAP may be added to the hot elevator with no preheating. In any method where preheating is being done, the equipment must be specifically designed for this purpose.
  - **3)** For RAP proportioning systems, meet the requirements of Article 2001.22, A.
  - **4)** When the heat transfer method is used, superheat the new aggregate so that, when combined with the RAP, the temperature of the resultant mixture will meet all requirements for mixing and placing the hot mixture.
  - **5)** Obtain the Engineer's approval for each plant modified for recycling mixtures.
  - **6)** For each job mix formula within a project, provide daily printouts identifying weight of RAP separately from total batch as recorded by a totalizer.

2. Continuous Mixer.

- **a.** Use an approved twin shaft pugmill capable of producing uniform mixtures within the job mix or other specified limits.
- **b.** Ensure paddles are of a type adjustable for angular position on the shafts and reversible to retard the flow of mix.
- **c.** Equip the mixer with a discharge hopper holding approximately 1 ton and discharging intermittently by means of quick acting gates.
- **d.** Regulate the distance to the receiving vehicle to minimize segregation.
- **e.** Provide satisfactory means to afford positive interlocking control between the flow of aggregate from the bins and the flow of asphalt binder from the meter or other proportioning source. Accomplish control by interlocking mechanical means or by any positive method for accurate control.
- **f.** Include an accurate revolution counter, operating continuously during production.
- **g.** Equip the plant with positive means to govern and maintain a constant time of mixing.

3. Drum Mixer.

- **a.** Comply with the following:
  - **1)** Use equipment capable of producing uniform mixtures within the job mix or other specified limits.
  - **2)** Introduce the aggregate, asphalt binder, and additives, when furnished, continuously and uniformly. This is to be controlled by the plant operator.
  - **3)** Discharge the mixture continuously and uniformly onto an elevator or conveyor that discharges into a hot mixture storage unit meeting requirements of Article 2001.22, L.
  - **4)** Continue the mixing until the asphalt binder is uniformly distributed and the aggregate particles are uniformly coated.
- **b.** The plant may be modified with a pugmill coater. The coater shall be inclined and positioned as an integral built-in unit, located between the drum and the hot elevator of the plant setup. Introduce the asphalt binder, and additives when furnished, continuously and uniformly at the lower end of the coater. This shall be controlled by the plant operator. Obtain the Engineer's approval for each plant modified.
- **c.** When adding RAP, modify drum mixing equipment to process RAP according to Article 2001.22, A.

L. Hot Mixture Storage.

1. Provide suitable hot mixture storage when the hot mixture is not hauled immediately to the project and placed.

2. Use hot mixture storage bins that are either 1) surge bins to balance production capacity with hauling and placing capacity; or 2) storage bins which are heated and/or insulated and have a controlled atmosphere around the mixture. Use hot mixture storage bins that:

- **a.** Are round or octagonal in shape and designed for the intended use.
- **b.** Fill using an enclosed system, unless skip conveyors are used.
- **c.** Dump material directly into trucks through quick opening and quick closing gates.
- **d.** Do not result in significant segregation, damage, or cooling.

3. To each bin, affix an indicating or control device which:

- Is visible to the loading operator, and
- Allows control of material remaining in the bin.

4. Limit the holding time to 4 hours in storage bins.

5. Use hot mixture placed in storage bins within 24 hours of production, unless the Engineer approves otherwise.

M. Safety Requirements.

1. Place adequate and safe stairways, platforms, and guarded ladders to plant units at points required for accessibility to sampling locations and other plant operations.

2. Guard and protect all gears, pulleys, chains, sprockets, and other moving parts.

3. Maintain ample and unobstructed passage for personnel at all times in and around the truck loading area. Protect this area from falling material.

4. Ensure bins comply with the requirements of Article 2001.06.

N. Plant Calibrations.

1. Provide personnel, weighing devices, test weights, and equipment for calibration of the plant and verifying accuracy of proportions.

2. Provide sufficient space between aggregate feeds and elevators to permit taking of samples of the discharge for accurate calibration and control of rate of feed.

3. Weigh samples of sufficient size for calibration and checking of proportions.

4. Ensure truck sampling and weighing is acceptable.

5. Allow the Engineer every opportunity to witness calibration of the equipment during the Engineer's normal working hours, or at a mutually agreeable time. This schedule limitation will be modified, if necessary, for work to be done under an accelerated work schedule.
6. Ensure the Engineer's representative indicates witnessing the calibration by signing the calibration documents and charts.

SPEC 2303
HMA MIXTURES

Section 2303. Flexible Pavement

2303.01 DESCRIPTION.

A. Design, produce, place, and compact flexible paving mixtures using proper quality control. Construct to the dimensions specified in the contract documents.

B. A surface course is the top lift. An intermediate course is the next lower lift or lifts. Use intermediate course mixtures for leveling, strengthening, and wedge courses. A base course is the lift or lifts placed on a prepared subgrade or subbase.

2303.02 MATERIALS.

A. Asphalt Binder.
Use the specified Performance Graded (PG) asphalt binder meeting the requirements of Section 4137. For shoulder mixtures refer to Section 2122. For base widening mixtures refer to Section 2213. Adjustments to the contract binder grade may be required according to Article 2303.02, C, 6.

B. Aggregates.

1. Individual Aggregates.

a. Use virgin mineral aggregate as specified in Section 4127.

b. When specified, furnish friction aggregate from sources identified in Materials I.M. T203.

1) Friction Classification L-2.
Use a combined aggregate such that:

a) At least 80% of the combined aggregate retained on the No. 4 sieve is Type 4 or better friction aggregate, and

b) At least 25% of the combined aggregate retained on the No. 4 sieve is Type 2 or better friction aggregate, and

c) For Interstates and all mixtures designed for Very High Traffic (VT), the fineness modulus of the combined Type 2 aggregate is at least 1.0. Calculations for fineness modulus are shown in Materials I.M. 501.

d) On Interstates and all mixtures designed for Very High Traffic (VT), if 40% or more of the total aggregate is a limestone as defined in Materials I.M. T203, at least 30% of the combined aggregate retained on the No. 4 sieve is Type 2 or better friction aggregate and at least 25% of combined aggregate passing No. 4 sieve is Type 2 or better friction aggregate.

2) Friction Classification L-3.
Use a combined aggregate such that:

a) At least 80% of the combined aggregate retained on the No. 4 sieve is Type 4 or better friction aggregate, and

b) At least 45% of the combined aggregate retained on the No. 4 sieve is Type 3 or better friction aggregate, or if Type 2 is used in place of Type 3, at least 25% of the combined aggregate retained on the No. 4 sieve is Type 2.

3) Friction Classification L-4.
Use a combined aggregate such that at least 50% of the combined aggregate retained on the No. 4 sieve is Type 4 or better friction aggregate.

2. Combined Aggregates.

a. Use a combined aggregate meeting the requirements in Materials I.M. 510.

b. When mixtures include RAM, use a combined aggregate gradation consisting of a mixture of RAM aggregate and virgin aggregate.

C. Recycled Asphalt Materials.

1. RAM includes RAP and RAS. The designations Classified and Unclassified are exclusively for the use of RAP in HMA.

2. Identify each RAP stockpile and document Classified and Unclassified RAP stockpiles as directed in Materials I.M. 505. Do not add material to a Classified RAP stockpile without the approval of the District Materials Engineer.

3. The Engineer may reject a RAP stockpile for non-uniformity based on visual inspection. Work the stockpiles in such a manner that the materials removed are representative of a cross section of the pile.

4. Place stockpiles of RAP as directed in Materials I.M. 505. Do not use RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or environmentally restricted materials. RAP stockpiles may include PCC (not to exceed 10% of the stockpile) from patches or composite pavement that was milled as part of the asphalt pavement.

5. When RAP is taken from a project, or is furnished by the Contracting Authority, the contract documents will indicate quantity of RAP expected to be available and test information, if known. RAP not used in HMA becomes the property of the Contractor.

6. For mix design purposes, the Contracting Authority will test samples of the RAM. The aggregate gradation and amount of asphalt binder in the RAM will be based on the Contracting Authority's extraction tests. For mixtures containing RAM, adjust the contract binder grade as directed in Materials I.M. 510. No adjustments will be made to the contract unit price for required changes to the asphalt binder grade. RAP may be used in accordance with Materials I.M. 510 Appendix C. For surface mixtures, 70% of the total asphalt binder shall be virgin.
   a. **Classified RAP.**
      1) Classified RAP is one of the following
         - RAP from a documented source.
         - RAP from an undocumented source meeting quality control sampling, testing, and reporting requirements in Materials I.M. 505. Material shall be tested at a lab designated by the Engineer according to Iowa Test Method 222 at no additional cost to the Contracting Authority.
      2) Classified RAP may be used in mixtures for which the RAP aggregate meets the quality requirements for the mixture design per Materials I.M. 510 Appendix A.
      3) When from a documented source, credit will be given for frictional aggregate and crushed particles used in the original pavement to be reclaimed as determined in the paving history (or mix design when paving history is unavailable).
      4) For all other Classified RAP, credit for crushed particles shall be the percent of aggregate retained on the No. 8 sieve from Engineer's extraction test. No friction credit will be given.
   b. **Unclassified RAP.**
      1) Any stockpiled RAP not meeting the requirements of Classified RAP shall be designated as Unclassified RAP. No frictional aggregate credit or aggregate crushed particles credit will be given for Unclassified RAP.
      2) When an Unclassified RAP stockpile is characterized by sampling and testing for mix design, no material can be added to the stockpile until the project is completed.

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7. Pre-consumer or post-consumer shingles that have been processed, sized, and ready for incorporation into an asphalt mixture constitute RAS material.

8. Up to 5% RAS by weight of total aggregate may be used in the design and production of an asphalt mixture. The percentage of RAS used is considered part of the maximum allowable RAP percentage. Unless explicitly stated otherwise in this specification or Materials I.M. 505, use RAS according to the same requirements as prescribed for RAP material.

9. RAS shall be certified from an approved supplier designated in Materials I.M. 506. Material processed prior to Iowa DOT source approval will not be certified.

D. Flexible Paving Mixture.

1. The JMF is the percentage of each material, including the asphalt binder, to be used in the HMA mixture. Ensure the JMF gradation is within the control points specified for the particular mixture designated.

2. The basic asphalt binder content is the historical, nominal mixture asphalt binder content, expressed as percent by weight (mass) of the asphalt binder in the total mixture. Apply the values in Table 2303.02-1, based on mixture size and type.

3. If the asphalt binder demand for the combination of aggregates submitted for an acceptable mix design exceeds the basic asphalt binder content (see Table 2303.02-1) by more than 0.75%, include an economic evaluation with the mix design. For economic evaluation, provide an alternate mix design utilizing aggregates which results in an optimum binder content not exceeding basic asphalt binder content by more than 0.75% and documentation of costs associated with hauling both proposed aggregates and alternate aggregates to plant site. Alternate JMF shall meet requirements of Section 2303.

Table 2303.02-1: Basic Asphalt Binder Content (%)

Size	Aggregate Type	1 inch	3/4 inch	1/2 inch	3/8 inch
Intermediate and Surface	Type A	4.75	5.50	6.00	6.00
Intermediate and Surface	Type B	5.25	5.75	6.00	6.25
Base	Type B	5.25	6.00	6.00	6.25

4. Use a mixture design meeting gyratory design and mixture criteria corresponding to the design level specified in the contract documents. The Engineer may approve mixtures substitutions meeting guidelines in Materials I.M. 511. When a commercial mix is specified, use 1/2 inch Standard Traffic (ST) or higher surface mixture, with PG 58-28S or PG 64-22S binder, for JMF approval.

5. For shoulders placed as a separate operation refer to Section 2122. When paving the shoulder with the mainline the Contractor has the option to substitute the mainline intermediate or surface mixture for a specified shoulder mixture at the Contractor's expense.

6. For base widening refer to Section 2213. When an adjoining surface is designed for Standard Traffic (ST) and is paved during the same project, use a base mixture at same traffic designation used in surface mixture.

7. WMA refers to asphalt concrete mixtures produced at temperatures approximately 50°F or more below those typically used in production of HMA but no higher than that shown in Article 2303.03, C, 3, d, 2, a. Temperature reductions may be achieved through additives or water injection systems.

8. Submit a mixture design complying with Materials I.M. 510. Propose both a production and a compaction temperature between 215ºF and 280ºF for WMA mixture designs.

9. Produce and place WMA mixtures meeting the same requirements established for HMA mixtures. Equivalent WMA mixtures may be substituted for HMA mixtures unless it is prohibited by the specifications.

E. Other Materials.

1. Tack Coat.
Tack coat may be SS-1, SS-1H, CSS-1, CSS-1H, CQS-1, or CQS-1H. Do not mix CQS, CSS, and SS grades. RC-70 and MC-70 may also be used prior to May 1 and after October 1, at the Contractor's option. The cement mixing test will be waived for tack coat emulsions.

2. Anti-strip Agent.

a. Perform a moisture sensitivity evaluation of the proposed asphalt mixture design in accordance with Materials I.M. 319 for the following mixtures when placed in travelled lanes:

1) Mixtures for Interstate and Primary highways designed for Very High Traffic (VT), or

2) Mixtures for Interstate and Primary highways containing quartzite, granite, or other siliceous (not a limestone or dolomite) aggregate obtained by crushing from ledge rock in at least 40% of the total aggregate (virgin and recycled) or at least 25% of the plus No. 4.

For the purpose of evaluating moisture sensitivity of a proposed mix design, Contractor may test proposed JMF from plant produced material placed off-site at no additional cost to the Contracting Authority.

b. Sample and test plant produced mixture for moisture susceptibility in accordance with Materials I.M. 204 Appendix F and Materials I.M. 319 for bid item plan quantities of more than 1000 tons as follows:

1) For mixtures satisfying Article 2303.02, E, 2, a.

2) For conditions satisfied in Article 2303.02, E, 2, f.

c. Moisture susceptibility testing will not be required for base repair, patching, temporary pavement, or paved shoulders. Moisture susceptibility testing for mixture bid items of 1000 tons or less is only required on the mix design for mixtures satisfying Article 2303.02, E, 2, a.

d. Use the following minimum stripping inflection point (SIP) requirements for plant produced material based on traffic designation:

Table 2303.02-1: Minimum Stripping Inflection Point

Traffic Designation	SIP, Number of Passes[1, 2]
S	10,000
H, V	14,000

Note 1: If ratio between creep slope and stripping slope as defined in Materials I.M 319 is less than 2.00, the SIP is invalid.

Note 2: Minimum SIP for mixtures placed as base widening is 5000 passes.

When notified of non-compliant results, the Engineer may suspend paving operations until an approved "significant mix change" is implemented.

e. When the Contractor's mix design SIP results are below the minimum specified in Article 2303.02, E, 2, d, an anti-strip agent will be required. Plant produced material with anti-strip shall be tested to verify the minimum SIP is achieved.

f. The Engineer may require an evaluation of the test method in Materials I.M. 319 for plant produced mixture at any time.

g. The following anti-strip agents may be used:

1) Hydrated Lime.
Meet the requirements of AASHTO M 303, Type I or ASTM C 1097, Type S. Hydrated lime will not be considered part of the aggregate when determining the job mix formula.

2) Liquid Anti-strip Additives.
For each JMF, obtain approval for liquid anti-strip additives blended into the binder. Approval will be based on the following conditions:

a) The asphalt binder supplier provides test results that the additive does not negatively impact the asphalt binder properties, including short term and long term aged properties.

b) The design is to establish the additive rate that produces the maximum SIP value.

3) Polymer-based Liquid Aggregate Treatments.
For each JMF, obtain approval for polymer-based liquid aggregate treatments. Approval will be based on the design establishing the optimum additive rate that produces the maximum SIP value. See Materials I.M. 319 for additional information.

3. Sand for Tack Coats.
Use sand meeting the requirements of Gradation No. 1 of the Aggregate Gradation Table in Article 4109.02.

4. WMA Technologies.
Chemical additives, organic additives, zeolites, or water injection systems may be used at the rate established by the mixture design in the production of WMA. Once production of a bid item has begun with a WMA technology, continue its use throughout the remainder of the bid item's production unless otherwise approved by the District Materials Engineer.

2303.03 CONSTRUCTION.

A. General.

1. The Contractor is responsible for all aspects of the project.

2. Provide quality control management and testing, and maintain the quality characteristics specified.

a. Apply Article 2303.03, D to asphalt mixture bid items when the plan quantity is greater than 1000 tons.

b. Apply Article 2303.03, E, for asphalt mixture bid items that have a plan quantity of 1000 tons or less as well as patching, detours, and temporary pavement bid items. For items bid in square yards, apply Article 2303.03, E when the plan quantity by weight (estimated with a unit weight of 145 pounds per cubic foot unless otherwise stated on the plans) does not exceed 1000 tons.

B. Equipment.
Use equipment meeting the requirements of Section 2001 with the following modifications:

1. Plant Calibration.

a. Calibrate each plant scale and metering system before work on a contract begins. Use calibration equipment meeting the manufacturer's guidelines and Materials I.M. 514.

b. The Engineer may waive calibration of permanent plant scales when a satisfactory operational history is available. The Engineer may require any scale or metering system to be recalibrated if operations indicate it is necessary.

c. Make calibration data available at the plant.

d. Calibrate each aggregate feed throughout an operating range wide enough to cover the proportion of that material required in the JMF. Make a new calibration each time there is a change in size or source of any aggregate being used.

e. For continuous and drum mixing plants, calibrate the asphalt metering pump at the operating temperature and with the outlet under pressure equal to that occurring in normal operations.

2. Paver.
Apply Article 2001.19. Spreaders described in Article 2001.13, D, may be used to place paved shoulders. Spreaders used to place the final lift of paved shoulders shall meet additional requirements of Article 2001.19.

3. Rollers.

a. For initial and intermediate rolling, use self-propelled, steel tired, pneumatic tired or vibratory rollers meeting the requirements of Article 2001.05, B, C, or F. Their weight (mass) or tire pressure may be adjusted when justified by conditions.

b. For finish rolling, use self-propelled, steel tired rollers or vibratory rollers in the static mode that meet the requirements of Article 2001.05, B, or F.

4. Scales.
Apply Article 2001.07, B, to paving operations regardless of the method of measurement.

C. Construction.

1. Maintenance of the Subgrade and Subbase.

a. Maintain completed subgrade and subbase to the required density, true cross section, and smooth condition, prior to and during subsequent construction activities.

b. If rutting or any other damage occurs to the subgrade or subbase as a result of hauling operations, immediately repair the subgrade and subbase. Such repair will include, if necessary, removal and replacement, at no additional cost to the Contracting Authority.

c. Should traffic by others authorized to do work on the project be specifically permitted by the Engineer to use loads which exceed the Contractor's established limit, the Contracting Authority will pay repair costs for repairs directed by the Engineer.

2. Preparation of Existing Surfaces.

a. Cleaning.
Clean and prepare existing surface according to Article 2212.03, B, 1.

b. Tack Coats.

1) Apply tack coats when the entire surface area on which the coat is to be applied is free of moisture. Do not apply them when the temperature on the surface being covered is less than 25°F.

2) Place a tack coat to form a continuous, uniform film on the area to be covered. Tack coat may be diluted with water at a 1:1 ratio to improve application. Unless directed otherwise, spread tack coat at the following undiluted rates:

- New HMA Surface: 0.03 to 0.05 gallon per square yard
- Milled HMA/CIR Surface: 0.05 to 0.07 gallon per square yard
- PCC/Existing HMA Surface: 0.04 to 0.06 gallon per square yard

3) Tack the vertical face of exposed, longitudinal joints as a separate operation at a rate from 0.10 to 0.15 gallon per square yard. Tack before the adjoining lift is placed. Lightly paint or spray vertical surfaces of all fixtures, curbs, bridges, or cold mixture with which the hot mixture will come in contact to facilitate a tight joint with the fresh mixture.

4) Limit tack coat application lengths to minimize inconvenience to the public. Keep applications within the hot mixture placing work area that is controlled by flaggers at each end. Plan applications so they will be covered with hot mixture when the work area is opened to traffic at the end of the days' work.

5) Allow tack coat to adequately cure prior to placement of HMA. If tack coat surface becomes dirty from weather or traffic, thoroughly clean and, if necessary, retack. A light application of sand cover may also be required for excessive application rates, breakdowns, and short sections remaining at the end of a day's run.

3. Handling, Production, and Delivery.

Ensure plant operation complies with the following requirements:

a. Handling Mineral Aggregate and RAM.
Apply Materials I.M. 505 and Materials I.M. 508.

b. Handling Asphalt Binder.
Maintain asphalt binder temperature between 260°F and 330°F. Heat modified asphalt binder according to the supplier's recommendations.

c. Handling Anti-Strip Agents.

1) Hydrated Lime.

a) Added to a Drum Mixer.

(1) Add hydrated lime at the rate of 0.75% by weight of the total aggregate (virgin and RAM) for Interstate and Primary projects. Add hydrated lime to a drum mixer using one of the following methods:

(a) Add to virgin aggregate on the primary feed belt, as a lime water slurry.

(b) Add to the outer drum of a double drum system away from heated gas flow and prior to the addition of the virgin asphalt binder.

(2) Alternative methods for mixing will be allowed only with the Engineer's approval. Do not introduce hydrated lime directly into a single drum mixer by blowing or by auger.

b) Added to a Batch Plant.
Add hydrated lime at the rate of 0.5% by weight of the total aggregate (virgin and RAM) for Interstate and Primary projects. Introduce it to a batch plant using one of the methods below. In any case, introduce the lime prior to the start of the dry mix cycle.

(1) Place on the recycle belt which leads directly into the weigh hopper.

(2) Add directly into the pugmill.

(3) Add directly into the hot aggregate elevator into the hot aggregate stream.

c) Added to the Aggregate Stockpile.
Add hydrated lime at a rate established by the optimization of the SIP as determined by Materials I.M. 319. Add it to the source aggregates defined in Article 2303.02, E, 2, thoroughly mixed with sufficient moisture to achieve aggregate coating, and then place in the stockpile.

2) **Liquid.**
   a) When liquid anti-strip additives are used, employ equipment complying with the anti-strip manufacturer's recommended practice to store, measure, and blend the additive with the binder.
   b) The additive may be injected into the asphalt binder by the asphalt supplier or the Contractor. If the Contractor elects to add the liquid anti-strip agent, they assume the material certification responsibilities of the asphalt binder supplier. Ensure the shipping ticket reports the type and amount of additive and time of injection.
   c) Ensure the asphalt supplier provides the Contactor and Engineer with the shelf life criteria defining when the anti-strip additive maintains its effectiveness. Do not use binder that has exceeded the shelf life criteria.
   d) When using polymer-based aggregate treatment, comply with the manufacturer's recommended specifications and guidelines.

d. Production of Hot Mix Asphalt Mixtures.
1) Regulate the exact proportions of the various materials to be within the limits specified to produce a satisfactory asphalt coating and mixture.
2) Do not allow the temperature of the mixtures to fall outside the following parameters:
   a) Keep the production temperature of WMA mixtures between 215ºF and 280ºF until placed on the grade. Maximum production temperature for WMA is 330ºF after October 1st.
   b) Do not produce WMA mixtures more than 10ºF below the target temperature designated in the JMF without the approval of the Engineer.
   c) Keep the production temperature of HMA mixtures between 225ºF and 330ºF until placed on the grade. Do not discharge HMA into the hopper when its temperature is less than:
      (1) 245ºF for a nominal layer thickness of 1 1/2 inches or less, or
      (2) 225ºF for a nominal layer thickness of more than 1 1/2 inches.
   d) Flexible paving mixtures not meeting these requirements will be rejected.
   e) Production temperature limits apply starting at point of discharge from mixer.
3) Minimize segregation to the extent that it cannot be visibly observed in the compacted surface.
4) Apply only approved release agents to trucks and equipment, as specified in Article 2001.01.
5) Except for an unavoidable delay or breakdown, provide continuous and uniform delivery of hot HMA to any individual spreading unit.

4. Placement.

a. Clean each lift according to Article 2212.03, B, 1. If necessary, re-tack.

b. Prior to placing the final lift, correct bumps or other significant irregularities that appear or are evident in the intermediate course or other lower course.

c. Do not place HMA mixtures under the following circumstances:
1) On a wet or damp surface.
2) When road surface temperature is less than that shown in Tables 2303.03-1 and 2303.03-2, unless allowed per Article 2303.03, F.

Table 2303.03-1: Base and Intermediate Course Lifts of Asphalt Mixtures

Nominal Thickness - inches	Road Surface Temperature, ºF
Less than 2	40
2 – 3	35
Over 3	35

Table 2303.03-2: Surface Course Lifts of Asphalt Mixtures

Nominal Thickness - inches	Road Surface Temperature, ºF
1	HMA: 50 / WMA: 40
1 1/2	HMA: 45 / WMA: 40
2 and greater	40

d. The Engineer may further limit placement if, in the Engineer's judgment, other conditions are detrimental to quality work.

e. Maintain a straight paving edge alignment. Correct edge alignment irregularities immediately.

f. Base the minimum layer thickness on Table 2303.03-3. Minimum layer thickness does not apply to leveling/scratch courses.

Table 2303.03-3: Minimum Lift Thickness

Design Mix Size - inches	Minimum Lift Thickness - inches
3/8	1
1/2	1 1/2
3/4	2
1	3

g. Complete each layer to full width before placing succeeding layers.
h. While operating on the road surface, do not use kerosene, distillate, other petroleum fractions, or other solvents, for cleaning hand tools or for spraying the paver hopper. Do not carry containers of cleaning solution on or near the paver. When a solvent is used, do not use the paver for at least 5 hours after cleaning.
i. After spreading, carefully smooth to remove all segregated aggregate and marks.
j. When placing two adjacent lanes, pave no more than 1 day of rated plant production before paving the adjacent lane(s). Place the adjacent lane to match the first lane during the next day of plant production.
k. At the close of each working day, clear all construction equipment from the roadbed.
l. Prior to opening a lane to traffic, place fillets, safety edge, or full width granular shoulders according to Article 2121.03, C, 4. Place the material adjacent to and equal in thickness to the resurfacing. Fillet removal is incidental to the HMA mixture.

5. Compaction.
a. General.
1) Promptly and thoroughly compact each layer. Use mechanical tampers for areas inaccessible to the rollers.
2) Use a rolling procedure and compactive effort that will produce a surface free of ridges, marks, or bumps.
3) The quality characteristic is in-place air void content and will be based on the theoretical maximum specific gravity (G_{mm}) for that day's mixture.
b. Class I Compaction.
1) Applications.
Use Class I compaction for all courses for the traffic lanes, ramps, and loops on all roadways.
2) Test Strip Construction for Class I Compaction.
a) For the purpose of evaluating properties of the asphalt mixtures and for evaluating an effective rolling pattern:
(1) Construct a test strip of the surface mixture prior to its placement on the surface course for Interstate highways, Primary highways, and ramps connecting Interstate and Primary highways.
(2) Construct a test strip of the intermediate mixture at the start of its placement on the intermediate course for Interstate highways, interstate-to-interstate ramps.
(3) Test strips for other mixtures may be constructed, but are not required.
b) Test strips are not required when the entire production of the mixture bid item is placed in a single day.
c) The quantity of mixture subject to the test strip production, will be pre-established with the Engineer and limited to a half day's production
d) When the contract documents specify both intermediate and surface courses and a test strip is required, place a surface course test strip in lieu of intermediate mixture in a section of the intermediate course prior to actual surface course placement. If surface course and intermediate course are not placed the same calendar year, then place test strip at beginning of surface mix production.
e) Only one test strip will be allowed for each mixture and shall be declared to the Engineer prior to placement. The Engineer may require additional test strips if a complying HMA mixture or rolling pattern was not established.
f) Use test strip production control that meets the requirements of Article 2303.03, D, 3, b. The test strip will be an independent lot. Determine sublots in accordance with Table 2303.03-5.
c. Class II Compaction.
Intended for paved shoulders, temporary crossovers, onsite detours, base widening in a non-travel lane and other situations where Class I is not specified.
1) Establish a rolling pattern to verify adequate density.
2) At the Engineer's option, cores or gauge readings at the frequency designated in Materials I.M. 204 Appendix F for the first day of placement will be used. The Engineer may modify the sample size and frequency provided compaction is thorough and effective.
3) The Engineer will accept the rolling pattern based on the average test results. When the average field voids is less than or equal to 8.0%, the pattern is considered thorough and effective.
4) When the average field voids exceeds 8.0%, modify the rolling pattern. The Engineer may require additional testing until thorough and effective compaction is achieved.
5) For areas inaccessible to rollers, use mechanical tampers or other approved compaction methods.

6. **Joints and Runouts.**
   a. Construct longitudinal joints for courses on resurfacing projects within 3 inches of the existing longitudinal joint. Construct longitudinal joints to secure complete joint closure and avoid bridging of the roller. When the joint is completed, the hot side shall be no more than 1/4 inch higher than the cold side.
   b. Saw transverse construction joint to a straight line at right angles to the center line to provide a full thickness vertical edge before continuing paving.
   c. Place temporary runouts according to road standards. Remove temporary runouts before commencing paving. Runout removal is incidental to the HMA mixture.

7. **Miscellaneous Operations.**
   a. **Leveling and Strengthening Courses.**
      1) Use the same mixture specified for the base or intermediate course.
      2) Compact leveling courses and intermediate mixtures placed as leveling/scratch courses (less than or equal to 1 inch plan thickness) using pneumatic and vibratory rollers. This is considered Class II compaction.
   b. **Wedge Courses.**
      1) Use the base or intermediate mixture to construct wedge courses used to secure desired curve super-elevation. When possible, spread using a finishing machine.
      2) Place wedge courses in compacted layers no thicker than 3 inches.
      3) On super-elevated curves which require wedge course placement, stage the shoulder construction. After completing each day's wedge placement operations and prior to suspending that day's construction activities, construct a full width shoulder on the high side up to the completed wedge course elevation. Shoulder construction staging will be considered incidental to shoulder construction.
      4) Use Class II compaction.
   c. **Fixtures in the Pavement Surface.**
      1) Adjust manholes, intakes, valve boxes, or other fixtures encountered within the area to be covered by HMA to conform to the final adjacent finished surface. Payment for adjustment of manholes or intakes will be per Section 2435. Payment for adjustment of valve boxes and other fixtures will be per Section 2554. Unless specified otherwise in the plans, adjust fixtures:
         - Between placing the surface course and the layer preceding the surface course, or
         - After placing the surface course using a composite patch or PCC patch.
      2) Use PCC and HMA patch material complying with the requirements of Section 2529. Make patches large enough to accommodate the structure being adjusted.
      3) Unless otherwise approved, construct patches to be square. Orient them diagonally to the direction of traffic flow. Ensure the elevation of the adjusted fixture and patch does not differ from the elevation of the surrounding pavement surface by more than 1/4 inch.
      4) When shaping and compacting resurfacing near inlets to storm sewer intakes, shape to ensure maximum drainage into intakes.
   d. **Fillets for Intersecting Roads and Driveways.**
      1) Shape, remove loose material, and tack the surface adjacent to the pavement. On the tack coated surface, place and compact the hot mixture in layers equal to the adjacent layer. Extend from the edge of the pavement as shown on the plans.
      2) Place and compact fillets at intersecting roads at the same time as the adjacent layer.
      3) Entrance fillets that are 8 feet or wider may be placed as a separate operation. Pave fillets which are 8 feet or wider with a self-propelled finishing machine described in Article 2001.19.
      4) The Engineer may approve other equipment for placement of fillets, based on a demonstration of satisfactory results.
   e. **Stop Sign Rumble Strips.**
      If the plans include the bid item Rumble Strip Panel (In Full Depth Patch), apply Section 2529. To meet the requirements of placing Stop Sign Rumble Strips before opening roadway sections to traffic, the Contractor may construct temporary rumble strip panels meeting the final pattern and location of the Stop Sign Rumble Strip indicated in the plans
   f. **Paved HMA Shoulders.**
      1) Compact paved HMA shoulders using one of the following methods:
         a) Class II compaction (Article 2303.03, C, 5, c),
         b) Same rolling pattern established for adjoining mainline or ramp driving lane, as determined by density coring.
      2) Shoulder area will not be included in PWL calculations for field voids on adjoining mainline or ramp driving lane. A price adjustment may be applied to shoulder areas that do not adhere to the established roller pattern.

D. Quality Assurance Program.

1. **General.**
   Except for small quantities as defined in Article 2303.03, A, 2, follow the procedures and meet the criteria established in Articles 2303.02 and 2303.03, B, Section 2521, and Materials I.M. 510 and 511.

Production Tolerances

Measured Characteristic	Target Value	Specification Tolerance
Cold feed gradation No. 4 and larger sieves	by JMF	±7.0%
Colf feed gradation No. 8	by JMF	±5.0%
Cold feed gradation No. 30	by JMF	±4.0%
Cole feed gradation No. 200	by JMF	±2.0%
Average Absolute Deviation (AAD)	0.0	≤ 1.0
Daily asphalt binder content	by JMF	±0.3
PWL Lab Voids	by JMF	±1.0%
PWL Field Voids	n/a	0-8.5% 91.5-100% of G_{mm}

2. Mix Design - Job Mix Formula.

a. The Contractor is responsible for the JMF for each mixture.

b. Submit a completed JMF, using the computer format of Form 956, for approval to the materials lab designated by the Contracting Authority. Submit supporting documentation demonstrating the design process was followed and how the recommended JMF was determined. Include an economic evaluation when required. Include trial and final proposed aggregate proportions (Form 955) and corresponding gyratory data. In addition, submit sufficient loose mixture and individual material samples for approval of the design.

c. Personnel preparing the JMF shall be Iowa DOT certified in HMA Level II.

d. An approved JMF will be required prior to beginning plant production.

3. Plant Production.

a. General.

All of the following qualify as a "significant mix change":

- A single occurrence of an aggregate interchange of greater than 5%.
- An aggregate interchange of greater than 5% from last approved JMF.
- A single occurrence of an asphalt content change greater than 0.2%.
- An asphalt content change greater than 0.2% from last approved JMF.
- A deletion or introduction of a new material into the mix.
- A change of additive dosage rate.
- A change of binder, aggregate, or additive source.

b. Production Control.

1) After the JMF is established, the combined aggregate gradation furnished for the project, asphalt binder content, asphalt film thickness, and laboratory air voids should consistently comply with the JMF target values and design criteria in Materials I.M. 510 Appendix A. Control them within the production tolerances given in Table 2303.03-4.

Table 2303.03-4: Production Tolerances

Measured Characteristic	Target Value (%)	Specification Tolerance (%) [(a)]
Cold feed gradation No. 4 and larger sieves	by JMF	± 7.0
Cold feed gradation No. 8	by JMF	± 5.0
Cold feed gradation No. 30	by JMF	± 4.0
Cold feed gradation No. 200	by JMF	± 2.0
Field laboratory air voids absolute deviation from target [(b)]	0.0	≤ 1.0
Daily asphalt binder content	by JMF	± 0.3
(a) Based on single test unless noted otherwise.		
(b) When lab voids acceptance is not based on PWL.		

2) The gyratory mix design gradation control points for the size mixture designated in the project plans will not apply to plant production control tolerances.

3) Adjustments to the JMF target gradation and asphalt binder content values may be made.

a) The Contractor determines from quality control testing that adjustments are necessary to achieve the specified properties.

b) Consult with the Engineer regarding adjustments to the JMF.

c) Notify the Engineer if the average daily gradation for a mixture bid item is outside the production tolerances. If other production tolerances and mixture requirements of Materials I.M. 510 Appendix A are acceptable, a change in gradation target can be requested.

d) The Contractor's adjustment recommendations prevail provided all specifications and established mix criteria are being met for plant production.

4) Calculate estimated film thickness every day of production according to Materials I.M. 501. Compliance is based on limits in Materials I.M. 510 Appendix A.

5) Calculate absolute deviation from target lab voids according to Materials I.M. 501. To determine the moving average absolute deviation from target laboratory voids, use the average of the last four individual sample absolute deviations from target laboratory voids.

6) Notify the Engineer whenever the process approaches a specification tolerance limit. When acceptance for lab voids is not based on PWL, cease operations when the moving average point for absolute deviation from target lab voids is outside the specification tolerance limit. Assume responsibility to cease operations, including not incorporating material which has not been placed. Do not start the production process again until notifying the Engineer of the corrective action proposed. The moving AAD may restart only in the event of a mandatory plant shutdown for failure to maintain the average within the production tolerance.
7) After the second occurrence of the moving AAD falling outside the specification tolerance limit, the Engineer may declare the lot or portions of the lot defective.

4. Sampling and Testing.

a. General.

1) Perform sampling and testing to provide the quality control of the mixture during plant production. Certified Plant Inspection according to Section 2521 is required.
2) Personnel involved in sampling and testing on both verification and quality control shall be Iowa DOT certified for the duties performed per Materials I.M. 213.
3) Provide easy and safe access for Iowa DOT staff to the location in the plant where samples are taken.
4) Maintain and calibrate the quality control testing equipment using prescribed procedures. Sample and test according to the specified procedures as listed in the applicable Materials I.M. and Specifications. When the results from a Contractor's quality control lab are used as part of product acceptance, the Contractor's quality control lab is required to be qualified.
5) Identify, store, and retain all quality control samples and field lab gyratory specimens used for acceptance until the lot is accepted.
6) Obtain verification samples at random times as directed and witnessed by the Engineer according to Materials I.M. 204 Appendix F. Secure all verification samples according to Materials I.M. 205 Appendix A. Store verification samples for the Contracting Authority until delivery to the Contracting Authority's lab.
7) Deliver the Plant Report to the Engineer and the designated district materials laboratory daily. At project completion, provide the Engineer a copy of the reports, charts, and other electronic file(s) containing project information generated during the progress of the work.

b. Asphalt Binder.

Sample and test asphalt binder to verify the quality of the binder grade. Do not sample when daily production is less than 100 tons of mixture.

c. Tack Material.

Sample and test asphalt emulsions to verify residual asphalt content.

d. Aggregate Gradation.

1) Use cold feed or ignition oven gradation for aggregate gradation control to assure materials are being proportioned according to the specifications.
2) Take a minimum of one aggregate gradation for each day's production that exceeds 100 tons of mixture. When more than one sample in a day's production is tested, use the average gradation to determine compliance of the daily lot.
3) Engineer will verify Contractor gradation with an ignition oven or a split cold feed sample. For ignition oven validation, split a cold feed sample with the Engineer to determine the need for a correction factor according to Materials I.M. 511. The Engineer may require additional cold feed split samples.

e. Uncompacted Asphalt Mixture.

1) Sample the loose mixture according to Materials I.M. 322.
2) Modify sampling location to include placement with mix stored from a previous day's production.
3) The number of daily samples is defined in Table 2303.03-5 based on the day's estimated production. See Materials I.M. 511 for determining sample locations.

Table 2303.03-5: Uncompacted Mixture Sampling

Estimated Daily Production, Tons	Number of Samples
101-500	1
501-1250	2
1251-2000	3
2001-4500	4
Over 4500	5

4) Do not take samples from the first 100 tons of mix produced each day or the first 100 tons of mix following a significant mix change. When paving operations are staged so each day of placement is less than 100 tons for the entire production of the bid item, establish a sampling plan with the Engineer that includes a minimum of one sample per 2500 tons.
5) Split samples for specimen preparation according to Materials I.M. 357.
6) Paired sampling may also be accomplished by taking a bulk sample and immediately splitting the sample according to Materials I.M. 322 on the grade.

7) Test the quality control sample of each production paired sample as follows:
   a) Prepare and compact two gyratory specimens according to Materials I.M. 325G.
   b) Determine the bulk specific gravity of compacted mixture (G_{mb}) at N_{design} for each specimen according to Materials I.M. 321. Average the results.
   c) Determine the Theoretical Maximum Specific Gravity (G_{mm}) of the uncompacted mixture according to Materials I.M. 350.
   d) Determine laboratory air voids for each sample according to Materials I.M. 501.Use the target laboratory voids listed in Materials I.M. 510 Appendix A unless otherwise specified in the contract documents.

f. Compacted Pavement Cores.

1) The Engineer will determine the core locations. The length laid in each lot will be divided into approximately equal sublots. Obtain one sample at a random location in each sublot. Determine a new random location for the sublot when the designated core location falls on a runout taper at an existing pavement, bridge, or bridge approach section where the thickness is less than the design thickness.
2) Take samples from the compacted mixture and test no later than the next working day following placement and compaction.
3) Restore the surfaces the same day. Dry, fill with the same material, and properly compact core holes.
4) Pavement core samples will be identified, taken possession of by the Engineer, and delivered to the Contractor's quality control field laboratory.
5) The Engineer may either:
   - Transport the cores directly to the lab, or
   - Secure the cores and allow the Contractor to transport the cores to the lab.
6) Prepare and test the cores according to Materials I.M. 320, 321, and 337.
7) Cut and trim samples under the direction of and witnessed by the Engineer for tests of G_{mb}, thickness, or composition by using a power driven masonry saw.
8) The compacted HMA pavement will be tested in a timely manner by the Engineer's personnel. The Engineer will test each lot of cores at the Contractor's field quality control laboratory. Cores may also be tested by the Contractor; however, the Contractor's test results will not be used for material acceptance.

5. Verification and Independent Assurance Testing.

a. The Contractor's quality control test results will be validated by the Engineer's verification test results on a regular basis using guidelines and tolerances set forth in Materials I.M. 216 and 511.

b. If the Engineer's verification test results validate the Contractor's test results, the Contractor's results will be used for material acceptance. Disputes between the Contractor's and Engineer's test results will be resolved according to Materials I.M. 511.

c. The Engineer will randomly select one or more of the daily production verification samples. Some or all of the samples selected will be tested in the materials laboratory designated by the Engineer. The Engineer will use the verification test results to determine if the Contractor's test results can be used for acceptance.

d. Personnel and laboratory equipment performing tests used in the acceptance of material are required to have participated in the statewide Independent Assurance Program according to Materials I.M. 207.

6. Acceptance of Asphalt Mixtures.

a. Lab Voids.

1) Use the following methods of acceptance for laboratory voids:
   a) For base widening, ramps and loops, shoulders, recreational trails, and other mixture bid items not placed in travel lanes of a permanent pavement, acceptance for laboratory voids will be based on a moving average absolute deviation (AAD) from target as defined in Materials I.M. 501. Use the production tolerance in Table 2303.03-4. During a day's production, if more than 100 tons of the bid item is placed in an area not listed above, apply Article 2303.03, D, 6, b, for entire production of bid item.
   b) Determine PWL for each lot as defined in Materials I.M. 501. The PWL limits shall be +/- 1.0% from the target air voids. Each mixture bid item will constitute a lot. Lot size is defined as follows:
      (1) No less than eight and no more than 15 sequential tests will constitute a lot (exceptions stated below).
      (2) After the eighth test, all subsequent samples collected will also be included in the lot up to a maximum of 15.
      (3) Once a lot has been established with at least eight tests, a new lot will begin the day following the fifteenth sample. Lots shall not contain partial days. When the fifteenth sample is reached, include all samples taken that day in the lot.
      (4) If the bid item's production has ended and fewer than eight tests are available, those tests may be combined with the previous lot provided the maximum lot size has not already been reached. When combining results, if the day to be combined contains the fifteenth sample, include all samples for that day. Do not combine partial day's results.
      (5) If samples cannot be combined with the previous lot due to maximum lot size restrictions or if fewer than eight tests are available for the entire production of a bid item, combine those tests into a single lot and use the AAD analysis in Materials I.M. 501.

(6) Test strips will be considered a separate lot.
(7) When the same mix type is produced for multiple bid items in one day from a single plant and the production going to each item exceeds 500 tons, assign all box samples to each bid item's existing lot for lab voids. In addition, assign the quantity of each bid item produced to its respective lot.
(8) When the same mix type is placed in both PWL and AAD areas in a single day, include all samples for that day in the PWL lot as well as the quantity of the mixture bid item produced and placed in the PWL area.

2) Determine the pay factor using the AAD procedure described in Materials I.M. 501 for mix in a PWL lot which is produced at irregular intervals and placed in irregular areas. The following items qualify as such and shall be combined into a single lot:

- Asphalt mixture produced and placed on gores, detours, cross-overs, temporary pavements, turning lanes, and fillets,
- Asphalt mixture produced and placed on ramps
- Asphalt mixture produced and placed on shoulders.

To be considered irregular, the production rate for mixture bid items described above is not to exceed 1000 tons in a single day.

b. Field Voids.

1) Class I.

a) A lot is considered to be one layer of one mixture bid item placed during a day's operation. The Engineer may approve classifying multiple layers of construction placed during a single day as a lot provided only one mixture was used.

b) For the following situations sampling for field voids may be waived by the Engineer provided compaction has been thorough and effective, or sampling may be modified by mutual agreement to include more than one day's production provided samples are taken prior to trafficking:

- When the day's operation is not more than 2500 square yards excluding areas deducted from the field voids lot,
- When the day's operation is not more than 500 tons excluding quantities deducted from the field voids lot,
- When the mixture is being placed in irregular areas, or
- When placing strengthening courses.

c) If a sample is damaged or measures less than 70% or more than 150% of the intended thickness, an alternate sampling location will be determined and used. Take samples from no less than 1 foot from the unconfined edge of a given pass of the placing equipment, from run-outs, or from day's work joints or structures.

d) Use the following methods of acceptance for field voids:

(1) For mixture bid items placed in the following areas:

- Base widening placed in a travel lane,
- Ramps,
- Bridge approaches placed as a separate operation,
- Non-interstate travel lanes intended to be in service for fewer than 12 months,
- State Park and Institutional roadways,
- Recreational trails, and
- Irregular areas identified by the Engineer that may include areas not suitable for continuous paving,

The Engineer will accept the field voids lot based on the average test results or an established effective rolling pattern when approved by the Engineer. Do not exceed 8.0% average field voids. The Engineer may modify the sample size and frequency provided compaction is thorough and effective. The Engineer may apply the pay schedule in Article 2303.05, A, 3, b, 3, to areas where thorough and effective compaction is not achieved.

(2) For all other areas of Class I compaction, determine PWL as defined in Materials I.M. 501. The PWL limit shall be between 91.5% of G_{mm} (8.5% voids) and -100% of G_{mm} (0% voids). Use maximum specific gravity (G_{mm}) results in field voids calculations as follows:

(a) When cores represent one day's production and more than one G_{mm} test result is available, use the average G_{mm} in the field voids calculation for all cores.

(b) When cores represent one day's production and only one G_{mm} test result is available, use the single G_{mm} test result in the field voids calculation for all cores.

(c) When the cores represent more than one day's production, use the average of all G_{mm} test results from all days corresponding with the cores.

e) When the PWL falls below 80.0, use the procedure outlined in Materials I.M. 501 to identify outliers with 1.80 as the quality index criterion. Only one core may be considered an outlier in a single lot. If an outlier is identified, recalculate the PWL with the results of the remaining cores and determine whether the PWL is improved. Use the larger of the original and recalculated PWL to determine the pay factor.

2) For Class II apply Article 2303.03, C, 5, c.

Examples of Laboratory Air Voids Lot Size Determination.

The HMA Charting program will automatically determine lot size. Here is an example:

*No less than 8 and no more than 15 sequential tests will consistute a lot (with the following exceptions)

*After the 8th test, all subsequent samples will be included in the lot up to a maximum of 15

*Once a lot has been established with at least 8 tests, a new lot will begin the day following the 15th sample.

*Lots shall not contain partial days. After the 15th sample is reached, include all samples taken that day.

Example #1	**# of lab void tests**
Contractor, Day 1, has 5 sublots based on the daily tonnage they produced.	5
Contractor, Day 2, has 5 sublots based on the daily tonnage they produce.	5
Contractor, Day 3, has 5 sublots based on the daily tonnage they produced.	5
Lot is established. Lot size is 15 tests.	**15**
A new lot will start on Day 4	

Example #2	**# of lab void tests**
Contractor, Day 1, has 4 sublots based on the daily tonnage they produced.	4
Contractor, Day 2, has 5 sublots based on the daily tonnage they produced.	5
Contractor, Day 3, has 5 sublots based on the daily tonnage they produced.	5
Lot has 14 tests so far, but hasn't hit the 15th yet	
Contractor, Day 4, has 5 sublots based on the daily tonnage they produced.	5
Lot is established. Lot size is 19 tests.	**19**
A new lot will start on Day 5	

Example #3	# of lab void tests
Contractor, Day 1, has 3 sublots based on the daily tonnage they produced.	3
Contractor, Day 2, has 2 sublots based on the daily tonnage they produced.	2
Bid item completed on Day 2. Lot size 5?	**5**
No, minimum of 8 must be achieved.	
Lot will be on the AAD spec, not PWL.	

Examples of Laboratory Air Voids Lot Size Determination.

The HMA Charting program will automatically determine lot size. Here is an example:
*No less than 8 and no more than 15 sequential tests will consistute a lot (with the following exceptions)
*After the 8th test, all subsequent samples will be included in the lot up to a maximum of 15
*Once a lot has been established with at least 8 tests, a new lot will begin the day following the 15th sample.
*Lots shall not contain partial days. After the 15th sample is reached, include all samples taken that day.

Example #1	**# of lab void tests**
Contractor, Day 1, has 5 sublots based on the daily tonnage they produced.	5
Contractor, Day 2, has 5 sublots based on the daily tonnage they produce.	5
Contractor, Day 3, has 5 sublots based on the daily tonnage they produced.	5
Lot is established. Lot size is 15 tests.	**15**
A new lot will start on Day 4	

Example #2	**# of lab void tests**
Contractor, Day 1, has 4 sublots based on the daily tonnage they produced.	4
Contractor, Day 2, has 5 sublots based on the daily tonnage they produced.	5
Contractor, Day 3, has 5 sublots based on the daily tonnage they produced.	5
Lot has 14 tests so far, but hasn't hit the 15th yet	
Contractor, Day 4, has 5 sublots based on the daily tonnage they produced.	5
Lot is established. Lot size is 19 tests.	**19**
A new lot will start on Day 5	

Example #3	# of lab void tests
Contractor, Day 1, has 3 sublots based on the daily tonnage they produced.	3
Contractor, Day 2, has 2 sublots based on the daily tonnage they produced.	2
Bid item completed on Day 2. Lot size 5?	**5**
No, minimum of 8 must be achieved.	
Lot will be on the AAD spec, not PWL.	

c. Asphalt Film Thickness.
A lot is considered one day's production of one mixture. When film thickness falls outside the limits in Materials I.M. 510 Appendix A, see Article 2303.05, A, 3, c, for payment adjustment.

d. Thickness.

1) The Engineer will measure cores, exclusive of thin surface treatments, according to Materials I.M. 337. Sampling frequency and lot definitions are as follows:

a) Class I Compaction.
The Engineer will obtain and test samples for each lot according to Materials I.M. 204 Appendix F. Density cores sampled as part of a field voids lot will be combined into daily lots based on cores' intended thickness. Samples for thickness not tested for G_{mb}, because they are less than 70% of the intended thickness, are included for thickness. In these particular instances, do not measure the thickness of additional sufficiently thick samples used to determine field voids. When measuring density of top lift from a full depth core, measure thickness before trimming core for density testing.

b) Class II Compaction.
The Engineer will obtain and test samples full depth once the final lift is placed. The lot shall be defined as the length of a day's production of the final lift. Take a minimum eight cores from each lot. The Engineer may approve classifying multiple days of construction as a lot.

2) Provided there is reasonable assurance that the pavement complies with the required thickness, the Engineer may waive sampling for thickness for the following situations:

a) When an alternate method is deployed by the Engineer
b) When the day's operation is 2500 square yards or less.
c) When the mixture is being placed in irregular areas.
d) When the mixture is being placed next to structures.

3) Establish the intended thickness daily with consideration given to field conditions and tie-in features.

4) When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective. If the final lift has not been placed, the Engineer may approve additional thickness to be placed on succeeding lifts to ensure a final grade as intended. The unit price of the defective lot will be used for payment of the additional material.

e. Smoothness.
~~Construct pavement to have a smooth riding surface according to the following:~~

~~**1)**~~ Apply Section 2317 to HMA surface mixture bid items of a Primary project ~~if any individual HMA mixture bid item is 1000 tons or greater or 5000 square yards or greater. Apply Section 2316 to all other Primary projects with a surface course and~~ or when specifically required for other projects.

~~**2)** When neither Section 2316 nor Section 2317 is applied to a project, the Engineer may check the riding surface for defects using one of the following criteria:~~

- ~~The surface shall not deviate from a straight line by more than 1/8 inch in 10 feet when measured longitudinally with a 10 foot straightedge.~~
- ~~The surface shall not contain any bump or dip exceeding 1/2 inch over a 25 foot length when measured with a method in Materials I.M. 341.~~

~~The Engineer may either require the defects be corrected according to Article 2316.03, B, 2, or apply a price adjustment.~~

E. Quality Control for Small HMA Paving Quantities.

1. General.
For small quantities, a lot will be the entire quantity of each HMA mixture bid item.

2. Mix Design.

a. Prepare the JMF. Prior to production, obtain the Engineer's approval for the JMF. Comply with Article 2303.02 and Materials I.M. 510.

b. For mixtures meeting the criteria in Article 2303.02, E, 2, a:

1) An anti-stripping agent is required when the optimum dosage is greater than 0%.
2) Use Materials I.M. 319 to optimize the design dosage rate.
3) When prior-approved designs have demonstrated acceptable field SIP values, the anti-stripping agent and dosage from the JMF may be used in lieu of optimization testing.

3. Plant Production.

a. Ensure production plant calibration for the JMF is current and no more than 12 months old.
b. Use certified asphalt binder and approved aggregate sources meeting the JMF. Ensure the plant maintains an asphalt binder log to track the date and time of binder delivery. Ensure delivery tickets identify the JMF.
c. Monitor the quality control test results and make adjustments to keep the mixture near the target JMF values.

4. **Sampling and Testing.**
   a. **Field Voids.**
      1) Take compacted mixture G_{mb} measurements, except when Class II compaction is specified, no later than the next working day following placement and compaction.
      2) The Engineer may accept the void content of the compacted layer based on cores or calculations from density gauge measurements. The Engineer may waive field void sampling provided the compaction has been thorough and effective.
      3) PWL for field voids will not apply to small quantities.
   b. **Lab Voids.**
      Material sampling and testing is for production quality control. Acceptance of mixture is based on Contractor certification. Sampling and testing of uncompacted mixture is only required for mechanically placed mixture. Sample and test a minimum of one uncompacted mixture sample according to the Standard Specifications and Materials I.M.s using certified technicians and qualified testing equipment. The Engineer may approve alternative sampling procedures or may waive sampling of uncompacted mix and gradation if Contractor can provide plant reports from other recent project(s) demonstrating the JMF has been produced within specification. Take the sample between the first 100 to 200 tons of production. No split samples for agency verification testing are required.
   c. **Binder.**
      No binder sampling or testing is required.
   d. **Moisture Sensitivity.**
      Moisture susceptibility testing on plant produced mixture is not required.
   e. **Gradation.**
      Perform a minimum of one aggregate gradation.

5. **Certification.**
   a. When the production tolerances in Table 2303.03-4 are not met, payment may be adjusted according to Article 1105.04.
   b. When the production tolerances are met, provide a certification for the production of any mixture in which the requirements in this article are applied. Place the test results and the following certification statement on the Daily Plant Report.
      "The mixture contains certified asphalt binder and approved aggregate as specified in the approved mix design and was produced in compliance with the provisions of Article 2303.03, E."
   c. The Daily Plant Report may be submitted at the end of the project for all certified quantities, or submitted at intervals for portions of the certified quantity.

F. **Cold Weather Paving.**

1. When road surface temperature is below requirements shown in Tables 2303.03-1 and 2303.03-2, or when air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 40°F, cold-weather paving may be considered by the Engineer.

2. **Cold Weather Paving Plan.**
   a. Submit a written cold weather paving plan to the Engineer. Document material, operational, and equipment changes for paving when air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 40°F.
   b. Include the following:
      1) Use an approved mix design that incorporates a warm mix additive. Do not use water injection.
      2) Identify warm mix additive and dosage rate.
      3) Identify modifications to compaction process and when modifications apply.
   c. If the National Weather Service forecast for the construction area predicts ambient air temperature less than 40°F at the projected time of paving within the next 24 hours, confirm or submit revisions to the cold weather paving plan for Engineer validation. Update plan as required to accommodate conditions anticipated for the next day's operations. Upon validation of the plan, the Engineer will allow paving for the next day. Once in effect, pave conforming to the Engineer-accepted cold weather paving plan for balance of that workday or shift regardless of the temperature at time of paving.
   d. Engineer's written acceptance will be required for the cold weather paving plan. Engineer's acceptance of the plan does not relieve Contractor of responsibility for the quality of HMA pavement placed in cold weather.

3. Do not place flexible paving mixtures over frozen subgrade or base, or where roadbed is unstable.

4. Engineer may further limit placement if, in the Engineer's judgment, other conditions are detrimental to quality work.

2303.04 METHOD OF MEASUREMENT.

A. Hot Mix Asphalt Mixture.

1. General.

a. Removal of fillets is incidental to the contract unit price for the mixture.

b. If the Contractor chooses to place intermediate or surface mixture in lieu of base for the outside shoulders, the quantity will be calculated from the pavement and shoulder template. If placed as a separate operation, the quantity will be calculated from scale tickets. If the substitute mixture placed on the shoulder is for an intermediate course fillet only, include the quantity in the fillet for payment in the quantity placed in the adjacent intermediate course.

c. Payment for the quality control requirements for small quantities will not be measured separately.

2. Measurement by Weight.

a. The quantity of the type specified, expressed in tons, will be determined from the weight of individual loads, including fillets, measured to the nearest 0.01 tons.

b. Loads may be weighed in trucks, weigh hoppers, or from the weight from batch plants computed by count of batches in each truck and batch weight. Article 2001.07 applies. Segregate the weights of various loads into the quantities for each pay item.

3. Measurement by Area.

a. The quantity of the type specified, expressed in square yards, will be shown in the contract documents to the nearest 0.1 square yard. The area of manholes, intakes, or other fixtures will not be deducted from the measured pavement area.

b. When constructing shoulders on a basis of payment of square yards, inspection of the profile and elevation will be based on the completed work relative to the pavement edge. The Contractor is responsible for the profile and elevation of the subgrade and for thickness.

B. Asphalt Binder.

1. Measure the amount of asphalt binder by in-line flow meter reading, according to Article 2001.07, B.

2. Compute the asphalt binder quantity added to the storage tank using a supplier certified transport ticket accompanying each load.

3. The quantity of asphalt binder not used in the work will be deducted.

4. When the quantity of asphalt binder in a batch is measured by weight and is separately identified by automatic or semi-automatic printout, the Engineer may compute the quantity of asphalt binder used from this printout. By mutual agreement, this method may be modified when small quantities or intermittent operations are involved.

5. The Engineer will calculate and exclude the quantity of asphalt binder used in mixtures in excess of the tolerance specified in Article 2303.03, D, 3, b.

6. When payment for HMA is based on area, the quantity of asphalt binder used will not be measured separately for payment.

C. Recycled Asphalt Pavement.

1. A completed Daily HMA Plant Report with the certification statement is required for measurement and payment for Contractor Certified HMA. The quantity of asphalt binder will be based on the approved JMF and any plant production quality control adjustments.

2. The quantity of asphalt binder in RAP incorporated into the mixture will be calculated in tons. This quantity shall be based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction tests.

3. The quantity of asphalt binder in RAP, which is incorporated into the mix, will be included in the quantity of asphalt binder used.

D. Anti-strip Agent.

Will not be measured separately. The quantity will be based on tons of HMA mixture with anti-strip agent added.

E. Tack Coat.

Will not be measured separately.

F. Hot Mix Asphalt Pavement Samples.
Will not be individually counted for payment if furnished according to Article 2303.03, D, 4, or required elsewhere in the contract documents,

G. Recycled Asphalt Shingles.
67% of the asphalt binder from RAS which is incorporated into the mixture will be included in the quantity of asphalt binder used.

H. Cold Weather Paving.
Will not be measured separately. The quantity will be based on tons of flexible paving mixture placed with warm mix additive.

2303.05 BASIS OF PAYMENT.

The costs of designing, producing, placing, and testing bituminous mixtures and the cost of furnishing and equipping the QM-A field laboratory will not be paid for separately, but are included in the contract unit price for the HMA mixes used. The application of tack coat and sand cover aggregate are incidental and will not be paid for separately. Pollution testing is at the Contractor's expense. The installation of temporary Stop Sign Rumble Strips will not be paid for separately, but is incidental to the price bid for the HMA course for which it is applied.

The quality control requirements for small quantities are incidental to the items of HMA mixtures in the contract.

A. Flexible Paving Mixture.

1. Payment will be the contract unit price for Asphalt Mixture of the type specified per ton or square yard.

2. Payment for test strips will be the contract unit price for the test strip mixture bid item per ton regardless of lift placement.

3. Payment will be adjusted by the following Pay Factor for field voids, laboratory voids, and film thickness determined for the lot.

Multiply the unit price for the HMA bid item by the Pay Factor rounded to three decimal places.

a. Laboratory Voids.

1) Payment when PWL is used for acceptance:

PWL	Pay Factor
100.0	1.060
90.1 – 99.9	0.006000*PWL + 0.4600
90.0	1.000
50.0 – 89.9	0.00625*PWL + 0.4375
Less than 50.0	0.750 maximum

When PWL is less than 50.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

2) When PWL applies, the minimum pay factor for lab voids shall be 1.0 when the following changes are made via plan note or special provision:

a) Decreasing the target lab voids from the limits published in Materials I.M. 510.

b) Increasing the minimum asphalt film thickness from the limits published in Materials I.M. 510.

~~2~~ 3) Payment when PWL lots are incomplete:

AAD from Target Air Void	Pay Factor
0.0 to 1.0	1.000
1.1 to 1.5	0.900
1.6 to 2.0	0.750
Over 2.0	0.500 maximum

When the AAD is more than 2.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

~~3~~ 4) Use the following payment schedule when a test strip is constructed:

AAD from Target Air Void	Pay Factor
0.0 to 1.5	1.000
1.6 to 2.0	2.5 - AAD
Over 2.0	0.500 maximum

When the AAD is more than 2.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

b. Field Voids.

1) Payment when PWL is used for acceptance:

PWL	Pay Factor
100.0	1.060
90.1 - 99.9	0.00600*PWL + 0.4600
90.0	1.000
50.0 –89.9	0.00625*PWL + 0.4375
Less than 50.0	0.750 maximum

When PWL is less than 50.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

2) Payment when a test strip is constructed:

Average Field Voids (Pa), %	Pay Factor
0.0 to 9.0	1.000
9.1 to 9.5	10 - Pa
Over 9.5	0.500 maximum

When the average air void content from a test strip exceeds 9.5%, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

3) Payment when PWL is not used for acceptance:

Average Field Voids (Pa), %	Pay Factor
0.0 to 8.0	1.000
8.1 to 9.5	(11-Pa)/3
Over 9.5	0.500 maximum

When the average air void content exceeds 9.5%, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

c. Film Thickness.

When film thickness (FT) is outside the limits in Materials I.M. 510 Appendix A, apply the following pay factor:

Placement	Pay Factor	
	Low Film (FT < LL)	**High Film (FT > UL)**
Base/Shoulders	1 - (0.15 (LL - FT))	1 - (0.15 (FT-UL))
Intermediate	1 - (0.20 (LL - FT))	1 - (0.20 (FT-UL))
Surface	1 - (0.25 (LL - FT))	1 - (0.25 (FT-UL))

Where

LL = Lower Limit (Materials I.M. 510, Appendix A)

UL = Upper Limit (Materials I.M. 510, Appendix A)

1. When basis of payment is by area, add 1.0 to the pay factor (computed above) and divide by 2.0.
2. For FT < 7.0 or FT > 16.0, the Engineer may consider the lot defective. This applies to all lots (days) of production.
3. No film thickness price adjustment for the test strip (first day of production, if no test strip performed) for each job mix formula.
4. No film thickness price adjustment on temporary pavement.

d. Pavement Thickness

1) Payment will be further adjusted by the appropriate percentage in Table 2303.05-1 below according to the quality index for thickness determined for that lot:

$$QI_{Thickness} = \frac{\text{Average Thickness}_{Measured} - (\text{Thickness}_{Intended} - 0.5)}{\text{Maximum Thickness}_{Measured} - \text{Minimum Thickness}_{Measured}}$$

Table 2303.05-1: Payment Adjustment for Thickness

Quality Index (Thickness) 8 Samples	Percent of Payment
Greater than 0.34	100
0.14 to 0.34	95
0.00 to 0.13	85
Less than 0.00	75 maximum

2) Do not apply the quality index adjustment to a layer with a designated thickness of “variable” or “nominal”, or to a layer designated as scratch course or leveling course. Do not apply the quality index adjustment to pavement layers designated in the contract documents as grade correction or cross slope correction. Place grade correction or cross slope correction layers as specified in the contract documents or as directed by the Engineer.

4. Payment for courses for which quality index (thickness) is not determined because of size or shape, and courses which are found to be deficient in average width, will be according to Article 1105.04.

B. Asphalt Binder.

1. Payment will be the contract unit price per ton for the number of tons of asphalt binder used in the work.

2. Payment for asphalt binder will be for new asphalt binder, the asphalt binder in the RAP which is incorporated in the mixture, and 67% of the asphalt binder from RAS which is incorporated into the mixture. The quantity of asphalt binder in RAM, which is incorporated into the mix, will be calculated in tons of asphalt binder in the RAM. This will be based on the actual asphalt binder content determined for the mix design from the results of the Engineer’s extraction test.

3. When the basis of payment for HMA is in square yards, compensation for asphalt binder will be included in the contract unit price per square yard.

C. Recycled Asphalt Pavement.
RAP owned by the Contracting Authority will be made available to the Contractor for the recycled mixture at no cost to the Contractor other than loading, hauling, and processing as required for incorporation into the mix.

D. Anti-strip Agent.

1. When anti-strip agent is required, payment will be made at the rate of $3.00 per ton of asphalt mixture in which the anti-strip agent is incorporated, if the Contracting Authority’s test results from the field produced mixture meet or exceed the minimum requirement established in Article 2303.02, E, 2, d.

2. Payment will be full compensation for designing, adding, and testing for anti-strip agent.

E. Tack Coat.
Incidental to HMA.

G. Hot Mix Asphalt Pavement Samples.

1. Payment will be the lump sum contract price.

2. Payment is full compensation for furnishing all samples for all courses or items of work, and for delivery of samples as specified in Article 2303.03, D, 4.

H. Cold Weather Paving.

1. When cold weather paving is permitted by the Engineer, payment will be made at the rate of $3.00 per ton of flexible paving mixture in which the warm mix additive is incorporated.

2. Contracting Authority will not pay for compaction additive when:
a. Pay factor for Field Voids is less than 1.0 for Class I compaction.
b. Compaction is not thorough and effective for Class II compaction.

3. If because of an excusable compensable delay, the Engineer directs Contractor to pave when temperatures meet cold weather definition, the Contracting Authority will relieve Contractor of responsibility for damage and defects the Engineer attributes to cold weather paving.

DS 23026
LOCAL SYSTEMS PROJ.

DS-23026
(New)

DEVELOPMENTAL SPECIFICATIONS
FOR
ALTERNATE ACCEPTANCE OF HMA FOR LOCAL SYSTEMS PROJECTS

Effective Date
October 17, 2023

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

This Specification becomes void on federal aid contracts. Apply requirements of Article 2303 of the Standard Specifications unless otherwise stated.

2303.03, D, 6, a, Lab Voids.

Replace the Article:

Use the following method of acceptance for laboratory voids:

a) For mixture bid items not defined as small quantities in Article 2303.03, A, 2, b, acceptance for laboratory voids will be based on a moving average absolute deviation (AAD) from target as defined in Materials I.M. 501. Use the production tolerance in Table 2303.03-4.

For mixture bid items not defined as small quantities in Article 2303.03, A, 2, b, of the Standard Specifications, acceptance for laboratory voids will be based on a moving absolute average deviation (AAD) from target as defined in Materials I.M. 501. Use the production tolerance in Table 2303.03-5.

2303.03, D, 6, b 1, d, 2.

Replace the first paragraph of the Article:

For all other areas of Class I compaction, determine PWL as defined in Materials I.M. 501. The PWL upper limit shall be 91.5% of G_{mm} (8.5% voids). Use maximum specific gravity (G_{mm}) results in field voids calculations as follows:

2303.05, A, 3, b, 1.

Replace the Article:

Payment when PWL is used for acceptance:

PWL	Pay Factor
80.0 –100.0	1.000
50.0 – 79.9	PF = 0.008333*PWL + 0.3333
Less than 50.0	0.750 maximum

When PWL is less than 50.0, the Engineer may declare the lot or parts of the lot deficient or unacceptable.

DS 23016
LONGITUDINAL JOINTS

DS-23016
(New)

DEVELOPMENTAL SPECIFICATIONS
FOR
EVALUATION OF LONGITUDINAL JOINT QUALITY FOR FLEXIBLE PAVING MIXTURES WITH INCENTIVE/DISINCENTIVE

Effective Date
October 17, 2023

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SUPPLEMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

23016.01 DESCRIPTION.

This work is evaluating in-place quality of centerline longitudinal joints on surface wearing courses for flexible paving and replaces Article 2303.03, D, 4, c, of the Standard Specifications.

23016.02 EVALUATION.

A. General Requirements.
For Class I compaction areas on the surface, longitudinal joint density lots independent from the mat will be established for mainline paving as specified in Article DS-23016.02, B, for acceptance. Class I compaction is defined in Article 2303.03, C, 5, of the Standard Specifications. Mainline shall be considered through lanes within the traveled way including middle turn lanes.

B. Sampling.

1. When surface paving abuts a previously placed surface course, forming a completed longitudinal joint eligible for evaluation, Engineer will obtain and test samples according to Materials I.M. 320 and 321. Using random core locations determined for daily field voids lot (mat), Engineer will randomly select three of these locations to be sampled for joint density. When length of longitudinal joint is less than 3 mat sublots, Engineer will select two sublot locations. When length of longitudinal joint(s) is less than 2 mat sublots, joint cores will be waived.

2. When sampling for mat field voids is modified to include multiple days due to low production, sampling from the joint may also be modified by the Engineer.

3. Joints constructed with tandem pavers will be included, unless otherwise indicated in the contract documents.

4. For vertical joints, center joint cores on the visible seam between to the two adjacent lanes as shown in Appendix A of these specifications.

5. For notched wedge joints, center joint cores 4 inches away from the visible seam in the direction of the wedge as shown in Appendix A of these specifications.

6. Under direction and witnessing of the Engineer, drill one 6 inch diameter core at each sample location as soon as possible, but no later than the day following the completion of the longitudinal joint.

7. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Engineer, longitudinally from within 12 inches of the original sample location.

8. Apply Article 2303.03, D, 5, c, of the Standard Specifications for post drilling operations.

9. Report sample locations and test results on the daily plant report corresponding with the JMF used in production of the sublot(s).

C. Lot Size.
Lot size shall be the length of field voids lot where longitudinal joint(s) exist.

D. Excluded Areas.

1. Engineer will not obtain samples from the following excluded areas to determine lot acceptance:
   - Joints where one side of the joint is formed by existing pavement not constructed under this contract
   - Joints where one side of the joint is not on the mainline surface.
   - Areas within 1 foot longitudinally of an obstruction during construction of surface course (manholes, inlet grates, utilities, bridge structures, runout, etc.). Should a random sample location fall within 1 foot of such an area, Engineer will select an alternate nearby location away from obstruction.
   - Small areas, such as intersections, gore areas or transitions, or anywhere Engineer determines paving and phasing methods do not allow for consistent longitudinal joint construction.

2. Prior to paving, submit requests in writing to the Engineer for consideration of areas to be excluded on this basis. Engineer will make the final determination.

E. Joint Density.
Determine average joint density as a percent of average mat density per Appendix A. Mat cores and joint cores shall be collected on the same day of production for density determination. Mat cores identified as outliers for field voids acceptance will not be used in average mat density calculation.

23016.04 METHOD OF MEASUREMENT.
The Engineer will measure the length of each longitudinal joint density lot in feet.

23016.05 BASIS OF PAYMENT.
Use Table DS-23016-01 to determine the lot payment adjustment.

Table DS-23016-01: Payment for Longitudinal Joint Density

Avg Joint Density (%)	Payment Adjustment ($/ft)
< 95.0[1]	0.16*Avg Joint Density -15.2
95.0 – 97.0	$0.00
> 97.0[2]	0.1333*Avg Joint Density – 12.93

1. Disincentive is not to exceed $0.80/ft.
2. Incentive is not to exceed $0.40/ft.

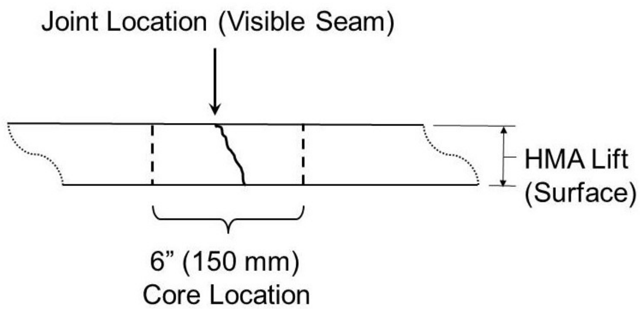
APPENDIX A

A. Joint Density

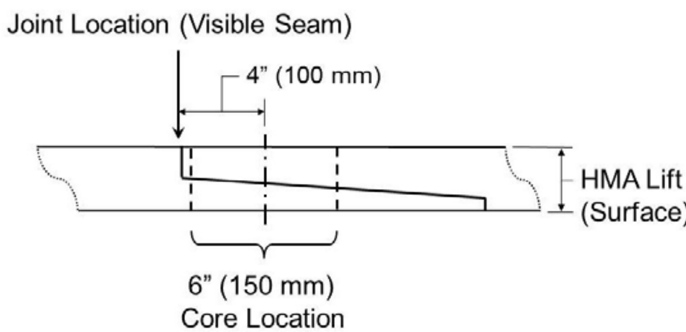
$$Avg\ Joint\ Density = 100 \times \frac{Avg\ Joint\ G_{mb}}{Avg\ Mat\ G_{mb}}$$

B. Coring Diagram

(a) Vertical Edge/Conventional (Butt) Joint



(b) Notched Wedge Joint



DS 23038
HIGH PERFORMANCE THIN LIFT OVERLAY

DS-23038
(New)

DEVELOPMENTAL SPECIFICATIONS
FOR
HIGH PERFORMANCE THIN LIFT OVERLAY

Effective Date
October 17, 2023

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

23038.03 DESCRIPTION.
These specifications describe requirements for a highly polymer modified asphalt thin lift surface course. Apply Section 2303 of the Standard Specifications unless otherwise directed in these specifications.

23038.03 MATERIALS.

A. Asphalt Binder.
Use PG 64-34E+ with a minimum percent recovery of 90% when tested at 64°C per AASHTO T 350 at 3.2 kPa.

B. Mix Design.

1.

Design Gyrations	50
Design Voids Target (Based on %Gmm)	≤ 2.0
Film Thickness	8.0 – 15.0
Aggregate Quality	A
Crushed Content (minimum)	50%
FAA (minimum)	40
Sand Equivalency (minimum)	50

2. Friction Aggregate.
- Interstates: minimum 30% of Total Aggregate shall be Type 2 or better
- Non-Interstates: minimum 50% of Total Aggregate shall be Type 4 or better

3. Hamburg Testing (AASHTO T324).
Required only for Interstate paving mixes. Compact to 3.5% air voids. No more than 4 mm rutting in the first 8000 passes.

4. Do not use more than 15.0% binder replacement. Do not use RAS.

5. Gradation.

Table DS-23038: Thin Lift Overlay Gradation

Sieve Size	Min % Passing	Max % Passing
1½ inch		
1 inch		
3/8 inch	91	100
#4		90
#8	27	63
#16		
#30		
#50		
#100		
#200	2	10

23038.03 CONSTRUCTION.

A. Apply tack coat prior to placement of thin lift overlay according to Section 2303 of the Standard Specifications.

B. Keep the production temperature of HMA mixtures between 225ºF and 335ºF until placed on the grade.

C. Compact with static steel wheeled roller.

D. Do not open to traffic until the entire mat has cooled below 150°F.

E. Quality Assurance/Quality Control.

1. **Field Voids Acceptance.**
   Acceptance for field voids shall be Class II compaction defined in Section 2303 of the Standard Specifications.

2. **Lab Voids Acceptance.**
   Sample from windrow or hopper. Apply Article 2303.05, A, 3, a, 2, of the Standard Specifications for AAD acceptance. Air void target is based on approved JMF.

3. Take at least one cold feed for gradation control each day of production.

23038.04 METHOD OF MEASUREMENT.
Hot Mix Asphalt Thin Lift Overlay will be measured according to Article 2303.04 of the Standard Specifications.

23038.05 BASIS OF PAYMENT.
Hot Mix Asphalt Thin Lift Overlay will be paid for according to Article 2303.05 of the Standard Specifications.

CONSTRUCTION MANUAL
APP 3-4

Asphalt Mixture Verification Responsibilities

Duty	Task	Performed By / REQ'D. CERT.	Minimum Frequency
1. Verify Aggregate Gradation.	• Direct and witness contractor sampling and splitting of cold feed combined aggregate. • Secure and identify split sample for delivery to District Lab or take possession of split sample.	Construction HMA SAMPLER & AGG. I	First Day and Weekly Thereafter
	• Test combined aggregate sample for gradation. • Compare results to contractor test results per IM 216. • Report validation results.	District Materials or Construction AGG. II	First Day and Weekly Thereafter
	• Investigate validation issues.	District Materials	As Needed
2. Verify Aggregate Quality.	• Obtain independent sample. • Send sample to Office of Materials with documentation.	District Materials AGG. I	1/20,000 Tons
3. Verify Asphalt Binder Quality.	• Direct and witness contractor sampling of asphalt binder. • Secure and identify sample for delivery to District Lab.	Construction HMA SAMPLER	1/Day
	• Test asphalt binder samples on DSR. • Report binder test results.	District Materials	First Day then 1/Week
	• Obtain binder sample from the pumping line with assistance from the contractor. • Send sample to Office of Materials with documentation.	District Materials HMA SAMPLER	1/20,000 Tons

4. Verify Uncompacted Mixture Properties.	• Select random sample locations. • Direct and witness contractor paired sampling of uncompacted mix as per IM 322 and IM 511. • Secure and identify one of each paired sample for delivery to District Lab.	Construction HMA SAMPLER	1/Sublot
	• Randomly select paired sample for testing. • Test selected sample for required mix properties. • Compare results to contractor test results per IM 216. • Report validation results.	District Materials HMA I	Asphalt Mixture Properties: 1/Day Extracted Gradation: First Day and 20% Thereafter
	• Investigate validation issues.	District Materials	As Needed

Asphalt Mixture Verification Responsibilities

Duty	Task	Performed By / REQ'D. CERT.	Minimum Frequency
5. Verify Compacted Pavement Properties.	• Select random sample locations. • Direct and witness contractor coring. • Inspect cores for damage and thickness and direct replacement coring of damaged or unusable cores. • Take possession of cores and transport to the contractors lab or secure core samples if contractor is transporting the cores. • Measure cores for thickness. • Test cores for density and record weights. • Provide copy of thickness and weights to contractor for reporting.	Construction HMA SAMPLER	8 Mat Cores/Lot 0, 2 or 3 Joint Cores / Lot (based on matched length)

	• Select random sections for smoothness testing. • Perform independent smoothness testing. • Compare results to contractor test results per IM 216. • Report validation results.	District Materials PROFILOMETER	10% of Project
	• Investigate validation issues.	District Materials	As Needed

Asphalt Mixture Independent Assurance Responsibilities			
Duty	**Task**	**Performed By / REQ'D. CERT.**	**Minimum Frequency**
1. Aggregate Gradation Independent Assurance.	• Systematically distribute aggregate proficiency samples to contractor technicians who perform QC gradation testing for acceptance and construction technicians who perform verification gradation testing per IM 205. ○ Contractor and Construction certified technicians who perform gradation testing must pick up, test and report results of samples to the Central Lab approximately every three months. • Record sample ID numbers and receiver for each sample distributed.	District Materials	Monthly
2. Asphalt Mixture Independent Assurance.	• Systematically distribute Asphalt Mixture proficiency samples to contractor technicians performing QMA testing of Asphalt Mixture per IM 205. ○ Contractor certified technicians who perform Asphalt Mixture testing must pick up, test and report results of samples to the Central Lab approximately every three months. • Record sample ID numbers and receiver for each sample distributed.	District Materials	Monthly

3. Core Density Independent Assurance.	• Retest one set of cores for density and thickness. • Compare results to construction technician test results. • Report comparison of test results.	District Materials HMA SAMPLER	1/Project

Other Required Asphalt Mixture Acceptance Responsibilities

Duty	**Task**	**Performed By / REQ'D. CERT.**	**Minimum Frequency**
1. Qualify Laboratory.	• Check condition of test equipment. • Check equipment calibration records. • Check for current test methods.	District Materials HMA I	Every Two Years
2. Observe Plant Calibration.	• Check for proper procedures per IM 508. • Check for approved JMF. • Check stockpile certifications. • Check plant settings.	District Materials HMA I	As Per DME
3. Materials Certifications.	• Check for approved aggregate sources. • Check certified aggregate truck tickets. • Check for approved asphalt binder source. • Check certified asphalt binder truck tickets. • Check for approved release agents per IM 491.15.	District Materials HMA I	Check at Time of Calibration and When Material Changes
4. Documentation.	• Review plant calibration. • Review job mix formulas.	District Materials HMA II	At Startup of Each Mix
	• Review entries in the Daily Plant Report. • Review entries in Plant Program for pay quantities and PWL.	Construction HMA I	First Day and Weekly Thereafter
	• Review quality control charts. • Review PWL data.	District Materials HMA I	Weekly

	• Obtain files of project documentation:
	  ○ Daily Plant Reports
	  ○ Correlation Summary Sheets
	  ○ Quality Control Charts
	  ○ Delivery Tickets
	  ○ Submitted Forms
		Construction	At End of Project

5. Inspect Stockpiles.	• Observe stockpiling procedures per IM 508. • Check for segregation. • Check for contamination. • Check for intermingling of stockpiles.	District Materials HMA I	First Day and Weekly Thereafter

Other Required Asphalt Mixture Acceptance Responsibilities

Duty	Task	Performed By / REQ'D. CERT.	Minimum Frequency
6. Aggregate Proportioning.	• Inspect method of securing cold-feed bin gate settings. • Monitor actual cold-feed gate and belt speed settings. • Monitor aggregate proportions. • Monitor interlocks.	District Materials HMA I	At Startup and When Problems Arise

7. Plant Operations.	• Observe coating of aggregates.
	• Observe mixing time (batch plant).
	• Prevent segregation:
	  ○ Observe truck loading.
	  ○ Observe level of mix in the silo.
	  ○ Observe operation of hopper/silo gates.
		District Materials or Construction
		HMA I
			At Startup and When Problems Arise

	• Monitor trucks for improper use of cleaning fluids per specification 2001.01.	District Materials or Construction HMA I	At Startup and Weekly Thereafter

8. Plant Adjustments.	• Participate in discussion of mix design adjustments. • Document proportion changes.	District Materials HMA II	Each Occurrence
9. Inspect Plant Facility.	• Check if lab qualification is current. • Check for all required test equipment. • Check for computer, fax, copier, and phone.	District Materials HMA I	At Startup
10. Check Weighing Equipment.	• Monitor check weighing. • Monitor verification weighing. • Monitor sensitivity check.	Construction HMA I	First Day and Weekly Thereafter
	• Witness truck tare weighing at random.	Construction HMA I	Once Per Project
11. Asphalt Binder Quantity Determination.	• Witness the In-Line Flow Meter calibration. • Monitor tank sticking procedures, when used for making asphalt binder yield checks.	Construction HMA I	First Day and Weekly Thereafter

MAPLE

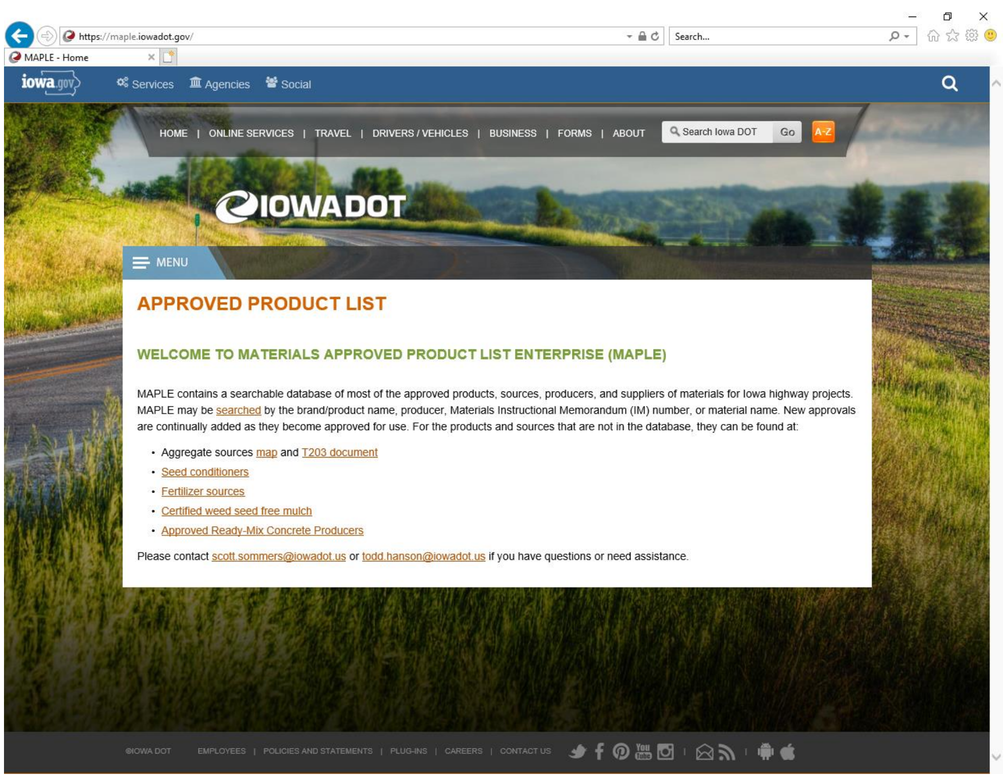
User's Guide for
Materials Approved List Enterprise (MAPLE)

1. Introduction

The Iowa DOT Materials Approved List Enterprise (MAPLE) has been in service for all users since July 2014. The MAPLE allows users to check all products approved in Iowa from a single data base. This document is to provide instruction on how to use the MAPLE.

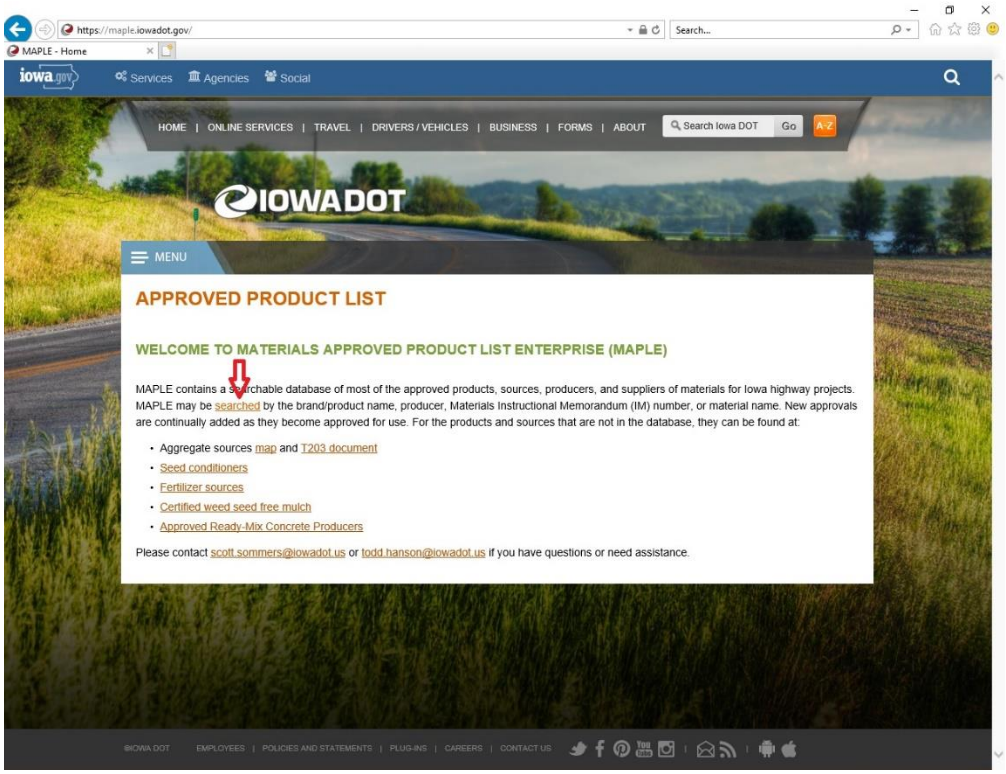
2 How to get to MAPLE

The MAPLE can be reached at: https://maple.iowadot.gov/

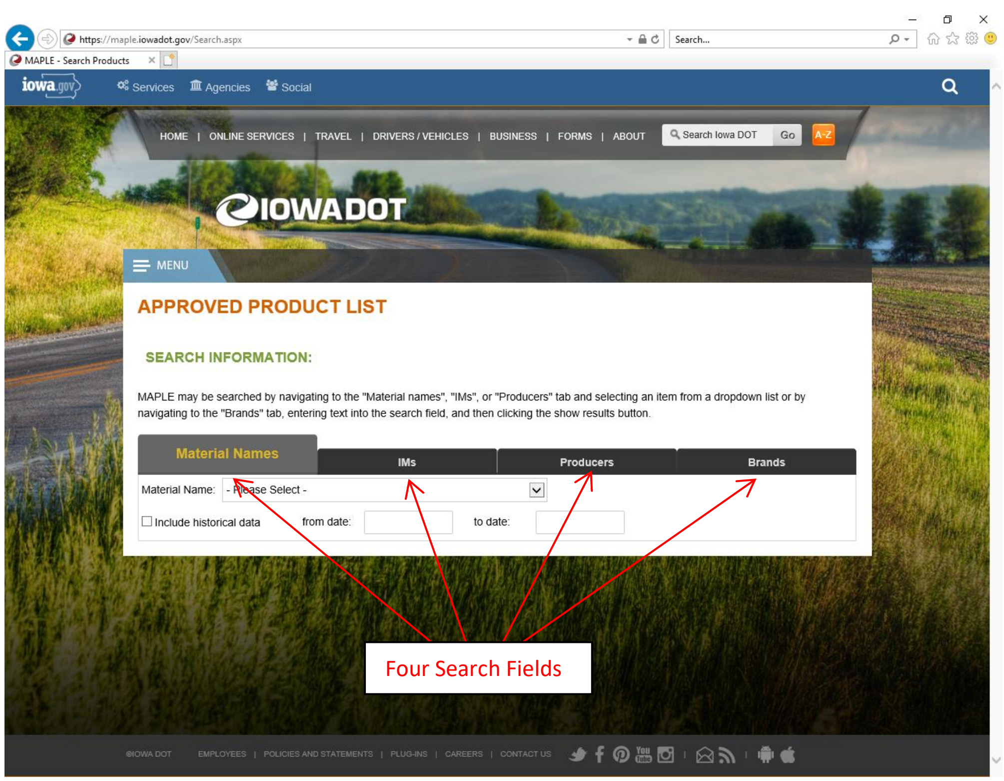


3. Searching MAPLE

Click on the **Searched** link as shown below.

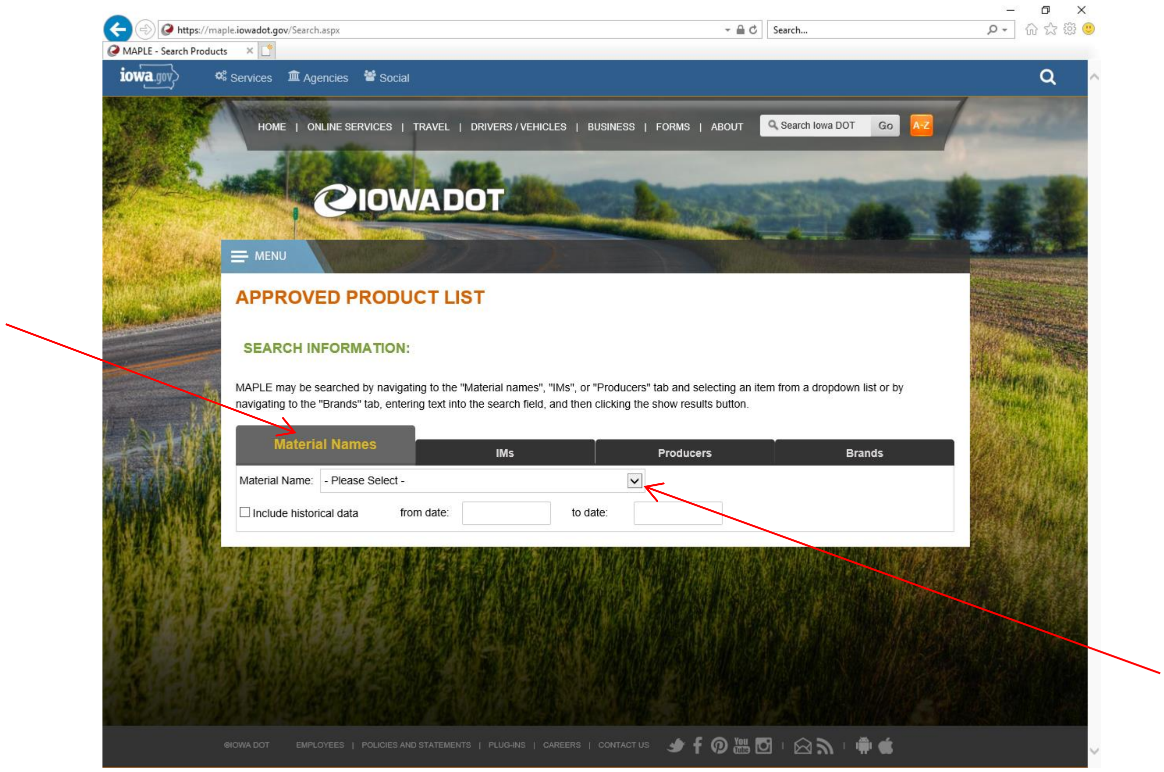


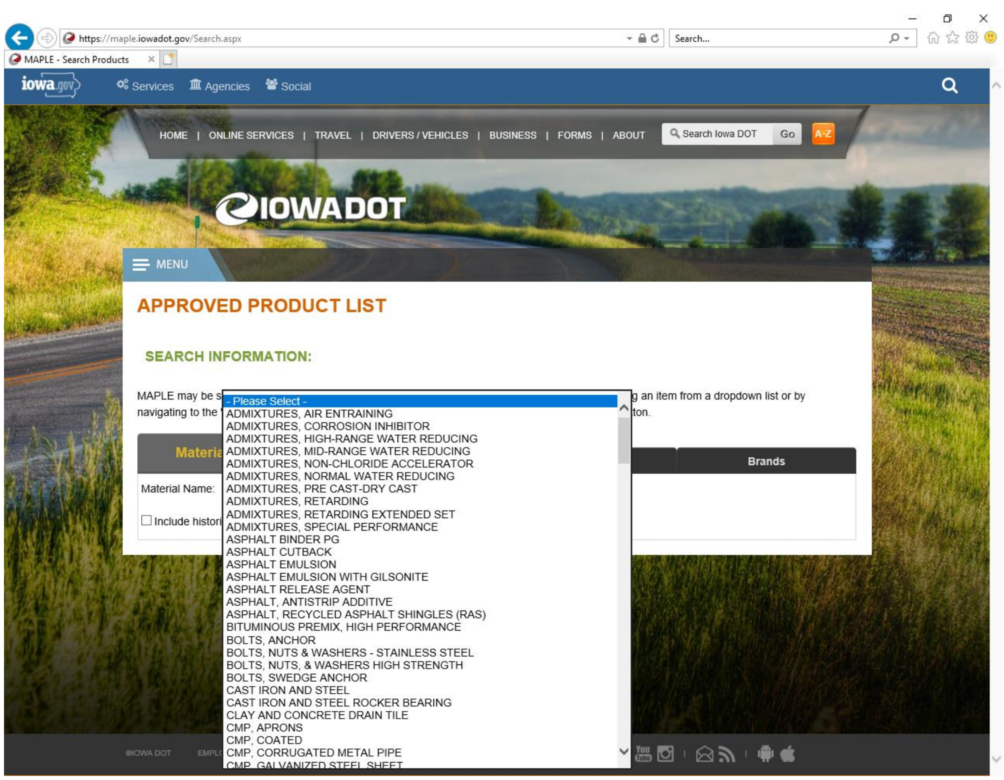
The user can search **MAPLE** through one of four fields listed: **Material Names, IMs, Producers, and Brands**.



4. Search by Material Names

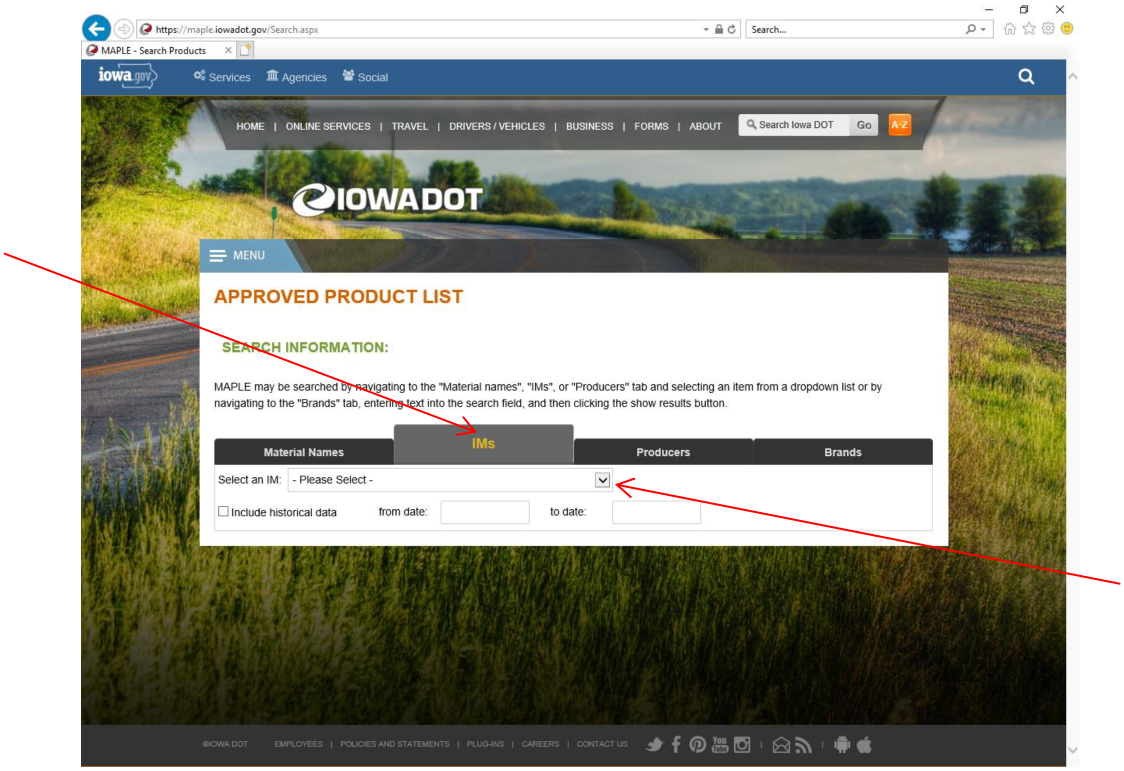
Click on the **Material Names** tab to search by type of material. Click on the arrow and a list will appear as shown. Click on any of the material names to produce an approved product list.

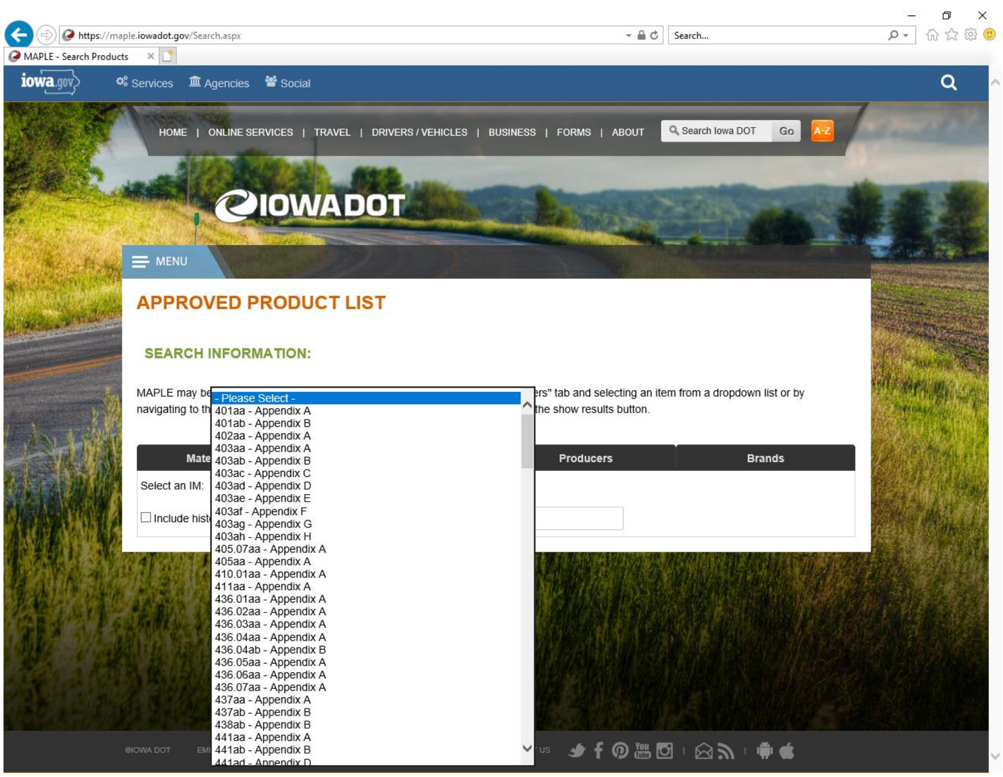




5. Searching by IMs

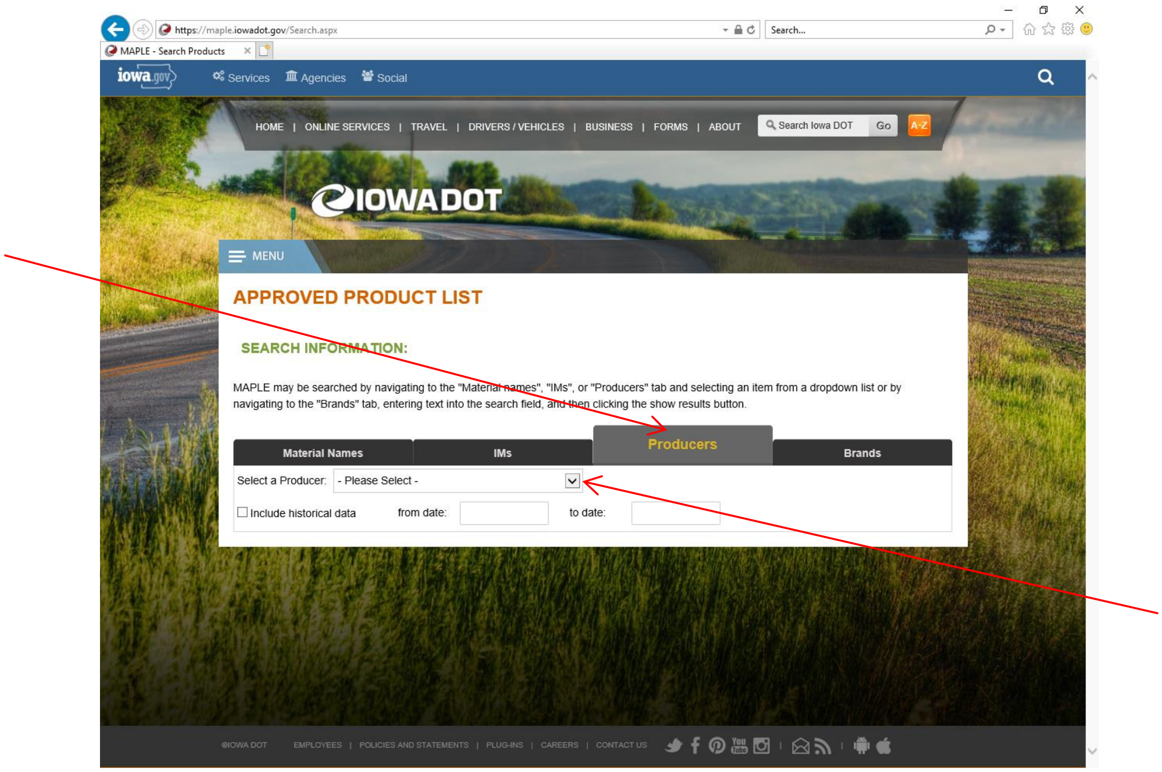
Click on the **IMs** tab to search by IM number. Click on the arrow and a list will appear as shown. Click on any of the IM's listed to produce a list of approved products in that IM.

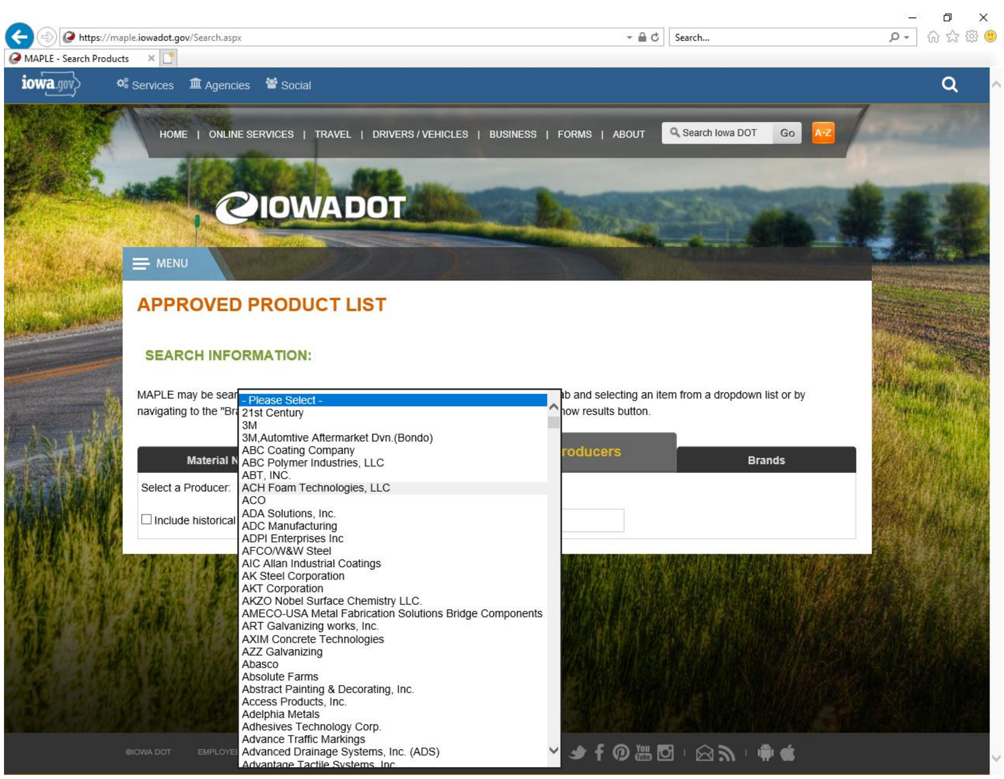




6. Searching by Producers

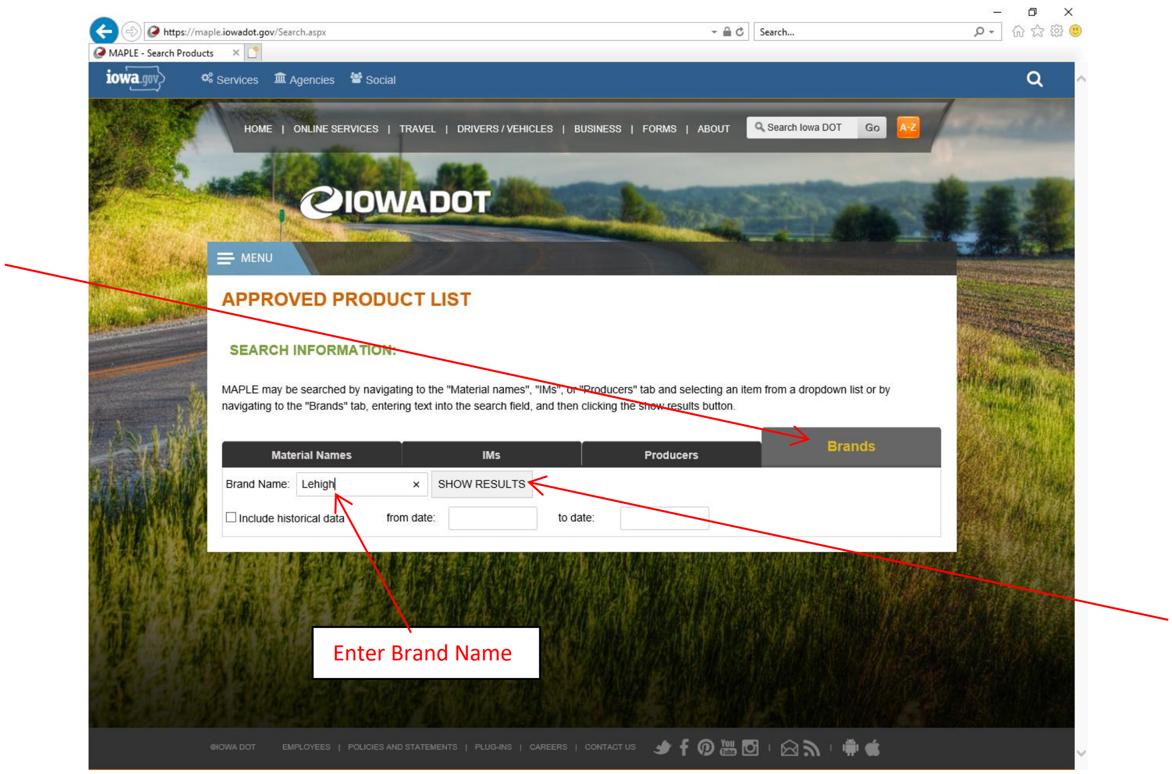
Click on the **Producers** tab to search by producer. Click on the arrow and a list will appear as shown. Click on any producer for a list of all approved products manufactured by that particular producer.

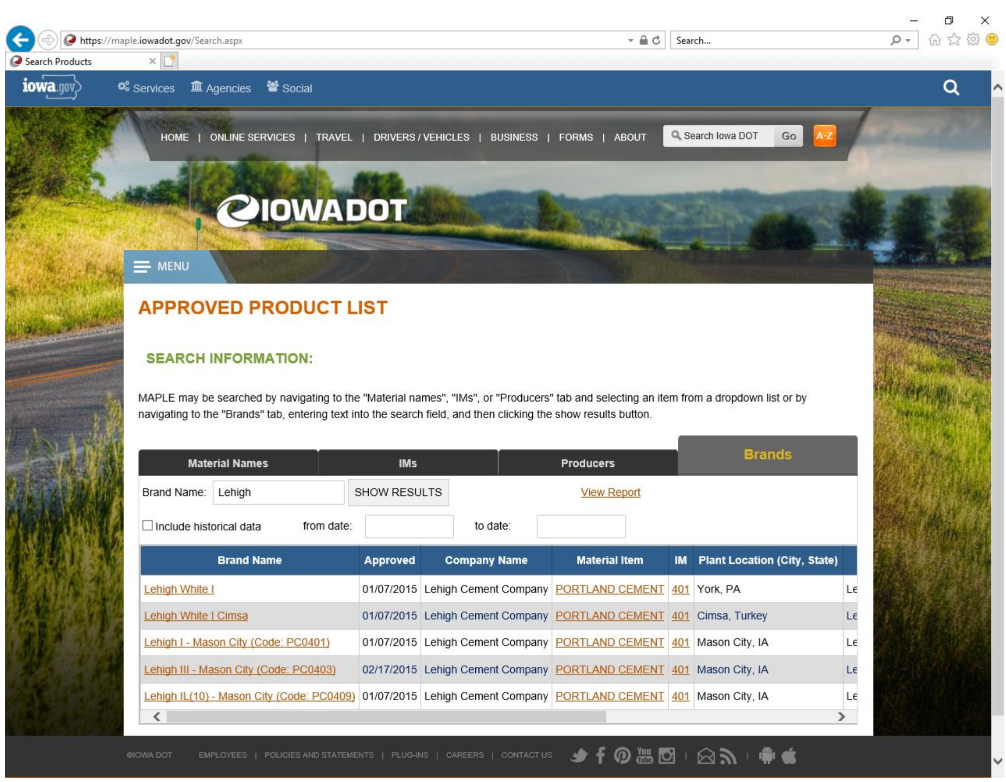




7. Searching by Brand Name

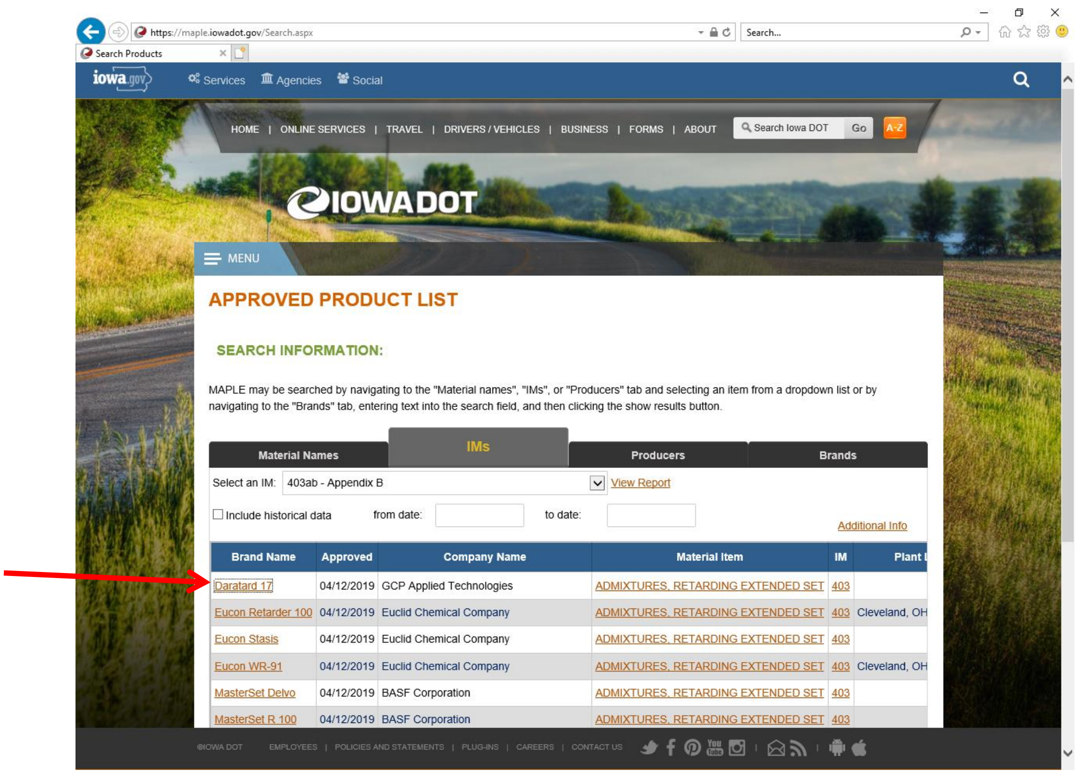
Click on the Brands tab to search by freeform typing the brand name of the product.



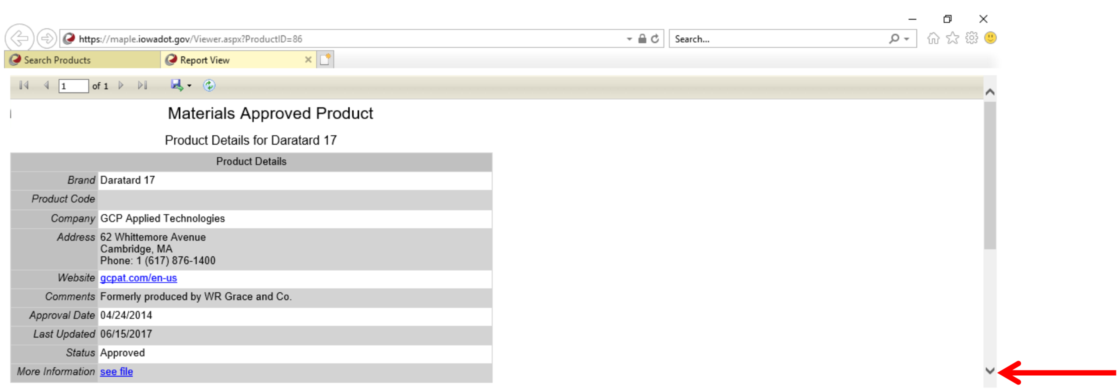


8. Selecting a Product

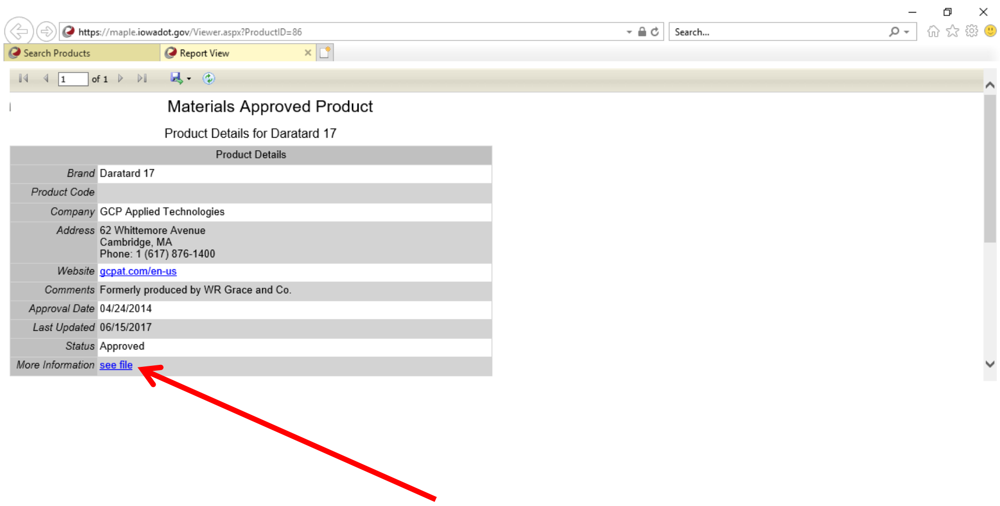
After a list of products has been displayed, click on the individual Brand Name to display more information about the product.



You can use the scroll bar on the right to scroll down for more information.



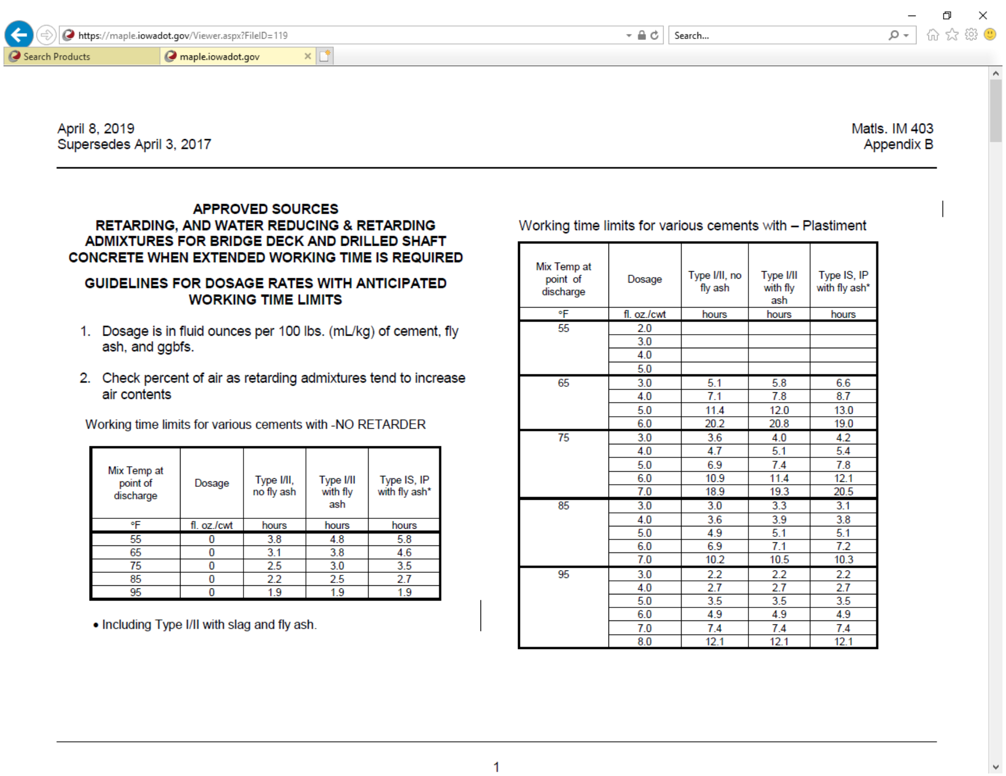
Some products may have a link in the **More Information** field. A pdf with the additional information will appear after clicking on see file. Additional info may be found on the following IM's: 403ab, 445.01ab, 451ad, 455.02aa, 455aa, 462aa, and 557ab.



Materials Approved Product

Product Details for Daratard 17

Product Details	
Brand	Daratard 17
Product Code	
Company	GCP Applied Technologies
Address	62 Whittemore Avenue Cambridge, MA Phone: 1 (617) 876-1400
Website	gcpat.com/en-us
Comments	Formerly produced by WR Grace and Co.
Approval Date	04/24/2014
Last Updated	06/15/2017
Status	Approved
More Information	see file



April 8, 2019
Supersedes April 3, 2017

Matls. IM 403
Appendix B

APPROVED SOURCES
RETARDING, AND WATER REDUCING & RETARDING ADMIXTURES FOR BRIDGE DECK AND DRILLED SHAFT CONCRETE WHEN EXTENDED WORKING TIME IS REQUIRED

GUIDELINES FOR DOSAGE RATES WITH ANTICIPATED WORKING TIME LIMITS

1. Dosage is in fluid ounces per 100 lbs. (mL/kg) of cement, fly ash, and ggbfs.
2. Check percent of air as retarding admixtures tend to increase air contents

Working time limits for various cements with -NO RETARDER

Mix Temp at point of discharge	Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type IS, IP with fly ash*
°F	fl. oz./cwt	hours	hours	hours
55	0	3.8	4.8	5.8
65	0	3.1	3.8	4.6
75	0	2.5	3.0	3.5
85	0	2.2	2.5	2.7
95	0	1.9	1.9	1.9

• Including Type I/II with slag and fly ash.

Working time limits for various cements with – Plastiment

Mix Temp at point of discharge	Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type IS, IP with fly ash*
°F	fl. oz./cwt	hours	hours	hours
55	2.0			
	3.0			
	4.0			
	5.0			
65	3.0	5.1	5.8	6.6
	4.0	7.1	7.8	8.7
	5.0	11.4	12.0	13.0
	6.0	20.2	20.8	19.0
75	3.0	3.6	4.0	4.2
	4.0	4.7	5.1	5.4
	5.0	6.9	7.4	7.8
	6.0	10.9	11.4	12.1
	7.0	18.9	19.3	20.5
85	3.0	3.0	3.3	3.1
	4.0	3.6	3.9	3.8
	5.0	4.9	5.1	5.1
	6.0	6.9	7.1	7.2
	7.0	10.2	10.5	10.3
95	3.0	2.2	2.2	2.2
	4.0	2.7	2.7	2.7
	5.0	3.5	3.5	3.5
	6.0	4.9	4.9	4.9
	7.0	7.4	7.4	7.4
	8.0	12.1	12.1	12.1

1

Clicking on **View Report** will enable the user to export the list  to Excel, Word, or a pdf file.