HOT MIX ASPHALT

REFERENCE MANUAL 2007 – 2008

TECHNICAL TRAINING AND CERTIFICATION PROGRAM

Iowa Department of Transportation

LEVEL 1 HMA CERTIFIED TECHNICIAN
REFERENCE MANUAL

IM 204 – Inspection of Construction Project Sampling and Testing

IM 205 – Quality Assurance Program for Construction – Overview & Description

IM 207 – Independent Assurance Program for Construction – Overview & Description

IM 208 – Materials Laboratory Qualification Program

IM 213 – Asphaltic Concrete & Portland Cement Concrete Certification Program

IM 216 – Guidelines for Verifying Certified Testing Results

IM 301 – Aggregate Sampling Methods and Determination of Minimum Size of Samples for Sieve Analysis

IM 320 – Method of Sampling Compacted Pavement Layers

IM 321 – Method of Test for Compacted Density of Asphaltic Concrete (Displacement Method)

IM 322 – Methods of Sampling Uncompacted Asphalt Concrete

IM 323 – Method of Sampling Asphaltic Materials

IM 325G – Method of Test for Determining the Density of Hot Mix Asphalt (HMA) By Means of the Superpave Gyratory Compactor (SGC)

IM 337 – Determining Thickness of Completed Courses of Base, Sub-base and Asphalt Concrete

IM 350 – Maximum Specific Gravity of Asphalt Paving Mixtures Field Procedure for Central Laboratory Test Method

IM 351 – Method of Determining Asphalt Content in Asphaltic Concrete Mixtures by Calculation

IM 357 – Method of Preparation of Bituminous Mix Samples for Test Specimens

IM 380 – Method of Test for Vacuum Saturated Specific Gravity and Absorption of Combined or Individual Aggregate Sources (Field Procedure for Central Laboratory Test Method No. 220A)

IM 437 – Inspection and Acceptance – Asphalt Cement 4137, Cutback Asphalt 4138, and Emulsified Asphalt 4140

IM 491.04 – Inspection and Acceptance of Hydrated Lime

IM 491.15 – Inspection and Acceptance of Release Agents for Bituminous Material

IM 491.16 – Inspection and Acceptance of Anti-Strip Agents

IM 501 – Asphaltic Terminology, Equations and Example Calculations

IM 508 – Asphaltic Concrete Plant Inspection

IM 509 – Tank Measurement and Asphalt Cement Content Determination

IM 510 – Method of Design of Hot Mix Asphalt Mixes

IM 511 – Control of Hot Mix Asphalt Mixtures

IM 514 – Verification of Field Density for Asphalt Concrete Paving

T101C – Aggregate Delivery Conversion Table

T101M – Aggregate Delivery Conversion Table – Metric

T102C – Temperature – Volume Corrections for Asphaltic Materials

T102M – Temperature – Volume Corrections for Asphaltic Materials – Metric

T103C - Temperature – Volume Corrections for Asphaltic Materials

T103M – Temperature – Volume Corrections for Asphaltic Materials – Metric

T104 – Gauging Table for Horizontal Cylindrical Tanks

T105 – Outage of Horizontal Cylindrical Tanks

T108 - Temperature – Volume Corrections for Emulsified Asphalts

T108 A - Temperature – Volume Corrections for Diluted Emulsified Asphalts

T203 – General Aggregate Source Information

Construction Manual – Section 2.53 – Price Guide

Construction Manual – Section 3.07 – Requirements for Monitoring

Construction Manual – Section 3.22 – Aggregate Gradation Testing, Sampling & Evaluation

Construction Manual – Section 3.5 – Weighing Equipment for Pay Quantities

Construction Manual – Chapter 8 – ACC Pavement, Bases, and Subbases

Standard Specification– 2001 with GS–01013 Revisions – Equipment Requirements

Standard Specification– 2303 with GS–01013 Revisions – Hot Mix Asphalt Mixtures

SS – 01042 Supplemental Specification for Hot Mix Asphalt (Gyratory Mix Design For Local Systems)

SS – 01045 Supplemental Specification for Recycled Asphalt Pavement (RAP)

SS – 01049 Supplemental Specification for Quality Control Program for Small HMA Paving Quantities

DS – 01003 Developmental Specifications For Hot Mix Asphalt Mixtures - Job Mix Formula Approval By Test Strip Method

SP – 010223 Special Provision For HMA 100M Esal Intermediate and Surface Mixtures

*****GENERAL REWRITE – PLEASE READ CAREFULLY.*****

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 Sources
Approved Shop Drawings
Approved Catalog Cut
Fabrication Report
Visual Approval by the Engineer

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 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 required, 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 IM. 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, clay tile, and corrugated plastic subdrain,
- In the form of a guaranteed analysis as with seed labels.

The inspector will verify that the certification has been received by documenting it in the project materials book. Certifications are Type A, Type C, Type D, or other type as required by the Engineer or IM.

Type A Certification

A Type A certification is a laboratory report with test results and a certification statement stating that the materials furnished comply with the specifications. The tests may be conducted in the manufacturer laboratory or another qualified laboratory. The test samples must be from the lots of material shipped.

Type C Certification

A Type C certification is a paper prepared by the manufacturer or producer stating that the materials furnished are in accordance wit the specifications. The applicable specification article or Office of Materials IM number is identified in the certification.

Type D Certification

A Type D certification is a letter or paper prepared by an approved manufacturer stating that the materials furnished comply with the applicable specifications of the Iowa Department of Transportation.

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 Materials according to the appropriate Office of 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). Approved lists are issued biannually for general information only. Approval for a source or producer may be rescinded at any time if it no longer meets the requirements of the IM.

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

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 Central Design Offices, before the material can be incorporated in the project.

F. FABRICATION REPORT

The project inspector must have a copy of the final fabrication 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 materials book. 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 mulch or 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

Refer to Appendix X.

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	Hot Mix Asphalt (QMA)
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, 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

ROADWAY & BORROW EXCAVATION & EMBANKMENTS

Section 2102 & 2107

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														
Special Backfill														
Crushed Stone (4132.02)		AS 209												
Crushed Concrete (4132.02)		209												
RAP (2303.02) Gravel (4132.03)		AS 209												
Granular Backfill		AS 209												
Engineering Fabric (4196)	Quality	AS 496.01												
GRADE INSPECTION														
Special & Select Backfill Compaction Control	Moisture	309, 310						V	RCE	1/lift/ 1500 ft.	1 lb	RCE	Field Book	
Moisture & Density Compaction Control	Density (Proctor) Moisture	309, 310						V	RCE	1/soil class 1/lift/1500 ft.	25 lb 1lb	RCE	Field Book	
Compacted Materials	Density	311, 326, 334						V	RCE	1/lift/mile or 1/1500 cy		RCE	Field Book	Unless otherwise specified or directed

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

SOIL AGGREGATE SUBBASE
Section 2110

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														
Granular Surfacing Material (4120)		AS 209												
GRADE INSPECTION														
Mixed Materials (2110)	Density (Proctor)	309						V	RCE	2/mile (min. 2/proj.)	5000 gm	RCE	Field Book	Change of Soil type requires additional Proctors
Uncompacted Mixture	Pulverization Moisture	2" Sieve Visual						V	RCE	2/mile		RCE	Field Book	
Compacted Mixture (2110)	Density Thickness Width	311, 312, 334 337						V	RCE	2/mile		RCE	Field Book	
Finished Subbase	Cross Section	Stringline						V	RCE	10/mile		RCE	Field Book	Template for secondary park & institutional roads

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

MODIFIED SUBBASE

Section 2115

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														
Natural Aggregate	Quality Gradation	AS 209												
Recycled Products														
Composite	Gradation	*As Per Spec.												
PCC Pavement	Gradation	*As Per Spec.												
Rap		*As Per Spec.												
GRADE INSPECTION														
Compacted Subbase	Density	*As Per Spec.						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	3/2 lane mi.		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	10/mi.		RCE	Field Book	
	Cross Section (Other)	Template						V	RCE	3/mi.		RCE	Field Book	

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

* Use Current Specification for Modified Subbase

GRANULAR SUBBASE
Section 2111

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														
Natural Aggregate (4121)	Quality Gradation	AS 209												
PCC Pavement	Gradation	209												
GRADE INSPECTION														
Compacted Subbase (2111)	Density	By Specification						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	3/2 lane mi.		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	10/ mi.		RCE	Field Book	
	Cross Section (Others)	Template						V	RCE	3/mi		RCE	Field Book	

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

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	REPT.	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregate-Coarse (4115), Intermediate		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compounds (4105)	Lab-Tested													
Clear Curing Compounds (4105)		AB 405.07												
Air Entraining Admixture (4103)	Quality	AB 403												
Water Reducing Admix. (4103)	Quality	AB 403												
Retarding Admixture (4103)	Quality	AB 403												
Joint Sealer (4136.02)	Lab Tested	436.01, 436.02,436.03												
Backer Rod (4136.02)	Lab Tested	AB 436.04												
Mixing Water (4102)	Lab Tested							V	RCE/ CONTR	1/ source	1 pint	CTRL		Not required for potable water from municipal supply

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

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Appendix E (US) Units

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														
Steel Reinforcement (4151)														
Dowels	Quality	AS 451												
Tie Bars	Quality	AS 451												
General Use	Quality	AS 451												
PLANT INSPECTION														
Aggregates-Fine (4110/4111)	Grad * QMC	302 306 336	CONTR	1/1500cy	IM 301	CONTR	800240	IA V	DME RCE CONTR	1/100,000 sy, sample 1/day, test 1st day + 2/lot	IM 301 IM 301	DME RCE/ DME		See Notes See IM 213
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 sy, sample 1/day, test 1st day + 1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308, 527	CONTR	1/half day	1000 gm	CONTR								Not applicable with probe
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												

AS-Approved Source	Cert A-Type A Certification	RCE-Resident Construction Engineer/Project Engineer	IA-Independent Assurance
ASD-Approved Shop Drawing	Cert C-Type C Certification	DME-District Materials Engineer	V-Verification
S&T-Sampling & Testing	Cert D-Type D Certification	CTRL-Central Materials Office	
		CONTR-Contractor	QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

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.	SAMP. SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115), Intermediate	Grad * QMC	302 306 336	CONTR	QMC 1/1500 cy	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 sy Sample 1/day,test 1st day+2/lot	IM 301 IM 301	DME RCE/ DME		See Notes
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 sy, sample 1/day, test 1st day + 1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308	CONTR	1/half day	IM 301	CONTR								
	Sp. Gr.	307	CONTR	IM 527	IM 301	CONTR								
	Quality	AS 209						V	DME	1/100,000 sy	50 lb	CTRL		
Portland Cement (4101)	Quality	AS Cert D		Each Load				V	DME	1/100,000 sy	15 lb	CTRL		
	Cement Yield		CONTR	1/10,000 cy		CONTR	820912							
Fly Ash	Quality	AS Cert D		Each Load			800240	V	DME	1/100,000 sy	15 lb	CTRL		
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert		Each Load				V	DME	1/100,000 sy	15 lb	CTRL		
Air Admixture	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		Sample batches not previously reported or as required by DME
Water Reducer	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		
Retarding Admixture	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
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DME-District Materials Engineer
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CONTR-Contractor
IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.
NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.
NOTE: Quality samples not required when mix quantity is less than 2000 sq. yds., except for curing compound.
NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

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	REPT.	S&T TYPE	SAMP. BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	
GRADE INSPECTION														
Chloride Solution	Concentration	373	RCE	1/day										
Steel Reinforcement:														
Dowels	Quality	AS 451.03B						V	DME	1/District/Yr	2 ft	CTRL		
Dowel Basket Assembly	Quality	AS 451 Cert D 451.03B												
Tie Bars	Quality	AS 451						V	DME	1/District/Yr	2 ft	CTRL		
General Use	Quality	AS 451						V	DME	1/District/Yr	48 in	CTRL		
Curing Compound	Quality	Tested 4105						V	DME	1/batch	1/qt	CTRL		Sample batches not previously reported or as required by DME
Plastic Concrete	Air	318 327	QMC CONTR	QMC only 2301.04C 1/350 cy		QMC CONTR	E115	IA V	DME RCE	1/100,000 sy 2301.04C 1/700 cy, 1/100 cy for transit mixer		DME RCE		Min. 1 test/pour
	Slump	317						V	RCE	1/700 cy, min 1/pour		RCE		For hand finish or fixed form only
	Grade Yield		RCE	1/1000 cy		RCE								
	Beams**	316, 327, 328	RCE	2/day		RCE	E115							
Hardened Concrete	Thickness*	346, 347						IA V	DME RCE/ CONTR	1/2000 sy	10%	DME RCE		
	Smoothness	341 Cert. Test Rept.	CONTR		100%	CONTR		V	DME		10%	DME		

AS-Approved Source
ASD-Approved Shop Drawing
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Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
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V-Verification
QMC-Quality Management Concrete

*IA thickness cores sent to Central Lab for additional project information testing (Interstate and Primary only.)

**None required when maturity is used. Quality samples not required when mix quantity is less than 2000 sq. yds., except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer. **NOTE:** Form #E115 available from the Office of Construction.

Sampling & Testing Guide-Minimum Frequency

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT
Section 2303, 2213, & 2114

Matls. IM 204
Appendix F (US) Units

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 (4126/4127)		AS 491.04												
Asphalt Binder		AS 437												
Emulsions & Cutbacks		AS 437												
Release Agent		AB 491.15												
PLANT INSPECTION														
Aggregates (2303)	Quality							V	DME	1/20,000 Ton	50 lb.	CTRL		
Combined Aggregate (4126, 4127)	Gradation		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								Dryer Drum Plants Only

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

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

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT
Section 2303, 2213, & 2114

Matls. IM 204
Appendix F (US) Units

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	
PLANT INSPECTION														
Mineral Filler								V	DME	1/project	5 kg	DME	821278	
Asphalt Binder	DSR Quality	AS Cert D						V V IA	RCE/ CONTR DME	Sample 1/day Test 1st 3days + 1/week 1/20,000 T of Mix Systems Approach	4 oz tin 1 qt	DME CTRL		Log all shipments
Cutback		AS 329												Log all shipments
Emulsion	Residue	AS 360						V	RCE	1/project	1 qt	DME		Plastic bottle required
GRADE INSPECTION														
Uncompacted Mixture:	Lab Density & Lab Voids	321, 350 325G	RCE/ CONTR	As per 2303	30 lb	CONTR		V IA	RCE/ CONTR	As per 2303 Test 1/day Systems Approach	30 lb	DME		May be adjusted by DME as per 2303
Compacted Mixture	Density, Thickness & Voids	320, 321 337	RCE/ CONTR	Lot	7/lot	RCE		IA	DME	1 lot/project*		DME		
	Smoothness	341	CONTR	100%	100%	CONTR		V	DME	10%		DME		

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

* A system approach may be applied at the discretion of the DME.

__NOTE__: Verification 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.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

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														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Granular Backfill (4133)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality								RCE	1/project	1 L	CTRL	731	Not required for potable water from Municipal Supply
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Water reducing Admixture	Quality	AS 403												Sample batches not previously reported or as required by DME
Curing Compound, White (4105)	Lab Tested	AS 405						V	DME	1/batch	1qt	CTRL		Bridge Barrier Rails AASHTO, M148, Cert. by Manufacturer
Curing Compound, Clear (4105)		AS 405.07												

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS
Sections 2403, 2404, 2405, 2406, 2412, & 2415

April 17, 2007
Supersedes October 17, 2006

Matls. IM 204
Appendix H (US) Units

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														
Pre-formed Joint Sealer (4136)	Lab-Tested	AS 436.02 436.05												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Steel Pile (4167)	Quality	467												
Concrete Pile (4166)	Quality	AS 570												
Timber Pile (4165)	Quality	Cert A 462 AS												
Timber (4162) & Lumber (4163		Treated-Cert A 462 AS												
Concrete Anchors	Quality	AS 453.09												
Epoxy Grout	Quality	AS 491.11												
Concrete Sealer	Quality	AS 491.12												
Subdrain Pipe (4143)	Quality	AS 443, 448												
Neoprene Bearing Pads (4195)		AS 495.03												
Bronze Bearing Plates (4190.03)		AS D/Cert A												

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

April 17, 2007
Supersedes October 17, 2006

Matls. IM 204
Appendix H (US) Units

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														
Steel Masonry Plate (4152)		ASD/Cert A												
Precast Units (2407)	Quality	AS 570												
Anchor Bolts (lighting, signing, handrail) (4153)	Lab Tested	ASD												
Structural Steel (4152)	Quality	Cert A												Monitor Sample According to plans or other instructions
Aluminum Bridge Rail & Anchor Assembly		ASD												
Conduit (Electrical) (4185.10)) Steel		AS												
Conduit (Plastic) (4185.10)	Lab Tested							V	DME	1/size	4'	CTRL		
Bentonite		Visual												
Flowable Mortar	Lab Tested	Approved Trial Mix 525, 375												Tested by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

April 17, 2007
Supersedes October 17, 2006

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

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	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/1000 cy Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May Use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA	DME RCE/ CONTR	1-1000 cy Sample 1/wk Test 1st day +20%	IM 301 IM 301	RCE		May Use System App.
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/1000 cy Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May Use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/1000 cy Sample 1/wk Test 1st day +20%	IM 301 IM 301	DME RCE		May Use System App.
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/1000 cy	50 lb	CTR L		
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/1000 cy	15 lb	CTR L		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

__NOTE:__ RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

April 17, 2007
Supersedes October 17, 2006

Matls. IM 204
Appendix H (US) Units

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	
PLANT INSPECTION														
Fly Ash	Quality	AS Cert D		Each Load			800240							
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert D		Each Load										
Air-Entraining Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	RCE	1/batch	0.5 L	CTRL		
Water Reducing Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					E145*	IA V	DME RCE	1/1000 cy 1/30 cy		DME RCE		DME may adjust
	Slump	317, 327						IA V	DME RCE	1/1000 cy 1/30 cy		Witness Only RCE		DME may adjust
	Beams	316, 327, 328							RCE	2/placement		RCE		If required per 2403.18 and 2403.19
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
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CONTR-Contractor
IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

*Available from the Office of Construction.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

April 17, 2007
Supersedes October 17, 2006

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TES BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	IM 451	6 ft	CTRL		
Reinforcing Steel Epoxy Coated (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	1 of largest bar in deck	6 ft	CTRL		Will be acceptance tested for coating
Steel Pile (4167)	Quality	AS Cert A		Each Heat			Field Book		DME	IM 467		CTRL		
Timber Pile (4165)	Quality	AS 462 Cert A						V	DME	IM 467		CTRL		No grade requirement Charge numbers on butt end.
Anchor Bolts (lighting, signing, handrail)	Lab Tested	ASD						V	DME	1/project	1 bolt w/nut & washer	CTRL		Sample only if not source inspected
Steel Masonry Plates (4152)		ASD Cert A		Each Shipment			Field Book							Approved by Materials Department
Bronze Bearing Plates (4190.03)	Lab Tested							V	DME	1/project	1 only	CTRL		Sample only if not source inspected
Neoprene Bearing Pads (4195)		AS 495.03		Each Shipment			820905							
Alum. Bridge Rail & Anchor Assembly		ASD		Each Shipment			Field Book							Approved By Materials Dept.
Drains (Std Steel Pipe)(as per plan)	Dimensions Galvanized	ASD Visual 332						V	DME	1/project		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

<u>**NOTE:**</u> RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

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														
Timber (4162) & Lumber (4163)	Quality	AS 462 Treated-Cert A												
Subdrain Pipe (4143)	Quality	AS Cert D 443, 448		Each Shipment										
Flowable Mortar (2506)	Flow Test	375	RCE	As needed for Project Control		RCE	830211							Mix Design approval by DME
Bentonite	Flow Test	Visual 375				RCE								
Smoothness (2317)	Profilometer	Cert. Test Report 341	CONTR	Each Project	Each Wheelpath	CONTR	821301	V		10%	DME			

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

Verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

October 17, 2006
Supersedes October 18, 2005

Matls. IM 204
Appendix I

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														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality								DME	1/project	1 quart	CTRL	731	Not required for potable water from Municipal Supply
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Permanent Casing	Quality	Cert A												According to plans or other instructions
Drilling Slurry		Visual DS-01038												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

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	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation	302, 306 336	CONTR	3/lot	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/1000 cy 1st day+20%	IM 301 IM 301	DME RCE		System Approach Applicable
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation	302, 306 336	CONTR	3/lot	IM 301	CONTR		IA	DME RCE/ CONTR	1/1000 cy 1st day+20%	IM 301 IM 301	DME RCE		System Approach Applicable
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/1000 cy	50 lb	CTRL		
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/1000 cy	15 lb	CTRL		
Fly Ash	Quality	AS Cert D		Each Load			800240							
Air-Entraining Admixture (4103)		AS 403						V	DME	1/batch	1 pint	CTRL		Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	DME	1/batch	1 pint	CTRL		Sample lots not previously reported or as required by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

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														
Plastic Concrete	Air Content	316, 327					E145*	IA	RCE	1/30 cy		RCE		DME may adjust
	Slump	317, 327	RCE	1/30 cy		RCE		IA	DME	1/30 cy		RCE		DME may adjust
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book							
Metal Access Pipe		Visual												
Drilling Slurry	Density, Viscosity, pH, Sand Content	387	CONTR	1/ 2 hours		CONTR								1/ 4 hours if consistent
Crosshole Sonic Log Test		SS-01032	CONTR	1/shaft		CONTR	Report, Analysis, Inter-pretation							

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

*Available from the Office of Construction.

COLD-IN-PLACE RECYCLED ASPHALT PAVEMENT

Section 2318, DS-01076

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														
Asphalt Stabilizing Agent	Quality	AS 437												
GRADE INSPECTION														
RAP (2318.02)	Max Size		RCE	1st day + 1/week	10 lb	RCE		V						
Stabilizing Agent (Engr. Emulsion)	Quality Residue	Cert D 360						V	RCE/CONTR RCE/CONTR	1/project 1/day (2)	1 qt 1 qt	CTRL DME		Must use plastic bottle for emulsion
Stabilizing Agent (Foamed Asphalt)	Quality DSR	Cert D						V	RCE/CONTR RCE/CONTR	1/project 1/day (2)	1 qt 1 qt	CTRL DME		
Stabilizing Agent (Std. Emulsion)	Quality Residue	Cert D 360						V	RCE	1/day(2)	1 qt	DME		Must use plastic bottle for emulsion
Uncompacted Mixture	Moisture Density	504 504						V	RCE	1/lot	30 lb	DME		Sealed Container
Compacted Mixture	Moisture(1) Density	504 504	CONTR CONTR	10/lot 10/lot		CONTR CONTR								Witnessed by RCE
Smoothness		DS-01076 only												

AS-Approved Source ASD-Approved Shop Drawing S&T-Sampling & Testing	Cert A-Type A Certification Cert C-Type C Certification Cert D-Type D Certification	RCE-Resident Construction Engineer/Project Engineer DME-District Materials Engineer CTRL-Central Materials Office CONTR-Contractor	IA-Independent Assurance V-Verification

(1) See IM 504 for Day 1 moisture correction factor.
(2) The sample from the first day and 1/week shall be forwarded to the District Laboratory for testing. The other samples shall be retained for submission in the event of a failing test result.

GRANULAR SURFACING/DRIVEWAY SURFACING

Sections 2312 & 2315

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														
Class C Gravel (4120.03)	Gradation Quality	AS 209												
Class A Crushed Stone (4120.04)	Gradation Quality	AS 209												
Class B Crushed Stone (4120.05)	Gradation Quality	AS 209												
Class D Crushed Stone (4120.06)	Gradation Quality	AS 209												
Aggregate for Type B, AC or cold laid Bituminous Concrete (for driveways only)	Gradation Quality	AS 209												
Crushed Stone Base (For driveways only) (4122)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Slope		RCE	3/mi.			Field Book							

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

Sampling and Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

CONCRETE BRIDGE FLOOR REPAIR & OVERLAY & SURFACING

Section 2413

Matls. IM 204
Appendix M

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-Fine (4110)		AS 209												
Aggregates-Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Mixing Water (4102)	Quality	Lab Tested						V	RCE	1/source	1 qt.	CTRL		Not needed for potable Municipal Water
Air Entraining Admixture (4103)	Quality	AS 403												
Water Reducing Admixture (4103)	Quality	AS 403												
Retarding Admixture (4103)		AS 403												
Curing Compound (4105)	Lab Tested	405						V	DME	1/batch	1 pt	CTRL		Sample lots not previously reported
PLANT INSPECTION														
Aggregate-Fine (4110)		AS Cert A												
Aggregate-Coarse (4115)	Quality	AS Cert A						V	DME	1/project	50 lb	CTRL		DME may adjust frequency
Portland Cement (4101)	Quality	AS Cert D						V	DME	1/project	15 lb	CTRL		
Air Entraining Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported
Water Reducing Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported
Retarding Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

Sampling and Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

CONCRETE BRIDGE FLOOR REPAIR & OVERLAY & SURFACING

Section 2413

Matls. IM 204
Appendix M

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														
Plastic Concrete (2413)	Air	318, 327						V	RCE	1/100 sy		RCE		
	Slump	317, 327						V	RCE	1/100 sy		RCE		
	Density	358						V	RCE	See Note		RCE		For Class O PCC only. (1)
	Thickness								RCE	3/50 sy		RCE		
	Cylinders							V	DME	3/project		DME		Primary Projects only (Information Only)
Concrete Sealer (2413.09)	Quality	AS 491.12												

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S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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(1) Nuclear density testing frequency for each placement shall be one test within 5 feet (1500 mm) of the beginning and end of the placement and additional tests shall be equally spaced a maximum of 100 feet (30 000 mm) throughout the length of the placement. Each placement shall have a minimum of three nuclear density tests.

October 17, 2006
Supersedes April 19, 2005

SURFACE TREATMENT (Seal Coat, Slurry, Joint Repair, Crack Filling, Fog Seal)

Section 2307, 2319, 2540, 2544, 2306, 2308

Matls. IM 204
Appendix P (US) Units

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 (4125)	Quality Gradation	AS 209												
Emulsions/ Cutbacks	Quality	AS												
Emulsion & Aggregate	Compatibility	349							DME	1/ source	1 qt & 10lb	DME/ CTRL		Seal Coat
Emulsion & Aggregate	Mix Design													Slurry
GRADE INSPECTION														
Aggregate	Quality Gradation	Cert D 301						V	DME	1/proj.	50 lb	CTRL		Seal Coat
Emulsion	Quality Residue Compatibility	Cert D 323, 360 349	RCE RCE	1/20,000 gal 1st day+ 1/week	1 qt 1 qt & 10 b	DME DME	Fieldbook(2)							Seal Coat/Slurry(1) Seal Coat
Cutback	Quality Viscosity Anti-Strip	Cert D 323, 329 AS 323, 374	RCE	1/20,000 gal	1 qt	DME	Fieldbook(2)							

AS-Approved Source	Cert A-Type A Certification	RCE-Resident Construction Engineer/Project Engineer	IA-Independent Assurance
ASD-Approved Shop Drawing	Cert C-Type C Certification	DME-District Materials Engineer	V-Verification
S&T-Sampling & Testing	Cert D-Type D Certification	CTRL-Central Materials Office	
		CONTR-Contractor	

Emulsion samples in plastic bottles only.
No samples required for joint repair, crack filling, and fog seal. Acceptance based on certification only.
(1) Samples of emulsion for slurry are required for full width placement only.
(2) Log all shipments

Sampling & Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

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 Fine (4110)		AS 209												
Aggregates Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compound (4105)	Lab Tested	405												
Air Entraining Admixture (4103)	Quality	AS 403												
Granular Backfill	Gradation Quality	AS CERT AS CERT												
Drain Tubing	Quality	AS 443												
Epoxy Grout		AS 491.11												
Joint Seal (4136.02)	Lab Tested	436.01 AS 436.02												
Backer Rod (4136.02)		AS 436.04												
Steel Reinforcing	Quality	AS 451												

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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

IA-Independent Assurance
V-Verification

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

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	
PLANT INSPECTION														
Aggregates-Coarse (4115)	Grad	302 306 336	CONTR	1/lot	IM 301	CONTR		V	RCE/ CONTR	1st day +20%	IM 301	RCE		
	Moist	308	CONTR	1 / half day	1000 gm	CONTR								
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Fine (4110)	Gradation	302, 306 336	CONTR	1/lot	IM 301	CONTR	830211	V	RCE/ CONTR	1st day+ 20%	IM 301 IM 301	RCE		
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR	830211							See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR	830211							
	Quality	AS 209												
Portland Cement (4101)	Quality	AS CERT D		Each Load										
Fly Ash	Quality	AS CERT D		Each Load										
Air Entraining Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		Sample lots not previously reported or as directed by DME
Water Reducing Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		
Retarding Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
CONTR-Contractor

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office

IA-Independent Assurance
V-Verification

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

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 HMA Mixture		Scale ticket with JMF number												Job Mix Formula (JMF) approved by DME
Plastic Concrete	Air Slump	318 327 318 327						V V	RCE RCE	2/half day 2/half day		RCE RCE		
Reinforcing Steel Epoxy-Coated Steel	Quality Quality	AS 451 AS 451		Each Shipment										
Calcium Chloride	Concentr.	373	RCE	1/lot		RCE								
Smoothness for Compacted HMA or Hardened Conc. (2529.10)		341	CONTR			CONTR								Approval by DME See Plans/Specs for exclusions

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

GRANULAR SHOULDERS

Section 2121

Matls. IM 204
Appendix U (US) Units

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														
Aggregate (4120.02)	Gradation Quality	AS 209												
Aggregate (Paved Shoulder Fillets) (4120.07)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Section	Template	RCE	3/mile 3/mile 3/mile		RCE	Field Book							
Aggregate (Paved Shoulder Fillets)	Gradation	Certification												

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

SUBDRAINS
Section 2502

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														
Drain Tubing (4143)	Quality	AS 443												
Rodent Guard (4143.01)		AS 443.01												
Subdrain Outlet (4143)		AS												
Porous Backfill (4131)	Quality Gradation	AS 209												
Granular Backfill (4133)	Quality Gradation	AS 209												
Class A (Outlets) (4120.04)	Quality Gradation	AS 209												
GRADE INSPECTION														
Drain Tubing (4143)	Quality	AS												
Engineering Fabric (4196)		AS 496.01												
Subdrain Outlet	Quality	AS Cert D												
Porous Backfill (4131)	Gradation	AS Cert A		Each Shipment										
Granular Backfill (4133)	Gradation	AS Cert A		Each Shipment										
Class A (Outlets) (4120.04)	Gradation	AS Cert A		Each Shipment										
Metal Posts (4154.09)		Visual	RCE											

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S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

WATER POLLUTION CONTROL
EROSION CONTROL
Section 2525, 2601

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														
Seeds 4169.02		Cert A												
Fertilizer 4169.03		AS 469.03												
Inoculants 4169.04		Seed Manufacturer Recommendation												
Sticking Agent		Manufacturer Recommendation												
Sod 4169.07		Visual				RCE	Field Book							
Mulch 4169.07		Visual				RCE	Field Book							
Stakes for Sod		Visual				RCE	Field Book							
Jute mesh 4169.10a		Visual				RCE	Field Book							
Wire Staples 4169.10b		Visual				RCE	Field Book							
Wood Excelsior Mat 4169.10c		Visual				RCE	Field Book							
Engineering Fabrics		AS IM 496.01					Field Book							
Silt Fence Wire and Posts (Std. Rd. Plan RC-16)		Visual				RCE	Field Book							

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

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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V-Verification

****THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.****

ACCEPTANCE OF SMALL QUANTITIES OF MATERIALS

Material	Maximum Quantity	Specifications	Alternate Acceptance Method
Beads, Glass	0.5 mi. application	4184	Visual
Dowel Baskets, Epoxy-coated	25		Visual & Field Check
Fly Ash	5 ton		Approved Source & Type
Hardware for Timber	100 lbs.	4153.07	Visual
Joint Filler, Preformed	50 ft.	4136.03	Visual & Dimension
Lighting Material-Conduit & Fittings	100 ft	4185.10	Visual & Brand Name
Paint, Bridge	5 gal.	4182	Visual & Brand Name
Pipe, Welded Steel for Bridge Railing	100 ft.	4153.05	Letter of Compliance

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Abrasives for Blast Cleaning	482.03				Approved Source			Note brand in field book
Admixture-Air Entraining	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Corrosion Inhibitor	402	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Retarder	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Water Reducer	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Aggregates-Non-proportioned	209	4110-4133			Approved Source/Certified Truck Tickets, (Form #821278)	D	Source	Certified Ticket for pay items by weight
Aggregates-Proportioned	209 & 204	4110-4133	IM 301	CONTR/RCE/ DME	Approved Source/Certified Truck Tickets, (Form #821278)	D	Source Project	
Aluminum, Structural		4190.01			Approved Shop Drawing & Fabrication Report			
Anchor Bolts	453.08	2522.04, D 4185.02, A 4187.01, C	1 bolt, nut & washer per size, per project	DME	Approved Source/Test Report/Steel Mill Certifications	A		
Anchors, Concrete	453.09				Approved Source			
Anti-Strip Agent	491.16				Approved Source			
Arrow Panels, Solar-Assisted	486.12	2528.06			Approved Source			
Asphalt Binder	437	4137	1 4-oz. tin	CONTR/DME	Approved Source/Certification/Test Rpt.	D	Source Project	
Asphalt, Cutback	437	4138	1 qt. tin	RCE	Approved Source/Certification/Test Rpt.	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Asphalt, Emulsified	437	4140	1 qt. bottle	RCE	Approved Source/Certification/Test Rpt.	D	Source	Project verification for seal coat
Attenuators -see crash cushion								
Attenuators, Guardrail					As per plan			
Backer Rod for Cold Pour Joint Seal	436.04	4136.02, C			Approved Source			
Backer Rod for Hot Pour Joint Seal	436.04	4136.02C			Approved Source			
Barrier Rail, Precast Concrete	571	2513			Approved Source/DOT Stamp/Fabrication Report		Source	
Beads, Glass	484	4184	1 qt.	DME	Approved Source		Subcontr.	
Bearing, Bronze		4190.03	1/project	DME	Test Report			
Bearing, Lead		4195.01			Certification	D		
Bearing, Neoprene	495.03	4195.02	1/pad	DME	Fabrication Report/Approved Source		Fabricator	
Bentonite Clay					Visual Approval by RCE			
Bolts, Nuts & Washers, Structural	453.06B	4153.06	Per IM 453.06B	DME	Certification/Rotational Capacity Test/Test Report	A		
Calcium Chloride Solution	373	4194.01	4 lbs. or 1 qt.	RCE	Test by RCE			
Caulking Compound		4192			Visual Approval by RCE			
Concrete, Special Sections	445	4145 4149.02, B			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp,Certification	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Concrete, Modular & Segmental Block	445.04				Approved Source/Certification	D		
Concrete, Precast Box Culvert	445.02	2415			Approved source, Approved Shop Drawing, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Concrete, Prestressed, Precast Units	570	2407			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Fabrication Report		Source	
Concrete Sealer	491.12	4139			Approved Source			
Conduit – See Lighting Matl.								
Curing Matls., Burlap		4104			Visual Approval by RCE			
Curing Matls., Clear	405.07	4105.07			Approved Source			
Curing Matls., Dark-colored	437	4105.06			Approved Source		Source	
Curing Matls., Plastic Film		4106.02			Visual Approval by RCE			
Curing Matls., White Pigmented	405	4105.05	1 qt.	DME	Batch (Lot) Accept		Source	
Crash Cushion	455	2509			Approved Source, Certification if source not clearly marked	D		
Delineators–See Signing Matls.								
Detectable Warning Panels	411	2511.02			Approved Source			
Dowel-See Steel Reinforcement								

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Drainage Trough, Elastomeric Bridge Joints	494				Approved Source			
Drains, Floor		2406.05			Approved Shop Drawing & Fabrication Report			
Drums, Channelizing	488.02	4188.02			Approved Source			
Epoxy-coated Steel-See Steel Reinforcement								
Epoxy Injection Resin	491.19				Approved Source			
Erosion Control, Fertilizer	469.03	4169.03			Approved Source			If material is suspect, DME will sample
Erosion Control, Fungicide		4169.05			Seed Manufacturing Recommendation			
Erosion Control, Inoculant		4169.04			Seed Manufacturing Recommendation			
Erosion Control, Jute Mesh		4169.10, A			Visual Approval by RCE			
Erosion Control, Mulch		4169.08			Visual Approval by RCE			
Erosion Control, Seed	469.02	4169.02			Certification	A		
Erosion Control, Silt Fence Fabric	496.01	4196.01			Approved Source			
Erosion Control, Silt Fence Wire & Posts		Std. Road Plan RC-16 Series			Visual Approval by RCE			
Erosion Control, Sod		4169.07			Visual Approval by RCE			
Erosion Control, Sod Stakes		4169.09			Visual Approval by RCE			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Erosion Control, Sticking Agent		4169.06			Seed Manufacturing Recommendation			
Erosion Control, Wire Staples		4169.10, B			Visual Approval by RCE			
Erosion Control, Wood Excelsior Mat	469.10				Approved Source			
Expansion Device, Steel		4152.02			Approved Shop Drawing & Fabrication Report			
Expansion Tube		4191.01, B			Visual Approval by RCE			
Fabric Engineering	496.01	4196.01			Approved Source			
Fasteners, Aluminum Structural	486	4190.02			Fabrication Report			
Fence, Barbed Wire		4154.04			Visual Approval by RCE			
Fence, Brace for Field Fence		4154.08			Visual Approval by RCE			
Fence, Tie & Tension Wire		4154.05			Visual Approval by RCE			
Fence, Chain Link Fabric	454.10	4154.03	1/source/yr		Approved Source/Certification		Project	
Fence, Chain Link Fittings		4154.11			Visual Approval by RCE			
Fence, Chain Link Posts, Braces, & Rails	454.10	4154.10	1/source/yr		Approved Source/Certification		Project	
Fence, Field Fence Fabric		4154.02			Visual Approval by RCE			
Fence, Gate		4154.12			Visual Approval by RCE			
Fence, Misc. Hardware					Visual Approval by RCE			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Fence, Orange Mesh Safety	488.03	4188.03			Approved Source			
Fence, Silt-See Erosion Control								
Fence, Staples		4154.06			Visual Approval by RCE			
Fence, Steel Line Posts		4154.09			Visual Approval by RCE			
Fence, Wood Fence Post	462	4154.07			Approved Source/Certification	D		
Fertilizer-See Erosion Control								
Fly Ash	491.17	4108	10 lbs.	DME	Approved Source/Certification	D	Project Source	Verification on paving only
Galvanized Items		4100.07		DME	Test Report by District Materials			
GGBFS	491.14	4100.08			Approved Source/Certification	D	Source Project	
Grating (Aluminum)		4187.01, A			Approved Shop Drawing & Fabrication Report			
Grout, Hydraulic Cement	491.13				Approved Source			
Grout, Polymer	491.11				Approved Source			
Guardrail, Box-beam Median Barrier		4155.06			Approved Shop Drawing & Fabrication Report			
Guardrail, Cable		4155.06	6 ft.	DME	Test Report by Central Lab			
Guardrail, High Tension Cable	455.01	SS-01048			Approved Source/Certification	D		
Guardrail, Formed Steel Beam	455.02	4155.02			Approved Source			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Guardrail, Steel Posts		4155.05			Mill Test Report	A		
Guardrail, Wood Posts	462	4155.04			Approved Source/Certification	A		
Iron Castings, Utility Access Covers, etc.	453.04	4153.04			Certification & Proper Identification Imprint	A		
Iron Castings, Utility Access Adjustment Rings	449.05				Approved Source/Certification	D		
Iron Bridge Rockers		4153.04			Approved Shop Drawing & Fabrication Report			
Joint Filler, Flexible Foam-Type CF & EF Joints	436.05	4136.03, B 4136.03, D			Approved Source			
Joint Filler, Type E Joint	436.03	4136.03, A			Approved Source			
Joint Filler, Bituminous	436.03	4136.03, A			Approved Source			
Joint Sealer for Concrete Sewer Pipes	491.09	4149.08			Approved Source			
Joint Sealer, Elastomeric (Neoprene)	436.02	4136.03			Approved Source			
Joint Sealer, Poured	436.01	4136.02, A			Approved Source			
Keyway		4191.01, A			Visual Approval by RCE			
Lighting Material, Aluminum Poles	557	4185.02, E			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Circuit Test		2523.21		Contractor	Test Report (Contractor) Form #820928			
Lighting Material, Connectors		4185.11			Approved Catalog Cut			
Lighting Material, Contactors		4185.05			Approved Catalog Cut			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Lighting Material, Control Cabinet		4185.07			Approved Shop Drawing & Catalog Cut			
Lighting Material, Conduit & Fittings, Plastic		4185.10	4'-Plastic	DME	Test Report			
Lighting Material, Conduit & Fittings, Steel	485.10	4185.10			Approved Source			
Lighting Material, Ground Rods & Clamps		4185.04			Visual			
Lighting Material, Handholes	445	4185.08			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Lighting Material, Junction Boxes		4185.09			Approved Catalog Cut			
Lighting Material, Lighting Tower	557	2522.04			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Lowering Device		2522.06			Approved Shop Drawing & Fabrication Report			
Lighting Material, Luminaries		4185.03			Approved Catalog Cut			
Lighting Material, Photoelectric Control		4185.06			Approved Catalog Cut			
Lighting Material, Sealant for Traffic Loop Detectors	491.18				Approved Source			
Lighting Material, Steel Poles	557	4185.02, D			Approved Shop Drawing/Approved Source/Certification	D		

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Lighting Material, Underground Warning Tape		2523.13			Visual Approval by RCE			
Lighting Material, Wire & Cable		4185.12			Approved Catalog Cut & Certification	D		DME may obtain verification samples
Lighting Material, Wood Poles	462	4185.02, F			Approved Source/Certification	D		
Lighting Material, Fasteners for Poles	453.09	4185.02, A	1 each type	DME	Test Report & Approved Shop Drawing			
Lighting Material, Mastarms	557	4185.02, B			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Slip Base	557	4185.02			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Transformer Base	557	4185.02, C			Approved Shop Drawing/Approved Source/Certification	D		
Markers (reflective) for Guardrail & Concrete Barrier Rail	486.08	4186.08			Approved Source			
Markers, Raised Pavement	483.07	2527.02, E			Approved Source			
Mastarms-See Lighting Materials								
Paint, Epoxy Aluminum	482.04				Approved Source			
Paint, Traffic-VOC-Compliant Solvent-borne	483.03	4183.03			Approved Source			
Paint, Traffic Waterborne	483.03	4183.04			Approved Source		Subcontr.	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Paint, Waterborne Acrylic Finish (Bridge Paint)	482.05	4182.03			Approved Source/Certification	D		
Paint, Zinc-rich Epoxy	482.02	4182.02			Approved Source/Certification	D		
Paint, Zinc-silicate Solvent-borne	482.05	4182.02			Approved Source/Certification	D		
Patch Material, Rapid-set Concrete	491.20				Approved Source			
Pedestrian Bridge, Pre-engineered	557				Approved Source/Approved Shop Drawing			
Piling, Concrete	570	4166			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Fabrication Report		Source	
Piling, Steel	467	4167			Approved Source/Mill Certification	A	Project	
Pipe, ABS Sewer/PVC	443, 446	4146.04 4146.05			Approved Source/Certification	D	Source	
Pipe, Clay Sewer		4149.02, A	2 each	DME	Test Report			
Pipe, Concrete	445	4145			Approved Fabricator, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Pipe, Corrugated Aluminized	441	4141			Approved Source/Certification			
Pipe, Corrugated Polyethylene 3-10 in.	443	4146.02 4143.02			Approved Source		Source	
Pipe, Corrugated Polyethylene 12-36 in.	446	4146.02			Approved Source/Certification	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Pipe, Corrugated Steel	441	4141			Approved Source/Certification	D	Fabricator	
Pipe, Ductile Iron Sewer		4149.02, C			Certification	A		
Pipe, Polyethylene Sewer	443, 446	4146.03			Approved Source/Certification	D	Source	
Pipe, Rodent Guard for PE Pipe	443.01	4143.01, B			Approved Source			
Pipe, Rodent Guard for CMP Pipe	443.01	4143.01, B			Approved Source			
Pipe, Concrete Subdrain Tile	448	4148			Approved Source/Certification	C	Source	
Pipe, Corrugated Metal Subdrain Outlet	441	4141			Approved Source/Certification	D	Fabricator	
Pipe, Corrugated Polyethylene Subdrain	443	4143.01, B			Approved Source		Source	
Pipe, Welded Steel for Bridge Rail (See Railing, Bridge)								
Pipe, Horizontal Subdrain	443	4143.01, A			Approved Source		Source	
Plant Material, Fertilizer	469.03	4170.09, B			Approved Source			
Plant Material, Mulch	470	4170.09, D		RCE	Field Review Report			
Plant Materials, Plants	470	4170.01-4170.08		Roadside Development	Field Review Report			Rpt. Issued-Roadside Development
Portland Cement Concrete Premix Pack	447				Approved Source/Certification	C	Source	
Portland Cement, All Types	401	4101	10 lbs.	DME	Approved Source/Certification	D	Project Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Railing, Bridge		4153.05			Approved Source/Approved Shop Drawing/Fabrication Report			
Reflective Sheeting-See Signing Material								
Release Agent	491.15				Approved Source			
Sealant, Traffic Loop-See Lighting Material								
Seed-See Erosion Control								
Signing Material, Delineator Posts		4186.10, C	1 each supplier	DME	Test Report			
Signing Material, Delineators	486.07	4186.07			Approved Source		Project	
Signing Material, Finished Sign	486	4186			Fabrication Report/Approved Source/Certification	D	Source	
Signing Material, Fasteners		4186.06			Fabrication Report			
Signing Material, Reflective	486.03	4186.03			Approved Source		Source	
Signing Material, Sign Panels		4186.02			Approved Shop Drawing & Fabrication Report			
Signing Material, Sign Support Structures	557	4187			Approved Source/Approved Shop Drawing/Fabrication Report			
Signing Material, Stainless Steel Fasteners	453.07		1 per size per proj.	DME	Approved Source/Mill Certification	A	Project	
Signing Material, Steel Posts		4186.10			Approved Shop Drawing & Fabrication Report			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Signing Material, Wood Posts	462	4186.10			Approved Source/Certification	A		
Signing Material, Galvanized Items		4100.07			Test Report by District Materials			
Sod-See Erosion Control								
Steel Castings		4153.03			Approved Source/Catalog Cut			
Steel Masonry Plates		4152.02			Mill Certification	A		
Steel Pile, Welded		4153.05			Approved Shop Drawing & Fabrication Report			
Steel, Pins/Rollers, Cold Finished		4153.02			Approved Source/Catalog Cut			
Steel, Pins/Rollers, Forged		4153.01			Approved Source/Catalog Cut			
Steel Reinforcement, Basket Assemblies	451.03B	4151.02			Approved Source/Certification	D		
Steel Reinforcement, Epoxy-coated	451.03B	4151.03, B	6 ft.	DME	Approved Source/Mill Certifications & Epoxy Certification/Test Report	A	Project	Test sample should be 3 ft. away from end of the bar.
Steel Reinforcement, Epoxy-coated Tie Bars	451.03B	4151.02, A	1 per project per year		Approved Source/Certification	D	Project	
Steel Reinforcement, Epoxy-coated Dowels	451.03B	4151.02	1 per project per year		Approved Source/Certification	D	Project	
Steel Reinforcement, Galvanized	451	4151.03, A	3 ft.	DME	Mill Certifications & Test Report for Galvanizing	A	Project	
Steel Reinforcement, Uncoated	451	4151	*6 ft. of most common	DME	Approved Source/Mill Certification	A	Project	*Proj. quant. under 45T Cert. Only, 45T+ 1 samp.

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Steel Reinforcement, Wire Mesh	451	4151.04	2 ft. x 2 ft.	DME	Approved Supplier or Distributor. Steel Reinforcement/Certification	A	Supplier	1 sample per source per year
Steel Mechanical Splicers for Reinforcement	451				Approved Source/Mill Certification/Epoxy Certification		Project	Need: Certification Statement, Project #, Quantity, Heat #
Steel Structural	557, 561 to 565	2408 4152			Approved Source/Approved Shop Drawing/Fabrication Report/Mill Certifications	A		
Step Irons for Utility Access		4149.06			Fabrication Report			
Structural Items, Other					Approved Shop Drawing & Fabrication Report			
Structural Plate (Arches)	444	4144	Visual	RCE	Approved Source/Certification Statement	C		
Studs, Shear	453.10				Approved Source/Certification	A		
Surface Finish, Special	491.10	2403.21, C			Approved Source			
Tape, Pavement Marking	483.06	2527.02, A			Approved Source			
Torque Calibration Machine (skidmore)		2408.38, C	Calibrate every 6 mo.	CTRL	Test Report			
Torque Wrench		2408.38, C	Calibrate every 6 mo.	CTRL	Test Report			
Traffic Signalization, Electrical Tests		2525.03, A, 3b 2525.06, A		Contractor	Test Report (Contractor) Form #820928			
Water		4102	1 qt. per source	DME	Test Report or City Water Supply			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Wire & Cable-See Lighting Material								
Wood, Hardware for Timber Structure	462	4153.07	1 ea. type		Test Report			
Wood, Timber Piles	462	4165			Approved Source/Certification	A		Charge number on butt ends
Wood, Treated Posts	462	4164			Approved Source/Certification	A		
Wood, Treated Timber & Lumber	462	4162			Approved Source/Certification	A		
Wood, Untreated Timber & Lumber	462	4162	Visual	RCE	Quality grad mark or certification of grade on items requiring grade			

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.

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.

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 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 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.

******THIS IS A NEW IM. – PLEASE READ CAREFULLY.******

INDEPENDENT ASSURANCE PROGRAM FOR CONSTRUCTION OVERVIEW & DESCRIPTION

The Independent Assurance Program (IAP) is a part of the Iowa DOT Quality Assurance Program for Construction. Appendix A contains the details of who is covered and what sampling and testing is covered in the program.

- Purpose of IAP— IAP is an unbiased and independent assessment of all sampling, testing, and testing equipment. This assessment includes evaluation of procedures and equipment used for the acceptance of highway materials and construction. 23 CFR Part 637 requires each state to have an IA Program.
- IAP is distinct from and not intended as an acceptance process or for use in verification of contractor sampling and testing results. IAP is distinct from and not intended for production quality control (QC) purposes. If IAP results indicate a potential problem with quality, the results may be used to initiate additional testing.
- IAP sampling shall be done in such a manner as to minimize variability. In order to eliminate material and process variability, split samples should be used. IAP samples may be taken independently of Agency verification or Contractor/Producer QC samples, or may be a split of a verification or an QC sample.
- Deficiencies in verification or QC processes that are identified through the IAP program must be investigated and resolved.
- IAP is an essential tool that helps to ensure integrity within the quality assurance (QA) program.

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

- Project Approach. The frequency of IAP activities is based <u>primarily on quantities of materials</u> being tested and requires minimums (as per IM 204) on every project. For projects with small quantities, project IAP will not be required:
  HMA quantities less than 5000 tons
  PCC paving quantities less than 5000 sq. yds.
  PCC for structural and miscellaneous less than 50 cu. yds.
  Non-Proportioned Aggregate less than 5000 tons.
- 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. <u>Each active technician should be checked at least 1 time per year. For HMA, the Districts Laboratories perform proficiency testing monthly during the construction season and field HMA laboratories perform proficiency testing up to 3 times per construction season. If a significant deficiency is observed for a technician, a later second check should be made.</u>

Record keeping is required for all IAP observations and tests. The record should include who and what was checked, when, where, and the outcome of the check. An annual report is required by the FHWA detailing the system approach program- how many people for each test were checked, what was found, and how it was resolved. Also any systematic issues should be detailed (i.e. problems with equipment or calibrations, need for additional training, improvements in test procedure instructions.).

******THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.******

IAP Responsibilities

HMA				
Procedure to Check	**To Whom**	**By Whom**	**How**	**Approach(1)**
Field Density Sampling	RCE	Training	Computer Program & Training	System
Field Density Testing	RCE	DME	Test same cores- IM 216	Project
Mix Sampling	RCE	DME	Observe	Project
Mix Properties Testing	CONTR, DME	CTRL	Proficiency- IM 208	System
Binder Sampling	RCE	Training or DME	Training or Observe	Both
Binder Properties Testing	DME	CTRL	Proficiency- IM 208	System
Aggregate Grad. Sampling	RCE, CONTR	Training or DME	Training or Observe	Both
Aggregate Grad. Testing	RCE, CONTR, DME(2)	DME, CTRL	Proficiency or Split test IM 208/216	System
Aggregate Quality Sampling	DME	Training/Demo.	Training	System
Aggregate Quality Testing	None	None	None	
Ride Testing	CONTR, DME	CTRL	Yearly Calibration	System

Note 1- The DME may use different approaches for DOT, local agency, and contractor personnel.
Note 2- When the District Laboratory is performing the verification gradation testing for a project.
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IAP Responsibilities

PCC Paving				
Procedure to Check	**To Whom**	**By Whom**	**How**	**Approach(1)**
Cores Sampling	RCE	Training	Training	System
Core Testing	RCE	DME	Test same cores- IM 216	Project
Air Sampling	RCE	DME	Observe	System
Air Testing	RCE	DME	Side-by-side tests- IM 216	System
Aggregate Grad. Sampling	RCE, CONTR(3)	Training or DME	Training or Observe	Both
Aggregate Grad. Testing	RCE, CONTR(3), DME(2)	DME	Split Test- IM 216	Both
Aggregate Quality Sampling	DME	Training/Demo.	Training	System
Aggregate Quality Testing	None	None		
Cementitious Materials Sampling	DME	Training/Demo.	Training	System
Cementitious Materials Testing	None	None		
Admixtures Sampling	DME	Training/Demo.	Training	System
Admixtures Testing	None	None		
Ride Testing	CONTR, DME	CTRL	Yearly Calibration	System

Note 1- The DME may use different approaches for DOT, local agency, and contractor personnel.
Note 2- When the District Laboratory is performing the verification gradation testing for a project.
Note 3- QMC projects only.
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IAP Responsibilities

PCC Structures				
Procedure to Check	**To Whom**	**By Whom**	**How**	**Approach(1)**
Slump Sampling	RCE	DME	Observe	System
Slump Testing	RCE	DME	Observe or side-by-side tests- IM 216	System
Air Sampling	RCE	DME	Observe	System
Air Testing	RCE	DME	Side-by-side tests- IM 216	System
Aggregate Grad. Sampling	RCE	DME	Observe	System
Aggregate Grad. Testing	RCE	DME	Split tests- IM 216	System
Aggregate Quality Sampling	DME	Training/Demo.	Training	System
Aggregate Quality Testing	None	None		
Cementitious Materials Sampling	DME	Training/Demo.	Training	System
Cementitious Materials Testing	None	None		
Admixtures Sampling	DME	Training/Demo.	Training	System
Admixtures Testing	None	None		
Ride Testing	CONTR, DME	CTRL	Yearly Calibration	System

Note 1- The DME may use different approaches for DOT, local agency, and contractor personnel.
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IAP Responsibilities

Non-Proportioned Aggregates (Including Recycled)				
Procedure to Check	**To Whom**	**By Whom**	**How**	**Approach(1)**
Aggregate Grad. Sampling	CONTR, DME	Training or DME	Training or Observe	Both
Aggregate Grad. Testing	CONTR, DME	DME	Proficiency or Split test IM 208/216	System
Aggregate Quality Sampling	DME	Training/Demo.	Training	System
Aggregate Quality Testing	None	None		

Note 1- The DME may use different approaches for DOT, local agency, and contractor personnel.
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor or Producer

MATERIALS LABORATORY QUALIFICATION PROGRAM

GENERAL

The FHWA has outlined a Laboratory Qualification Program in the Federal-Aid Policy Guide update published as 23 CFR 637 on June 29, 1995. The updated guide has requirements for laboratories performing testing on Federal-Aid highway projects.

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, IA testing, or dispute resolution testing.

LABORATORIES TO BE QUALIFIED

The following laboratories are included in the qualification program for all Federal-Aid projects:

Central Materials Laboratory
6 District Laboratories
District Area Laboratories
Resident Construction Laboratories*
Aggregate Producer Laboratories
Ready Mix Laboratories
PCC Contractor Laboratories
HMA Contractor Laboratories
Consultant and Commercial Laboratories *
City and County Laboratories *

* May be qualified at the time of a project.

LABORATORY QUALIFICATION PROCESS

A two-level qualification system is required by the FHWA. Laboratories are either accredited or qualified. The accreditation process is more rigorous than the qualification process.

Accredited Laboratory Process

The Central Materials Laboratory and the six District Laboratories will be accredited as outlined in the 23 CFR 637 guide. The Central Materials Laboratory is accredited through the AASHTO Materials Reference Laboratory Program. The District Materials Laboratories will be accredited by using the Central Materials Staff and equipment to check testing and testing procedures and by using the same calibration and training documentation process. Laboratories will be accredited for a two-year period. In addition, an annual review will be made by the Central Office Staff. Appendix A contains the procedures for accrediting the District Materials Laboratories.

Qualified Laboratory Process

The remaining laboratories will be qualified as outlined below:

The District Materials Offices will qualify laboratories. Laboratories will be qualified for a two-year period. In addition, an annual review will be made by District Staff. Appendix B contains the procedures for qualifying materials laboratories.

Three laboratory types will be qualified, aggregate laboratories, PC Concrete laboratories and Hot Mix Asphalt laboratories.

Qualified laboratories will have the following:

1. Current manuals and test methods to perform the qualified testing available
2. A technician certified by the Iowa DOT to perform the qualified testing
3. Proper equipment to perform the qualified testing (calibrated or checked annually according to Appendix B)
4. Satisfactory project and proficiency test results
5. Documentation of equipment calibrations, equipment checks, and proficiency results

ADMINISTRATION OF THE PROCESS

The Central Materials Laboratory will be responsible for implementation and operation of the Laboratory Qualification Program. The Central Materials Laboratory will accredit the District Laboratories. The District Materials Offices will qualify laboratories.

NON-COMPLIANCE/DISPUTE RESOLUTION

A laboratory that does not meet the requirements of the IM is subject to elimination from the qualification program.

Disputes concerning calibration and correlation of equipment will be resolved by the office responsible for the qualification. For disputes that cannot be resolved at the District, the Central Materials Laboratory will be the final authority.

DISTRICT LABORATORY ACCREDITATION PROGRAM

The Central Materials Laboratory (CML) will accredit the District Materials Laboratories and maintain records of the accreditation for five years. The CML Staff will check the following prior to accrediting a laboratory:

1. Check for current manuals and test procedures covering the accredited testing.
2. Check the certification and training records of the testing personnel.
3. Document that proper equipment is available to perform qualified testing.
4. Check documentation system.

Scheduling of the annual accreditation review will be discussed with the laboratories needing accreditation.

Table 1 is the list of items to be reviewed.

An oral close out on any deficiencies will be held with the testing personnel. Written notice will be sent within two months of the inspection. CML personnel will re-inspect if necessary after correction of any deficiencies.

A report showing the laboratory, the date accredited, and the expiration date will be issued by the Materials Testing Engineer.

NON-COMPLIANCE/DISPUTE RESOLUTION

A laboratory that does not meet the requirements of the IM is subject to elimination from the qualification program.

The CML and the District Materials Engineer will resolve disputes concerning calibration and correlation of equipment.

TABLE 1 - Laboratory Accreditation Checklist

	√	**Minimum Calib./Verif. Interval**	**Calib./Verif. Procedure**
Tester Qualifications-Proper Iowa DOT certifications			
Current Test Procedures			
Current Calibration Procedures & Records			
Documentation of correlation results and corrective actions taken for previous construction season			
Balances		12 months	Iowa 917-B
Ovens		12 months	Iowa 1501-A
Mechanical Shakers		12 months	Iowa 1502-A
Marshall Compactor T-245		12 months	Iowa 1504-A
Gyratory Compactor T-312		6 months	Iowa 1522-A
Marshall Molds T-245		12 months	Iowa 1523-A
Comp. Test Machine T-245		12 months	Iowa 1505-A
Sieves		6 months	Iowa 1506-A
Thermometers - Test		6 months	Iowa 1607-A
Thermometers - Ref.		12 months	Iowa 1607-A
Timers T-201, T-202		6 months	Iowa 1508-A
Sand Equivalent T-176		12 months	Iowa 1509-A
Gyratory Compactor Molds T-312		12 months	Iowa 1524-A
Vacuum Systems T-209		12 months	Iowa 1510-A
Pycnometers T-228, T209		12 months	Iowa 1618-A
Fine Aggregate Anularity T-304		12 months	Iowa 1525-A
Dynamic Shear Rheometer T-315		6 months	Iowa 1612-A
Balance Weights M-231		12 months	
Sample Splitters T-248		12 months	(visual condition)

LABORATORY QUALIFICATION PROGRAM

The District Materials Office will qualify the other laboratories and maintain records of the qualification for three years. The District Staff will check the following prior to qualifying a laboratory:

1. Establish the type of laboratory (Aggregate, Hot Mix Asphalt, PC Concrete).
2. Check for current manuals and test procedures covering the qualified testing.
3. Check the certification of the testing personnel.
4. Document that proper equipment is available to perform qualified testing.
5. Check documentation system.

Scheduling of the qualification review will be discussed with the laboratories seeking qualification. The District Materials Engineer should be contacted for laboratories that have been qualified in other states. The District Materials Office may qualify a laboratory based on an acceptable qualification report and qualification program from another state transportation agency.

Table 1 and the pages following cover the list of items to be reviewed.

An oral close out on any deficiencies will be held with the testing personnel. Written notice will be sent within two weeks of the inspection. District personnel will re-inspect after correction of any deficiencies.

A form showing the laboratory type, the date qualified, and the expiration date will be issued by the District Materials Engineer.

The list of Qualified Laboratories will be maintained on a database accessible by authorized Materials Personnel.

NON-COMPLIANCE/DISPUTE RESOLUTION

A laboratory that does not meet the requirements of the IM is subject to elimination from the qualification program.

The office responsible for the qualification will resolve disputes concerning calibration and correlation of equipment. For disputes that cannot be resolved at the District level, the Central Materials Laboratory will be the final authority.

Table 1 - Laboratory Qualification Checklist

	√	**Calib./Verif. Interval**	**Calib./Verif. Procedure**
Tester Qualifications-Proper Iowa DOT certifications			
Current Test Procedures			
Current Calibration Procedures & Records			
Documentation of correlation results and corrective actions taken for previous construction season.			
Aggregate Laboratory			
Balances		12 months	Iowa 917-B
Sieves- wear, tear, size, and opening size		12 months	Iowa 1506-A
Splitter- condition		12 months	(Visual)
Mechanical Shakers- condition (if used)		12 months	Iowa 1502-A
HMA Laboratory			
Balances- and water bath		12 months	Iowa 917-B
Sieves- wear, tear, size, and opening size		12 months	Iowa 1506-A
Splitter- condition		12 months	(Visual)
Mechanical Shakers- condition (if used)		12 months	Iowa 1502-A
Rice equipment- vacuum and flask		12 months	IM 350
Thermometers		12 months	Iowa 1607-A
Ovens- temperatures		12 months	Iowa 1501-A
Gyratory Compactor and molds		12 months	Iowa 1524-A
Marshall Hammer and molds		12 months	Correlation Checks
PCC Laboratory			
Balances		12 months	Iowa 917-B
Sieves- wear, tear, size, and opening size		12 months	Iowa 1506-A
Splitter- condition		12 months	(Visual)
Mechanical Shakers- condition (if used)		12 months	Iowa 1502-A
Air Meter		12 months	IM 318
Slump Cone and equipment-condition		12 months	
Beam Breaker		12 months	Central Lab

LABORATORY ITEMS

The following list contains, as a minimum, what is required for a qualified asphalt laboratory. The test equipment to perform each of the required tests is contained in the respective IM.

- Field Lab and Office [Suggested size 8 ft. x 44 ft. (2.4 m x 13.41 m)]. Locate the Field Lab so it is convenient to the plant, but outside the influence of plant vibration.

  Air-conditioned
  Personal computer
  Phone
  Fax machine
  Copy Machine
  Sample storage
  Work table
  Bulletin board
  Water available to perform necessary testing
  Desk and chair
  Incidental spoon, trowels, pans, pails

- The personal computer shall be capable of running Iowa DOT programs. It is recommended to have at least Windows 2000 or newer software on the computer. Iowa DOT programs have been checked and are capable of running on Windows 2000 and newer software.

  3.5" high-density floppy disk drive (CD drive recommended)
  Color monitor, VGA or better
  Printer, ink jet recommended.

- Diamond saw for cutting core lifts.

- Diamond core drill (minimum 4" diameter core).

Iowa Department of Transportation

MATERIALS LABORATORY QUALIFICATION PROGRAM
Laboratory Inspection - per Materials Instructional Memorandum 208

Company Name: ______________________________

Laboratory name: ______________________________

Laboratory type: Aggregate HMA PCC (Circle one)

Laboratory location: ______________________________

Laboratory contact person: ______________________________

Laboratory technician:	Certification number:	Expires:
______________	______________	________
______________	______________	________
______________	______________	________

Current manuals and written test procedures available? ______________________________

Current calibration procedures and records? ______________________________

____

Documentation of correlation results and corrective actions taken for previous construction season? ________

____

____

Proper equipment available to perform qualified testing? ______________________________

____

Other remarks: ______________________________

____

Date of inspection: ______________ Qualification expiration date: ______________

Inspection performed by: ______________________________
Print name

____
Sign name

Inspection received by: ______________________________
Print name

____
Sign name

District Number ______________

cc: Materials Engineer, Contractor/Producer, Ames, File

Iowa Department of Transportation

AGGREGATE LABORATORY INSPECTION
QUALITY CONTROL CHECKLIST

Contractor/Producer: ____________________ Location: ____________

Certified Technician: ____________________ Certification No: ____________

		Yes	No
Balances	(Iowa Test Method 917-B)		
	Updated balance calibration records available?	____	____
	Check balance using 500 gm & 1000 gm calibrated weights?	____	____
	Is balance accurate to 0.1%?	____	____
Sieves			
	Is there adequate correlation history to qualify?	____	____
	Were go/no-go gauges used to check accuracy?	____	____
	Are the sieves in good condition (no loose frames, holes, or tears)?	____	____
Splitter			
	Is the splitter in good condition? (i.e., missing shuts, cracked welds, or leaking seams)	____	____
Shaker			
	Is shaker apparatus secure and level?	____	____
Scale			
	Are the laboratory weights used for routine calibrations accurate? (Use 0.1% difference from our calibrated weights as standard.)	____	____

Comments ____

cc:Materials Engineer
Contractor/Producer
Ames
File

Inspected By: ____________________

Date Inspected: ____________________

Iowa Department of Transportation

HMA LABORATORY INSPECTION
QUALITY CONTROL CHECKLIST

Contractor/Producer: ____________________ Location: ____________________

Certified Technician: ____________________ Certification No.: ____________________

		Yes	No
Thermometers	(IM 321, IM 325, IM 325G, IM 350)		
Thermometer Calibration and Documentation available?		____	____

Temperature of check: ____________ (25 deg C or 135 deg C)

State reference thermometer ____________

Contractor reference thermometer ____________

Difference ____________

		Yes	No
Rice Pycnometer	(IM 350)		
Calibration chart and/or documentation available?		____	____
Equipment achieves between 25.5 and 30mm of mercury vacuum?		____	____
Mercury is free of bubbles?		____	____
Gyratory/Marshall Compactor	(IM 325/IM 325G)		
Calibration documentation available?		____	____
Is equipment generally clean?		____	____
Documentation of annual mold measurements?		____	____
Ovens	(IM 325/IM 325G)		
Documentation of temperature checks?		____	____
General condition satisfactory?		____	____
Do all parts work as intended?		____	____

Water Bath (IM 321)

Temperature? ____________

Correlation

	Yes	No
Correlation results available for previous year?	____	____

Comments: ____

____

____

____

NOTE: HMA labs must also qualify as an aggregate lab.

cc: Materials Engineer
Contractor/Producer
Ames
File

Inspected By: ____________________

Date Inspected: ____________________

Iowa Department of Transportation

READY MIX/PCC PAVING LABS
QUALITY CONTROL CHECKLIST

Contractor/Producer: ____________________ Location: ____________

Certified Technician: ____________________ Certification No: ________

Inspection Checklist Items:

	Yes	No
Air Meter (IM 318)		
Check meter using approved 5% pugs.	____	____
Is air meter clean?	____	____
Proper rod and mallet.	____	____
Slump Cone (IM 317)		
Interior of cone free of dents or projections.	____	____
5/8" by 24" tamping rod.	____	____
Rigid, nonabsorbent base.	____	____
Equipment clean and free of hardened concrete.	____	____
Beam Breaker (IM 316)		
Current annual calibration sheet	____	____
Equipment clean.	____	____
Beam Molds (IM 328)		
Molds clean and free of dents	____	____
General condition of molds good.	____	____

Comments ____

NOTE: PCC labs must also qualify as an aggregate lab.

cc: Materials Engineer
Contractor/Producer
Ames
File

Inspected By: ____________________

Date Inspected: ____________________

INDEPENDENT ASSURANCE PROFICIENCY & TESTING FOR HMA

GENERAL

The HMA Proficiency Program is part of the Independent Assurance Program described in IM 205. The HMA Proficiency Program provides participating laboratories with a means to:

- Check both the instrument and the operator under actual testing conditions.
- Compare individual test results with the average of a large body of results so that corrective action may be taken where wide discrepancies occur.
- Evaluate the quality of test results, thereby reducing the risk of dispute due to testing errors.

Each accredited and qualified Laboratory and certified staff shall establish and maintain their proficiency by following program described herein.

A project approach for independent assurance may be used for RCE, county, city, and consultant laboratories.

PROFICIENCY SAMPLE

The Central Materials Laboratory will prepare and send out proficiency samples during the construction season (April through September). The samples and tests for laboratories will be as follows:

A. District Laboratories

1. Asphalt Binder
   a. G*/Sin Delta
2. HMA Mix
   a. G_{mb} Laboratory Density
   b. G_{mm} Maximum Specific Gravity
   c. % Binder, Ignition Oven
   d. Gradation, Ignition Oven
3. Combined Aggregate
   a. Gradation
   b. G_{sa} Apparent Specific Gravity (every other sample)

c. G_{sb} Bulk Specific Gravity (every other sample)

d. Percent Absorption (every other sample)

e. Fine Aggregate Angularity (every other sample)

f. Sand Equivalency (every other sample)

B. HMA Laboratories

1. HMA Mix

a. G_{mb} Laboratory Density

b. G_{mm} Maximum Specific Gravity

2. Combined aggregate

a. Gradation

C. Aggregate Laboratories

1. Gradation

PROFICIENCY SAMPLE FREQUENCY

District Laboratories will receive a set of proficiency samples monthly April through September. The samples will be tested and the results reported within 14 calendar days of receipt.

HMA laboratories and HMA aggregate laboratories will pick-up proficiency samples one to three times per year depending on how many projects are done in a particular year. The frequency criteria is as follows:

- A sample shall be picked up for the technician's first HMA project of the construction season.
- At 3 months from the first sample pickup, the technician must pick up a second sample in order to continue performing acceptance testing.
- At 3 months from the second sample pickup, the technician must pick up a third sample in order to continue performing acceptance testing.

Each certified technician routinely working in the laboratory shall perform the proficiency tests and report the results within 14 calendar days of receipt.

TEST RESULT ANALYSIS

Test results from the proficiency samples will be analyzed using the current AASHTO Material Reference Laboratory (AMRL) procedure. The analysis compares the results from each participant and each District and Central Laboratory to the overall mean. Test results will also be compared to the Central Materials Laboratory results.

Any test result that is 3.0 standard deviations or greater from the mean will be considered failing. Two consecutive proficiency sample results that are 2.0 standard deviations or greater from the mean will be considered failing.

In the event of a small data set or large or small variation within a data set, the individual results will be compared with the Central Laboratory results. IM 216 will be used to compare the results. Proficiency test results beyond the tolerance will be considered failing.

INVESTIGATION OF FAILING TEST RESULTS

The technician with failing test results shall review the calculation, test procedures, and perform a calibration if warranted. When there are two or more consecutive failing results, the Central Materials Laboratory or the District Material Engineer will contact the technician and arrange to conduct an evaluation of the procedures and equipment to correct any deficiencies. More than 3 consecutive failing results by a technician will constitute unsatisfactory performance as defined in IM 213 and become a part of their permanent file.

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), Grade Inspection, 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 – Office of Materials
Director – Office of Construction
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
Coordinator of Technical Training & Certification Program**

** Appointed by Program Director

The Director of the Office of Materials 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 or an agency approved by the Program Director. Producers/Contractors are encouraged to conduct their own pretraining program. A complete listing of training opportunities is available in the Technical Training & Certification Program's Information and Registration Booklet or at the Technical Training & Certification Program website, www.iowa.gov/dot/materials/training.htm. This book is available at any of the Iowa DOT Materials Offices. They may also be obtained from the ICPA, IRMCA, ILPA, and APAI.

CERTIFICATION REQUIREMENTS

1. A candidate must attend 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. In order to obtain certification for any technical level, these persons must pass all applicable tests for the level of certification they wish to obtain. 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.

Out-of-state technicians will be issued certifications when the following criteria are met:

1. The applicant must be certified in another state or shall have received equivalent training, if the state does not have a certification program, in each level of certification they are requesting.

2. 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 applicable schooling before they can retake the exam.

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

Out-of-state applications should be submitted to the District Materials Office closest to the home location of the applicant. Copies of all the applicant's certifications must accompany the application.

CERTIFICATION

Upon successfully completing the requirements for certification, the Program Director will issue a certificate and a pocket certification card. This certification is not transferable. A certification shall be valid for five years.

CERTIFICATION IDENTIFICATION

The certificate will contain letters that identify the District of record, the certificate holder, certification number, the level of certification, and the expiration date of each level.

The assigned certification number may change if the certificate holder changes their residence.

RENEWAL OF CERTIFICATION

A certification shall be valid through December 31st of the fifth year. A 90-day grace period will be allowed. If the individual has not renewed their certification within the 90-day grace period, they are automatically decertified. The individual may obtain certification by taking the examination for the level of certification they are requesting. If the individual does not take the examination within one year after their certification(s) expire, i.e., 12/31/expiration year, they must retake all applicable schooling and pass the examinations. 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.

All certified technicians will be required to pass an examination in each level of certification they hold before recertification will be issued. Failure of any level shall require the applicant to retake the applicable schooling and pass the test.

The certificate holder shall be responsible for applying for certification renewal and for maintaining a current address on file with the appropriate District Materials Office.

Technicians certified as Level I HMA and/or Level II PCC shall attend a minimum of two update classes each in the five-year period between certification and each recertification. The Iowa DOT or an agency or organization approved by the TTCP will hold these classes. These update classes will be listed in the Technical Training & Certification Program Booklet and on the program website, or the certified technician may contact the Iowa DOT for information. If an individual does not attend the two update classes required before their certification expires, they must take the entire schooling and pass the examination for the certification required.

The certified technician will not receive credit for the following:

1. More than one update per training season in each level of certification.
2. An update taken during the same training season in which the individual recertified.

UNSATISFACTORY PERFORMANCE NOTICE

A certified technician failing to perform the required specified duties or inadequately performing these duties, will receive an Unsatisfactory Notice (Office of 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 permanent file with the District Materials Office in which the technician resides. The notice will also be placed on the statewide computer file.

SUSPENSION & DECERTIFICATION

A three-month suspension will be given upon receipt of two Unsatisfactory Performance Notices. Technicians that are suspended shall not perform any duties of the applicable certification, including any duties for which the affected certification is 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.

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

The certificate will become invalid 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 the certificate.

3. Use of false or fraudulent actions or documentation by the certificate holder.

4. Not performing tests and technician duties properly and in accordance to specifications.

Action will be effective on the date the Program Director issues the suspension or decertification notice.

Technicians that are decertified shall not perform any duties requiring certification. Technicians may request reinstatement after one year.

Appeals and reinstatement requests shall be submitted in writing to the Program Director. Appeals and reinstatement requests will be considered by the Certification Board.

If reinstatement is authorized, the applicant 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	
Level I Aggregate	Certified Sampling Technician	None
Level II Aggregate	Certified Aggregate Technician	Level I Aggregate
	PORTLAND CEMENT CONCRETE	
Level I PCC**	PCC Testing Technician	None
Level II PCC	PCC Plant Technician	Level II Aggregate & 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
	HOT MIX ASPHALT	
HMA Sampler	HMA Sampler	None
Level I HMA	HMA Technician	Level II Aggregate
Level II HMA	HMA Mix Design Technician	Level I HMA
	PROFILOGRAPH	
Profilograph	Profilograph Technician	None
	PRESTRESS	
Prestress	Prestress Technician	Level I PCC or ACI Grade I *If the technician will be performing gradations, they will need to be Aggregate Level II- certified.*

UNSATISFACTORY PERFORMANCE NOTICE

Issued To: ______________________ Date: ________________

____

____

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

This notice will be placed in your permanent file with the District Materials Office in which you reside. It will also be placed on the statewide computer file.

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

Unsatisfactory Performance:

____

____

____

____

____

____

____

____
District Materials Engineer

cc: Program Director – 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.

LEVEL I AGGREGATE

- 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

LEVEL II AGGREGATE

- IM 216 - Guidelines for Verifying Certified Testing Results
- 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

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 383 - Testing the Strength of PCC Using the Maturity Method
- IM 385 - Temperature of Freshly-Mixed Concrete
- IM 525 - Designing Flowable Mortar
- Iowa 410-B - Method of Test for Flow of Grout Mixtures
- 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

HMA SAMPLER

- 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)
- IM 322 - Method of 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 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
- IM 514 - Correlation of Field Density for Hot Mix Asphalt (HMA) Paving

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

PROFILOGRAPH

- IM 341 - Determining Pavement & Bridge Ride Quality

PRESTRESS

- IM 570 - Precast & Prestressed Concrete Bridge Units

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

B. Gradation Testing

1. Follow appropriate gradation 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.

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

The Quality Control Technician shall have no other duties while performing certified inspection duties. 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.

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.

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

A. Aggregate Stockpiles.

1. Assure proper stockpiling of aggregate deliveries. (stockpile build & additions) (daily check list, 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) (plant book, IM 508)
    a. Obtain truck tickets.
    b. Check for proper certification.
    c. Check for proper approved source.
    d. Enter deliveries in Plant Book Program, Aggregate Certification page.

3. Observe loader operation. (daily) (daily check list, 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 aggr. by overloading bins.

B. Asphalt Binder Delivery. (each delivery) (plant report & plant book, 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 Book Program, Asphalt Binder Shipment Log page.

C. Plant Operations. (daily)

1. Prepare Plant Report Program for daily entries. (plant report, 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. (daily check list, 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. (daily check list, spec 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. (daily check list, spec 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. (plant report, IM 508 & 509)

    a. Perform start-up tank stick measurement before mix production begins (if applicable).
    b. Perform final tank stick measurement after mix production is done (if applicable).
    c. Perform intermediate tank stick measurements as needed.
    d. If using meter for quantity, obtain totalizer printout readings and periodically check against tank stick readings.
    e. 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) (plant report, 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) (spec 2001.07 & .20)
(daily check list, IM 508)
   a. Perform sensitivity checks of scales.
   b. Check for interference at scale pivot points.

2. Pay Quantity Scales. (min. 1/day) (spec 2001.07 & .20, IM 508)
(daily check list, plant book)
   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) (daily check list)

   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 Book Program, Daily Check List or Plant Scale Checks page. (daily) (plant book)

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

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

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

3. Enter sample data into Plant Book Program, Sample Log page.

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

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

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

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

H. Testing. (daily) (spec 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.
   f. Enter sample data into Plant Book Program Sample Log page.

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.
   h. Enter sample data into Plant Book Program, Sample Log page.

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 enter weights into Plant Book Program, Plant Moistures page (drum mix plants).

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) (spec 2303.04, plant report, plant book, IM 204, 511 & 508)

1. Prepare computerized Daily Plant Report (form 241).

    a. Check that all data is correct.
    b. Check that all data is complete.
    c. Compute moving averages for gradation and lab voids.
    d. Compute tons of mix used to date.
    e. Enter mix adjustment data on report.
    f. Check for spec compliance.
    g. Immediately report non-complying results.
    h. Obtain and record mat temperatures and stationing.
    i. Provide daily Plant Report printout 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. Copy and export daily data and paste into control charts program.

4. Enter all asphalt binder or aggregate proportion changes in Plant Book Program, Mix Adjustments page.

5. Enter tack shipment quantities in Plant Book Program, Tack Shipment Log page.

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

J. Miscellaneous. (daily) (daily check list, IM 208 & 511)

1. Fill out Plant Book Program, Daily Check List page.

2. Clean lab.

3. Back-up computer files.

4. Dispose of samples as directed by District Lab.

5. 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 Central Materials Office 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 and Plant Book Programs 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 IM 491.15
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.

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.

PROFILOGRAPH TECHNICIAN DUTIES

Duties of the Profilograph Technician are detailed in IM 341 and consist of, but are not limited to the following:

A. Test pavement for smoothness criteria.

B. Evaluate and certify test results.

   1. Certified person that reduces trace must sign certified test report.

   2. Profilograms become part of permanent project record.

C. Documentation

   1. Certified Profilograph Test report must include following statement:

      This is to certify that all testing and trace reduction herein described has been performed according to applicable contract specifications and requirements.

October 16, 2007
Supersedes October 17, 2006

Matls. IM 216

GUIDELINES FOR VALIDATING TEST RESULTS

GENERAL

Agency laboratory and field personnel validate testing by Contractor and producer personnel on a regular basis. Tolerances given herein are for use as guides to flag test result variations that indicate a possible discrepancy.

TOLERANCES

The tolerances shown in the following listing apply to the difference between Contractor and producer test results and verification 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.

TEST NAME	TEST METHOD	TOLERANCE
Slump of PC Concrete	IM 317	1/4 in. (6 mm)
Air Content of PC Concrete	IM 318	0.4%
Length of Concrete Cores	IM 347	0.10 in. (2 mm)
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%
Wet Density by Nuclear Gauge, Soils & Bases	IM 334	2.0 lb./ft.^{3} (32 kg/m^3)
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	10% of mean
% Binder, Ignition Oven	IM 338	0.3%
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
Sand Equivalency	T176	10 % of mean

Pavement Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		1.0 in./mi. (16 mm/km)
6.1 to 20.0 (96 to 315)		2.0 in./mi. (32 mm/km)
20.1 to 40.0 (316 to 630)		3.0 in./mi. (47 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Pavement Profile Index (0.0" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
25.0 (395) or less		3.0 in./mi. (47 mm/km)
25.1 to 40.0 (396 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Bridge Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		2.0 in./mi. (32 mm/km)
6.1 to 20.0 (96 to 315)		3.0 in./mi. (47 mm/km)
20.1 to 40.0 (316 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		6.0 in./mi. (95 mm/km)

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: 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
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

*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"/37.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
1"/25.0mm	97.1	99.1	2.9	0.9	2.0	2	Yes
3/4"/19.0mm	72.2	65.1	24.9	34.0	9.1	6	No
1/2"/12.5mm	38.1	34.9	34.1	30.2	3.9	7	Yes
3/8"/9.5mm	12.0	8.8	26.1	26.1	0.0	6	Yes
#4/4.75mm	0.6	0.2	11.4	8.6	2.8	5	Yes
#8/2.36mm	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. (37.5 mm) and 1 in. (25 mm) sieves for the above verification test is 100.0 - 97.1 = 2.9%. Between the 1/2 in. (12.5 mm) and 3/8 in. (9.5mm) 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. (25 mm) and 3/4 in. (19 mm) sieves. Since the suspect difference is due primarily to the percent passing results on the 3/4 in. (19 mm) sieves, it is these results that should at least be investigated first. Only further investigation can determine which 3/4 in. (19 mm) 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"/9.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
#4/4.75mm	95.0	95.0	5.0	5.0	0.0	3	Yes
#8/2.36mm	87.8	86.3	7.2	8.7	1.5	2	Yes
#16/1.18mm	72.0	71.5	15.8	14.8	1.0	3	Yes
#30/600um	44.0	43.8	28.0	27.7	0.3	4	Yes
#50/300um	12.2	13.0	31.8	30.8	1.0	4	Yes
#100/150um	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. % 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

D.O.T. FBR: ______

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 (4.75 mm) sieves. This evidence and the difference in the test values found for the #4 (4.75 mm) sieves, strongly point to an error in one of the #4 (4.75 mm) sieve results.

When RAP mixes are used, the comparison data is of the composite gradation results and not of the cold feed.

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: __________

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Grad No.	Sample ID	Specs												
		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.: ______________________

	Good	Fair	Poor
Care of Equipment:	_____	_____	_____
Sampling Procedure:	_____	_____	_____
Splitting Procedure:	_____	_____	_____
Sieving to Completion:	_____	_____	_____
Computations:	_____	_____	_____
Reporting:	_____	_____	_____

Mix Change (Y/N): _______

Date of Change: _______

Total, % Asphalt (Pb): _______

Effective % Asphalt (Pbe): _______

Proper Equipment: _______

Applicable Specs.: _______

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_______

QMC GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

QMC Gradation Correlation I.M. 216

Project No.: ____________________

Contract ID: ____________ Date Sampled: ____________

Plant Name: ____________ County: ____________ Gradation Date: ____________

Contractor: ____________ Mix Design Number: ____________ Design No.: ____________

Coarse Agg. Source: ____________ Intermediate Agg. Source: ____________ Fine Agg. Source: ____________

Monitor: ____________ Cert. No.: ____________ Proper Equipment: ____________

C.P.I.: ____________ Cert. No.: ____________ 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: ____________________

AGGREGATE SAMPLING & MINIMUM SIZE OF SAMPLES FOR SIEVE ANALYSIS

SCOPE

This IM sets forth approved sampling methods and the minimum amount of dry materials necessary for the determination of particle size distribution.

LOCATION FOR SAMPLING

Safety must be foremost when determining sample locations. The Contractor/Producer shall make adequate provisions, satisfactory to the Engineer, for the safety of personnel responsible to obtain representative samples of the aggregate.

Provisions shall include guards for moving belts, pulleys, and wheels near the sampling point, and a stable platform with adequate safety rails when sampling is to be done from an elevated location.

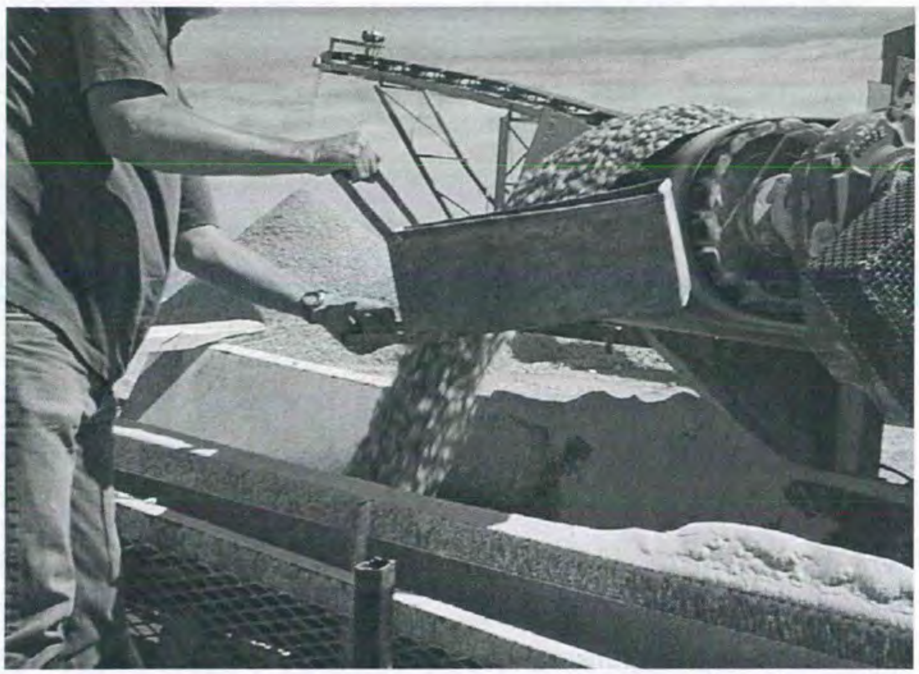
Stopped belt sampling locations must be equipped with an on-off switch near, and in plain view of the sampling location. This switch, when in the off position, must have full control of the belt.

1. Conveyor Belt/Template Method

   To obtain an off-the-belt sample: stop the belt, insert a template (as illustrated in the pictures below) at three or more separate locations along the belt, remove <u>all</u> material within the template, and combine it into the sample. In belt sampling, the ends of the template should be spaced just far enough apart to get an increment approximately one-third the minimum mass (weight) of the sample. If the template does not yield the minimum size of sample in three locations, additional locations will be necessary. No less than three separate locations should be used in obtaining one sample.

2. Stream Flow Method

When obtaining a sample by interception of the aggregate stream flow, care must be exercised, so the sampling device (See picture below.) passes quickly through the entire stream flow and does not overflow. At least three separate passes shall be made with the sampling device when obtaining a sample. Each pass is an increment of the sample. This is normally considered to be the best method to obtain a representative sample of coarse aggregate.



3. Stockpile Method (for fine aggregate only, or as directed by the District Materials Engineer)

Stockpile sampling of fine aggregate may be accomplished by either using a shovel or a sand probe. When obtaining a field sample by the stockpile method, a minimum of three increments shall be taken at different locations around the stockpile. Avoid sampling in areas prone to segregation, such as along the bottom of cone stockpiles.

NOTE: Stockpile sampling of coarse aggregate should be avoided. If it becomes absolutely necessary to obtain a sample from a stockpile, consult the District Materials Engineer to help devise an adequate and proper sampling plan.

SHIPPING SAMPLES

Transport aggregate samples in bags or other containers constructed to preclude loss or contamination of the sample, or damage to the contents from mishandling during shipment.

Shipping containers for aggregate samples shall each have suitable identification attached and enclosed so that field reporting, laboratory logging and testing may be facilitated.

SAMPLE SIZES

Minimum sample sizes for sieve analysis of aggregates are based on the maximum size of the product and the intended use. The following table lists the required minimum field sample and test sample sizes based on the smallest sieve through which at least 95% of the sample will pass.

SIEVE SIZE	FIELD SAMPLE (lbs./kg)	TEST SAMPLE (gms/kg)
1½ in. (37.5 mm)	50/23.0	5,000/5.0(2)
1 in. (25.0 mm)	30/13.5	3,500/3.5
¾ in. (19.0 mm)	20/9.0	2,000/2.0
½ in. (12.5 mm)	20/9.0	1,500/1.5
⅜ in. (9.5 mm)	10/4.5	1,000/1.0(1)
#4 sieve (4.75mm)	10/4.5	500/0.5
#8 sieve (2.36mm)	10/4.5	200/0.2

(Products with maximum sizes over 1½ in. (37.5 mm) are normally visually inspected. Contact the appropriate District Materials Engineer.)

(1) When testing fine aggregate for PC Concrete, the minimum test sample is 500 grams.
(2) When testing 1½" aggregate for Special Backfill, Granular Subbase, or Modified Subbase the minimum test sample is 2500 grams.

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
- Core tongs if a core drill is used to cut the sample
- Hammer
- Steel plate 4 in. (100 mm) wide, 4 in. (100 mm) long, 1/8 in. (3.175 mm) 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 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.

April 15, 2003
Supersedes April 27, 1999

Matls. IM 321

METHOD OF TEST FOR COMPACTED DENSITY OF HOT MIX ASPHALT (HMA) (DISPLACEMENT METHOD)
(General Rewrite)

SCOPE

This IM provides the method of test used in determining the bulk specific gravity (G_{mb}), bulk density, of laboratory-compacted specimens of HMA or cores takes from compacted HMA 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 (25°C) 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 (25° ± 3°C) (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 with a damp cloth; blot the free water from the surface of the sample. 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:

$$G_{mb} = \frac{W_1}{W_3 - W_2}$$

October 17, 2006
Supersedes April 18, 2006

Matls. IM 322

SAMPLING UNCOMPACTED HOT MIX ASPHALT

SCOPE

Two methods of sampling hot mix asphalt (HMA) are used for sampling mix to be submitted for laboratory tests. The necessary containers for Agency samples are available for purchase by the Contractor from the Iowa Department of Transportation Warehouse in Ames, Iowa.

REFERENCED DOCUMENTS

Standard Specification 2303 Hot Mix Asphalt Mixtures
Standard Specification 2309 Surface Recycling by Heater Scarification
IM 336 Reducing Aggregate Field Samples to Test Samples
IM 357 Preparation of Hot Mix Asphalt (HMA) Mix Samples for Test Specimens

APPARATUS

- Metal Sampling Template, with a minimum area of 64 in.^{2} (410 cm^2) & 4 in. (100 mm) deep.
- Laboratory Sampling Scoop (Square Pointed)
- Putty Knife
- 2-gallon (7.5-liter) capacity cardboard box (for Agency samples)
- Sampling Container
- Ruler
- Jabber Sampler (for thick lifts)
- Quartermaster (Optional)
- Square-pointed Shovel

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 of sufficient size to run each of the required tests (approximately 30 pounds (14 kg) for each lab). Samples taken from thick layers will be proportionately larger.

Sampling Methods

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 hot mix asphalt is not to be used in situations involving Heater Scarification Work as stated in Standard Specification 2309.

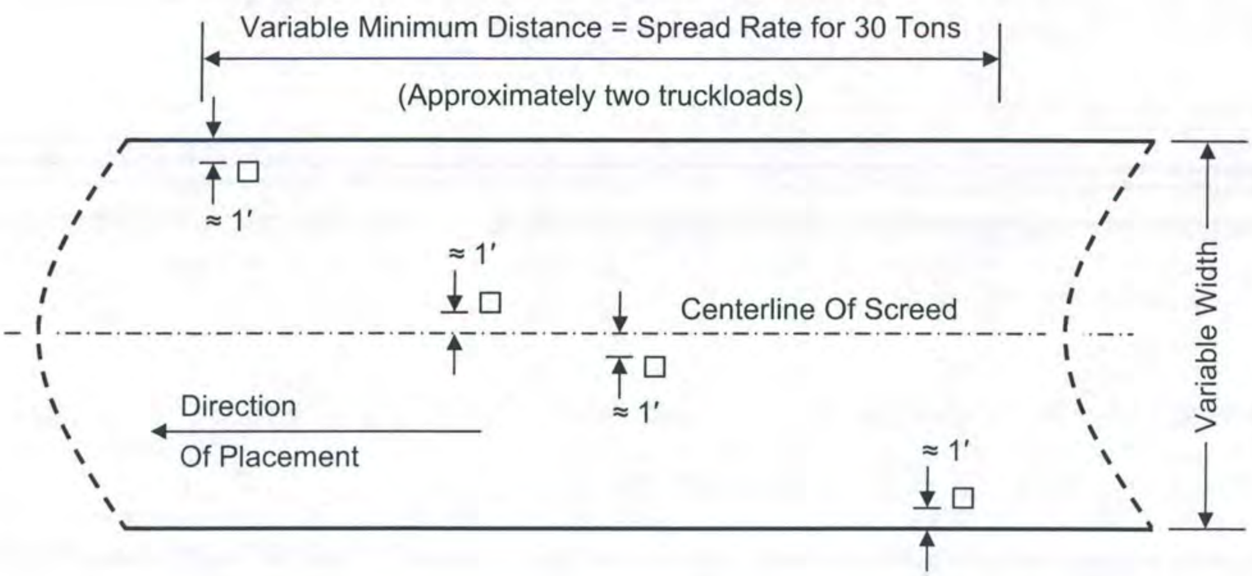
1. Samples shall always be taken behind the laydown machine before the material receives any compaction. Sampling shall be distributed over at least 30 tons (30 Mg) of mix placed (approximately two different truckloads).

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). A square pointed shovel may be used to take the sample from the inside of the template. A scoop can be used to remove the remaining material from along 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. Samples shall be taken to represent a cross-section of the mat as follows:

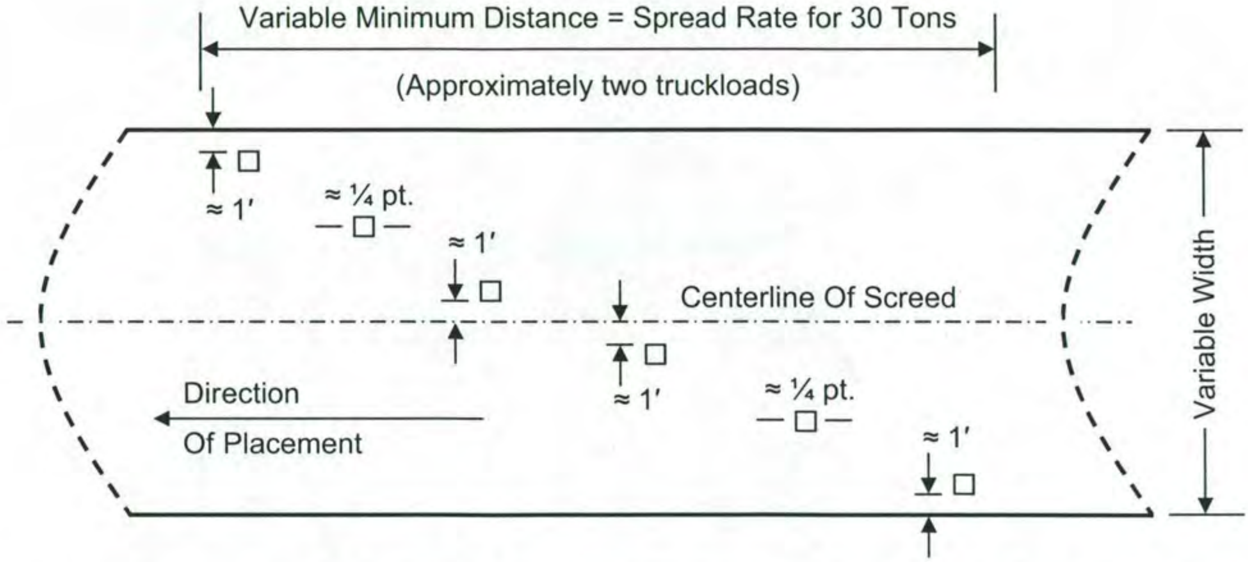
   a. A minimum of four template samples shall be taken. One approximately 1 foot (0.30 meters) in from the left edge of the mat, one approximately 1 foot (0.30 meters) left of the center of the screed, one approximately 1 foot (0.30 meters) right of the center of the screed, and one approximately 1 foot (0.30 meters) 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



4. When sampling from thick lifts [generally greater than 3 inches (80 mm) 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 by 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.

A. Hopper Sampling

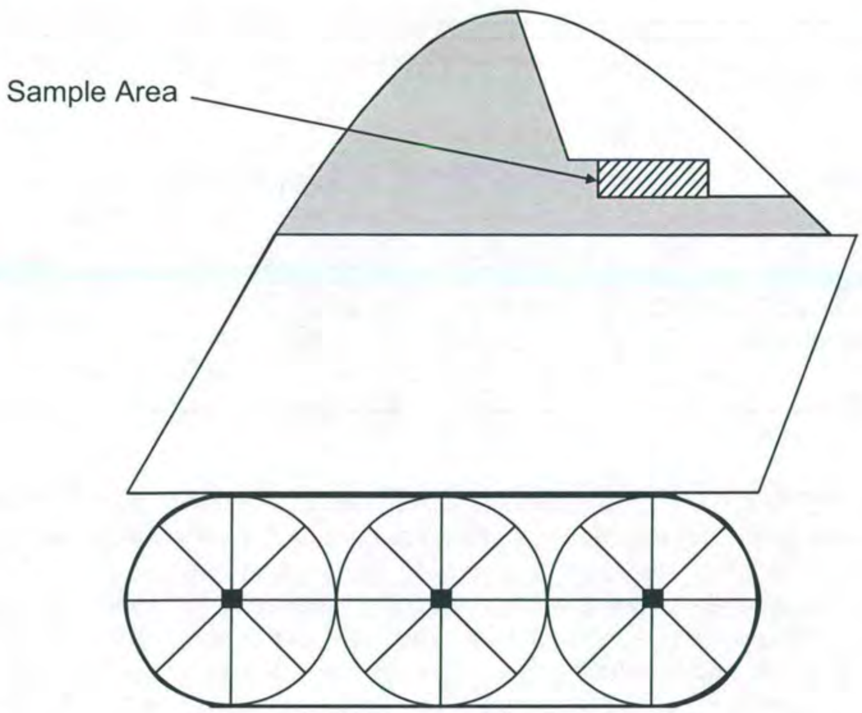
This method of sampling hot mix asphalt shall be limited to projects using the Heater Scarification Process as stated in Standard Specification 2309.

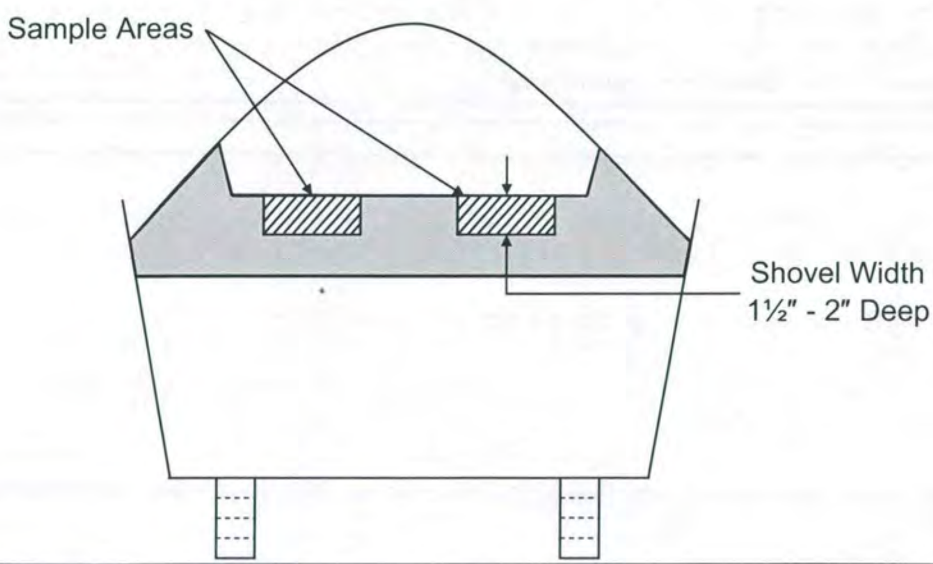
1. The sample shall always be taken from the paver hopper.

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 (30 Mg) 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 plateau is reached. Just prior to taking the sample, all foreign material shall be scraped from the shovel. The sample shall be removed from the plateau in a manner that will assure collection of material over an area, which is of uniform dimension. In placing material into the box, the material from the front face of the shovel shall be included.





Paired Samples

Field Sampling (Side-by-Side Sampling) to obtain paired samples as required to provide Agency verification samples and Contractor quality control samples.

This method is only to be used when sampling directly from the pavement with a template.

1. The Contractor shall obtain HMA samples in accordance with the procedures outlined above, except that, two boxes of at least 30 pounds (14 kg) each shall be obtained from each samples site as directed and witnessed by the Engineer.

2. 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.

3. Perform the same procedures as stated above to remove all materials from the adjacent location and place this material in the second box.

4. Agency personnel will immediately take possession of one of the two boxes, secure it and fill out a sample identification (Form #193) before retuning the sample to the Contractor for transport to the Agency's testing lab.

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.

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 (60-pound minimum) 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.
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.

METHOD OF SAMPLING ASPHALTIC MATERIALS
(General Rewrite)

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 (one-liter) capacity cardboard sample catching containers.
- 3 oz. (90 mL) ointment tin for asphalt binder.
- One-quart (one-liter) capacity wide-mouth cans with lids for cutback asphalts and complete analysis binder samples.
- One-quart (one-liter) and one gallon (four liter) 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. (90 mL) tin

   b. Binder complete analysis – 1 quart (1 liter) metal can

   c. Cutback asphalts – 1 quart (1 liter) metal can

   d. Asphalt emulsion – partial analysis 1 quart (1 liter) – must be a plastic bottle
   – complete analysis – 1 gallon (4 liter) – 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 (four liters) 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" (6 mm) form 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 (one liter) or one gallon (four liters) 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.

METHOD OF TEST FOR DETERMINING THE DENSITY OF HOT MIX ASPHALT (HMA) USING THE SUPERPAVE GYRATORY COMPACTOR (SGC)

SCOPE

This method describes the procedures for compacting hot mix asphalt samples using the SGC and determining their percent compaction. This method consolidates the provisions of AASHTO TP4 and makes the following exceptions:

- Compaction temp
- Compacting to N_{max} instead of N_{des}
- Use leveling load

REFERENCED DOCUMENTS

Standard Specification 2303 Hot Mix Asphalt
AASHTO TP4 Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP 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 (150 mm in diameter)
- 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 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 ± 5 mm	Daily
Angle	1.25° ± 0.02°	See IM 208
Pressure	600 ± 18 kPa	See IM 208
Speed of Rotation	30.0 ± 0.5 gyrations per minute	See IM 208
Mold dimension	149.90 to 150.00 mm	See IM 208
Platen dimension	149.50 to 149.75 mm	See IM 208

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} or N_{max}.

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 hot mix 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 4800 grams.

3. Heat the pans of 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).
   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.

5. 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.

6. Place the mold in the gyratory.

> **NOTE:** Some gyratories allow charging the mold with mix after the mold has been positioned in the compactor.

7. If the desired number of gyrations (N_{des} or N_{max}) has not been entered into the gyratory, do that now. The number of gyrations to apply is determined from the Job Mix Formula (JMF).

8. Apply the load to the mixture in the mold.

9. Apply the gyratory angle to the specimen.

10. Compact to N_{des} or N_{max} as specified.

11. After compaction is complete, remove the angle from the specimen, apply the leveling load, and raise the loading ram if needed (this is done automatically on some gyratories).

12. 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.

> **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. Record or print the height data for each specimen compacted.

14. After the specimens have cooled, they may be tested for bulk specific gravity, G_{mb} per IM 321.

CALCULATIONS

To determine the lab density of a compacted specimen at any gyration level (back calculate), use the G_{mb} of the final compacted specimen and the height of the specimen at different numbers of gyrations. The corrected density is calculated as follows:

$$G_{mb(corrected)} = \frac{G_{mb} h_m}{h_x}$$

Where: $G_{mb(corrected)}$ = Corrected bulk density of the specimen.
G_{mb} = Bulk specific gravity of the specimen.
h_m = Height of the extruded specimen, mm.
h_x = Height of the specimen during compaction at x gyrations, mm.

Report the corrected bulk specific gravity of the specimen, $G_{mb(corrected)}$, to 3 decimal places.

Given: $G_{mb} = 2.369$
$h_m = 117.5$ mm

Calculate $G_{mb(corrected)}$ at: $N_{ini} = 8$ gyrations $h_8 = 135.4$ mm
$N_{des} = 109$ gyrations $h_{109} = 119.4$ mm

$$G_{mb(corrected)} @ N_{ini} = \frac{2.369 \times 117.5 \text{ mm}}{135.4 \text{ mm}} = 2.056$$

$$G_{mb(corrected)} @ N_{des} = \frac{2.369 \times 117.5 \text{ mm}}{119.4 \text{ mm}} = 2.331$$

METHOD TO DETERMINE THE THICKNESS OF COMPLETED COURSES OF BASE, SUBBASE & HOT MIX ASPHALT
(General Rewrite)

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. (500 mm) long
3. Ruler with graduations of 1/16 in. (1 mm)
4. Tape measure

PROCEDURES

Specifications and instructions require that the thickness of the completed pavement courses be measured to the nearest 1/8 in. (3 mm) 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. Refer to IM 320 for drilling and removal procedures.

A-3 Measure with a ruler, to the nearest 1/8 in. (3 mm), 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. (500 mm) 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. (3 mm), 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. (3 mm) 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. (3 mm), and record in the appropriate field book and report form.

EXAMPLE DETERMINATION OF QUALITY INDEX (QI)

Design thickness 4 in. (101.6 mm)

Individual core averages as determined and recorded per this IM.

4.50 in. (114 mm)
3.75 in. (95 mm)
4.00 in. (102 mm)
4.12 in. (105 mm)
3.50 in. (89 mm)
3.88 in. (99 mm)
4.12 in. (105 mm)

Average = 3.982 in. (101.3 mm)

Range = (high value - low value) = 1 in. (25.4 mm)

$$QI = \frac{\text{Average - (Design - 0.5*)}}{\text{Range}}$$

*0.5 is used with English units, 12.7 is used with S.I. units.

$$QI = \frac{3.982 - (4.00 - 0.5)}{1.00}$$

$$QI = 0.48$$

Report QI upon completion of each lot. Refer to applicable specifications for specific details and disposition for each type of construction.

DETERMINING MAXIMUM SPECIFIC GRAVITY OF HOT MIX ASPHALT (HMA) MIXTURES

SCOPE

This test method is intended to determine the maximum specific gravity (G_{mm}) of HMA 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 T209-90.

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)
- 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)
- 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 pycnometer may be ensured by the use of the cover plate.

The following notes apply to both the Erlenmeyer flask apparatus and the alternate equipment identified in #11.

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 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 mass (weight) used in G_{mm} determinations must be appropriately adjusted by the difference in mass (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 density portions of the field sample are normally taken first and the G_{mm} sample obtained from the remainder. When the remaining amount is less than 2,000 grams, 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. 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.

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 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, 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.

7. Insert rubber stopper and connect vacuum hose. Apply the vacuum necessary to attain between 1.0 in. and 1.2 in. (25.5 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, or occasionally shake the pycnometer manually, or jar it by striking it with an open hand, being careful not to allow material to get vacuumed out. This will facilitate the removal of gas bubbles trapped in the mix and on the interior surface of the pycnometer.

8. Remove the vacuum apparatus from the pycnometer and fill with water to the top of the neck of the pycnometer. Allow the water filled pycnometer to stand 10 minutes or until the water level in the neck remains constant (time to reach equilibrium between pycnometer and the water varies with test temperature and room temperature).

9. Tip the pycnometer slightly and use a glass cover plate and bulb syringe to add water until the pycnometer is completely full.

10. Dry the outside of the pycnometer and glass plate with a clean cloth, chamois or paper towel, and weigh to the nearest 0.1 gram. Immediately after weighing, remove the glass plate and determine the temperature of the water to the nearest 0.5°F (0.2°C) with the general purpose thermometer.

11. Pour off water and dispose of sample.

CALCULATIONS

$$G_{mm} = \frac{WR}{W + W_1 - W_2}$$

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

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									

DETERMINING ASPHALT BINDER CONTENT IN HOT MIX ASPHALT (HMA) MIXTURES BY CALCULATION

SCOPE

The percent of binder in hot mix asphalt mixtures can be determined by calculation using test results from IM 350 and IM 369.

REFERENCED DOCUMENTS:

IM 350, Determining Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures

IM 369, Determining Specific Gravity of Asphalt Binder

PROCEDURE

A. Determine the Effective Specific Gravity of the Aggregate, G_{se}.

$$G_{se} = \frac{100 - P_b}{\dfrac{100}{G_{mm}} - \dfrac{P_b}{{}^*G_b}}$$

$^*G_b$ at 77°F/77°F (25°C/25°C)

Throughout the first day of production, obtain at least three (3) samples of HMA, which will represent that day's production. Determine the maximum specific gravities on each of these samples according to IM 350 and determine the average. The binder contents may be obtained by measurements from tank stick or flow meter. The specific gravity of the binder may be obtained from the certification document or by test using IM 369.

B. After G_{se} has been determined it is used throughout the project to calculate the binder content of the mixture. If any proportions are changed G_{se} must be redetermined.

Determine the Binder Content for a given set of proportions, P_b.

$$P_b = \frac{(G_{se})*(G_b) - (G_{mm})*(G_b)}{(G_{se})*(G_{mm}) - (G_{mm})*(G_b)} \times 100$$

REPORTING

The calculated asphalt content is reported to three (3) significant figures.

EXAMPLE CALCULATIONS

Given:

P_b = 5.75
G_b = 1.021
G_{mm} = 2.451

$$G_{se} = \frac{100 - 5.75}{\frac{100}{2.451} - \frac{5.75}{1.021}} = \frac{94.25}{40.80 - 5.63}$$

$$G_{se} = \frac{94.25}{35.17} = 2.680$$

$$P_b = \frac{(G_{se})*(G_b) - (G_{mm})*(G_b)}{(G_{se})*(G_{mm}) - (G_{mm})*(G_b)} \times 100$$

Given:

G_{se} = 2.680
G_b = 1.021
G_{mm} = 2.451

$$P_b = \frac{(2.680)(1.021) - (2.451)(1.021)}{(2.680)(2.451) - (2.451)(1.021)} \times 100 = 5.75\ \%\ \text{Asph.}$$

DETERMINATION OF BINDER CONTENT BY CALCULATION FROM G_{mm}

Project No. ________________ Sample ID. ________________
County ________________ Test No. ________________
Contractor ________________ Date ________________
Mix Type ________________ Mix Design # ________________

CALCULATION OF G_{se}

P_b ....(Measurement from tank stick or meter) .... 1) __.__ __
G_b .... 2) __.__ __ __
P_s ....(100 - line 1) .... 3) __.__ __ __
P_b / G_b ....(line 1 / line 2) .... 4) __.__ __ __

$$\text{Avg. } G_{mm} = \frac{(\text{sample 1} + \text{sample 2} + \text{sample 3})}{3} = \frac{(\quad + \quad + \quad)}{3} = \quad \text{5) \_\_.\_\_ \_\_ \_\_}$$

100 / Avg. G_{mm} ....(100 / line 5) ....(vol. of mixture) .... 6) __ __.__ __ __
Vol. Mixture - Asph. Vol. ....(line 6 - line 4) .... 7) __ __.__ __ __
G_{se} ....(line 3 / line 7) .... 8) __.__ __ __

CALCULATION OF P_b

G_{mm} ....(from individual G_{mm} test) .... 9) __.__ __ __
G_{se} x G_b ....(line 8 x line 2) ....10) __.__ __ __
G_{mm} x G_b ......(line 9 x line 2) .... 11) __.__ __ __
G_{se} x G_{mm} .....(line 8 x line 9) ....12) __.__ __ __
G_{se} x G_b - G_{mm} x G_b ....(line 10 - line 11) .... 13) __.__ __ __
G_{se} x G_{mm} - G_{mm} x G_b ....(line 12 - line 11) .... 14) __.__ __ __
line 13 / line 14 .... 15) __.__ __ __
P_b by calculation ....(100 x line 15) .... 16) __.__

PREPARATION OF HOT MIX ASPHALT (HMA) 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 bituminous mix.

APPARATUS

- Ventilated oven capable of maintaining a temperature at 275°F ± 5°F (135°C ± 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. (600 mm x 600 mm x 75 mm) for approximately 40 lb. (18 kg) samples. Large samples, approximately 80 lb. (36 kg), will require the use of a pan size not less than 27 in. x 36 in. x 4 in. (675 mm x 900 mm x 100 mm).
- Bituminous 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. 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. (37.5 mm). 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. (37.5 mm), 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.

VACUUM-SATURATED SPECIFIC GRAVITY & ABSORPTION OF COMBINED OR INDIVIDUAL AGGREGATE SOURCES

SCOPE

This test method is intended to determine the specific gravity and absorption of combined aggregate for asphalt mix designs only. This method uses a flask pycnometer and a vacuum system.

REFERENCED DOCUMENTS

AASHTO T209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
IM 336 Methods of Reducing Aggregate Field Samples to Test Samples

TEST METHOD

A. Apparatus

1. Balance, 10,000-gram minimum capacity and capable of weighing to the nearest 0.1 gram.
2. 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) or other suitable pycnometer.
3. Vacuum pump or water aspirator for evacuating air from the pycnometer.
4. Thermometers, ASTM 15F (30°F to 180°F [ASTM 15C (2°C to 80°C)]), softening point and a general-purpose thermometer of suitable range with graduations every 0.5°F (0.2°C).
5. Large, flat weighing pan about 16 in. by 24 in. by 2 3/4 in. (400 mm by 600 mm by 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.
6. Glass 4 in. by 4 in. (100 mm by 100 mm) cover plate for accurate filling of pycnometer flask. This is for use with the glass flask.
7. Scoop, spatula or trowel, and bulb syringe.
8. Elevated water container, with gravity discharge valve and tubing, of sufficient capacity to conduct a complete test.
9. Funnel for transferring sample from weighing pan into the pycnometer.

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.

10. Manometer for measuring absolute pressure.

11. Equipment meeting AASHTO T-209 or ASTM D-2041 will also be considered acceptable.

B. Pycnometer Calibration

Prior to being put in service, a pycnometer calibration will be performed by accurately determining the mass of water at 77°F ± 0.5°F (25°C ± 0.2°C) required to fill the pycnometer. Accurate filling of the pycnometer is assured by the use of a cover plate.

NOTE: It is necessary to verify the calibration of each pycnometer before using and to periodically check the calibration thereafter to detect any change in weight due to wear or changes in the mineral content of the water. This is done by accurately filling the pycnometer with water at any temperature recorded on the calibration sheet, drying the outside of the pycnometer, and weighing the pycnometer, water, and proper cover plate.

NOTE: Cover plate and 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 the specific gravity determinations must be appropriately adjusted by the difference in weight between the original cover plate and its replacement.

This applies to both Erlenmeyer flask apparatus and the alternate equipment identified in A11 above.

C. Specific Gravity Test Procedure

1. Obtain a test sample of at least 2000 grams of oven dried individual source aggregate or combined aggregate. Combined aggregate samples are built up to asphalt mix design proportions by following IM 336.

2. Weigh the oven-dried test sample to the nearest 0.1 gram.

3. Transfer the sample into the calibrated pycnometer, which contains water to a depth of about 2 1/2 in. (65 mm).

4. Add water, if necessary to cover the sample. Agitate the sample to remove any loosely trapped air.

5. Insert rubber stopper and connect vacuum hose. Apply a vacuum to attain between 1.0 in. and 1.2 in. (25.5 mm and 30 mm) H_g (mercury) absolute pressure, as measured by a manometer, to the flask contents for 30 minutes. During the vacuum time period agitate the flask and contents continually by using a mechanical vibratory device, or manually by shaking and rolling the flask at intervals of about 2 minutes. This will facilitate the removal of air bubbles trapped in the sample and on the interior surface of the glass.

6. Remove the vacuum apparatus from the pycnometer and fill with water to the top of the neck of the pycnometer. Allow the water filled pycnometer to stand for 20 minutes.

7. Tip the pycnometer slightly and use a glass cover plate and bulb syringe to add water until the pycnometer is completely full.

8. Dry the outside of the pycnometer and glass plate with a clean cloth, chamois or paper towel, and weigh to the nearest 0.1 gram. Immediately after weighing, remove the glass plate and determine the temperature of the water to the nearest 0.5°F (0.2°C) degree with the general-purpose thermometer.

D. Calculation of Vacuum Apparent Specific Gravity (G_{sa})

Calculate the vacuum apparent specific gravity (lines 1 through 11 of the data sheet, Appendix A) of the aggregate sample as follows:

$$\text{Apparent Specific Gravity} = \frac{WR}{W + W_1 - W_2}$$

Where: W = weight of dry sample, grams

W_1 = weight of pycnometer filled with water at test temperature, grams. (This value must be determined anytime the test temperature changes from the calibration temperature by more than ± 0.5°F (± 0.3°C)

W_2 = weight of pycnometer filled with water and sample, grams

R = correction multiplier (from table)

$$R = \frac{d_t}{0.99707}$$

Where: d_t = density of water at test temperature, grams/cc (from table)
0.99707 = density of water at 77°F (25°C) grams/cc

E. Absorption Test Procedure

1. After determining the specific gravity, pour water from the sample through a No. 200 (75-µm) mesh sieve.

2. Remove the sample from the flask and wash the sample over a No. 200 (75-µm) mesh sieve.

3. Split the sample on a No. 8 (2.36-mm) sieve. This may require using water. If water is used, the wash water from the fine portion is passed through a No. 200 (75-µm) sieve.

   NOTE: If less than 10% of the material passes the No. 8 (2.36-mm) sieve, the material passing the No. 8 (2.36-mm) sieve may be discarded.

   NOTE: If more than 90% of the material passes the No. 8 (2.36-mm) sieve, the material retained on the No. 8 (2.36-mm) sieve may be discarded.

4. Place the coarse portion [plus No. 8 (2.36-mm) sieve] of the sample on a bath towel and roll the sample around by holding on to each end of the towel. (The towel will absorb most of the free water from the aggregate particles.)

5. Place the coarse portion of the sample in a large, flat pan or on a clean hard surface. Observe when the particles develop a dull appearance and leave no streaks of moisture when moved indicating a saturated surface-dry (SSD) condition. This usually requires only about 2 to 3 minutes.

6. After the coarse particles obtain an SSD appearance immediately weigh to the nearest 0.1 gram.

7. Place the fine portion [minus No. 8 (2.36-mm) sieve] in a large pan and dry to a SSD condition by stirring and turning the particles continuously so they will dry evenly. When the material becomes free flowing and there is no tendency for the finer particles to adhere to a cool, dry steel spatula, the material is considered to be in a SSD condition.

   To aid the removal of the free water, the fine sample may be placed in a 150-mm or larger Buchner funnel containing an appropriate filter paper. A vacuum is then applied to the flask, which collects the water until the water is dripping from the funnel at a rate of 1 to 2 drops per second. The fine sample is then transferred to the large, flat pan for drying to a SSD condition as above.

   The use of a hot plate placed in front of, or in back of, a fan to circulate air over the sample to aid in obtaining an SSD condition is permissible.

> **NOTE:** Free water accumulates at the bottom of the pan. Paper towel may be used to dry the pan. **DO NOT** attempt to dry the sample with the paper towel.

8. Immediately after the fine portion of the sample has attained an SSD condition, weigh to the nearest 0.1-gram.

9. Re-combine the coarse and fine portions of the saturated-surface-dry sample, dry to a constant weight (mass) on a hot plate or in an oven and weigh to the nearest 0.1-gram (coarse and fine portions may be dried separately).

F. Calculation of Water Absorption, %Abs (Vacuum Method)

Calculate the water absorption (lines 12 through 17 of the data sheet, Appendix A) of the aggregate sample as follows:

$$\%\,\text{Abs} = \frac{(W_a + W_b - W_c)(100)}{W_c}$$

Where: W_a = saturated surface-dry (SSD) weight of coarse portion
W_b = saturated surface-dry (SSD) weight of fine portion
W_c = combined dry weight of coarse and fine portion

G. Bulk Dry Specific Gravity (G_{sb})

This test method determines the vacuum apparent specific gravity (G_{sa}) of individual or combined aggregate sources. For the purpose of asphalt mix design; the aggregate bulk specific gravity (G_{sb}) is needed. Aggregate bulk specific gravity (lines 18 through 20 of the data sheet, Appendix A) may be determined from apparent specific gravities as follows:

$$G_{sb} = \frac{G_{sa}}{1 + (\text{ABS})(G_{sa})}$$

Where: ABS = %Abs/100
%Abs = percent absorption

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									

*****GENERAL REWRITE – PLEASE READ CAREFULLY.*****

AGGREGATE SPECIFIC GRAVITY FOR COMBINED OR INDIVIDUAL SOURCES

County: ____________ Project No.: ____________ Date: ____________

Project Location: ____________

Contractor: ____________

Mix Type: ____________ Course: ____________ Size: ____________

Aggregate Sources: ____________ Size: ____________

Sample Identification: Lab. No.

1	Pycnometer No.		
2	Sample Weight	W	
3	Weight Pyc. & Water@Test Temp. (Calibration)	W1	
4	Total Weight (Line 2 + Line 3)	W+W1	
5	Weight Pyc. & Sample & Water	W2	
6	Weight Displaced Water (Line 4 - Line 5)		
7	Test Temp. of Water, (Degrees F)		
8	R Multiplier (Chart)	R	
9	Vac. Apparent Sp. Gr. {(W) X (R)/(Line 6)}	G_{sa}	

		+#8	-#8
10	Weight SSD Material		
11	Weight of Dry Material		
13	Weight of Absorbed Water (Line 10 - Line 11)		
14	Total Weight Absorbed (Line 13 (+#8 + -#8))		
15	Total Weight Dry Material (Line 11 (+#8+ -#8))		
16	% Abs, {(100) X (Line 14)/(Line 15)}		

17	ABS=%Abs/100, (Line 16/100)		
18	1 + (ABS) X (Gsa), {(1+(Line 17)) X (Line 9)}		
19	Bulk Dry Sp. Gr. (Line 9/Line 18)	G_{sb}	

ASPHALT BINDER, CUTBACK ASPHALT & EMULSIFIED ASPHALT

SCOPE

Acceptance of asphalt materials will be based on certification from an approved supplier. Asphalt binders will be certified by the Combined State Binder Group's "Method of Acceptance for Asphalt Binders." The certification of cutbacks and emulsions will be based on Standard Specification 4138 and 4140 respectively.

A Supplier of asphalt binders is defined as one who produces the final product or who makes the blend or modification that alters the final properties of the Performance Graded Asphalt Binder (PGAB). A Supplier shall be a refinery, a terminal or a Hot Mix Asphalt (HMA) producer. If any modification, blending, or blending of PGAB from different sources is made at the HMA plant, the HMA producer must be the approved supplier and must provide the required certification.

A Supplier of cutbacks and emulsions is defined as a refinery or terminal, which produces the final product. A Contractor diluting emulsion in the field will not be considered a supplier.

Approval shall be secured for each source before materials can be furnished as certified material. Approved sources are listed in Appendixes A and B of this IM.

SOURCE APPROVAL

Applications for source approval shall be made, in writing, to the Office of Materials in Ames. The appropriate District Materials Office will recommend the approval when assured that the supplier has met all qualifications. The Office of Materials will issue a formal approval.

Approval of suppliers will be based on compliance with the following requirements:

A. Acceptable Control Laboratory

A control laboratory will be considered acceptable if it shows that test results can be obtained within precision limits established by AASHTO for each test. Precision will be judged by comparison with results obtained by the Central Laboratory in Ames or acceptable performance in an approved round robin testing program. Laboratory facilities and procedures may be inspected and reviewed by Highway Division personnel.

Suppliers not participating in an approved round robin testing program shall submit a minimum of two samples of each type of material from regular production to the Central Laboratory in Ames. Complete sample identification and supplier test results for all specified tests must be submitted for each sample. A comparison of the Central Materials Office test results with the suppliers test results will be made.

B. Acceptable Quality Control Program

The supplier shall submit an outline of the Quality Control Program showing testing frequencies, tests performed, and a typical test report to the Office of Materials.

C. Records & Documentation

A satisfactory program for storage of test reports and shipment records shall be maintained. This program shall enable proper identification and documentation of all shipments made to projects and shall include a file of refinery test reports covering all asphalt binders.

Continued approval of a source will be based on the following:

A. Ability to consistently supply material meeting specifications

B. Ability to meet precision limits for testing or has an acceptable performance on round robin testing.

C. Continuation of originally approved Quality Control Program.

D. Maintenance of required records

E. Proper documentation of shipments

Approval to deliver certified material may be withdrawn for inadequate compliance with these requirements.

MONITORING APPROVED SOURCES

Monitoring activities of suppliers, including inspection of test reports, quality control records and procedures, and shipping records will be conducted by the appropriate District Materials Office in accordance with Appendices C and D of this IM.

All District Materials Office monitoring activities shall be reported to the Central Materials Office.

DOCUMENTATION

Each shipment invoice covering certified materials delivered to a project shall have a signed certification statement as to type and grade, specific gravity or weight per gallon (liter), quantity in load, batch number or other identification, project number, and compliance with the appropriate Iowa Department of Transportation Specifications. A copy of this invoice shall be furnished to the Contracting Authority at the time of delivery.

A supplier receiving material shall promptly obtain a report of complete test analysis covering each batch or identifiable lot received.

ACCEPTANCE

Properly identified and certified materials may be incorporated into a project. Final acceptance will be based on the certifications and the results of tests on project samples secured in accordance with IM 204 or in accordance with special requirements when specified. Project samples with noncompliant test results may require additional tests.

NOTE: Emulsions, which are to be shipped to Iowa projects, shall be held in storage tanks for a minimum of 24 hours. Certification shall be based on tests made at the time of shipment.

*****GENERAL REWRITE – PLEASE READ CAREFULLY.*****

APPROVED SOURCES OF ASPHALT BINDER

Method of Acceptance for Asphalt Binders

CERTIFIED SUPPLIERS – APRIL 2006

SUPPLIER		IADOT	MNDOT	NDDOT	NEDOR	SDDOT	WISDOT
Asphalt Operating Services, LLC	Bartlett, IL						X
Barton Enterprises	Newport, MN		X				
Bituminous Matr'l & Supply	Des Moinse, IA	X					
Bituminous Matr'l & Supply	Tama, IA	X					
Border Chemical Co.	Winnipeg, Manitoba			X			
BP - Bit Mat Products	South Bend, IN						X
BP - Jacobus Petroleum	Milwaukee, WI						X
BP Products North America Inc	Whiting, IN	X					X
CHS	Laurel, MT			X		X	
CHS	Grand Forks, ND		X	X			
CHS	Mandan, ND			X		X	
CHS	Hardin, MT			X			
ConocoPhillips	Forestview, IL						X
ConocoPhillips Company	Kansas City, MO.	X					
ConocoPhillips Company	Roxanna, IL				X		
Const Resources Mgmt Inc	Gladstone, MI						X
Const Resources Mgmt Inc	Milwaukee, WI						X
Const Resources Mgmt Inc	Waukesha, WI						X
Const Resources Mgmt Inc	Green Bay, WI						X
Exxon Mobil	Billings, MT			X		X	
Flint Hills Resources, LP	Davenport, IA	X					
Flint Hills Resources, LP	Omaha, NE	X			X	X	
Flint Hills Resources, LP	Rosemount, MN	X	X		X	X	X
Flint Hills Resources, LP	Green Bay, WI						X
Flint Hills Resources, LP	West Fargo, ND		X	X		X	
Flint Hills Resources, LP	Stevens Point, WI						X
Flint Hills Resources, LP	Marshall, MN	X	X	X	X	X	
Flint Hills Resources, LP	Dubuque, IA	X					X
Flint Hills Resources, LP	Savage, MN	X	X	X	X	X	X
Flint Hills Resources, LP	Algona, IA	X					
Flint Hills Resources, LP (Omaha II)	Omaha, NE	X			X		
Frontier Ref Inc	Cheyenne, WY				X		
H G Meigs LLC	Abbotsford, WI						X
H G Meigs LLC	Portage, WI		X				X
Husky Energy	Calgary, Alberta			X			
Husky Oil	Saskatoon, SASK		X			X	
Jebro, Inc.	Corson, SD	X	X			X	
Jebro, Inc.	Sioux City, IA	X	X	X	X	X	

SUPPLIER		IADOT	MNDOT	NDDOT	NEDOR	SDDOT	WISDOT
Marathon Ashland Petroleum LLC	Utica, IL						X
Marathon Ashland Petroleum LLC	St Paul Park, MN		X				X
Marathon Ashland Petroleum LLC	Utica, IL						X
Marathon Ashland Petroleum LLC	St Paul Park, MN		X				X
McAsphalt Ind LTD	Thunder Bay, Ontario		X				
McAsphalt Ind LTD	Winnipeg, Manitoba		X				
Midwest Industrial Fuels	LaCrosse, WI	X	X				X
Midwest Industrial Fuels	Rochester, MN	X	X				X
Monarch Oil	Omaha, NE				X		
Moose Jaw Asphalt, Inc	Moose Jaw, Sask			X		X	
Murphy Oil USA, Inc.	Rhinelander, WI						X
Murphy Oil USA, Inc.	Superior, WI		X				X
Murphy Oil USA, Inc.	Crookston, MN		X	X		X	
Peoria River Terminal	Peoria, IL						X
Peoria River Terminal - Ameropan Oil	Chicago, IL						X
Peoria River Terminal - Bell Oil	Chicago, IL						X
Pioneer Oil Co.	Billings, MT			X			
Pounders Emulsions	Yorkton, SASK			X			
Seneca Petroleum, Co.	Portage, IN						X
Seneca Petroleum, Co.	Lemont, IL						X
Sinclair Oil Corp.	Casper, WY				X	X	
Texpar Energy LLC	Davenport, IA	X					
Westway Terminal Company, Inc	St Paul, MN		X				

APPROVED SOURCES
CUTBACK & EMULSIFIED ASPHALT

The following sources are approved to furnish **Cutback Asphalt** based on certification:

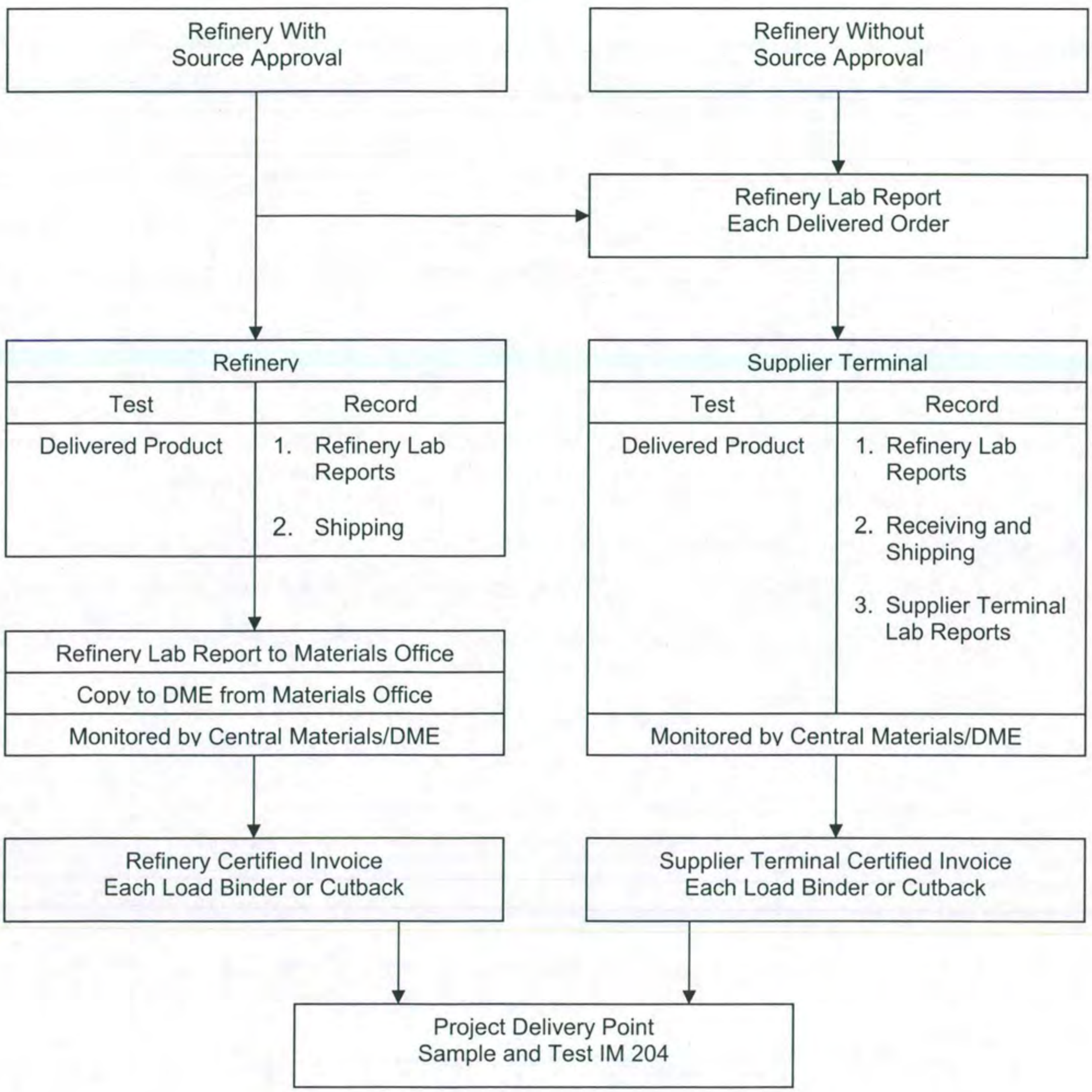
SUPPLIER	ADDRESS
Bituminous Materials & Supply Company	Des Moines, IA
Bituminous Materials & Supply Company	Tama, IA
Coastal Refining & Marketing, Inc.	Eldorado, KS
Illinois Road Contractors Inc.	Meredosia, IL
Jebro, Inc.	Sioux City, IA
Jebro, Inc.	Sioux Falls, SD
Flint Hills Resources	Algona, IA
Flint Hills Resources	Dubuque, IA
Flint Hills Resources	Marshall, MN
Flint Hills Resources	Omaha, NE
Flint Hills Resources	St. Paul, MN
L.L. Pelling Company, Inc.	Coralville, IA
Midwest Industrial Fuel Company	La Crosse, WI

The following sources are approved to furnish **Emulsified Asphalt** based on certification:

SUPPLIER	ADDRESS
Bituminous Materials & Supply Company	Des Moines, IA
Bituminous Materials & Supply Company	Tama, IA
H.G. Meigs	Portage, WI
Illinois Road Contractors Inc.	Meredosia, IL
Jebro, Inc.	Sioux City, IA
Flint Hills Resources	Algona, IA
Flint Hills Resources	Dubuque, IA
Flint Hills Resources	Marshall, MN
Flint Hills Resources	Omaha, NE
Flint Hills Resources	St. Paul, MN

SUPPLIER	**ADDRESS**
Monarch Terminal	Omaha, NE
Vance Brothers, Inc.	Kansas City, MO

ASPHALT BINDER & CUTBACK FLOW CHART



MONITORING GUIDE
ASPHALT REFINERIES & TERMINALS

REFINERIES

Refinery monitoring samples will be taken on request by the Central Materials Office or when deemed necessary by the District Materials Engineer. These samples will be taken before the material is incorporated into terminal or contractor storage. The Central Laboratory will conduct all testing of these samples.

DISTRIBUTION TERMINALS

The appropriate District Materials Office will review terminal procedures and records related to Iowa DOT work each time a terminal is visited for monitoring purposes.

Active suppliers of asphalt products to Iowa DOT projects shall be monitored at least once a year.

Intermittent suppliers shall be monitored at the discretion of the District Materials Engineer.

MONITOR & CORRELATION TESTING

The Central Materials Laboratory shall test samples taken during monitor visits.

Monitor samples for binder, emulsion and cutback shall be taken at least once a year beginning in the spring. Monitor samples are to be taken by the supplier and must be witnessed by DOT personnel.

NOTE: Both the Central Materials Office and the supplier for correlation purposes must test monitor samples. The supplier must provide the monitor sample test results to the Central Office in a timely manner.

Monitor samples from a terminal submitted to the Central Laboratory will be used for correlation between the terminal control laboratory and the Central Laboratory. Test reports on these samples will be distributed to the monitoring District Materials Office and the terminal.

INSPECTION & ACCEPTANCE
HYDRATED LIME

GENERAL

Hydrated lime for soil stabilization shall meet the requirements of AASHTO M216. Details of use will be shown on the plans.

Hydrated lime used in hot mix asphalt (HMA) mixtures shall meet the requirements of AASHTO M303, except that the gradation shall be determined in accordance with AASHTO T11.

ACCEPTANCE

Acceptance of hydrated lime for use on Department of Transportation projects will be based on approved manufacturer and satisfactory test results on assurance samples.

MANUFACTURER APPROVAL

Manufacturer approval will be based on test results obtained on an annual sample submitted by the manufacturer to the Office of Materials for testing and recommendation of the District Materials Engineer after an acceptance of plant facilities and quality control procedures.

An approval will remain in effect unless withdrawn because of deficient test results on samples submitted.

ASSURANCE & MONITOR SAMPLING

The District Materials Office shall sample and submit for test assurance samples as desired by the Engineer.

The Office of Materials may request additional samples for monitoring purposes.

APPROVED SUPPLIERS
HYDRATED LIME

SOURCES	SOIL STABILIZATION	ACC MIXTURES
Ash Grove Cement Company Springfield, MO	Yes	Yes
Carmeuse Lime Chicago Heights, IL	Yes	Yes
Cutler-Magner Company Duluth, MN	Yes	Yes
Linwood Mining & Mineral Company Davenport, IA	Yes	Yes
Mississippi Lime Company St. Genevieve, MO	Yes	Yes
Pete Lien and Sons, Inc. Rapid City, SD	Yes	Yes
Western Lime Corporation West Bend, WI	Yes	Yes

RELEASE AGENTS
FOR BITUMINOUS MATERIALS

SCOPE
Release agents used to prevent bituminous materials from adhering to interior surfaces of truck bodies shall meet the requirements of applicable Iowa Department of Transportation Specifications.

ACCEPTANCE

Acceptance of release agents for use on Iowa Department of Transportation projects is based on manufacturer and brand name approval. Brand names must be identifiable on the containers. Approved manufacturers and brand names are listed in Appendix A.

MANUFACTURER & BRAND NAME APPROVAL

Product approval is based on information supplied by the producer and the results of tests showing the effect on asphalt binder. Requests for approval shall be made to the Office of Materials in Ames, Iowa, and shall be accompanied by a sample of the release agent together with product information including brand name and instructions for use. The release agent shall not alter the G*/sin (delta) results of the asphalt by more than 10%.

MONITOR SAMPLING & TESTING

The Office of Materials may sample and test release agents to verify compliance with specifications.

APPROVED SOURCES
RELEASE AGENTS FOR BITUMINOUS MATERIALS

PRODUCER	BRAND NAME
Archer Petroleum Omaha, NE	Quick Release
Astec Corporation	Glide Off Sta-Off
BG Chemical, LP Fort Worth, TX	Black Magic for Drag Slats Black Magic for Trucks Black Magic for Rubber Black Magic 13
Biospan Technologies	AR3600
Birco Corp. Henderson, CO	Tar-Git
Buckeye International Maryland Heights, MO	Buckeye Shopmaster
Certified Laboratories Fort Worth, TX	Certisuds
Chem-Tech, Inc. Golden Valley, MN	Asphalt Release Asphalt Release Plus
ChemStation of Iowa Des Moines, IA	Release Agent 1475 Release Agent 2790 Release Agent 5895 Release Agent 6992
Chevron Lubricants Distributed by Ottsen Oil Company Cedar Rapids, IA	Chevron Soluble Oil B.
Compound Technologies, Inc. Cartersville, GA	SPX-7 No. 1 Asphalt Release Agent
Drummond American Vernon, IL	Riptide Slip N Slide
Emulso Corporation Buffalo, NY	AR-92

PRODUCER	BRAND NAME
Enviro-Chem Roswell, GA	Exodus Enviro Foam Foamex Super Slick
Du Bois Chemicals Cincinnati, OH	Liqui-Slip Poly-Slip Slide-eze Slide-All DIVER-SLIP
Fine Organics Corporation Lodi, NJ	FO Release FO Release II
Franmar Chemical, Inc. Normal, IL	BEAN-e-doo®
Microblend Morrow, GA	Gargoyle Tuff-Act
Penetone Corporation Tenafly, NJ	Superload
Presto Chemical Company Roswell, GA	E-Z Slip Kwik Release Bio-Kream Syn-Coat
Schaeffer Manufacturing Company St. Louis, MO	4002
Spartan Chemical Company Toledo, OH	Spartan SD-20
Tec-Team Industries, Inc. Smyrna, GA	Teclon-50 Tec-Shield
Texas Refinery Fort Worth, TX	Big Red Cotton Picker Water Tank Oil
United Laboratories, Inc. Addison, IL	U596 E-Z-GO U796 E-Z-GOLD

PRODUCER	BRAND NAME
Wacker Chemical Corporation Adrian, MI	E2008
Waco Chemical	2000 Phalt Free Foam Plus Slide Plus
Zep Manufacturing Atlanta, GA	ZEP R-6690 Freeze Free Release FA Special Mix E2008 X2400

October 17, 2006
Supersedes October 2, 2001

Matls. IM 491.16

ANTI-STRIP AGENTS FOR CUTBACK ASPHALT

GENERAL

Anti-strip agents used in cutback asphalt shall be approved brands. Sources, approved brand names, and approved dosages are listed in Appendix A.

BRAND NAME APPROVAL

Brand approval will be based on information supplied by the producer and the results of anti-stripping tests. Requests for approval shall be made to the Office of Materials in Ames, Iowa, and shall be accompanied by a sample of the anti-strip agent together with product information including brand name, recommended dosage, and instructions for use. Anti-strip testing shall be in accordance with Laboratory Test Method No. Iowa 629. The treatment shall be heat stable for 24 hours at 250°F (121°C).

MONITOR SAMPLING & TESTING

The Office of Materials may sample and test anti-strip agents to verify results of the original approval.

APPROVED SOURCES
ANTI-STRIP FOR CUTBACK ASPHALT

PRODUCER	BRAND NAME	DOSAGE IN %
AKZO Nobel Asphalt Applications	Redicote 82-S	0.5
	Redicote 90-S	0.5
	Kling Beta LV	0.25
	Kling Beta 2550 HM	0.25
ARR-MAZ Products, Inc.	AD-Here CB	0.25
ARR-MAZ Products	SC-901	0.5
(Previously Tomah Products, Inc.)	Acra-500	0.5
B.J. Chemical Services	Unichem 8161	0.5
	Unichem 8162	0.5
	Unichem 8163	0.5
	Unichem 8169	0.5
Carter-Waters	Anti-Strip CW-2	1.0
MeadWestvaco Corp.	Pave Bond Special	0.25
	Pave 192	0.7
	Pave Bond Lite	0.5
	Morelife 2200 PC	0.25 & 0.5
	Morelife 3300	0.25
	Indulin 814	0.5

ASPHALTIC TERMINOLOGY, EQUATIONS & EXAMPLE CALCULATIONS

SCOPE

This IM describes the terminology and many of the equations associated with asphaltic materials. In addition, there are a number of example calculations showing how to determine various properties.

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.

MISCELLANEOUS TERMINOLOGY

Asphalt Joint Sealer – An asphalt product used for sealing cracks and joints in pavements and other structures.

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.

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.

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 on products in addition to virgin aggregate and binder. This is also referred to as Reclaimed Asphalt Pavement.

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.

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)

P_b = % of asphalt binder in the hot mix asphalt mixture

$P_{b(RAP)}$ = % of asphalt binder in RAP material

P_s = % of combined aggregate in the hot mix asphalt mixture
= $100 - P_b$

P_{ba} = % of asphalt binder absorbed by aggregate, aggregate 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_{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
$G_{mb(corrected)}$	=	corrected G_{mb} at any level of gyratory compaction
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
V	=	the calculated volume of the specimen at N_x, cc
d	=	the inside diameter of the mold, mm
h_m	=	the height of the specimen at N_{max}, mm
h_x	=	the height of the specimen at any gyration level N_x, mm
C	=	Ratio of measured G_{mb} to calculated G_{mb} at N_{max}
	=	Correction factor used for calculating the corrected density
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
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. Any additional needed information will be provided with the sample calculation.

$P_b = 5.75\%$	$G_{sa} = 2.667$	$G_{mb\ (field)} = 2.310$
$P_s = 100 - 5.75 = 94.25\%$	$G_{se} = 2.659$	$G_{mb\ (lab)} = 2.408$
% Abs = 1.39	$G_{sb} = 2.572$	% RAP = 10.0%
ABS = 1.39/100 = 0.0139	$G_{sb(SSD)} = 2.608$	$P_{b(RAP)} = 5.00\%$
$G_b = 1.031$	$G_{mm} = 2.438$	

% minus #200 (75 µm) sieve = 5.0%
% frictional agg. retained on #4 (4.75 mm) = 90%
% frictional agg. of total blend = 20%
% retained on #4 (4.75 mm) of total blend = 60%

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) $$= \frac{G_b \text{ (at 77° F)}}{0.9961} = \frac{1.031}{0.9961} = 1.035$$

G_b (at 77°F) $$= 0.9961 * G_b \text{ (at 60°F)} = 0.9961 * (1.035) = 1.031$$

% 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)

$$= \% \text{ Abs}_1(P_{s1}) + \% \text{ Abs}_2(P_{s2}) + \% \text{ Abs}_3(P_{s3}) + \ldots$$

$$= 0.67(0.50) + 1.23(0.05) + 2.21(0.45) = 1.39\%$$

Where:

% Abs_1 = 0.67%	P_{s1} = 50%
% Abs_2 = 1.23%	P_{s2} = 5%
% Abs_3 = 2.21%	P_{s3} = 45%

$\mathbf{G_{sa}}$

$$= \frac{WR}{W + W_1 - W_2} \qquad = \frac{(2000.0)(1.0000)}{2000.0 + 6048.0 - 7298.1} = 2.667$$

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

$\mathbf{G_{sb}}$

$$= \frac{G_{sa}}{1 + (ABS)(G_{sa})} \qquad = \frac{2.667}{1 + (0.0139)(2.667)} = 2.572$$

$\mathbf{G_{sb\ (combined)}}$

$$= \frac{100}{\frac{P_{s1}}{G_{sb1}} + \frac{P_{s2}}{G_{sb2}} + \frac{P_{s3}}{G_{sb3}} + ..} \qquad = \frac{100}{\frac{50.0}{2.657} + \frac{5.0}{2.642} + \frac{45.0}{2.640}} = 2.649$$

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

$\mathbf{G_{se}}$

$$= \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}} \qquad = \frac{100 - 5.75}{\frac{100}{2.438} - \frac{5.75}{1.031}} = 2.659$$

$\mathbf{G_{mm}}$

$$= \frac{WR}{W + W_1 - W_2} \qquad = \frac{(2020.0)(1.0000)}{2020.0 + 6048.0 - 7239.5} = 2.438$$

Where: W = Sample weight of sample, 2020.0 g
W_1 = 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

$$= \frac{d_t}{0.99707} \qquad = \frac{0.99707}{0.99707} = 1.0000$$

Where: d_t = 0.99707 g/cc at 77°F.

G_{mb} $= \dfrac{W_1}{W_3 - W_2}$ $= \dfrac{4800.0}{4805.6 - 2727.7} = 2.310$

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 $= \dfrac{G_{mm} - G_{mb}}{G_{mm}} \times 100$ $= \dfrac{2.438 - 2.310}{2.438} \times 100 = 5.3\%$

P_a $= 100 - \dfrac{G_{mb(field)}}{G_{mm}} \times 100$ $= 100 - \dfrac{2.310}{2.438} \times 100 = 5.3\%$

VMA $= 100 - \dfrac{G_{mb} \times P_s}{G_{sb}}$ $= 100 - \dfrac{(2.310)(94.25)}{2.572} = 15.4\%$

VFA $= \dfrac{VMA - P_a}{VMA} \times 100$ $= \dfrac{15.4 - 5.3}{15.4} \times 100 = 65.6\%$

P_{ba} $= \dfrac{(G_{se} - G_{sb})}{(G_{se} \times G_{sb})} \times G_b \times 100$ $= \dfrac{2.659 - 2.572}{(2.659)(2.572)} \times 1.031 \times 100 = 1.31\%$

P_{be} $= P_b - \dfrac{P_{ba} \times P_s}{100}$ $= 5.75 - \dfrac{(1.31)(94.25)}{100} = 4.52\%$

F/B (Marshall) $= \dfrac{\text{Total \% of minus \#200 } (75\,\mu m) \text{ material}}{P_b}$ $= \dfrac{5.00}{5.75} = 0.87$

F/B (Gyratory) $= \dfrac{\text{Total \% of minus \#200 } (75\,\mu m) \text{ material}}{P_{be}}$ $= \dfrac{5.00}{4.52} = 1.11$

Where: Total % of minus #200 (75 µm) includes both virgin aggregate and RAP when used.

GYRATORY EQUATIONS

V $= \dfrac{(\pi)(d^2)(h_x)}{4000}$ $= \dfrac{(\pi)(150.0)^2(118.0)}{4000} = 2086.1$

$$G_{mb\,(calculated)} = \frac{W}{V} = \frac{4800.0}{2086.1} = 2.301$$

Where: W = Sample weight of mix in the mold, 4800.0 g

$$C = \frac{G_{mb\,(measured)}}{G_{mb\,(calculated)}} = \frac{2.310}{2.301} = 1.004$$

$$G_{mb\,(corrected)} = (G_{mb\,(calculated)})C = (2.301)(1.004) = 2.310$$

$$C_x = \frac{G_{mb\,(corrected)(x)}}{G_{mm}} \times 100 = \frac{2.310}{2.438} \times 100 = 94.7\%$$

$$C_x = \frac{G_{mb} h_m}{G_{mm} h_x} \times 100$$

Where: h_m = 117.5 mm
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

$$C_8 = \left(\frac{(2.310) \times (117.5\text{mm})}{(2.438) \times (135.4\text{mm})}\right) \times 100 = 82.2\%$$

$$C_{109} = \left(\frac{(2.310) \times (117.5\text{mm})}{(2.438) \times (119.4\text{mm})}\right) \times 100 = 93.2\%$$

$$C_{174} = \left(\frac{(2.310) \times (117.5\text{mm})}{(2.438) \times (117.5\text{mm})}\right) \times 100 = 94.7\%$$

$$S = \frac{(\log(N_{max}) - \log(N_{ini}))}{C_{max} - C_{ini}} = \frac{(\log(174) - \log(8))}{0.947 - 0.822} = 10.7$$

Where: C_{max} and C_{ini} are expressed as decimals.

RAP FORMULAS

$P_{b(added)}$

$$= \frac{(100)(\text{total intended } P_b) - (\%\ RAP)(P_{b(RAP)})}{100 - (\%\ RAP)(P_{b(RAP)})(0.01)}$$

$$= \frac{(100)(5.75) - (10.0)(5.00)}{100 - (10.0)(5.00)(0.01)} = 5.28\%$$

$\%\ RAP_{(aggregate)}$

$$= \frac{(\%\ RAP)(1.00 - (P_{b(RAP)})(0.01))}{\%\ \text{virgin agg.} + (\%\ RAP)(1.00 - (P_{b(RAP)})(0.01))} \times 100$$

$$= \frac{(10.0)(1.00 - (5.00)(0.01))}{90.0 + (10.0)(1.00 - (5.00)(0.01))} \times 100 = 9.55\%$$

% virgin agg.

$$= \frac{(\%\ \text{virgin agg.})}{\%\ \text{virgin agg.} + (\%\ RAP)(1.00 - (P_{b(RAP)})(0.01))} \times 100$$

$$= \frac{90.0}{90.0 + (10.0)(1.00 - (5.00)(0.01))} \times 100 = 90.45\%$$

Total P_b

$$= P_{b(added)} + ((\%\ RAP)(P_{b(RAP)})(0.01)) - ((P_{b(added)})(\%\ RAP)(P_{b(RAP)})(0.0001))$$

$$= 5.28 + (10.0)(5.00)(0.01) - (5.28)(10.0)(5.00)(0.0001) = 5.75\%$$

MISCELLANEOUS

Optimum P_b

$$= \frac{(\text{high voids - target voids})}{(\text{high voids - low voids})}(\text{high } P_b - \text{low } P_b) + \text{low } P_b$$

Where: There are 2 P_b contents with 1 on either side of the intended P_b
The % voids at those two bracket P_b values are used

$$= \frac{(5.5 - 4.0)}{(5.5 - 3.0)} \times (6.75 - 4.75) + 4.75 = 5.95\%$$

% Moisture $= \dfrac{\text{Wet Wt. Sample} - \text{Dry Wt. Sample}}{\text{Dry Wt. Sample}} \times 100$

Where: Wet Wt. Sample = 2100.0 g
Dry Wt. Sample = 2000.0 g

$$= \frac{2100.0 - 2000.0}{2000.0} \times 100 = 5.0\%$$

To adjust the height of a G_{mb} specimen to reach the intended height, the following equation is used.

Adjusted sample weight $= \dfrac{\text{(trial sample weight)(intended height)}}{\text{trial sample height}}$

$$= \frac{(4775.0)(115.0)}{109.5} = 5014.8$$

G_{sb} $= \dfrac{G_{sb(SSD)}}{1 + ABS}$ $= \dfrac{2.608}{1 + 0.0139} = 2.572$

% Frictional Agg. of total blend of all + 4 (4.75mm) material $= \dfrac{\text{(\% frictional agg. retained on \#4 (4.75mm))(\% frictional agg. of total blend)}}{\text{(\% retained on \#4 (4.75mm) of total blend)}}$

$$= \frac{(90)(20)}{60} = 30\%$$

Percent Lab Density $= \dfrac{G_{mb(field)}}{G_{mb(lab)}} \times 100$ $= \dfrac{2.310}{2.408} \times 100 = 95.9\%$

Min. P_b $= \dfrac{[(G_b)(G_{se})(VMA - V_t) + (G_b)(100 - VMA)(G_{se} - G_{sb})]}{(G_b)(G_{se})(VMA - V_t) + (G_b)(100 - VMA)(G_{se} - G_{sb}) + (G_{se})(G_{sb})(100 - VMA)} \times 100$

$$= \frac{[(1.031)(2.659)(15.4 - 4.0) + (1.031)(100 - 15.4)(2.659 - 2.572)]}{(1.031)(2.659)(15.4 - 4.0) + (1.031)(100 - 15.4)(2.659 - 2.572) + (2.659)(2.572)(100 - 15.4)} \times 100 = 6.29\%$$

You have 13,000 grams of aggregate and 650 grams of asphalt binder. Determine the asphalt binder content (P_b) of the mixture.

$P_{b\ (mix\ basis)}$ $= \frac{W_b}{W_s + W_b} \times 100 \qquad = \frac{650}{13000 + 650} \times 100 = 4.76\%$

Where: W_b = Weight of the asphalt binder, g
W_s = Weight of the aggregate, g
$P_{b\ (mix\ basis)}$ = 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.

$W_{b\ (mix\ basis)}$ $= \frac{(P_b)(W_s)(0.01)}{1 - (P_b)(0.01)} \qquad = \frac{(5.5)(13000)(0.01)}{1 - (5.5)(0.01)} = 756.6$

Where: $W_{b\ (mix\ basis)}$ = Weight of the added binder, mix basis, g
W_s = Weight of the aggregate, g

QUALITY INDEX (QI) EXAMPLE:

Given: lab. G_{mb} = 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.

$$\bar{x} = \frac{2.319 + 2.316 + 2.310 + 2.298 + 2.242 + 2.340 + 2.345}{7} = 2.310$$

The sample standard deviation is determined as follows:

$$\sigma_{n-1} = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}} \qquad = \sqrt{\frac{0.007}{7 - 1}} = 0.034$$

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 $$= \frac{\text{Highest } G_{mb} - \text{Avg. } G_{mb}}{\sigma_{n-1}} \qquad = \frac{2.345 - 2.310}{0.034} = 1.03$$

Suspected Low Outlier $$= \frac{\text{Avg. } G_{mb} - \text{Lowest } G_{mb}}{\sigma_{n-1}} \qquad = \frac{2.310 - 2.242}{0.034} = 1.99$$

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).

$\mathbf{x}_{\mathbf{avg\ (new)}} = 2.321$ $\qquad$ $\boldsymbol{\sigma}_{\mathbf{n\text{-}1\ (new)}} = 0.018$

QI $$= \frac{2.321 - (0.95)(2.408)}{0.018} = 1.88$$

<u>GRADATION EXAMPLE</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	19 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	600 μm	300 μm	150 μm	75 μm
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 and do the same thing with each of the other aggregates to get 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	37.8	25.6	10.1	5.4	4.0

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	4.0	
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	0.38	0.62	0.73	0.62	0.66	1.31	5.01

The surface area 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.

FT $= \dfrac{P_{be}}{SA} \times 10 \qquad = \dfrac{4.52}{5.01} \times 10 = 9.0$

SA $= (\%\,\text{Passing})(\text{Surface Area Coefficient}) \qquad = (38)(0.0164) = 0.62$

Where: The Surface Area Coefficients are constants.

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.

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.

$$2{,}000 \text{ gal binder @ } 296°F = \frac{(8.67 \text{ lbs./gal})(2{,}000 \text{ gal})}{(2{,}000 \text{ lbs./ton})} = 8.67 \text{ tonsbinder @ } 296 \text{ °F}$$

This value must be converted to the tons of binder at 60°F.

$$8.67 \text{ tons binder @ } 296°F = (8.67 \text{ tons @ } 296 \text{ °F})(0.9200 \text{ @ } 60 \text{ °F} / 296 \text{ °F})$$

$$= 7.98 \text{ tons binder @ } 60 \text{ °F}$$

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. The reported tonnage of binder hauled in during the day is typically reported at 60°F.

$$\text{Tons of binder used in mix} = 28.0 \text{ tons} + 7.98 \text{ tons} = 35.98 \text{ tons binder}$$

******GENERAL REWRITE******

HOT MIX ASPHALT (HMA) PLANT INSPECTION

GENERAL

The Contractor's Certified, Level I HMA, Technician should witness the contractor operations, from the initial plant set up to the final shutdown. The contractor plant and method of operations should be examined thoroughly before work begins. Any deficiencies, which are observed with regard to specification compliance or safety, should be reported to the contractor and the engineer.

Normally, two certified technicians are required to perform the various materials quality control tests and plant production control inspection functions. The overall responsibility for plant inspection remains with the Contractor. This section deals primarily with this overall responsibility, therefore, no guidelines will be presented regarding division of duties and functions. The assignment of duties and functions of the inspection monitors are the responsibility of the Resident Construction Engineer and the District Materials Engineer.

PLANT INSPECTOR DUTIES

A. Preliminary

The first phase of the contractor operations consists of preparing the plant site and building stockpiles. The Contractor's certified technician should be assigned to the project prior to this phase of the work so that those procedures, which are governed by the specifications, may be observed and properly controlled.

The general areas or procedures requiring attention are:

1. Construction of Stockpiles to:

   a. Minimize segregation

   b. Eliminate contamination and intermingling

   This is accomplished by constructing the stockpile in lifts, controlling stockpile height, controlling drifting and rolling of material, constructing partitions or bulkheads, and stabilizing the stockpile work area. Refer to the specifications for specific requirements.

> **NOTE:** All aggregate must be properly certified before being placed in the stockpile.

2. Plant Erection Which Provides:

   a. Safe working conditions

   b. Reliable operation

   This is accomplished by proper site preparation, placement of adequate foundations for bins and mixing equipment and constructing safeguards such as berms and drainage ways.

B. Job Mix Formula (JMF)

The job mix formula together with the specifications provide the initial basis for setting up and starting the job, therefore, the plant inspector must be thoroughly familiar with the information provided by the Job Mix Formula Report (Form #956).

Before the laboratory can develop a job mix formula, the contractor, material producers, and District Materials Engineer must make numerous arrangements in the field. The contractor must first select his/her material sources and estimate, in cooperation with the producers, the tentative proportions and gradations of each of the materials. The District Materials Engineer must be consulted before samples of the materials are obtained. The Contractor is responsible for the mix design per IM 510. Adjustments may be necessary in these proposed proportions since the exact gradations may not be known in advance.

If the composite gradation complies with the limits specified for the job mix formula, production limits are set for the individual aggregates by agreement between the Contractor and the Producer and documented on Form #955.

Aggregate production and inspection are covered in detail by IM 204 and IM 209.

If the materials as first analyzed do not consistently meet the specified limits, it may be necessary to adjust the proportion percentages or production limits. Familiarity with the material sources and production methods facilitates setting realistic limits. This reduces the number of trial and error steps and subsequent adjustments. It is advantageous to maintain records of this type for each material source and type.

When changes are made during the design stage, they will be incorporated in the job mix formula report. If changes are found necessary after production begins, they are to be made as provided for in Materials IM 511 unless a complete new job mix formula is required.

A typical Mix Design Report with a description of information is shown on the following pages.

Form 955 ver. 6.0r

Iowa Department of Transportation

Highway Division-Office of Materials
Proportion & Production Limits For Aggregates

County : Monona   Project No.: IM-29-5(89)106--13-67   Date: 03/12/04
Project Location: Southbound from MP 105.61 to 112.71   Mix Design No.: ABD4-001
Contract Mix Tonnage: 500,000   Course: Surface   Mix Size (in.): 3/4
Contractor: Quality Construction   Mix Type: HMA 30M   Design Life ESAL's: 15,000,000

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
3/4 Cr. Lmst.	A19512	25.0%	Quality Aggregate	A	4	10-12	2.643	1.75
3/4 Clean Lmst.	A19513	15.0%	Quality Aggregate	A	4	14-21	2.624	1.21
3/8 Qtz. Chip	A19515	20.0%	Quality Aggregate	A	2	2-3	2.628	0.34
Man. Sand	A19517	25.0%	Quality Aggregate	A	4	5-12	2.662	2.09
Natural Sand	A19518	15.0%	Quality Aggregate	A	4		2.636	0.60

Type and Source of Asphalt Binder: PG 64-28 Quality Binder

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/4 Cr. Lmst.	100	100	89	75	41	26	20	17	14	12	9.9
3/4 Clean Lmst.	100	100	25	5.2	2.6	2.4	2.3	2.2	2.1	2.0	1.7
3/8 Qtz. Chip	100	100	100	100	47	5.7	2.5	1.7	1.1	0.7	0.4
Man. Sand	100	100	100	100	95	63	37	21	11	6.8	4.6
Natural Sand	100	100	100	100	96	85	71	48	15	1.6	0.6

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	93	87	65	42		21			6
Comb Grading	100	100	86	80	58	37	26	17	9.0	5.4	4.1
Lower Tolerance	100	93	79	73	51	32		13			2
S.A.sq. m/kg	Total	4.41		+0.41	0.24	0.30	0.42	0.50	0.55	0.66	1.33

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	25.0% of mix 3/4 Cr. Lmst. Min	Max	15.0% of mix 3/4 Clean Lmst. Min	Max	20.0% of mix 3/8 Qtz. Chip Min	Max	25.0% of mix Man. Sand Min	Max	15.0% of mix Natural Sand 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	100.0	100.0	
1/2"	82.0	96.0	18.0	32.0	100.0	100.0	100.0	100.0	100.0	100.0	
3/8"	68.0	82.0	0.0	12.2	98.0	100.0	98.0	100.0	98.0	100.0	
#4	34.0	48.0	0.0	9.6	40.0	54.0	88.0	100.0	89.0	100.0	
#8	21.0	31.0	0.0	7.4	0.7	10.7	58.0	68.0	80.0	90.0	
#30	13.0	21.0	0.0	6.2	0.0	5.7	17.0	25.0	44.0	52.0	
#200	7.9	11.9	0.0	3.7	0.0	2.4	2.6	6.6	0.0	2.6	

Comments:

Copies to: Quality Construction   Cent. Lab   RCE   Dist 3

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

Signed: ____________________ Producer

Signed: ____________________ Contractor

Form 956 ver. 6.0r

Iowa Department of Transportation

Highway Division - Office of Materials
HMA Gyratory Mix Design

County :	Monona		Project : IM-29-5(89)106--13-67	Mix No. :	ABD4-001
Mix Size (in.) :	3/4	Type A	Contractor : Quality Construction	Contract No. :	12345
Mix Type:	HMA 30M	L - 2	Design Life ESAL's : 15,000,000	Date Reported :	03/12/04
Intended Use :	Surface		Project Location : Southbound from MP 105.61 to 112.71		

A

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA
3/4 Cr. Lmst.	25.0%	A19512	Quality Aggregate	10-12	2.643	1.75	47.3
3/4 Clean Lmst.	15.0%	A19513	Quality Aggregate	14-21	2.624	1.21	45.0
3/8 Qtz. Chip	20.0%	A19515	Quality Aggregate	2-3	2.628	0.34	48.0
Man. Sand	25.0%	A19517	Quality Aggregate	5-12	2.662	2.09	49.3
Natural Sand	15.0%	A19518	Quality Aggregate		2.636	0.60	41.2

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

B

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	93	87	65	42		21			6.1
	100	100	86	80	58	37	26	17	9.0	5.4	4.1
Lower Tolerance	100	93	79	73	51	32		13			2.1

C

Asphalt Binder Source and Grade: Quality Binder PG 64-28

Gyratory Data

% Asphalt Binder	3.85	4.35	4.85	4.87	5.35	Number of Gyrations
Corrected Gmb @ N-Des.	2.347	2.370	2.389	2.390	2.415	N-Initial
Max. Sp.Gr. (Gmm)	2.532	2.509	2.490	2.490	2.476	8
% Gmm @ N- Initial	84.8	86.3	87.4	87.5	88.5	N-Design
%Gmm @ N-Max	93.7	95.5	97.1	97.2	98.8	109
% Air Voids	7.3	5.5	4.1	4.0	2.5	N-Max
% VMA	14.6	14.2	13.9	13.9	13.5	174
% VFA	49.8	60.9	70.9	71.2	81.7	Gsb for Angularity
Film Thickness	7.27	8.56	9.70	9.74	10.69	Method A
Filler Bit. Ratio	1.26	1.07	0.95	0.94	0.86	2.647
Gsb	2.641	2.641	2.641	2.641	2.641	Pba / %Abs Ratio
Gse	2.687	2.682	2.682	2.685	2.687	0.49
Pbe	3.20	3.78	4.28	4.29	4.71	Slope of Compaction
Pba	0.67	0.60	0.60	0.64	0.67	Curve
% New Asphalt Binder	100.0	100.0	100.0	100.0	100.0	13.8
Asphalt Binder Sp.Gr. @ 25c	1.036	1.036	1.036	1.036	1.036	Mix Gmm Check
% Water Abs	1.30	1.30	1.30	1.30	1.30	Excellent
S.A. m^2 / Kg.	4.41	4.41	4.41	4.41	4.41	Pb Range Check
% + 4 Type 4 Agg. Or Better	100.0	100.0	100.0	100.0	100.0	1.50
% + 4 Type 2 or 3 Agg.	25.4	25.4	25.4	25.4	25.4	Specification Check
Angularity-method A	45	45	45	45	45	Comply
% Flat & Elongated	0.0	0.0	0.0	0.0	0.0	TSR Check
Sand Equivalent	82	82	82	82	82	82.0

D

Disposition : An asphalt content of 4.9% is recommended to start this project.

Data shown in 4.87% column is interpolated from test data.

Comments : ______________________

Copies to : Quality Construction Cent. Lab RCE Dist 3

Mix Designer & Cert.# : Jon Rayson 12345 Signed : ______________________

HMA MIX DESIGN

Refer to:

A JMF aggregate proportions, sources

B JMF target and design gradation with tolerances.

C Source and grade of the asphalt binder used in the job mix formula.

D The target asphalt binder content recommended to start mixture production. Expressed as a percent of asphalt binder, based on the total mass of the mixture. Established during the mixture design process.

C. Sampling and Testing

There are a number of sampling and testing procedures that a plant inspector must be familiar with and perform in order to establish and maintain acceptable quality construction. A number of these tests, measurements, and calculations, in addition to documenting specification compliance, also provide the basis for determining contract pay quantities.

Sampling frequencies are provided for in IM 204 and the Standard Specifications.

Sampling and testing methods are provided for in IM 300 series. IM 511 and the Standard Specifications provide directions on sampling and testing requirements.

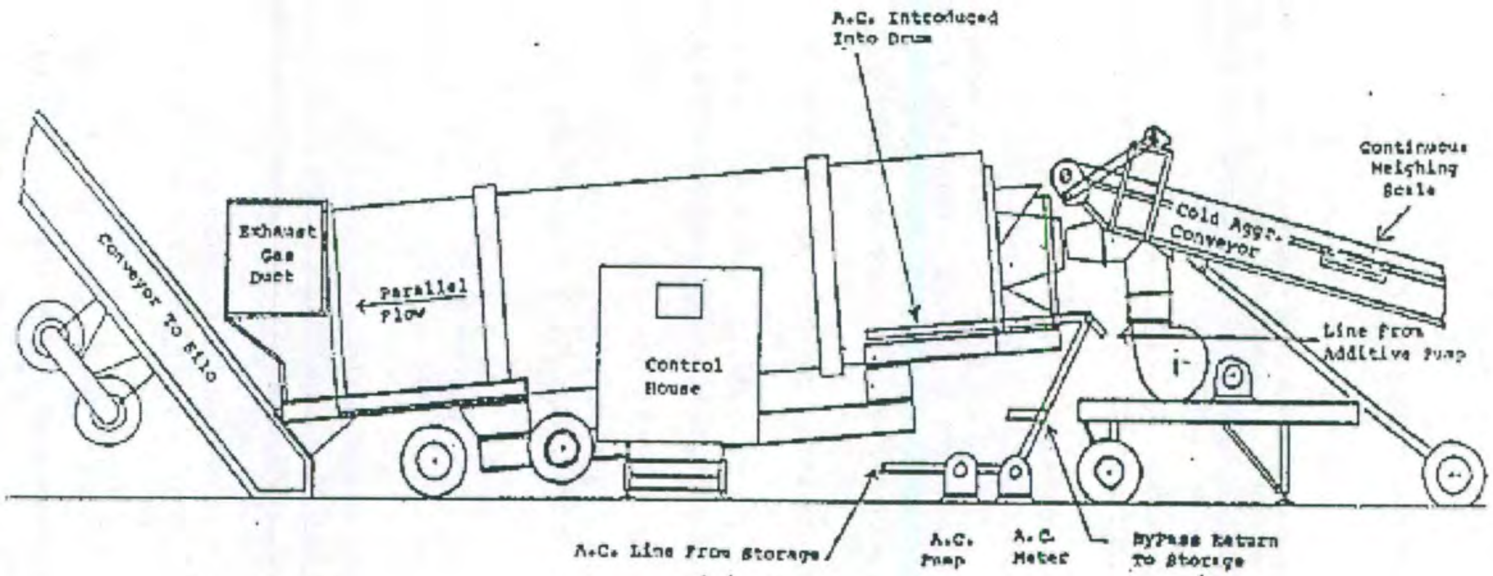
D. Plant Equipment

Items of equipment to be checked for specification compliance prior to beginning operations are listed below:

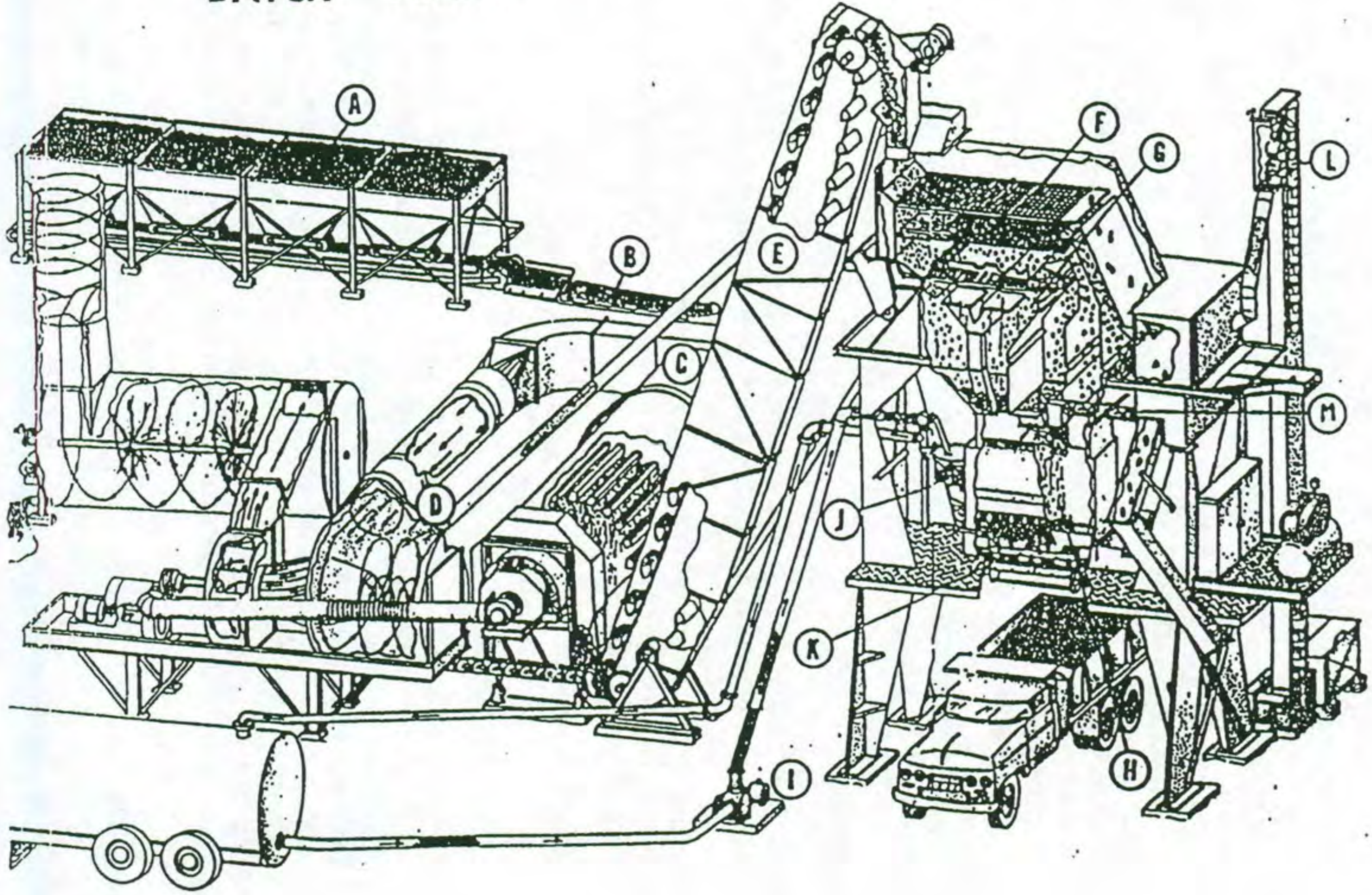
1. Truck Scales or weigh hoppers
2. Cold Aggregate Feeders
3. Dryer
4. Dust Collector and Feeder
5. Cold-Feed Storage Bins and Feeders
6. Revolution Counters, and/or Scales
7. Thermometer Equipment.
8. Equipment for Heating, Storing and Measuring Asphalt Binder
9. Asphalt Pump, Surge Tank, and/or Scales
10. Testing Laboratory
11. Safety Requirements

Refer to the following plant diagrams and descriptions.

DRIER DRUM MIXER



BATCH PLANT



BATCH PLANT MATERIAL FLOW DIAGRAM

A. Multiple Compartment Cold-feeder
B. Cold Elevator
C. Drier
D. Horizontal Cyclone Dust Collector & Exhaust Washer
E. Return Hot Aggregate Elevator & Dust
F. Screening Unit
G. Hot Aggregate Storage Bins
H. Aggregate Batcher & Scale
I. Asphalt Transfer Pump
J. Asphalt Batcher & Scale
K. Pugmill Mixer
L. Optional Mineral Filler Elevator
M. Optional Mineral Filler Feeder

E. Plant Calibration

The specifications require that all material proportioning equipment be calibrated and checked for accuracy. The job mix formula provides the basis for the calibrations.

The specifications require the contractor to provide personnel, scales, test weights, and equipment for calibrating each delivery component. The plant inspector shall determine moisture contents of the various materials. Use the formula:

$$\% \text{ moisture} = \frac{\text{wet mass - dry mass}}{\text{dry mass}}$$

The plant calibration may be monitored by and is subject to the approval of the District Materials Engineer or authorized representative. The plant inspector should be present and observe all procedures. The Contractor will furnish the plant inspector with copies of the calibration results, so adequate information is available for making adjustments when indicated. Should difficulty be experienced during plant calibrations, the District Materials Engineer should be contacted for assistance. Normally, the District Materials Engineer will assign one or more experienced inspectors to monitor the calibration of proportioning and mixing plants. The plant inspector should be thoroughly acquainted with plant operations, so problems are recognized and corrected as early as possible.

A sample calibration has been included as a guide in this section. Due to the wide variation in plant equipment, this example will not cover all situations, but it should provide the basis for understanding the overall procedure.

1. Cold Aggregate Feeders

The first step in calibrating a proportioning plant is the calibration of the cold aggregate feeders. These units determine the final gradation of the mixture.

a. Fixed Speed-Variable Gate Opening Cold-feeders

These feeders 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 feeder makes while the material is delivered. From the RPM of the feeder and the weight (mass) of the material, the deliver rate in pounds (kg) per minute is calculated (corrected for moisture). The calibration is graphed by plotting the pounds (kg) of dry aggregate delivered per minute at the gate openings used in the calibration.

b. Fixed Gate Opening-Variable Speed Cold-feeders

With this system, a gate opening is selected for each cold-feeder. 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 (kg) of dry aggregate delivered per minute at the speeds of the cold-feeder motor used in the calibration.

These cold-feeders 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 cold-feeders proportionately.

c. With either type of cold-feed, the gate setting is very important and should be checked regularly.

d. Refer to the example calibration forms included.

2. Conveyor Scales

The specifications require Drier Drum Mixing Plants be equipped with continuous weighing central conveyor scales that are interlocked with the asphalt deliver 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 (mass) 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 (mass) shown on the totalizing meter, with the weight (mass) actually delivered as determined by running material over the conveyor into a tared truck. The truck tare and loaded weights must be obtained by weighings 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, all continuous and drum mixing plants deliver asphalt material to the mixer through volumetric pumps. The pumps are adjusted by changing drive sprockets or movement of a vernier dial control. These volumetric systems must be calibrated throughout the proposed operating range at the normal operating temperature. When totalizing meters are required, they must be adjusted to readout the quantity delivered within the specified deliver tolerance.

If the contractor elects to use in-line flow meter readings for pay, the meter must be accurate to plus or minus 0.2% as demonstrated through the calibrations process or by comparison to tank stick readings if approved by the DME. If this degree of accuracy cannot be attained, measurement for pay shall still be by tank stick.

When a flow meter is used for pay, yield checks will be performed.

4. Hot Aggregate Feeders 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 (1,361-kg) batch plant with a volumetric asphalt measurement, and one for a continuous plant with a sprocket type asphalt pump.

The plant inspector is at this point cautioned not to make adjustments or effect settings of plant equipment, and in no way manipulate or operate any equipment at any time. All operations connected with the contractor plant or other equipment are by specification the strict and total responsibility of the contractor.

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.

Form 820115
3-86

Iowa Department of Transportation
CALIBRATION OF PLANT EQUIPMENT
Cold Feed and Asphalt Cement Delivery
(Continuous - Batch - Drum)

County Tama
Project FR-30-6(44)--26-86
Date 8-4-96
Proj. Eng. John Peters

Contractor Cessford Const. Plant Location Montour Quarry Material Ident. & % 3/4" Cr. Lmst 58% Moisture 2.6 %
Plant Type and Name Cedar Rapids - Drum Mix ADM-1 Pollution Control ______ Material Ident. & % Sand 30% Moisture 4.0 %
Mix Type B Binder Recycled Class I Mix Size 3/4" Gate ______ Material Ident. & % RAP 12% Moisture 5.1 %
Asphalt Type and Grade AC-10 Temperature °F ______ RPM Feeder/RPM Plant/Master: Maximum Plant Set for 300 TPH

Bin Number	#1 SAND			#2 and 3			3/4" Cr. Lmst.			#5 R.A.P.		
~~Pump vernier setting/gate opening in inches~~/Dial setting	Dial - 8.2			Dial - 5.9			Dial - 5.9			Dial - 6.1		
Run number	1	2	3	1	2	3	1	2	3	1	2	3
Revolutions delivered/Time delivered												
Total wet weight aggregate delivered/TPH wet	93.6			178.5 →						37.8		
Total weight A.C. delivered Total dry weight aggregate delivered/TPH Dry	90.0			174.0 →						36.0		
Dry weight per revolution												
Dry weight per minute												
~~Average dry weight per (Minute Rev.)~~/Tach set point	88.0			48.0			23.0			79.0		
	Gate 6"			Gate 6"			Gate 6"			Gate 4"		

Date scale was certified 8-4-86

The above data is furnished as set forth in the Standard Specifications for plant operations, for informational purposes only. The Contracting Authority makes no representations as to accuracy, either expressed or implied, which are to be construed to relieve the Contractor from the responsibility to comply with the specifications.

Calibrated by Theodore Huisman (Name) Monitoried by Mark Trueblood (Name)

Contractor Cessford Constrvction Title Asphalt Tech - Dist Materials

Distribution:
White Copy - Plant Inspector
Canary Copy - Contractor
Pink Copy - District Materials Engineer
Goldenrod Copy - Project Engineer

Form 820015
3-86

County Tama
Project FR-30-6(44)--26-86
Date 8-4-88
P. oj. Eng. Tom Reis

CALIBRATION OF PLANT EQUIPMENT
(DRUM MIX PLANT)

Contractor Cessford Construction Plant Location Montour Quarry

Plant Type and Name Cedar Rapids Drum Mix Pollution Control Baghouse

Mix Type A Surface Class Mix Size 3/4"

Asphalt Type and Grade AC-10 Temperature °F A.C. #/Gal. 8.55

WEIGHT BELT				A.C. PUMP				WEIGHT SILO			
Run Number	1	2	3	Run Number	1	2		Run Number	1	2	
Span	2541	2578	2578	Meter Er. Gals.	299	300					
Fine Zero	5524	5524	5524	Corrected Gals.							
Total weight aggregate lbs.	17,640	17,460	17,500	Metered lbs.	2556	2565		Total weight lbs.	28160	28500	
Truck total weight aggregate lbs.	17,900	17,440	17,490	Truck lbs.	2560	2568		Truck lbs.	28180	28510	
Difference	-260	+20	+10	Difference	-4	-3		Difference	-20	-10	
% Error	1.45	0.10	0.06	% Error	0.16	0.12		% Error	0.07	0.04	

Date scale was certified 8-4-88

Sensitivity check on weightsilo was O.K.

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Calibrated by Ted Huisman (Name) Witnessed by Mark Trueblood (Name)

Contractor Cessford Construction Title Asphalt Tech-District 1 Materials

Distribution:
White Copy - Plant Inspector
Canary Copy - Contractor
Pink Copy - District Materials Engineer
Goldenrod Copy - Project Engineer

ASPHALTIC CONCRETE
BATCH PLANT

PROJECT:	IJST-9-B(16)--4A-96
TYPE:	A Surface
CONTRACTOR:	Fred Carlson

INTENDED A.C. = 5.5 %

SIZE OF BATCH:	AGGREGATE:	ASPHALT:

ASPHALT SCALE

APPLIED LOAD	SCALE READING RUN:	#1	#2	#3	#4

Note: Due to midrange scale error no batches below 2100 lbs will be allowed!!

SRe ______ #

SR ______ # @ ______ #

Used 1200# of Weights

AGGREGATE SCALE

APPLIED LOAD	SCALE READING RUN:	#1	#2	#3	#4
			Acc. Error		
150		✓			
300		✓			
450		+3			
600		+2			
750		+1½			
900		✓			
1050		✓			
1200		-1½	-1½		
1350		-1½			
1500		-7½			
1650		-7			
1800		-7			
1950		-7½			
2100		-6			
2250		-6			
2400		-3	-4½		
2550		-3			
2700		±2			
2850		+4			
3000		✓	-4½		

SRe OK 1 #

SR 1 # @ 3000 # OK

/s/ [signature] DATE 6-7-88

witnessed by Matt Hiatt HCT

Iowa Department of Transportation
CALIBRATION OF PLANT EQUIPMENT
Cold Feed and Asphalt Cement Delivery
(Continuous - Batch - Drum)

County Winn
Project UST-9-B(14)-96
6-7-88
Proj. Eng. Erdman

Contractor Fred Carlson Co. Location Decorah Pit Material Ident. & % Oil Moisture ___ %
Plant Type and Name H+B Pollution Control Bag House Material Ident. & % ___ Moisture ___ %
Mix Type A Class Surface Mix Size 1/2 Gate ___ Material Ident. & % ___ Moisture ___ %
Asphalt Type and Grade Koch AC-10 Temperature °F ___ RPM Feeder/TPH Plant/Master ___ Plant Set for ___ TPH

Bin Number	Oil			Oil			Oil			Oil		
Pump vernier setting/gate opening in inches/Dial setting	15			25			25			30		
Run number	1	2	3									
~~Revolutions delivered/Time delivered~~ Gross	198	155		226	233	226	234			265	273	266
~~Total wet weight aggregate delivered/TPH wet~~ Tare	42.5	50		50	53	52	55			54.5	53.5	52.5
Total weight A.C. delivered ~~Total dry weight aggregate delivered/TPH Dry~~ Net	106	105		176.5	180	174	179			217	218	213.5
~~Dry weight per revolution~~												
~~Dry weight per minute~~												
Average dry weight per (Minute-Rev.)/Tach set point	105.75			177.5						216.7		

Date scale was certified ___

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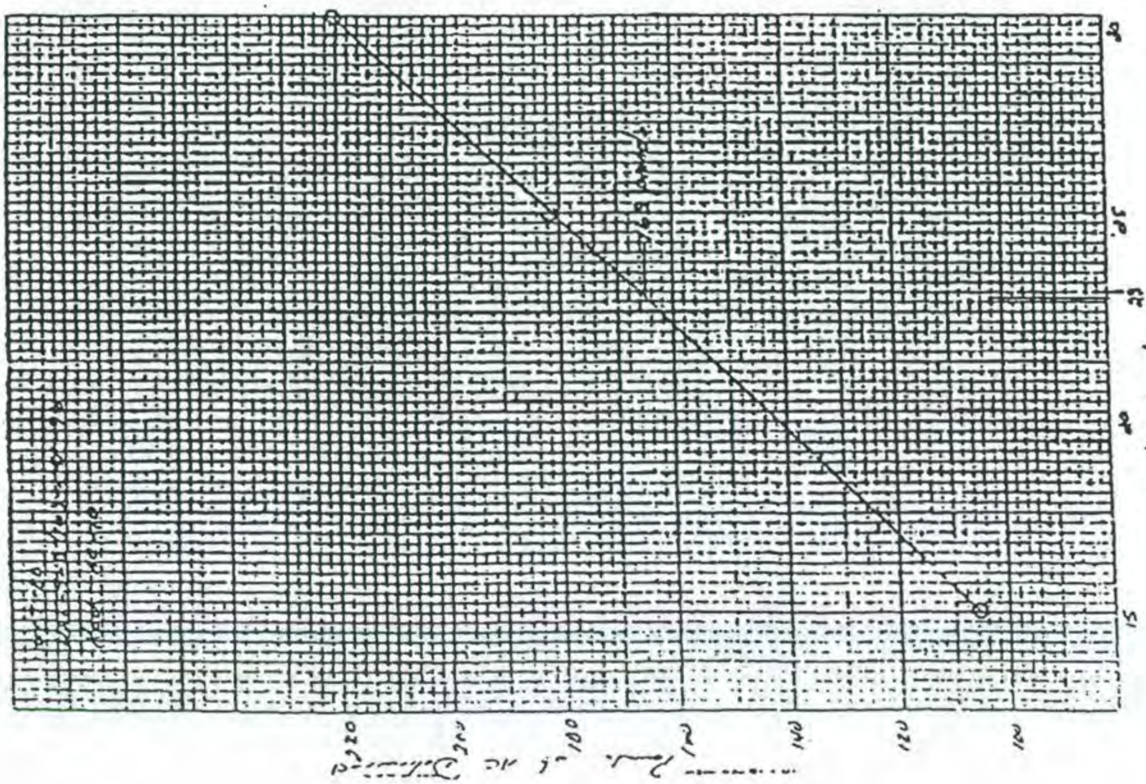
Distribution:
White Copy - Plant Inspector
Canary Copy - Contractor
Pink Copy - District Materials Engineer
Goldenrod Copy - Project Engineer

Calibrated by ___ Witnessed by ___
Contractor ___ Title A.C. Tech



Iowa Department of Transportation
CALIBRATION OF PLANT EQUIPMENT
Cold Feed and Asphalt Cement Delivery
(Continuous - Batch - Drum)

County Winneshiek
Project 115T-9-8(16)--4A-96
Contract No.
Date 6-7-88
Proj. Eng. Erdman

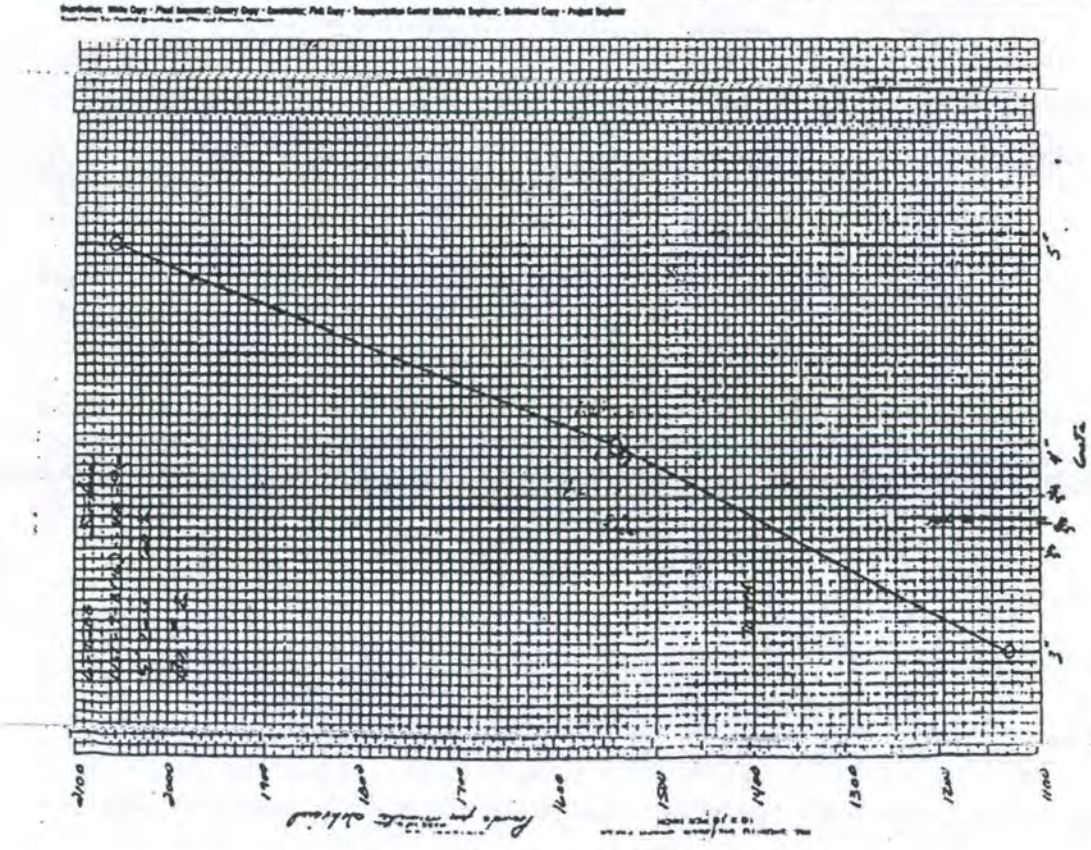
Contractor Fred Carlson Co. Plant Location Decorah Pit Material ID Lmst. % 60 Moisture 4.2 %
Plant Type and Name H & B Pollution Control Bag House
Mix Type A Class Surface Mix Size 1/2"
Asphalt Type and Grade Koch AC-10 RPM Feeder/RPM Plant/Master 20.1 Plant Set For ___ mg/hr (TPH)

Bin Number Material ID	2			2			2					
Pump vernier setting/gate opening in mm(in)/Dial setting	3"			4"			5"					
Run number												
Revolutions delivered/Time delivered	80.7	81.1		81.2	81.2		81.8	81.2				
Total wet mass(wt.) aggregate delivered mg/hr (TPH) wet	4760	4740		6450	6520		8670	8660				
~~Total weight bulb delivered~~ Total dry mass(wt.) aggregate delivered Dry	4568	4549		6190	6257		8321	8311				
Dry mass (wt.) aggregate per revolution	56.6	56.1		76.2	77.1		102.3	102.4				
Dry mass (wt.) aggregate per minute	1138	1127		1532	1549		2057	2057				
Average dry mass (wt.) agg. per (Minute-Rev.)/Tach set point	1132.5			15405			2057					

Date scale was certified Sept. 27, 87

The above data is furnished as set forth in the Standard Specifications for plant operations, for informational purposes only. The Contracting Authority makes no representations as to accuracy, either expressed or implied, which are to be construed to relieve the Contractor from the responsibility to comply with the specifications.

Calibrated by Mike [signature] Witnessed by Mark [signature]
Contractor Title A.C. Tech



Iowa Department of Transportation
CALIBRATION OF PLANT EQUIPMENT
Cold Feed and Asphalt Cement Delivery
(Continuous - Batch - Drum)

County Winn
Project 4ST-9-8(K6)1-4A96
Date 6-7-88
Proj. Eng. Edwoan

Contractor Fred Carlson Const. Location Decorah Pit Material Ident. & % Sand #1 Moisture 3.1 %
Plant Type and Name H+B Pollution Control Baghouse Material Ident. & % ______ Moisture ______ %
Mix Type ______ Class A Mix Size ______ Code ______ Material Ident. & % ______ Moisture ______ %
Asphalt Type and Grade Koch AC-10 Temperature °F ______ RPM Feeder/RPM Plant/Meter 20.8 Plant Set for ______ TPH

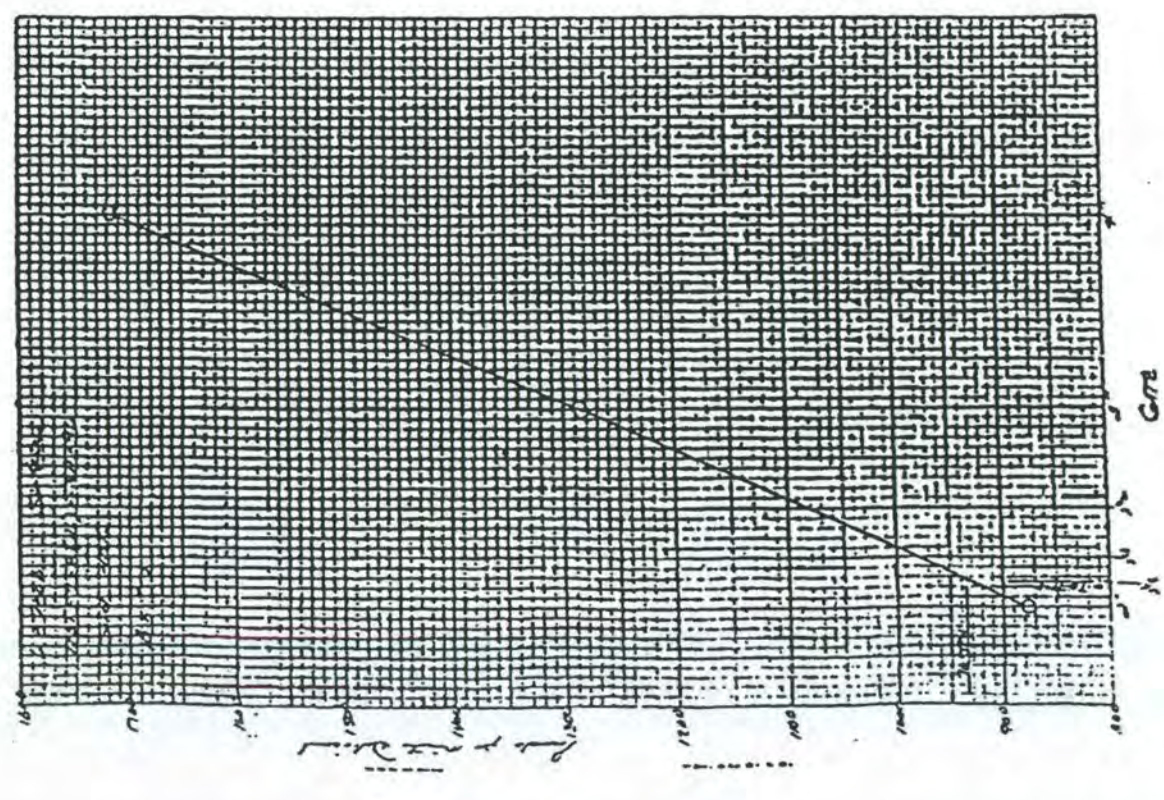
Bin Number								
Pump vernier setting/gate opening in inches/Dial setting	2"		3"		4"			
Run number	1	2						
Revolutions delivered/Time delivered	63.1	63.1	63.0	63.3	63.4	63.3		
Total wet weight aggregate delivered/TPH wet	2740	2750	4020	4080	5400	5380		
Total weight A.C. delivered / Total dry weight aggregate delivered/TPH Dry	2658	2667	3899	3858	5238	5218		
Dry weight per revolution	42.1	42.3	61.9	61.6	82.6	82.4		
Dry weight per minute	876	879	1287	1281	1718	1715		
Average dry weight per (Minute-Rev.)/Tach set point	877.5		1284		1716.5			

Date scale was certified 5-4-88

The above data is furnished as set forth in the Standard Specifications for plant operations, for informational purposes only. The Contracting Authority makes no representations as to accuracy, either expressed or implied, which are to be construed to relieve the Contractor from the responsibility to comply with the specifications.

Distribution:
White Copy - Plant Inspector
Canary Copy - Contractor
Pink Copy - District Materials Engineer
Goldenrod Copy - Project Engineer

Calibrated by Mike [illegible] Witnessed by [illegible]
Contractor ______ Title A.C. [illegible]



INITIAL PLANT SETTING

TYPICAL PLANT COLD-FEED SETTINGS

The following example is based on initial plant output of 70 TPH (63,500 kg/hr) of mix. See example.

Set for 70 TPH (63,500 kg/hr.) total cold-feed aggregate (Dry Weight):

$$\frac{70 \text{ TPH} \times 2000 \text{ lbs./ton}}{60 \text{ min./hr.}} = 2333 \text{ lbs./min. of mix}$$

$$\frac{63{,}500 \text{ kg/hr.}}{60 \text{ min./hr.}} = 1{,}058 \text{ kg/min. of mix}$$

Material	% in Mix	kg/min.	(lbs./min.)	Gate Setting
1/2 in. (12.5 mm) Cr. Stone	60%	35	1400	Approx. 3 5/8
Sand	40%	423	933	Approx. 2 1/8

DRUM MIXING PLANT

The following example is based on initial plant output of 300 TPH (272,160 kg/hr.). See example.

Set aggregate delivery controls on plant control console to deliver 300 TPH (272,160 kg/hr.) of dry aggregate.

Master control set on maximum.

kg/hr or TPH		kg/hr	or TPH
272,160 or (300) x 58% 3/4 inch crushed limestone	=	157,853	174
272,160 or (300) x 30% Sand	=	81,648	90
272,160 or (300) x 12% RAP	=	32,659	36
100%		272,160	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. (1,361 kg) batch plant, cold-feeds as cited previously and 5.5% binder content.

SCALE SETTING

Binder: 5.5% x 3000 lbs. (1,361 kg) = 165 lbs. (75 kg) per batch (see example)

Combined Hot Aggr: 3000 lbs. (1,361 kg) – 165 lbs. (75 kg) = 2835 lbs. (1,287 kg) per batch

Asphalt pump (volumetric) = 165 lbs. (75 kg) 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.

F. Production Inspection Duties

1. Temperature Control

It is necessary to 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	Truck body at plant
• Final Mixture (on road)	Behind Paver

2. Gradation Control

   a. Cold-feed Gradation Control

      The contractor is responsible for ensuring the gradation of the final mixture consistently complies with the requirements of the job mix formula. Cold-feed proportioning will be monitored and verified as part of the overall plant inspection activity. The final acceptance gradation will normally be based on the cold-feed gradation.

      Advisory sampling and testing will be performed at the aggregate sources and after cold-feed combination at the plant site. Cold-feed check samples will be taken daily to verify the accuracy of proportioning and to provide guidance to the contractor with regard to mixture gradation. Addition quality tests above the minimum specified may be run at the option of the District Materials Engineer.

      The sampling and testing frequencies are outlined in Materials. IM204. Samples must be secured in a safe and reliable manner as provided In Sections 1108 and 2001 of the Standard Specifications. Testing procedures shall be in accordance with IM Series 300.

      The cold-feed samples are to be obtained by incrementally cutting the stream or belt flow of combined aggregate feeding the drier. The contractor is responsible for furnishing a plant set-up that allows representative samples to be obtained. This may require equipment modification.

   b. 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

   When the sieve analysis test indicates the combined material does not comply with the gradation requirements, the plant inspector shall take the following steps:

   1. Recheck test procedures and computations.
   2. Check gate settings and feeder operations.
   3. Check the materials and material handling procedures.
   4. Notify the RCE, the DME and the contractor of the results.
   5. 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 writing, in accordance with IM 511.

Several alternatives are normally available to the contractor when difficulties are encountered:

- Change material handling procedures.
- Correct proportioning.
- Change proportions. (Job Mix Formula irregularities change.)
- Waste fines collected by dust.
- Change materials. (New Job Mix Formula collection systems required.)
- Reset Job Mix Formula target.
- Change processing procedures at gradation source.

3. Asphalt Content Control (Also refer to Materials IM 509.)

The control of this material component is the most important plant inspection responsibility because the performance of the finished pavement is directly related to the quantity of binder incorporated in the mix. Separate check systems are used for drum-mix and batch plants as follows:

a. Drum Mixing Type Plants

During the first day or two of operations, and during periods when asphalt or aggregate delivery is questionable, it is advisable to perform proportioning validation 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.

Validation Methods:

(1) Compare asphalt delivered by metering pump or scale with outage shown by 2 or 4 hour tank measurement (compare by pounds (kg), gallons (liters), 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 making intermediate tank measurements at 2-or 4-hour intervals and by checking the operation and sensitivity of the scale equipment.

If the measurements indicate that uniform control is not being maintained, the contractor is required by the specifications to adjust and correct his operations to obtain specification compliance. Such actions may include but not be limited to cleaning, repair, or replacement of equipment, recalibration of pumps and feeders, and training of personnel. In some cases it may be necessary for the contractor to obtain assistance from equipment manufacturers or distributors. Refer to the checklist on pages for possible causes of difficulty.

The inspectors should be aware of the fact that the specifications provide for establishing mutual agreements for determining asphalt quantities on projects involving small quantities, or intermittent or diversified operations.

c. Plant Inspection Control List

1. Before Calibration

   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. Learn the contractor method of operating the system.
   e. Check the truck scales.

2. During Operation

   a. Determine percent binder by tank stick measurement method as required.
   b. Determine percent binder by verification as required.
   c. Check batch scales for sensitivity.
   d. Check truck scales for sensitivity and accuracy.

3. 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.

4. 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.

IM 509 provides the detail procedure for making tank measurements and determining asphalt content.

G. 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.

H. 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.

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.

I. 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.

<u>NOTE</u>: RAP gradation % passing is found on Form #955.

J. Completed Project

When a project is completed, the plant inspector should again check all records and 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.

K. Diary and Report Requirements

1. The diary must be filled out daily.

2. 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 on all hot mix and cold mix construction.

   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.

3. Testing Worksheets. All worksheets and other original documents used by

inspection personnel are to include identification of: 1. individuals associated with sampling and testing, 2. County and Project No., 3. Material and sampling point, 4. Date and time of sampling and testing and, 5. 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.

L. Mixture Segregation

In addition to determining if all of the required equipment is available, calibrated, and functioning properly, the plant inspector should monitor mixture uniformity for potential problems. One of the most troublesome difficulties encountered during production is mixture segregation, which may be caused by plant equipment or operation. 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.

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 of the mix results in non-uniform distribution of the material in the pavement. This can lead to a patchy appearance as well as early structural distress.

M. Asphalt Binder Contamination

Another potential problem encountered during production is contamination of the asphalt binder. This 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.

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.

Form 820193
7-94

Central Lab. No. ABC4-000

Iowa Department of Transportation

IDENTIFICATION OF SAMPLE FOR TEST

(Read Instructions on back before taking sample and filling out form)

Material: Uncompacted Mix @ 4.9% Binder — Senders Sample No.: 3DR4-001

Intended Use: HMA 30M S 3/4 L-2 — Accounting ID Number: 67-CO67-029

County: Monona — Group No.: ____ — Design No.: ABD4-001

Project: IM-29-5(89)106--13-67 — Contract ID Number: 12345

Contractor: Quality Construction (Name) — Incognito, Iowa (Address)

Supplier: Quality Binder — Source: Incognito, Iowa

Producer: Quality Binder — Brand: ____ — Lot No.: ____

Location of Producing Plant: ____

____ Sec. ____ Twp. ____ Range ____ Co. ____

Unit of Material Represented: Approximately Station 105+00. Lift 2 of 2.

Quantity Represented: 40 lbs. Box

Sampled by: Jon Rayson (name) — Incognito, Iowa (address)

Date sampled: 06/01/04

Report to District(s) (Check appropriate box (es)): 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐

Report to Residency (Write appropriate residency number): 22

Report to Counties (Write appropriate count number): 67

Report to Other: Rayson (Name) — Incognito, Iowa (Address) — (Phone)

Report to Other: (Name) (Title) (Address) (Phone)

Report to Other: (Name) (Title) (Address) (Phone)

Results need by: Date ____

Additional Detailed Information: (For paint give analysis printed on container. For tile give grade specified, etc.)

Mix Info:		Lab Results:		Combined Gradation:			
Intended %AC		Gmb		1 1/2"		#8	
Target Pa		Gmm		1"		#16	
# Gyrations		Pa		3/4"		#30	
# Blows				1/2"		#50	
% RAP				3/8"		#100	
% Add AC				#4		#200	

Comments: ____

" X " Sample Type	
	Assurance
	Verification
X	Project Information
	Mix Design
	Dept. Information
	Warehouse Stock
	Research Project

Form 820193
7-94

Central Lab. No. APG4-000

Iowa Department of Transportation

IDENTIFICATION OF SAMPLE FOR TEST

(Read Instructions on back before taking sample and filling out form)

Material: PG 64 -28
Senders Sample No.: 3CJP04-02PG
Intended Use: Verification
Accounting ID Number: 67-CO67-029
County: Monona
Group No.:
Design No.: ABD4-001
Project: IM-29-5(89)106--13-67
Contract ID Number: 12345
Contractor: Quality Construction (Name) Incognito, Iowa (Address)
Supplier: Quality Binder
Source: Incognito, Iowa
Producer: Quality Binder
Brand:
Lot No.:
Location of Producing Plant:
Sec. Twp. Range Co.
Unit of Material Represented: 1 / 80 tons of binder
Quantity Represented: 1 Quart
Sampled by: Jon Rayson (name) Incognito (address)
Date sampled: 06/01/04

Report to District(s) (Check appropriate box (es)): 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐

Report to Residency (Write appropriate residency number):
Report to Counties (Write appropriate count number): 67
Report to Other: Rayson (Name) Incognito, Iowa (Address) (Phone)
Report to Other: (Name) (Title) (Address) (Phone)
Report to Other: (Name) (Title) (Address) (Phone)

Results need by: Date

Additional Detailed Information: (For paint give analysis printed on container. For tile give grade specified, etc.)

Please run complete testing

" X " Sample Type	
	Assurance
	Verification
X	Project Information
	Mix Design
	Dept. Information
	Warehouse Stock
	Research Project

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.

INSTRUCTIONS FOR COMPLETING DAILY ACC PLANT REPORT

PROJECT NO.

Enter the project number listed on the project plans.

CONTRACT ID

Enter the nine-digit contract number listed on the contract. This is **not** the five-digit accounting ID number.

MIX DESIGN NO.

Enter the mix design number listed on Form #956, for the mix being produced for the day.

COUNTY

Enter the county listed on the project plans.

CONTRACTOR

A group of people or company must perform the work being done, either a prime contractor or a subcontractor. Enter the name of the contractor performing the work. If it is a subcontractor, list this after the contractor name.

RECYCLE SOURCE

When RAP is used on a project, it must come from a known source, list the source of where the RAP material came from. Example: "project grade" - "stockpile."

CLASS

Base courses are classified by class 1 or 2. If no mix class is listed on the Form #956, leave it blank.

SIZE

Each mix is designed at a certain size. Example: 1 in. (26.5 mm), 3/4 in. (19 mm), 1/2 in. (13.2 mm) or 3/8 in. (9.5 mm). Enter the proper mix size listed on the 956 form.

MIX TYPE

List the type of mix specified for the project listed in the contract documents.

PAGE NO.

Leave this line blank; it is used for filing when the project is completed.

REPORT NO.

Start with number 1 at the beginning of work for each contractor on each project for each mix placed. The ending report number shall coincide with the last day of production for each mix. Example: If it takes 15 days to place a binder mix, you shall have to report 1 through 15. If it takes 12 days to place a surface mix, you shall have to report 1 through 12. If work carries over into another construction season, do not start the sequence over; continue the numbering system until work is completed.

DESIGN BLOWS, DESIGN GYRATIONS

Either a mix is designed by using traffic count or ESALs. When the mix being used is based on traffic count, the Form #956 will have a designed Marshall blows and a triple hammer machine will be used for testing. When the mix being used is based on ESALs, the Form #956 will have a designed Gyrations and a Gyratory machine will be used for testing. Report the appropriate information listed on the Form #956.

TEST SUMMARY INFORMATION

This section is located on the left-hand side of the report. This section consists of six columns for data entries. The first column is reserved for target and specification limit information. The second, third, fourth, and fifth columns are reserved for actual test information.

HOT BOX ID NO.

During production each day, a sample of the hot mix is taken from the grade at different intervals according to the amount of mix being produced for each mix type. This sample shall be given a serial identification number for each mix tested. Example: "QMA, QMA-1, QMA-2" or " GYR-1, GYR-2, GYR-3."

DATE SAMPLED

Enter the date the hot box sample is taken and tested.

GRADATION ID

Enter the cold-feed gradation identification number for each sample tested on a given day of production in the second, third, and fourth columns. The fifth column shall say "Avg." if an average is calculated.

1 in. (26.5 mm), 3/4 in. (19 mm), 1/2 in. (13.2 mm), 3/8 in. (9.5 mm), #4 (4.75 mm), #8 (2.36 mm), #16 (1.18 mm), #30 (600 µm), #50 (300 µm), #100 (150 µm), #200 (75 µm).

Enter the specification limits for the proper sieves in the first column. Enter the final % passing for each sieve in the second, third, or fourth column. The second column is for the first test, the third column is for the second test, and the fourth column is for the third test. If RAP is used in the mix, the final composite % passing each sieve shall be entered in the appropriate column. The fifth column is for the average final % passing if needed.

MOVING AVERAGES

The moving averages for the #4 (4.75 mm), #8 (2.36 mm), #30 (600 µm) and #200 (75 µm) sieves are based on the last actual four tests performed divided by four. Enter the moving average directly below the gradation. These figures shall be entered in the appropriate rows provided.

COMPLIANCE

After a cold-feed gradation has been tested, it is compared to the specifications for compliance. If the gradation complies, enter a Y in the appropriate column. If the gradation does not comply, enter an N in the appropriate column.

INTENDED ADDED PERCENT AC

Each mix is designed with a percentage of virgin AC added to the mix. This percent is entered in the first column. This percentage is found on Form #956.

ACTUAL ADDED PERCENT AC

The % of virgin AC added to a mix is kept track of by tank stick or by an approved ticket printout. This calculated actual % virgin AC figure shall be entered in the second column.

INTENDED TOTAL PERCENT AC

When RAP is used in a mix, the RAP contains a percentage of AC. This percentage of AC, along with the virgin AC added, equals the total design AC content. Enter this calculated figure in the first column.

ACTUAL TOTAL PERCENT AC

The actual total percent AC is calculated by the percent of actual virgin AC and the percentage of AC in the RAP material. Enter this figure in the second column.

Gmb (BULK SPECIFIC GRAVITY)

This figure is arrived from the hot box samples tested throughout the day of production. The first hot box tested shall have the Gmb data entered in the second column. The second hot box tested shall have the Gmb data entered in the third column.

Gmm (MAXIMUM SPECIFIC GRAVITY)

This figure is also arrived from the hot box samples tested throughout the day of production. Enter the test results the same way as listed for the Gmb test data.

Pa (% OF AIR VOIDS)

The Pa figure is calculated by using the Gmb and Gmm test results. Enter the Pa results in the second, third, fourth, and fifth columns.

MOVING AVERAGE

After four Pa figures have been calculated, a moving average is established for each mix placed. Enter the moving average figure in the appropriate column the average pertains to.

TIME

Enter the time of day each hot box sample is taken from the grade in the second, third, fourth, or fifth columns.

STATION

Enter the station number where each hot box sample is taken.

SIDE

On a two-lane road there is a left and right of centerline looking up station. On a divided or four-lane road, there is northbound, southbound, westbound, and eastbound. Each lane has a left and right looking up station. Enter the side where the hot box sample is taken.

Example: NB LT = northbound left side, RT = right side

SAMPLE MEGAGRAMS (TONS)

Enter the megagrams (tonnage) of mix placed which represents where the hot box sample is taken.

SUBLOT MEGAGRAMS (TONS)

A day's production is divided into sublots according to the amount of mix being produced. Enter the size of each sublot according to IM 511 requirements.

MEGAGRAMS (TONS) TO DATE

The megagrams (tons) to date is a running total of each mix placed on the roadway throughout the project. This running total does not include plant or road waste.

FINES/BITUMEN RATIO

Enter the Fines/Bitumen Ratio calculated from the percent passing #200 (75 µm) sieve and the total percent AC figure on Marshall mixes. Enter the Fines/Bitumen Ratio calculated from the percent passing #200 (75 µm) sieve and the Effective % AC figure on Superpave mixes. This calculation is entered in the second column provided on the report. If an average gradation is calculated, show the average Fines/Bitumen Ratio figure in the fifth column.

Gsb

Enter the bulk specific gravity on the combined aggregate listed on Form #956.

Gb

Enter the specific gravity of the asphalt cement at 25°C (77°F).

EFFECTIVE % AC

Enter the effective asphalt content %, mix basis.

MIX CHANGE INFO

Enter any mix changes that occur during production of a mix.

Example: An aggregate proportion change was made at 9:05 a.m. today. 235 Mg of mix had been produced before the change.

TEMPERATURES & DENSITY INFORMATION

AIR TEMPERATURE

Record the air temperature at the time intervals shown on the report.

AC TEMPERATURE

Record the virgin AC temperature at the time intervals shown on the report.

MIX TEMPERATURE

Record the mix temperature at the time intervals shown on the report.

DATE PLACED

Enter the date the mix was placed on the roadway.

DATE TESTED

Enter the date the roadway cores are tested.

COURSE PLACED

Enter the mix placed. Example: Base, Binder, and Surface.

TESTED BY

Enter the name of the person testing the roadway cores.

STATION

Enter the station where each roadway core was cut from the mat for testing.

CL REFERENCE

A roadway core is obtained at random, a distance from centerline according to where the mix is placed. Enter the distance and side from centerline where each core is cut.

Example: 4 ft. (1.22 m) RT, 3.05 m (10 ft.) LT, District.

W1 DRY

Enter the mass of each roadway core under the appropriate core number.

W2 in $H_2 0$

Enter the mass of each roadway core under the appropriate core number.

W3 WET

Enter the mass of each core, after excess water has been blotted off.

DIFFERENCE

Enter the figure obtained by subtracting the W2 mass from the W3 mass for each core.

FIELD DENSITY

Enter the field density for each core under the appropriate core number.

PERCENT DENSITY

Enter the percent density for each core under the appropriate core number.

PERCENT VOIDS

Enter the percent voids for each core under the appropriate core number.

THICKNESS

Enter the thickness of each roadway core tested under the appropriate core number.

Gmb (LOT AVG.)

Enter the Marshall specific gravity average by adding the individual test results performed during the day of production, and divide by the number of tests performed that day.

Gmm (LOT AVG.)

Enter the maximum specific gravity average by adding the individual test results performed during the day of production, and dividing by the number of tests performed that day.

DISTRICT LABS Pa

Only use this cell when the District Materials Department does the testing on the hot box samples taken. Enter the percent air voids figure calculated by the District Materials Department.

TARGET % RAP

Enter the target % RAP for each day of production when RAP is used in the mix.

AVERAGE FIELD DENSITY

Enter the average field density by adding the seven individual field density figures together and divide by 7.

AVERAGE PERCENT DENSITY

Enter the average percent density by adding the seven individual percent density figures together and divide by 7.

AVERAGE PERCENT FIELD VOIDS

Enter the average percent field voids obtained by dividing the Average Density by the Maximum Specific Gravity figure and multiply by 100. Then subtract this figure from 100.

SPECIFIED DENSITY PERCENT

Enter the minimum density required by specification for type of compaction. <u>Example:</u> 94, 95, 96.

QUALITY INDEX (QI)

Three numbers are needed to calculate the Quality Index for the roadway cores. Show work.

$$\frac{\text{Enter the Avg. \% Density - Enter Specified Density \%}}{\text{Enter Standard Deviation}} = \text{Enter QI}$$

LOW OUTLIER

If the QI result is less than 0.73, a possible low outlier shall be calculated and entered.

HIGH OUTLIER

If the QI result is less than 0.73, a possible high outlier shall be calculated and entered.

NEW QI

If the original QI is below 0.73 and one of the outlier calculations is 1.80 or higher, a new QI shall be calculated by removing the test result data of the lowest density core or highest density core, depending if you have a low outlier or high outlier.

FILM THICKNESS (FT)

Enter the microns calculation.

VMA

Enter the percent Voids in Mineral Aggregates calculation.

REMARKS

Enter remarks of delays at the plant site, non-compliant test results, District. Example: Production was stopped for 35 minutes because of a mechanical problem on the grade.

CPI

Enter the Certified Plant Inspector name. Do not use initials.

CERT NO.

Enter the Certified Plant Inspector certification number.

QMA TECHNICIAN

Enter the Quality Management Asphalt Technician name. Do not use initials.

CERT NO.

Enter the Quality Management Asphalt Technician certification number.

Attached are examples of completed reports for different types of mix. Refer to the Remarks Section on each example for the type of use.

800241M - 01/98

DAILY ACC PLANT REPORT

Project No.:	STP-69-7(23)--2C-99	County:	Wright	Class:	
Report No.:	6	Contract ID:	99-0697-023	Contractor:	Mathy Construction
Size:	19mm	Design Blows:		Mix Design No.:	ABD7-55R4
Recycle Source:		Mix Type:	A	Design Gyrations:	86

Hot Box I.D. No.:		10-1-SP	10-2-SP	10-3-SP	10-4-SP	
Date Sampled:		07/29/97	07/29/97	07/29/97	07/29/97	
Gradation ID:	Specs	CF10-1SP				
25mm Sieve	100	100				
19mm Sieve	90-100	100				
12.5mm Sieve		91				
9.5mm Sieve		77				
* 4.75mm Sieve		42				
* Moving Average		**41**				
* 2.36mm Sieve	23-35	24				
* Moving Average		**25**				
1.18mm Sieve		18				
* 600um Sieve		11				
* Moving Average		**11**				
300um Sieve		6.2				
150um Sieve		3.8				
* 75um Sieve	2.0-8.0	3.0				
* Moving Average		**3.0**				
Compliance (Y/N)		Y				
Intended Added, % AC	5.80					
Actual Added, % AC		5.81				
Intended Total, % AC	5.80					
Actual Total, % AC		5.81				
Gmb:		2.297	2.321	2.296	2.301	
Gmm:		2.413	2.398	2.402	2.414	
Pa:		4.8	3.2	4.4	4.7	
Moving Average	3.0-5.0	**4.3**	**4.2**	**4.1**	**4.3**	
Time		07:30	09:30	11:30	02:30	
Station		430+00	380+00	320+00	235+00	
Side		Rt	Rt	Rt	Rt	
Sample Mg's		252.00	857.00	1,437.00	2,203.00	
Sublot Mg's		500.00	833.33	833.33	964.95	
Mg's to Date		19,005.00	19,838.33	20,671.66	21,636.61	
Fines / Bitumen Ratio	0.6-1.20	0.65				

Gsb: 2.544 Gb: 1.0250 Effective % AC: 4.64

Mix Change Info:

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°C)	15	19	22	24	25	25	
A.C. Temp. (°C)	151	146	149	151	153	154	
Mix Temp. (°C)	146	141	138	139	143	142	

Date Placed: 07/29/97 Date Tested: 07/30/97

Course Placed: Surface Tested By: George Seward

Density Record

Core No.:	1	2	3	4	5	6	7
Station	46+65	63+95	70+25	91+95	97+98	113+35	128+45
CL Reference	1.2m Rt	3.0m Rt	1.8m Rt	2.4m Rt	2.4m Rt	0.6m Rt	1.8m Rt
W 1 Dry	552.4	656.6	573.4	529.3	608.0	549.3	545.0
W 2 in H20	302.3	356.5	316.2	292.3	338.7	298.6	304.4
W 3 Wet	552.5	657.3	573.9	530.2	608.3	550.3	545.6
Difference	250.2	300.8	257.7	237.9	269.6	251.7	241.2
Field Density	2.208	2.183	2.225	2.225	2.255	2.182	2.260
% Density	95.833	94.748	96.571	96.571	97.873	94.705	98.090
% Voids	8.3	9.3	7.6	7.6	6.3	9.3	6.1
Thickness	38	44	38	38	38	38	35

Gmb (Lot Avg.):	2.304	Avg. Field Density:	2.220
Gmm (Lot Avg.):	2.407	Avg. % Density:	96.342
TC Labs Pa:		Avg. % Field Voids:	7.0
Target % RAP:		Specified % Density:	95

$$Q.I. = \frac{96.342 - 95.000}{1.353} = 0.99$$

Low Outlier: High Outlier: New Q.I. =

Film Thickness (FT): 14.4 VMA: 14.7

Remarks: **This is an example of a sharp mix using the Gyratory.**

C.P.I.: George Seward CI095 Cert. No.

QMA Tech: Michael Gullickson NE119 Cert. No.

Distribution: Central Materials TC Materials Proj. Engineer Contractor Plant

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DAILY ACC PLANT REPORT

Project No.: STPN-9-6(45)--2J-66 County: Mitchell Class: 1 Report No.: 7

Contract ID: 66-0096-045 Contractor: Fred Carlson Co. Size: 13.2mm Design Blows: 50

Mix Design No.: ABD7-2011R2 Recycle Source: Mix Type: B Design Gyrations:

Hot Box I.D. No.:		QMA-18	QMA-19	QMA-20	QMA-21	
Date Sampled:		05/30/97	05/30/97	05/30/97	05/30/97	
Gradation ID:	Specs	SU-7A		SU-7C		
25mm Sieve	100	100		100		
19mm Sieve	100	100		100		
12.5mm Sieve	92-100	92		94		
9.5mm Sieve	79-92	84		85		
* 4.75mm Sieve	61-75	68		69		
* Moving Average		**68**		**68**		
* 2.36mm Sieve	49-59	53		55		
* Moving Average		**54**		**54**		
1.18mm Sieve		37		38		
* 600um Sieve	18-26	24		25		
* Moving Average		**24**		**25**		
300um Sieve		12		13		
150um Sieve		6.7		7.1		
* 75um Sieve	3.0-5.8	4.8		5.0		
* Moving Average		**4.5**		**4.7**		
Compliance (Y/N)		Y		Y		
Intended Added, % AC	6.10					
Actual Added, % AC		5.91				
Intended Total, % AC	6.10					
Actual Total, % AC		5.91				
Gmb:		2.355	2.366	2.350	2.344	
Gmm:		2.443	2.448	2.439	2.440	
Pa:		3.6	3.3	3.6	3.9	
Moving Average	3.0-4.0	**3.6**	**3.5**	**3.5**	**3.6**	
Time		08:00	11:00	02:00	04:30	
Station		289+00	278+00	262+00	249+50	
Side		LT	LT	LT	LT	
Sample Mg's		123.00	717.00	1,265.00	2,347.00	
Sublot Mg's		500.00	666.67	666.67	686.84	
Mg's to Date		9,956.08	10,622.75	11,289.42	11,976.26	
Fines / Bitumen Ratio	0.3-1.20	0.81				

Gsb: 2.609 Gb: 1.0248 Effective % AC: 4.99

Mix Change Info: A 2% aggregate proportion change was made before production started today.

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°C)	12	16	20	22	23	22	
A.C. Temp. (°C)	149	149	149	149	149	149	
Mix Temp. (°C)	144	145	144	143	140	144	.

Date Placed: 05/30/97 Date Tested: 06/02/97

Course Placed: Surface Tested By: Jay Haas

Density Record

Core No.:	1	2	3	4	5	6	7
Station	296+12	290+39	275+63	268+82	260+64	252+88	243+21
CL Reference	2.0m Lt	3.2m Lt	2.8m Lt	2.3m Lt	0.4m Lt	2.7m Lt	2.1m Lt
W 1 Dry	977.4	984.6	867.4	889.6	930.8	1,019.5	807.5
W 2 in H20	551.3	556.4	493.3	499.5	520.6	575.5	455.8
W 3 Wet	977.8	984.9	867.8	889.9	931.3	1,019.9	807.9
Difference	426.5	428.5	374.5	390.4	410.7	444.4	352.1
Field Density	2.292	2.298	2.316	2.279	2.266	2.294	2.293
% Density	97.366	97.621	98.386	96.814	96.262	97.451	97.409
% Voids	6.2	5.9	5.2	6.7	7.2	6.1	6.1
Thickness	54	55	48	49	53	56	43

Gmb (Lot Avg.): 2.354 Avg. Field Density: 2.291

Gmm (Lot Avg.): 2.443 Avg. % Density: 97.330

TC Labs Pa: Avg. % Field Voids: 6.2

Target % RAP: Specified % Density: 95

$$Q.I. = \frac{97.330 - 95.000}{0.662} = 3.52$$

Low Outlier: High Outlier: New Q.I. =

Film Thickness (FT): 9.0 VMA: 15.1

Remarks: Die roll gradation tested.

This is a completed report for a Marshall Mix.

C.P.I.: Jay Haas NE208 Cert. No.

QMA Tech: Al Forde NE118 Cert. No.

Distribution: Central Materials ___ TC Materials ___ Proj. Engineer ___ Contractor ___ Plant

800241M - 01/98

DAILY ACC PLANT REPORT

Project No.: STPN-9-6(45)--2J-66 | County: Mitchell | Class: 1 | Report No.: 4

Contract ID: 66-0096-045 | Contractor: Fred Carlson, Co. | Size: 19mm | Design Blows: 50

Mix Design No.: ABD7-2003 R1 | Recycle Source: | Mix Type: B | Design Gyrations:

Hot Box I.D. No.:		QMA-13	QMA-14	QMA-15	QMA-16	
Date Sampled:		05/05/97	05/05/97	05/05/97	05/05/97	
Gradation ID:	Specs	BI-4A	BI-4B	BI-4C	Avg.	
25mm Sieve		100	100	100	100	
19mm Sieve	98-100	97	99	100	99	
12.5mm Sieve	83-97	93	90	90	91	
9.5mm Sieve	74-88	78	78	80	79	
* 4.75mm Sieve	57-71	61	61	65	62	
* Moving Average		**61**	**61**	**62**		
* 2.36mm Sieve	41-53	45	45	48	46	
* Moving Average		**44**	**45**	**46**		
1.18mm Sieve		35	35	37	36	
* 600um Sieve	16-26	23	23	25	24	
* Moving Average		**23**	**23**	**23**		
300um Sieve		10	9.9	10	10	
150um Sieve		5.4	5.4	4.9	5.2	
* 75um Sieve	3.0-6.3	4.1	4.0	3.7	3.9	
* Moving Average		**3.9**	**4.0**	**4.0**		
Compliance (Y/N)		N	Y	Y	3	
Intended Added, % AC	5.90					
Actual Added, % AC		5.76			5.76	
Intended Total, % AC	5.90					
Actual Total, % AC		5.76			5.76	
Gmb:		2.374	2.341	2.344	2.363	
Gmm:		2.441	2.441	2.441	2.444	
Pa:		2.7	4.1	4.0	3.3	
Moving Average	3.0-4.5	**3.3**	**3.6**	**3.6**	**3.5**	
Time		08:15	10:45	01:45	02:44	
Station		337+00	325+00	314+00	300+00	
Side		Lt	Lt	Lt	Lt	
Sample Mg's		252.00	854.00	1,460.00	2,333.00	
Sublot Mg's		500.00	666.67	666.67	910.02	
Mg's to Date		7,985.96	8,652.63	9,319.30	10,229.32	
Fines / Bitumen Ratio	0.3-1.20	0.71			0.68	

Gsb: 2.598 | Gb: 1.0248 | Effective % AC: 4.80

Mix Change Info:

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°C)	10	13	17	18	19	21	
A.C. Temp. (°C)	149	149	149	149	149	149	
Mix Temp. (°C)	140	144	141	136	138	139	

Date Placed: 05/05/97 | Date Tested: 05/06/97

Course Placed: Binder | Tested By: Jay Haas

Density Record

Core No.:	1	2	3	4	5	6	7
Station	291+15	295+22	303+86	318+29	318+70	329+19	334+85
CL Reference	3.3m Lt	1.2m Lt	0.5m Lt	2.5m Lt	3.2m Lt	3.2m Lt	2.1m Lt
W 1 Dry	993.2	922.0	930.8	943.0	816.2	939.4	798.1
W 2 in H20	564.3	525.8	523.2	534.2	459.1	530.4	453.7
W 3 Wet	993.3	922.3	931.4	943.4	816.7	939.7	798.5
Difference	429.0	396.5	408.2	409.2	357.6	409.3	344.8
Field Density	2.315	2.325	2.280	2.304	2.282	2.295	2.315
% Density	98.260	98.684	96.774	97.793	96.859	97.411	98.260
% Voids	5.2	4.8	6.6	5.7	6.6	6.0	5.2
Thickness	48	47	47	48	43	47	42

Gmb (Lot Avg.): 2.356 | Avg. Field Density: 2.302

Gmm (Lot Avg.): 2.442 | Avg. % Density: 97.720

TC Labs Pa: | Avg. % Field Voids: 5.7

Target % RAP: | Specified % Density: 95

$$\text{Q.I.} = \frac{97.720 - 95.000}{0.736} = 3.70$$

Low Outlier: | High Outlier: | New Q.I. =

Film Thickness (FT): 9.9 | VMA: 14.5

Remarks: **This is a completed example of a Marshall Mix Report were the first gradation is non-compliant, backups were tested, an average gradation & new FBR was calculated.**

C.P.I.: Jay Haas | NE208 Cert. No.

QMA Tech: Al Forde | NE118 Cert. No.

Distribution: Central Materials | TC Materials | Proj. Engineer | Contractor | Plant

800241M - 01/98

DAILY ACC PLANT REPORT

Project No.: STPN-9-6(45)--2J-66 County: Mitchell Class: 1 Report No.: 7

Contract ID: 66-0096-045 Contractor: Fred Carlson Co. Size: 13.2mm Design Blows: 50

Mix Design No.: ABD7-2011 Recycle Source: Mix Type: B Design Gyrations:

Hot Box I.D. No.:		DS-12A	DS-12B	DS-12C		
Date Sampled:		05/30/97	05/30/97	05/30/97		
Gradation ID:	Specs	SU-7A				
25mm Sieve	100	100				
19mm Sieve	100	100				
12.5mm Sieve	92-100	92				
9.5mm Sieve	79-92	84				
* 4.75mm Sieve	61-75	68				
* Moving Average						
* 2.36mm Sieve	49-59	53				
* Moving Average						
1.18mm Sieve		37				
* 600um Sieve	18-26	24				
* Moving Average						
300um Sieve		12				
150um Sieve		6.7				
* 75um Sieve	3.0-5.8	4.8				
* Moving Average						
Compliance (Y/N)		Y				
Intended Added, % AC	6.10					
Actual Added, % AC		5.91				
Intended Total, % AC	6.10					
Actual Total, % AC		5.91				
Gmb:						
Gmm:						
Pa:						
Moving Average	3.0-4.0					
Time		08:00	12:00	02:00		
Station		289+00	271+50	258+75		
Side		Rt	Rt	Rt		
Sample Mg's		167.00	1,305.00	1,680.00		
Sublot Mg's						
Mg's to Date				9,956.08		
Fines / Bitumen Ratio	0.3-1.20	0.81				

Gsb: 2.609 Gb: 1.0248 Effective % AC: 4.99

Mix Change Info:

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°C)	12	16	20	22	23	22	
A.C. Temp. (°C)	149	149	149	149	149	149	
Mix Temp. (°C)	144	145	144	143	140	144	

Date Placed: 05/30/97 Date Tested: 06/02/97

Course Placed: Surface Tested By: Danny Steenhard

Density Record

Core No.:	1	2	3	4	5	6	7
Station	296+12	290+39	275+63	268+82	260+64	252+88	243+21
CL Reference	2.0m Lt	3.2m Lt	2.8m Lt	2.3m Lt	0.4m Lt	2.7m Lt	2.1m Lt
W 1 Dry	977.4	984.6	867.4	889.6	930.8	1,019.5	807.5
W 2 in H20	551.3	556.4	493.3	499.5	520.6	575.5	455.8
W 3 Wet	977.8	984.9	867.8	889.9	931.3	1,019.9	807.9
Difference	426.5	428.5	374.5	390.4	410.7	444.4	352.1
Field Density	2.292	2.298	2.316	2.279	2.266	2.294	2.293
% Density	97.366	97.621	98.386	96.814	96.262	97.451	97.409
% Voids	6.2	5.9	5.2	6.7	7.2	6.1	6.1
Thickness	54	55	48	49	53	56	43

Gmb (Lot Avg.): 2.354 Avg. Field Density: 2.291

Gmm (Lot Avg.): 2.443 Avg. % Density: 97.330

TC Labs Pa: 3.6 Avg. % Field Voids: 6.2

Target % RAP: Specified % Density: 95

$$\text{Q.I.} = \frac{97.330 - 95.000}{0.662} = 3.52$$

Low Outlier: High Outlier: New Q.I. =

Film Thickness (FT): 9.0 VMA: 15.1

Remarks: **This is a completed report for a non-QMA tested mix.**
Hot box testing performed by TC Materials Department.

C.P.I.: Jay Haas NE208 Cert. No.
QMA Tech: N.E.I.T.C. Materials Cert. No.

Distribution: Central Materials ___ TC Materials ___ Proj. Engineer ___ Contractor ___ Plant

TANK MEASUREMENT
& ASPHALT CEMENT CONTENT DETERMINATION

GENERAL

This Instructional Memorandum covers the procedures used by the contracting authority to determine: (1). The quantity of asphalt cement incorporated in a project, and (2) the asphalt cement content of individual production runs of asphalt mixtures. This IM also provides instruction for completing Form #E216 (#M216). The plant inspector is referred to the applicable specifications and instructions for the specified tolerances and measurement frequencies.

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 (#M216)

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 ACC Plant Page, which reflects the daily virgin AC tank stick information.

START OF PERIOD

TANK NO., TANK IDENTIFICATION

Each asphalt cement 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. 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, by the radius of the tank (½ the diameter) squared, by the constant pi (3.141592). That is, volume (V) =1(pi)r_2. When measurements are obtained in meters, convert m^3 to liters by multiplying by 1,000. 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 (liters) 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 cement 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 (Celsius) 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 (15°C). Refer to tables T102 or T103 to obtain the appropriate four-digit correction factor which corresponds to the Celsius (Fahrenheit) temperature recorded for each tank used.

CORRECTED LITERS (GALLONS) (G)

Enter the corrected gallons (liters) at 60°F (15°C) for each tank being used by multiplying rows A, C, & F or D & F, depending on which method is used to measure the AC. 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 LITERS (GALLONS) (H)

Enter the total corrected gallons (liters) by adding the corrected gallons (liters) figures for each tank being used.

TOTAL AC ADDED

TOTAL KILOGRAMS (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 (mass) tickets are obtained for each load placed in the storage tank during the production run. Each shipment ticket should be logged in the plant field book, with the appropriate date and unloading time. The weight (mass) is converted to corrected gallons (liters) at 60°F (15°C) by dividing by the weight (mass) per gallons (liters) coefficient provided by the supplier. Quantities added shall be certified or determined at the job site.

Enter the total pounds (kilograms) added to each tank being used.

WEIGHT (MASS) PER GALLON (LITER) (J)

The asphalt cement supplier provides the average mass per gallon (liter). If asphalt cement from different sources has been used during the production run, it is necessary to compute a massed average mass per gallon (liter) for the total quantity used. If emulsified asphalt cement or cutback asphalt cement is being used, it is necessary to reduce the mass of the diluted material to asphalt cement residue. The quantity of asphalt cement residue incorporated is determined by multiplying the total mass of emulsion or cutback by the percent residue value furnished by the supplier.

Enter the weight (mass) per gallon (liter) listed on the AC shipment tickets. The weight (mass) per gallon (liter) cannot change on a given day of production.

TOTAL CORRECTED GALLONS (LITERS) (K)

Enter the total corrected liters (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 (liters) 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 (Celsius) 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 (15°C). Refer to tables T102 or T103 to obtain the appropriate four-digit correction factor which corresponds to the Fahrenheit (Celsius) temperature recorded for each tank used.

CORRECTED GALLONS (LITERS) (R)

Enter the corrected gallons (liters) at 60°F (15°C) for each tank being used by multiplying rows L, N, & Q or O & Q, depending which method is used to measure the AC. 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 (LITERS) (S)

Enter the total corrected gallons (liters) by adding the corrected gallons (liters) figures for each tank being used.

CALCULATIONS

TOTAL CORRECTED GALLONS (LITERS) USED (T)

Enter the total corrected gallons (liters) used each day of production by adding (H) and (K), then subtracting (S).

MASS (WEIGHT) PER GALLON (LITER) (U)

Enter the four-digit figure listed in the (J) row from above.

TOTAL POUNDS (KILOGRAMS) OF AC USED (V)

This number is obtained by multiplying (T) by (U).

TOTAL POUNDS (KILOGRAMS) OF MIX PRODUCED (W)

Enter the total pounds (kilograms) of mix produced by the plant each day.

The total pounds (kilograms) of mixture are determined by adding the net weight (mass) 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 (KILOGRAMS) OF MIX WASTED (X)

Enter the total pounds (kilograms) 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 (KILOGRAMS OF AC WASTED (Y)

This number is determined by multiplying the percent asphalt cement (Z) by the total pounds of mix wasted (X). This quantity will not be included in the project pay quantity total.

NET TONS (MEGAGRAMS) OF ASPHALT CEMENT INCORPORATED IN THE PROJECT

This is the net quantity of asphalt cement for which the contractor is eligible to receive pay.

This number is obtained by subtracting (Y) from (V) and then dividing by 1000 for Megagrams or 2000 for Tons. **THIS FIGURE SHALL BE GIVEN TO THE ROAD INSPECTOR EACH DAY.**

NET TONS (MEGAGRAMS) OF MIX INCORPORATED IN THE PROJECT

This number is obtained by subtracting (X) from (W) and then dividing by 2000 for Tons or 1000 for Megagrams. This is the net quantity eligible for payment. **THIS FIGURE SHALL CORRELATE WITH THE ROAD FIGURE EACH DAY.**

PERCENT VIRGIN ASPHALT CEMENT, BY TANK MEASUREMENT (Z)

This percent virgin AC is obtained by dividing (V) by (W) and multiplying by 100.

This percentage is obtained by dividing the total net pounds (kilograms) of asphalt cement incorporated (V) by the total net pounds (kilograms)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.

COMMENTS

Self-explanatory:

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 #904 SHALL BE INCORPORATED IN THE RESIDENT OR COUNTY ENGINEER PROJECT FILE.

8/96

Form E216

DAILY VIRGIN AC 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 (G)= (A*C*F)or(D*F):				

Total Corrected Gallons (H)= (G+G+G+G): ____________

Total AC Added

Total Pounds (I):				
Weight Per Gallon (J):				

Total Corrected Gallons (K)= (I+I+I+I/J): ____________

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 (R)= (L*N*Q)or(O*Q):				

Total Corrected Gallons (S)= (R+R+R+R): ____________

Calculations

Total Corrected Gallons Used (T)= (H+K-S): ____________

Average Weight Per Gallon (U): ____________

Total Pounds Of AC Used (V)= (T*U): ____________

Total Pounds Of Mix Made (W): ____________

Total Pounds Of Mix Wasted (X): ____________

Total Pounds Of AC Wasted (Y)= (X*Z): ____________

Net Tons Of AC Used On Road = ((V-Y) / 2000): ____________

Net Tons Of Mix Used On Road = ((W-X) / 2000): ____________

Percent Virgin AC by Tank Stick (Z)= ((V / W) * 100): ____________

Comments: ____________

8/96

Form E216

DAILY VIRGIN AC TANK MEASUREMENT SHEET

Project No.: NHSN-63-9(19)--2R-45

Date: 09/08/96

Contract ID.: 45-0639-019

Report No.: 5

Start Of Period

Tank No.:	1			
Time:	06:47			
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 (G)= (A*C*F)or(D*F):	20,681			
Total Corrected Gallons (H)= (G+G+G+G):	20,681			

Total AC Added

Total Pounds (I):	103,066			
Weight Per Gallon (J):	8.5641			
Total Corrected Gallons (K)= (I+I+I+I/J):	12,035			

End Of Period

Time:	06:58			
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 (R)= (L*N*Q)or(O*Q):	5,968			
Total Corrected Gallons (S)= (R+R+R+R):	5,968			

Calculations

Total Corrected Gallons Used (T)= (H+K-S):	26,748
Average Weight Per Gallon (U):	8.5641
Total Pounds Of AC Used (V)= (T*U):	229,073
Total Pounds Of Mix Made (W):	4,001,650
Total Pounds Of Mix Wasted (X):	
Total Pounds Of AC Wasted (Y)= (X*Z):	
Net Tons Of AC Used On Road = ((V-Y) / 2000):	**114.54**
Net Tons Of Mix Used On Road = ((W-X) / 2000):	**2,000.83**
Percent Virgin AC by Tank Stick (Z)= ((V / W) * 100):	**5.72**

Comments: Example using T-104 Tables.

8/96

Form E216

DAILY VIRGIN AC TANK MEASUREMENT SHEET

Project No.: NHSN-63-9(19)--2R-45

Date: 09/08/96

Contract ID.: 45-0639-019

Report No.: 5

Start Of Period

Tank No.:	1	2	2	
Time:	06:47	10:05	02:00	
Tank Capacity (Gallons) (A):	25,000	25,000	25,000	
Outage (% of Diameter) (B):				
T-104 Innage (% of Capacity) (C):				
Direct Reading (Gallons) (D):	23,450	21,075	15,000	
Temp. °F (E):	300	300	300	
T-102 Temp. Corr. Factor (F):	0.9187	0.9187	0.9187	
Corrected Gallons (G)= (A*C*F)or(D*F):	21,544	19,362	13,781	
Total Corrected Gallons (H)= (G+G+G+G):	40,906			

Total AC Added

Total Pounds (I):	103,066			
Weight Per Gallon (J):	8.5641			
Total Corrected Gallons (K)= (I+I+I+I/J):	12,035			

End Of Period

Time:	06:58	10:30	02:25	
Tank Capacity (Gallons) (L):	25,000	25,000	25,000	
Outage (% of Diameter) (M):				
T-104 Innage (% of Capacity) (N):				
Direct Reading (Gallons) (O):	9,750	15,000	8,560	
Temp. °F (P):	295	300	300	
T-102 Temp. Corr. Factor (Q):	0.9204	0.9187	0.9187	
Corrected Gallons (R)= (L*N*Q)or(O*Q):	8,974	13,781	7,864	
Total Corrected Gallons (S)= (R+R+R+R):	30,619			

Calculations

Total Corrected Gallons Used (T)= (H+K-S):	22,322
Average Weight Per Gallon (U):	8.5641
Total Pounds Of AC Used (V)= (T*U):	191,168
Total Pounds Of Mix Made (W):	3,207,523
Total Pounds Of Mix Wasted (X):	10,000
Total Pounds Of AC Wasted (Y)= (X*Z):	596
Net Tons Of AC Used On Road = ((V-Y) / 2000):	**95.29**
Net Tons Of Mix Used On Road = ((W-X) / 2000):	**1,598.76**
Percent Virgin AC by Tank Stick (Z)= ((V / W) * 100):	**5.96**

Comments: Example using Direct Reading.

Tank 2 was measured twice during the day of production.

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

Contract ID.: 45-0639-019

Date: 09/09/96

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

Contract ID.: 45-0639-019

Date: 09/09/96

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.

METHOD OF DESIGN OF HOT MIX ASPHALT MIXES

SCOPE

The design of hot mix asphalt mixes 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 4126 Type B Aggregate for Hot Mix Asphalt
Standard Specification 4127 Type A Aggregate for Hot Mix Asphalt
AASHTO R-35 Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)
AASHTO T283 Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage
IM 302 Sieve Analysis of Aggregates
IM 306 Determining the Amount of Material Finer than the #200 (75 μm) Sieve in Aggregate
IM 336 Reducing Aggregate Field Samples to Test Samples
IM 321 Compacted Density of Hot Mix Asphalt (HMA)(Displacement)
IM 325G Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
IM 350 Determining Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
IM 357 Preparation of Hot Mix Asphalt (HMA) 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 Asphaltic Terminology, Equations & Example Calculations
IM 511 Control of Hot Mix Asphalt Mixtures

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 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 aggregate source properties shall comply with Standard Specifications 4126 and 4127.

The Contractor selects the aggregate and Recycled Asphalt Pavement (RAP) sources and the types and 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 Form #820955 to the laboratory. The gradation of the combined aggregate submitted for trial mix testing shall meet the requirements of the Project Plans and Specifications.

The Contractor must notify the District Materials Engineer prior to sampling of the aggregate stockpiles and RAP. The Contractor should estimate, in cooperation with the producers, the tentative proportions and gradations of each of the materials. A stockpile of at least 500 tons (500 Mg), or project amount if less must be produced so that representative samples of the processed material can be obtained. The target gradation, for each source, to be reported on Form #820955 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 RAP 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 within 15 working days. The following information will be provided: 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.

If the anticipated RAP content exceeds 20%, the designated binder grade will drop one step. (If a PG 64-22 was originally specified, PG 58-28 shall be used). If the anticipated RAP content exceeds 30%, the selection of the binder grade shall be based on testing performed by the Contracting Authority.

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. (114 kilograms) 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. (228 kilograms) of aggregate may be necessary. This will allow enough material for the following:

1. Four mix samples of a minimum 13,000-gram batch.

> **NOTE:** 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. (23 kilograms) of material will be used for mix design verification when required.

To prepare the aggregate and RAP 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:

$$Z = \frac{X}{X + Y} \times 100$$

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 RAP must be air dried to a surface dried condition prior to further preparation.

6. Review aggregate gradations as indicated on Form# 820955. If the gradation result, for each individual aggregate, found in Step C.4 is within the production tolerance of the gradation indicated on Form #820955, 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 Form #820955, sieving on each sieve size down to an including the #8 sieve is performed. All sieving must be done to completion.

> **NOTE:** 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) or until the aggregates reach a constant weight when weighed at 30 minute intervals.

> **NOTE:** RAP is not oven-dried.

9. When a mix designer suspects that the coarse aggregate portion contains excessive fines (dust coatings or clumps), an amount of correction should be established. The procedure used to determine the amount of correction required is found in Appendix B of this IM.

10. 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 RAP sources are as provided by the Contracting Authority.

> **NOTE:** 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 Form #820955 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. A higher surface area will generally, but not always, require a higher binder content.

e. The following table showing statewide averages

BASIC ASPHALT BINDER CONTENT, PERCENT

Mixture Size	Aggr. Type	1 inch	3/4 inch	1/2 inch	3/8 inch
Intermediate and Surface	A	4.75	5.50	6.00	6.00
Intermediate and Surface	B	5.25	5.75	6.00	6.25
Base	B	5.25	6.00	6.00	6.25

4. Check that the trial asphalt binder content selected for each aggregate blend could meet the film thickness and F/B ratio criteria as 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

Trial mixes are prepared at a minimum of three different asphalt binder contents to assure close bracketing of the final recommended design binder content. Trial binder contents shall cover a minimum range of 1.0%. The final recommended binder content must be bracketed by trial binder contents within 1.0% above and below. Contractor prepared mix designs may require a mixture prepared at the recommended design binder content for DOT mix design verification.

> **NOTE:** If a four-point design is desired, the trial binder contents shall cover a minimum range of 1.5%.

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 Form #820955 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. A higher surface area will generally, but not always, require a 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.

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.

1. Accurately batch the aggregates in the correct proportions to obtain the desired batch weight. The desired amount of RAP 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, %

NOTE: If RAP 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:

$$\text{Binder Weight} = \frac{(\text{aggregate batch weight})(\text{Target } P_b)}{(\%\text{ aggregate batch weight})}$$

NOTE: If RAP is included in the mix, the $P_{b\,(added)}$ content must be determined. Use the formulas in IM 501.

3. 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. The mixing bowl and utensils shall also be heated before mixing operations begin. Always keep the mixing bowl buttered.

> **NOTE:** It generally takes 4 hours to bring aggregates & binder to mixing temperature. RAP will be heated in a separate pan for a maximum of 2 hours to minimize binder aging.

4. Weigh the required amount of RAP 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. Cure all samples for 2 hours at 275°F (135°C). 1 hour into curing, all samples are removed, thoroughly stirred and placed back into the oven for remainder of curing time.

11. Place approximately 4800 grams of material into the mold for gyratory specimens. Compact specimens at 275°F (135°C) 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. In addition, the mixture may be checked for moisture susceptibility using AASHTO T-283.

DOCUMENTATION

A copy of the SHADES computer file containing all the test data must be submitted to the DME for approval of the JMF. The signed individual materials report (Form #820955) and JMF report (Form #820956) (including economic justification when required) are required prior to starting the paving.

Distribution of the documents:

District Materials Engineer
Project Engineer
Contractor
Central Materials Office

HOT MIX ASPHALT (HMA) DESIGN CRITERIA

Overview of the HMA Mixture Design Criteria Chart (Table 1)

The HMA 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 (ESAL), 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 3M S ½ L-3**" describes the HMA mixture for up to 3 million ESALs, surface layer, ½-inch mixture size, with level 3 friction aggregate.

The columns to the right of the mixture designations define the required level of compaction (N values) and the maximum or 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 1M ESAL surface/intermediate 7-76-117 mixture requires 96 percent of G_{mm} (4.0% air voids) at N-design. The 7-76-117 base mixture for 3M ESALs requires 96.5 percent of G_{mm} (3.5% air voids) at N-design.

The middle columns identify the volumetric properties of the compacted HMA mixture when analyzed at the target air voids at N-design.

The aggregate properties are defined in the right columns. The quality of the aggregate (Type A or B) is further specified in Standard Specifications 4126 and 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. The friction columns specify the minimum amounts of friction quality coarse aggregate (Type 4, 3, 2) as defined in Materials IM T203. The details of the friction criteria are specified in Standard Specification 2303. Table Note 4 defines the allowable quantity of flat and elongated aggregate for all mixtures.

For any specified HMA mixture, the mix design criteria are found by reading across the table. The HMA mixtures are grouped by ESAL 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.

VMA Requirements

The minimum VMA requirements are shown on Table 3.

Table 1
HMA MIXTURE DESIGN CRITERIA

Mix Designation	Gyratory Density							Friction [2]			Aggregate [3]			
	N_{ini} - N_{des} - N_{max}	Initial % G_{mm} (max)	Design % G_{mm} (target)	Maximum % G_{mm} (max)	VFA	Film Thickness	Filler: Binder	Type 4 (min)	Type 3 (min)	Type 2 (min)	Quality Type	Crush (min)	FAA (min)	Sand Equiv. (min)
HMA 100K S-I-B	7 - 68 - 104	92.5	97.0	98.5	75-85	8.0-13.0	0.6-1.4				B[1]	45[1]	---	40
HMA 300K S-I	7 - 68 - 104	92.0	96.5	98.0	70-80	8.0-13.0	0.6-1.4				B[1]	45[1]	---	40
HMA 300K B	7 - 68 - 104	92.5	97.0	98.5	75-85									
HMA 1M S L-4	7 - 76 - 117	90.5	96.0	98.0	65-78	8.0-15.0	0.6-1.4	50			A[1]	60[1]	40	40
HMA 1M S														
HMA 1M I											B[1]	45[1]		
HMA 1M B	7 - 68 - 104	92.0	96.5	98.0	70-80						B[1]	45[1]	---	
HMA 1M B (shld pav sep)	7 - 68 - 104	92.0	97.0	98.0	75-85						B[1]	45[1]	---	
HMA 3M S L-4	7 - 86 - 134	89.5	96.0	98.0	65-78	8.0-15.0	0.6-1.4	50			A	75	40	40
HMA 3M S L-3								80	45	(30)				
HMA 3M S														
HMA 3M I												60		
HMA 3M B	7 - 76 - 117	90.5	96.5	98.0	65-78						B	45		
HMA 10M S L-3	8 - 96 - 152	89.0	96.0	98.0	65-78	8.0-15.0	0.6-1.4	80	45	(30)	A	75	43	45
HMA 10M I														
HMA 10M B	7 - 86 - 134	89.5	96.0	98.0	65-78						B	75	40	
HMA 30M S L-3	8 - 109 - 174	89.0	96.0	98.0	65-75	8.0-15.0	0.6-1.4	80	45	(30)	A	85	45	45
HMA 30M S L-2								80		25				
HMA 30M I														
HMA 30M B	8 - 96 - 152	89.0	96.0	98.0	65-75						B	75	40	
HMA 100M S L-2	9 - 126 - 204	89.0	96.0	98.0	65-75	8.0-15.0	0.6-1.4	80		25	A	85	45	50
HMA 100M I														
HMA 100M B	8 - 109 - 174	89.0	96.0	98.0	65-75						B	75	43	

Note (1) On local agency projects, the minimum percent crushed and quality type shown above shall be used unless specified in plans.
Note (2) See Iowa DOT Standard Specification 2303.02
Note (3) Flat & Elongated 10% maximum at a 5:1 ratio.

Table 2

Aggregate Gradation Control Points								
	Mix Size - Control Points (% passing)							
	1 inch (25 mm)		3/4 inch (19 mm)		1/2 inch (12.5 mm)		3/8 inch (9.5 mm)	
Sieve Size	**min.**	**max.**	**min.**	**max.**	**min.**	**max.**	**min.**	**max.**
1 1/2 inch (37.5 mm)	100							
1 inch (25 mm)	90	100	100					
3/4 inch (19 mm)		90	90	100	100			
1/2 inch (12.5 mm)				90	90	100	100	
3/8 inch (9.5 mm)						90	90	100
No. 4 (4.75 mm)								90
No. 8 (2.36 mm)	19	45	23	49	28	58	32	67
No. 16 (1.18 mm)(1)				28		32		
No. 30 (600 mm)(2)				24		25		
No. 200 (75 mm)	1	7	2	8	2	10	2	10

(1) Only applies to surface and intermediate mixtures for HMA 30M and above.
(2) Only applies to surface and intermediate mixtures for HMA 10M.

Table 3

Minimum VMA Criteria(1)				
	Mix Size			
Mix Designation	**1 inch (25 mm)**	**3/4 inch (19 mm)**	**1/2 inch (12.5 mm)**	**3/8 inch (9.5 mm)**
HMA 100K	12.0	13.0	14.0	15.0
HMA 300K				
HMA 1M				
HMA 3M				
HMA 10M				
HMA 30M	11.5	12.5	13.5	14.5
HMA 100M				

(1) Applies to all layers in the pavement structure (surface, intermediate and base).

******THIS IS A NEW APPENDIX – PLEASE READ CAREFULLY******

PROCEDURE FOR DETERMINING THE AGGREGATE CORRECTION FOR FINES ADHERING TO COARSE AGGREGATE

PROCEDURE

To compensate for the amount of fine material that adheres to the coarse portion, obtain a coarse aggregate sample of approximately 1000 grams.

Oven dry to a constant weight, weigh, and wash this sample over one size smaller sieve than on which it was initially split. Again dry the coarse portion to constant weight, and weigh. Determine the amount of correction required from the following equation:

$$C = \frac{(A - B)}{A} \times Z$$

Where: "A" = oven dry sample weight before washing, g
"B" = oven dry sample weight after washing, g
"C" = % correction added to the % of total sample retained
"Z" = % of total sample retained (from A-4 of Material Preparation)

Round "C" to the nearest whole number and apply the correction to the sample Form #820955 gradation and split sample proportions as necessary when batching.

EXAMPLE

Check on the #8 sieve

X = 45.0 pounds retained
Y = 32.5 pounds passing

Determine "Z" using the equation from Step A-9 of Materials Preparation.

$$Z = \frac{45.0}{45.0 + 32.5} \times 100$$

Z = 58.1% retained

A = 983 grams
B = 967 grams

Determine "C"

$$C = \frac{(983 - 967)}{983} \times 58.1$$

C = 0.95%

This rounds off to 1.0%.

The sieve analysis shows the following gradation:

Sieve	% Passing
1"	100
3/4"	100
1/2"	99
3/8"	86
#4	61
#8	41
#16	20
#30	10
#50	6.2
#100	5.1
#200	4.6

The gradation indicates 59% retained on the #8 sieve.

59% retained on #8 + 1.0% correction equals 60% on #8 sieve.

To obtain the desired amount of coarse aggregate on the plus #8 sieve, the amount of the coarse portion would need to be increased while decreasing the fine portion accordingly.

CONTROL OF HOT MIX ASPHALT MIXTURES

SCOPE

This IM describes the Quality Control/Quality Assurance (QC/QA) procedures for monitoring and controlling plant-produced Hot Mix Asphalt (HMA) on Quality Management of Asphalt (QMA) projects. Because the plant-produced mixtures may not develop test characteristics that meet design criteria, each mixture shall be evaluated during plant production. The evaluation procedures outlined herein are to be carefully followed so that all mix characteristics will conform to the appropriate requirements.

REFERENCE DOCUMENTS

Standard Specification 2303 Hot Mix Asphalt
Supplemental Specification 01014 Hot Mix Asphalt (Gyratory Mix Design for Local Systems)
AASHTO R 9-90 Acceptance Sampling Plans for Highway Construction
IM 204 Inspection of Construction Project Sampling & Testing
IM 208 Materials Laboratory Qualification 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 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 510 Method of Design of Hot Mix Asphalt Mixes

RESPONSIBILITIES

Appendix A contains an outline of the responsibilities required for all parties.

The Table of Responsibility, in Appendix A, is broken up into two main categories, Quality Action and Type of Project. The Type of Project is further broken down into two sub-categories, Certified Plant Inspection (CPI) and QMA, and projects with small quantities. The Quality Action is subdivided into the types of work needing to be performed. These areas are General, Asphalt Binder, Aggregate, Loose Hot Mix, Compacted Hot Mix and Revisions. The table is organized in a way to represent how the work would progress during a Hot Mix Asphalt paving operation.

Each Quality Action identifies the group responsible for ensuring the desired action is performed. The groups are the Contractor (CONTR), Resident Construction Office/Project Engineer (RCE), District Materials Office (DME), and the Central Materials Office (CTRL).

In addition, there are certain levels of certification required to perform specific activities. Depending on the Quality Action, an individual might be required to be a HMA Sampler, Level I HMA, Level II HMA, Level I AGG, or a Level II AGG Certified Technician.

SAMPLING & TESTING

Samples of the combined aggregate, asphalt binder, and plant-produced mixture are obtained in accordance with IM 204 and analyzed as soon as the operations of the plant stabilize.

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 and included in the moving averages. Additional samples of aggregate and loose hot mix asphalt may be taken to provide better quality control. The results of testing done on additional samples will be for informational purposes only. Any proposed changes in the quality control and verification sampling/testing frequencies require the approval of the District Materials Engineer.

All testing done by the Contractor that is used as part of the acceptance decision shall be performed in qualified labs by certified technicians. On all QMA projects, the Level I HMA-Certified Technician is responsible for making sure that all samples are obtained according to the applicable IMs. Samples of loose HMA and asphalt binder must be taken by someone with a minimum of a HMA Sampler Certification.

Samples taken for acceptance purposes shall be retained until the lot has been accepted.

A. ASPHALT BINDER

The procedure used in the sampling of asphalt binder is found in IM 323. AASHTO procedures are used in the testing of asphalt binder. The frequencies for taking asphalt binder samples are found in IM 204.

B. AGGREGATE

The procedure used in the sampling of aggregate is found in IM 301. The procedures used in the testing of aggregate are found in IM 336 and IM 302. The frequencies for taking aggregate samples are found in IM 204.

When results from one or more sieves of the specified gradation sample are outside the allowable gradation tolerances, the Engineer may direct and witness one additional aggregate sample or process one loose mix sample to include in the gradation acceptance decision.

C. LOOSE HOT MIX

The procedure used in the sampling of loose hot mix asphalt is found in IM 322. The procedures used in the testing of loose hot mix asphalt are found in IM 357, IM 350, IM 325, IM 325G, and IM 338. The frequencies for taking loose hot mix asphalt samples are found in IM 204.

The first production sample each day shall be obtained within the first 500 tons (500 Mg) of mix produced. Subsequent daily samples will be obtained from the remaining daily production by dividing the anticipated production beyond the first 500 tons (500 Mg) into three sublots and randomly selecting a sampling point within each sub lot. When less than 2000 tons (2000 Mg) of mix is anticipated to be produced in a day, samples shall be obtained at a minimum rate of one per 750 tons (750 Mg), after the first 500 tons (500 Mg) is sampled. In both cases, samples shall not be taken within the first 100 tons (100 Mg) of production. The specific ton or truckload to begin sampling shall be determined by the Engineer using a random number system. The production samples shall be obtained as directed and witnessed by the Engineer.

The laboratory density, G_{mb}, of each production sample will be determined by averaging the densities of the compacted specimens. Two Gyratory specimens are compacted to the specified number of gyrations. The number of gyrations or blows is specified in the project documents.

Laboratory voids, P_a, for each production sample will be determined from the results of laboratory density and the corresponding individual Rice, G_{mm}, results. The moving average of lab voids will be determined by averaging the last four individual lab void values. A separate moving average will be established for each Job Mix Formula (JMF).

The calibration of the Rice pycnometer shall be checked at the beginning of a project and anytime that a correlation problem occurs.

D. COMPACTED HOT MIX

The procedure used in the sampling of compacted hot mix asphalt is found in IM 320. The procedures used in the testing of compacted hot mix asphalt are found in IM 321 and IM 337. The frequencies for taking compacted hot mix asphalt samples are found in IM 204.

The Engineer will provide inspection staff to direct and witness the sampling and perform density measurement during time agreed between the Engineer and the Contractor. The Engineer should make every effort to meet the Contractor's schedule. Results must be determined and reported within the period of time specified in this IM.

The Engineer will transport the cores in accordance with IM 320. The Engineer and Contractor will determine that cores are not damaged. The Engineer will decide if a core is damaged prior to testing.

Field density will be based on the average of the seven density cores taken for each lot. The Quality Index (QI) for density will be determined using the field density compared to the average lab density obtained from samples, which correspond to the pavement from which the cores were taken. Field voids will be determined using the field density and the average of the Rice test results of production samples.

The Quality Index is a statistical measure of the difference between the field density and the minimum required density. The index identifies and compensates for values falling outside the statistical norm (outliers). The Quality Index is based on AASHTO R 9-90. The equations used in the determination of the Quality Index are located in the Specifications. Examples on how to calculate the QI as well as outliers are located in IM 501.

VALIDATION

Validation is defined as the ability of two labs to achieve similar (statistically equivalent) test values on split or paired samples (split for aggregate samples and paired for HMA samples). To achieve or reestablish validation, a minimum of two consecutive test results must meet IM 216 tolerances.

When any of the following events occur, validation has not been achieved or maintained.

- The difference between test results on each of two consecutive split/paired samples exceeds the IM 216 tolerance.
- The difference between test results on any two of three consecutive split/paired samples exceeds the IM 216 tolerance.
- The test results in a series of split/paired samples (minimum of 3 samples, normally no more than 5) 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.

DISPUTE RESOLUTION

When validation is not achieved or maintained, the District Materials Engineer may apply the following actions as appropriate to resolve split/paired test result differences.

- Retest the same sample
- The District labs will test additional verification samples.
- The District Materials Engineer will review the sampling and testing procedures of both labs
- The District Materials Engineer will immediately test samples sent in by the Contractor without allowing cool down and reheating (hot-to-hot testing).
- Both labs will test samples using comparable reheat periods.
- The District Materials Engineer will establish a correction factor based on the reheat evaluation outlined in Appendix B.
- Both labs will test a sample that was taken and split by the Engineer.
- 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.
- The District Materials Engineer 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.

Resolution decisions by the Iowa DOT Central Materials Laboratory will be final. 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.

- If 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.
- If validation cannot be achieved on loose hot mix tests for G_{mm} or G_{mb}, the Engineer's test results will be used for any calculations involving that particular test value for the entire lot.

PRODUCTION TOLERANCES

Production tolerances are listed in the specifications.

Variations between two consecutive test results in G_{mb} or G_{mm} of more than 0.030 shall be investigated 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. On non-QMA designed mixtures, the investigation should include the testing of back-up samples obtained during the production of the lot.

REPORTING

For each production sample of loose HMA the Contractor will determine, report, and plot (per QMA specification), 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. The inter lab correlation reports shall be made available. **NOTE:** Under no circumstances can changes in the target gradation be set outside of the control points.

Test results are to be recorded and plotted in the computer programs provided by the Iowa DOT. A copy of the completed Daily HMA Plant Report (Form #800241) summarizing all test results including the field density QI shall be faxed to the District Materials Engineer within four hours of beginning operations on the next working day. Copies of computer files containing the project information shall be furnished to the Engineer upon project completion.

ADJUSTING (TROUBLESHOOTING)

As stated in Standard Specification 2303, "The Contractor shall be responsible for all aspects of the project, provide Quality Control management and testing, and maintain the quality characteristics specified".

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, the Contractor must obtain approval of a new JMF from the District Materials Engineer. The Contractor may change the target binder content to maintain the required mixture characteristics, provided the appropriate documentation and reporting is performed. All changes in proportions must be reported on the Daily ACC Plant Report (Form #800241).

The addition of new materials to the JMF may be approved by the District Materials Engineer without laboratory tests if the materials are produced from geologically comparable sources, do not constitute more than 15 percent 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.

Any time the moving average for laboratory voids falls outside the specification tolerance limit, the Contractor must cease operations. The Contractor assumes the responsibility to cease operations, including not incorporating produced material, which has not been placed. Production shall not be started again until the Contractor notifies the Engineer of the corrective action proposed.

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.

GUIDANCE TABLES

The tables below are intended to provide guidance on dealing with the most common problems, which arise during the production of HMA. 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.

Lab Problem Table

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 all 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		■			■			■			■		■	■		■	■	
	Aggr. SG (Gsb)			■			■									■			■
	Aggr. Absorption									■			■						
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 Aggr. Sources			■			■			■			■			■			■
Step 4-Do	Lower Binder	■									■								
	Increase Binder				■			■											
	Lower -200		■						■					■					
	Increase -200					■						■					■		
	Adjust Aggr. Proportions		■	■		■	■		■	■		■	■	■	■	■	■	■	■
	Recompute Volumetrics			■			■			■			■			■			■

Field Problem Table

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 all 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-If	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													■				

*****GENERAL REWRITE – PLEASE READ CAREFULLY.*****

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 Level I Aggr. Technician
(5) Must be done by Certified Level II Aggr. 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

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.

CORRELATION OF FIELD DENSITY FOR HOT MIX ASPHALT (HMA) PAVING

GENERAL

Correlation sampling and testing of the field density test result insures that testing equipment is operating properly and the results are within the range of tolerance. Investigations are conducted and corrections made when results do not correlate.

SAMPLE

A sample consists of all the cored specimens of one day's paving production.

HANDLING, STORING AND SHIPPING SAMPLES

These specimens must be identified and stored in a manner, which will not affect their densities. Upon request from the District Materials Laboratory, cores are to be taken and transported the next working day. A completed Daily Plant Report, Form #800241 shall accompany each set of cores.

TESTING AND SAMPLING FREQUENCY

The District Materials Office, on a random basis for correlation will select samples as specified. A minimum of one sample per project will be obtained.

CORRELATING THE RESULT

The District Laboratory shall test each specimen of the submitted sample in accordance with IM 321. The test results of each specimen will be compared to each corresponding field test result for correlation. Bulk Specific Gravity (G_{mb}) results that do not correlate to within 0.020 will be considered suspect. Other information gained through this correlation testing, such as trends developing, will also give cause to suspect the results. Immediate investigation must be conducted and correction made on all suspect test results.

NOTE: Each District Laboratory procedure and equipment is accredited and monitored through the established program with the Central Laboratory, which includes Cooperative Testing.

REPORTING

The District Materials Office shall submit reports of the correlation of field density tests to the project file along with the documentation of what action was taken for suspect results.

AGGREGATE DELIVERY CONVERSION TABLE

	Tons/Hour										
%	50	60	70	80	90	100	110	120	130	140	150
	Pounds/Minute										
2.5	42	50	58	67	75	83	92	100	108	117	125
5.0	83	100	117	133	150	167	183	200	217	233	250
7.5	125	150	175	200	225	250	275	300	325	350	375
10.0	167	200	233	267	300	333	367	400	433	467	500
12.5	208	250	292	333	375	417	458	500	542	583	625
15.0	250	300	350	400	450	500	550	600	650	700	750
17.5	292	350	408	467	525	583	642	700	758	817	875
20.0	333	400	467	533	600	667	733	800	867	933	1000
22.5	375	450	525	600	675	750	825	900	975	1050	1125
25.0	417	500	583	667	750	833	917	1000	1083	1167	1250
27.5	458	550	642	733	825	917	1008	1100	1192	1283	1375
30.0	500	600	700	800	900	1000	1100	1200	1300	1400	1500
32.5	542	650	758	867	975	1083	1192	1300	1408	1517	1625
35.0	583	700	817	933	1050	1167	1283	1400	1517	1633	1750
37.5	625	750	875	1000	1125	1250	1375	1500	1625	1750	1875
40.0	667	800	933	1067	1200	1333	1467	1600	1733	1867	2000
42.5	708	850	992	1133	1275	1417	1558	1700	1842	1983	2125
45.0	750	900	1050	1200	1350	1500	1650	1800	1950	2100	2250
47.5	792	950	1108	1267	1425	1583	1742	1900	2058	2217	2375
50.0	833	1000	1167	1333	1500	1667	1833	2000	2167	2333	2500
52.5	875	1050	1225	1400	1575	1750	1925	2100	2275	2450	2625
55.0	917	1100	1283	1467	1650	1833	2017	2200	2383	2567	2750
57.5	958	1150	1342	1533	1725	1917	2108	2300	2492	2683	2875
60.0	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
62.5	1042	1250	1458	1667	1875	2083	2292	2500	2708	2917	3125
65.0	1083	1300	1517	1733	1950	2167	2383	2600	2817	3033	3250
67.5	1125	1350	1575	1800	2025	2250	2475	2700	2925	3150	3375
70.0	1167	1400	1633	1867	2100	2333	2567	2800	3033	3267	3500
72.5	1208	1450	1692	1933	2175	2417	2658	2900	3142	3383	3625
75.0	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750
77.5	1292	1550	1808	2067	2325	2583	2842	3100	3358	3617	3875
80.0	1333	1600	1867	2133	2400	2667	2933	3200	3467	3733	4000
82.5	1375	1650	1925	2200	2475	2750	3025	3300	3575	3850	4125
85.0	1417	1700	1983	2267	2550	2833	3117	3400	3683	3967	4250
87.5	1458	1750	2042	2333	2625	2917	3208	3500	3792	4083	4375
90.0	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200	4500
92.5	1542	1850	2158	2467	2775	3083	3392	3700	4008	4317	4625
95.0	1583	1900	2217	2533	2850	3167	3483	3800	4117	4433	4750
97.5	1625	1950	2275	2600	2925	3250	3575	3900	4225	4550	4875
100.0	1667	2000	2333	2667	3000	3333	3667	4000	4333	4667	5000

AGGREGATE DELIVERY CONVERSION TABLE

	Tons/Hour										
%	150	160	170	180	190	200	210	220	230	240	250
	Pounds/Minute										
2.5	125	133	142	150	158	167	175	183	192	200	208
5.0	250	267	283	300	317	333	350	367	383	400	417
7.5	375	400	425	450	475	500	525	550	575	600	625
10.0	500	533	567	600	633	667	700	733	767	800	833
12.5	625	667	708	750	792	833	875	917	958	1000	1042
15.0	750	800	850	900	950	1000	1050	1100	1150	1200	1250
17.5	875	933	992	1050	1108	1167	1225	1283	1342	1400	1458
20.0	1000	1067	1133	1200	1267	1333	1400	1467	1533	1600	1667
22.5	1125	1200	1275	1350	1425	1500	1575	1650	1725	1800	1875
25.0	1250	1333	1417	1500	1583	1667	1750	1833	1917	2000	2083
27.5	1375	1467	1558	1650	1742	1833	1925	2017	2108	2200	2292
30.0	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500
32.5	1625	1733	1842	1950	2058	2167	2275	2383	2492	2600	2708
35.0	1750	1867	1983	2100	2217	2333	2450	2567	2683	2800	2917
37.5	1875	2000	2125	2250	2375	2500	2625	2750	2875	3000	3125
40.0	2000	2133	2267	2400	2533	2667	2800	2933	3067	3200	3333
42.5	2125	2267	2408	2550	2692	2833	2975	3117	3258	3400	3542
45.0	2250	2400	2550	2700	2850	3000	3150	3300	3450	3600	3750
47.5	2375	2533	2692	2850	3008	3167	3325	3483	3642	3800	3958
50.0	2500	2667	2833	3000	3167	3333	3500	3667	3833	4000	4167
52.5	2625	2800	2975	3150	3325	3500	3675	3850	4025	4200	4375
55.0	2750	2933	3117	3300	3483	3667	3850	4033	4217	4400	4583
57.5	2875	3067	3258	3450	3642	3833	4025	4217	4408	4600	4792
60.0	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000
62.5	3125	3333	3542	3750	3958	4167	4375	4583	4792	5000	5208
65.0	3250	3467	3683	3900	4117	4333	4550	4767	4983	5200	5417
67.5	3375	3600	3825	4050	4275	4500	4725	4950	5175	5400	5625
70.0	3500	3733	3967	4200	4433	4667	4900	5133	5367	5600	5833
72.5	3625	3867	4108	4350	4592	4833	5075	5317	5558	5800	6042
75.0	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000	6250
77.5	3875	4133	4392	4650	4908	5167	5425	5683	5942	6200	6458
80.0	4000	4267	4533	4800	5067	5333	5600	5867	6133	6400	6667
82.5	4125	4400	4675	4950	5225	5500	5775	6050	6325	6600	6875
85.0	4250	4533	4817	5100	5383	5667	5950	6233	6517	6800	7083
87.5	4375	4667	4958	5250	5542	5833	6125	6417	6708	7000	7292
90.0	4500	4800	5100	5400	5700	6000	6300	6600	6900	7200	7500
92.5	4625	4933	5242	5550	5858	6167	6475	6783	7092	7400	7708
95.0	4750	5067	5383	5700	6017	6333	6650	6967	7283	7600	7917
97.5	4875	5200	5525	5850	6175	6500	6825	7150	7475	7800	8125
100.0	5000	5333	5667	6000	6333	6667	7000	7333	7667	8000	8333

AGGREGATE DELIVERY CONVERSION TABLE

	Tons/Hour										
%	250	260	270	280	290	300	310	320	330	340	350
	Pounds/Minute										
2.5	208	217	225	233	242	250	258	267	275	283	292
5.0	417	433	450	467	483	500	517	533	550	567	583
7.5	625	650	675	700	725	750	775	800	825	850	875
10.0	833	867	900	933	967	1000	1033	1067	1100	1133	1167
12.5	1042	1083	1125	1167	1208	1250	1292	1333	1375	1417	1458
15.0	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750
17.5	1458	1517	1575	1633	1692	1750	1808	1867	1925	1983	2042
20.0	1667	1733	1800	1867	1933	2000	2067	2133	2200	2267	2333
22.5	1875	1950	2025	2100	2175	2250	2325	2400	2475	2550	2625
25.0	2083	2167	2250	2333	2417	2500	2583	2667	2750	2833	2917
27.5	2292	2383	2475	2567	2658	2750	2842	2933	3025	3117	3208
30.0	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500
32.5	2708	2817	2925	3033	3142	3250	3358	3467	3575	3683	3792
35.0	2917	3033	3150	3267	3383	3500	3617	3733	3850	3967	4083
37.5	3125	3250	3375	3500	3625	3750	3875	4000	4125	4250	4375
40.0	3333	3467	3600	3733	3867	4000	4133	4267	4400	4533	4667
42.5	3542	3683	3825	3967	4108	4250	4392	4533	4675	4817	4958
45.0	3750	3900	4050	4200	4350	4500	4650	4800	4950	5100	5250
47.5	3958	4117	4275	4433	4592	4750	4908	5067	5225	5383	5542
50.0	4167	4333	4500	4667	4833	5000	5167	5333	5500	5667	5833
52.5	4375	4550	4725	4900	5075	5250	5425	5600	5775	5950	6125
55.0	4583	4767	4950	5133	5317	5500	5683	5867	6050	6233	6417
57.5	4792	4983	5175	5367	5558	5750	5942	6133	6325	6517	6708
60.0	5000	5200	5400	5600	5800	6000	6200	6400	6600	6800	7000
62.5	5208	5417	5625	5833	6042	6250	6458	6667	6875	7083	7292
65.0	5417	5633	5850	6067	6283	6500	6717	6933	7150	7367	7583
67.5	5625	5850	6075	6300	6525	6750	6975	7200	7425	7650	7875
70.0	5833	6067	6300	6533	6767	7000	7233	7467	7700	7933	8167
72.5	6042	6283	6525	6767	7008	7250	7492	7733	7975	8217	8458
75.0	6250	6500	6750	7000	7250	7500	7750	8000	8250	8500	8750
77.5	6458	6717	6975	7233	7492	7750	8008	8267	8525	8783	9042
80.0	6667	6933	7200	7467	7733	8000	8267	8533	8800	9067	9333
82.5	6875	7150	7425	7700	7975	8250	8525	8800	9075	9350	9625
85.0	7083	7367	7650	7933	8217	8500	8783	9067	9350	9633	9917
87.5	7292	7583	7875	8167	8458	8750	9042	9333	9625	9917	10208
90.0	7500	7800	8100	5400	8700	9000	9300	9600	9900	10200	10500
92.5	7708	8017	8325	8633	8942	9250	9558	9867	10175	10483	10792
95.0	7917	8233	8550	8867	9183	9500	9817	10133	10450	10767	11083
97.5	8125	8450	8775	9100	9425	9750	10075	10400	10725	11050	11375
100.0	8333	8667	9000	9333	9667	10000	10333	10667	11000	11333	11667

AGGREGATE DELIVERY CONVERSION TABLE

	Tons/Hour										
%	350	360	370	380	390	400	410	420	430	440	450
	Pounds/Minute										
2.5	292	300	308	317	325	333	342	350	358	367	375
5.0	583	600	617	633	650	667	683	700	717	733	750
7.5	875	900	925	950	975	1000	1025	1050	1075	1100	1125
10.0	1167	1200	1233	1267	1300	1333	1367	1400	1433	1467	1500
12.5	1458	1500	1542	1583	1625	1667	1708	1750	1792	1833	1875
15.0	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	2250
17.5	2042	2100	2158	2217	2275	2333	2392	2450	2508	2567	2625
20.0	2333	2400	2467	2533	2600	2667	2733	2800	2867	2933	3000
22.5	2625	2700	2775	2850	2925	3000	3075	3150	3225	3300	3375
25.0	2917	3000	3083	3167	3250	3333	3417	3500	3583	3667	3750
27.5	3208	3300	3392	3483	3575	3667	3758	3850	3942	4033	4125
30.0	3500	3600	3700	3800	3900	4000	4100	4200	4300	4400	4500
32.5	3792	3900	4008	4117	4225	4333	4442	4550	4658	4767	4875
35.0	4083	4200	4317	4433	4550	4667	4783	4900	5017	5133	5250
37.5	4375	4500	4625	4750	4875	5000	5125	5250	5375	5500	5625
40.0	4667	4800	4933	5067	5200	5333	5467	5600	5733	5867	6000
42.5	4958	5100	5242	5383	5525	5667	5808	5950	6092	6233	6375
45.0	5250	5400	5550	5700	5850	6000	6150	6300	6450	6600	6750
47.5	5542	5700	5858	6017	6175	6333	6492	6650	6808	6967	7125
50.0	5833	6000	6167	6333	6500	6667	6833	7000	7167	7333	7500
52.5	6125	6300	6475	6650	6825	7000	7175	7350	7525	7700	7875
55.0	6417	6600	6783	6967	7150	7333	7517	7700	7883	8067	8250
57.5	6708	6900	7092	7283	7475	7667	7858	8050	8242	8433	8625
60.0	7000	7200	7400	7600	7800	8000	8200	8400	8600	8800	9000
62.5	7292	7500	7708	7917	8125	8333	8542	8750	8958	9167	9375
65.0	7583	7800	8017	8233	8450	8667	8883	9100	9317	9533	9750
67.5	7875	8100	8325	8550	8775	9000	9225	9450	9675	9900	10125
70.0	8167	8400	8633	8867	9100	9333	9567	9800	10033	10267	10500
72.5	8458	8700	8942	9183	9425	9667	9908	10150	10392	10633	10875
75.0	8750	9000	9250	9500	9750	10000	10250	10500	10750	11000	11250
77.5	9042	9300	9558	9817	10075	10333	10592	10850	11108	11367	11625
80.0	9333	9600	9867	10133	10400	10667	10933	11200	11467	11733	12000
82.5	9625	9900	10175	10450	10725	11000	11275	11550	11825	12100	12375
85.0	9917	10200	10483	10767	11050	11333	11617	11900	12183	12467	12750
87.5	10208	10500	10792	11083	11375	11667	11958	12250	12542	12833	13125
90.0	10500	10800	11100	11400	11700	12000	12300	12600	12900	13200	13500
92.5	10792	11100	11408	11717	12025	12333	12642	12950	13258	13567	13875
95.0	11083	11400	11717	12033	12350	12667	12983	13300	13617	13933	14250
97.5	11375	11700	12025	12350	12675	13000	13325	13650	13975	14300	14625
100.0	11667	12000	12333	12667	13000	13333	13367	14000	14333	14667	15000

AGGREGATE DELIVERY CONVERSION TABLE

	Tons/Hour										
%	450	460	470	480	490	500	510	520	530	540	550
	Pounds/Minute										
2.5	375	383	392	400	408	417	425	433	442	450	458
5.0	750	767	783	800	817	833	850	867	883	900	917
7.5	1125	1150	1175	1200	1225	1250	1275	1300	1325	1350	1375
10.0	1500	1533	1567	1600	1633	1667	1700	1733	1767	1800	1833
12.5	1875	1917	1958	2000	2042	2083	2125	2167	2208	2250	2292
15.0	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700	2750
17.5	2625	2683	2742	2800	2858	2917	2975	3033	3092	3150	3208
20.0	3000	3067	3133	3200	3267	3333	3400	3467	3533	3600	3667
22.5	3375	3450	3525	3600	3675	3750	3825	3900	3975	4050	4125
25.0	3750	3833	3917	4000	4083	4167	4250	4333	4417	4500	4583
27.5	4125	4217	4308	4400	4492	4583	4675	4767	4858	4950	5042
30.0	4500	5600	5700	4800	4900	5000	5100	5200	5300	5400	5500
32.5	4875	4983	5092	5200	5308	5417	5525	5633	5742	5850	5958
35.0	5250	5367	5483	5600	5717	5833	5950	6067	6183	6300	6417
37.5	5625	5750	5875	6000	6125	6250	6375	6500	6625	6750	6875
40.0	6000	6133	6267	6400	6533	6667	6800	6933	7067	7200	7333
42.5	6375	6517	6658	6800	6942	7083	7225	7367	7508	7650	7792
45.0	6750	6900	7050	7200	7350	7500	7650	7800	7950	8100	8250
47.5	7125	7283	7442	7600	7758	7917	8075	8233	8392	8550	8708
50.0	7500	7667	7833	8000	8167	8333	8500	8667	8833	9000	9167
52.5	7875	8050	8225	8400	8575	8750	8925	9100	9275	9450	9625
55.0	8250	8433	8617	8800	8983	9167	9350	9533	9717	9900	10083
57.5	8625	8817	9008	9200	9392	9583	9775	9967	10158	10350	10542
60.0	9000	9200	9400	9600	9800	10000	10200	10400	10600	10800	11000
62.5	9375	9583	9792	10000	10208	10417	10625	10833	11042	11250	11458
65.0	9750	9967	10183	10400	10617	10833	11050	11267	11483	11700	11917
67.5	10125	10350	10575	10800	11025	11250	11475	11700	11925	12150	12375
70.0	10500	10733	10967	11200	11433	11667	11900	12133	12367	12600	12833
72.5	10875	11117	11358	11600	11842	12083	12325	12567	12808	13050	13292
75.0	11250	11500	11750	12000	12250	12500	12750	13000	13250	13500	13750
77.5	11625	11883	12142	12400	12658	12917	13175	13433	13692	13950	14208
80.0	12000	12267	12533	12800	13067	13333	13600	13867	14133	14400	14667
82.5	12375	12650	12925	13200	13475	13750	14025	14300	14575	14850	16125
85.0	12750	13033	13317	13600	13883	14167	14450	14733	15017	15300	15583
87.5	13125	13417	13708	14000	14292	14583	14875	15167	15458	15750	16042
90.0	13500	13800	14100	14400	14700	15000	15300	15600	15900	16200	16500
92.5	13875	14183	14492	14800	15108	15417	15725	16033	16342	16650	16958
95.0	14250	14567	14883	15200	15517	15833	16150	16467	16783	17100	17417
97.5	14625	14950	15275	15600	15925	16250	16575	16900	17225	17550	17875
100.0	15000	15333	15667	16000	16333	16667	17000	17333	17667	18000	18333

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**
	Kilograms/Minute										
2.5	19	21	23	25	27	29	31	33	35	38	40
5.0	38	42	46	50	54	58	63	67	71	75	79
7.5	56	63	69	75	81	88	94	100	106	113	119
10.0	75	83	92	100	108	117	125	133	142	150	158
12.5	94	104	115	125	135	146	156	167	177	188	198
15.0	113	125	138	150	163	175	188	200	213	225	238
17.5	131	146	160	175	190	204	219	233	248	263	277
20.0	150	167	183	200	217	233	250	267	283	300	317
22.5	169	188	206	225	244	263	281	300	319	338	356
25.0	188	208	229	250	271	292	313	333	354	375	396
27.5	206	229	252	275	298	321	344	367	390	413	435
30.0	225	250	275	300	325	350	375	400	425	450	475
32.5	244	271	298	325	352	379	406	433	460	488	515
35.0	263	292	321	350	379	408	438	467	496	525	554
37.5	281	313	344	375	406	438	469	500	531	563	594
40.0	300	333	367	400	433	467	500	533	567	600	633
42.5	319	354	390	425	460	496	531	567	602	638	673
45.0	338	375	413	450	488	525	563	600	638	675	713
47.5	356	396	435	475	515	554	594	633	673	713	752
50.0	375	417	458	500	542	583	625	667	708	750	792
52.5	394	438	481	525	569	613	656	700	744	788	831
55.0	413	458	504	550	596	642	688	733	779	825	871
57.5	431	479	527	575	623	671	719	767	815	863	910
60.0	450	500	550	600	650	700	750	800	850	900	950
62.5	469	521	573	625	677	729	781	833	885	938	990
65.0	488	542	596	650	704	758	813	867	921	975	1029
67.5	506	563	619	675	731	788	844	900	956	1013	1069
70.0	525	583	642	700	758	817	875	933	992	1050	1108
72.5	544	604	665	725	785	846	906	967	1027	1088	1148
75.0	563	625	688	750	813	875	938	1000	1063	1125	1188
77.5	581	646	710	775	840	904	969	1033	1098	1163	1227
80.0	600	667	733	800	867	933	1000	1067	1133	1200	1267
82.5	619	688	756	825	894	963	1031	1100	1169	1238	1306
85.0	638	708	779	850	921	992	1063	1133	1204	1275	1346
87.5	656	729	802	875	948	1021	1094	1167	1240	1313	1385
90.0	675	750	825	900	975	1050	1125	1200	1275	1350	1425
92.5	694	771	848	925	1002	1079	1156	1233	1310	1388	1465
95.0	713	792	871	950	1029	1108	1188	1267	1346	1425	1504
97.5	731	813	894	975	1056	1138	1219	1300	1381	1463	1544
100.0	750	833	917	1000	1083	1167	1250	1333	1417	1500	1583

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**
	Kilograms/Minute										
2.5	42	44	46	48	50	52	54	56	58	60	63
5.0	83	88	92	96	100	104	108	113	117	121	125
7.5	125	131	138	144	150	156	163	169	175	181	188
10.0	167	175	183	192	200	208	217	225	233	242	250
12.5	208	219	229	240	250	260	271	281	292	302	313
15.0	250	263	275	288	300	313	325	338	350	363	375
17.5	292	306	321	335	350	365	379	394	408	423	438
20.0	333	350	367	383	400	417	433	450	467	483	500
22.5	375	394	413	431	450	469	488	506	525	544	563
25.0	417	438	458	479	500	521	542	563	583	604	625
27.5	458	481	504	527	550	573	596	619	642	665	688
30.0	500	525	550	575	600	625	650	675	700	725	750
32.5	542	569	596	623	650	677	704	731	758	785	813
35.0	583	613	642	671	700	729	758	788	817	846	875
37.5	625	656	688	719	750	781	813	844	875	906	938
40.0	667	700	733	767	800	833	867	900	933	967	1000
42.5	708	744	779	815	850	885	921	956	992	1027	1063
45.0	750	788	825	863	900	938	975	1013	1050	1088	1125
47.5	792	831	871	910	950	990	1029	1069	1108	1148	1188
50.0	833	875	917	958	1000	1042	1083	1125	1167	1208	1250
52.5	875	919	963	1006	1050	1094	1138	1181	1225	1269	1313
55.0	917	963	1008	1054	1100	1146	1192	1238	1283	1329	1375
57.5	958	1006	1054	1102	1150	1198	1246	1294	1342	1390	1438
60.0	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
62.5	1042	1094	1146	1198	1250	1302	1354	1406	1458	1510	1563
65.0	1083	1138	1192	1246	1300	1354	1408	1463	1517	1571	1625
67.5	1125	1181	1238	1294	1350	1406	1463	1519	1575	1631	1688
70.0	1167	1225	1283	1342	1400	1458	1517	1575	1633	1692	1750
72.5	1208	1269	1329	1390	1450	1510	1571	1631	1692	1752	1813
75.0	1250	1313	1375	1438	1500	1563	1625	1688	1750	1813	1875
77.5	1292	1356	1421	1485	1550	1615	1679	1744	1808	1873	1938
80.0	1333	1400	1467	1533	1600	1667	1733	1800	1867	1933	2000
82.5	1375	1444	1513	1581	1650	1719	1788	1856	1925	1994	2063
85.0	1417	1488	1558	1629	1700	1771	1842	1913	1983	2054	2125
87.5	1458	1531	1604	1677	1750	1823	1896	1969	2042	2115	2188
90.0	1500	1575	1650	1725	1800	1875	1950	2025	2100	2175	2250
92.5	1542	1619	1696	1773	1850	1927	2004	2081	2158	2235	2313
95.0	1583	1663	1742	1821	1900	1979	2058	2138	2217	2296	2375
97.5	1625	1706	1788	1869	1950	2031	2113	2194	2275	2356	2438
100.0	1667	1750	1833	1917	2000	2083	2167	2250	2333	2417	2500

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	**155**	**160**	**165**	**170**	**175**	**180**	**185**	**190**	**195**	**200**	**205**
	Kilograms/Minute										
2.5	65	67	69	71	73	75	77	79	81	83	85
5.0	129	133	138	142	146	150	154	158	163	167	171
7.5	194	200	206	213	219	225	231	238	244	250	256
10.0	258	267	275	283	292	300	308	317	325	333	342
12.5	323	333	344	354	365	375	385	396	406	417	427
15.0	388	400	413	425	438	450	463	475	488	500	513
17.5	452	467	481	496	510	525	540	554	569	583	598
20.0	517	533	550	567	583	600	617	633	650	667	683
22.5	581	600	619	638	656	675	694	713	731	750	769
25.0	646	667	688	708	729	750	771	792	813	833	854
27.5	710	733	756	779	802	825	848	871	894	917	940
30.0	775	800	825	850	875	900	925	950	975	1000	1025
32.5	840	867	894	921	948	975	1002	1029	1056	1083	1110
35.0	904	933	963	992	1021	1050	1079	1108	1138	1167	1196
37.5	969	1000	1031	1063	1094	1125	1156	1188	1219	1250	1281
40.0	1033	1067	1100	1133	1167	1200	1233	1267	1300	1333	1367
42.5	1098	1133	1169	1204	1240	1275	1310	1346	1381	1417	1452
45.0	1163	1200	1238	1275	1313	1350	1388	1425	1463	1500	1538
47.5	1227	1267	1306	1346	1385	1425	1465	1504	1544	1583	1623
50.0	1292	1333	1375	1417	1458	1500	1542	1583	1625	1667	1708
52.5	1356	1400	1444	1488	1531	1575	1619	1663	1706	1750	1794
55.0	1421	1467	1513	1558	1604	1650	1696	1742	1788	1833	1879
57.5	1485	1533	1581	1629	1677	1725	1773	1821	1869	1917	1965
60.0	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050
62.5	1615	1667	1719	1771	1823	1875	1927	1979	2031	2083	2135
65.0	1679	1733	1788	1842	1896	1950	2004	2058	2113	2167	2221
67.5	1744	1800	1856	1913	1969	2025	2081	2138	2194	2250	2306
70.0	1808	1867	1925	1983	2042	2100	2158	2217	2275	2333	2392
72.5	1873	1933	1994	2054	2115	2175	2235	2296	2356	2417	2477
75.0	1938	2000	2063	2125	2188	2250	2313	2375	2438	2500	2563
77.5	2002	2067	2131	2196	2260	2325	2390	2454	2519	2583	2648
80.0	2067	2133	2200	2267	2333	2400	2467	2533	2600	2667	2733
82.5	2131	2200	2269	2338	2406	2475	2544	2613	2681	2750	2819
85.0	2196	2267	2338	2408	2479	2550	2621	2692	2763	2833	2904
87.5	2260	2333	2406	2479	2552	2625	2698	2771	2844	2917	2990
90.0	2325	2400	2475	2550	2625	2700	2775	2850	2925	3000	3075
92.5	2390	2467	2544	2621	2698	2775	2852	2929	3006	3083	3160
95.0	2454	2533	2613	2692	2771	2850	2929	3008	3088	3167	3246
97.5	2519	2600	2681	2763	2844	2925	3006	3088	3169	3250	3331
100.0	2583	2667	2750	2833	2917	3000	3083	3167	3250	3333	3417

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	210	215	220	225	230	235	240	245	250	255	260
	Kilograms/Minute										
2.5	88	90	92	94	96	98	100	102	104	106	108
5.0	175	179	183	188	192	196	200	204	208	213	217
7.5	263	269	275	281	288	294	300	306	313	319	325
10.0	350	358	367	375	383	392	400	408	417	425	433
12.5	438	448	458	469	479	490	500	510	521	531	542
15.0	525	538	550	563	575	588	600	613	625	638	650
17.5	613	627	642	656	671	685	700	715	729	744	758
20.0	700	717	733	750	767	783	800	817	833	850	867
22.5	788	806	825	844	863	881	900	919	938	956	975
25.0	875	896	917	938	958	979	1000	1021	1042	1063	1083
27.5	963	985	1008	1031	1054	1077	1100	1123	1146	1169	1192
30.0	1050	1075	1100	1125	1150	1175	1200	1225	1250	1275	1300
32.5	1138	1165	1192	1219	1246	1273	1300	1327	1354	1381	1408
35.0	1225	1254	1283	1313	1342	1371	1400	1429	1458	1488	1517
37.5	1313	1344	1375	1406	1438	1469	1500	1531	1563	1594	1625
40.0	1400	1433	1467	1500	1533	1567	1600	1633	1667	1700	1733
42.5	1488	1523	1558	1594	1629	1665	1700	1735	1771	1806	1842
45.0	1575	1613	1650	1688	1725	1763	1800	1838	1875	1913	1950
47.5	1663	1702	1742	1781	1821	1860	1900	1940	1979	2019	2058
50.0	1750	1792	1833	1875	1917	1958	2000	2042	2083	2125	2167
52.5	1838	1881	1925	1969	2013	2056	2100	2144	2188	2231	2275
55.0	1925	1971	2017	2063	2108	2154	2200	2246	2292	2338	2383
57.5	2013	2060	2108	2156	2204	2252	2300	2348	2396	2444	2492
60.0	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600
62.5	2188	2240	2292	2344	2396	2448	2500	2552	2604	2656	2708
65.0	2275	2329	2383	2438	2492	2546	2600	2654	2708	2763	2817
67.5	2363	2419	2475	2531	2588	2644	2700	2756	2813	2869	2925
70.0	2450	2508	2567	2625	2683	2742	2800	2858	2917	2975	3033
72.5	2538	2598	2658	2719	2779	2840	2900	2960	3021	3081	3142
75.0	2625	2688	2750	2813	2875	2938	3000	3063	3125	3188	3250
77.5	2713	2777	2842	2906	2971	3035	3100	3165	3229	3294	3358
80.0	2800	2867	2933	3000	3067	3133	3200	3267	3333	3400	3467
82.5	2888	2956	3025	3094	3163	3231	3300	3369	3438	3506	3575
85.0	2975	3046	3117	3188	3258	3329	3400	3471	3542	3613	3683
87.5	3063	3135	3208	3281	3354	3427	3500	3573	3646	3719	3792
90.0	3150	3225	3300	3375	3450	3525	3600	3675	3750	3825	3900
92.5	3238	3315	3392	3469	3546	3623	3700	3777	3854	3931	4008
95.0	3325	3404	3483	3563	3642	3721	3800	3879	3958	4038	4117
97.5	3413	3494	3575	3656	3738	3819	3900	3981	4063	4144	4225
100.0	3500	3583	3667	3750	3833	3917	4000	4083	4167	4250	4333

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	265	270	275	280	285	290	295	300	305	310	315
	Kilograms/Minute										
2.5	110	113	115	117	119	121	123	125	127	129	131
5.0	221	225	229	233	238	242	246	250	254	258	263
7.5	331	338	344	350	356	363	369	375	381	388	394
10.0	442	450	458	467	475	483	492	500	508	517	525
12.5	552	563	573	583	594	604	615	625	635	646	656
15.0	663	675	688	700	713	725	738	750	763	775	788
17.5	773	788	802	817	831	846	860	875	890	904	919
20.0	883	900	917	933	950	967	983	1000	1017	1033	1050
22.5	994	1013	1031	1050	1069	1088	1106	1125	1144	1163	1181
25.0	1104	1125	1146	1167	1188	1208	1229	1250	1271	1292	1313
27.5	1215	1238	1260	1283	1306	1329	1352	1375	1398	1421	1444
30.0	1325	1350	1375	1400	1425	1450	1475	1500	1525	1550	1575
32.5	1435	1463	1490	1517	1544	1571	1598	1625	1652	1679	1706
35.0	1546	1575	1604	1633	1663	1692	1721	1750	1779	1808	1838
37.5	1656	1688	1719	1750	1781	1813	1844	1875	1906	1938	1969
40.0	1767	1800	1833	1867	1900	1933	1967	2000	2033	2067	2100
42.5	1877	1913	1948	1983	2019	2054	2090	2125	2160	2196	2231
45.0	1988	2025	2063	2100	2138	2175	2213	2250	2288	2325	2363
47.5	2098	2138	2177	2217	2256	2296	2335	2375	2415	2454	2494
50.0	2208	2250	2292	2333	2375	2417	2458	2500	2542	2583	2625
52.5	2319	2363	2406	2450	2494	2538	2581	2625	2669	2713	2756
55.0	2429	2475	2521	2567	2613	2658	2704	2750	2796	2842	2888
57.5	2540	2588	2635	2683	2731	2779	2827	2875	2923	2971	3019
60.0	2650	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150
62.5	2760	2813	2865	2917	2969	3021	3073	3125	3177	3229	3281
65.0	2871	2925	2979	3033	3088	3142	3196	3250	3304	3358	3413
67.5	2981	3038	3094	3150	3206	3263	3319	3375	3431	3488	3544
70.0	3092	3150	3208	3267	3325	3383	3442	3500	3558	3617	3675
72.5	3202	3263	3323	3383	3444	3504	3565	3625	3685	3746	3806
75.0	3313	3375	3438	3500	3563	3625	3688	3750	3813	3875	3938
77.5	3423	3488	3552	3617	3681	3746	3810	3875	3940	4004	4069
80.0	3533	3600	3667	3733	3800	3867	3933	4000	4067	4133	4200
82.5	3644	3713	3781	3850	3919	3988	4056	4125	4194	4263	4331
85.0	3754	3825	3896	3967	4038	4108	4179	4250	4321	4392	4463
87.5	3865	3938	4010	4083	4156	4229	4302	4375	4448	4521	4594
90.0	3975	4050	4125	4200	4275	4350	4425	4500	4575	4650	4725
92.5	4085	4163	4240	4317	4394	4471	4548	4625	4702	4779	4856
95.0	4196	4275	4354	4433	4513	4592	4671	4750	4829	4908	4988
97.5	4306	4388	4469	4550	4631	4713	4794	4875	4956	5038	5119
100.0	4417	4500	4583	4667	4750	4833	4917	5000	5083	5167	5250

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	**320**	**325**	**330**	**335**	**340**	**345**	**350**	**355**	**360**	**365**	**370**
	Kilograms/Minute										
2.5	133	135	138	140	142	144	146	148	150	152	154
5.0	267	271	275	279	283	288	292	296	300	304	308
7.5	400	406	413	419	425	431	438	444	450	456	463
10.0	533	542	550	558	567	575	583	592	600	608	617
12.5	667	677	688	698	708	719	729	740	750	760	771
15.0	800	813	825	838	850	863	875	888	900	913	925
17.5	933	948	963	977	992	1006	1021	1035	1050	1065	1079
20.0	1067	1083	1100	1117	1133	1150	1167	1183	1200	1217	1233
22.5	1200	1219	1238	1256	1275	1294	1313	1331	1350	1369	1388
25.0	1333	1354	1375	1396	1417	1438	1458	1479	1500	1521	1542
27.5	1467	1490	1513	1535	1558	1581	1604	1627	1650	1673	1696
30.0	1600	1625	1650	1675	1700	1725	1750	1775	1800	1825	1850
32.5	1733	1760	1788	1815	1842	1869	1896	1923	1950	1977	2004
35.0	1867	1896	1925	1954	1983	2013	2042	2071	2100	2129	2158
37.5	2000	2031	2063	2094	2125	2156	2188	2219	2250	2281	2313
40.0	2133	2167	2200	2233	2267	2300	2333	2367	2400	2433	2467
42.5	2267	2302	2338	2373	2408	2444	2479	2515	2550	2585	2621
45.0	2400	2438	2475	2513	2550	2588	2625	2663	2700	2738	2775
47.5	2533	2573	2613	2652	2692	2731	2771	2810	2850	2890	2929
50.0	2667	2708	2750	2792	2833	2875	2917	2958	3000	3042	3083
52.5	2800	2844	2888	2931	2975	3019	3063	3106	3150	3194	3238
55.0	2933	2979	3025	3071	3117	3163	3208	3254	3300	3346	3392
57.5	3067	3115	3163	3210	3258	3306	3354	3402	3450	3498	3546
60.0	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650	3700
62.5	3333	3385	3438	3490	3542	3594	3646	3698	3750	3802	3854
65.0	3467	3521	3575	3629	3683	3738	3792	3846	3900	3954	4008
67.5	3600	3656	3713	3769	3825	3881	3938	3994	4050	4106	4163
70.0	3733	3792	3850	3908	3967	4025	4083	4142	4200	4258	4317
72.5	3867	3927	3988	4048	4108	4169	4229	4290	4350	4410	4471
75.0	4000	4063	4125	4188	4250	4313	4375	4438	4500	4563	4625
77.5	4133	4198	4263	4327	4392	4456	4521	4585	4650	4715	4779
80.0	4267	4333	4400	4467	4533	4600	4667	4733	4800	4867	4933
82.5	4400	4469	4538	4606	4675	4744	4813	4881	4950	5019	5088
85.0	4533	4604	4675	4746	4817	4888	4958	5029	5100	5171	5242
87.5	4667	4740	4813	4885	4958	5031	5104	5177	5250	5323	5396
90.0	4800	4875	4950	5025	5100	5175	5250	5325	5400	5475	5550
92.5	4933	5010	5088	5165	5242	5319	5396	5473	5550	5627	5704
95.0	5067	5146	5225	5304	5383	5463	5542	5621	5700	5779	5858
97.5	5200	5281	5363	5444	5525	5606	5688	5769	5850	5931	6013
100.0	5333	5417	5500	5583	5667	5750	5833	5917	6000	6083	6167

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	375	380	385	390	395	400	405	410	415	420	425
	Kilograms/Minute										
2.5	156	158	160	163	165	167	169	171	173	175	177
5.0	313	317	321	325	329	333	338	342	346	350	354
7.5	469	475	481	488	494	500	506	513	519	525	531
10.0	625	633	642	650	658	667	675	683	692	700	708
12.5	781	792	802	813	823	833	844	854	865	875	885
15.0	938	950	963	975	988	1000	1013	1025	1038	1050	1063
17.5	1094	1108	1123	1138	1152	1167	1181	1196	1210	1225	1240
20.0	1250	1267	1283	1300	1317	1333	1350	1367	1383	1400	1417
22.5	1406	1425	1444	1463	1481	1500	1519	1538	1556	1575	1594
25.0	1563	1583	1604	1625	1646	1667	1688	1708	1729	1750	1771
27.5	1719	1742	1765	1788	1810	1833	1856	1879	1902	1925	1948
30.0	1875	1900	1925	1950	1975	2000	2025	2050	2075	2100	2125
32.5	2031	2058	2085	2113	2140	2167	2194	2221	2248	2275	2302
35.0	2188	2217	2246	2275	2304	2333	2363	2392	2421	2450	2479
37.5	2344	2375	2406	2438	2469	2500	2531	2563	2594	2625	2656
40.0	2500	2533	2567	2600	2633	2667	2700	2733	2767	2800	2833
42.5	2656	2692	2727	2763	2798	2833	2869	2904	2940	2975	3010
45.0	2813	2850	2888	2925	2963	3000	3038	3075	3113	3150	3188
47.5	2969	3008	3048	3088	3127	3167	3206	3246	3285	3325	3365
50.0	3125	3167	3208	3250	3292	3333	3375	3417	3458	3500	3542
52.5	3281	3325	3369	3413	3456	3500	3544	3588	3631	3675	3719
55.0	3438	3483	3529	3575	3621	3667	3713	3758	3804	3850	3896
57.5	3594	3642	3690	3738	3785	3833	3881	3929	3977	4025	4073
60.0	3750	3800	3850	3900	3950	4000	4050	4100	4150	4200	4250
62.5	3906	3958	4010	4063	4115	4167	4219	4271	4323	4375	4427
65.0	4063	4117	4171	4225	4279	4333	4388	4442	4496	4550	4604
67.5	4219	4275	4331	4388	4444	4500	4556	4613	4669	4725	4781
70.0	4375	4433	4492	4550	4608	4667	4725	4783	4842	4900	4958
72.5	4531	4592	4652	4713	4773	4833	4894	4954	5015	5075	5135
75.0	4688	4750	4813	4875	4938	5000	5063	5125	5188	5250	5313
77.5	4844	4908	4973	5038	5102	5167	5231	5296	5360	5425	5490
80.0	5000	5067	5133	5200	5267	5333	5400	5467	5533	5600	5667
82.5	5156	5225	5294	5363	5431	5500	5569	5638	5706	5775	5844
85.0	5313	5383	5454	5525	5596	5667	5738	5808	5879	5950	6021
87.5	5469	5542	5615	5688	5760	5833	5906	5979	6052	6125	6198
90.0	5625	5700	5775	5850	5925	6000	6075	6150	6225	6300	6375
92.5	5781	5858	5935	6013	6090	6167	6244	6321	6398	6475	6552
95.0	5938	6017	6096	6175	6254	6333	6413	6492	6571	6650	6729
97.5	6094	6175	6256	6338	6419	6500	6581	6663	6744	6825	6906
100.0	6250	6333	6417	6500	6583	6667	6750	6833	6917	7000	7083

AGGREGATE DELIVERY CONVERSION TABLE

	Megagrams/Hour										
%	430	435	440	445	450	455	460	465	470	475	480
	Kilograms/Minute										
2.5	179	181	183	185	188	190	192	194	196	198	200
5.0	358	363	367	371	375	379	383	388	392	396	400
7.5	538	544	550	556	563	569	575	581	588	594	600
10.0	717	725	733	742	750	758	767	775	783	792	800
12.5	896	906	917	927	938	948	958	969	979	990	1000
15.0	1075	1088	1100	1113	1125	1138	1150	1163	1175	1188	1200
17.5	1254	1269	1283	1298	1313	1327	1342	1356	1371	1385	1400
20.0	1433	1450	1467	1483	1500	1517	1533	1550	1567	1583	1600
22.5	1613	1631	1650	1669	1688	1706	1725	1744	1763	1781	1800
25.0	1792	1813	1833	1854	1875	1896	1917	1938	1958	1979	2000
27.5	1971	1994	2017	2040	2063	2085	2108	2131	2154	2177	2200
30.0	2150	2175	2200	2225	2250	2275	2300	2325	2350	2375	2400
32.5	2329	2356	2383	2410	2438	2465	2492	2519	2546	2573	2600
35.0	2508	2538	2567	2596	2625	2654	2683	2713	2742	2771	2800
37.5	2688	2719	2750	2781	2813	2844	2875	2906	2938	2969	3000
40.0	2867	2900	2933	2967	3000	3033	3067	3100	3133	3167	3200
42.5	3046	3081	3117	3152	3188	3223	3258	3294	3329	3365	3400
45.0	3225	3263	3300	3338	3375	3413	3450	3488	3525	3563	3600
47.5	3404	3444	3483	3523	3563	3602	3642	3681	3721	3760	3800
50.0	3583	3625	3667	3708	3750	3792	3833	3875	3917	3958	4000
52.5	3763	3806	3850	3894	3938	3981	4025	4069	4113	4156	4200
55.0	3942	3988	4033	4079	4125	4171	4217	4263	4308	4354	4400
57.5	4121	4169	4217	4265	4313	4360	4408	4456	4504	4552	4600
60.0	4300	4350	4400	4450	4500	4550	4600	4650	4700	4750	4800
62.5	4479	4531	4583	4635	4688	4740	4792	4844	4896	4948	5000
65.0	4658	4713	4767	4821	4875	4929	4983	5038	5092	5146	5200
67.5	4838	4894	4950	5006	5063	5119	5175	5231	5288	5344	5400
70.0	5017	5075	5133	5192	5250	5308	5367	5425	5483	5542	5600
72.5	5196	5256	5317	5377	5438	5498	5558	5619	5679	5740	5800
75.0	5375	5438	5500	5563	5625	5688	5750	5813	5875	5938	6000
77.5	5554	5619	5683	5748	5813	5877	5942	6006	6071	6135	6200
80.0	5733	5800	5867	5933	6000	6067	6133	6200	6267	6333	6400
82.5	5913	5981	6050	6119	6188	6256	6325	6394	6463	6531	6600
85.0	6092	6163	6233	6304	6375	6446	6517	6588	6658	6729	6800
87.5	6271	6344	6417	6490	6563	6635	6708	6781	6854	6927	7000
90.0	6450	6525	6600	6675	6750	6825	6900	6975	7050	7125	7200
92.5	6629	6706	6783	6860	6938	7015	7092	7169	7246	7323	7400
95.0	6808	6888	6967	7046	7125	7204	7283	7363	7442	7521	7600
97.5	6988	7069	7150	7231	7313	7394	7475	7556	7638	7719	7800
100.0	7167	7250	7333	7417	7500	7583	7667	7750	7833	7917	8000

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (CUSTOMARY UNITS)

GROUP 0 – SPECIFIC GRAVITY AT 60°F ABOVE 0.966
LEGEND: t = Observed Temperature in Degrees Fahrenheit
M = Multiplier for Correcting Oil Volumes to the Basis of 60°F

t	M	t	M	t	M	t	M	t	M
0	1.0211	**50**	1.0035	**100**	0.9861	**150**	0.9689	**200**	0.9520
1	1.0208	**51**	1.0031	**101**	0.9857	**151**	0.9686	**201**	0.9516
2	1.0204	**52**	1.0028	**102**	0.9854	**152**	0.9682	**202**	0.9513
3	1.0201	**53**	1.0024	**103**	0.9851	**153**	0.9679	**203**	0.9509
4	1.0197	**54**	1.0021	**104**	0.9847	**154**	0.9675	**204**	0.9506
5	1.0194	**55**	1.0017	**105**	0.9844	**155**	0.9672	**205**	0.9503
6	1.0190	**56**	1.0014	**106**	0.9840	**156**	0.9669	**206**	0.9499
7	1.0186	**57**	1.0010	**107**	0.9837	**157**	0.9665	**207**	0.9496
8	1.0183	**58**	1.0007	**108**	0.9833	**158**	0.9662	**208**	0.9493
9	1.0179	**59**	1.0003	**109**	0.9830	**159**	0.9658	**209**	0.9489
10	1.0176	**60**	1.0000	**110**	0.9826	**160**	0.9655	**210**	0.9486
11	1.0172	**61**	0.9997	**111**	0.9823	**161**	0.9652	**211**	0.9483
12	1.0169	**62**	0.9993	**112**	0.9819	**162**	0.9648	**212**	0.9479
13	1.0165	**63**	0.9990	**113**	0.9816	**163**	0.9645	**213**	0.9476
14	1.0162	**64**	0.9986	**114**	0.9813	**164**	0.9641	**214**	0.9472
15	1.0158	**65**	0.9983	**115**	0.9809	**165**	0.9638	**215**	0.9469
16	1.0155	**66**	0.9979	**116**	0.9806	**166**	0.9635	**216**	0.9466
17	1.0151	**67**	0.9976	**117**	0.9802	**167**	0.9631	**217**	0.9462
18	1.0148	**68**	0.9972	**118**	0.9799	**168**	0.9628	**218**	0.9459
19	1.0144	**69**	0.9969	**119**	0.9795	**169**	0.9624	**219**	0.9456
20	1.0141	**70**	0.9965	**120**	0.9792	**170**	0.9621	**220**	0.9452
21	1.0137	**71**	0.9962	**121**	0.9788	**171**	0.9618	**221**	0.9449
22	1.0133	**72**	0.9958	**122**	0.9785	**172**	0.9614	**222**	0.9446
23	1.0130	**73**	0.9955	**123**	0.9782	**173**	0.9611	**223**	0.9442
24	1.0126	**74**	0.9951	**124**	0.9778	**174**	0.9607	**224**	0.9439
25	1.0123	**75**	0.9948	**125**	0.9775	**175**	0.9604	**225**	0.9436
26	1.0119	**76**	0.9944	**126**	0.9771	**176**	0.9601	**226**	0.9432
27	1.0116	**77**	0.9941	**127**	0.9768	**177**	0.9597	**227**	0.9429
28	1.0112	**78**	0.9937	**128**	0.9764	**178**	0.9594	**228**	0.9426
29	1.0109	**79**	0.9934	**129**	0.9761	**179**	0.9590	**229**	0.9422
30	1.0105	**80**	0.9930	**130**	0.9758	**180**	0.9587	**230**	0.9419
31	1.0102	**81**	0.9927	**131**	0.9754	**181**	0.9584	**231**	0.9416
32	1.0098	**82**	0.9923	**132**	0.9751	**182**	0.9580	**232**	0.9412
33	1.0095	**83**	0.9920	**133**	0.9747	**183**	0.9577	**233**	0.9409
34	1.0091	**84**	0.9916	**134**	0.9744	**184**	0.9574	**234**	0.9405
35	1.0088	**85**	0.9913	**135**	0.9740	**185**	0.9570	**235**	0.9402
36	1.0084	**86**	0.9909	**136**	0.9737	**186**	0.9567	**236**	0.9399
37	1.0081	**87**	0.9906	**137**	0.9734	**187**	0.9563	**237**	0.9395
38	1.0077	**88**	0.9902	**138**	0.9730	**188**	0.9560	**238**	0.9392
39	1.0074	**89**	0.9899	**139**	0.9727	**189**	0.9557	**239**	0.9389
40	1.0070	**90**	0.9896	**140**	0.9723	**190**	0.9553	**240**	0.9385
41	1.0067	**91**	0.9892	**141**	0.9720	**191**	0.9550	**241**	0.9382
42	1.0063	**92**	0.9889	**142**	0.9716	**192**	0.9547	**242**	0.9379
43	1.0060	**93**	0.9885	**143**	0.9713	**193**	0.9543	**243**	0.9375
44	1.0056	**94**	0.9882	**144**	0.9710	**194**	0.9540	**244**	0.9372
45	1.0053	**95**	0.9878	**145**	0.9706	**195**	0.9536	**245**	0.9369
46	1.0049	**96**	0.9875	**146**	0.9703	**196**	0.9533	**246**	0.9365
47	1.0046	**97**	0.9871	**147**	0.9699	**197**	0.9530	**247**	0.9362
48	1.0042	**98**	0.9868	**148**	0.9696	**198**	0.9526	**248**	0.9359
49	1.0038	**99**	0.9864	**149**	0.9693	**199**	0.9523	**249**	0.9356

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (CUSTOMARY UNITS)

GROUP 0 – SPECIFIC GRAVITY AT 60°F ABOVE 0.966
LEGEND: t = Observed Temperature in Degrees Fahrenheit
M = Multiplier for Correcting Oil Volumes to the Basis of 60°F

t	M	t	M	t	M	t	M	t	M
250	0.9352	**300**	0.9187	**350**	0.9024	**400**	0.8864	**450**	0.8705
251	0.9349	**301**	0.9184	**351**	0.9021	**401**	0.8861	**451**	0.8702
252	0.9346	**302**	0.9181	**352**	0.9018	**402**	0.8857	**452**	0.8699
253	0.9342	**303**	0.9177	**353**	0.9015	**403**	0.8854	**453**	0.8696
254	0.9339	**304**	0.9174	**354**	0.9011	**404**	0.8851	**454**	0.8693
255	0.9336	**305**	0.9171	**355**	0.9008	**405**	0.8848	**455**	0.8690
256	0.9332	**306**	0.9167	**356**	0.9005	**406**	0.8845	**456**	0.8687
257	0.9329	**307**	0.9164	**357**	0.9002	**407**	0.8841	**457**	0.8683
258	0.9326	**308**	0.9161	**358**	0.8998	**408**	0.8838	**458**	0.8680
259	0.9322	**309**	0.9158	**359**	0.8995	**409**	0.8835	**459**	0.8677
260	0.9319	**310**	0.9154	**360**	0.8992	**410**	0.8832	**460**	0.8674
261	0.9316	**311**	0.9151	**361**	0.8989	**411**	0.8829	**461**	0.8671
262	0.9312	**312**	0.9148	**362**	0.8986	**412**	0.8826	**462**	0.8668
263	0.9309	**313**	0.9145	**363**	0.8982	**413**	0.8822	**463**	0.8665
264	0.9306	**314**	0.9141	**364**	0.8979	**414**	0.8819	**464**	0.8661
265	0.9302	**315**	0.9138	**365**	0.8976	**415**	0.8816	**465**	0.8658
266	0.9299	**316**	0.9135	**366**	0.8973	**416**	0.8813	**466**	0.8655
267	0.9296	**317**	0.9132	**367**	0.8969	**417**	0.8810	**467**	0.8652
268	0.9293	**318**	0.9128	**368**	0.8966	**418**	0.8806	**468**	0.8649
269	0.9289	**319**	0.9125	**369**	0.8963	**419**	0.8803	**469**	0.8646
270	0.9286	**320**	0.9122	**370**	0.8960	**420**	0.8800	**470**	0.8643
271	0.9283	**321**	0.9118	**371**	0.8957	**421**	0.8797	**471**	0.8640
272	0.9279	**322**	0.9115	**372**	0.8953	**422**	0.8794	**472**	0.8636
273	0.9276	**323**	0.9112	**373**	0.8950	**423**	0.8791	**473**	0.8633
274	0.9273	**324**	0.9109	**374**	0.8947	**424**	0.8787	**474**	0.8630
275	0.9269	**325**	0.9105	**375**	0.8944	**425**	0.8784	**475**	0.8827
276	0.9266	**326**	0.9102	**376**	0.8941	**426**	0.8781	**476**	0.8624
277	0.9263	**327**	0.9099	**377**	0.8937	**427**	0.8778	**477**	0.8621
278	0.9259	**328**	0.9096	**378**	0.8934	**428**	0.8775	**478**	0.8618
279	0.9256	**329**	0.9092	**379**	0.8931	**429**	0.8772	**479**	0.8615
280	0.9253	**330**	0.9089	**380**	0.8928	**430**	0.8768	**480**	0.8611
281	0.9250	**331**	0.9086	**381**	0.8924	**431**	0.8765	**481**	0.8608
282	0.9246	**332**	0.9083	**382**	0.8921	**432**	0.8762	**482**	0.8605
283	0.9243	**333**	0.9079	**383**	0.8918	**433**	0.8759	**483**	0.8602
284	0.9240	**334**	0.9076	**384**	0.8915	**434**	0.8756	**484**	0.8599
285	0.9236	**335**	0.9073	**385**	0.8912	**435**	0.8753	**485**	0.8596
286	0.9233	**336**	0.9070	**386**	0.8908	**436**	0.8749	**486**	0.8593
287	0.9230	**337**	0.9066	**387**	0.8905	**437**	0.8746	**487**	0.8590
288	0.9227	**338**	0.9063	**388**	0.8902	**438**	0.8743	**488**	0.8587
289	0.9223	**339**	0.9060	**389**	0.8899	**439**	0.8740	**489**	0.8583
290	0.9220	**340**	0.9057	**390**	0.8896	**440**	0.8737	**490**	0.8580
291	0.9217	**341**	0.9053	**391**	0.8892	**441**	0.8734	**491**	0.8577
292	0.9213	**342**	0.9050	**392**	0.8889	**442**	0.8731	**492**	0.8574
293	0.9210	**343**	0.9047	**393**	0.8886	**443**	0.8727	**493**	0.8571
294	0.9207	**344**	0.9044	**394**	0.8883	**444**	0.8724	**494**	0.8568
295	0.9204	**345**	0.9040	**395**	0.8880	**445**	0.8721	**495**	0.8565
296	0.9200	**346**	0.9037	**396**	0.8876	**446**	0.8718	**496**	0.8562
297	0.9197	**347**	0.9034	**397**	0.8873	**447**	0.8715	**497**	0.8559
298	0.9194	**348**	0.9031	**398**	0.8870	**448**	0.8712	**498**	0.8556
299	0.9190	**349**	0.9028	**399**	0.8867	**449**	0.8709	**499**	0.8552

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (METRIC UNITS)

GROUP 0 – DENSITY AT 15°C ABOVE 0.9654

LEGEND: t = Observed Temperature in Degrees Celsius
M = Multiplier for Reducing Volume to 15°C

t	M	t	M	t	M	t	M	t	M
-25.0	1.0254	0.0	1.0095	25.0	0.9937	50.0	0.9782	75.0	0.9628
-24.5	1.0251	0.5	1.0092	25.5	0.9934	50.5	0.9779	75.5	0.9625
-24.0	1.0248	1.0	1.0089	26.0	0.9931	51.0	0.9776	76.0	0.9622
-23.5	1.0244	1.5	1.0085	26.5	0.9928	51.5	0.9773	76.5	0.9619
-23.0	1.0241	2.0	1.0082	27.0	0.9925	52.0	0.9770	77.0	0.9616
-22.5	1.0238	2.5	1.0079	27.5	0.9922	52.5	0.9767	77.5	0.9613
-22.0	1.0235	3.0	1.0076	28.0	0.9918	53.0	0.9763	78.0	0.9609
-21.5	1.0232	3.5	1.0073	28.5	0.9915	53.5	0.9760	78.5	0.9606
-21.0	1.0228	4.0	1.0069	29.0	0.9912	54.0	0.9757	79.0	0.9603
-20.5	1.0225	4.5	1.0066	29.5	0.9909	54.5	0.9754	79.5	0.9600
-20.0	1.0222	5.0	1.0063	30.0	0.9906	55.0	0.9751	80.0	0.9597
-19.5	1.0219	5.5	1.0060	30.5	0.9903	55.5	0.9748	80.5	0.9594
-19.0	1.0216	6.0	1.0057	31.0	0.9900	56.0	0.9745	81.0	0.9591
-18.5	1.0212	6.5	1.0053	31.5	0.9897	56.5	0.9742	81.5	0.9588
-18.0	1.0209	7.0	1.0050	32.0	0.9894	57.0	0.9739	82.0	0.9585
-17.5	1.0206	7.5	1.0047	32.5	0.9891	57.5	0.9736	82.5	0.9582
-17.0	1.0203	8.0	1.0044	33.0	0.9887	58.0	0.9732	83.0	0.9578
-16.5	1.0200	8.5	1.0041	33.5	0.9884	58.5	0.9729	83.5	0.9576
-16.0	1.0196	9.0	1.0037	34.0	0.9881	59.0	0.9726	84.0	0.9573
-15.5	1.0193	9.5	1.0034	34.5	0.9878	59.5	0.9723	84.5	0.9570
-15.0	1.0190	10.0	1.0031	35.0	0.9875	60.0	0.9720	85.0	0.9567
-14.5	1.0187	10.5	1.0028	35.5	0.9872	60.5	0.9717	85.5	0.9564
-14.0	1.0184	11.0	1.0025	36.0	0.9869	61.0	0.9714	86.0	0.9561
-13.5	1.0180	11.5	1.0022	36.5	0.9866	61.5	0.9711	86.5	0.9558
-13.0	1.0177	12.0	1.0019	37.0	0.9863	62.0	0.9708	87.0	0.9555
-12.5	1.0174	12.5	1.0016	37.5	0.9860	62.5	0.9705	87.5	0.9552
-12.0	1.0171	13.0	1.0012	38.0	0.9856	63.0	0.9701	88.0	0.9548
-11.5	1.0168	13.5	1.0009	38.5	0.9853	63.5	0.9698	88.5	0.9545
-11.0	1.0164	14.0	1.0006	39.0	0.9850	64.0	0.9695	89.0	0.9542
-10.5	1.0161	14.5	1.0003	39.5	0.9847	64.5	0.9692	89.5	0.9539
-10.0	1.0158	15.0	1.0000	40.0	0.9844	65.0	0.9689	90.0	0.9536
-9.5	1.0155	15.5	0.9997	40.5	0.9841	65.5	0.9686	90.5	0.9533
-9.0	1.0152	16.0	0.9994	41.0	0.9838	66.0	0.9683	91.0	0.9530
-8.5	1.0148	16.5	0.9991	41.5	0.9835	66.5	0.9680	91.5	0.9527
-8.0	1.0145	17.0	0.9988	42.0	0.9832	67.0	0.9677	92.0	0.9524
-7.5	1.0142	17.5	0.9985	42.5	0.9829	67.5	0.9674	92.5	0.9521
-7.0	1.0139	18.0	0.9981	43.0	0.9825	68.0	0.9670	93.0	0.9518
-6.5	1.0136	18.5	0.9978	43.5	0.9822	68.5	0.9667	93.5	0.9515
-6.0	1.0132	19.0	0.9975	44.0	0.9819	69.0	0.9664	94.0	0.9512
-5.5	1.0129	19.5	0.9972	44.5	0.9816	69.5	0.9661	94.5	0.9509
-5.0	1.0126	20.0	0.9969	45.0	0.9813	70.0	0.9658	95.0	0.9506
-4.5	1.0123	20.5	0.9966	45.5	0.9810	70.5	0.9655	95.5	0.9503
-4.0	1.0120	21.0	0.9963	46.0	0.9807	71.0	0.9652	96.0	0.9500
-3.5	1.0117	21.5	0.9959	46.5	0.9804	71.5	0.9649	96.5	0.9497
-3.0	1.0114	22.0	0.9956	47.0	0.9801	72.0	0.9646	97.0	0.9494
-2.5	1.0111	22.5	0.9953	47.5	0.9798	72.5	0.9643	97.5	0.9491
-2.0	1.0107	23.0	0.9950	48.0	0.9794	73.0	0.9640	98.0	0.9488
-1.5	1.0104	23.5	0.9947	48.5	0.9791	73.5	0.9637	98.5	0.9485
-1.0	1.0101	24.0	0.9943	49.0	0.9788	74.0	0.9634	99.0	0.9482
-0.5	1.0098	24.5	0.9940	49.5	0.9785	74.5	0.9631	99.5	0.9479

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (METRIC UNITS)

GROUP 0 – DENSITY AT 15°C ABOVE 0.9654
LEGEND: t = Observed Temperature in Degrees Celsius
M = Multiplier for Reducing Volume to 15°C

t	M	t	M	t	M	t	M	t	M
100.0	0.9476	125.0	0.9326	150.0	0.9177	175.0	0.9031	200.0	0.8886
100.5	0.9473	125.5	0.9323	150.5	0.9174	175.5	0.9028	200.5	0.8883
101.0	0.9470	126.0	0.9320	151.0	0.9171	176.0	0.9025	201.0	0.8880
101.5	0.9467	126.5	0.9317	151.5	0.9168	176.5	0.9022	201.5	0.8877
102.0	0.9464	127.0	0.9314	152.0	0.9165	177.0	0.9019	202.0	0.8874
102.5	0.9461	127.5	0.9311	152.5	0.9163	177.5	0.9017	202.5	0.8872
103.0	0.9458	128.0	0.9308	153.0	0.9160	178.0	0.9014	203.0	0.8869
103.5	0.9455	128.5	0.9305	153.5	0.9157	178.5	0.9011	203.5	0.8866
104.0	0.9452	129.0	0.9302	154.0	0.9154	179.0	0.9008	204.0	0.8863
104.5	0.9449	129.5	0.9299	154.5	0.9151	179.5	0.9005	204.5	0.8860
105.0	0.9446	130.0	0.9296	155.0	0.9148	180.0	0.9002	205.0	0.8857
105.5	0.9443	130.5	0.9293	155.5	0.9145	180.5	0.8999	205.5	0.8854
106.0	0.9440	131.0	0.9290	156.0	0.9142	181.0	0.8996	206.0	0.8851
106.5	0.9437	131.5	0.9287	156.5	0.9139	181.5	0.8993	206.5	0.8849
107.0	0.9434	132.0	0.9284	157.0	0.9136	182.0	0.8990	207.0	0.8846
107.5	0.9431	132.5	0.9281	157.5	0.9133	182.5	0.8988	207.5	0.8843
108.0	0.9428	133.0	0.9278	158.0	0.9130	183.0	0.8985	208.0	0.8840
108.5	0.9425	133.5	0.9275	158.5	0.9127	183.5	0.8982	208.5	0.8837
109.0	0.9422	134.0	0.9272	159.0	0.9124	184.0	0.8979	209.0	0.8835
109.5	0.9419	134.5	0.9269	159.5	0.9121	184.5	0.8976	209.5	0.8832
110.0	0.9416	135.0	0.9266	160.0	0.9118	185.0	0.8973	210.0	0.8829
110.5	0.9413	135.5	0.9263	160.5	0.9115	185.5	0.8970	210.5	0.8826
111.0	0.9410	136.0	0.9260	161.0	0.9112	186.0	0.8967	211.0	0.8823
111.5	0.9407	136.5	0.9257	161.5	0.9109	186.5	0.8964	211.5	0.8820
112.0	0.9404	137.0	0.9254	162.0	0.9106	187.0	0.8961	212.0	0.8817
112.5	0.9401	137.5	0.9251	162.5	0.9104	187.5	0.8959	212.5	0.8815
113.0	0.9397	138.0	0.9248	163.0	0.9101	188.0	0.8956	213.0	0.8812
113.5	0.9394	138.5	0.9246	163.5	0.9098	188.5	0.8953	213.5	0.8809
114.0	0.9391	139.0	0.9242	164.0	0.9095	189.0	0.8950	214.0	0.8806
114.5	0.9388	139.5	0.9239	164.5	0.9092	189.5	0.8947	214.5	0.8803
115.0	0.9385	140.0	0.9236	165.0	0.9089	190.0	0.8944	215.0	0.8800
115.5	0.9382	140.5	0.9233	165.5	0.9086	190.5	0.8941	215.5	0.8797
116.0	0.9379	141.0	0.9230	166.0	0.9083	191.0	0.8938	216.0	0.8794
116.5	0.9376	141.5	0.9227	166.5	0.9080	191.5	0.8935	216.5	0.8792
117.0	0.9373	142.0	0.9224	167.0	0.9077	192.0	0.8932	217.0	0.8789
117.5	0.9371	142.5	0.9222	167.5	0.9075	192.5	0.8930	217.5	0.8786
118.0	0.9368	143.0	0.9219	168.0	0.9072	193.0	0.8927	218.0	0.8783
118.5	0.9365	143.5	0.9216	168.5	0.9069	193.5	0.8924	218.5	0.8780
119.0	0.9362	144.0	0.9213	169.0	0.9066	194.0	0.8921	219.0	0.8778
119.5	0.9359	144.5	0.9210	169.5	0.9063	194.5	0.8918	219.5	0.8775
120.0	0.9356	145.0	0.9207	170.0	0.9060	195.0	0.8915	220.0	0.8772
120.5	0.9353	145.5	0.9204	170.5	0.9057	195.5	0.8912	220.5	0.8769
121.0	0.9350	146.0	0.9201	171.0	0.9054	196.0	0.8909	221.0	0.8766
121.5	0.9347	146.5	0.9198	171.5	0.9051	196.5	0.8906	221.5	0.8763
122.0	0.9344	147.0	0.9195	172.0	0.9048	197.0	0.8903	222.0	0.8760
122.5	0.9341	147.5	0.9192	172.5	0.9046	197.5	0.8901	222.5	0.8758
123.0	0.9338	148.0	0.9189	173.0	0.9043	198.0	0.8898	223.0	0.8755
123.5	0.9335	148.5	0.9186	173.5	0.9040	198.5	0.8895	223.5	0.8752
124.0	0.9332	149.0	0.9183	174.0	0.9037	199.0	0.8892	224.0	0.8749
124.5	0.9329	149.5	0.9180	174.5	0.9034	199.5	0.8889	224.5	0.8746

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (METRIC UNITS)

GROUP 0 – DENSITY AT 15°C ABOVE 0.9654
LEGEND: t = Observed Temperature in Degrees Celsius
M = Multiplier for Reducing Volume to 15°C

t	M	t	M
225.0	0.8743	250.0	0.8602
225.5	0.8740	250.5	0.8599
226.0	0.8737	251.0	0.8596
226.5	0.8735	251.5	0.8594
227.0	0.8732	252.0	0.8591
227.5	0.8729	252.5	0.8588
228.0	0.8726	253.0	0.8585
228.5	0.8723	253.5	0.8582
229.0	0.8721	254.0	0.8580
229.5	0.8718	254.5	0.8577
230.0	0.8715	255.0	0.8574
230.5	0.8712	255.5	0.8571
231.0	0.8709	256.0	0.8568
231.5	0.8707	256.5	0.8566
232.0	0.8704	257.0	0.8563
232.5	0.8701	257.5	0.8560
233.0	0.8698	258.0	0.8557
233.5	0.8695	258.5	0.8554
234.0	0.8693	259.0	0.8552
234.5	0.8690	259.5	0.8549
235.0	0.8687	260.0	0.8546
235.5	0.8684	260.5	0.8543
236.0	0.8681	261.0	0.8540
236.5	0.8678	261.5	0.8538
237.0	0.8675	262.0	0.8535
237.5	0.8673	262.5	0.8532
238.0	0.8670	263.0	0.8529
238.5	0.8667	263.5	0.8526
239.0	0.8664	264.0	0.8524
239.5	0.8661	264.5	0.8521
240.0	0.8658	265.0	0.8518
240.5	0.8655	265.5	0.8515
241.0	0.8652	266.0	0.8512
241.5	0.8650	266.5	0.8510
242.0	0.8647	267.0	0.8507
242.5	0.8644	267.5	0.8504
243.0	0.8641	268.0	0.8501
243.5	0.8638	268.5	0.8498
244.0	0.8636	269.0	0.8496
244.5	0.8633	269.5	0.8493
245.0	0.8630	270.0	0.8490
245.5	0.8627	270.5	0.8487
246.0	0.8624	271.0	0.8484
246.5	0.8622	271.5	0.8482
247.0	0.8619	272.0	0.8479
247.5	0.8616	272.5	0.8476
248.0	0.8613	273.0	0.8473
248.5	0.8610	273.5	0.8470
249.0	0.8608	274.0	0.8468
249.5	0.8605	274.5	0.8465

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (CUSTOMARY UNITS)

GROUP 0 – SPECIFIC GRAVITY AT 60°F OF 0.850 TO 0.966
LEGEND: t = Observed Temperature in Degrees Fahrenheit
M = Multiplier for Correcting Oil Volumes to the Basis of 60°F

t	M	t	M	t	M	t	M	t	M
0	1.0241	**50**	1.0040	**100**	0.9842	**150**	0.9647	**200**	0.9456
1	1.0237	**51**	1.0036	**101**	0.9838	**151**	0.9643	**201**	0.9452
2	1.0233	**52**	1.0032	**102**	0.9834	**152**	0.9639	**202**	0.9448
3	1.0229	**53**	1.0028	**103**	0.9830	**153**	0.9635	**203**	0.9444
4	1.0225	**54**	1.0024	**104**	0.9826	**154**	0.9632	**204**	0.9441
5	1.0221	**55**	1.0020	**105**	0.9822	**155**	0.9628	**205**	0.9437
6	1.0217	**56**	1.0016	**106**	0.9818	**156**	0.9624	**206**	0.9433
7	1.0213	**57**	1.0012	**107**	0.9814	**157**	0.9620	**207**	0.9429
8	1.0209	**58**	1.0008	**108**	0.9810	**158**	0.9616	**208**	0.9425
9	1.0205	**59**	1.0004	**109**	0.9806	**159**	0.9612	**209**	0.9422
10	1.0201	**60**	1.0000	**110**	0.9803	**160**	0.9609	**210**	0.9418
11	1.0197	**61**	0.9996	**111**	0.9799	**161**	0.9605	**211**	0.9414
12	1.0193	**62**	0.9992	**112**	0.9795	**162**	0.9601	**212**	0.9410
13	1.0189	**63**	0.9988	**113**	0.9791	**163**	0.9597	**213**	0.9407
14	1.0185	**64**	0.9984	**114**	0.9787	**164**	0.9593	**214**	0.9403
15	1.0181	**65**	0.9980	**115**	0.9783	**165**	0.9589	**215**	0.9399
16	1.0177	**66**	0.9976	**116**	0.9779	**166**	0.9585	**216**	0.9395
17	1.0173	**67**	0.9972	**117**	0.9775	**167**	0.9582	**217**	0.9391
18	1.0168	**68**	0.9968	**118**	0.9771	**168**	0.9578	**218**	0.9388
19	1.0164	**69**	0.9964	**119**	0.9767	**169**	0.9574	**219**	0.9384
20	1.0160	**70**	0.9960	**120**	0.9763	**170**	0.9570	**220**	0.9380
21	1.0156	**71**	0.9956	**121**	0.9760	**171**	0.9566	**221**	0.9376
22	1.0152	**72**	0.9952	**122**	0.9756	**172**	0.9562	**222**	0.9373
23	1.0148	**73**	0.9948	**123**	0.9752	**173**	0.9559	**223**	0.9369
24	1.0144	**74**	0.9944	**124**	0.9748	**174**	0.9555	**224**	0.9365
25	1.0140	**75**	0.9940	**125**	0.9744	**175**	0.9551	**225**	0.9361
26	1.0136	**76**	0.9936	**126**	0.9740	**176**	0.9547	**226**	0.9358
27	1.0132	**77**	0.9932	**127**	0.9736	**177**	0.9543	**227**	0.9354
28	1.0128	**78**	0.9929	**128**	0.9732	**178**	0.9539	**228**	0.9350
29	1.0124	**79**	0.9925	**129**	0.9728	**179**	0.9536	**229**	0.9346
30	1.0120	**80**	0.9921	**130**	0.9725	**180**	0.9532	**230**	0.9343
31	1.0116	**81**	0.9917	**131**	0.9721	**181**	0.9528	**231**	0.9339
32	1.0112	**82**	0.9913	**132**	0.9717	**182**	0.9524	**232**	0.9335
33	1.0108	**83**	0.9909	**133**	0.9713	**183**	0.9520	**233**	0.9331
34	1.0104	**84**	0.9905	**134**	0.9709	**184**	0.9517	**234**	0.9328
35	1.0100	**85**	0.9901	**135**	0.9705	**185**	0.9513	**235**	0.9324
36	1.0096	**86**	0.9897	**136**	0.9701	**186**	0.9509	**236**	0.9320
37	1.0092	**87**	0.9893	**137**	0.9697	**187**	0.9505	**237**	0.9316
38	1.0088	**88**	0.9889	**138**	0.9693	**188**	0.9501	**238**	0.9313
39	1.0084	**89**	0.9885	**139**	0.9690	**189**	0.9498	**239**	0.9309
40	1.0080	**90**	0.9881	**140**	0.9686	**190**	0.9494	**240**	0.9305
41	1.0076	**91**	0.9877	**141**	0.9682	**191**	0.9490	**241**	0.9301
42	1.0072	**92**	0.9873	**142**	0.9678	**192**	0.9486	**242**	0.9298
43	1.0068	**93**	0.9869	**143**	0.9674	**193**	0.9482	**243**	0.9294
44	1.0064	**94**	0.9865	**144**	0.9670	**194**	0.9478	**244**	0.9290
45	1.0060	**95**	0.9861	**145**	0.9666	**195**	0.9475	**245**	0.9286
46	1.0056	**96**	0.9857	**146**	0.9662	**196**	0.9471	**246**	0.9283
47	1.0052	**97**	0.9854	**147**	0.9659	**197**	0.9467	**247**	0.9279
48	1.0048	**98**	0.9850	**148**	0.9655	**198**	0.9463	**248**	0.9275
49	1.0044	**99**	0.9846	**149**	0.9651	**199**	0.9460	**249**	0.9272

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (CUSTOMARY UNITS)

GROUP 0 – SPECIFIC GRAVITY AT 60°F OF 0.850 TO 0.966
LEGEND: t = Observed Temperature in Degrees Fahrenheit
M = Multiplier for Correcting Oil Volumes to the Basis of 60°F

t	M	t	M	t	M	t	M	t	M
250	0.9268	**300**	0.9083	**350**	0.8902	**400**	0.8724	**450**	0.8550
251	0.9264	**301**	0.9080	**351**	0.8899	**401**	0.8721	**451**	0.8547
252	0.9260	**302**	0.9076	**352**	0.8895	**402**	0.8717	**452**	0.8543
253	0.9257	**303**	0.9072	**353**	0.8891	**403**	0.8714	**453**	0.8540
254	0.9253	**304**	0.9069	**354**	0.8888	**404**	0.8710	**454**	0.8536
255	0.9249	**305**	0.9065	**355**	0.8884	**405**	0.8707	**455**	0.8533
256	0.9245	**306**	0.9061	**356**	0.8881	**406**	0.8703	**456**	0.8529
257	0.9242	**307**	0.9058	**357**	0.8877	**407**	0.8700	**457**	0.8526
258	0.9238	**308**	0.9054	**358**	0.8873	**408**	0.8696	**458**	0.8522
259	0.9234	**309**	0.9050	**359**	0.8870	**409**	0.8693	**459**	0.8519
260	0.9231	**310**	0.9047	**360**	0.8866	**410**	0.8689	**460**	0.8516
261	0.9227	**311**	0.9043	**361**	0.8863	**411**	0.8686	**461**	0.8512
262	0.9223	**312**	0.9039	**362**	0.8859	**412**	0.8682	**462**	0.8509
263	0.9219	**313**	0.9036	**363**	0.8856	**413**	0.8679	**463**	0.8505
264	0.9216	**314**	0.9032	**364**	0.8852	**414**	0.8675	**464**	0.8502
265	0.9212	**315**	0.9029	**365**	0.8848	**415**	0.8672	**465**	0.8498
266	0.9208	**316**	0.9025	**366**	0.8845	**416**	0.8668	**466**	0.8495
267	0.9205	**317**	0.9021	**367**	0.8841	**417**	0.8665	**467**	0.8492
268	0.9201	**318**	0.9018	**368**	0.8838	**418**	0.8661	**468**	0.8488
269	0.9197	**319**	0.9014	**369**	0.8834	**419**	0.8658	**469**	0.8485
270	0.9194	**320**	0.9010	**370**	0.8831	**420**	0.8654	**470**	0.8481
271	0.9190	**321**	0.9007	**371**	0.8827	**421**	0.8651	**471**	0.8478
272	0.9186	**322**	0.9003	**372**	0.8823	**422**	0.8647	**472**	0.8474
273	0.9182	**323**	0.9000	**373**	0.8820	**423**	0.8644	**473**	0.8471
274	0.9179	**324**	0.8996	**374**	0.8816	**424**	0.8640	**474**	0.8468
275	0.9175	**325**	0.8992	**375**	0.8813	**425**	0.8637	**475**	0.8464
276	0.9171	**326**	0.8989	**376**	0.8809	**426**	0.8633	**476**	0.8461
277	0.9168	**327**	0.8985	**377**	0.8806	**427**	0.8630	**477**	0.8457
278	0.9164	**328**	0.8981	**378**	0.8802	**428**	0.8626	**478**	0.8454
279	0.9160	**329**	0.8978	**379**	0.8799	**429**	0.8623	**479**	0.8451
280	0.9157	**330**	0.8974	**380**	0.8795	**430**	0.8619	**480**	0.8447
281	0.9153	**331**	0.8971	**381**	0.8792	**431**	0.8616	**481**	0.8444
282	0.9149	**332**	0.8967	**382**	0.8788	**432**	0.8612	**482**	0.8440
283	0.9146	**333**	0.8963	**383**	0.8784	**433**	0.8609	**483**	0.8437
284	0.9142	**334**	0.8960	**384**	0.8781	**434**	0.8605	**484**	0.8433
285	0.9138	**335**	0.8956	**385**	0.8777	**435**	0.8602	**485**	0.8430
286	0.9135	**336**	0.8952	**386**	0.8774	**436**	0.8599	**486**	0.8427
287	0.9131	**337**	0.8949	**387**	0.8770	**437**	0.8595	**487**	0.8423
288	0.9127	**338**	0.8945	**388**	0.8767	**438**	0.8592	**488**	0.8420
289	0.9124	**339**	0.8942	**389**	0.8763	**439**	0.8588	**489**	0.8416
290	0.9120	**340**	0.8938	**390**	0.8760	**440**	0.8585	**490**	0.8413
291	0.9116	**341**	0.8934	**391**	0.8756	**441**	0.8581	**491**	0.8410
292	0.9113	**342**	0.8931	**392**	0.8753	**442**	0.8578	**492**	0.8406
293	0.9109	**343**	0.8927	**393**	0.8749	**443**	0.8574	**493**	0.8403
294	0.9105	**344**	0.8924	**394**	0.8746	**444**	0.8571	**494**	0.8399
295	0.9102	**345**	0.8920	**395**	0.8742	**445**	0.8567	**495**	0.8396
296	0.9098	**346**	0.8916	**396**	0.8738	**446**	0.8564	**496**	0.8393
297	0.9094	**347**	0.8913	**397**	0.8735	**447**	0.8560	**497**	0.8389
298	0.9091	**348**	0.8909	**398**	0.8731	**448**	0.8557	**498**	0.8386
299	0.9087	**349**	0.8906	**399**	0.8728	**449**	0.8554	**499**	0.8383

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (METRIC UNITS)

GROUP 1 – DENSITY AT 15°C BETWEEN 0.8495 – 0.965
LEGEND: t = Observed Temperature in Degrees Celsius
M = Multiplier for Reducing Volume to 15°C

t	M	t	M	t	M	t	M	t	M
-25.0	1.0290	**0.0**	1.0108	**25.0**	0.9929	**50.0**	0.9752	**75.0**	0.9578
-24.5	1.0286	**0.5**	1.0104	**25.5**	0.9925	**50.5**	0.9749	**75.5**	0.9575
-24.0	1.0283	**1.0**	1.0101	**26.0**	0.9922	**51.0**	0.9745	**76.0**	0.9571
-23.5	1.0279	**1.5**	1.0097	**26.5**	0.9918	**51.5**	0.9742	**76.5**	0.9568
-23.0	1.0276	**2.0**	1.0094	**27.0**	0.9915	**52.0**	0.9738	**77.0**	0.9564
-22.5	1.0272	**2.5**	1.0090	**27.5**	0.9911	**52.5**	0.9735	**77.5**	0.9561
-22.0	1.0268	**3.0**	1.0086	**28.0**	0.9907	**53.0**	0.9731	**78.0**	0.9557
-21.5	1.0265	**3.5**	1.0083	**28.5**	0.9904	**53.5**	0.9728	**78.5**	0.9554
-21.0	1.0261	**4.0**	1.0079	**29.0**	0.9900	**54.0**	0.9724	**79.0**	0.9550
-20.5	1.0258	**4.5**	1.0076	**29.5**	0.9897	**54.5**	0.9721	**79.5**	0.9547
-20.0	1.0254	**5.0**	1.0072	**30.0**	0.9893	**55.0**	0.9717	**80.0**	0.9543
-19.5	1.0250	**5.5**	1.0068	**30.5**	0.9889	**55.5**	0.9714	**80.5**	0.9540
-19.0	1.0247	**6.0**	1.0065	**31.0**	0.9886	**56.0**	0.9710	**81.0**	0.9536
-18.5	1.0243	**6.5**	1.0061	**31.5**	0.9882	**56.5**	0.9707	**81.5**	0.9533
-18.0	1.0239	**7.0**	1.0058	**32.0**	0.9879	**57.0**	0.9703	**82.0**	0.9529
-17.5	1.0236	**7.5**	1.0054	**32.5**	0.9875	**57.5**	0.9700	**82.5**	0.9526
-17.0	1.0232	**8.0**	1.0050	**33.0**	0.9871	**58.0**	0.9696	**83.0**	0.9523
-16.5	1.0228	**8.5**	1.0047	**33.5**	0.9868	**58.5**	0.9693	**83.5**	0.9519
-16.0	1.0224	**9.0**	1.0043	**34.0**	0.9864	**59.0**	0.9689	**84.0**	0.9516
-15.5	1.0221	**9.5**	1.0040	**34.5**	0.9861	**59.5**	0.9686	**84.5**	0.9512
-15.0	1.0217	**10.0**	1.0036	**35.0**	0.9857	**60.0**	0.9682	**85.0**	0.9509
-14.5	1.0213	**10.5**	1.0032	**35.5**	0.9854	**60.5**	0.9679	**85.5**	0.9506
-14.0	1.0210	**11.0**	1.0029	**36.0**	0.9850	**61.0**	0.9675	**86.0**	0.9502
-13.5	1.0206	**11.5**	1.0025	**36.5**	0.9847	**61.5**	0.9672	**86.5**	0.9499
-13.0	1.0203	**12.0**	1.0022	**37.0**	0.9843	**62.0**	0.9668	**87.0**	0.9495
-12.5	1.0199	**12.5**	1.0018	**37.5**	0.9840	**62.5**	0.9665	**87.5**	0.9492
-12.0	1.0195	**13.0**	1.0014	**38.0**	0.9836	**63.0**	0.9661	**88.0**	0.9489
-11.5	1.0192	**13.5**	1.0011	**38.5**	0.9833	**63.5**	0.9658	**88.5**	0.9485
-11.0	1.0188	**14.0**	1.0007	**39.0**	0.9829	**64.0**	0.9654	**89.0**	0.9482
-10.5	1.0185	**14.5**	1.0004	**39.5**	0.9826	**64.5**	0.9651	**89.5**	0.9478
-10.0	1.0181	**15.0**	1.0000	**40.0**	0.9822	**65.0**	0.9647	**90.0**	0.9475
-9.5	1.0177	**15.5**	0.9996	**40.5**	0.9819	**65.5**	0.9644	**90.5**	0.9472
-9.0	1.0174	**16.0**	0.9993	**41.0**	0.9815	**66.0**	0.9640	**91.0**	0.9468
-8.5	1.0170	**16.5**	0.9989	**41.5**	0.9812	**66.5**	0.9637	**91.5**	0.9465
-8.0	1.0166	**17.0**	0.9986	**42.0**	0.9808	**67.0**	0.9633	**92.0**	0.9461
-7.5	1.0163	**17.5**	0.9982	**42.5**	0.9805	**67.5**	0.9630	**92.5**	0.9458
-7.0	1.0159	**18.0**	0.9978	**43.0**	0.9801	**68.0**	0.9626	**93.0**	0.9455
-6.5	1.0155	**18.5**	0.9975	**43.5**	0.9798	**68.5**	0.9623	**93.5**	0.9451
-6.0	1.0151	**19.0**	0.9971	**44.0**	0.9794	**69.0**	0.9619	**94.0**	0.9448
-5.5	1.0148	**19.5**	0.9968	**44.5**	0.9791	**69.5**	0.9616	**94.5**	0.9444
-5.0	1.0144	**20.0**	0.9964	**45.0**	0.9787	**70.0**	0.9612	**95.0**	0.9441
-4.5	1.0140	**20.5**	0.9961	**45.5**	0.9784	**70.5**	0.9609	**95.5**	0.9438
-4.0	1.0137	**21.0**	0.9957	**46.0**	0.9780	**71.0**	0.9605	**96.0**	0.9434
-3.5	1.0133	**21.5**	0.9954	**46.5**	0.9777	**71.5**	0.9602	**96.5**	0.9431
-3.0	1.0130	**22.0**	0.9950	**47.0**	0.9773	**72.0**	0.9598	**97.0**	0.9427
-2.5	1.0126	**22.5**	0.9947	**47.5**	0.9770	**72.5**	0.9595	**97.5**	0.9424
-2.0	1.0122	**23.0**	0.9943	**48.0**	0.9766	**73.0**	0.9592	**98.0**	0.9421
-1.5	1.0119	**23.5**	0.9940	**48.5**	0.9763	**73.5**	0.9588	**98.5**	0.9417
-1.0	1.0115	**24.0**	0.9936	**49.0**	0.9759	**74.0**	0.9585	**99.0**	0.9414
-0.5	1.0112	**24.5**	0.9933	**49.5**	0.9756	**74.5**	0.9581	**99.5**	0.9410

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (METRIC UNITS)

GROUP 1 – DENSITY AT 15°C BETWEEN 0.8495 – 0.9653
LEGEND: t = Observed Temperature in Degrees Celsius
M = Multiplier for Reducing Volume to 15°C

t	M	t	M	t	M	t	M	t	M
100.0	0.9407	**125.0**	0.9238	**150.0**	0.9072	**175.0**	0.8909	**200.0**	0.8749
100.5	0.9404	**125.5**	0.9235	**150.5**	0.9069	**175.5**	0.8906	**200.5**	0.8746
101.0	0.9400	**126.0**	0.9231	**151.0**	0.9065	**176.0**	0.8903	**201.0**	0.8743
101.5	0.9397	**126.5**	0.9228	**151.5**	0.9062	**176.5**	0.8899	**201.5**	0.8739
102.0	0.9393	**127.0**	0.9225	**152.0**	0.9059	**177.0**	0.8896	**202.0**	0.8736
102.5	0.9390	**127.5**	0.9222	**152.5**	0.9056	**177.5**	0.8893	**202.5**	0.8733
103.0	0.9387	**128.0**	0.9218	**153.0**	0.9052	**178.0**	0.8890	**203.0**	0.8730
103.5	0.9383	**128.5**	0.9215	**153.5**	0.9049	**178.5**	0.8887	**203.5**	0.8727
104.0	0.9380	**129.0**	0.9212	**154.0**	0.9046	**179.0**	0.8883	**204.0**	0.8723
104.5	0.9376	**129.5**	0.9208	**154.5**	0.9042	**179.5**	0.8880	**204.5**	0.8720
105.0	0.9373	**130.0**	0.9205	**155.0**	0.9039	**180.0**	0.8877	**205.0**	0.8717
105.5	0.9370	**130.5**	0.9202	**155.5**	0.9036	**180.5**	0.8874	**205.5**	0.8714
106.0	0.9366	**131.0**	0.9198	**156.0**	0.9033	**181.0**	0.8871	**206.0**	0.8711
106.5	0.9363	**131.5**	0.9195	**156.5**	0.9029	**181.5**	0.8867	**206.5**	0.8708
107.0	0.9359	**132.0**	0.9191	**157.0**	0.9026	**182.0**	0.8864	**207.0**	0.8705
107.5	0.9356	**132.5**	0.9188	**157.5**	0.9023	**182.5**	0.8861	**207.5**	0.8702
108.0	0.9353	**133.0**	0.9185	**158.0**	0.9020	**183.0**	0.8858	**208.0**	0.8698
108.5	0.9349	**133.5**	0.9181	**158.5**	0.9017	**183.5**	0.8855	**208.5**	0.8695
109.0	0.9346	**134.0**	0.9178	**159.0**	0.9013	**184.0**	0.8851	**209.0**	0.8692
109.5	0.9342	**134.5**	0.9174	**159.5**	0.9010	**184.5**	0.8848	**209.5**	0.8689
110.0	0.9339	**135.0**	0.9171	**160.0**	0.9007	**185.0**	0.8845	**210.0**	0.8686
110.5	0.9336	**135.5**	0.9168	**160.5**	0.9004	**185.5**	0.8842	**210.5**	0.8683
111.0	0.9332	**136.0**	0.9164	**161.0**	0.9000	**186.0**	0.8839	**211.0**	0.8680
111.5	0.9329	**136.5**	0.9161	**161.5**	0.8997	**186.5**	0.8835	**211.5**	0.8676
112.0	0.9325	**137.0**	0.9158	**162.0**	0.8994	**187.0**	0.8832	**212.0**	0.8673
112.5	0.9322	**137.5**	0.9155	**162.5**	0.8991	**187.5**	0.8829	**212.5**	0.8670
113.0	0.9319	**138.0**	0.9151	**163.0**	0.8987	**188.0**	0.8826	**213.0**	0.8667
113.5	0.9315	**138.5**	0.9148	**163.5**	0.8984	**188.5**	0.8823	**213.5**	0.8664
114.0	0.9312	**139.0**	0.9145	**164.0**	0.8981	**189.0**	0.8819	**214.0**	0.8660
114.5	0.9308	**139.5**	0.9141	**164.5**	0.8977	**189.5**	0.8816	**214.5**	0.8657
115.0	0.9305	**140.0**	0.9138	**165.0**	0.8974	**190.0**	0.8813	**215.0**	0.8654
115.5	0.9302	**140.5**	0.9135	**165.5**	0.8971	**190.5**	0.8810	**215.5**	0.8651
116.0	0.9298	**141.0**	0.9131	**166.0**	0.8968	**191.0**	0.8807	**216.0**	0.8648
116.5	0.9295	**141.5**	0.9128	**166.5**	0.8964	**191.5**	0.8803	**216.5**	0.8645
117.0	0.9292	**142.0**	0.9125	**167.0**	0.8961	**192.0**	0.8800	**217.0**	0.8642
117.5	0.9289	**142.5**	0.9122	**167.5**	0.8958	**192.5**	0.8797	**217.5**	0.8639
118.0	0.9285	**143.0**	0.9118	**168.0**	0.8955	**193.0**	0.8794	**218.0**	0.8635
118.5	0.9282	**143.5**	0.9115	**168.5**	0.8952	**193.5**	0.8791	**218.5**	0.8632
119.0	0.9279	**144.0**	0.9112	**169.0**	0.8948	**194.0**	0.8787	**219.0**	0.8629
119.5	0.9275	**144.5**	0.9108	**169.5**	0.8945	**194.5**	0.8784	**219.5**	0.8626
120.0	0.9272	**145.0**	0.9105	**170.0**	0.8942	**195.0**	0.8781	**220.0**	0.8623
120.5	0.9269	**145.5**	0.9102	**170.5**	0.8939	**195.5**	0.8778	**220.5**	0.8620
121.0	0.9265	**146.0**	0.9098	**171.0**	0.8935	**196.0**	0.8775	**221.0**	0.8617
121.5	0.9262	**146.5**	0.9095	**171.5**	0.8932	**196.5**	0.8771	**221.5**	0.8614
122.0	0.9258	**147.0**	0.9092	**172.0**	0.8929	**197.0**	0.8768	**222.0**	0.8611
122.5	0.9255	**147.5**	0.9089	**172.5**	0.8926	**197.5**	0.8765	**222.5**	0.8608
123.0	0.9252	**148.0**	0.9085	**173.0**	0.8922	**198.0**	0.8762	**223.0**	0.8604
123.5	0.9248	**148.5**	0.9082	**173.5**	0.8919	**198.5**	0.8759	**223.5**	0.8601
124.0	0.9245	**149.0**	0.9079	**174.0**	0.8916	**199.0**	0.8755	**224.0**	0.8598
124.5	0.9241	**149.5**	0.9075	**174.5**	0.8912	**199.5**	0.8752	**224.5**	0.8595

TEMPERATURE-VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS (METRIC UNITS)

GROUP 1 – DENSITY AT 15°C BETWEEN 0.8495 – 0.9653
LEGEND: t = Observed Temperature in Degrees Celsius
M = Multiplier for Reducing Volume to 15°C

t	M	t	M
225.0	0.8592	**250.0**	0.8437
225.5	0.8589	**250.5**	0.8434
226.0	0.8586	**251.0**	0.8431
226.5	0.8582	**251.5**	0.8428
227.0	0.8579	**252.0**	0.8425
227.5	0.8576	**252.5**	0.8422
228.0	0.8573	**253.0**	0.8418
228.5	0.8570	**253.5**	0.8415
229.0	0.8566	**254.0**	0.8412
229.5	0.8563	**254.5**	0.8409
230.0	0.8560	**255.0**	0.8406
230.5	0.8557	**255.5**	0.8403
231.0	0.8554	**256.0**	0.8400
231.5	0.8551	**256.5**	0.8397
232.0	0.8548	**257.0**	0.8394
232.5	0.8545	**257.5**	0.8391
233.0	0.8541	**258.0**	0.8388
233.5	0.8538	**258.5**	0.8385
234.0	0.8535	**259.0**	0.8382
234.5	0.8532	**259.5**	0.8379
235.0	0.8529	**260.0**	0.8376
235.5	0.8526	**260.5**	0.8373
236.0	0.8523	**261.0**	0.8370
236.5	0.8520	**261.5**	0.8367
237.0	0.8517	**262.0**	0.8364
237.5	0.8514	**262.5**	0.8361
238.0	0.8510	**263.0**	0.8357
238.5	0.8507	**263.5**	0.8354
239.0	0.8504	**264.0**	0.8351
239.5	0.8501	**264.5**	0.8348
240.0	0.8498	**265.0**	0.8345
240.5	0.8495	**265.5**	0.8342
241.0	0.8492	**266.0**	0.8339
241.5	0.8489	**266.5**	0.8336
242.0	0.8486	**267.0**	0.8333
242.5	0.8483	**267.5**	0.8330
243.0	0.8480	**268.0**	0.8326
243.5	0.8477	**268.5**	0.8323
244.0	0.8474	**269.0**	0.8320
244.5	0.8471	**269.5**	0.8317
245.0	0.8468	**270.0**	0.8314
245.5	0.8465	**270.5**	0.8311
246.0	0.8462	**271.0**	0.8308
246.5	0.8459	**271.5**	0.8305
247.0	0.8456	**272.0**	0.8302
247.5	0.8453	**272.5**	0.8299
248.0	0.8449	**273.0**	0.8296
248.5	0.8446	**273.5**	0.8293
249.0	0.8443	**274.0**	0.8290
249.5	0.8440	**274.5**	0.8287

GAUGING TABLE FOR HORIZONTAL CYLINDRICAL TANKS

Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity
0.0	100.0000	**5.0**	98.1307	**10.0**	94.7960	**15.0**	90.5940
0.1	99.9946	**5.1**	98.0749	**10.1**	94.7190	**15.1**	90.5029
0.2	99.9848	**5.2**	98.0186	**10.2**	94.6420	**15.2**	90.4120
0.3	99.9721	**5.3**	97.9619	**10.3**	94.5649	**15.3**	90.3201
0.4	99.9571	**5.4**	97.9044	**10.4**	94.4878	**15.4**	90.2290
0.5	99.9400	**5.5**	97.8468	**10.5**	94.4094	**15.5**	90.1363
0.6	99.9212	**5.6**	97.7884	**10.6**	94.3310	**15.6**	90.0440
0.7	99.9008	**5.7**	97.7297	**10.7**	94.2527	**15.7**	89.9515
0.8	99.8788	**5.8**	97.6703	**10.8**	94.1742	**15.8**	89.8580
0.9	99.8554	**5.9**	97.6106	**10.9**	94.0946	**15.9**	89.7657
1.0	99.8308	**6.0**	97.5503	**11.0**	94.0152	**16.0**	89.6730
1.1	99.8048	**6.1**	97.4897	**11.1**	93.9352	**16.1**	89.5790
1.2	99.7776	**6.2**	97.4285	**11.2**	93.8555	**16.2**	89.4850
1.3	99.7494	**6.3**	97.3669	**11.3**	93.7746	**16.3**	89.3913
1.4	99.7200	**6.4**	97.3048	**11.4**	93.6940	**16.4**	89.2970
1.5	99.6896	**6.5**	97.2422	**11.5**	93.6128	**16.5**	89.2028
1.6	99.6581	**6.6**	97.1789	**11.6**	93.5315	**16.6**	89.1070
1.7	99.6256	**6.7**	97.1158	**11.7**	93.4497	**16.7**	89.0133
1.8	99.5923	**6.8**	97.0517	**11.8**	93.3680	**16.8**	88.9180
1.9	99.5579	**6.9**	96.9875	**11.9**	93.2854	**16.9**	88.8229
2.0	99.5227	**7.0**	96.9229	**12.0**	93.2030	**17.0**	88.7270
2.1	99.4866	**7.1**	96.8576	**12.1**	93.1199	**17.1**	88.6310
2.2	99.4497	**7.2**	96.7920	**12.2**	93.0370	**17.2**	88.5350
2.3	99.4119	**7.3**	96.7260	**12.3**	92.9532	**17.3**	88.4390
2.4	99.3734	**7.4**	96.6591	**12.4**	92.8695	**17.4**	88.3430
2.5	99.3340	**7.5**	96.5926	**12.5**	92.7853	**17.5**	88.2460
2.6	99.2939	**7.6**	96.5251	**12.6**	92.7010	**17.6**	88.1490
2.7	99.2530	**7.7**	96.4577	**12.7**	92.6163	**17.7**	88.0510
2.8	99.2113	**7.8**	96.3894	**12.8**	92.5320	**17.8**	87.9540
2.9	99.1690	**7.9**	96.3211	**12.9**	92.4462	**17.9**	87.8570
3.0	99.1258	**8.0**	96.2520	**13.0**	92.3610	**18.0**	87.7600
3.1	99.0821	**8.1**	96.1829	**13.1**	92.2749	**18.1**	87.6620
3.2	99.0376	**8.2**	96.1131	**13.2**	92.1890	**18.2**	87.5630
3.3	98.9924	**8.3**	96.0432	**13.3**	92.1025	**18.3**	87.4650
3.4	98.9466	**8.4**	95.9724	**13.4**	92.0160	**18.4**	87.3670
3.5	98.9002	**8.5**	95.9019	**13.5**	91.9290	**18.5**	87.2680
3.6	98.8530	**8.6**	95.8304	**13.6**	91.8420	**18.6**	87.1690
3.7	98.8053	**8.7**	95.7591	**13.7**	91.7544	**18.7**	87.0700
3.8	98.7569	**8.8**	95.6869	**13.8**	91.6670	**18.8**	86.9700
3.9	98.7079	**8.9**	95.6148	**13.9**	91.5788	**18.9**	86.8700
4.0	98.6582	**9.0**	95.5418	**14.0**	91.4910	**19.0**	86.7710
4.1	98.6081	**9.1**	95.4691	**14.1**	91.4021	**19.1**	86.6710
4.2	98.5573	**9.2**	95.3955	**14.2**	91.3140	**19.2**	86.5710
4.3	98.5059	**9.3**	95.3219	**14.3**	91.2243	**19.3**	86.4710
4.4	98.4540	**9.4**	95.2475	**14.4**	91.1355	**19.4**	86.3700
4.5	98.4014	**9.5**	95.1733	**14.5**	91.0455	**19.5**	86.2690
4.6	98.3484	**9.6**	95.0985	**14.6**	90.9560	**19.6**	86.1680
4.7	98.2948	**9.7**	95.0233	**14.7**	90.8656	**19.7**	86.0660
4.8	98.2406	**9.8**	94.9477	**14.8**	90.7760	**19.8**	85.9650
4.9	98.1859	**9.9**	94.8718	**14.9**	90.6848	**19.9**	85.8540

GAUGING TABLE FOR HORIZONTAL CYLINDRICAL TANKS

Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity
20.0	85.7620	**25.0**	80.4490	**30.0**	74.7670	**35.0**	68.8080
20.1	85.6590	**25.1**	80.3380	**30.1**	74.6500	**35.1**	68.6860
20.2	85.5560	**25.2**	80.2270	**30.2**	74.5330	**35.2**	68.5640
20.3	85.4530	**25.3**	80.1160	**30.3**	74.4160	**35.3**	68.4420
20.4	85.3510	**25.4**	80.0050	**30.4**	74.2990	**35.4**	68.3200
20.5	85.2490	**25.5**	79.8940	**30.5**	74.1820	**35.5**	68.1980
20.6	85.1460	**25.6**	79.7830	**30.6**	74.0650	**35.6**	68.0760
20.7	85.0430	**25.7**	79.6720	**30.7**	73.9470	**35.7**	67.9540
20.8	84.9400	**25.8**	79.5610	**30.8**	73.8300	**35.8**	67.8320
20.9	84.8370	**25.9**	79.4500	**30.9**	73.7120	**35.9**	67.7100
21.0	84.7330	**26.0**	79.3390	**31.0**	73.5930	**36.0**	67.5880
21.1	84.6290	**26.1**	79.2270	**31.1**	73.4760	**36.1**	67.4660
21.2	84.5250	**26.2**	79.1140	**31.2**	73.3580	**36.2**	67.3430
21.3	84.4210	**26.3**	79.0020	**31.3**	73.2400	**36.3**	67.2200
21.4	84.3170	**26.4**	78.8900	**31.4**	73.1220	**36.4**	67.0980
21.5	84.2130	**26.5**	78.7780	**31.5**	73.0040	**36.5**	66.9750
21.6	84.1080	**26.6**	78.6660	**31.6**	72.8860	**36.6**	66.8530
21.7	84.0020	**26.7**	78.5530	**31.7**	72.7680	**36.7**	66.7310
21.8	83.8990	**26.8**	78.4400	**31.8**	72.6490	**36.8**	66.6080
21.9	83.7940	**26.9**	78.3280	**31.9**	72.5300	**36.9**	66.4850
22.0	83.6880	**27.0**	78.2150	**32.0**	72.4110	**37.0**	66.3820
22.1	83.5820	**27.1**	78.1020	**32.1**	72.2920	**37.1**	66.2380
22.2	83.4760	**27.2**	77.9890	**32.2**	72.1730	**37.2**	66.1180
22.3	83.3700	**27.3**	77.8750	**32.3**	72.0540	**37.3**	65.9920
22.4	83.2630	**27.4**	77.7610	**32.4**	71.9350	**37.4**	65.8690
22.5	83.1580	**27.5**	77.6470	**32.5**	71.8160	**37.5**	65.7460
22.6	83.0510	**27.6**	77.5330	**32.6**	71.6980	**37.6**	65.6230
22.7	82.9450	**27.7**	77.4190	**32.7**	71.5780	**37.7**	65.4990
22.8	82.8390	**27.8**	77.3050	**32.8**	71.4570	**37.8**	65.3750
22.9	82.7310	**27.9**	77.1900	**32.9**	71.3400	**37.9**	65.2510
23.0	82.6240	**28.0**	77.0770	**33.0**	71.2190	**38.0**	65.1270
23.1	82.5170	**28.1**	76.9620	**33.1**	71.1010	**38.1**	65.0040
23.2	82.4100	**28.2**	76.8480	**33.2**	70.9800	**38.2**	64.8810
23.3	82.3020	**28.3**	76.7340	**33.3**	70.8600	**38.3**	64.7580
23.4	82.1940	**28.4**	76.6200	**33.4**	70.7400	**38.4**	64.6320
23.5	82.0870	**28.5**	76.5060	**33.5**	70.6200	**38.5**	64.5710
23.6	81.9780	**28.6**	76.3890	**33.6**	70.5000	**38.6**	64.3850
23.7	81.8700	**28.7**	76.2720	**33.7**	70.3800	**38.7**	64.2610
23.8	81.7600	**28.8**	76.1580	**33.8**	70.2600	**38.8**	64.1350
23.9	81.6520	**28.9**	76.0430	**33.9**	70.1400	**38.9**	64.0120
24.0	81.5430	**29.0**	75.9280	**34.0**	70.0190	**39.0**	63.8900
24.1	81.4340	**29.1**	75.8130	**34.1**	69.8980	**39.1**	63.7660
24.2	81.3250	**29.2**	75.6980	**34.2**	69.7770	**39.2**	63.6410
24.3	81.2160	**29.3**	75.5820	**34.3**	69.6563	**39.3**	63.5170
24.4	81.1080	**29.4**	75.4650	**34.4**	69.5350	**39.4**	63.3920
24.5	80.9900	**29.5**	75.3490	**34.5**	69.4130	**39.5**	63.2680
24.6	80.8900	**29.6**	75.2310	**34.6**	69.2920	**39.6**	63.1440
24.7	80.7800	**29.7**	75.1160	**34.7**	69.1710	**39.7**	63.0190
24.8	80.6700	**29.8**	75.0000	**34.8**	69.0500	**39.8**	62.8940
24.9	80.5600	**29.9**	74.8840	**34.9**	68.9290	**39.9**	62.7700

GAUGING TABLE FOR HORIZONTAL CYLINDRICAL TANKS

Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity
40.0	62.6450	**45.0**	56.3520	**50.0**	50.0000	**55.0**	43.6480
40.1	62.5200	**45.1**	56.2250	**50.1**	49.8770	**55.1**	43.5210
40.2	62.3940	**45.2**	56.0980	**50.2**	49.7480	**55.2**	43.3970
40.3	62.2690	**45.3**	55.9720	**50.3**	49.6210	**55.3**	43.2680
40.4	62.1440	**45.4**	55.8450	**50.4**	49.4940	**55.4**	43.1420
40.5	62.0190	**45.5**	55.7180	**50.5**	49.3660	**55.5**	43.0180
40.6	61.8940	**45.6**	55.5910	**50.6**	49.2390	**55.6**	42.8900
40.7	61.7690	**45.7**	55.4620	**50.7**	49.1120	**55.7**	42.7620
40.8	61.6450	**45.8**	55.3370	**50.8**	48.9830	**55.8**	42.6370
40.9	61.5210	**45.9**	55.2100	**50.9**	48.8570	**55.9**	42.5100
41.0	61.3960	**46.0**	55.0820	**51.0**	48.7290	**56.0**	42.3830
41.1	61.2700	**46.1**	54.9570	**51.1**	48.6030	**56.1**	42.2570
41.2	61.1440	**46.2**	54.8290	**51.2**	48.4750	**56.2**	42.1290
41.3	61.0180	**46.3**	54.7040	**51.3**	48.3480	**56.3**	42.0020
41.4	60.8920	**46.4**	54.5760	**51.4**	48.2200	**56.4**	41.8760
41.5	60.7670	**46.5**	54.4500	**51.5**	48.0930	**56.5**	41.7490
41.6	60.6420	**46.6**	54.3220	**51.6**	47.9650	**56.6**	41.6280
41.7	60.5180	**46.7**	54.1970	**51.7**	47.8370	**56.7**	41.4990
41.8	60.3920	**46.8**	54.0700	**51.8**	47.7100	**56.8**	41.3720
41.9	60.2650	**46.9**	53.9420	**51.9**	47.5830	**56.9**	41.2460
42.0	60.1380	**47.0**	53.8170	**52.0**	47.4570	**57.0**	41.1200
42.1	60.0120	**47.1**	53.6890	**52.1**	47.3290	**57.1**	40.9940
42.2	59.8860	**47.2**	53.5620	**52.2**	47.2010	**57.2**	40.8690
42.3	59.7600	**47.3**	53.4350	**52.3**	47.0740	**57.3**	40.7410
42.4	59.6350	**47.4**	53.3070	**52.4**	46.9470	**57.4**	40.6150
42.5	59.5100	**47.5**	53.1810	**52.5**	46.8190	**57.5**	40.4900
42.6	59.3850	**47.6**	53.0530	**52.6**	46.6930	**57.6**	40.3650
42.7	59.2590	**47.7**	52.9260	**52.7**	46.5650	**57.7**	40.2400
42.8	59.1310	**47.8**	52.7990	**52.8**	46.4380	**57.8**	40.1140
42.9	59.0060	**47.9**	52.6710	**52.9**	46.3110	**57.9**	39.9880
43.0	58.8800	**48.0**	52.5430	**53.0**	46.1830	**58.0**	39.8620
43.1	58.7540	**48.1**	52.4170	**53.1**	46.0580	**58.1**	39.7350
43.2	58.6280	**48.2**	52.2900	**53.2**	45.9300	**58.2**	39.6080
43.3	58.5010	**48.3**	52.1630	**53.3**	45.8050	**58.3**	39.4820
43.4	58.3720	**48.4**	52.0350	**53.4**	45.6780	**58.4**	39.3580
43.5	58.2510	**48.5**	51.9070	**53.5**	45.5500	**58.5**	39.2330
43.6	58.1240	**48.6**	51.7800	**53.6**	45.4240	**58.6**	39.1080
43.7	57.9980	**48.7**	51.6520	**53.7**	45.2980	**58.7**	38.9820
43.8	57.8710	**48.8**	51.5250	**53.8**	45.1710	**58.8**	38.8560
43.9	57.7430	**48.9**	51.3970	**53.9**	45.0430	**58.9**	38.7300
44.0	57.6170	**49.0**	51.2710	**54.0**	44.9180	**59.0**	38.6040
44.1	57.4900	**49.1**	51.1430	**54.1**	44.7900	**59.1**	38.4790
44.2	57.3630	**49.2**	51.0170	**54.2**	44.6630	**59.2**	38.3550
44.3	57.2380	**49.3**	50.8880	**54.3**	44.5380	**59.3**	38.2310
44.4	57.1100	**49.4**	50.7610	**54.4**	44.4090	**59.4**	38.1060
44.5	56.9820	**49.5**	50.6340	**54.5**	44.2820	**59.5**	37.9810
44.6	56.8580	**49.6**	50.5060	**54.6**	44.1550	**59.6**	37.8560
44.7	56.7320	**49.7**	50.3790	**54.7**	44.0280	**59.7**	37.7310
44.8	56.6030	**49.8**	50.2520	**54.8**	43.9020	**59.8**	37.6060
44.9	56.4790	**49.9**	50.1230	**54.9**	43.7750	**59.9**	37.4800

GAUGING TABLE FOR HORIZONTAL CYLINDRICAL TANKS

Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity
60.0	37.3550	**65.0**	31.1920	**70.0**	25.2330	**75.0**	19.5510
60.1	37.2300	**65.1**	31.0710	**70.1**	25.1160	**75.1**	19.4400
60.2	37.1060	**65.2**	30.9500	**70.2**	25.0000	**75.2**	19.3300
60.3	36.9810	**65.3**	30.8290	**70.3**	24.8840	**75.3**	19.2200
60.4	36.8560	**65.4**	30.7080	**70.4**	24.7690	**75.4**	19.1100
60.5	36.7320	**65.5**	30.5870	**70.5**	24.6510	**75.5**	19.0100
60.6	36.6080	**65.6**	30.4650	**70.6**	24.5350	**75.6**	18.8920
60.7	36.4830	**65.7**	30.3440	**70.7**	24.4180	**75.7**	18.7840
60.8	36.3590	**65.8**	30.2230	**70.8**	24.3020	**75.8**	18.6750
60.9	36.2340	**65.9**	30.1020	**70.9**	24.1870	**75.9**	18.5660
61.0	36.1100	**66.0**	29.9810	**71.0**	24.0720	**76.0**	18.4570
61.1	35.9880	**66.1**	29.8600	**71.1**	23.9570	**76.1**	18.3480
61.2	35.9650	**66.2**	29.7400	**71.2**	23.8420	**76.2**	18.2400
61.3	35.7390	**66.3**	29.6200	**71.3**	23.7280	**76.3**	18.1300
61.4	35.6150	**66.4**	29.5000	**71.4**	23.6110	**76.4**	18.0220
61.5	35.4910	**66.5**	29.3800	**71.5**	23.4940	**76.5**	17.9130
61.6	35.3680	**66.6**	29.2600	**71.6**	23.3800	**76.6**	17.8060
61.7	35.2420	**66.7**	29.1400	**71.7**	23.2660	**76.7**	17.6980
61.8	35.1190	**66.8**	29.0200	**71.8**	23.1520	**76.8**	17.5900
61.9	34.9960	**66.9**	28.8890	**71.9**	23.0380	**76.9**	17.4830
62.0	34.8730	**67.1**	28.7810	**72.0**	22.9230	**77.0**	17.3760
62.1	34.7490	**67.2**	28.6600	**72.1**	22.8100	**77.1**	17.2690
62.2	34.6250	**67.3**	28.5430	**72.2**	22.6950	**77.2**	17.1610
62.3	34.5010	**67.4**	28.4220	**72.3**	22.5810	**77.3**	17.0550
62.4	34.3770	**67.5**	28.3020	**72.4**	22.4670	**77.4**	16.9490
62.5	34.2540	**67.6**	28.1840	**72.5**	22.3530	**77.5**	16.8420
62.6	34.1310	**67.7**	27.0650	**72.6**	22.2390	**77.6**	16.7370
62.7	34.0080	**67.8**	27.9450	**72.7**	22.1250	**77.7**	16.6300
62.8	33.8850	**67.9**	27.8270	**72.8**	22.0110	**77.8**	16.5240
62.9	33.7620	**68.0**	27.7080	**72.9**	21.8980	**77.9**	16.4180
63.0	33.6380	**68.1**	27.4700	**73.0**	21.7850	**78.0**	16.3120
63.1	33.5150	**68.2**	27.3510	**73.1**	21.6720	**78.1**	16.2060
63.2	33.3920	**68.3**	27.2320	**73.2**	21.5600	**78.2**	16.1010
63.3	33.2690	**68.4**	27.1140	**73.3**	21.4470	**78.3**	15.9980
63.4	33.1470	**68.5**	26.9960	**73.4**	21.3340	**78.4**	15.8920
63.5	33.0250	**68.6**	26.8780	**73.5**	21.2220	**78.5**	15.7870
63.6	32.9020	**68.7**	26.7600	**73.6**	21.1100	**78.6**	15.6830
63.7	32.7800	**68.8**	26.6420	**73.7**	20.9980	**78.7**	15.5790
63.8	32.6570	**68.9**	26.5240	**73.8**	20.8860	**78.8**	15.4750
63.9	32.5340	**69.0**	26.4070	**73.9**	20.7730	**78.9**	15.3710
64.0	32.4120	**69.1**	26.2880	**74.0**	20.6610	**79.0**	15.2670
64.1	32.2900	**69.2**	26.1700	**74.1**	20.5500	**79.1**	15.1630
64.2	32.1682	**69.3**	26.0520	**74.2**	20.4390	**79.2**	15.0600
64.3	32.0460	**69.4**	25.9350	**74.3**	20.3280	**79.3**	14.9570
64.4	31.9240	**69.5**	25.8180	**74.4**	20.2170	**79.4**	14.8540
64.5	31.8020	**69.6**	25.7010	**74.5**	20.1060	**79.5**	14.7510
64.6	31.6800	**69.7**	25.5840	**74.6**	19.9950	**79.6**	14.6490
64.7	31.5580	**69.8**	25.4670	**74.7**	19.8840	**79.7**	14.5470
64.8	31.4360	**69.9**	25.3500	**74.8**	19.7730	**79.8**	14.4440
64.9	31.3140	**70.0**	25.2330	**74.9**	19.6620	**79.9**	14.3410

GAUGING TABLE FOR HORIZONTAL CYLINDRICAL TANKS

Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity	Outage % of Diameter	Filled % of Capacity
80.0	14.2380	**85.0**	9.4060	**90.0**	5.2040	**95.0**	1.8693
80.1	14.1460	**85.1**	9.3152	**90.1**	5.1282	**95.1**	1.8141
80.2	14.0350	**85.2**	9.2240	**90.2**	5.0523	**95.2**	1.7594
80.3	13.9340	**85.3**	9.1344	**90.3**	4.9767	**95.3**	1.7052
80.4	13.8320	**85.4**	9.0440	**90.4**	4.9015	**95.4**	1.6516
80.5	13.7310	**85.5**	8.9545	**90.5**	4.8267	**95.5**	1.5986
80.6	13.6300	**85.6**	8.8645	**90.6**	4.7525	**95.6**	1.5460
80.7	13.5290	**85.7**	8.7757	**90.7**	4.6781	**95.7**	1.4941
80.8	13.4290	**85.8**	8.6860	**90.8**	4.6045	**95.8**	1.4427
80.9	13.3290	**85.9**	8.5979	**90.9**	4.5309	**95.9**	1.3919
81.0	13.2290	**86.0**	8.5090	**91.0**	4.4582	**96.0**	1.3418
81.1	13.1300	**86.1**	8.4212	**91.1**	4.3851	**96.1**	1.2921
81.2	13.0300	**86.2**	8.3330	**91.2**	4.3131	**96.2**	1.2431
81.3	12.9300	**86.3**	8.2456	**91.3**	4.2409	**96.3**	1.1947
81.4	12.8310	**86.4**	8.1580	**91.4**	4.1696	**96.4**	1.1470
81.5	12.7320	**86.5**	8.0710	**91.5**	4.0981	**96.5**	1.0998
81.6	12.6330	**86.6**	7.9840	**91.6**	4.0276	**96.6**	1.0534
81.7	12.5350	**86.7**	7.8975	**91.7**	3.9568	**96.7**	1.0076
81.8	12.4370	**86.8**	7.8110	**91.8**	3.8869	**96.8**	0.9624
81.9	12.3380	**86.9**	7.7251	**91.9**	3.8171	**96.9**	0.9179
82.0	12.2400	**87.0**	7.6390	**92.0**	3.7480	**97.0**	0.8742
82.1	12.1430	**87.1**	7.5538	**92.1**	3.6789	**97.1**	0.8310
82.2	12.0460	**87.2**	7.4680	**92.2**	3.6106	**97.2**	0.7887
82.3	11.9490	**87.3**	7.3837	**92.3**	3.5423	**97.3**	0.7470
82.4	11.8510	**87.4**	7.2990	**92.4**	3.4749	**97.4**	0.7061
82.5	11.7540	**87.5**	7.2147	**92.5**	3.4074	**97.5**	0.6660
82.6	11.6570	**87.6**	7.1305	**92.6**	3.3408	**97.6**	0.6266
82.7	11.5610	**87.7**	7.0468	**92.7**	3.2740	**97.7**	0.5881
82.8	11.4650	**87.8**	6.9630	**92.8**	3.2085	**97.8**	0.5503
82.9	11.3690	**87.9**	6.8801	**92.9**	3.1424	**97.9**	0.5134
83.0	11.2730	**88.0**	6.7970	**93.0**	3.0771	**98.0**	0.4773
83.1	11.1771	**88.1**	6.7146	**93.1**	3.0125	**98.1**	0.4421
83.2	11.0820	**88.2**	6.6320	**93.2**	2.9483	**98.2**	0.4077
83.3	11.9867	**88.3**	6.5503	**93.3**	2.8842	**98.3**	0.3744
83.4	10.8930	**88.4**	6.4685	**93.4**	2.8211	**98.4**	0.3419
83.5	10.7972	**88.5**	6.3872	**93.5**	2.7578	**98.5**	0.3104
83.6	10.7030	**88.6**	6.3060	**93.6**	2.6952	**98.6**	0.2800
83.7	10.6087	**88.7**	6.2254	**93.7**	2.6331	**98.7**	0.2506
83.8	10.5150	**88.8**	6.1445	**93.8**	2.5715	**98.8**	0.2224
83.9	10.4210	**88.9**	6.0648	**93.9**	2.5103	**98.9**	0.1952
84.0	10.3270	**89.0**	5.9848	**94.0**	2.4497	**99.0**	0.1692
84.1	10.2343	**89.1**	5.9054	**94.1**	2.3894	**99.1**	0.1446
84.2	10.1420	**89.2**	5.8258	**94.2**	2.3297	**99.2**	0.1212
84.3	10.0485	**89.3**	5.7473	**94.3**	2.2703	**99.3**	0.0992
84.4	9.9560	**89.4**	5.6690	**94.4**	2.2116	**99.4**	0.0788
84.5	9.8637	**89.5**	5.5906	**94.5**	2.1532	**99.5**	0.0600
84.6	9.7710	**89.6**	5.5122	**94.6**	2.0956	**99.6**	0.0429
84.7	9.6799	**89.7**	5.4351	**94.7**	2.0381	**99.7**	0.0279
84.8	9.5880	**89.8**	5.3580	**94.8**	1.9814	**99.8**	0.0152
84.9	9.4971	**89.9**	5.2810	**94.9**	1.9251	**99.0**	0.0054
						100.0	0.0000

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS

Gallons per Foot of Length

Outage Inches (H)	77 (38.5)	Interval	78 (39)	Interval	79 (39.5)	Interval	80 (40)	Interval	81 (40.5)	Interval	82 (41)
	Tank Diameter in Inches										
0.25	0.076	0.000	0.076	0.001	0.077	0.000	0.077	0.001	0.078	0.000	0.078
0.50	0.214	0.002	0.216	0.001	0.217	0.002	0.219	0.001	0.220	0.001	0.221
0.75	0.394	0.002	0.396	0.003	0.399	0.002	0.401	0.003	0.404	0.002	0.406
1.00	0.605	0.004	0.609	0.004	0.613	0.004	0.617	0.004	0.621	0.004	0.625
1.25	0.845	0.006	0.851	0.005	0.856	0.006	0.862	0.005	0.867	0.006	0.873
1.50	1.110	0.007	1.117	0.008	1.125	0.007	1.132	0.007	1.139	0.007	1.146
1.75	1.397	0.010	1.407	0.009	1.416	0.009	1.425	0.009	1.434	0.009	1.443
2.00	1.706	0.011	1.717	0.011	1.728	0.011	1.739	0.011	1.750	0.011	1.761
2.25	2.033	0.014	2.047	0.013	2.060	0.013	2.073	0.013	2.086	0.013	2.099
2.50	2.379	0.016	2.395	0.015	2.410	0.016	2.426	0.015	2.441	0.015	2.456
2.75	2.742	0.018	2.760	0.018	2.778	0.018	2.796	0.018	2.814	0.017	2.831
3.00	3.121	0.021	3.142	0.020	3.162	0.021	3.183	0.020	3.203	0.020	3.223
3.25	3.516	0.023	3.539	0.023	3.562	0.023	3.585	0.023	3.608	0.023	3.631
3.50	3.925	0.026	3.951	0.026	3.977	0.026	4.003	0.025	4.028	0.026	4.054
3.75	4.349	0.029	4.378	0.028	4.406	0.029	4.435	0.028	4.463	0.029	4.492
4.00	4.786	0.032	4.818	0.032	4.850	0.031	4.881	0.031	4.912	0.032	4.944
4.25	5.236	0.035	5.271	0.035	5.306	0.035	5.341	0.034	5.375	0.034	5.409
4.50	5.699	0.038	5.737	0.038	5.775	0.038	5.813	0.038	5.851	0.037	5.888
4.75	6.174	0.042	6.216	0.041	6.257	0.041	6.298	0.041	6.339	0.040	6.379
5.00	6.661	0.045	6.706	0.045	6.751	0.044	6.795	0.044	6.839	0.044	6.883
5.25	7.160	0.048	7.208	0.048	7.256	0.048	7.304	0.047	7.351	0.047	7.398
5.50	7.669	0.052	7.721	0.052	7.773	0.051	7.824	0.051	7.875	0.050	7.925
5.75	8.190	0.055	8.245	0.056	8.301	0.054	8.355	0.055	8.410	0.054	8.464
6.00	8.721	0.059	8.780	0.059	8.839	0.058	8.897	0.058	8.955	0.058	9.013
6.25	9.262	0.063	9.325	0.063	9.388	0.062	9.450	0.062	9.512	0.061	9.573
6.50	9.813	0.067	9.880	0.066	9.946	0.067	10.013	0.065	10.078	0.065	10.143
6.75	10.374	0.071	10.445	0.070	10.515	0.070	10.585	0.070	10.655	0.069	10.724
7.00	10.944	0.075	11.019	0.075	11.094	0.074	11.168	0.073	11.241	0.073	11.314
7.25	11.524	0.079	11.603	0.078	11.681	0.078	11.759	0.078	11.837	0.077	11.914
7.50	12.112	0.084	12.196	0.082	12.278	0.083	12.361	0.081	12.442	0.081	12.523
7.75	12.710	0.087	12.797	0.087	12.884	0.087	12.971	0.086	13.057	0.085	13.142
8.00	13.316	0.092	13.408	0.091	13.499	0.091	13.590	0.090	13.680	0.089	13.769
8.25	13.930	0.097	14.027	0.095	14.122	0.095	14.217	0.095	14.312	0.094	14.406
8.50	14.553	0.101	14.654	0.100	14.754	0.100	14.854	0.098	14.952	0.099	15.051
8.75	15.184	0.105	15.289	0.105	15.394	0.104	15.498	0.103	15.601	0.103	15.704
9.00	15.822	0.110	15.932	0.110	16.042	0.109	16.151	0.107	16.258	0.108	16.366
9.25	16.469	0.115	16.584	0.114	16.698	0.113	16.811	0.113	16.924	0.112	17.036
9.50	17.123	0.119	17.242	0.119	17.361	0.118	17.479	0.118	17.597	0.116	17.713
9.75	17.784	0.125	17.909	0.124	18.033	0.122	18.155	0.123	18.278	0.121	18.399

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS
Gallons per Foot of Length

Outage Inches (H)	Tank Diameter in Inches										
	77	Interval	78	Interval	79	Interval	80	Interval	81	Interval	82
	38.5		39		39.5		40		40.5		41
10.00	18.453	0.129	18.582	0.129	18.711	0.128	18.839	0.127	18.966	0.126	19.092
10.25	19.129	0.134	19.263	0.134	19.397	0.133	19.530	0.132	19.662	0.131	19.793
10.50	19.812	0.139	19.951	0.139	20.090	0.138	20.228	0.137	20.365	0.136	20.501
10.75	20.501	0.145	20.646	0.144	20.790	0.143	20.933	0.142	21.075	0.141	21.216
11.00	21.198	0.150	21.348	0.149	21.497	0.148	21.645	0.147	21.792	0.146	21.938
11.25	21.901	0.156	22.057	0.154	22.211	0.153	22.364	0.152	22.516	0.152	22.668
11.50	22.611	0.161	22.772	0.159	22.931	0.159	23.090	0.157	23.247	0.157	23.404
11.75	23.327	0.166	23.493	0.165	23.658	0.164	23.822	0.163	23.985	0.162	24.147
12.00	24.049	0.172	24.221	0.171	24.392	0.169	24.561	0.168	24.729	0.167	24.896
12.25	24.778	0.177	24.955	0.176	25.131	0.175	25.306	0.174	25.480	0.172	25.652
12.50	25.512	0.183	25.695	0.182	25.877	0.180	26.057	0.180	26.237	0.178	26.415
12.75	26.253	0.188	26.441	0.188	26.629	0.186	26.815	0.185	27.000	0.183	27.183
13.00	26.999	0.194	27.193	0.194	27.387	0.192	27.579	0.190	27.769	0.189	27.958
13.25	27.751	0.200	27.951	0.199	28.150	0.198	28.348	0.196	28.544	0.195	28.739
13.50	28.509	0.206	28.715	0.205	28.920	0.203	29.123	0.203	29.326	0.200	29.526
13.75	29.272	0.212	29.484	0.211	29.695	0.210	29.905	0.207	30.112	0.207	30.319
14.00	30.041	0.218	30.259	0.217	30.476	0.215	30.691	0.214	30.905	0.213	31.118
14.25	30.815	0.224	31.039	0.223	31.262	0.222	31.484	0.219	31.703	0.219	31.922
14.50	31.594	0.231	31.825	0.229	32.054	0.227	32.281	0.226	32.507	0.225	32.732
14.75	32.378	0.237	32.615	0.236	32.851	0.234	33.085	0.232	33.317	0.230	33.547
15.00	33.168	0.243	33.411	0.242	33.653	0.240	33.893	0.238	34.131	0.237	34.368
15.25	33.963	0.249	34.212	0.248	34.460	0.247	34.707	0.244	34.951	0.243	35.194
15.50	34.762	0.256	35.018	0.255	35.273	0.252	35.525	0.251	35.776	0.249	36.025
15.75	35.566	0.263	35.829	0.261	36.090	0.259	36.349	0.257	36.606	0.256	36.862
16.00	36.376	0.269	36.645	0.267	36.912	0.266	37.178	0.263	37.441	0.262	37.703
16.25	37.189	0.276	37.465	0.274	37.739	0.272	38.011	0.270	38.281	0.269	38.550
16.50	38.008	0.282	38.290	0.281	38.571	0.279	38.850	0.276	39.126	0.275	39.401
16.75	38.831	0.289	39.120	0.288	39.408	0.285	39.693	0.283	39.976	0.281	40.257
17.00	39.658	0.296	39.954	0.295	40.249	0.292	40.541	0.290	40.831	0.287	41.118
17.25	40.490	0.303	40.793	0.301	41.094	0.299	41.393	0.297	41.690	0.294	41.984
17.50	41.326	0.310	41.636	0.308	41.944	0.306	42.250	0.303	42.553	0.302	42.855
17.75	42.166	0.317	42.483	0.315	42.798	0.313	43.111	0.310	43.421	0.308	43.729
18.00	43.010	0.325	43.335	0.322	43.657	0.319	43.976	0.318	44.294	0.315	44.609
18.25	43.859	0.331	44.190	0.330	44.520	0.326	44.846	0.325	45.171	0.322	45.493
18.50	44.711	0.339	45.050	0.336	45.386	0.334	45.720	0.332	46.052	0.329	46.381
18.75	45.568	0.346	45.914	0.343	46.257	0.341	46.598	0.339	46.937	0.336	47.273
19.00	46.428	0.354	46.782	0.350	47.132	0.349	47.481	0.345	47.826	0.344	48.170
19.25	47.292	0.361	47.653	0.358	48.011	0.356	48.367	0.353	48.720	0.350	49.070
19.50	48.160	0.369	48.529	0.365	48.894	0.363	49.257	0.360	49.617	0.358	49.975
19.75	49.032	0.376	49.408	0.373	49.781	0.370	50.151	0.368	50.519	0.365	50.884
20.00	49.907	0.384	50.291	0.380	50.671	0.378	51.049	0.375	51.424	0.373	51.797

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS
Gallons per Foot of Length

Outage Inches (H)	Tank Diameter in Inches										
	82	Interval	**83**	Interval	**84**	Interval	**85**	Interval	**86**	Interval	**87**
	41		**41.5**		**42**		**42.5**		**43**		**43.5**
0.25	0.078	0.001	0.079	0.000	0.079	0.001	0.080	0.000	0.080	0.001	0.081
0.50	0.221	0.002	0.223	0.001	0.224	0.001	0.225	0.002	0.227	0.001	0.228
0.75	0.406	0.003	0.409	0.002	0.411	0.003	0.414	0.002	0.416	0.003	0.419
1.00	0.625	0.004	0.629	0.004	0.633	0.003	0.636	0.004	0.640	0.004	0.644
1.25	0.873	0.005	0.878	0.005	0.883	0.005	0.888	0.006	0.894	0.005	0.899
1.50	1.146	0.007	1.153	0.007	1.160	0.007	1.167	0.007	1.174	0.007	1.181
1.75	1.443	0.009	1.452	0.008	1.460	0.009	1.469	0.009	1.478	0.009	1.487
2.00	1.761	0.011	1.772	0.011	1.783	0.010	1.793	0.011	1.804	0.011	1.815
2.25	2.099	0.013	2.112	0.013	2.125	0.013	2.138	0.013	2.151	0.012	2.163
2.50	2.456	0.016	2.472	0.015	2.487	0.015	2.502	0.015	2.517	0.015	2.532
2.75	2.831	0.018	2.849	0.017	2.866	0.018	2.884	0.017	2.901	0.017	2.918
3.00	3.223	0.020	3.243	0.020	3.263	0.020	3.283	0.019	3.302	0.020	3.322
3.25	3.631	0.022	3.653	0.023	3.676	0.022	3.698	0.022	3.720	0.023	3.743
3.50	4.054	0.025	4.079	0.025	4.104	0.025	4.129	0.025	4.154	0.025	4.179
3.75	4.492	0.028	4.520	0.028	4.548	0.027	4.575	0.028	4.603	0.027	4.630
4.00	4.944	0.031	4.975	0.030	5.005	0.031	5.036	0.030	5.066	0.031	5.097
4.25	5.409	0.034	5.443	0.034	5.477	0.033	5.510	0.034	5.544	0.033	5.577
4.50	5.888	0.037	5.925	0.037	5.962	0.036	5.998	0.036	6.034	0.037	6.071
4.75	6.379	0.040	6.419	0.040	6.459	0.040	6.499	0.039	6.538	0.040	6.578
5.00	6.883	0.043	6.926	0.043	6.969	0.043	7.012	0.043	7.055	0.042	7.097
5.25	7.398	0.047	7.445	0.047	7.492	0.046	7.538	0.046	7.584	0.045	7.629
5.50	7.925	0.051	7.976	0.049	8.025	0.050	8.075	0.049	8.124	0.049	8.173
5.75	8.464	0.053	8.517	0.054	8.571	0.053	8.624	0.053	8.677	0.052	8.729
6.00	9.013	0.057	9.070	0.057	9.127	0.057	9.184	0.056	9.240	0.056	9.296
6.25	9.573	0.061	9.634	0.061	9.695	0.060	9.755	0.060	9.815	0.059	9.874
6.50	10.143	0.065	10.208	0.064	10.272	0.064	10.336	0.064	10.400	0.063	10.463
6.75	10.724	0.068	10.792	0.068	10.860	0.068	10.928	0.067	10.995	0.067	11.062
7.00	11.314	0.072	11.386	0.073	11.459	0.071	11.530	0.071	11.601	0.071	11.672
7.25	11.914	0.076	11.990	0.076	12.066	0.076	12.142	0.075	12.217	0.075	12.292
7.50	12.523	0.081	12.604	0.080	12.684	0.079	12.763	0.079	12.842	0.079	12.921
7.75	13.142	0.084	13.226	0.085	13.311	0.083	13.394	0.083	13.477	0.083	13.560
8.00	13.769	0.089	13.858	0.089	13.947	0.087	14.034	0.088	14.122	0.086	14.208
8.25	14.406	0.093	14.499	0.092	14.591	0.093	14.684	0.091	14.775	0.091	14.866
8.50	15.051	0.097	15.148	0.097	15.245	0.097	15.342	0.095	15.437	0.095	15.532
8.75	15.704	0.102	15.806	0.101	15.907	0.101	16.008	0.100	16.108	0.100	16.208
9.00	16.366	0.106	16.472	0.106	16.578	0.105	16.683	0.105	16.788	0.104	16.892
9.25	17.036	0.111	17.147	0.110	17.257	0.110	17.367	0.109	17.476	0.108	17.584
9.50	17.713	0.116	17.829	0.115	17.944	0.114	18.058	0.114	18.172	0.113	18.285
9.75	18.399	0.120	18.519	0.120	18.639	0.119	18.758	0.118	18.876	0.118	18.994

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS
Gallons per Foot of Length

Outage Inches (H)	Tank Diameter in Inches										
	82	Interval	**83**	Interval	**84**	Interval	**85**	Interval	**86**	Interval	**87**
	41		**41.5**		**42**		**42.5**		**43**		**43.5**
10.00	19.092	0.125	19.217	0.125	19.342	0.123	19.465	0.123	19.588	0.122	19.710
10.25	19.793	0.130	19.923	0.129	20.052	0.129	20.181	0.127	20.308	0.127	20.435
10.50	20.501	0.135	20.636	0.134	20.770	0.133	20.903	0.133	21.036	0.131	21.167
10.75	21.216	0.140	21.356	0.139	21.495	0.138	21.633	0.138	21.771	0.136	21.907
11.00	21.938	0.145	22.083	0.145	22.228	0.143	22.371	0.142	22.513	0.142	22.655
11.25	22.668	0.150	22.818	0.149	22.967	0.148	23.115	0.148	23.263	0.146	23.409
11.50	23.404	0.155	23.559	0.155	23.714	0.153	23.867	0.153	24.020	0.151	24.171
11.75	24.147	0.160	24.307	0.160	24.467	0.159	24.626	0.157	24.783	0.157	24.940
12.00	24.896	0.166	25.062	0.165	25.227	0.164	25.391	0.163	25.554	0.162	25.716
12.25	25.652	0.172	25.824	0.170	25.994	0.169	26.163	0.168	26.331	0.167	26.498
12.50	26.415	0.177	26.592	0.175	26.767	0.175	26.942	0.173	27.115	0.173	27.288
12.75	27.183	0.183	27.366	0.181	27.547	0.180	27.727	0.179	27.906	0.177	28.083
13.00	27.958	0.188	28.146	0.187	28.333	0.186	28.519	0.184	28.703	0.183	28.886
13.25	28.739	0.194	28.933	0.192	29.125	0.191	29.316	0.190	29.506	0.189	29.695
13.50	29.526	0.200	29.726	0.198	29.924	0.196	30.120	0.196	30.316	0.194	30.510
13.75	30.319	0.205	30.524	0.204	30.728	0.202	30.930	0.201	31.131	0.200	31.331
14.00	31.118	0.210	31.328	0.210	31.538	0.208	31.746	0.207	31.953	0.205	32.158
14.25	31.922	0.217	32.139	0.215	32.354	0.214	32.568	0.213	32.781	0.211	32.992
14.50	32.732	0.222	32.954	0.222	33.176	0.220	33.396	0.218	33.614	0.217	33.831
14.75	33.547	0.229	33.776	0.227	34.003	0.226	34.229	0.224	34.453	0.223	34.676
15.00	34.368	0.235	34.603	0.233	34.836	0.232	35.068	0.230	35.298	0.229	35.527
15.25	35.194	0.241	35.435	0.239	35.674	0.238	35.912	0.236	36.148	0.235	36.383
15.50	36.025	0.247	36.272	0.246	36.518	0.244	36.762	0.242	37.004	0.241	37.245
15.75	36.862	0.253	37.115	0.252	37.367	0.250	37.617	0.249	37.866	0.246	38.112
16.00	37.703	0.260	37.963	0.258	38.221	0.257	38.478	0.254	38.732	0.253	38.985
16.25	38.550	0.266	38.816	0.264	39.080	0.263	39.343	0.261	39.604	0.259	39.863
16.50	39.401	0.273	39.674	0.271	39.945	0.269	40.214	0.267	40.481	0.266	40.747
16.75	40.257	0.280	40.537	0.277	40.814	0.276	41.090	0.273	41.363	0.272	41.635
17.00	41.118	0.286	41.404	0.284	41.688	0.282	41.970	0.280	42.250	0.279	42.529
17.25	41.984	0.293	42.277	0.290	42.567	0.289	42.856	0.286	43.142	0.285	43.427
17.50	42.855	0.299	43.154	0.297	43.451	0.295	43.746	0.293	44.039	0.291	44.330
17.75	43.729	0.306	44.035	0.304	44.339	0.302	44.641	0.300	44.941	0.298	45.239
18.00	44.609	0.313	44.922	0.310	45.232	0.309	45.541	0.306	45.847	0.305	46.152
18.25	45.493	0.319	45.812	0.318	46.130	0.315	46.445	0.313	46.758	0.311	47.069
18.50	46.381	0.326	46.707	0.325	47.032	0.322	47.354	0.320	47.674	0.318	47.992
18.75	47.273	0.334	47.607	0.331	47.938	0.329	48.267	0.327	48.594	0.325	48.919
19.00	48.170	0.340	48.510	0.339	48.849	0.336	49.185	0.334	49.519	0.331	49.850
19.25	49.070	0.348	49.418	0.346	49.764	0.343	50.107	0.341	50.448	0.338	50.786
19.50	49.975	0.355	50.330	0.353	50.683	0.350	51.033	0.348	51.381	0.345	51.726
19.75	50.884	0.362	51.246	0.360	51.606	0.357	51.963	0.355	52.318	0.353	52.671
20.00	51.797	0.369	52.166	0.367	52.533	0.365	52.898	0.362	53.260	0.359	53.619

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS
Gallons per Foot of Length

Outage Inches (H)	Tank Diameter in Inches										
	87	Interval	**88**	Interval	**89**	Interval	**90**	Interval	**91**	Interval	**92**
	43.5		**44**		**44.5**		**45**		**45.5**		**46**
0.25	0.081	0.000	0.081	0.001	0.082	0.000	0.082	0.001	0.083	0.000	0.083
0.50	0.228	0.001	0.229	0.002	0.231	0.001	0.232	0.001	0.233	0.002	0.235
0.75	0.419	0.002	0.421	0.002	0.423	0.003	0.426	0.002	0.428	0.002	0.430
1.00	0.644	0.004	0.648	0.003	0.651	0.004	0.655	0.004	0.659	0.003	0.662
1.25	0.899	0.005	0.904	0.005	0.909	0.005	0.914	0.006	0.920	0.005	0.925
1.50	1.181	0.007	1.188	0.006	1.194	0.007	1.201	0.007	1.208	0.007	1.215
1.75	1.487	0.008	1.495	0.009	1.504	0.008	1.512	0.009	1.521	0.008	1.529
2.00	1.815	0.010	1.825	0.011	1.836	0.010	1.846	0.010	1.856	0.011	1.867
2.25	2.163	0.013	2.176	0.013	2.189	0.012	2.201	0.012	2.213	0.013	2.226
2.50	2.532	0.014	2.546	0.015	2.561	0.015	2.576	0.014	2.590	0.015	2.605
2.75	2.918	0.017	2.935	0.017	2.952	0.017	2.969	0.017	2.986	0.016	3.002
3.00	3.322	0.019	3.341	0.020	3.361	0.019	3.380	0.019	3.399	0.019	3.418
3.25	3.743	0.021	3.764	0.022	3.786	0.022	3.808	0.022	3.830	0.021	3.851
3.50	4.179	0.024	4.203	0.025	4.228	0.024	4.252	0.024	4.276	0.024	4.300
3.75	4.630	0.028	4.658	0.027	4.685	0.027	4.712	0.026	4.738	0.027	4.765
4.00	5.097	0.030	5.127	0.029	5.156	0.030	5.186	0.030	5.216	0.029	5.245
4.25	5.577	0.033	5.610	0.032	5.642	0.033	5.675	0.032	5.707	0.032	5.739
4.50	6.071	0.035	6.106	0,036	6.142	0.036	6.178	0.035	6.213	0.035	6.248
4.75	6.578	0.039	6.617	0.038	6.655	0.039	6.694	0.038	6.732	0.038	6.770
5.00	7.097	0.042	7.139	0.042	7.181	0.042	7.223	0.041	7.264	0.041	7.305
5.25	7.629	0.046	7.675	0.045	7.720	0.045	7.765	0.044	7.809	0.044	7.853
5.50	8.173	0.049	8.222	0.048	8.270	0.049	8.319	0.047	8.366	0.048	8.414
5.75	8.729	0.052	8.781	0.052	8.833	0.051	8.884	0.052	8.936	0.050	8.986
6.00	9.296	0.056	9.352	0.055	9.407	0.055	9.462	0.054	9.516	0.055	9.571
6.25	9.874	0.059	9.933	0.059	9.992	0.059	10.051	0.058	10.109	0.057	10.166
6.50	10.463	0.063	10.526	0.062	10.588	0.062	10.650	0.062	10.712	0.061	10.773
6.75	11.062	0.067	11.129	0.066	11.195	0.066	11.261	0.065	11.326	0.065	11.391
7.00	11.672	0.070	11.742	0.070	11.812	0.070	11.882	0.069	11.951	0.068	12.019
7.25	12.292	0.074	12.366	0.073	12.439	0.074	12.513	0.073	12.586	0.072	12.658
7.50	12.921	0.078	12.999	0.078	13.077	0.077	13.154	0.077	13.231	0.076	13.307
7.75	13.560	0.082	13.642	0.082	13.724	0.081	13.805	0.081	13.886	0.080	13.966
8.00	14.208	0.087	14.295	0.085	14.380	0.085	14.465	0.085	14.550	0.084	14.634
8.25	14.866	0.090	14.956	0.090	15.046	0.089	15.135	0.089	15.224	0.088	15.312
8.50	15.532	0.095	15.627	0.094	15.721	0.093	15.814	0.093	15.907	0.093	16.000
8.75	16.208	0.099	16.307	0.098	16.405	0.098	16.503	0.097	16.600	0.096	16.696
9.00	16.892	0.103	16.995	0.102	17.097	0.102	17.199	0.102	17.301	0.101	17.402
9.25	17.584	0.108	17.692	0.107	17.799	0.106	17.905	0.106	18.011	0.105	18.116
9.50	18.285	0.112	18.397	0.111	18.508	0.111	18.619	0.110	18.729	0.110	18.839
9.75	18.994	0.116	19.110	0.116	19.226	0.116	19.342	0.114	19.456	0.114	19.570

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS

Gallons per Foot of Length

Tank Diameter in Inches

Outage Inches (H)	87	Interval	88	Interval	89	Interval	90	Interval	91	Interval	92
	43.5		44		44.5		45		45.5		46
10.00	19.710	0.122	19.832	0.120	19.952	0.120	20.072	0.119	20.191	0.119	20.310
10.25	20.435	0.126	20.561	0.125	20.686	0.125	20.811	0.124	20.935	0.123	21.058
10.50	21.167	0.131	21.298	0.130	21.428	0.129	21.557	0.129	21.686	0.128	21.814
10.75	21.907	0.136	22.043	0.135	22.178	0.134	22.312	0.133	22.445	0.132	22.577
11.00	22.655	0.140	22.795	0.140	22.935	0.139	23.074	0.138	23.212	0.137	23.349
11.25	23.409	0.146	23.555	0.144	23.699	0.144	23.843	0.143	23.986	0.142	24.128
11.50	24.171	0.151	24.322	0.149	24.471	0.149	24.620	0.148	24.768	0.146	24.914
11.75	24.940	0.155	25.095	0.155	25.250	0.154	25.404	0.153	25.557	0.151	25.708
12.00	25.716	0.160	25.876	0.160	26.036	0.159	26.195	0.158	26.353	0.157	26.510
12.25	26.498	0.166	26.664	0.165	26.829	0.164	26.993	0.163	27.156	0.162	27.318
12.50	27.288	0.171	27.459	0.170	27.629	0.169	27.798	0.168	27.966	0.167	28.133
12.75	28.083	0.177	28.260	0.176	28.436	0.174	28.610	0.173	28.783	0.173	28.956
13.00	28.886	0.182	29.068	0.181	29.249	0.179	29.428	0.179	29.607	0.178	29.785
13.25	29.695	0.187	29.882	0.186	30.068	0.185	30.253	0.184	30.437	0.183	30.620
13.50	30.510	0.193	30.703	0.191	30.894	0.191	31.085	0.189	31.274	0.189	31.463
13.75	31.331	0.199	31.530	0.197	31.727	0.196	31.923	0.195	32.118	0.193	32.311
14.00	32.158	0.205	32.363	0.202	32.565	0.202	32.767	0.200	32.967	0.199	33.166
14.25	32.992	0.210	33.202	0.208	33.410	0.207	33.617	0.206	33.823	0.205	34.028
14.50	33.831	0.216	34.047	0.214	34.261	0.213	34.474	0.211	34.685	0.211	34.896
14.75	34.676	0.221	34.897	0.220	35.117	0.219	35.336	0.217	35.553	0.216	35.769
15.00	35.527	0.227	35.754	0.226	35.980	0.224	36.204	0.223	36.427	0.222	36.649
15.25	36.383	0.233	36.616	0.232	36.848	0.230	37.078	0.229	37.307	0.228	37.535
15.50	37.245	0.239	37.484	0.238	37.722	0.236	37.958	0.235	38.193	0.233	38.426
15.75	38.112	0.246	38.358	0.243	38.601	0.243	38.844	0.240	39.084	0.240	39.324
16.00	38.985	0.252	39.237	0.249	39.486	0.249	39.735	0.246	39.981	0.245	40.226
16.25	39.863	0.258	40.121	0.256	40.377	0.254	40.631	0.253	40.884	0.251	41.135
16.50	40.747	0.263	41.010	0.263	41.273	0.260	41.533	0.259	41.792	0.257	42.049
16.75	41.635	0.270	41.905	0.269	42.174	0.266	42.440	0.265	42.705	0.264	42.969
17.00	42.529	0.276	42.805	0.275	43.080	0.273	43.353	0.271	43.624	0.269	43.893
17.25	43.427	0.283	43.710	0.281	43.991	0.279	44.270	0.278	44.548	0.275	44.823
17.50	44.330	0.290	44.620	0.287	44.907	0.286	45.193	0.284	45.477	0.282	45.759
17.75	45.239	0.296	45.535	0.293	45.828	0.293	46.121	0.290	46.411	0.288	46.699
18.00	46.152	0.302	46.454	0.301	46.755	0.298	47.053	0.297	47.350	0.295	47.645
18.25	47.069	0.310	47.379	0.307	47.686	0.305	47.991	0.303	48.294	0.301	48.595
18.50	47.992	0.316	48.308	0.313	48.621	0.312	48.933	0.310	49.243	0.307	49.550
18.75	48.919	0.322	49.241	0.321	49.562	0.318	49.880	0.316	50.196	0.315	50.511
19.00	49.850	0.329	50.179	0.328	50.507	0.325	50.832	0.323	51.155	0.321	51.476
19.25	50.786	0.336	51.122	0.334	51.456	0.332	51.788	0.330	52.118	0.327	52.445
19.50	51.726	0.343	52.069	0.341	52.410	0.339	52.749	0.336	53.085	0.335	53.420
19.75	52.671	0.350	53.021	0.347	53.368	0.346	53.714	0.343	54.057	0.341	54.398
20.00	53.619	0.357	53.976	0.355	54.331	0.353	54.684	0.350	55.034	0.348	55.382

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS

Gallons per Foot of Length

Outage Inches (H)	Tank Diameter in Inches								
	92	Interval	**93**	Interval	**94**	Interval	**95**	Interval	**96**
	46		**46.5**		**47**		**47.5**		**48**
0.25	0.083	0.000	0.083	0.001	0.084	0.000	0.084	0.001	0.085
0.50	0.235	0.001	0.236	0.001	0.237	0.001	0.238	0.002	0.240
0.75	0.430	0.003	0.433	0.002	0.435	0.002	0.437	0.003	0.440
1.00	0.662	0.004	0.666	0.003	0.669	0.004	0.673	0.004	0.677
1.25	0.925	0.005	0.930	0.005	0.935	0.005	0.940	0.005	0.945
1.50	1.215	0.006	1.221	0.007	1.228	0.006	1.234	0.007	1.241
1.75	1.529	0.009	1.538	0.008	1.546	0.008	1.554	0.008	1.562
2.00	1.867	0.010	1.877	0.010	1.887	0.010	1.897	0.010	1.907
2.25	2.226	0.012	2.238	0.012	2.250	0.012	2.262	0.012	2.274
2.50	2.605	0.014	2.619	0.014	2.633	0.014	2.647	0.015	2.662
2.75	3.002	0.017	3.019	0.016	3.035	0.017	3.052	0.016	3.068
3.00	3.418	0.019	3.437	0.019	3.456	0.019	3.475	0.018	3.493
3.25	3.851	0.021	3.872	0.022	3.894	0.021	3.915	0.021	3.936
3.50	4.300	0.024	4.324	0.024	4.348	0.023	4.371	0.024	4.395
3.75	4.765	0.027	4.792	0.026	4.818	0.026	4.844	0.026	4.870
4.00	5.245	0.029	5.274	0.029	5.303	0.029	5.332	0.029	5.361
4.25	5.739	0.032	5.771	0.032	5.803	0.032	5.835	0.031	5.866
4.50	6.248	0.035	6.283	0.035	6.318	0.034	6.352	0.034	6.386
4.75	6.770	0.038	6.808	0.038	6.846	0.037	6.883	0.037	6.920
5.00	7.305	0.041	7.346	0.041	7.387	0.041	7.428	0.040	7.468
5.25	7.853	0.045	7.898	0.043	7.941	0.044	7.985	0.043	8.028
5.50	8.414	0.047	8.461	0.047	8.508	0.047	8.555	0.047	8.602
5.75	8.986	0.051	9.037	0.050	9.087	0.050	9.137	0.050	9.187
6.00	9.571	0.054	9.625	0.053	9.678	0.054	9.732	0.053	9.785
6.25	10.166	0.058	10.224	0.057	10.281	0.057	10.338	0.056	10.394
6.50	10.773	0.061	10.834	0.061	10.895	0.060	10.955	0.060	11.015
6.75	11.391	0.065	11.456	0.064	11.520	0.064	11.584	0.063	11.647
7.00	12.019	0.069	12.088	0.067	12.155	0.068	12.223,	0.067	12.290
7.25	12.658	0.072	12.730	0.072	12.802	0.071	12.873	0.071	12.944
7.50	13.307	0.076	13.383	0.075	13.458	0.075	13.533	0.075	13.608
7.75	13.966	0.079	14.045	0.080	14.125	0.079	14.204	0.078	14.282
8.00	14.634	0.084	14.718	0.083	14.801	0.083	14.884	0.082	14.966
8.25	15.312	0.088	15.400	0.087	15.487	0.087	15.574	0.086	15.660
8.50	16.000	0.091	16.091	0.092	16.183	0.091	16.274	0.090	16.364
8.75	16.696	0.096	16.792	0.096	16.888	0.095	16.983	0.094	17.077
9.00	17.402	0.100	17.502	0.100	17.602	0.099	17.701	0.098	17.799
9.25	18.116	0.104	18.220	0.104	18.324	0.104	18.428	0.102	18.530
9.50	18.839	0.109	18.948	0.108	19.056	0.108	19.164	0.107	19.271
9.75	19.570	0.113	19.683	0.113	19.796	0.112	19.908	0.112	20.020

OUTAGE OF HORIZONTAL CYLINDRICAL TANKS
Gallons per Foot of Length

Outage Inches (H)	Tank Diameter in Inches 92	Interval	93	Interval	94	Interval	95	Interval	96
	46		46.5		47		47.5		48
10.00	20.310	0.118	20.428	0.117	20.545	0.116	20.661	0.116	20.777
10.25	21.058	0.122	21.180	0.122	21.302	0.121	21.423	0.120	21.543
10.50	21.814	0.127	21.941	0.126	22.067	0.125	22.192	0.125	22.317
10.75	22.577	0.132	22.709	0.131	22.840	0.130	22.970	0.129	23.099
11.00	23.349	0.136	23.485	0.136	23.621	0.135	23.756	0.134	23.890
11.25	24.128	0.141	24.269	0.140	24.409	0.140	24.549	0.139	24.688
11.50	24.914	0.147	25.061	0.145	25.206	0.144	25.350	0.144	25.494
11.75	25.708	0.151	25.859	0.150	26.009	0.150	26.159	0.148	26.307
12.00	26.510	0.156	26.666	0.155	26.821	0.154	26.975	0.153	27.128
12.25	27.318	0.161	27,479	0.160	27.639	0.159	27.798	0.158	27.956
12.50	28.133	0.166	28.299	0.166	28.465	0.164	28.629	0.163	28.792
12.75	28.956	0.171	29.127	0.170	29.297	0.169	29.466	0.169	29.635
13.00	29.785	0.176	29.961	0.175	30.136	0.175	30.311	0.173	30.484
13.25	30.620	0.182	30.802	0.181	30.983	0.179	31.162	0.179	31.341
13.50	31.463	0.187	31.650	0.186	31.836	0.185	32.021	0.183	32.204
13.75	32.311	0.193	32.504	0.191	32.695	0.190	32.885	0.190	33.075
14.00	33.166	0.198	33.364	0.197	33.561	0.196	33.757	0.194	33.951
14.25	34.028	0.203	34.231	0.203	34.434	0.201	34.635	0.200	34.835
14.50	34.896	0.209	35.105	0.207	35.312	0.207	35.519	0.205	35.724
14.75	35.769	0.215	35.984	0.213	36.197	0.213	36.410	0.210	36.620
15.00	36.649	0.220	36.869	0.219	37.088	0.218	37.306	0.217	37.523
15.25	37.535	0.226	37.761	0.225	37.986	0.223	38.209	0.222	38.431
15.50	38.426	0.232	38.658	0.231	38.889	0.229	39.118	0.228	39.346
15.75	39.324	0.237	39.561	0.237	39.798	0.235	40.033	0.233	40.266
16.00	40.226	0.244	40.470	0.242	40.712	0.241	40.953	0.239	41.192
16.25	41.135	0.250	41.385	0.248	41.633	0.246	41.879	0.246	42.125
16.50	42.049	0.256	42.305	0.254	42.559	0.252	42.811	0.252	43.063
16.75	42.969	0.261	43.230	0.260	43.490	0.259	43.749	0.257	44.006
17.00	43.893	0.268	44.161	0.266	44.427	0.265	44.692	0.263	44.955
17.25	44.823	0.274	45.097	0.273	45.370	0.271	45.641	0.269	45.910
17.50	45.759	0.280	46.039	0.279	46.318	0.277	46.595	0.275	46.870
17.75	46.699	0.287	46.986	0.285	47.271	0.283	47.554	0.281	47.835
18.00	47.645	0.293	47.938	0.291	48.229	0.289	48.518	0.288	48.806
18.25	48.595	0.299	48.894	0.298	49.192	0.296	49.488	0.294	49.782
18.50	49.550	0.306	49.856	0.304	50.160	0.302	50.462	0.301	50.763
18.75	50.511	0.312	50.823	0.310	51.133	0.309	51.442	0.307	51.749
19.00	51.476	0.318	51.794	0.317	52.111	0.315	52.426	0.314	52.740
19.25	52.445	0.326	52.771	0.323	53.094	0.322	53.416	0.320	53.736
19.50	53.420	0.332	53.752	0.330	54.082	0.328	54.410	0.326	54.736
19.75	54.398	0.339	54.737	0.337	55.074	0.335	55.409	0.333	55.742
20.00	55.382	0.346	55.728	0.343	56.071	0.342	56.413	0.339	56.752

TABLE C1 TEMPERATURE VOLUME CORRECTIONS FOR EMULSIFIED ASPHALT

LEGEND: t = Observed Temperature in Degrees Celsius (Fahrenheit)
M = Multiplier for Correcting Volumes to the Basis of 15.6°C (60°F)

***Multiplier (M) for °C is a close approximation.**

°C^{t}	°F	M*	°C^{t}	°F	M*	°C^{t}	°F	M*
10.0	50	1.00250	35.0	95	0.99125	60.0	140	0.98000
10.6	51	1.00225	35.6	96	0.99100	60.6	141	0.97975
11.1	52	1.00200	36.1	97	0.99075	61.1	142	0.97950
11.7	53	1.00175	36.7	98	0.99050	61.7	143	0.97925
12.2	54	1.00150	37.2	99	0.99025	62.2	144	0.97900
12.8	55	1.00125	37.8	100	0.99000	62.8	145	0.97875
13.3	56	1.00100	38.3	101	0.98975	63.3	146	0.97850
13.9	57	1.00075	38.9	102	0.98950	63.9	147	0.97825
14.4	58	1.00050	39.4	103	0.98925	64.4	148	0.97800
15.0	59	1.00025	40.0	104	0.98900	65.0	149	0.97775
15.6	60	1.00000	40.6	105	0.98875	65.6	150	0.97750
16.1	61	0.99975	41.1	106	0.98850	66.1	151	0.97725
16.7	62	0.99950	41.7	107	0.98825	66.7	152	0.97700
17.2	63	0.99925	42.2	108	0.98800	67.2	153	0.97675
17.8	64	0.99900	42.8	109	0.98775	67.8	154	0.97650
18.3	65	0.99875	43.3	110	0.98750	68.3	155	0.97625
18.9	66	0.99850	43.9	111	0.98725	68.9	156	0.97600
19.4	67	0.99825	44.4	112	0.98700	69.4	157	0.97575
20.0	68	0.99800	45.0	113	0.98675	70.0	158	0.97550
20.6	69	0.99775	45.6	114	0.98650	70.6	159	0.97525
21.1	70	0.99750	46.1	115	0.98625	71.1	160	0.97500
21.7	71	0.99725	46.7	116	0.98600	71.7	161	0.97475
22.2	72	0.99700	47.2	117	0.98575	72.2	162	0.97450
22.8	73	0.99675	47.8	118	0.98550	72.8	163	0.97425
23.3	74	0.99650	48.3	119	0.98525	73.3	164	0.97400
23.9	75	0.99625	48.9	120	0.98500	73.9	165	0.97375
24.4	76	0.99600	49.4	121	0.98475	74.4	166	0.97350
25.0	77	0.99575	50.0	122	0.98450	75.0	167	0.97325
25.6	78	0.99550	50.6	123	0.98425	75.6	168	0.97300
26.1	79	0.99525	51.1	124	0.98400	76.1	169	0.97275
26.7	80	0.99500	51.7	125	0.98375	76.7	170	0.97250
27.2	81	0.99475	52.2	126	0.98350	77.2	171	0.97225
27.8	82	0.99450	52.8	127	0.98325	77.8	172	0.97200
28.3	83	0.99425	53.3	128	0.98300	78.3	173	0.97175
28.9	84	0.99400	53.9	129	0.98275	78.9	174	0.97150
29.4	85	0.99375	54.4	130	0.98250	79.4	175	0.97125
30.0	86	0.99350	55.0	131	0.98225	80.0	176	0.97100
30.6	87	0.99325	55.6	132	0.98200	80.6	177	0.97075
31.1	88	0.99300	56.1	133	0.98175	81.1	178	0.97050
31.7	89	0.99275	56.7	134	0.98150	81.7	179	0.97025
32.2	90	0.99250	57.2	135	0.98125	82.2	180	0.97000
32.8	91	0.99225	57.8	136	0.98100	82.8	181	0.96975
33.3	92	0.99200	58.3	137	0.98075	83.3	182	0.96950
33.9	93	0.99175	58.9	138	0.98050	83.9	183	0.96925
34.4	94	0.99150	59.4	139	0.98025	84.4	184	0.96900
						85.0	185	0.96875

TEMPERATURE-VOLUME CORRECTIONS FOR DILUTED EMULSIFIED ASPHALT

Applicable only for 1 to 1 dilution

LEGEND: **°C/°F = Observed Temperature in Degrees Celsius (Fahrenheit)**
M = Multiplier for Correcting Volumes to the Basis of 15.6°C (60°F)

***Multiplier (M) for °C is a close approximation.**

°C	°F	M*	°C	°F	M*	°C	°F	M*
15.6	60	1.00000	32.2	90	0.99422	49.4	121	0.98700
16.1	61	0.99982	32.8	91	0.99400	50.0	122	0.98675
16.7	62	0.99964	33.3	92	0.99378	50.6	123	0.98650
17.2	63	0.99948	33.9	93	0.99356	51.1	124	0.98625
17.8	64	0.99930	34.4	94	0.99334	51.7	125	0.98600
18.3	65	0.99912	35.0	95	0.99312	52.2	126	0.98575
18.9	66	0.99894	35.6	96	0.99290	52.8	127	0.98550
19.4	67	0.99877	36.1	97	0.99268	53.3	128	0.98524
20.0	68	0.99858	36.7	98	0.99245	53.9	129	0.98498
20.6	69	0.99840	37.2	99	0.99222	54.4	130	0.98473
21.1	70	0.99822	37.8	100	0.99200	55.0	131	0.98447
21.7	71	0.99802	38.3	101	0.99177	55.6	132	0.98420
22.2	72	0.99783	38.9	102	0.99154	56.1	133	0.98394
22.8	73	0.99764	39.4	103	0.99131	56.7	134	0.98368
23.3	74	0.99744	40.0	104	0.99108	57.2	135	0.98341
23.9	75	0.99725	40.6	105	0.99085	57.8	136	0.98314
24.4	76	0.99706	41.1	106	0.99062	58.3	137	0.98288
25.0	77	0.99686	41.7	107	0.99039	58.9	138	0.98262
25.6	78	0.99666	42.2	108	0.99016	59.4	139	0.98235
26.1	79	0.99647	42.8	109	0.98992	60.0	140	0.98208
26.7	80	0.99628	43.3	110	0.98969	60.6	141	0.98182
27.2	81	0.99608	43.9	111	0.98945	61.1	142	0.98154
27.8	82	0.99587	44.4	112	0.98921	61.7	143	0.98126
28.3	83	0.99566	45.0	113	0.98896	62.2	144	0.98099
28.9	84	0.99546	45.6	114	0.98872	62.8	145	0.98072
29.4	85	0.99526	46.1	115	0.98848	63.3	146	0.98044
30.0	86	0.99505	46.7	116	0.98823	63.9	147	0.98016
30.6	87	0.99484	47.2	117	0.98798	64.4	148	0.97989
31.1	88	0.99464	47.8	118	0.98774	65.0	149	0.97962
21.7	89	0.99442	48.3	119	0.98750	65.6	150	0.97934
			48.9	120	0.98725			

GENERAL AGGREGATE SOURCE INFORMATION

GENERAL

Generally, only those sources, which have been sampled or tested within the last ten years, are listed. This listing additionally ranks sources in accordance with a frictional classification as defined herein for aggregates used in Hot Mix Asphalt (HMA) construction, and a durability class for coarse aggregates used in Portland Cement Concrete construction. Upon request, new sources or different combinations of beds within an existing source can be evaluated for classification for either type of use. These rankings do not in any way waive the normal quality requirements for the particular types of aggregates indicated in contract documents.

PORTLAND CEMENT CONCRETE AGGREGATES

Aggregates shall be produced from sources approved in accordance with the requirements of Office of Materials IM 409. The engineer may approve scalping of some portion of the coarser fraction.

All aggregates produced and inspected for intended use in contracts under Iowa Department of Transportation Specifications shall be stored in identifiable stockpiles unless they are being delivered as produced.

DURABILITY CLASSIFICATION

The coarse aggregates have been divided into three classes in accordance with their durability level as determined by performance or laboratory testing.

Class 2 durability aggregates will produce no deterioration of pavements of the non-interstate segments of the road system after 15 years and only minimal deterioration in pavements after 20 years.

Class 3 durability aggregates will produce no deterioration of pavements of non-interstate segments of the road system after 20 years of age and less than 5% deterioration of the joints after 25 years.

Class 3i durability aggregates will produce no deterioration of the interstate road system after 30 years of service and less than 5% deterioration of the joints after 35 years.

NOTE: Those sources with a “B” in their durability class designation may have 1/2 in. Bridge Deck Overlay/Repair material available.

HOT MIX ASPHALT AGGREGATES

Aggregates for HMA construction have been classified into five main functional types in accordance with their frictional characteristics. Those aggregates with the potential to develop the greatest amount of friction under traffic conditions are classified as Type 1 with the potential for friction decreasing as the type number increases. One or more friction types may be specified for use in pavement surface courses. If a type is not specified in the contract documents, Type 5 or better will be acceptable.

When aggregates of friction Type 1 through Type 4 are specified for construction, a source approval including bed limitations is required for each project. Tentative bed limitations are shown in this publication.

The frictional classification types are listed and defined in order of descending quality as follows.

Type 1: Aggregates, which are generally, a heterogeneous combination of minerals with coarse-grained microstructure of very hard particles (generally, a Mohs hardness range of 7 to 9) bonded together by a slightly softer matrix. These aggregates are typified by those developed for and used by the grinding-wheel industry such as calcinated bauxite (synthetic) and emery (natural). They are not available from Iowa sources. Due to their high cost, these aggregates would be specified only for use in extremely critical situations.

Type 2: Natural aggregates in this class are crushed quartzite and granites. The mineral grains in these materials generally have a Mohs hardness range of 5 to 7. Synthetic aggregates in this class are some air-cooled steel furnace slags and others with similar characteristics.

Type 3: Natural aggregates in this class are crushed traprocks, and/or crushed gravels. The crushed gravels shall contain 40% or more igneous and metamorphic particles. Synthetic aggregates in this class are the expanded shales with a Los Angeles abrasion loss less than 35 percent.

Type 4: Aggregates crushed from dolomitic or limestone ledges in which 80 percent of the grains are 20 microns or larger. The mineral grains in the approved ledges for this classification generally have a Mohs hardness range of 3 to 4. For natural gravels, the Type 5 carbonate (see below) particles, as a fraction of the total material, shall not exceed the non-carbonate particles by more than 20 percent.

The Friction Type 4D classification will no longer be a Friction designation. Friction Type 4D aggregates have been reclassified as Friction Type 5. Any source or bed combination can be reevaluated for a different Friction Classification by the Geology Section at the request of the Aggregate Producer.

Type 5: Aggregates crushed from dolomitic or limestone ledges in which 20 percent or more of the grains are 30 microns or smaller.

SOURCE LISTINGS - Explanation

The use of Xs in the PCC or HMA columns indicates use where no classification is required or, if required, has not been made.

NOTE: - indicates additional source restrictions.

Bed numbers shown for PCC aggregate are those on the formal source approval letter. Beds shown for HMA sources are those which have been used or have potential for use and are of the designated friction type.

Frictional Classification - as indicated on page 2
Hot Mix Asphalt - Type A and B

Durability Class for Portland Cement Concrete
Coarse Aggregate Fine Aggregate
("B" indicates acceptability for Bridge Deck Overlay/Repair)

Source Code Number - Used to identify sources on test requests and for data storage.

Specific Gravity
(DWU-Determine When Used)

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
29	**DES MOINES DIST 5**	**CRUSHED STONE**											
A29002	L&W QUARRIES INC	MEDIAPOLIS-LEONARD	SE	01	T071	R04W	2.65	3				15	1
										4	4	15- 18	
										5	5	20	
A29008	CESSFORD CONST CO	NELSON	NE	26	T072	R02W	2.62	3				21- 24	
										4	4	7- 20	
											4	15- 24	
										5	5	24- 27	
A29012	CESSFORD CONST CO	GEODE	NE	01	T069	R05W				4	4	11- 12	
										5	5	9- 13	
		SAND & GRAVEL											
A29502	CESSFORD CONST CO	SPRING GROVE	SW	36	T069	R03W		3		4	4		
							2.66		X				

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
01	**ADAIR DIST 4**	**CRUSHED STONE**											
A01002	SCHILDBERG CONST CO INC	MENLO	SE	17	T077	R31W				5	5	15 - 16	
											4	14	
A01006	SCHILDBERG CONST CO INC	HOWE	SW	01	T076	R31W					5	25	
A01008	SCHILDBERG CONST CO INC	JEFFERSON	NE	17	T077	R31W					5	20	
											5	25	
02	**ADAMS DIST 4**	**CRUSHED STONE**											
A02002	SCHILDBERG CONST CO INC	MT ETNA	SW	23	T073	R34W					4	11 - 13	
A02004	SCHILDBERG CONST CO INC	CORNING		10	T071	R34W					4	3 - 5	
		SAND & GRAVEL											
A02502	SCHILDBERG CONST CO INC	MT ETNA	NW	23	T073	R34W	2.67	2		4	4		
							2.67		X				
03	**ALLAMAKEE DIST 2**	**CRUSHED STONE**											
A03002	BRUENING ROCK PROD INC	WEXFORD	NE	36	T098	R03W	2.70	3i				1C - 5	
										4	4	1 - 8	
A03008	BRUENING ROCK PROD INC	MCCABE	NE	06	T097	R05W					4	1 - 6	
A03010	ROVERUD CONST INC	RUDE	SE	17	T100	R06W							
A03014	BRUENING ROCK PROD INC	HAMMELL-BOONIES	SW	02	T099	R06W		X		4	4	5 - 6	
A03018	ROVERUD CONST INC	SWENSON	SW	17	T096	R05W							
A03022	ROVERUD CONST INC	LIVINGOOD	SW	07	T096	R06W				4	4	4 - 7	
											4	2 - 7	
A03028	ROVERUD CONST INC	WELPER-JOHNSON	SW	35	T099	R04W							
A03034	RIEHM CONST CO INC	WILDE	SE	13	T099	R05W		X		4	4	1 - 5	
A03036	BRUENING ROCK PROD INC	SWENSON	SE	19	T096	R05W							
A03038	RIEHM CONST CO INC	RIEHM	SE	07	T100	R04W	DWU	3i		4	4	1 - 4	
A03040	BRUENING ROCK PROD INC	DEE	SE	21	T099	R04W	DWU	3iB		4	4	5A - 5D	
A03042	NIEMANN CONST CO	CHURCHTOWN	SW	29	T099	R04W					4	1 - 3	
										4	4	3	
A03046	BRUENING ROCK PROD INC	MOHS	SW	29	T096	R04W	DWU	2		5	5	1 - 2	
											5	1 - 4	
A03048	BRUENING ROCK PROD INC	POSTVILLE	SW	16	T096	R06W	2.61	3				6 - 8	
											4	2 - 5	
A03050	BRUENING ROCK PROD INC	GREEN	NW	16	T096	R06W	2.63	3		4	4	2 - 3A	
A03052	BRUENING ROCK PROD INC	ROSSVILLE	NE	35	T097	R05W	DWU			4	4	1 - 5	
A03054	BRUENING ROCK PROD INC	WEST RIDGE	NE	08	T098	R06W							
A03056	NIEMANN CONST CO	WAUKON	SW	05	T097	R05W							
A03060	NIEMANN CONST CO	HANOVER	NE	36	T099	R06W							
A03064	ROVERUD CONST INC	RAINBOW	SE	26	T097	R05W							
A03066	WILTGEN CONST CO	ELSBERND	NW	29	T097	R06W	DWU	3				2	
A03068	WILTGEN CONST CO	JEFFERSON	SW	30	T097	R05W							
		SAND & GRAVEL											
A03502	CARLSON MATERIALS CO	HARPERS FERRY	SW	07	T097	R02W	2.67	3iB		3	3		
							2.67		X				
A03506	BRUENING ROCK PROD INC	HAMMELL-BOONIES	SW	02	T099	R06W				4	4		
A03510	CARLSON MATERIALS CO	LONNING	SE	02	T099	R06W				4	4		
							DWU		X				
A03512	ROVERUD CONST INC	ZEZULKA	NE	11	T100	R04W				3	3		
							2.66		X				
A03516	ROVERUD CONST INC	HAMMELL	NW	15	T100	R03W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
04	**APPANOOSE DIST 5**	**CRUSHED STONE**											
A04016	L&W QUARRIES INC	LEMLEY EAST #5	CT	35	TO70	R19W	2.70	2		5	5	1 - 3	1
										5	5	6	
A04018	L&W QUARRIES INC	CLARKDALE #8	SE	15	TO69	R18W					5	4	
05	**AUDUBON DIST 4**	**SAND & GRAVEL**											
A05506	HALLETT MATERIALS CO	EXIRA	SW	08	TO78	R35W	2.68	3		4	4		
							2.66		X				
06	**BENTON DIST 6**	**CRUSHED STONE**											
A06002	BMC AGGREGATES LC	SMITH	NW	19	TO86	R12W	2.65	2		4	4	21 - 26	
A06004	WENDLING QUARRIES INC	GARRISON A	SE	28	TO85	R11W	2.67	2		4	4	6 - 16	
A06006	WENDLING QUARRIES INC	GARRISON B	NE	33	TO85	R11W	2.64	2		4	4	6 - 16	
A06008	WENDLING QUARRIES INC	BALLHEIM	NE	17	TO86	R12W					X		
A06012	COOTS MATERIALS CO INC	JABENS	SW	07	TO85	R11W	DWU	2				6 - 11	
							2.63	2		4	4	12	
										4	4	10 - 12	
A06014	WENDLING QUARRIES INC	VINTON-MILROY	S2	10	TO85	R10W					4		
A06016	COOTS MATERIALS CO INC	COOTS	SW	36	TO86	R11W					X		
A06018	WENDLING QUARRIES INC	PORK CHOP-EAST	NW	11	TO85	R09W					X		
A06020	WENDLING QUARRIES INC	PORK CHOP-WEST	NE	10	TO85	R09W							
A06022	WENDLING QUARRIES INC	LONG	SE	13	TO84	R09W					X		
		SAND & GRAVEL											
A06502	WENDLING QUARRIES INC	VINTON-MILROY	S2	10	TO85	R10W				4	4		
							2.65		X				
A06504	COOTS MATERIALS CO INC	MT AUBURN	SW	31	TO86	R10W				3	3		
							2.65		X				
A06506	WENDLING QUARRIES INC	PORK CHOP	CT	11	TO85	R09W				4	4		
							DWU		X				
07	**BLACK HAWK DIST 2**	**CRUSHED STONE**											
A07004	BMC AGGREGATES LC	WATERLOO SOUTH	NW	18	TO87	R12W	DWU	3				25	
										4	4	17 - 24	
										4	4	32 - 36	
										5	5	5 - 24	
A07008	BMC AGGREGATES LC	MORGAN	NE	15	TO89	R12W					5	1 - 3	
											5	4A - 4B	
A07014	NIEMANN CONST CO	GLORY	NE	36	TO87	R11W					4	3 - 4	
											5	1 - 4	
A07018	BMC AGGREGATES LC	RAYMOND-PESKE	SW	01	TO88	R12W	2.66	2		4	4	1B - 5	
										4	4	6 - 10	
A07020	BMC AGGREGATES LC	STEINBRON	SE	01	TO88	R11W	2.62	3i		X	X	1	
A07022	BMC AGGREGATES LC	MESSERLY	NE	08	TO90	R14W							
		SAND & GRAVEL											
A07504	BMC AGGREGATES LC	WATERLOO SAND	SW	09	TO89	R13W				3	3		
							2.65		X				
A07506	MANATT'S INC	ASPRO	NW	01	TO88	R13W				4	4		
							2.65		X				
A07508	BMC AGGREGATES LC	GILBERTVILLE		16	TO88	R12W				4	4		
							2.65		X				
A07512	ZEIEN S&G	ZEIEN	NW	23	TO87	R12W							
A07518	NIEMANN CONST CO	JANESVILLE	NE	14	TO90	R14W				3	3		
							2.66		X				

NOTE: 1 – AASHTO 67, GRADATION #5, 40% MAXIMUM; RESTRICTION DOES NOT APPLY TO STRUCTURAL CONCRETE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
08	**BOONE DIST 1**	**SAND & GRAVEL**											
A08504	KNIFE RIVER	JENSEN	SW	36	TO85	R25W							
A08526	KNIFE RIVER	POWERS		29	TO84	R28W							
09	**BREMER DIST 2**	**CRUSHED STONE**											
A09002	BMC AGGREGATES LC	FREDERIKA	NE	12	TO93	R13W					5	2 - 8	
A09004	NIEMANN CONST CO	DENVER-FOELSKE	NE	29	TO91	R13W				4	4	4 - 9	
A09006	NIEMANN CONST CO	TRIPOLI-PLATTE	SW	36	TO93	R13W	2.62	3i		4	4	1 - 5	
A09008	NIEMANN CONST CO	DENVER #2	NE	20	TO91	R13W							
		SAND & GRAVEL											
A09504	NIEMANN CONST CO	NOLTE	SE	31	TO92	R11W				4	4		
							2.65		X				
A09508	NIEMANN CONST CO	TRIPOLI-PLATTE	SW	36	TO93	R13W							
A09510	CROELL REDI-MIX	PLAINFIELD-ADAMS	NE	32	TO93	R14W	2.66		X				
A09512	NIEMANN CONST CO	BOEVERS	NE	31	TO92	R11W			X				
10	**BUCHANAN DIST 6**	**CRUSHED STONE**											
A10002	NIEMANN CONST CO	WESTON-LAMONT	NW	14	TO90	R07W	2.61	3iB				1 - 6	
										4	4	1 - 7	
A10004	NIEMANN CONST CO	BLOOM-JESUP	SW	32	TO89	R10W	2.63	3				2 - 5	
										4	4	1 - 7	
A10008	BRUENING ROCK PROD INC	OELWEIN	NW	02	TO90	R09W	2.65	3i		4	4	4 - 5	
										4	4	4 - 6	
A10010	NIEMANN CONST CO	HAZELTON	NW	11	TO90	R09W	2.60	3iB		4	4	4	
A10012	NIEMANN CONST CO	INDEPENDENCE	NW	14	TO88	R09W					5		
A10014	NIEMANN CONST CO	OELWEIN #1	SW	02	TO90	R09W				5	5	1 - 12	
A10016	NIEMANN CONST CO	OELWEIN #2	SE	03	TO90	R09W	DWU	3i		4	4	13 - 16	
A10018	NIEMANN CONST CO	EAST AURORA	SE	17	TO90	R07W				4	4	1 - 5	
A10022	BRUENING ROCK PROD INC	BROOKS	NW	02	TO88	R09W	2.60	3i		4	4	7	
											5	1 - 6	
A10024	NIEMANN CONST CO	RASMUSSEN #2	SE	21	TO88	R08W					5		
A10026	NIEMANN CONST CO	BRANDON	SE	27	TO87	R10W					5		
A10028	NIEMANN CONST CO	HERTZBERGER	NE	36	TO87	R10W					5		
A10030	NIEMANN CONST CO	SOUTH AURORA	NW	19	TO90	R07W	2.62	3iB			4	1 - 3	
A10032	NIEMANN CONST CO	SELLS	NW	25	TO88	R09W					5		
A10034	NIEMANN CONST CO	TROY MILLS	SE	30	TO87	R07W							
A10036	WENDLING QUARRIES INC	KILER	NW	34	TO87	R10W					4		
A10038	BMC AGGREGATES LC	WIDGER	SW	07	TO88	R10W	2.61	3i				1B	
										4	4	1A - 1B	
A10040	ZUPKE SAND & GRAVEL	ZUPKE-OELWEIN		09	TO90	R09W							
		SAND & GRAVEL											
A10504	NIEMANN CONST CO	WARD	NE	14	TO90	R07W				4	4		
							2.65		X				
A10506	MANATT'S INC	GREENLEY	SE	29	TO89	R09W				4	4		
							2.64		X				
A10510	NIEMANN CONST CO	HUFFMAN	SE	02	TO89	R08W				4	4		
							2.65		X				
A10514	NIEMANN CONST CO	HOLLERMAN	SE	26	TO90	R07W				4	4		
A10516	NIEMANN CONST CO	MILLER	NW	14	TO88	R09W	2.65		X				
A10518	MANATT'S INC	YEAROUS	SE	19	TO89	R09W	2.65		X				
A10520	BRUENING ROCK PROD INC	BROOKS	SW	02	TO88	R09W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
11	**BUENA VISTA DIST 3**	**SAND & GRAVEL**											
A11502	ROHLIN CONST CO INC	ROHLIN	SW	02	TO93	R38W				4	4		
A11504	MARTIN MARIETTA	RAILROAD	NE	03	TO93	R37W				3	3		
A11506	MARTIN MARIETTA	LINN GROVE	NW	25	TO93	R38W				4	4		
A11508	WETHERALL CONST CO	NEWELL	NW	01	TO90	R36W				4	4		
A11510	MARTIN MARIETTA	SIOUX RAPIDS		05	TO93	R36W				3	3		
A11512	BUENA VISTA COUNTY	MARATHON	SE	19	TO93	R35W				4	4		
A11514	LUNDELL CONST	STORM LAKE	SW	18	TO90	R36W				4	4		
A11516	HALLETT MATERIALS CO	SIOUX RAPIDS	W2	12	TO93	R37W				3	3		
A11518	KNIFE RIVER	MOLGAARD	NW	03	TO93	R38W							
12	**BUTLER DIST 2**	**CRUSHED STONE**											
A12004	GREENE LS CO	LUBBEN	NW	25	TO93	R17W					5	1 - 21	
A12008	GREENE LS CO	FLORRY-STEERE	CT	08	TO93	R17W					5	1 - 11	
A12010	CARLSON/BRUENING	CLARKSVILLE-ENGLE	NE	16	TO92	R15W							
A12014	NIEMANN CONST CO	OLTMANN	SE	08	TO91	R16W					X		
A12016	GREENE LS CO	WIEGMANN-BRISTOW	SE	23	TO92	R18W				X	X	1 - 11	
A12018	GREENE LS CO	NEYMEYER	SW	28	TO90	R18W							
A12020	GREENE LS CO	BRUNS #2	NW	21	TO91	R18W							
		SAND & GRAVEL											
A12502	CROELL REDI-MIX	CLARKSVILLE	NW	01	TO92	R16W	2.67	2		4	4		
							2.67		X				
A12504	SHELL ROCK S&G	BROOKS	NE	02	TO91	R15W	2.66	X		4	4		
							2.67		X				
A12508	GREENE LS CO	AUSTINVILLE	NW	23	TO90	R18W	2.64		X	3	3		
A12514	GREENE LS CO	DE VRIES	SW	28	TO90	R18W				4	4		
							2.63		X				
A12516	GREENE LS CO	JENSEN	S2	18	TO93	R16W				4	4		
A12518	NIEMANN CONST CO	SHELL ROCK-ADAMS	NE	03	TO91	R15W				3	3		
							2.66		X				
13	**CALHOUN DIST 3**	**SAND & GRAVEL**											
A13502	KNIFE RIVER	LAKE CITY	NE	26	TO86	R34W				4	4		
14	**CARROLL DIST 3**	**SAND & GRAVEL**											
A14506	MARTIN MARIETTA	POUND	SE	18	TO85	R33W				4	4		
A14510	TIEFENTHALER INC	LANESBORO	NW	17	TO85	R33W	2.72	2		4	4		
							2.68		X				
A14512	MARTIN MARIETTA	OPEN	SE	15	TO84	R34W				4	4		
A14514	TIEFENTHALER INC	MACKE		06	TO85	R33W	2.69	2		4	4		
							2.66		X				
A14516	KNIFE RIVER	RICHLAND	NE	23	TO83	R33W				4	4		
15	**CASS DIST 4**	**CRUSHED STONE**											
A15004	SCHILDBERG CONST CO INC	LEWIS	SE	17	TO75	R37W					4	10 - 11	
A15008	SCHILDBERG CONST CO INC	ATLANTIC MINE	NE	13	TO76	R37W					5	25	

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
16	**CEDAR DIST 6**	**CRUSHED STONE**											
A16002	WENDLING QUARRIES INC	HUNT	SW	10	T081	R04W	DWU	3iB		4	4	1	
A16004	WENDLING QUARRIES INC	LOWDEN-SCHNECKLOTH	NW	04	T081	R01W	DWU	3i				1	
										4	4	1 - 3	
A16006	WENDLING QUARRIES INC	STONEMILL	SE	14	T080	R03W	DWU	3iB		4	4	4	
A16010	WENDLING QUARRIES INC	PEDEN	NE	10	T079	R03W				5	5		
A16012	WEBER STONE CO INC	ONION GROVE	SE	14	T082	R02W	2.61	3i		4	4	1 - 7	
A16014	WENDLING QUARRIES INC	TOWNSEND	NW	02	T079	R02W							
A16018	WENDLING QUARRIES INC	LOWDEN-MASSILLON	NW	23	T082	R01W							
A16022	WENDLING QUARRIES INC	TRICON	N2	09	T082	R04W	DWU	3i		4	4	1	
		SAND & GRAVEL											
A16502	WENDLING QUARRIES INC	SHARPLISS	NW	12	T079	R03W				4	4		
							2.65		X				
A16506	WEBER STONE CO INC	ONION GROVE	SE	14	T082	R02W	2.65		X				
A16508	WENDLING QUARRIES INC	MASSILLON	CT	11	T082	R01W	2.65		X				
17	**CERRO GORDO DIST 2**	**CRUSHED STONE**											
A17008	MARTIN MARIETTA	PORTLAND WEST	NE	19	T096	R19W	2.75	3iB		4	4	1 - 8	
A17012	MARTIN MARIETTA	UBBEN	SW	26	T094	R20W	2.68	2				3	
										5	5	1 - 3	
A17020	MARTIN MARIETTA	MASON CITY	NE	29	T097	R20W	DWU	3i				7	
							2.73	3				7 - 9	
										4	4	8 - 9	
										X	X	1 - 6	
A17022	HOLCIM INC	HOLCIM	SE	19	T097	R20W	DWU	2				1 - 4	
							DWU	2				11 - 13	
A17024	HEARTLAND ASPHALT	RIVERVIEW	NE	29	T096	R19W				4	4	1 - 12	
		SAND & GRAVEL											
A17506	KNIFE RIVER	NELSON-FORBES	SW	27	T096	R19W				4	4		
A17512	NORTH IOWA S&G INC	WEPKING	NE	15	T097	R21W	DWU		X	3	3		
A17514	MARTIN MARIETTA	HOLCIM SAND	NE	19	T097	R20W	DWU	2		3	3		
							2.65		X				
A17518	HEARTLAND ASPHALT	AIRPORT	NE	08	T096	R21W				3	3		
18	**CHEROKEE DIST 3**	**SAND & GRAVEL**											
A18506	HALLETT MATERIALS CO	CHEROKEE SOUTH	NE	16	T091	R40W	2.70	2		3	3		
							2.69		X				
A18512	FABER & SON CONST CO	KILLIAM	SW	20	T093	R39W				4	4		
A18514	HIGMAN SAND & GRAVEL	MONTGOMERY	NE2	20	T093	R39W				4	4		
A18516	MARTIN MARIETTA	WASHTA #1	NE	30	T090	R41W				3	3		
A18518	MARTIN MARIETTA	QUIMBY	SW	15	T090	R41W				3	3		
A18520	MARTIN MARIETTA	QUIMBY-EAST	NW	06	T090	R40W				3	3		
A18526	HALLETT MATERIALS CO	CHEROKEE NORTH	SW	23	T092	R40W	2.70	2		3	3		
							2.67		X				
A18528	HIGMAN SAND & GRAVEL	WASHTA-BEAZLEY	SW	31	T090	R41W	DWU		X	3	3		
A18530	HIGMAN SAND & GRAVEL	PATTERSON		32	T091	R40W	2.69	2					
							DWU		X				
A18532	CHEROKEE COUNTY	WALKER		31	T090	R41W							
A18534	HALLETT MATERIALS CO	NELSON	CT	23	T092	R40W	2.67	2					
							2.68		X				
A18536	HIGMAN SAND & GRAVEL	BECK	NE	30	T093	R39W	DWU	2					
									X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
19	**CHICKASAW DIST 2**	**CRUSHED STONE**											
A19002	GREENE LS CO	TRACY	SE	29	TO94	R14W	2.55	2		4	4	9 - 10	
A19004	BRUENING ROCK PROD INC	DEERFIELD-MAHONEY	SE	33	TO97	R14W					X		
A19006	GREENE LS CO	HUNT	NE	29	TO94	R14W	2.57	2		4	4	9 - 10	
A19008	GREENE LS CO	BOICE	NE	16	TO95	R14W					5		
		SAND & GRAVEL											
A19504	GREENE LS CO	HUNT	NW	29	TO94	R14W				4	4		
A19506	BLAZEK S&G CO	BLAZEK	NW	32	TO96	R11W				4	4		
							2.66		X				
A19508	ROVERUD CONST INC	BUSTA	SE	23	TO96	R11W				4	4		
							2.65		X				
A19510	RIVER BEND ENTERPRISES	NASHUA	NE	31	TO94	R14W				X	X		
							2.66		X				
A19512	GREENE LS CO	PEARL ROCK	SE	31	TO94	R14W				4	4		
							2.65		X				
A19514	BRUENING ROCK PROD INC	NASHUA	SW	33	TO95	R14W	DWU		X				
A19516	NIEMANN CONST CO	REWOLDT	NE	25	TO94	R13W	2.64		X				
A19518	CARLSON MATERIALS CO	AGGLAND		31	TO96	R12W	2.64		X				
A19520	WILTGEN CONST CO	ROFONKE	NE SE	16	TO95	R14W							
A19522	CROELL REDI MIX	BUCKY'S	NW	03	TO95	R11W	2.65		X				
20	**CLARKE DIST 5**	**CRUSHED STONE**											
A20002	SCHILDBERG CONST CO INC	OSCEOLA	NW	12	TO72	R26W					5	1 - 10	
											X	1 - 4	1
21	**CLAY DIST 3**	**SAND & GRAVEL**											
A21506	DAVE'S S&G	EVERLY	SW	31	TO97	R38W	2.70	2		3	3		
							2.68		X				
A21508	MARTIN MARIETTA	SCHARNBURG	NE	11	TO96	R38W				4	4		
A21510	NORGAARD S&G	DICKENS	NW	20	TO96	R35W				3	3		
							2.70		X				
A21514	MARTIN MARIETTA	CORNELL	SW	27	TO94	R36W				4	4		
A21516	SIEH S&G	SPENCER #1	SW	24	TO96	R36W	2.69	2		3	3		
							2.66		X				
A21518	HALLETT MATERIALS CO	SPENCER #2	SW	05	TO97	R37W				4	4		
A21520	MARTIN MARIETTA	EVERLY	SE	06	TO96	R38W				4	4		
A21522	KNIFE RIVER	STAINS		30	TO97	R38W				4	4		
A21526	ROHLIN CONST CO INC	CLAY COUNTY	NW	20	TO96	R35W							
A21528	DAVE'S S&G	GOEKEN	NE	05	TO96	R38W	DWU	2					
A21530	ROHLIN CONST CO INC	BRAUNSCHWEIG		16	TO94	R36W							
A21532	CLAY COUNTY	ELSER	CT	03	TO94	R36W							
A21534	HALLETT MATERIALS CO	CLARK EVERLY	NW	06	TO96	R38W							
A21536	HALLETT MATERIALS CO	GILLETT GROVE	NE	03	TO94	R36W							
22	**CLAYTON DIST 2**	**CRUSHED STONE**											
A22002	KUHLMAN CONST CO	TWIN ROCK-SCHRADER	NW	14	TO94	R05W				4	4	1 - 11	
										4	4	3 - 11	
A22004	ROVERUD CONST INC	BENTE-ELKADER-WATSON	SW	12	TO93	R05W	2.66	2				6 - 9	
										4	4	1 - 9	
A22006	BRUENING ROCK PROD INC	MARQUETTE	NW	16	TO95	R03W	DWU	3i		4	4	1 - 3	
A22008	KUHLMAN CONST CO	ANDEREGG	SE	32	TO92	R02W	DWU			4	4	2 - 8	
A22010	KUHLMAN CONST CO	OSTERDOCK	SE	02	TO91	R03W	2.67	2				2 - 5	
										4	4	1 - 8	
A22012	KUHLMAN CONST CO	SCHMIDT	NE	33	TO91	R01W	2.66	3i				4B - 6	
										4	4	2 - 6	
A22014	ROVERUD CONST INC	BLUME	NE	09	TO93	R03W	2.64	2				1 - 7	
										4	4	1 - 12	

NOTE: 1 – FRICTION TYPE TO BE DETERMINED WHEN USED ON WINTERSET BEDS 1-4

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
22	**CLAYTON DIST 2**	**CRUSHED STONE**											
A22016	KUHLMAN CONST CO	GISLESON	NW	06	T095	R04W	2.66	3i		4	4	1 - 8	
										4	4	1 - 15	
A22018	ROVERUD CONST INC	ZURCHER	SE	01	T094	R05W				4	4		
A22020	KUHLMAN CONST CO	MUELLER	NE	30	T094	R03W	DWU	3i		4	4	1 - 8	
A22024	MIELKE'S QUARRY	SPOOK CAVE	NE	21	T095	R04W				4	4	1 - 2	
A22026	KUHLMAN CONST CO	DOERRING-LUANA	SE	05	T095	R05W					4		
A22030	KUHLMAN CONST CO	EBERHARDT	NW	27	T093	R05W	2.72	3		4	4	1 - 5	
											4	1 - 8	
A22032	KUHLMAN CONST CO	WELLMAN	NW	25	T092	R06W		X		X	4	1 - 6	
A22034	KUHLMAN CONST CO	KRUSE	NW	17	T092	R04W	2.70	3B		4	4	5 - 11	
							2.70	2B		4	4	5 - 12	
										4	4	2 - 12	
A22038	KUHLMAN CONST CO	FASSBINDER	SW	09	T092	R03W	2.67	3i		4	4	2B - 6	
A22040	KUHLMAN CONST CO	HARTMAN	NW	29	T091	R06W	2.68	3i		4	4	1 - 4	
A22042	ROVERUD CONST INC	MORAREND	CT	35	T092	R03W	2.67	X				1 - 8	
										4	4	1 - 10	
A22044	KUHLMAN CONST CO	BOGE	SW	18	T091	R02W							
A22046	KUHLMAN CONST CO	JOY SPRINGS-BURRACK	NW	19	T091	R06W	2.65	3i		4	4	1	
A22048	ROVERUD CONST INC	TUCKER	SW	18	T091	R05W							
A22056	ROVERUD CONST INC	MCGREGOR	NE	34	T095	R03W					4		
A22058	ROVERUD CONST INC	ST OLAF	SE	25	T094	R05W							
A22060	ROVERUD CONST INC	JOHNSON	NW	26	T093	R04W	2.64	3i		4	4	2 - 5	
										4	4	1 - 5	
A22062	ROVERUD CONST INC	SNY MAGILL	SE	22	T094	R03W	DWU	3i		4	4	6 - 10	
A22066	ROVERUD CONST INC	PETERSON	NW	09	T094	R06W							
A22068	RIVER CITY STONE INC	MILLVILLE	NW	10	T091	R02W	DWU	3i				1 - 8	
A22070	ROVERUD CONST INC	BERNHARD/GIARD	NW	35	T095	R04W	DWU	3i		4	4	1 - 3	
A22072	PATTISON BROS	CLAYTON TERMINAL		07	T093	R02W	DWU	3i		4	4	3 - 4	
								3		4	4	1	
A22074	RIVER CITY STONE INC	STRAWBERRY POINT	NE	19	T091	R06W	DWU	3i				1 - 2	
A22076	ROVERUD CONST INC	LARSON	NW	08	T093	R05W							
A22078	ROVERUD CONST INC	SMITH		07	T093	R06W							
A22080	KUHLMAN CONST CO	HILINE	NW	08	T091	R03W							
A22082	NIEMANN CONST CO	REIERSON	NW	20	T094	R06W							
A22084	CJ MOYNA & SONS	MOYNA		14	T093	R05W							
A22086	CJ MOYNA & SONS	WILLIE	SW	18	T093	R02W							
A22088	WILTGEN CONST CO	KEPPLER	NW	29	T094	R05W							
		SAND & GRAVEL											
A22510	ROVERUD CONST INC	BENTE	SE	15	T093	R05W	2.66	X		4	4		
							2.66		X				
A22512	KUHLMAN CONST CO	FAIRGROUND	NE	26	T093	R05W				4	4		
							2.66		X				
A22514	KUHLMAN CONST CO	JOY SPRINGS	SW	19	T091	R06W				X	X		
A22518	KUHLMAN CONST CO	THURN	CT	25	T092	R05W				3	3		
							2.65		X				
A22520	KUHLMAN CONST CO	WELTERLEN	SE	32	T091	R05W	2.65		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
23	**CLINTON DIST 6**	**CRUSHED STONE**											
A23002	WENDLING QUARRIES INC	BLOORE-ELWOOD	NW	08	T083	R02E	DWU	3i		4	4	1 - 2	
A23004	WENDLING QUARRIES INC	BEHR	SW	02	T081	R03E	2.61	3i		4	4	1 - 2	
A23006	WENDLING QUARRIES INC	SHAFFTON	NE	11	T080	R05E	DWU	3i		4	4	16 - 17	
							DWU	3		4	4	3 - 14	
							DWU	3				19 - 20	
										4	4	3 - 15	
A23010	WENDLING QUARRIES INC	GOOSE LAKE	SW	22	T083	R05E				4	4	1 - 10	
A23012	WENDLING QUARRIES INC	TEEDS GROVE	SW	03	T083	R06E					4		
A23016	WENDLING QUARRIES INC	LYONS	NW	18	T082	R07E					4		
A23026	WENDLING QUARRIES INC	MILL CREEK	NE	22	T082	R06E					4		
A23028	WENDLING QUARRIES INC	DELMAR	SE	06	T083	R04E							
A23030	WENDLING QUARRIES INC	EDON VALLEY		04	T083	R01E							
A23032	ANDERSON S&G	ANDERSON		23	T081	R03E							
A23034	PRESTON READY MIX	TRANSTAR	NE	25	T081	R05E							
		SAND & GRAVEL											
A23502	WENDLING QUARRIES INC	DOYLE	NE	30	T083	R07E				4	4		
							2.67		X				
A23504	WENDLING QUARRIES INC	BEHR	SW	02	T081	R03E	2.68	2		4	4		
							2.68		X				
A23506	WENDLING QUARRIES INC	SCHNECKLOTH	S2	10	T080	R05E				4	4		
							2.67		X				
A23508	WENDLING QUARRIES INC	GATEWAY	NE	27	T081	R06E				4	4		
							2.66		X				
A23510	WENDLING QUARRIES INC	SHAFFTON	N2	11	T080	R05E				4	4		
							2.66		X				
A23514	ANDERSON S&G	ANDERSON	NW	23	T081	R03E	2.68		X				
A23516	WENDLING QUARRIES INC	OLSON	NW	23	T081	R02E							
24	**CRAWFORD DIST 3**	**SAND & GRAVEL**											
A24512	HALLETT MATERIALS CO	DUNLAP	SE	27	T082	R41W	2.70	2		3	3		
							2.66		X				
A24514	NATURAL MATERIALS	DENISON	SE	28	T084	R39W	DWU	2		3	3		
							DWU		X				
25	**DALLAS DIST 4**	**SAND & GRAVEL**											
A25502	HALLETT MATERIALS CO	MESSERSCHMIDT	NW	28	T079	R27W	2.70	2		4	4		
							2.67		X				
A25510	HALLETT MATERIALS CO	PERRY	NW	01	T081	R29W	2.70	2		4	4		
							2.67		X				
A25512	HALLETT MATERIALS CO	VAN METER	SE	16	T078	R27W	2.68	2		3	3		
							2.66		X				
A25514	HALLETT MATERIALS CO	BOONEVILLE	S2	26	T078	R26W	2.68	2		3	3		
							DWU		X				
A25516	HALLETT MATERIALS CO	VAN METER SOUTH		21,22	T078	R27W	2.68	2		3	3		
							2.66		X				
A25518	MARTIN MARIETTA	RACCOON RIVER SAND		27,28	T078	R26W	DWU	2					
							DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
26	**DAVIS DIST 5**	**CRUSHED STONE**												
A26004	DOUDS STONE INC	LEWIS		W2	02	TO69	R12W	2.60	3		4	4	1	
											5	5	3 - 7	
												5	3 - 5	
											4	4	6 - 7	
A26006	DOUDS STONE INC	BROWN	SW	NW	02	TO69	R12W	2.60	3		4	4	1	
											5	5	3 - 7	
												5	3 - 5	
											4	4	6 - 7	
		SAND & GRAVEL												
A26502	DOUDS STONE INC	ELDON-FRANKLIN		SW	01	TO70	R12W	2.67		X				
27	**DECATUR DIST 5**	**CRUSHED STONE**												
A27002	SCHILDBERG CONST CO INC	GRAND RIVER		NW	22	TO70	R27W					5	12 - 14	
A27008	SCHILDBERG CONST CO INC	DECATUR		SE	32	TO69	R26W					X	7	1
												5	9 - 15	
28	**DELAWARE DIST 6**	**CRUSHED STONE**												
A28002	KUHLMAN CONST CO	SEDGEWICK #2		SW	36	TO90	R06W	2.66	3iB		4	4	3	
A28006	KUHLMAN CONST CO	SEDGEWICK #1		SW	36	TO90	R06W				4	4	1 - 3	
A28008	KUHLMAN CONST CO	EDGEWOOD WEST		CT	04	TO90	R05W	2.67	3i				2 - 7	
											4	4	1 - 7	
A28010	KUHLMAN CONST CO	TIBBOTT		SW	23	TO90	R04W	2.70	3i				1 - 5	
											4	4	1 - 7	
A28012	KUHLMAN CONST CO	BAUL		SE	22	TO89	R06W	2.69	3i		4	4	1 - 4	
A28014	KUHLMAN CONST CO	LOGAN		SW	10	TO88	R05W	2.69	3				2 - 8	
											4	4	1 - 8	
A28016	KUHLMAN CONST CO	WHITE		NW	02	TO88	R04W	2.72	3i		4	4	1 - 2	
A28020	BARD CONCRETE CO	DEUTMEYER		SW	13	TO88	R03W	DWU	3i		4	4	2 - 6	
A28030	KUHLMAN CONST CO	GRIEF		NE	18	TO87	R03W					4		
A28032	RIVER CITY STONE INC	SCHNITTJER-DELHI		NE	35	TO88	R04W							
A28038	KUHLMAN CONST CO	KUHLMAN		NW	06	TO90	R04W	2.70	3i		4	4	1B - 5	
A28040	BARD CONCRETE CO	KRAPFL		SE	23	TO89	R03W	2.69	3i		4	4	4	
											4	4	1 - 4	
A28042	KUHLMAN CONST CO	WALSTON-MASONVILLE		SE	21	TO89	R06W	2.69	3i				1 - 4	
											4	4	1 - 6	
A28044	NIEMANN CONST CO	DUNDEE		NE	20	TO90	R06W					4		
A28046	KUHLMAN CONST CO	PINS		NW	27	TO88	R03W							
A28050	KUHLMAN CONST CO	BUCK CREEK		NW	20	TO87	R04W							
A28052	RIVER CITY STONE INC	MANCHESTER		SW	09	TO88	R05W	DWU	3				5 - 8	
A28054	RIVER CITY STONE INC	WINCH	NW	SW	02	TO87	R04W							
A28056	RIVER CITY STONE INC	THORPE		NW	33	TO90	R05W							
A28058	RIVER CITY STONE INC	ROSSOW/MANCHESTER	NE	NW	16	TO88	R05W							
		SAND & GRAVEL												
A28502	KUHLMAN CONST CO	SEDGEWICK		SW	36	TO90	R06W				4	4		
								2.65		X				
A28504	BARD CONCRETE CO	TEGLER		NE	36	TO89	R03W				4	4		
								2.65		X				
A28506	BARD CONCRETE CO	DYERSVILLE		NW	26	TO89	R03W				4	4		
								2.65		X				
A28510	KUHLMAN CONST CO	LOGAN		SW	10	TO88	R05W	2.65		X				
A28514	KUHLMAN CONST CO	FERGESEN		NE	32	TO89	R06W				4	4		
								DWU		X				
A28520	RIVER CITY STONE INC	MANCHESTER		SW	10	TO88	R05W	2.65		X				
A28524	KUHLMAN CONST CO	LAKE DELHI		NW	14	TO88	R05W	2.64		X				

NOTE 1: FRICTION TYPE TO BE DETERMINED WHEN USED

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
29	**DES MOINES DIST 5**	**CRUSHED STONE**								
A29002	L&W QUARRIES INC	MEDIAPOLIS-LEONARD	SE 01 TO71 R04W	2.65	3				15	1
							4	4	15 - 18	
							5	5	20	
A29008	CESSFORD CONST CO	NELSON	NE 26 TO72 R02W	2.62	3				21 - 24	
							4	4	7 - 20	
								4	15 - 24	
							5	5	24 - 27	
A29012	CESSFORD CONST CO	GEODE	NE 01 TO69 R05W				4	4	11 - 12	
							5	5	9 - 13	
							4	4	17	
		SAND & GRAVEL								
A29502	CESSFORD CONST CO	SPRING GROVE	SW 36 TO69 R03W	DWU	3		4	4		
				2.66		X				
30	**DICKINSON DIST 3**	**SAND & GRAVEL**								
A30502	CONCRETE SAND & MATERIALS	MILFORD	12 TO98 R37W	2.70	2		3	3		
				2.66		X				
A30504	ROHLIN CONST CO INC	ROHLIN	NE 06 TO98 R36W				3	3		
A30506	HUMMEL S&G	FOSTORIA	NE 26 TO98 R37W				4	4		
A30508	HALLETT MATERIALS CO	FOSTORIA/LOST	32 TO98 R37W	2.71	2		3	3		
				2.67		X				
A30510	CEMSTONE S&G	EAST	NE 07 TO98 R36W	2.71	2		3	3		
				2.66		X				
A30512	DICKINSON CO	WESTPORT	NE 17 TO98 R38W				4	4		
A30514	HALLETT MATERIALS CO	MILFORD/LEITH	NE 04 TO98 R37W	DWU	2					
A30516	COHRS CONSTRUCTION INC	CROSBY	NW 21 T100 R37W							
A30518	COHRS CONSTRUCTION INC	SMITH	SE 06 TO98 R36W							
A30520	HALLETT MATERIALS CO	MILFORD/DERNER	W2 13 E2 14 TO98 R37W	DWU	2					
				DWU		X				
A30522	HALLETT MATERIALS CO	FODNESS	CT 23 T100 R36W							

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
31	**DUBUQUE DIST 6**	**CRUSHED STONE**											
A31002	RIVER CITY STONE INC	ROSE SPUR		27	TO90	R02E	2.66	3i				1 - 8	
										4	4	1 - 15	
A31006	KUHLMAN CONST CO	DYERSVILLE-SUNDHEIM	SE	32	TO89	R02W	2.66	3i		4	4	4 - 12	
										4	4	1 - 8	
A31008	RIVER CITY STONE INC	KLEIN-RICHARDSVILLE	NW	33	TO90	R01E	DWU	3i				3A - 4B	
										4	4	1 - 4	
A31010	RIVER CITY STONE INC	BROWN	NW	33	TO89	R02E	2.68	3i		4	4	3 - 9A	
										4	4	2 - 9	
A31014	BARD CONCRETE CO	KURT	N2	35	TO87	R02W	2.70	3iB		4	4	1 - 2	
A31018	RIVER CITY STONE INC	MELOY	NW	23	TO87	R01E	DWU	3i		4	4	1 - 3	
A31020	RIVER CITY STONE INC	SCHLITCHE	SE	11	TO89	R02W	DWU	3i		4	4	1 - 4	
A31024	KUHLMAN CONST CO	JOHNS CREEK	SW	36	TO88	R02W	2.69	3i				3 - 4	
										4	4	1 - 4	
A31026	WENDLING QUARRIES INC	ARNSDORF	SE	25	TO87	R02E	DWU	3i		4	4	1 - 2	
A31028	RIVER CITY STONE INC	THOLE	NW	21	TO87	R02E	DWU	3i			4	1 - 2	1
A31030	RIVER CITY STONE INC	KEMP	NE	09	TO89	R01W					4		
A31034	RIVER CITY STONE INC	HERMSEN	NE	33	TO90	R02W					4		
A31036	RIVER CITY STONE INC	BALLTOWN	SE	05	TO90	R01E							
A31038	RIVER CITY STONE INC	HARTBECKE	SW	21	TO88	R01W					4		
A31040	RIVER CITY STONE INC	KENNEDY	NW	03	TO88	R01W					4		
A31042	RIVER CITY STONE INC	GANSEN	NW	09	TO87	R02E					4		
A31046	WENDLING QUARRIES INC	DECKER	SE	24	TO87	R02E	DWU	3i		4	4	1 - 5	
A31048	RIVER CITY STONE INC	MCDERMOTT	NE	35	TO88	R01W	2.65	3i		4	4	2	
A31050	RIVER CITY STONE INC	PLOESSEL-DYERSVILLE	N2	07	TO88	R02W	2.74	3i		4	4	3 - 5	
A31052	KUHLMAN CONST CO	EPWORTH-KIDDER	SW	02	TO88	R01W							
A31054	RIVER CITY STONE INC	MERRITT	SE	05	TO89	R02E							
A31056	RIVER CITY STONE INC	RUBIE	SE	06	TO88	R03E	DWU	3iB		4	4	5 - 9	2
A31058	RIVER CITY STONE INC	HOLY CROSS	SW	12	TO90	R02W							
A31060	BARD CONCRETE CO	EAST CASCADE	SE	22	TO87	R01W	2.71	3i		4	4	2 - 5	
A31064	RIVER CITY STONE INC	WEBER	NW	32	TO89	R02E	2.67	3i		4	4	3 - 9A	
A31066	RIVER CITY STONE INC	FILLMORE	SW	26	TO87	R01W	2.70	3i		4	4	2 - 4	
		SAND & GRAVEL											
A31502	AGGREGATE MATLS.-FLYNN	NINE MILE ISLAND	NE	24	TO88	R03E	2.66	3i		3	3		
							2.66		X				
A31504	BARD CONCRETE CO	SAUSER PROPERTY	NW	36	TO87	R02W				4	4		
							2.66		X				
A31512	BARD CONCRETE CO	BURKLE	SW	19	TO89	R02W	2.66		X				
A31514	RIVER CITY STONE INC	FILLMORE	CT	26	TO87	R01W	2.66		X				

NOTE 1: TOP 17.0' OF BED 2
NOTE 2: TOP 6.0' OF BED 9

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
32	**EMMET DIST 3**	**SAND & GRAVEL**											
A32502	HALLETT MATERIALS CO	ESTHERVILLE	N2	03	TO99	R34W	2.70	2		3	3		
							DWU		X				
A32506	EMMET COUNTY	FREY	NW	21	T100	R34W				4	4		
A32514	BOGGESS CONST	WALLINGFORD		07	TO98	R33W					4		
							DWU		X				
A32518	ROHLIN CONST CO INC	EGELAND		20	TO98	R33W				4	4		
A32520	ROHLIN CONST CO INC	YOUNG	NE	19	TO98	R32W				4	4		
A32522	ESTHERVILLE ROCK & GRAVEL	OLD ESTHERVILLE S&G		30	TO99	R33W							
A32524	EMMET COUNTY	PETERSON	SW	34	T100	R34W							
A32526	ROHLIN CONST CO INC	DAVID YOUNG	NE	29	TO98	R33W				4	4		
A32530	HALLETT MATERIALS CO	ESTHERVILLE/WHITE	SW	16	T100	R34W	DWU	2		4	4		
							DWU		X				
A32534	ROHLIN CONST CO INC	ENERSON		28	T100	R34W				4	4		
A32538	ESTHERVILLE ROCK & GRAVEL	JENSEN	NW	03	T099	R34W	DWU	2					
							DWU		X				
A32540	HALLETT MATERIALS CO	FISHER	NE	33	TO98	R32W							
A32542	HALLETT MATERIALS CO	GRAETTINGER	SE	33	TO98	R33W				4	4		
A32544	DUININCK BROS INC	ANDERSON		7,8	T100	R34W							
33	**FAYETTE DIST 2**	**CRUSHED STONE**											
A33002	NIEMANN CONST CO	ELDORADO-JACOBSEN	SW	17	TO95	R08W	2.69	3iB		5	5	4 - 6B	
A33004	NIEMANN CONST CO	HOUG	SW	11	TO94	R08W				5	5	1 - 9	
A33006	NIEMANN CONST CO	MARYVILLE	SE	24	TO91	R07W	2.69	3i		4	4	1 - 2	
A33010	WILTGEN CONST CO	VOSHELL	NW	21	TO93	R07W				X	X	1 - 4	
A33016	NIEMANN CONST CO	MAYNARD	NE	23	TO92	R09W					X		
A33018	NIEMANN CONST CO	FAIRBANK	SW	28	TO91	R10W		X		4	4	5	
											4	1 - 5	
A33020	NIEMANN CONST CO	YEAROUS	SW	19	TO93	R08W				4	4	1 - 10	
A33022	NIEMANN CONST CO	MILLER	SW	35	TO95	R10W				4	4	1 - 8	
A33024	NIEMANN CONST CO	WAUCOMA	NW	25	TO95	R10W	2.69	3iB		5	5	2 - 4	
A33026	WILTGEN CONST CO	LYNCH	NW	05	TO95	R10W				4	4	1 - 5	
A33030	NIEMANN CONST CO	SCHWEMMAN-ST LUCAS	NE	29	TO95	R09W				X	X		
A33032	BRUENING ROCK PROD INC	LANDIS	SE	12	TO93	R08W		X		4	4	1 - 5	
A33034	NIEMANN CONST CO	MCDONOUGH	SE	36	TO94	R08W							
A33036	NIEMANN CONST CO	GRAHAM-HAWKEYE	SW	06	TO94	R09W		X		4	4	1 - 4	
A33038	NIEMANN CONST CO	PAPE	NE	28	TO95	R08W	DWU	3iB		5	5	3 - 5	
A33040	NIEMANN CONST CO	SINNOTT		25	TO93	R09W							
		SAND & GRAVEL											
A33506	NIEMANN CONST CO	ALPHA	NW	03	TO94	R10W	2.64	X		4	4		
							2.64		X				
A33508	CARLSON MATERIALS CO	DURSCHER	NW	03	TO94	R07W					4		
A33510	ZUPKE S&G	RANDALIA	NW	29	TO93	R09W				4	4		
							2.66		X				
A33512	NIEMANN CONST CO	WADENA	NE	25	TO93	R07W				4	4		
							2.66		X				
A33518	KUHLMAN CONST CO	BASSETT	SE	11	TO91	R07W				4	4		
							2.65		X				
A33520	BRUENING ROCK PROD INC	OELWEIN SAND	NE	09	TO91	R09W	2.65		X				
A33522	BRUENING ROCK PROD INC	PAPE	SE	08	TO95	R08W	2.65		X				
A33524	CROELL REDI-MIX	ROGERS		04	TO94	R07W	2.66		X				
A33526	WILTGEN CONST CO	ELDORADO	NE	13	TO95	R09W							
A33528	NIEMANN CONST CO	KASEMEIER	SE	19	TO93	R10W	DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
34	**FLOYD DIST 2**	**CRUSHED STONE**											
A34002	GREENE LS CO	CARVILLE-BUNN	SW	23	T095	R15W	2.63	2		4	4	1 - 4	
A34004	GREENE LS CO	MAXON	SE	07	T094	R17W	2.68	2				4C - 19	
										5	5	1 - 17	
A34006	GREENE LS CO	JOHLAS	SW	07	T094	R15W					X		
A34008	GREENE LS CO	WARNHOLTZ	SW	09	T096	R16W	2.70	3i		5	5	1 - 4	
							2.68	2		4	4	17 - 18	
											X	1 - 18	
A34010	GREENE LS CO	LACOSTA	SE	25	T097	R17W	2.67	3i		5	5	1 - 4	
										5	5	1 - 8	
										4	4	9 - 14	
A34012	GREENE LS CO	WILLIAMS	NW	29	T096	R18W							
A34014	BRUENING ROCK PROD INC	HANNMANN	NE	20	T094	R15W							
A34018	CROELL REDI-MIX	JONES	N	26	T097	R17W							
		SAND & GRAVEL											
A34502	GREENE LS CO	ROCKFORD	SE	15	T095	R18W	2.68	2		3	3		
							2.65		X				
A34506	GREENE LS CO	LENT	NE	08	T096	R16W				4	4		
A34510	GREENE LS CO	BRACKEL	NE	17	T094	R17W				4	4		
A34514	GREENE LS CO	LITTLE CEDAR	NW	01	T095	R15W	2.65		X	3	3		
A34516	GREENE LS CO	CEDAR ACRE RESORTS	E2	17	T095	R15W	2.65		X				
A34518	GREENE LS CO	ENABNIT	NW	21	T094	R17W							
35	**FRANKLIN DIST 2**	**CRUSHED STONE**											
A35002	MARTIN MARIETTA	DOWS	NE	30	T091	R22W				4	4	1 - 4	
										4	4	1 - 12	
										4	4	7 - 12	
										5	5	5 - 6	
A35006	MARTIN MARIETTA	HIBNESS	SE	22	T091	R20W	2.58	3				1 - 4A	
										4	4	1 - 12	
A35010	GREENE LS CO	MILLER	NE	13	T091	R19W					4	1 - 5	
A35016	GREENE LS CO	AYRES		01	T092	R19W							
		SAND & GRAVEL											
A35502	CARLSON MATERIALS CO	GENEVA	SW	07	T091	R19W	2.68	2		3	3		
							2.64		X				
A35508	MARTIN MARIETTA	STUCK	SW	30	T091	R22W				4	4		
A35512	MARTIN MARIETTA	ANDERSON-POPEJOY	NE	28	T090	R22W	2.68		X	3	3		
A35514	CARLSON MATERIALS CO	KOCH	SW	08	T091	R19W				4	4		
							2.69		X				
A35516	KNIFE RIVER	PETERS	SW	04	T092	R20W				3	3		
							2.65		X				
A35518	KNIFE RIVER	REINKE	SW	22	T091	R20W				4	4		
A35520	KNIFE RIVER	BRANDT	N2	34	T090	R19W				4	4		
							2.68		X				
A35522	MARTIN MARIETTA	RASH	SE	27	T090	R22W				4	4		
							2.63		X				
36	**FREMONT DIST 4**	**CRUSHED STONE**											
A36002	SCHILDBERG CONST CO INC	THURMAN	NW	23	T070	R43W					4		
37	**GREENE DIST 1**	**SAND & GRAVEL**											
A37504	HALLETT MATERIALS CO	JEFFERSON	SW	04	T083	R31W	2.66	2		4	4		
							2.64		X				
A37514	ARCADIA LIMESTONE CO	WRIGHT	NW	05	T084	R32W				4	4		
							2.66		X				
A37520	GREENE CO REDI MIX	HAMILTON		27	T083	R30W	2.59		X				
A37522	KNIFE RIVER	HAUPERT		20	T084	R30W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
38	**GRUNDY DIST 1**	**SAND & GRAVEL**												
A38504	CARLSON MATERIALS CO	HERONIMOUS		SE	35	TO88	R17W	2.63		X				
A38506	CARLSON MATERIALS CO	MEESTER	NE	NE	12	TO88	R17W	2.63		X				
39	**GUTHRIE DIST 4**	**SAND & GRAVEL**												
A39502	KNIFE RIVER	HEILAND		SW	29	TO79	R30W				4	4		
A39506	BUTTLER CONST CO	BAYARD		NE	22	TO81	R32W				4	4		
A39508	MCALISTER AGGREGATES LLC	L & L		NE	33	TO78	R31W				4	4		
40	**HAMILTON DIST 1**	**CRUSHED STONE**												
A40006	MARTIN MARIETTA	GRANDGEORGE		SE	18	TO89	R25W					5	3 - 5	
		SAND & GRAVEL												
A40512	KNIFE RIVER	ANDERSON			12	TO87	R26W							
41	**HANCOCK DIST 2**	**CRUSHED STONE**												
A41002	BMC AGGREGATES LC	GARNER NORTH		SE	11	TO95	R24W	2.77	3iB		4	4	1 - 4	
								2.77	3i		4	4	6	
A41004	BMC AGGREGATES LC	GARNER SOUTH-WIELAND		NW	13	TO95	R24W	2.77	3iB		4	4	1 - 4	
								2.77	3i		4	4	6	
		SAND & GRAVEL												
A41504	HANCOCK COUNTY	HUTCHINS		E2	27	TO96	R26W					4		
A41506	HANCOCK COUNTY	KLEMME			26	TO95	R24W					4		
A41510	NUCKOLL'S CONCRETE SERVICES INC	BRITT			34	TO96	R26W	DWU	2		3	3		
								DWU		X				
A41518	HANCOCK COUNTY	AUSTIN		NE	11	TO97	R25W							
42	**HARDIN DIST 1**	**CRUSHED STONE**												
A42002	MARTIN MARIETTA	ALDEN		NW	20	TO89	R21W	2.59	3iB		4	4	0 - 3	1
								DWU	3iB				3	
								DWU	3				0 - 1	
A42004	GERHKE QUARRIES INC	GIFFORD		NW	04	TO86	R19W					5		
		SAND & GRAVEL												
A42502	WELDON BROS CONST CO	IOWA FALLS		NW	20	TO89	R20W	2.65	2		4	4		
								2.68		X				
A42510	MARTIN MARIETTA	JANSSEN		SE	34	TO89	R20W	2.65			4	4		
								2.65		X				
A42512	HARDIN AGGREGATES INC	GIFFORD		SW	31	TO87	R19W				4	4		
								2.66		X				
A42524	KNIFE RIVER	GRIFFEL		SE	31	TO89	R19W				3	3		
A42528	KNIFE RIVER	LLOYD			04	TO86	R19W	DWU			4	4		

NOTE 1: WHEN BED 2 IS VISUALLY APPARENT, IT SHALL NOT EXCEED A THICKNESS OF ONE FOOT IN FULL-FACE OPERATION.

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
43	**HARRISON DIST 4**	**CRUSHED STONE**											
A43002	SCHILDBERG CONST CO INC	LOGAN		19	T079	R42W				5	5	25E	
										5	5	25C- 25E	
											4	26	
A43004	NATURAL MATERIALS	LOGAN		17	T079	R42W				5	5	25E	
										5	5	25C- 25E	
											4	26	
		SAND & GRAVEL											
A43506	SCHEMMER LS INC	LOGAN	SE	08	T079	R42W				3	3		
							DWU		X				
A43512	HALLETT MATERIALS CO	WOODBINE-MCCANN	SW	29	T081	R41W	2.68	3		3	3		
							2.64		X				
A43514	NATURAL MATERIALS	LOGAN		17	T079	R42W							
44	**HENRY DIST 5**	**CRUSHED STONE**											
A44002	COOTS MATERIALS CO INC	SMITH	SE	17	T071	R06W							
A44006	HENRY COUNTY	LEEPER	NE	18	T071	R06W	DWU	2		4	4	8 - 11	
A44008	DOUDS STONE INC	TWEEDY	SW	36	T071	R06W				4	4	13- 14	
										5	5	9 - 14	
		SAND & GRAVEL											
A44502	CESSFORD CONST CO	NORTH ROME	SW	29	T072	R07W				4	4		
							2.66		X				
A44504	IDEAL SAND CO	ENSMINGER-ROME	NW	32	T072	R07W	2.67		X				
45	**HOWARD DIST 2**	**CRUSHED STONE**											
A45002	ROVERUD CONST INC	ECKERMAN	NW	33	T100	R11W	2.61	2		X	X	8 - 9	
A45006	BRUENING ROCK PROD INC	NELSON	NE	33	T099	R13W	2.54	2		4	4	1 - 3	
							2.54	2		4	4	8 - 9	
A45008	BRUENING ROCK PROD INC	DOTZLER	NE	23	T099	R12W	2.50	3		4	4	7 - 10A	
A45010	BRUENING ROCK PROD INC	DALEY	NE	11	T098	R11W	2.59	3		4	4	9 - 11	
A45014	FALK CONST CO	CECELIA	SE	08	T097	R14W					5		
A45018	BRUENING ROCK PROD INC	LE ROY	NW	10	T100	R14W					X		
A45020	BRUENING ROCK PROD INC	RIECKS	NW	24	T100	R11W							
A45022	BRUENING ROCK PROD INC	MAUER	SE	13	T100	R13W							
A45024	BRUENING ROCK PROD INC	MAPLE LEAF	SE	04	T098	R13W							
A45026	BRUENING ROCK PROD INC	BRUENING BROTHERS #1	SE	22	T100	R11W						1 - 3	
A45028	BRUENING ROCK PROD INC	ELMA	NW	06	T097	R13W	DWU	3		4	4	2 - 3B	
A45030	BRUENING ROCK PROD INC	DIEKEN-TANK	SE	24	T100	R13W							
A45032	ROVERUD CONST INC	KITCHEN		13	T100	R12W							
		SAND & GRAVEL											
A45502	BRUENING ROCK PROD INC	MAPLE LEAF-POTTER	SE	04	T098	R13W				4	4		
A45504	ROVERUD CONST INC	ECKERMAN	NW	33	T100	R11W	DWU	3		4	4		
							2.65		X				
A45508	CARLSON MATERIALS CO	SOVEREIGN	SW	01	T098	R12W	DWU	3		3	3		
							2.65		X				
A45514	CARLSON MATERIALS CO	EASTLAND	NE	26	T100	R14W				3	3		
A45516	CARLSON MATERIALS CO	FREIDERICH	NE	15	T098	R14W				3	3		
							2.67		X				
A45518	BRUENING ROCK PROD INC	ELMA	NW	06	T097	R13W	2.67		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
46	**HUMBOLDT DIST 2**	**CRUSHED STONE**											
A46006	MARTIN MARIETTA	HODGES	NE	32	T092	R28W	2.60	3i		4	4	10 - 18	
							DWU	3i		5	5	4 - 8	
A46014	MARTIN MARIETTA	PEDERSEN	SW	28	T092	R28W	2.59	3i		5	5	4 - 13	
							2.58	3i		5	5	4 - 20	
							2.57	3i		5	5	14 - 20	
A46016	KNIFE RIVER	ERICKSON		30	T091	R28W							
		SAND & GRAVEL											
A46504	MARTIN MARIETTA	PETERSON	SW	27	T092	R29W				4	4		
A46512	NORTHWEST MATERIALS	WARREN	SW	08	T092	R30W	DWU			X	X		
A46516	KNIFE RIVER	ERICKSON		30	T091	R28W				3	3		
A46518	MARTIN MARIETTA	PEDERSEN	SW	28	T092	R28W			X				
47	**IDA DIST 3**	**SAND & GRAVEL**											
A47502	HALLETT MATERIALS CO	BATTLE CREEK		05	T086	R41W				3	3		
A47504	HIGMAN SAND & GRAVEL	CROCKER	NW	06	T089	R41W							
48	**IOWA DIST 6**	**SAND & GRAVEL**											
A48502	MARENGO READY MIX	KIMMICH	SE	24	T081	R11W				4	4		
							2.66		X				
A48506	WENDLING QUARRIES INC	MARENGO	NW	22	T081	R11W	2.66		X				
A48508	MARENGO READY MIX	DISTERHOFF	SE	34	T081	R10W	2.66		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
49	**JACKSON DIST 6**	**CRUSHED STONE**											
A49002	BELLEVUE S&G CO	BELLEVUE	SW	25	T087	R04E	2.67	3i		4	4	1 - 3	
A49004	BELLEVUE S&G CO	LAMOTT	NW	02	T086	R03E				4	4		
A49008	WENDLING QUARRIES INC	IRON HILL	SW	16	T085	R02E	DWU	3i		4	4	3 - 6	
										4	4	1 - 6	
A49010	WENDLING QUARRIES INC	ANDREW	NW	21	T085	R03E	2.70	3iB		4	4	1B - 3	
										4	4	1 - 7	
A49012	WENDLING QUARRIES INC	FROST	SE	16	T084	R03E	DWU	3iB		4	4	1A - 1D	
										4	4	1 - 2	
A49016	WENDLING QUARRIES INC	WEIS	SE	22	T085	R04E					4		
A49018	WENDLING QUARRIES INC	PATASKA	NW	23	T085	R05E					4		
A49020	WENDLING QUARRIES INC	PRESTON	SW	26	T084	R05E	2.67	3i		4	4	7 - 10	
										4	4	1 - 10	
A49021	PRESTON READY MIX	PRESTON R/M	SW	26	T084	R05E	2.67	3i		4	4	7 - 10	
										4	4	1 - 10	
A49022	WENDLING QUARRIES INC	BELLEVUE	SE	23	T086	R04E				4	4		
A49024	WENDLING QUARRIES INC	MAQUOKETA EAST	SW	07	T084	R03E	DWU	3i				1 - 8	
							2.70	3i		4	4	7 - 8	
A49026	WENDLING QUARRIES INC	MILES	SW	20	T084	R06E					4		
A49028	WENDLING QUARRIES INC	FULTON	SW	25	T085	R02E	DWU	3i		4	4	2	
										4	4	1 - 2	
A49030	BELLEVUE S&G CO	SPRINGBROOK		15	T085	R04E				4	4		
A49032	WENDLING QUARRIES INC	OTTER CREEK-GLAHN	CT	21	T086	R02E							
A49034	WENDLING QUARRIES INC	KILBURG	NW	21	T085	R05E							
A49040	WENDLING QUARRIES INC	JOINERVILLE-HAMANN	SE	20	T084	R02E				4	4	1 - 3	
A49042	WENDLING QUARRIES INC	PETERSON		24	T084	R06E				4	4	1 - 2	
A49044	WENDLING QUARRIES INC	FRANK	NW	14	T087	R04E							
A49046	WENDLING QUARRIES INC	ROWAN	NE	25	T086	R03E							
A49048	PRESTON READY MIX	DRURY	CT	32	T085	R06E							
A49050	RIVER CITY STONE INC	MARSHALL	NW	01	T084	R06E							
A49052	WENDLING QUARRIES INC	STILLMUNKES		10	T085	R05E							
A49054	DUANE KUNDE	KUNDE	E2	33	T084	R05E							
A49058	WENDLING QUARRIES INC	61 ROAD CUT	N2	31	T084	R03E	2.67	3i		4	4	1	
A49060	BELLEVUE S&G CO	ST DONATUS		18	T087	R04E							
A49062	PRESTON READY MIX	JOHNSON		31	T084	R04E							
A49064	BELLEVUE S&G CO	VEACH		01	T085	R02E							
A49066	BELLEVUE S&G CO	MOREHEAD	NW	13	T085	R01E							
		SAND & GRAVEL											
A49504	WENDLING QUARRIES INC	KNIPELMEYER	NE	36	T087	R04E				4	4		
							2.64		X				
A49506	BELLEVUE S&G CO	BELLEVUE	E2	01	T086	R04E	2.64	3iB		3	3		
							2.68		X				
A49510	WENDLING QUARRIES INC	MAQUOKETA	NE	13	T084	R02E				4	4		
							2.65		X				
A49516	WENDLING QUARRIES INC	TURNER	NE	07	T084	R07E	2.63	3iB		3	3		
							2.65		X				
A49520	WENDLING QUARRIES INC	BALDWIN	SW	28	T084	R01E	2.66		X				
A49522	CENTURY READY MIX	EWING	NW	02	T084	R01E	DWU		X				
A49524	BELLEVUE S&G CO	GRIEBEL	SE	25	T087	R04E	DWU	3B		4	4		
							2.67		X				
A49526	BELLEVUE S&G CO	BELLEVUE FARM	SE	25	T087	R04E	DWU	3i					
							DWU		X				
A49528	AGGREGATE MATERIALS CO	STEVENS	NW	02	T084	R01E	2.65		X				
A49530	PRESTON READY MIX	PETERSEN	SW	18	T084	R07E	DWU	3iB		4	4		
							DWU		X				
A49532	WEBER STONE CO INC	IRON HILL	NE	16	T085	R02E	2.65		X				
A49534	PRESTON READY MIX	MARBURGER	SE	13	T084	R07E	DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
50	**JASPER DIST 1**	**CRUSHED STONE**											
A50002	MARTIN MARIETTA	SULLY MINE	SE	16	TO79	R17W	2.54	3i		4	4	36 - 41	
											4	10 - 19	
		SAND & GRAVEL											
A50502	MARTIN MARIETTA	COLFAX	NE	01	TO79	R21W	2.66	2		3	3		
							2.67		X				
A50504	MARTIN MARIETTA	REASNOR	NE	10	TO78	R19W				4	4		
							2.66		X				
51	**JEFFERSON DIST 5**	**CRUSHED STONE**											
A51006	WINN CORP	JEFFERSON	NE	09	TO71	R10W							
52	**JOHNSON DIST 6**	**CRUSHED STONE**											
A52002	WENDLING QUARRIES INC	FOUR CO	NW	04	TO81	R08W					X		
A52004	RIVER PRODUCTS CO	CONKLIN	NW	33	TO80	R06W	2.66	3iB		4	4	2 - 10	
							DWU	3i		5	5	23 - 24	1
										5	5	2 - 5	
										4	4	6 - 10	
										4	4	21	
A52006	RIVER PRODUCTS CO	KLEIN	NW	02	TO79	R07W	2.66	3iB		4	4	2 - 10	
							DWU	3i		5	5	23 - 24	1
										5	5	2 - 5	
										4	4	6 - 10	
										4	4	21	
A52008	RIVER PRODUCTS CO	ERNST	SW	20	TO80	R05W					X		
		SAND & GRAVEL											
A52502	S&G MATERIALS INC	SHOWERS	NE	27	TO79	R06W				4	4		
							2.65		X				
A52506	S&G MATERIALS INC	BUTLER	SW	33	TO79	R06W	DWU		X				
A52508	S&G MATERIALS INC	WILLIAMS	NW	34	TO79	R06W	DWU		X				

NOTE 1: 1.25 INCH MAXIMUM TOP SIZE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
53	**JONES DIST 6**	**CRUSHED STONE**											
A53002	BARD CONCRETE CO	FARMERS-BEHRENDS	NE	14	T086	R03W	2.64	3i		4	4	1 - 5	
A53004	WENDLING QUARRIES INC	MONTICELLO	NE	24	T086	R04W	2.66	3i		4	4	1	
A53006	WENDLING QUARRIES INC	ANAMOSA	SE	13	T084	R04W	DWU	3i				1 - 5	
										4	4	1 - 6	
A53010	WENDLING QUARRIES INC	BALLOU-OLIN	NE	24	T083	R03W	DWU	3iB				3	
							DWU	3				2 - 3	
										4	4	1 - 3	
A53012	WENDLING QUARRIES INC	WYOMING		33	T084	R01W	2.69	3iB		4	4	1 - 2C	
A53014	WEBER STONE CO INC	JACOBS-SCOTCH GROVE	SW	07	T085	R02W					5		
A53016	WEBER STONE CO INC	STONE CITY		5,6	T084	R04W	2.45	3i		4	4	2B - 3	
A53018	RIVER CITY STONE INC	FINN	NE	06	T085	R01W	DWU	3i		4	4	2 - 5	
A53020	WENDLING QUARRIES INC	CANTON	NE	24	T085	R01W					X		
A53024	RIVER CITY STONE INC	SULLIVAN	NW	14	T086	R03W	DWU	3i				1 - 5	
A53026	RIVER CITY STONE INC	ANAMOSA	SW	15	T084	R04W							
		SAND & GRAVEL											
A53502	WENDLING QUARRIES INC	MONTICELLO	SE	07	T086	R03W				4	4		
							2.66		X				
A53506	RIVER CITY STONE INC	FINN	N2	06	T085	R01W				4	4		
							2.65		X				
A53508	WENDLING QUARRIES INC	ANAMOSA-VERNON	SW	13	T084	R04W				4	4		
							2.66		X				
A53510	WENDLING QUARRIES INC	KNAPP	SE	27	T084	R03W				4	4		
							2.65		X				
A53514	WENDLING QUARRIES INC	FLEMING	NE	12	T083	R03W				4	4		
							2.66		X				
A53522	WEBER STONE CO INC	WEBER	SE SW	05	T084	R04W	2.66		X				
A53526	BARD CONCRETE CO	STEPHENS	NW	34	T086	R03W				4	4		
							2.66		X				
A53528	WEBER STONE CO INC	ANAMOSA	NE	14	T084	R04W	2.65		X				
A53530	RIVER CITY STONE INC	ANAMOSA-WOOD'S	CT	15	T084	R04W	2.66		X				
54	**KEOKUK DIST 5**	**CRUSHED STONE**											
A54002	DOUDS STONE INC	KESWICK	NW	21	T077	R12W	2.61	2		4	4	13 - 15	1
										4	4	13 - 18	
A54004	DOUDS STONE INC	OLLIE	SW	01	T074	R11W	2.66	3		4	4	13 - 18	
							2.57	3				27 - 29	1
										4	4	13 - 19	
										4	4	27 - 30	
											5	31 - 33	
A54008	DOUDS STONE INC	HARPER	SE	11	T076	R11W				4	4	15 - 24	
										4	4	32 - 37	
										4	4	38 - 40	
A54010	DOUDS STONE INC	LYLE	NW	13	T074	R13W	DWU	3				40	
										4	4	36 - 38	
		SAND & GRAVEL											
A54502	WINN S&G	WINN	SE	06	T074	R10W	2.66		X				

NOTE 1: 1.25 INCH MAXIMUM TOP SIZE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
55	**KOSSUTH DIST 2**	**SAND & GRAVEL**											
A55506	KOSSUTH COUNTY	WHITTEMORE	NW	16	T095	R30W				4	4		
A55508	KOSSUTH COUNTY	IRVINGTON	NW	36	T095	R29W				4	4		
A55518	REDING S&G	REDING		02	T094	R29W							
A55536	HANSEN CONST CO	BREESE	NE	15	T098	R30W							
A55548	MARTIN MARIETTA	BORMANN SAND	NW	39	T094	R29W							
56	**LEE DIST 5**	**CRUSHED STONE**											
A56002	CESSFORD CONST CO	HAWKEYE	NE	10	T068	R06W					5	1 - 21	
										4	4	22 - 27	
A56004	CESSFORD CONST CO	FRANKLIN	NE	25	T068	R06W	2.49	2				12	1
										4	4	12 - 14	
A56006	CESSFORD CONST CO	ARGYLE	SE	18	T066	R06W				4	4	1 - 17	
											5	4 - 12	
										4	4	13 - 17	
A56008	CESSFORD CONST CO	DONNELLSON	SE	05	T067	R06W				4	4	10 - 15	
A56012	CESSFORD CONST CO	VINCENNES	NW	19	T066	R06W							
		SAND & GRAVEL											
A56504	CESSFORD CONST CO	VINCENNES	SE	32	T066	R06W				4	4		
							2.67		X				
A56506	BROCKMAN SAND CO	FORT MADISON	SW	11	T067	R05W				4	4		
							2.67		X				
A56508	SHIPLEY CONTRACTING CORP	LEE COUNTY S&G	SE	11	T067	R05W	DWU		X				

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
57	**LINN DIST 6**	**CRUSHED STONE**								
A57002	WENDLING QUARRIES INC	BETENBENDER-COGGON	SW 03 T086 R06W	DWU	3i				8 - 9	
				DWU	2				8 - 10	
A57004	WENDLING QUARRIES INC	PLOWER	SE 36 T086 R06W	2.62	3				9 - 11	
							4	4	1 - 10	
A57006	WENDLING QUARRIES INC	ROBINS	NE 21 T084 R07W	2.57	3i		4	4	3	1
A57008	WENDLING QUARRIES INC	BOWSER-SPRINGVILLE	SW 29 T084 R05W	DWU	3i		4	4	6 - 7	
				DWU	3		4	4	8	
A57010	WENDLING QUARRIES INC	TROY MILLS	SE 09 T086 R07W				X	X		
A57012	WENDLING QUARRIES INC	MORGAN CREEK	SE 22 T083 R08W				X	X		
A57014	WENDLING QUARRIES INC	SWEETING	NW 18 T085 R08W					4		
A57016	WENDLING QUARRIES INC	ALICE	NW 08 T085 R07W					4		
A57018	MARTIN MARIETTA	CEDAR RAPIDS	NE 15 T082 R06W	2.64	3i				2 - 9	1
							4	4	2 - 14	
A57020	WENDLING QUARRIES INC	LISBON	NW 24 T082 R05W	DWU	3iB		4	4	1	
A57022	CRAWFORD QUARRY CO	LEE CRAWFORD	NW 23 T083 R08W	2.55	3i		4	4	8	
A57026	NIEMANN CONST CO	COOK	NW 10 T086 R07W							
A57028	WENDLING QUARRIES INC	BEVERLY	NW 07 T082 R07W	DWU	3i		4	4	6 - 7	
A57030	BRUENING ROCK PROD INC	HENNESSEY	NE 01 T082 R07W	DWU	3i		4	4	4 - 5	
		SAND & GRAVEL								
A57502	WENDLING QUARRIES INC	SWEETING	NE 18 T085 R08W				4	4		
				2.64		X				
A57506	WENDLING QUARRIES INC	CEDAR RAPIDS	NE 27 T084 R08W				4	4		
				2.65		X				
A57508	WENDLING QUARRIES INC	EAST MARION	NE 36 T084 R06W				3	3		
				2.65		X				
A57516	MARTIN MARIETTA	CEDAR RAPIDS SAND	SW 35 T083 R07W	2.65		X				
A57520	WENDLING QUARRIES INC	IVANHOE	NW 29 T082 R05W				4	4		
				2.66		X				
A57522	WENDLING QUARRIES INC	CENTRAL CITY	NE 10 T085 R06W				4	4		
				2.65		X				
A57524	WENDLING QUARRIES INC	COGGON	NW 11 T086 R06W				4	4		
				2.65		X				
A57526	WENDLING QUARRIES INC	TROY MILLS	SE 09 T086 R07W	2.65		X				
A57528	AGGREGATES INC	AGGREGATES INC	SW 26 T084 R08W	DWU	2B		3	3		
				2.65		X				
A57530	WENDLING QUARRIES INC	HESS	SW 04 T082 R06W	DWU		X				
A57532	CROELL READY MIX	PALO	NE 21 T084 R08W	DWU		X				
A57534	MARTIN MARIETTA	LINN COUNTY SAND	NE 05 T082 R06W	DWU		X				
58	**LOUISA DIST 5**	**CRUSHED STONE**								
A58002	RIVER PRODUCTS CO	COLUMBUS JUNCTION	NW 03 T074 R05W	2.55	3				16 - 19	2
							4	4	15 - 19	
							4	4	19 - 21	
		SAND & GRAVEL								
A58504	RIVER PRODUCTS CO	FREDONIA A INLAND	SW 17 T075 R04W				4	4		
		PUMPING		2.66		X				
		FREDONIA B RIVER	SW 17 T075 R04W				4	4		
		PUMPING		2.66		X				

NOTE 1: 1.25 INCH MAXIMUM TOP SIZE
NOTE 2: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
60	**LYON DIST 3**	**SAND & GRAVEL**											
A60502	PETTENGILL CONC & GRAVEL	ROCK RAPIDS #1	NW	33	T100	R45W	2.69	2		3	3		
							2.67		X				
A60504	PETTENGILL CONC & GRAVEL	ROCK RAPIDS #2	NE	09	TO99	R45W				3	3		
A60506	PETTENGILL CONC & GRAVEL	ROCK VALLEY		17	T100	R45W				4	4		
A60508	DIETER PIT	DIETER	SE	24	T100	R49W				4	4		
A60510	HALLETT MATERIALS CO	OLSON	NW	21	T099	R48W				4	4		
A60512	JOE'S READY MIX INC	LITTLE ROCK	NW	03	T099	R43W	DWU	2		4	4		
							2.66		X				
A60514	MARTIN MARIETTA	DOON		21	TO98	R45W				3	3		
A60516	MARTIN MARIETTA	OPEN	SW	24	TO98	R46W				3	3		
A60518	ROCK VALLEY GRAVEL CO	OPEN	NW	17	TO99	R48W				4	4		
A60520	HOGAN	WINTER	SE	18	TO99	R43W				4	4		
A60522	HYMANS CONST CO	OPEN		17	TO98	R44W				4	4		
A60524	MARTIN MARIETTA	OPEN		29	TO98	R45W				4	4		
A60528	HYMANS CONST CO	RUDD		20	T100	R45W				4	4		
A60534	DUININCK BROS	EGEBO		16	TO99	R48W				4	4		
A60536	ROHLIN CONST CO	VAN ENGEN	SW	35	TO98	R46W							
A60540	SOUTHERN MN CONST CO INC	KANANGEITER	SE	04	TO99	R43W							
A60542	KRUSE PAVING	EBEN	NW	17	TO99	R43W							
A60544	DAKOTA ROAD BUILDERS INC	ORVE	NE	24	T100	R49W							
A60546	ROHLIN CONST CO	VANDERBRINK	NW	07	TO98	R45W							
61	**MADISON DIST 4**	**CRUSHED STONE**											
A61002	SCHILDBERG CONST CO INC	EARLY CHAPEL-DAGGETT	SW	03	TO76	R29W				5	5	15	
											5	12	
											4	14B	
A61006	SCHILDBERG CONST CO INC	92 QUARRY	SW	05	TO75	R29W				5	5	15	
A61010	MARTIN MARIETTA	EARLHAM	N2	09	TO77	R28W					5	25E	
A61012	MARTIN MARIETTA	WINTERSET NORTH	SE	27	TO76	R27W					5	25	
A61013	SCHILDBERG CONST CO INC	WINTERSET WEST	SW	28	TO76	R27W					5	25E	
A61016	PERU QUARRY	PERU	NE	27	TO75	R27W							
A61018	MARTIN MARIETTA	PAMMEL		08	TO75	R28W				5	5	15	
A61024	MARTIN MARIETTA	PENN-DIXIE	SW	32	TO76	R27W					5	25	
A61026	MARTIN MARIETTA	MASON	SW	16	TO77	R28W					4	20	
											5	25	
A61028	GRIMES ASPHALT & PAVING	GRIMES ASPHALT & PAV	SE	04	TO74	R27W					5	25	
A61032	MARTIN MARIETTA	THRAILKILL	NE	08	TO77	R28W					4	20	
											5	25	
A61034	BIG STONES QUARRY INC	CLANTON CREEK	NW	10	TO74	R27W							
A61036	SCHILDBERG CONST CO INC	MONARCH CEMENT OF IOWA	NE	08	TO77	R28W						25B-25E	
62	**MAHASKA DIST 5**	**CRUSHED STONE**											
A62008	MARTIN MARIETTA	GIVEN #2	SE	14	TO74	R16W							
		SAND & GRAVEL											
A62502	SKYLINE CONST CO	G71	SW	15	TO74	R16W	2.67		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
63	**MARION DIST 5**	**CRUSHED STONE**								
A63002	MARTIN MARIETTA	DURHAM MINE	NE 08 T075 R18W	DWU	3i		4	4	101	
				2.59	2		4	4	88 - 95	
							4	4	95 - 96	1
A63010	BRUENING ROCK PROD INC	S&S	SE 25 T075 R20W					4		
		SAND & GRAVEL								
A63502	PELLA CONST CO LTD	BEAN PROPERTY	NE 02 T075 R18W				4	4		
				2.67		X				
A63512	MARTIN MARIETTA	NEW HARVEY	NW 12 T075 R18W	2.67		X				
64	**MARSHALL DIST 1**	**CRUSHED STONE**								
A64002	MARTIN MARIETTA	FERGUSON	SW 05 T082 R17W	2.65	3i		4	4	10 - 21	
				2.66	3		4	4	10 - 17	
				DWU	2		4	4	8 - 17	
				2.66	2		4	4	8 - 21	
				DWU	2		4	4	2 - 17	
							4	4	1 - 18	
A64004	CESSFORD CONST CO	LE GRAND	SW 36 T084 R17W	2.58	3i		5	5	1 - 7	
							4	4	8 - 27	
		SAND & GRAVEL								
A64502	MARTIN MARIETTA	MARSHALLTOWN	SW 29 T084 R17W	2.66	2		4	4		
				2.65		X				
A64506	KNIFE RIVER	BEACH	NW 09 T085 R20W					X		
65	**MILLS DIST 4**	**CRUSHED STONE**								
A65006	SCHILDBERG CONST CO INC	MALVERN	NW SE 31 T072 R41W					X		
66	**MITCHELL DIST 2**	**CRUSHED STONE**								
A66002	FALK CONST CO	DUENOW	SE 08 T099 R17W	2.77	3iB				5	
					3				13	
							4	4	1 - 5	
							4	4	7 - 13	
A66006	FALK CONST CO	WILDE	NE 07 T098 R18W					5		
A66014	FALK CONST CO	STAFF	NE 17 T097 R17W	DWU	3i				3	
A66016	FALK CONST CO	LESCH	SW 12 T097 R17W	DWU	3i				6 - 7	
							5	5	1 - 8	
							4	4	9 - 14	
A66018	FALK CONST CO	DYNES	SW 30 T099 R15W							
A66020	FALK CONST CO	ASPEL	NE 03 T099 R15W							
A66022	FALK CONST CO	WAGNER	NW 29 T098 R16W		X		X	X		
A66024	FALK CONST CO	GRUNDEL	07 T098 R18W							
A66026	R D SMITH ENTERPRISE	KOSTER	NE 35 T099 R18W							
		SAND & GRAVEL								
A66502	FALK CONST CO	OSAGE-SCHMIDT	NW 01 T097 R17W				4	4		
				2.63		X				
A66504	FALK CONST CO	ST ANSGAR-BLAZEK	SW 36 T099 R18W				3	3		
A66510	FALK CONST CO	NEWBURG	NW 26 T099 R18W				3	3		
A66512	FALK CONST CO	KLAAHSEN	SW 36 T099 R18W	2.66		X				
A66514	FALK CONST CO	LOVIK	SE SW 12 T097 R17W	2.65		X				

NOTE 1: BOTTOM 5.0' ONLY OF BED 95

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
67	**MONONA DIST 3**	**SAND & GRAVEL**											
A67502	HALLETT MATERIALS CO	RODNEY		02	T085	R44W	DWU	2		3	3		
							DWU		X				
A67506	HARGRAVE	HARGRAVE	NE	31	T085	R46W				4	4		
A67508	MIDWEST PAVING CO	ONAWA	SW	09	T082	R45W				4	4		
68	**MONROE DIST 5**	**CRUSHED STONE**											
A68004	DOUDS STONE INC	EDDYVILLE SOUTH	SW	02	T073	R16W							
69	**MONTGOMERY DIST 4**	**CRUSHED STONE**											
A69002	SCHILDBERG CONST CO INC	STENNETT	NE	27	T073	R38W					4	16 - 17	
A69006	NATURAL MATERIALS	RED OAK	NW	12	T072	R39W					4	9	
		SAND & GRAVEL											
A69504	WESTERN ENGINEERING	ELLIOT		13	T073	R38W				4	4		
70	**MUSCATINE DIST 5**	**CRUSHED STONE**											
A70002	WENDLING QUARRIES INC	MOSCOW	NW	08	T078	R02W	2.66	3i		5	5	11 - 17	
							2.67	3iB		4	4	21A- 24	
										5	5	8 - 17	
											5	1 - 9	
A70006	TUBE CITY IMS CORPORATION	WILTON	SE	02	T078	R02W				2	2		
A70008	HARSCO CORP/HECKETT DIV	MONTPELIER	SE	11	T077	R01E				2	2		
		SAND & GRAVEL											
A70504	WENDLING QUARRIES INC	ATALISSA-MCKILLIP	NW	20	T078	R02W				4	4		
							2.66		X				
A70506	ACME FUEL AND MATERIALS	ACME	SE	22	T076	R02W	2.65		X				
A70508	HAHN S&G	HAHN	SE	16	T076	R02W							
A70510	NORTHERN GRAVEL CO	NORTHERN		15	T076	R02W							
71	**O'BRIEN DIST 3**	**SAND & GRAVEL**											
A71508	MARTIN MARIETTA	SHELDON	SW	16	T097	R42W				4	4		
A71510	MARTIN MARIETTA	OPEN	SE	29	T097	R42W				4	4		
A71512	MARTIN MARIETTA	SANBORN	SW	04	T096	R41W				4	4		
A71514	MARTIN MARIETTA	PAULLINA	SE	23	T095	R41W				4	4		
A71516	MARTIN MARIETTA	OPEN	SE	01	T094	R41W				4	4		
A71518	MARTIN MARIETTA	OPEN		17	T095	R39W				4	4		
A71520	MARTIN MARIETTA	PRIMGHAR	NW	04	T095	R39W				4	4		
A71522	FABER & SON CONST CO	SHELDON	SE	19	T097	R42W				4	4		
A71526	MARTIN MARIETTA	OPEN	SE	20	T097	R42W				4	4		
A71528	O'BRIEN COUNTY	COUNTY	NW	27	T095	R39W				4	4		
A71530	ROHLIN CONST CO	ROHLIN		14	T097	R42W				4	4		
A71532	KNIFE RIVER	DOUMA	SE	05	T096	R41W							
A71534	HALLETT MATERIALS CO	SHELDON/KLEINWALTERINK	CT	16	T097	R42W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
72	**OSCEOLA DIST 3**	**SAND & GRAVEL**								
A72504	NORTHWEST R/M CONC INC	OCHEYEDAN	SE 15 SW 14 T099 R40W	2.71	2		3	3		
				2.68		X				
A72506	HALLETT MATERIALS CO	ASHTON	SW 28 T098 R42W	2.69	2		3	3		
				2.69		X				
A72508	MARTIN MARIETTA	THOMAS	NW 36 T099 R40W				4	4		
A72514	MARTIN MARIETTA	OPEN	NW 31 T100 R40W				4	4		
A72518	FABER & SON CONST CO	VASS	19 T100 R42W				4	4		
A72520	NORTHWEST R/M CONC INC	OCHEYEDAN NORTH	NE 23 T099 R40W				4	4		
A72522	HIGMAN SAND & GRAVEL	KAPPES	NE 11 T098 R42W	DWU	2					
						X				
A72524	KNIFE RIVER	BOERHAVE	SE 21 T098 R42W	DWU		X				
A72526	NORTHWEST R/M CONC INC	OCHEYEDAN SOUTH	19 T099 R39W							
A72528	KNIFE RIVER	DIRKS	SW 36 T099 R40W							
A72530	NORTHWEST R/M CONC INC	BOYD	NW 36 T099 R40W	2.65	2					
				2.66		X				
A72532	HALLETT MATERIALS CO	OCHEYEDAN	NW 14 T099 R40W							
73	**PAGE DIST 4**	**CRUSHED STONE**								
A73004	SCHILDBERG CONST CO INC	SHAMBAUGH	SW 20 T067 R36W					4		
		SAND & GRAVEL								
A73508	HALLETT MATERIALS CO	SHENANDOAH-CONNELL II	NE 07 T069 R39W	DWU	2					
				2.63		X				
74	**PALO ALTO DIST 3**	**SAND & GRAVEL**								
A74502	HALLETT MATERIALS CO	EMMETSBURG S&G	36 T096 R33W	2.71	2		3	3		
				2.64		X				
A74504	MARTIN MARIETTA	DORWEILLER	SW 05 T094 R31W				3	3		
				2.67		X				
A74506	MARTIN MARIETTA	WEST BEND	NW 08 T094 R31W				3	3		
A74508	MARTIN MARIETTA	OPEN	NW 10 T097 R33W				4	4		
A74509	HOFFERT S&G	EMMETSBURG	NW 22 T096 R33W	2.69	2		4	4		
				2.66		X				
A74512	ROHLIN CONST CO INC	KAY	SW 20 T096 R31W							
75	**PLYMOUTH DIST 3**	**SAND & GRAVEL**								
A75502	HIGMAN SAND & GRAVEL	AKRON	NW 01 T092 R49W	2.70	2		3	3		
				2.67		X				
A75503	EVERIST INC	AKRON	NE 01 T092 R49W	2.69	2		3	3		
				2.67		X				
A75506	MARTIN MARIETTA	REMSEN	SE 03 T092 R44W				4	4		
A75508	MARTIN MARIETTA	ASPEN	NE 11 T092 R49W				3	3		
A75510	MARTIN MARIETTA	KINGSLEY	NE 35 T090 R44W				4	4		
A75512	HYMANS CONST CO	KINGSLEY	NE 13 T090 R44W				4	4		
A75514	WALKERS EXCAVATING CO	OYENS	05 T092 R44W				3	3		
A75516	HALLETT MATERIALS CO	BRUNSVILLE	03 T092 R46W				4	4		
A75518	HALLETT MATERIALS CO	HINTON	NW 16 T090 R46W	DWU	3		3	3		
A75520	HALLETT MATERIALS CO	MERRILL	02 T091 R46W				4	4		
A75522	ROHLIN CONST CO INC	THOMS	26 T092 R46W							
A75524	L&M SAND & GRAVEL INC	G DIRKSEN #2	31 T093 R44W	2.65		X				
A75526	L&M SAND & GRAVEL INC	FRITZ DIRKSEN	05 T092 R44W	DWU		X				
A75528	HIGMAN SAND & GRAVEL	LEMARS	04 T092 R45W	DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
76	**POCAHONTAS DIST 3**	**CRUSHED STONE**								
A76002	MARTIN MARIETTA	GILMORE CITY	NE 36 TO92 R31W	2.64	3iB		5	5	1A - 3	
							4	4	1B - 3	
A76004	MARTIN MARIETTA	MOORE	SW 25 TO92 R31W	2.65	3iB		5	5	1A - 3	
							4	4	3	
							4	4	1B - 3	
							4	4	4 - 10	
							5	5	4 - 12	
		SAND & GRAVEL								
A76506	MARTIN MARIETTA	EGLE	NE 02 TO90 R31W				4	4		
A76508	MARTIN MARIETTA	OPEN	NE 07 TO91 R33W				4	4		
A76510	MARTIN MARIETTA	ZEAMAN	SE 13 TO92 R31W				4	4		
A76512	MARTIN MARIETTA	LIZARD CREEK	13 TO90 R31W				4	4		
A76514	BLACKTOP SERVICES	MILLER	12 TO93 R31W	DWU		X	4	4		
77	**POLK DIST 1**	**SAND & GRAVEL**								
A77502	MARTIN MARIETTA	JOHNSTON	NW 17 TO79 R24W	DWU	2		3	3		
				2.67		X				
A77504	HALLETT MATERIALS CO	DENNY-JOHNSTON	08 TO79 R24W	2.70	2		3	3		
				2.67		X				
A77508	HALLETT MATERIALS CO	EDM #1-WHITE	SE 18 TO78 R23W							
A77514	HALLETT MATERIALS CO	WEST DES MOINES	SE 29 TO78 R25W							
A77520	MARTIN MARIETTA	ARMY POST ROAD	SW 29 TO78 R25W	2.65	2		3	3		
				2.66		X				
A77522	HALLETT MATERIALS CO	EDM #2-VANDALIA	NE 07 NW 08 TO78 R23W	2.69	2		3	3		
				2.65		X				
A77526	HALLETT MATERIALS CO	ARMY POST EAST	SE 29 TO78 R25W	2.66	2		3	3		
				2.65		X				
A77528	HALLETT MATERIALS	PLEASANT HILL	08 TO78 R23W	2.68	2		3	3		
				2.66		X				
A77530	HALLETT MATERIALS CO	NORTH DES MOINES	NE 16 TO79 R24W	2.67	2					
				2.66		X				
A77532	LOUNSBURY S&G	WEST DES MOINES	30 TO78 R25W							
A77534	MARTIN MARIETTA	SAYLORVILLE SAND	09 TO79 R24W	2.66		X				
78	**POTTAWATTAMIE DIST 4**	**CRUSHED STONE**								
A78002	SCHILDBERG CONST CO INC	CRESCENT	35 TO76 R44W				4	4	25B-25E	
							4	4	25C-25E	
								4	25A-25C	
								5	25F	
								4	26A-26E	
								4	27A-27B	
A78006	SCHILDBERG CONST CO INC	MACEDONIA-K&S	NE 28 TO74 R40W					4		
		SAND & GRAVEL								
A78504	WESTERN ENGRG CO INC	OAKLAND	SW 23 TO75 R40W	2.65	3		4	4		
				2.65		X				
A78506	SCHILDBERG CONST CO INC	CRESCENT	NE 34 TO76 R44W				4	4		
79	**POWESHIEK DIST 1**	**CRUSHED STONE**								
A79002	MARTIN MARIETTA	MALCOM MINE	SE 04 TO80 R15W	2.60	2		4	4	10 - 13	
80	**RINGGOLD DIST 4**	**CRUSHED STONE**								
A80002	SCHILDBERG CONST CO INC	WATTERSON	SE 19 TO67 R29W					5	7	

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
81	**SAC DIST 3**	**SAND & GRAVEL**											
A81502	HALLETT MATERIALS CO	SACTON-LAKEVIEW	S2	08	TO86	R36W	2.72	3		3	3		
							2.67		X				
A81504	HALLETT MATERIALS CO	AUBURN	NW	02	TO86	R35W	2.68	2		4	4		
							2.64		X				
A81506	HALLETT MATERIALS CO	SAC CITY	NW	36	TO88	R36W				4	4		
							DWU		X				
A81508	LAKE VIEW CONCRETE PROD	LAKEVIEW	SE	05	TO86	R36W				4	4		
A81514	TIEFENTHALER INC	CARNARVON S&G	NE	16	TO86	R36W	2.68	2		3	3		
							2.66		X				
A81520	KNIFE RIVER	UREN	SE	11	TO87	R36W				3	3		
							2.67		X				
A81522	HALLETT MATERIALS CO	ULMER	SW	28	TO87	R35W				4	4		
A81524	KNIFE RIVER	NO NAME	SE	04	TO87	R37W				4	4		
A81526	MARTIN MARIETTA	BETTIN		19	TO87	R36W				4	4		
A81528	HALLETT MATERIALS CO	WALL LAKE	NW	18	TO86	R36W	2.70	3					
							2.67		X				
A81530	HALETT MATERIALS CO	LEITZ NORTH	SE	29	TO87	R35W	DWU		X				
A81532	HIGMAN SAND & GRAVEL	EARLY-THORPE		22	TO89	R37W	DWU	2		4	4		
							2.66		X				
A81534	MARTIN MARIETTA	SAC COUNTY S&G SE	SE	22	TO89	R37W	2.68		X				
A81536	TIEFENTHALER INC	DAIKER	NE	12	TO86	R35W	DWU		X				
A81540	TIEFENTHALER INC	COLBURN		13	TO87	R35W							
82	**SCOTT DIST 6**	**CRUSHED STONE**											
A82002	RIVERSTONE GROUP INC	MCCAUSLAND (MC 39)	W2	17	TO80	R04E	DWU	3i		4	4	17 - 19*	1
							DWU	3		4	4	1 - 16	1
A82004	RIVERSTONE GROUP INC	NEW LIBERTY (MC 41)	NE	33	TO80	R01E	DWU	3iB		4	4	1 - 2	1
A82006	RIVERSTONE GROUP INC	LECLAIRE (MC 38)	NW	35	TO79	R05E	2.71	3i				14 - 27	
							DWU	3i				28 - 29	
							DWU	3				2 - 13	
										4	4	1 - 28	
A82008	LINWOOD MINING & MINERALS	LINWOOD MINE	SW	13	TO77	R02E	2.67	3i		5	5	20 - 25	
							2.69	3i		5	5	27 - 30B	
							DWU	3i		4	4	33 - 41	
							DWU	3		5	5	19	
										4	4	24 - 25	
		SAND & GRAVEL											
A82502	RIVERSTONE GROUP INC	MCCAUSLAND (MC 43)	SW	17	TO80	R05E				4	4		
							2.66		X				
83	**SHELBY DIST 4**	**SAND & GRAVEL**											
A83506	HALLETT MATERIALS CO	HARLAN-REINIG	NW	30	TO79	R38W	2.65	3					
							2.65		X				
A83508	NATURAL MATERIALS	JACKSONVILLE		12	TO79	R37W							

* TOP 32' OF BED 19

NOTE 1: 1.25-INCH MAXIMUM TOP SIZE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
84	**SIOUX DIST 3**	**SAND & GRAVEL**												
A84502	VALLEY SAND AND GRAVEL	VANZEE		NW	20	TO97	R46W	2.69	2		3	3		
								2.67		X				
A84504	HYMANS CONST CO	VANDERESCH		SE	20	TO96	R47W	DWU	2		3	3		
A84506	HALLETT MATERIALS CO	HUDSON-OSTERCAMP		SE	07	TO96	R47W				3	3		
								2.69		X				
A84508	JOE'S READY MIX INC	SIOUX CENTER		NW	33	TO95	R45W				4	4		
								DWU		X				
A84510	EVERIST INC	HAWARDEN-NORTH	S2	NW	22	TO95	R48W	2.70	2		3	3		
								2.67		X				
A84511	HYMANS CONST CO	HAWARDEN		NE	01	TO95	R48W	DWU	2		3	3		
A84514	BOYDEN	COUNTY			35	TO97	R44W				4	4		
A84516	MARTIN MARIETTA	NO NAME			25	TO97	R48W							
A84518	MARTIN MARIETTA	ALTON		SE	15	TO94	R44W				4	4		
A84520	COUNTY PIT	CHATSWORTH		SW	28	TO94	R48W				4	4		
A84522	HALLETT MATERIALS CO	HYMAN		SW	31	TO96	R47W							
A84524	VALLEY SAND AND GRAVEL	GROTH		NW	36	TO97	R48W				4	4		
A84526	BEDROCK GRAVEL CO	JONAS		NE	36	TO94	R44W	DWU		X	4	4		
A84528	HIGMAN S&G	HIGMAN-CHATSWORTH		W2	28	TO94	R48W	2.69	2		4	4		
								DWU		X				
A84530	VALLEY SAND AND GRAVEL	GROENWEG		NW	15	TO97	R46W	DWU	2		3	3		
								DWU		X				
A84532	KNIFE RIVER	LASSON			32	TO94	R44W	DWU	2					
								DWU		X				
A84534	KNIFE RIVER	CLEVERINGA		SE	25	TO95	R44W							
85	**STORY DIST 1**	**CRUSHED STONE**												
A85006	MARTIN MARIETTA	AMES MINE		SW	24	TO84	R24W	2.57	3i		5	5	19 - 25	
											4	4	26,28- 39	1
								2.68	3iB		4	4	47	
		SAND & GRAVEL												
A85510	HALLETT MATERIALS CO	AMES SOUTH			18	TO83	R23W	2.66	2		3	3		
								2.65		X				
86	**TAMA DIST 1**	**CRUSHED STONE**												
A86002	WENDLING QUARRIES INC	MONTOUR		NW	09	TO83	R16W	2.61	3i		5	5	1 - 7	
								2.63	3i		4	4	13 - 20	
											4	4	8 - 12	
		SAND & GRAVEL												
A86502	MANATT'S INC	FLINT		NW	03	TO82	R15W				3	3		
								2.65		X				
87	**TAYLOR DIST 4**	**CRUSHED STONE**												
A87004	SCHILDBERG CONST CO INC	102 QUARRY		NE	32	TO68	R34W					4		
88	**UNION DIST 4**	**CRUSHED STONE**												
A88002	SCHILDBERG CONST CO INC	THAYER		NE	35	TO72	R28W					5	25A-25E	
												5	25E	

NOTE 1: THE CONTENT OF BED 26 SHALL NOT BE MORE THAN 50% IN THE OVERALL PRODUCT.

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
89	**VAN BUREN DIST 5**	**CRUSHED STONE**											
A89002	DOUDS STONE INC	DOUDS MINE	SE	25	TO70	R11W	2.46	2		4	4	6 - 13	
A89006	CESSFORD CONST CO	FARMINGTON-COMANCHE	NE	05	TO67	R08W	2.69	3i		5	5	3	
							2.52	2		4	4	16 - 17	
											4	18 - 22	
										5	5	5 - 12	
A89008	DOUDS STONE INC	SELMA-GARDNER	NW	16	TO70	R11W	2.69	3		4	4	11	
										5	5	7 - 10	
											5	7 - 11	
										4	4	14 - 21	
										4	4	22 - 31	
90	**WAPELLO DIST 5**	**SAND & GRAVEL**											
A90504	DOUDS STONE INC	HOFFMAN	SE	10	TO72	R14W				4	4		
							2.65		X				
92	**WASHINGTON DIST 5**	**CRUSHED STONE**											
A92002	DOUDS STONE INC	WEST CHESTER	NE	19	TO76	R08W	2.64	3		4	4	5 - 7	
							DWU	2				14 - 16	
A92006	DOUDS STONE INC	COPPOCK	NE	30	TO74	R07W				5	5	3 - 4	
A92008	RIVER PRODUCTS CO	PEPPER-KEOTA FIELD	SW	31	TO76	R09W							
A92014	DOUDS STONE INC	COPPOCK NORTH	SE	19	TO74	R07W							
		SAND & GRAVEL											
A92502	RIVER PRODUCTS CO	RIVERSIDE	NE	10	TO77	R06W				4	4		
							2.65		X				
94	**WEBSTER DIST 1**	**CRUSHED STONE**											
A94002	MARTIN MARIETTA	FT DODGE MINE	SW	24	TO89	R29W	2.65	3iB		4	4	36 - 42	
A94006	MARTIN MARIETTA	YATES	SW	01	TO89	R29W					5		
A94008	KNIFE RIVER	BUSKE	SE	36	TO90	R29W				5	5	1 - 11	
		SAND & GRAVEL											
A94502	NORTHWEST MATERIALS	YATES	SW	01	TO89	R29W				4	4		
							2.66		X				
A94522	AUTOMATED S&G	CROFT	NW	14	TO89	R29W	2.65		X				
A94526	KNIFE RIVER	BUSKE	SE	36	TO90	R29W				3	3		
							2.67		X				
A94528	KNIFE RIVER	CONDON	NW	19	TO90	R30W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
96	**WINNESHIEK DIST 2**	**CRUSHED STONE**											
A96002	ROVERUD CONST INC	KENDALLVILLE	NE	33	T100	R10W	2.68	3B		4	4	3 - 7	
											4	1 - 7	
A96003	WILTGEN CONST CO	BROWN	NW	08	TO99	R10W							
A96004	ROVERUD CONST INC	HOVEY	SW	28	TO98	R08W	2.64	3B		4	4	1 - 4	
										4	4	1 - 6	
A96005	BRUENING ROCK PROD INC	MCGEE	NW	19	TO99	R10W							
A96007	WILTGEN CONST CO	JACKSON	NE	31	TO96	R10W							
A96008	BRUENING ROCK PROD INC	WELKEN	SW	04	TO98	R07W	2.71	3i		4	4	4 - 8	
A96009	ROVERUD CONST INC	DRACKLEY		15	TO99	R08W							
A96010	ROVERUD CONST INC	ANDERSON	SW	22	T100	R10W	2.65	3B		5	5	1 - 4	
A96014	NIEMANN CONST CO	FESTINA	SW	26	TO96	R09W		X		5	5	1 - 3	
A96016	BRUENING ROCK PROD INC	SKYLINE A	SE	10	TO98	R08W	2.66	3B		5	5	1 - 3	
										4	4	4 - 8	
A96017	BRUENING ROCK PROD INC	SKYLINE B	CT	10	TO98	R08W	2.66	3B		5	5	1 - 3	
										4	4	4 - 11	
A96022	WILTGEN CONST CO	MADISON #2	NE	18	TO98	R08W					5		
A96025	WILTGEN CONST CO	MADISON #1	NW	17	TO98	R08W					4		
A96030	ROVERUD CONST INC	ASK	NE	27	TO98	R07W					4		
A96032	ROVERUD CONST INC	BRUVOLD	NW	20	TO98	R07W					X		
A96034	BRUENING ROCK PROD INC	THOMPSON	SE	29	TO98	R09W							
A96038	ROVERUD CONST INC	NORDNESS	SE	09	TO97	R08W					X		
A96040	ROVERUD CONST INC	LOCUST	NE	11	TO99	R08W					X		
A96046	BRUENING ROCK PROD INC	SERSLAND-SMORSTAD	SE	09	TO97	R07W				X	X		
A96048	NIEMANN CONST CO	LOVE #1	NW	30	TO96	R10W					X		
A96049	NIEMANN CONST CO	LOVE #2	SW	30	TO96	R10W					X	1 - 10	
A96050	BRUENING ROCK PROD INC	BULLERMAN-FESTINA	SE	14	TO96	R09W					4	1 - 3	
A96052	ROVERUD CONST INC	ESTREM	SW	04	TO97	R07W	2.63	3B				1 - 6	
										5	5	1 - 8	
A96054	ROVERUD CONST INC	HORSESHOE BEND	SW	20	TO97	R09W					X		
A96058	BRUENING ROCK PROD INC	BROGHAMMER	SE	26	TO99	R08W					X		
A96060	ROVERUD CONST INC	BURR OAK	SE	23	T100	R09W				4	4		
A96062	ROVERUD CONST INC	HOLT HAUS	SE	28	TO98	R08W					X		
A96064	ROVERUD CONST INC	STIKA	NW	15	TO97	R10W	DWU	3i		4	4	1 - 4A	
A96066	BRUENING ROCK PROD INC	KROSHUS	SW	13	T100	R07W					X		
A96068	BRUENING ROCK PROD INC	HOLKESVIK	SW	01	TO99	R08W							
A96070	WILTGEN CONST CO	KUHN	NW	33	TO96	R08W							
A96072	BRUENING ROCK PROD INC	MCKENNA NORTH	SW	34	T100	R09W							
A96074	WILTGEN CONST CO	OSSIAN	SW	21	TO96	R08W							
A96076	ROVERUD CONST INC	PRASKA	NE	19	TO97	R10W							
A96078	BRUENING ROCK PROD INC	BUSTA	NW	30	TO96	R10W							
A96082	WILTGEN CONST CO	CROW	SW	17	TO97	R10W							
A96084	WILTGEN CONST CO	YOUNG	SE	28	T100	R08W							
A96086	BRUENING ROCK PROD INC	BRUVOLD	NE	29	TO98	R07W							
A96090	BRUENING ROCK PROD INC	MCKENNA SOUTH	SE	28	TO99	R09W	DWU	3iB		5	5	1 - 5	
A96092	ROVERUD CONST INC	HANSON	SE	26	T100	R08W							
A96094	ROVERUD CONST INC	CAROLAN	SE	27	TO99	R09W							
A96100	WILTGEN CONST CO	YOUNG	NE	05	TO98	R07W							
		SAND & GRAVEL											
A96502	CARLSON MATERALS CO	DECORAH	NE	22	TO98	R08W				4	4		
							2.63		X				
A96506	ROVERUD CONST INC	FREEPORT	NE	07	TO98	R07W	2.65		X				
A96514	ROVERUD CONST INC	ELSBERND	NE	16	TO96	R09W				4	4		
							2.66		X				
A96520	CARLSON MATERIALS CO	SWEDES BOTTOM	NE	06	TO98	R08W	2.63		X	4	4		
A96522	BRUENING ROCK PROD INC	WOHLSEORS	NW	17	TO98	R10W							
A96526	ROVERUD CONST INC	STIKA	NW	15	TO98	R08W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
96	**WINNESHIEK DIST 2**	**SAND & GRAVEL *(CONTINUED)***											
A96528	BRUENING ROCK PROD INC	GJETLEY	NE	08	TO98	R07W				4	4		
A96530	CARLSON MATERIALS CO	CARLSON-FREEPORT	NE	13	TO98	R08W	2.63		X				
A96532	WILTGEN CONST CO	SCHMITT	NE	34	TO96	R09W	DWU		X	3	3		
97	**WOODBURY DIST 3**	**SAND & GRAVEL**											
A97502	HALLETT MATERIALS CO	CORRECTIONVILLE-BUCK	NW	13	TO89	R42W				3	3		
							DWU		X				
A97508	MARTIN MARIETTA	CORRECTIONVILLE #2	NW	35	TO89	R42W				3	3		
A97510	HALLETT MATERIALS CO	CORRECTIONVILLE-COCKBURN	SE	11	TO88	R43W				3	3		
A97514	PERSINGER S&G	SMITHLAND	NW	25	TO86	R44W				3	3		
							DWU		X				
A97516	HALLETT MATERIALS CO	ANTHON		05	TO87	R43W	2.72	3		3	3		
							2.67		X				
A97518	HALLETT MATERIALS CO	SMITHLAND		35	TO86	R44W	2.69	3		3	3		
							2.67		X				
A97520	HALLETT MATERIALS CO	CORRECTIONVILLE-BREESIE		01	TO88	R43W				4	4		
A97526	FLEWELLING S&G	FLEWELLING	NW	10	TO89	R44W	2.67		X				
A97528	HALLETT MATERIALS CO	EDWARD	SE	23	TO89	R42W							
A97530	NELSTAR	NELSTAR		14	TO88	R43W							
A97532	KNIFE RIVER	CREASEY	SE	09	TO89	R44W							
98	**WORTH DIST 2**	**CRUSHED STONE**											
A98002	MARTIN MARIETTA	HARRIS	SW	29	T100	R20W	DWU	3i		4	4	10	
							2.73	3B		4	4	6 - 7	
							DWU	3		4	4	6 - 11	
							DWU	2				2 - 11	
										4	4	2 - 10	
A98010	BMC AGGREGATES LC	FERTILE	SW	36	TO98	R22W	2.73	3B		4	4	15 - 20	
							DWU	2B				15 - 29	
							DWU	2B				22 - 29	
											4	5 - 10	
										4	4	5 - 20	
A98014	FALK CONST CO	STEVENS	NW	01	TO98	R20W	2.77	3				8 - 11B	
											5	1 - 3	
										4	4	4 - 7	
A98016	ULLAND BROS CONST	EMIL OLSON-BOLTON	SW	10	TO99	R20W	DWU	2				2 - 5A	
								X		4	4	3 - 7	
											5	1 - 7	
A98020	FALKSTONE	TRENHAILE	W2 NE	09	TO99	R20W	DWU	2				2	
		SAND & GRAVEL											
A98502	RANDALL TRANSIT MIX	RANDALL TRANSIT MIX	NW	31	T100	R20W				4	4		
							2.66		X				
A98504	BMC AGGREGATES LC	FERTILE	NW	36	TO98	R22W				3	3		
							2.65		X				
A98506	MARTIN MARIETTA	KNUTSON	SW	30	T100	R20W				4	4		
A98518	FALK CONST CO	COOPER	NE	12	TO98	R20W					4		
A98522	ULLAND BROS CONST	EMIL OLSON-BOLTON	SW	10	TO99	R20W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
99	**WRIGHT DIST 2**	**CRUSHED STONE**											
A99002	BECKER GRAVEL	VOSS		36	TO90	R26W	2.59	3i		4	4	8	
		SAND & GRAVEL											
A99502	WRIGHT MATERIALS	WRIGHT	NW	12	TO93	R24W	2.65	2		3	3		
							2.63		X				
A99510	MARTIN MARIETTA	MEINEKE	NE	14	TO90	R23W				4	4		
							DWU		X				
A99514	KNIFE RIVER	VOSS		36	TO90	R26W							
A99516	GIESE CONST CO	MCALPINE		24	TO92	R24W							
A99518	KNIFE RIVER	REICHTER	SE	06	TO92	R26W							
A99520	KNIFE RIVER	DENNIS PETERSON	NE	15	TO90	R23W							
IL	**ILLINOIS**	**CRUSHED STONE**											
AIL002	CESSFORD CONST CO	BIGGSVILLE, HENDERSON CO		17	TO10	R04W				4	4		
AIL006	RIVERSTONE GROUP INC	MIDWAY (MC 45), ROCK ISLAND CO	SW	16	TO18	R02E	DWU	3iB		4	4	1 - 5	
AIL008	RIVERSTONE GROUP INC	MCMAHON (MC 08), WHITESIDE CO	NE	11	TO20	R02E							
AIL010	RIVERSTONE GROUP INC	ALLIED (MC 30), ROCK ISLAND CO		14	TO17	R02W	DWU	3i		4	4	18	
							2.69	3		5	5	7 - 13	
							DWU	3				14	
							2.72	3		4	4	16 - 17	
AIL012	MATERIAL SERVICES	OTTAWA-LIGHTWEIGHT								4	4		
AIL014	CESSFORD CONST CO	DALLAS CITY, HENDERSON CO	SW	36	TO08	R07W	2.63	3i		4	4	5B	1
											4	2 - 3	
AIL016	RIVERSTONE GROUP INC	CLEVELAND (MC 31), HENRY CO	SW	31	TO17	R02E	DWU	3i		4	4		
AIL018	MEDUSA AGGREGATES	KANKAKEE, KANKAKEE CO	NW	07	TO30	R14W	DWU	2					
AIL020	GRAY QUARRIES/W L MILLER	HAMILTON, HANCOCK CO	NE	31	TO05	R08W	2.65	3		4	4	2	1
							DWU	3		4		4	
							DWU	2				7	
AIL026	REIN SCHULTZ & DAHL	EMERSON	SE	13	TO21	R06E					4		
AIL028	WENDLING QUARRIES INC	TURNBAUGH-MT CARROLL, IL	SW	10	TO24	R04E	DWU	3		4	4	3 - 7	
AIL030	WENDLING QUARRIES INC	HUIZENGA	NW	21	TO21	R03E					4		
AIL032	GALENA STONE CO	EUSTICE, JO DAVIESS CO	NE	16	TO27	R02E							
AIL034	GALENA STONE CO	VIRTUE, JO DAVIESS CO	W2	24	TO28	R02W							
AIL038	COOTS MATERIALS CO INC	ROTH, JO DAVIESS CO	SW	35	TO29	R02W							
AIL040	COOTS MATERIALS CO INC	MONMOUTH, WARREN CO	NW	06	TO11	R02W							
		SAND & GRAVEL											
AIL502	RIVERSTONE GROUP INC	ALBANY (MC@511), ROCK IS CO	SW	34	TO20	R02E	2.65	3i		3	3		
							2.67		X				
AIL504	RIVERSTONE GROUP INC	BIG ISLAND (MC 51), ROCK IS CO		16	TO17	R02W	2.67	3		3	3		
							2.67		X				
AIL506	ILLINOIS-WISCONSIN S&G	SOUTH BELOIT	NW	08	TO16	R02E				4	4		
AIL508	RIVERSTONE GROUP INC	BARSTOW (MC 52), ROCK IS CO	NE	34	TO18	R01E				4	4		
AIL510	NELSON S&G CO	WHITESIDE COUNTY-SAND	SW	29	TO21	R07E				4	4		
AIL514	MIDWEST S&G	HENRY PIT, MARSHALL CO	NW	03	TO13	R10E	DWU		X				
AIL516	BUILDERS S&G	CORDOVA, ROCK ISLAND CO	SE	33	TO21	R02E	DWU	3i		4	4		
							DWU		X				
AIL518	WENDLING QUARRIES INC	THOMPSON	SE	02	TO23	R03E	DWU		X				
AIL520	RIVERSTONE GROUP INC	CORDOVA (MC14@508),ROCK IS CO	S2	05	TO20	R02E	DWU	3iB					
							DWU		X				
KS	**KANSAS**	**CRUSHED STONE**											
AKS002	BINGHAM S&G	BAXTER SPRINGS, CHEROKEE CO		22	TO29	R23E				3	3		

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
MN	**MINNESOTA**	**CRUSHED STONE**											
AMN002	HECTOR CONST CO	NEW ALBIN, HOUSTON CO	NW	09	T101	R04W		X		X	X		
AMN004	ROVERUD CONST INC	POOL HILL, HOUSTON CO	SW	33	T101	R04W		X		X	X		
AMN006	ROVERUD CONST INC	OTTERNESS, FILLMORE CO	E2	11	T101	R08W	2.75	3i		X	X	1 - 2	
AMN008	NEW ULM QUARTZITE QUARRY	QUARTZITE, BROWN CO	SW	35	T110	R31W				2	2		
AMN012	ROVERUD CONST INC	NEWBURG, FILLMORE CO	NE	08	T101	R08W		X		X	X		
AMN014	PEDERSEN BROS	BIG SPRINGS, FILLMORE CO	SW	09	T101	R10W					4	1 - 6	
AMN016	ROVERUD CONST INC	EITZEN, HOUSTON CO	SE	20	T101	R05W		X		X	X		
AMN018	ULLAND BROS	GRAND MEADOW, MOWER CO	NE	09	T103	R14W				X	X		
AMN020	ED BUNNE	LEROY, MOWER CO	NE	27	T101	R14W				X	X		
AMN022	ROVERUD CONST INC	UNDERPASS	NE	20	T101	R07W							
AMN024	MARTIN MARIETTA	YELLOW MEDICINE, YLW MED CO	SW	28	T116	R39W	DWU	3i		2	2	1	
AMN026	ORTONVILLE STONE CO	BIG STONE, BIG STONE CO		26	T121	R46W	DWU	3i		2	2		
AMN030	ROVERUD CONST INC	GENGLER, HOUSTON CO	SW	16	T102	R05W	DWU	3B		4	4	1 - 2	
AMN032	SIOUX ROCK PRODUCTS	COTTONWOOD, COTTONWOOD CO	SE	08	T107	R35W	DWU	3i		2	2		
AMN034	ROVERUD CONST INC	ENGRAV, HOUSTON CO	NE	24	T101	R08W							
AMN036	MILESTONE MATERIALS	GOLDBERG, OLMSTEAD CO	SW	36	T108	R14W				4	4		
AMN038	MILESTONE MATERIALS	RIFLE HILL, FILLMORE CO	NW	35	T102	R12W							
AMN042	DUININCK BROS INC	SCOTT, ROCK CO	NW	14	T104	R45W							
AMN044	MILESTONE MATERIALS	BIESANZ, WINONA CO	SW	19	T107	R07W	DWU	3i				1 - 2	
AMN046	MILESTONE MATERIALS	43 QUARRY, WINONA CO	NW	16	T106	R07W	DWU	3i				1 - 2	
		SAND & GRAVEL											
AMN504	BRUENING ROCK PROD INC	NEW ALBIN, HOUSTON CO		09	T101	R04W				4	4		
AMN506	HECTOR CONST CO	LUTTCHENS, HOUSTON CO	NW	23	T101	R04W	2.63	2B		4	4		
							2.68		X				
AMN508	SOUTHERN MN CONST CO INC	HANSON, JACKSON CO	NE	34	T101	R34W				4	4		
AMN510	WILLETT	WILLETT, JACKSON CO	SW	25	T102	R35W				4	4		
AMN512	MARTIN MARIETTA	MAUDLIN, NOBLES CO	SE	26	T101	R42W				4	4		
AMN516	ULLAND BROS	OLSON, FREEBORN CO	NW	31	T102	R20W	DWU		X				
AMN518	CARLSON MATERIALS CO	LANESBORO, FILLMORE CO	SE	07	T104	R10W	DWU		X				
AMN520	BUNNE & RANNELL	BUNNE & RANNELL, FILLMORE CO	SE	33	T101	R13W	DWU		X				
AMN522	AGGREGATE INDUSTRIES	PRAIRIE ISLAND #3, GOODHUE CO		23	T114	R15W	DWU	2					
AMN524	AGGREGATE INDUSTRIES	HASTING #2, DAKOTA CO		02	T114	R17W							
AMN526	NORTHWESTERN AGGR	LAKEVILLE, DAKOTA CO		01	T114	R20W							
AMN528	HANCOCK CONCRETE CO	POPE, POPE CO	NW	08	T125	R37W							
AMN532	ULLAND BROS	LARSON, FREEBORN CO		25	T102	R21W							
AMN534	ROVERUD CONST INC	SMERUD, HOUSTON CO	SW	35	T101	R03W	DWU		X				
AMN536	AGGREGATE INDUSTRIES	ELK RIVER, SHERBURNE CO		9,10	T033	R26W	DWU	2					
							DWU		X				
AMN538	ULLAND BROS	SHADE, MOWER CO	NW	04	T101	R18W	DWU		X				
AMN540	DUININCK BROS INC	SCOTT, ROCK CO		21	T104	R44W							
AMN542	RANDY KRAMER EXCAVATING	KIMBALL, STEARNS CO		34	T122	R29W							
AMN544	AGGREGATE INDUSTRIES	LAKEVILLE, DAKOTA CO		06	T114	R19W	DWU	2					

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
MO	**MISSOURI**	**CRUSHED STONE**											
AMO002	L&W QUARRIES INC	KAHOKA, CLARK CO	NE	17	TO65	R07W	DWU	2		4	4	2A - 3B	
										4	4	14 - 16	
AMO004	NORRIS AGGREGATES CO	MERCER, MERCER CO	SE	22	TO66	R23W					5	3 - 5	
AMO006	GREENE LS CO	TURNER PROP, NODAWAY CO	SW	31	TO67	R34W					5		
AMO012	NORRIS AGGREGATES CO	DR JEFFERIES, HARRISON CO	NW	03	TO66	R26W				5	5	25C-25E	
AMO014	CARTER-WATERS CORP	EXPANDED SHALE, N. MARKET MO					DWU	2		3	3		
AMO018	NORRIS AGGREGATES CO	ROUTE C, DAVIESS CO	NE	30	TO61	R28W				5	5	2 - 5	
AMO022	IRON MT TRAP ROCK CO	IRON MT, ST FRANCOIS CO								3	3		
AMO024	CENTRAL STONE CO	HUNTINGTON, RALLS CO	NE	17	TO56	R06W	2.68	3i				6 - 9	
							2.68	3		4	4	6 - 11	
AMO026	MISSOURI PORTABLE STONE	WARRENTON, WARREN CO		15	TO46	R02W				3	3		
AMO027	ST JOE LEAD	PEA RIDGE MINE, WASH. CO								3	3		
AMO028	PLATTIN MATERIALS CO	PLATTIN, ST GENEVIEVE CO		09	TO39	R07W							
AMO030	KNOX COUNTY STONE CO	EDINA, KNOX CO	NE	25	TO62	R12W				4	4	1 - 9	
AMO032	SCHILDBERG CONST CO INC	GRAHAM, NODAWAY CO	NW	36	TO63	R37W				4	4	2 - 3	
AMO038	CENTRAL STONE CO	GREENSBURG, SCOTLAND CO		22	TO64	R12W							
AMO040	S&A CONSTRUCTION	SO ALLENDALE, WORTH CO	NW SW	17	TO65	R30W							
AMO042	TRAGER	GALLATIN, DAVIESS CO		13	TO58	R28W							
AMO044	CENTRAL STONE CO	NEW LONDON, RALLS CO	NE	24	TO56	R05W							
AMO046	NORRIS AGGREGATES CO	BETHANY, HARRISON CO	SW	01	TO63	R28W				5	5		
		SAND & GRAVEL											
AMO502	IDEAL SAND CO	WAYLAND, CLARK CO	SW	21	TO65	R06W				4	4		
							2.66		X				
AMO504	MEDUSA AGGREGATES	ALBANY, GENTRY CO		27	TO63	R31W				4	4		
AMO506	MILBURN CO	GALLITIN, DAVIESS CO	CT	16	TO59	R27W				4	4		
AMO510	TURNER QUARRIES	CLEARMONT, NODAWAY CO	SW	34	TO66	R37W				4	4		
AMO516	STONER SAND CO	MT MORIAH, HARRISON CO		12	TO64	R26W	2.65		X				
AMO518	CENTRAL STONE CO	TAYLOR, MARION CO	NW	01	TO59	R06W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
NE	**NEBRASKA**	**CRUSHED STONE**											
ANE002	MARTIN MARIETTA	WEEPING WATER MINE, CASS CO		03	T010	R11E	2.69	3iB		5	5	10A- 10B	
							DWU	3iB		5	5	9-10A&B	1
							DWU	2		5	5	9-10A&B	2
ANE010	FORT CALHOUN STONE CO	FT CALHOUN, WASHINGTON CO	SE	01	T017	R12E				5	5	25C- 25E	
											5	25A- 25C	
											5	25F	
											5	26A- 26E	
											5	27A- 27B	
ANE012	MARTIN MARIETTA	SPRINGFIELD, SARPY CO		28	T013	R12E							
		SAND & GRAVEL											
ANE538	STALP S&G	WEST POINT, CUMING CO	SE	28	T022	R06E	2.64		X				
		CLASS V AGGREGATE FOR CONCRETE											
ANE502	LYMAN-RICHEY S&G	CULLOM #5, CASS CO	SW	31	T013	R12E	2.62	3		4	4		
							2.62		X				
ANE504	LYMAN-RICHEY S&G	WATERLOO #40, DOUGLAS CO	SE	19	T015	R10E	2.62	3		4	4		
							2.62		X				
ANE514	LYMAN-RICHEY S&G	OREAPOLIS #8, CASS CO	SE	36	T013	R13E	2.62	3		4	4		
							2.62		X				
ANE526	WESTERN S&G	FREMONT, DODGE CO	NW	36	T017	R08E	2.62	3		4	4		
							2.62		X				
ANE530	WESTERN S&G	SOUTH BEND, CASS CO	SW	13	T012	R10E	2.62	3		4	4		
							2.62		X				
ANE532	WESTERN S&G	ABEL SPUR, SAUNDERS CO	SW	30	T013	R09E	2.62	3		4	4		
							2.62		X				
ANE534	MALLARD S&G	SPRINGFIELD #3, SARPY CO		32	T013	R12E	2.62	3		4	4		
							2.62		X				
ANE536	MARTIN MARIETTA	GRETNA, SARPY CO		17	T013	R10E	2.62	3		4	4		
							2.62		X				
ANE542	LYMAN-RICHEY S&G	PLANT #47, DODGE CO	NW	07	T017	R09E	2.62	3		4	4		
							2.62		X				
ANE544	MALLARD S&G	VALLEY, DOUGLAS CO	NE	06	T015	R10E	2.62	3		4	4		
							2.62		X				
ANE546	LYMAN-RICHEY S&G	PLANT #77, HALL CO	NE SW	27	T011	R09W	2.62		X				

NOTE 1: IF BED 9 IS INCORPORATED WITH BEDS 10A&B, THE DURABILITY CLASS BECOMES A CLASS 3iB IF THE COARSE AGGREGATE DOES NOT EXCEED 45% OF THE TOTAL AGGREGATE IN THE CONCRETE MIX.
NOTE 2: BED 9 CAN'T BE USED BY ITSELF IN PC CONCRETE. IF BED 9 IS INCORPORATED WITH BEDS 10A&B, THE DURABILITY BECOMES A CLASS 2.

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	DUR PCC FA	FRICT HMA A	FRICT HMA B	BEDS	NOTE
SD	**SOUTH DAKOTA**	**CRUSHED STONE**											
ASD002	EVERIST INC	DELL RAPIDS E. MINNEHAHA CO	SW	10	T104	R49W	2.64	3iB		2	2		
ASD004	CONCRETE MATLS CO	SIOUX FALLS QUARTZITE		13	T101	R50W	2.64	3iB		2	2	1	
ASD006	MYRL & ROY'S PAVING INC	EAST SIOUX, MINNEHAHA CO	SE	27	T101	R48W	DWU	3i		2	2	1	
ASD008	SPENCER QUARRIES INC	SPENCER, HANSON CO		24	T103	R57W				2	2		
ASD010	EVERIST INC	DELL RAPIDS W. MINNEHAHA CO	NW	16	T104	R49W	2.64	3iB		2	2		
		SAND & GRAVEL											
ASD502	BOYER SAND AND GRAVEL	BOYER, UNION CO		10	TO95	R48W	DWU	2		4	4		
ASD504	MIDWEST PAVING CO	HAWARDEN, UNION CO	SW	15	TO95	R48W				4	4		
ASD506	MIDWEST PAVING CO	RICHLAND, UNION CO	SW	20	TO92	R49W				4	4		
ASD508	CONCRETE MATERIALS CO	CANTON, LINCOLN CO		17	TO89	R48W				4	4		
							2.68		X				
ASD510	CONCRETE MATERIALS CO	MINNEHAHA CO		02	T101	R49W							
ASD514	HIGMAN S&G	HUDSON, UNION CO		02	TO95	R48W	DWU	2		4	4		
ASD516	HIGMAN S&G	VOLIN, CLAY CO		12	TO94	R54W							
ASD518	MYRL & ROY'S PAVING INC	MCVAY, LINCOLN CO	SE	17	TO98	R45W							
ASD520	BOYER SAND AND GRAVEL	BOYER NORTH, UNION CO	NE	01	TO95	R48W							
ASD522	EVERIST INC	BROOKINGS, BROOKINGS CO	S2	31	T110	R49W	DWU		X				
ASD524	HIGMAN S&G	SPINK, UNION CO		05	TO93	R50W							
ASD526	CONCRETE MATERIALS CO	CORSON, MINNEHAHA CO		23,24	T102	R48W	DWU	2					
WI	**WISCONSIN**	**CRUSHED STONE**											
AWI002	BRYAN DRESSER TRAP ROCK	DRESSER-TRAPROCK								3	3		
AWI004	MARTIN MARIETTA	CNWRR-ROCK SPRINGS								2	2		
AWI006	KIELER KOWALSKI	TENNYSON, GRANT CO					DWU	3i		4	4		
AWI008	QUALITY STONE INC	WETZEL, CRAWFORD CO	NE	31	TO07	R06W	DWU	3i		4	4	7	
AWI010	ED KRAEMER & SONS INC	RICHARDS, GRANT CO	SW	21	TO01	R02W	DWU	3i		4	4		
AWI012	SCARPELLI MATERIALS	WATERLOO QTZ, DODGE CO		27,28,33, 34	TO08	R13E				2	2		
AWI018	RIVER CITY STONE INC	FREESE, GRANT CO	NW	28	TO01	R02W							
AWI020	MILESTONE MATERIALS	MEDARY, LA CROSSE CO	NW	27	TO16	R07W				4	4		
AWI022	MILESTONE MATERIALS	KINGS BLUFF, LA CROSSE CO	NE	25	TO18	R08W	DWU	3		4	4	1 - 4	
							DWU	2				1 - 5	1
AWI030	HAVERLAND STONE CO	HAVERLAND, GRANT CO	NW	26	TO02	R02W							
AWI034	ED KRAEMER & SONS INC	HOUSEHOLDER, RICHLAND CO											
AWI036	MILESTONE MATERIALS	TORK, WOOD CO.											
AWI038	ROCKY MTN ENTERPRISES	ATHEN, MARATHON CO	SE	24	TO30	R04E		3i		2	2		
AWI040	MILESTONE MATERIALS	JACKSON COUNTY IRON MINE		22	TO21	R03W				2	2		
AWI042	BOON CONSTRUCTION CO	CROSBY	NW SW	13	TO23	R03W				2	2		
AWI044	MILESTONE MATERIALS	SLAMA, CRAWFORD CO		17,18	TO07	R06W	DWU	3i		4	4	3 - 8	
		SAND & GRAVEL											
AWI502	PRAIRIE S&G CO	PRAIRIE DU CHIEN, CRAWFORD CO		24	TO07	R07W	2.67	3i		4	4		
							2.67		X				
AWI504	DUBUQUE S&G CO	VOGT FARM, GRANT CO		17	TO90	R03E	2.67	3i		3	3		
							2.67		X				
AWI506	PRAIRIE S&G CO	KRAMER, CRAWFORD CO	NE	12	TO07	R07W	DWU	X		3	3		
							2.68		X				
AWI508	PRAIRIE S&G CO	BARN	SE	12	TO07	R07W	2.68	X					
							2.69		X				
AWI510	RIVER CITY STONE INC	KRUG, GRANT CO	SW	17	TO01	R02W	DWU		X				
AWI512	MILESTONE MATERIALS	GIBBS	NE	25	TO25	R09W							
AWI514	HOLST EXCAVATING	REDWING #7	NE	33	TO25	R18W							
AWI516	MILESTONE MATERIALS	SCHEER, TREMPEALAU CO		19	TO18	R08W	DWU		X				

NOTE 1: BED 1- TOP 16' OF BED 5

**REVETMENT STONE
SOURCE APPROVAL**

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
DISTRICT 1								
A40006	MARTIN MARIETTA	GRAND GEORGE	SW	18	TO89	R25W	3-5	D
A42002	MARTIN MARIETTA	ALDEN	NW	20	TO89	R21W	3	A, B, D, E
A42004	GEHRKE QUARRIES INC	GIFFORD	NW	04	TO86	R19W	9-10	A, B, E
A50002	MARTIN MARIETTA	SULLY	SE	16	TO79	R17W	36-41	D, E
							42-47	D, E
A64002	MARTIN MARIETTA	FERGUSON	SW	05	TO82	R17W	8-17	E
							1-7	D, E
A85006	MARTIN MARIETTA	AMES MINE	SW	24	TO84	R24W	26	E
							30-35	E
							47	A, B, D, E
A86002	WENDLING QUARRIES INC	MONTOUR	NW	09	TO83	R06W	8-12	D, E
A94002	MARTIN MARIETTA	FORT DODGE MINE	SW	24	TO89	R29W	36-42	A, B, D, E
DISTRICT 2								
A03002	BRUENING ROCK PROD INC	WEXFORD	NE	36	TO98	R03W	1B-8	A, B, D, E
A03028	ROVERUD CONST CO	WELPER-JOHNSON	SW	35	TO99	R04W	FULL FACE	A, B, D, E
A03040	BRUENING ROCK PROD INC	DEE	SE	21	TO99	R04W	5A-5D	A, B, D, E
A03050	BRUENING ROCK PROD INC	GREEN	NW	16	TO96	R06W	1-3	A, B, D, E
A03066	WILTGEN CONST CO	ELSBERN	NW	29	TO97	R06W	2	A, B, D, E
A07004	BMC AGGREGATES LC	WATERLOO SOUTH	NW	18	TO87	R12W	1-23	A, B, D, E
							17-23	A, B, D, E
A07014	NIEMANN CONST CO	GLORY	NE	36	TO87	R11W	1-TOP 5' OF BED 4	D
A07018	BMC AGGREGATES LC	RAYMOND-PESKE	SW	01	TO88	R12W	1B-5	A, B, D, E
							1B-10	A, B, D, E
							6-10	A, B, D, E
A09004	NIEMANN CONST CO	DENVER-FOELSKE	NE	29	TO91	R13W	BOTTOM 8'	A, B, D, E
							BED 12-TOP 9' BED 13	
A09006	NIEMANN CONST CO	TRIPOLI-PLATTE	SW	36	TO93	R13W	1-4	A, B, D, E
A12004	GREENE LIMESTONE CO	LUBBEN	NW	25	TO93	R17W	1-20	D
A12014	NIEMANN CONST CO	OLTMANN	SE	08	TO91	R16W	1-TOP ½ BED 10	D
A12020	GREENE LIMESTONE CO	BRUNS #2	NW	21	TO91	R18W	1-5	D
A17008	MARTIN MARIETTA	PORTLAND WEST		19	TO96	R19W	1-8	A, B, D, E
A17020	MARTIN MARIETTA	MASON CITY	NE	29	TO97	R20W	1-6, 7-9	A, B, D, E
A19002	GREENE LIMESTONE CO	TRACY	SE	29	TO94	R11W	9-10	A, B, D, E
A22002	KUHLMAN CONST CO	TWIN ROCK-SCHRADER	NW	14	TO94	R05W	3-11	A, B, D, E
A22004	ROVERUD CONST CO	BENTE/ELKADER/WATSON	SW	12	TO93	R05W	5-9	A, B, D, E
A22008	KUHLMAN CONST CO	ANDEREGG	SE	32	TO92	R02W	2-8	A, B, D, E
A22010	KUHLMAN CONST CO	OSTERDOCK	SE	02	TO91	R03W	3-8	A, B, D, E
A22012	KUHLMAN CONST CO	SCHMIDT	NE	33	TO91	R01W	2-6	A, B, D, E
A22014	ROVERUD CONST CO	BLUME	NE	09	TO93	R03W	1-12	A, B, D, E
A22016	KUHLMAN CONST CO	GISLESON	NW	06	TO95	R04W	1-15	A, B, D, E
A22020	KUHLMAN CONST CO	MUELLER	NE	30	TO94	R03W	1-8	A, B, D, E
A22026	KUHLMAN CONST CO	DOERRING-LUANA	SE	05	TO95	R05W	3-5	A, B, D, E
A22030	KUHLMAN CONST CO	EBERHARDT	NW	27	TO93	R05W	1-6	A, B, D, E
A22034	KUHLMAN CONST CO	KRUSE	NW	17	TO92	R04W	5-12	A, B, D, E
A22038	KUHLMAN CONST CO	FASSBINDER	SW	09	TO92	R03W	2-6	A, B, D, E
A22040	KUHLMAN CONST CO	HARTMAN	NW	29	TO91	R06W	1-4	A, B, D, E
A22042	ROVERUD CONST CO	MORAREND	CT	35	TO92	R03W	1-9	A, B, D, E
A22046	KUHLMAN CONST CO	JOY SPRINGS-BURRACK	NW	19	TO91	R06W	1-2	A, B, D, E
A22048	ROVERUD CONST CO	TUCKER	SW	18	TO91	R05W	1-3	D
A22060	ROVERUD CONST CO	JOHNSON	NW	26	TO93	R04W	2-5	A, B, D, E
A22062	ROVERUD CONST CO	SNY MAGILL	SE	22	TO94	R03W	6-10	A, B, D, E
A22070	ROVERUD CONST CO	BERNHARD/GIARD	NW	35	TO95	R04W	1-3	A, B, D, E
A22074	RIVER CITY STONE CO	STRAWBERRY POINT	NE	19	TO91	R06W	1-2	A, B, D, E
A22082	NIEMANN CONST CO	REIERSON	NW	20	TO94	R06W	1	D

REVETMENT STONE
SOURCE APPROVAL

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
DISTRICT 2 (Continued)								
A22084	CJ MOYNA & SONS	MOYNA		14	TO93	R05W	6-9	A, B, D, E
A33002	NIEMANN CONST CO	ELDORADO-JACOBSON	SW	17	TO95	R08W	4-6B	A, B, D, E
A33004	NIEMANN CONST CO	HOUG	SW	11	TO94	R08W	3-8	A, B, D, E
A33006	NIEMANN CONST CO	MARYVILLE	S2	24	TO91	R07W	1-2	A, B, D, E
A33010	WILTGEN CONST CO	VOSHELL	NW	21	TO93	R07W	1-4	A, B, D, E
A33016	NIEMANN CONST CO	MAYNARD	NE	23	TO92	R09W	FULL FACE	D
A33018	NIEMANN CONST CO	FAIRBANK	SW	28	TO91	R10W	1-5C	D
							5A-5C	A, B, D, E
A33020	NIEMANN CONST CO	YEAROUS	SW	19	TO93	R08W	1-10C	D
A33022	NIEMANN CONST CO	MILLER	SW	35	TO95	R10W	1-6	D
A33024	NIEMANN CONST CO	WAUCOMA	NW	25	TO95	R10W	1-TOP 4' BED 5	A, B, D, E
A33026	WILTGEN CONST CO	LYNCH	NW	05	TO95	R10W	6-8	A, B, D, E
A33030	NIEMANN CONST CO	SCHWAMMAN-ST LUCAS	NE	29	TO95	R09W	FULL FACE	A, B, D, E
A33032	BRUENING ROCK PROD INC	LANDIS	SE	12	TO93	R08W	1-5	A, B, D, E
A33034	NIEMANN CONST CO	MCDONOUGH	SE	36	TO94	R08W	1-3	D
A33036	NIEMANN CONST CO	GRAHAM-HAWKEYE	SW	06	TO94	R09W	1-4	A, B, D, E
A33038	NIEMANN CONST CO	PAPE	NE	28	TO95	R08W	1-3	A, B, D, E
							3-5	A, B, D, E
A34004	GREENE LIMESTONE CO	MAXON	SE	07	TO94	R17W	4C-19	A, B, D, E
A34006	GREENE LIMESTONE CO	JOHLAS	SW	07	TO94	R15W	1-7	D
A34008	GREENE LIMESTONE CO	WARNHOLTZ	SW	09	TO96	R16W	5-16	D
							17-18	A, B, D, E
A35002	MARTIN MARIETTA	DOWS	NE	30	TO91	R22W	1-12	A, B, D, E
							1-13	D
A35006	MARTIN MARIETTA	HIBNESS	SE	22	TO91	R20W	1-12A	A, B, D, E
A41002	BMC AGGREGATES LC	GARNER NORTH	SE	11	TO95	R24W	6	A, B, D, E
A41004	BMC AGGREGATES LC	GARNER SOUTH-WIELAND	NW	13	TO95	R24W	6	A, B, D, E
A45002	ROVERUD CONST CO	ECKERMAN	NW	33	T100	R11W	7-9	A, B, D, E
A45006	BRUENING ROCK PROD INC	NELSON	NE	33	TO99	R13W	8-9	A, B, D, E
A45008	BRUENING ROCK PROD INC	DOTZLER	NE	23	TO99	R12W	7-10A	A, B, D, E
A45010	BRUENING ROCK PROD INC	DALEY	NE	11	TO98	R11W	9-10	A, B, D, E
A46006	MARTIN MARIETTA	HODGES	NE	32	TO92	R28W	4-18	D
A46014	MARTIN MARIETTA	PEDERSEN	SW	28	TO92	R28W	4-13, 4-20	D
A66002	FALK CONST CO	DUENOW	SE	08	TO99	R17W	6-8	A, B, D, E
A76002	MARTIN MARIETTA	GILMORE CITY	NE	36	TO92	R31W	1A-3	A, B, D, E
A76004	MARTIN MARIETTA	MOORE	SW	25	TO92	R31W	1A-3	A, B, D, E
A96002	ROVERUD CONST CO	KENDALLVILLE	NE	33	T100	R10W	2-9	A, B, D, E
A96004	ROVERUD CONST CO	HOVEY	SW	28	TO98	R08W	2-6	A, B, D, E
A96014	NIEMANN CONST CO	FESTINA	SW	26	TO96	R09W	1-3	A, B, D, E
A96017	BRUENING ROCK PROD INC	SKYLINE B	CT	10	TO98	R08W	4-11	A, B, D, E
A96048	NIEMANN CONST CO	LOVE #1	NW	30	TO96	R10W	1-10	D
A96049	NIEMANN CONST CO	LOVE #2	NW	30	TO96	R10W	1-10	D
A96052	ROVERUD CONST CO	ESTREM	SW	04	TO97	R07W	2-8	A, B, D, E
A96060	ROVERUD CONST CO	BURR OAK	SE	23	T100	R09W	3-5	A, B, D, E
A96064	ROVERUD CONST CO	STIKA	NW	15	TO97	R10W	5A-8B	A, B, D, E
A98002	MARTIN MARIETTA	HARRIS	SW	29	T100	R20W	6-11	A, B, D, E
A98016	ULLAND BROS	EMIL OLSON-BOLTON	SW	10	TO99	R20W	2-5B	A, B, D, E
A98010	BMC AGGREGATES LC	FERTILE	SW	36	TO98	R22W	15-20	A, B, D, E
A99002	KNIFE RIVER	VOSS		36	TO90	R26W	8	A, B, D, E
AMN004	ROVERUD CONST CO	POOL HILL, HOUSTON CO	SW	33	T101	R04W	1-8	A, B, D, E
AMN030	ROVERUD CONST CO	GENGLER, HOUSTON CO	SW	16	T102	R05W	1-4	A, B, D, E
AMN034	ROVERUD CONST CO	ENGRAV, HOUSTON CO	NW	24	T101	R08W	1A-2B	A, B, D, E

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 3

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
AMN024	MARTIN MARIETTA	YELLOW MEDICINE, YELLOW MED	SW	28	T116	R39W	GRANITE	A, B, D, E
AMN032	SIOUX ROCK PRODUCTS	COTTONWOOD, COTTONWOOD CO	SE	08	T107	R35W	ENTIRE LEDGE*	A, B, D, E
ASD002	EVERIST INC	DELL RAPIDS, MINNEHAHA CO	SW	10	T104	R49W	ENTIRE LEDGE*	A, B, D, E
ASD004	CONCRETE MATERIALS CO	SIOUX FALLS QUARTZITE		13	T101	R50W	ENTIRE LEDGE*	A, B, D, E
ASD006	MYRL & ROY'S PAVING INC	EAST SIOUX, MINNEHAHA CO	SE	27	T101	R48W	ENTIRE LEDGE*	A, B, D, E
ASD008	SPENCER QUARRIES INC	SPENCER, HANSON CO		24	T103	R57W	ENTIRE LEDGE*	A, B, D, E

*ISOLATED POCKETS OF SANDSTONE MAY BE CAUSE TO REJECT ALL OR PORTIONS OF A SHOT; ALSO, THE PIPESTONE DEPOSITS WILL DEFINE THE LOWER LIMITS OF LEDGE. IN BOTH INSTANCES A VISUAL EXAMINATION WILL REVEAL THE PRESENCE OF EITHER UNCONSOLIDATED SANDSTONE OR PIPESTONE MATERIAL.

DISTRICT 4

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A01002	SCHILDBERG CONST CO INC	MENLO	SE	17	T077	R31W	15A-15C	B, D, E
A01006	SCHILDBERG CONST CO INC	HOWE	SW	01	T076	R31W	25B-25E	D
A01008	SCHILDBERG CONST CO INC	JEFFERSON	NE	17	T077	R31W	25B-25E	D
A02002	SCHILDBERG CONST CO INC	MT ETNA	SW	23	T073	R34W	11-13	D
A02004	SCHILDBERG CONST CO INC	CORNING		10	T071	R34W	3-5	D
A15008	SCHILDBERG CONST CO INC	ATLANTIC MINE	NE	13	T076	R37W	25B-25E	D
A36002	SCHILDBERG CONST CO INC	THURMAN	NW	23	T070	R43W	18	D
A43002	SCHLDBERG CONST CO INC	LOGAN		19	T079	R42W	25B-25E & 3' OF 26	B, D, E
A43004	WESTERN IA LIMESTONE	LOGAN		17	T079	R42W	25B-25E & 3' OF 26	B, D, E
A61002	SCHILDBERG CONST CO INC	EARLY CHAPEL-DAGGETT	NW	10	T076	R29W	14B	B, D, E
A61024	MARTIN MARIETTA	PENN-DIXIE	SW	32	T076	R27W	TOP 4' OF BED 20A	D, E
A61026	MARTIN MARIETTA	MASON	SW	16	T077	R28W	TOP 4' OF BED 20A	D, E
A69002	SCHILDBERG CONST CO INC	STENNETT	NE	27	T073	R38W	KERFORD	D
A73004	SCHILDBERG CONST CO INC	SHAMBAUGH	SW	20	T067	R36W	4-6	D
A78002	SCHILDBERG CONST CO INC	CRESCENT		35	T076	R24W	25B-25E	D, E
A78006	SCHILDBERG CONST CO INC	MACEDONIA	NE	28	T074	R40W	16	D
A87004	SCHILDBERG CONST CO INC	102 QUARRY	NE	32	T068	R34W	1	D
A88002	SCHILDBERG CONST CO INC	THAYER	NE	35	T072	R28W	20B	D
							25B-25E	B, E
AMO040	S&A CONSTRUCTION	SOUTH ALLENDALE, WORTH CO	SW	17	T065	R30W	CAPTAIN CREEK	B, D, E
ANE002	MARTIN MARIETTA	WEEPING WATER, CASS CO		03	T010	R11E	10A-10B	E
							9-10B	E
ANE004	KERFORD LIMESTONE	WEEPING WATER, CASS CO	SE	32	T011	R11E	10A-10B	D, E
ANE010	FORT CALHOUN STONE	FORT CALHOUN, WASHINGTON CO	SE	01	T017	R12E	25B-25E	D, E

**REVETMENT STONE
SOURCE APPROVAL**

DISTRICT 5

CODE	OPERATOR	SOURCE NAME	LOCATION	BEDS	REVETMENT CLASS
A04004	L&W QUARRIES	MARTIN #3	E2 20 T070 R19W	1-3	D
				6	D, E
A04016	L&W QUARRIES	LEMLEY EAST #5	CT 35 T070 R19W	1-3	D
				6	D, E
A04018	L&W QUARRIES	CLARKDALE #8	SE 15 T069 R18W	1A	D, E
				1C	D, E
				4	D
A20002	MARTIN MARIETTA	OSCEOLA	NW 12 T072 R26W	1-10	D
				20A	D
A26004	DOUDS STONE INC	LEWIS	W2 02 T069 R12W	3-5	D
				6-7	D, E
				3-7	D, E
A26006	DOUDS STONE INC	BROWN	SW NW 02 T069 R12W	1	D, E
A27002	MARTIN MARIETTA	GRAND RIVER	NW 22 T070 R27W	17	D
A27008	MARTIN MARIETTA	DECATUR	SE 32 T069 R27W	7	D
				13-14	D
A29002	L&W QUARRIES	MEDIAPOLIS	SE 01 T071 R04W	3-7	D, E
				15-18	D, E
A29008	CESSFORD CONST CO	NELSON	NE 26 T072 R02W	7-14	D, E
				7-20	D, E
				15-20	D
				15-24	D
				21-24	D, E
				25-27	D
A29012	CESSFORD CONST CO	GEODE	NE 01 T069 R05W	1-5	D, E
				9-13	D, E
				REEF	E
A44008	DOUDS STONE INC	NELSON-TWEEDY	SE 36 T071 R06W	9-14	D, E
				13-14	D, E
A51006	WINN CORP	JEFFERSON	NE 09 T071 R10W	5-8	D, E
				LOWER 4' OF BED 8	D, E
				10-12	D, E
A54002	DOUDS STONE INC	KESWICK	NW 21 T077 R12W	13-15	D, E
				13-17	D
A54004	DOUDS STONE INC	OLLIE	SW 01 T074 R11W	9-12	D, E
				9-13	D
				9-18	D, E
				13-18	D, E
				19-26	D
				27-29	D, E
				30-33	D
A54008	DOUDS STONE INC	HARPER	SE 11 T076 R11W	13-22	D, E
				32-37	D, E
				38-40	D, E
A54010	DOUDS STONE INC	LYLE	NW 13 T074 R13W	36-38	D, E
				40	D, E
A56002	CESSFORD CONST CO	HAWKEYE	NE 10 T068 R06W	1-21	D
				22-27	D, E
A56008	CESSFORD CONST CO	DONNELLSON	SE 05 T067 R06W	10-13	D, E
A62008	MARTIN MARIETTA	GIVEN #2	SE 14 T074 R16W	2-6	D
A63002	MARTIN MARIETTA	DURHAM MINE	NE 08 T075 R18W	88-95	D, E
				95-96	D, E
A63010	BRUENING ROCK PROD INC	S&S	SE 25 T075 R20W	25	D, E
A89002	DOUDS STONE INC	DOUDS MINE	SE 25 T070 R11W	5-13	D, E

**REVETMENT STONE
SOURCE APPROVAL**

DISTRICT 5 (Continued)

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A89006	CESSFORD CONST CO	FARMINGTON-COMANCHE	NE	05	TO67	R08W	5-12	D
							14-15	D
							16-17	D, E
							18-23	D
A89008	DOUDS STONE INC	SELMA-GARDNER	NW	16	TO70	R11W	14-21	D, E
							14-31	D, E
							22-31	D, E
A92002	DOUDS STONE INC	WESTCHESTER	NE	19	TO76	R08W	15-16	D, E
A92008	RIVER PRODUCTS CO	PEPPER-KEOTA FIELD	SW	31	TO76	R09W	2-20	D
							22-28	D
							29-36	D
AIL014	CESSFORD CONST CO	DALLAS CITY, HENDERSON CO	SW	36	TO08	R07W	5-6	D, E
AIL020	GRAY QUARRY INC	GRAY, HANCOCK CO	NE	31	TO05	R08W	2	D, E
AMO002	L&W QUARRIES	KAHOKA, CLARK CO	NE	17	TO65	R07W	2A-3B	D, E
AMO012	NORRIS AGGREGATES CO	JEFFERIES, HARRISON CO	NW	03	TO66	R26W	25C-25D	D, E
AMO024	CENTRAL STONE	HUNTINGTON, RALLS CO	NE	17	TO56	R06W	6-11	D, E

DISTRICT 6

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A06006	WENDLING QUARRIES INC	GARRISON B	NE	33	TO85	R11W	6-23	A, B, D, E
							6-36	EROSION
A06012	COOTS MATERIALS CO INC	JABENS	SW	07	TO85	R11W	6-11, 12	A, B, D, E
A06014	WENDLING QUARRIES INC	VINTON-MILROY	S2	10	TO85	R10W	1-7	D
A06016	COOTS MATERIALS CO INC	COOTS	SW	36	TO86	R11W	2A ON DOWN	D
A10002	NIEMANN CONST CO	LAMONT-WESTON	NW	14	TO90	R07W	1-6	A, B, D, E
A10004	NIEMANN CONST CO	JESUP-BLOOM	SW	32	TO89	R10W	2-5	A, B, E
							2-8	D
A10008	BRUENING ROCK PROD INC	OELWEIN-MISHLER	NW	02	TO90	R09W	4-5	A, B, D, E
A10010	NIEMANN CONST CO	HAZELTON	NW	11	TO90	R09W	4A-4D	A, B, D, E
A10016	NIEMANN CONST CO	OELWEIN #2	SE	03	TO90	R09W	13-17	A, B, D, E
A10022	BRUENING ROCK PROD INC	BROOKS	NW	02	TO88	R09W	4-5	EROSION
A10024	NIEMANN CONST CO	RASMUSSEN #2	SE	21	TO88	R08W	1-6 + QUARRY FLR	D
A10030	NIEMANN CONST CO	AURORA-SOUTH	NW	19	TO90	R07W	1-3	A, B, D, E
A16004	WENDLING QUARRIES INC	LOWDEN-SCHNECKLOTH	NW	04	TO81	R01W	1	A, B, D, E
A16006	WENDLING QUARRIES INC	STONEMILL	SE	14	TO80	R03W	4A-4D	A, B, D, E
A16010	WENDLING QUARRIES INC	PEDEN	NE	10	TO79	R03W	1-3	D, EROSION
A16012	WEBER STONE CO	ONION GROVE	SE	14	TO82	R02W	1-7	A, B, D, E
A16014	WENDLING QUARRIES INC	TOWNSEND	NW	02	TO79	R02W	2-10	A, B, D, E
A16022	WENDLING QUARRIES INC	TRICON	N2	09	TO82	R04W	1	A, B, D, E
A23002	WENDLING QUARRIES INC	BLOORE-ELWOOD	NW	08	TO83	R02E	1-2	A, B, D, E
A23004	WENDLING QUARRIES INC	BEHR	SW	02	TO81	R03E	1-2	A, B, D, E
A23006	WENDLING QUARRIES INC	SHAFFTON	NE	11	TO80	R05E	16-20	A, B, D, E
							3-14	D, EROSION
A23010	WENDLING QUARRIES INC	GOOSE LAKE	SW	22	TO83	R05E	2-4	E
A23012	WENDLING QUARRIES INC	TEEDS GROVE	SW	03	TO83	R06E	2-4	A, B, D, E
A23016	WENDLING QUARRIES INC	LYONS	NW	18	TO82	R07E	UPPER OR LOWER LEDGE	E
A28008	KUHLMAN CONST	EDGEWOOD WEST	CT	04	TO90	R05W	2-7	A, B, D, E
A28010	KUHLMAN CONST	TIBBOTT	SW	23	TO90	R04W	1-5	A, B, D, E
A28014	KUHLMAN CONST	LOGAN	SW	10	TO88	R05W	2-8	A, B, D, E
A28016	KUHLMAN CONST	WHITE	NW	02	TO88	R04W	1-2	A, B, D, E
A28020	BARD CONCRETE	DEUTMEYER	SW	13	TO88	R03W	1-6	A, B, D
A28030	KUHLMAN CONST	GRIEF	NE	18	TO87	R03W	1-2	A, B, D, E

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 6 (Continued)

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A28038	KUHLMAN CONST	EDGEWOOD EAST	NW	06	T090	R04W	1B-5	A, B, D, E
							2-6	E
A28040	BARD CONCRETE	KRAPFL	SE	23	T089	R03W	1-5	A, B, D
							4	E
A28052	RIVER CITY STONE CO	MANCHESTER	SW	09	T088	R05W	6-8	A, B, E
			TOP LEDGES – NORTH					D
A28056	RIVER CITY STONE CO	THORPE	NW	33	T090	R05W	FULL FACE	A, B, D, E
A28058	RIVER CITY STONE CO	ROSSOW/MANCHESTER	NW	16	T088	R05W	2-8	A, B, D, E
A31002	RIVER CITY STONE CO	ROSE SPUR		27	T090	R02E	1-8	A, B, D, E
A31006	KUHLMAN CONST	DYERSVILLE	SE	32	T089	R02W	4-12	A, B, D, E
A31008	RIVER CITY STONE CO	KLEIN-RICHARDSVILLE	NW	33	T090	R01E	2-4B	A, B, D
							3A-4B	E
A31010	RIVER CITY STONE CO	BROWN	NW	33	T089	R02E	FULL FACE	D
							3-9	A, B, E
A31014	BARD CONCRETE	KURT	N2	35	T087	R02W	1-2	A, B, D, E
A31018	RIVER CITY STONE CO	MELOY	NW	23	T087	R01E	FULL FACE	A, B, D
							1-3	E
A31020	RIVER CITY STONE CO	SCHLITCHE	SE	11	T089	R02W	1-4	A, B, D, E
A31026	WENDLING QUARRIES INC	ARNSDORF	SE	25	T087	R02E	1-2	A, B, D, E
A31028	RIVER CITY STONE CO	THOLE	NW	21	T087	R02E	2-3	A, B
							3	D, E
A31034	RIVER CITY STONE CO	HERMSEN	NE	33	T090	R02W	1-2	A, B, D, E
A31036	RIVER CITY STONE CO	BALLTOWN	SE	05	T090	R01E	1-7	A, B, D, E
A31040	RIVER CITY STONE CO	KENNEDY	NW	03	T088	R01W	FULL FACE	A, B, D, E
A31044	RIVER CITY STONE CO	GASSMAN	SE	07	T088	R03E	2-9	A
							2-10	B, D
							5-9	E
A31050	RIVER CITY STONE CO	PLOESSEL-DYERSVILLE	N2	07	T088	R02W	2-5	A, B, D
							3-5	E
A31052	WEBER STONE CO	EPWORTH-KIDDER	SW	02	T088	R01W	FULL FACE	A, B, D, E
A31056	RIVER CITY STONE CO	RUBIE	SE	06	T088	R03E	5-9	A, B, E
							FULL FACE	D
A31058	RIVER CITY STONE CO	HOLY CROSS	SW	12	T090	R02W	FULL FACE	A, B, D, E
A31060	BARD CONCRETE	CASCADE EAST	SE	22	T087	R01W	1-5	A, B, D
							2-5	E
A31064	RIVER CITY STONE CO	WEBER	NE	32	T089	R02E	3-9A	A, B, D, E
A31066	RIVER CITY STONE CO	FILLMORE	SW	26	T087	R01W	FULL FACE	A, B, D
							2-4	E
A49002	BELLEVUE S & G CO	BELLEVUE	SW	25	T087	R04E	1-3	A, B, D, E
A49008	WENDLING QUARRIES INC	IRON HILL	SW	16	T085	R02E	1-6	A, B, D, E
A49010	WENDLING QUARRIES INC	ANDREW	NW	21	T085	R03E	1B-5B	A, B, D, E
A49012	WENDLING QUARRIES INC	FROST	SE	16	T084	R03E	1A-1E	A, B, D, E
A49016	WENDLING QUARRIES INC	WEIS	SE	22	T085	R04E	7	A, B, D, E
A49018	WENDLING QUARRIES INC	PATASKA	NW	23	T085	R05E	1	A, B, D, E
A49020	WENDLING QUARRIES INC	PRESTON	SW	26	T084	R05E	1-10	D, E
							7-10	A, B, D, E
A49021	PRESTON READY MIX	PRESTON R/M	SW	26	T084	R05E	7-10	A, B, D, E
A49022	WENDLING QUARRIES INC	BELLEVUE	SE	23	T086	R04E	1B-3	A, B, D, E
A49024	WENDLING QUARRIES INC	MAQUOKETA EAST	SW	07	T084	R03E	1-8	A, B, D, E
A49040	WENDLING QUARRIES INC	JOINERVILLE	SE	20	T084	R02E	1-3	A, B, D, E
A52002	WENDLING QUARRIES INC	FOUR COUNTY	NW	04	T081	R08W	9-16	D
A53002	BARD CONCRETE	FARMERS-BEHRENDS	NE	14	T086	R03W	1-5	A, B, D, E
A53004	WENDLING QUARRIES INC	MONTICELLO	NE	24	T086	R04W	FULL FACE	A, B, D, E
A53010	WENDLING QUARRIES INC	BALLOU-OLIN	NE	24	T083	R03W	FULL FACE	A, B, D, E
A53012	WENDLING QUARRIES INC	WYOMING		33	T084	R01W	1-2C	A, B, D, E

REVETMENT STONE
SOURCE APPROVAL

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
DISTRICT 6 (Continued)								
A53014	WEBER STONE CO	JACOBS-SCOTCH GROVE	SW	07	T085	R02W	FULL FACE	A, B, D, E
A53016	WEBER STONE CO	STONE CITY	E2	06	T084	R04W	1, 3	A, B, D, E
A53018	RIVER CITY STONE CO	FINN	NE	06	T085	R01W	2-5	A, B, E
							FULL FACE	D
							4-5	E
A53024	RIVER CITY STONE CO	SULLIVAN	NW	14	T086	R03W	FULL FACE	A, B, D, E
A53026	RIVER CITY STONE CO	ANAMOSA	SW	15	T084	R04W	REEF MATERIAL	A, B, D, E
A57002	WENDLING QUARRIES INC	BETENBENDER-COGGON	SW	03	T086	R06W	1-10	A, B, D, E
A57006	WENDLING QUARRIES INC	ROBINS	NE	21	T084	R07W	1-3	D
A57008	WENDLING QUARRIES INC	BOWSER-SPRINGVILLE	SW	29	T084	R05W	1-8	A, B, D, E
A57010	WENDLING QUARRIES INC	TROY MILLS	SE	09	T086	R07W	FULL FACE	D
A57014	WENDLING QUARRIES INC	SWEETING	NW	18	T085	R08W	1-4	D
A57018	MARTIN MARIETTA	CEDAR RAPIDS	NE	15	T082	R06W	2-9	A, B, D, E
A57028	WENDLING QUARRIES INC	BEVERLY	NW	07	T082	R07W	6-7	A, B, E
							1-7	D
A57030	BRUENING ROCK PROD INC	HENNESSEY	NE	01	T082	R07W	9-14, 15-16	D
A70002	WENDLING QUARRIES INC	MOSCOW	NW	08	T078	R02W	11-17	D, E
							21A-24	A, B, D, E
							1-9	EROSION
A82002	RIVERSTONE GROUP INC	MCCAUSLAND	W2	17	T080	R04E	1-19	A, B, D, E
A82004	RIVERSTONE GROUP INC	NEW LIBERTY	NE	33	T080	R01E	1-2	A, B, D, E
A82006	RIVERSTONE GROUP INC	LECLAIRE	NW	35	T079	R05E	2-32	A, B, D, E
AIL006	RIVERSTONE GROUP INC	MIDWAY (MC 45), ROCK IS CO	SW	16	T018	R02E	0-160'	A, B, D, E
AIL010	RIVERSTONE GROUP INC	ALLIED (MC 30), ROCK ISLAND CO		14	T017	R02W	16'-173'	A, B, D, E
AIL016	RIVERSTONE GROUP INC	CLEVELAND (MC 31), HENRY CO	SW	31	T017	R02E	10'-215'	A, B, D, E

**APPROVED PRODUCERS
WITH QC PROGRAMS**

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
A			
A-LINE CRUSHING SERVICE	808 DEARBORN AVE	WATERLOO, IA 50703	319-232-3889
ACME FUEL & MATERIALS CO	2544 PETTIBONE AVENUE	MUSCATINE, IA 52761	563-263-1105
AGGREGATE INDUSTRIES	2915 WATERS ROAD STE 105	EAGAN, MN 55121	651-686-2302
AGGREGATE MATERIALS CO	1400 E 12TH STREET	DUBUQUE, IA 52001	563-583-6642
AGGREGATES INC	6101 BLAIRS FERRY ROAD NE	CEDAR RAPIDS, IA 52411	319-395-0050
ANDERSON SAND & GRAVEL CO	2578 270TH AVENUE	DEWITT, IA 52742	563-659-5506
ARCADIA LIMESTONE CO	19011 CRYSTAL AVENUE	ARCADIA, IA 51430	712-689-2299
B			
BMC AGGREGATES LC	101 BMC DRIVE	ELK RUN HEIGHTS, IA 50707	319-235-6583
			319-235-7065 **(FAX)**
BARD CONCRETE CO	2021 325TH AVENUE	DYERSVILLE, IA 52040	563-875-7145
			563-875-7860 **(FAX)**
BEDROCK GRAVEL CO	3527 320TH STREET	AUBURN, IA 51433	712-688-2418
BELLCO OF NEBRASKA INC	2826 SOUTH AVENUE	COUNCIL BLUFFS, IA 51503	712-322-8501
			712-322-8526 **(FAX)**
BELLEVUE SAND & GRAVEL CO	29427 HWY 52	BELLEVUE, IA 52031	563-872-3886
BENTON'S SAND & GRAVEL	815 CENTER STREET	CEDAR FALLS, IA 50613	319-266-2621
			319-266-5926 **(FAX)**
BIG STONES QUARRY, INC	2487 290TH STREET	PERU, IA 50222	515-988-4106
			515-440-0944 **(FAX)**
BLAZEK CORPORATION	1830 RIDGEWAY BLVD	LAWLER, IA 52154	563-238-7150
BOGGESS CONST CO	321 NORTH 17TH COURT	ESTHERVILLE, IA 51334	712-867-4516
BOON CONSTRUCTION CO	N 5399 STATE HWY 73	NEILLSVILLE, WI 54456	
BOYER SAND & ROCK INC	4162 BIRCH AVENUE	HAWARDEN, IA 51023	712-552-2308
BROCKMAN SAND CO	2397 263RD AVENUE-POB 312	FORT MADISON, IA 52627	319-372-7138
BRUENING ROCK PRODUCTS INC /SKYLINE CONSTRUCTION	325 WASHINGTON STREET-POB 127	DECORAH, IA 52101	563-382-2933
			563-382-8375 **(FAX)**
BUILDERS SAND & CEMENT CO	104 WESTERN AVENUE	DAVENPORT, IA 52801	563-322-1757
C			
C. J. MOYNA & SONS INC	24412 HWY 13	ELKADER, IA 52043	563-245-1442
CARNARVON SAND & GRAVEL	811 N 10TH ST	DENISON, IA 51442	712-664-2511
CEMSTONE PRODUCTS COMPANY	2025 CENTRE POINT BLVD- SUITE 300	MENDOTA SPRINGS, MN 55120-1221	651-688-9292
CENTRAL STONE CO #1	RR 1-POB 236	HANNIBAL, MO 63401-9622	573-735-4525
CESSFORD CONST CO	2320 ZELLER AVENUE	LE GRAND, IA 50142	641-479-2695
			641-479-2003 **(FAX)**
CESSFORD CONST CO - SE DIV	3808 OLD HWY 61	BURLINGTON, IA 52601	319-753-2297
			319-753-0926 **(FAX)**
COHRS CONSTRUCTION INC	15700 NORTH TRADEWIND DRIVE	SPIRIT LAKE, IA 51360	712-832-3714
CONCRETE INC	POB 54	GIFFORD, IA 50259	641-858-3637
CONCRETE MATERIALS CO	1201 WEST RUSSELL	SIOUX FALLS, SD 57104	605-357-6000
CONRECO INC	4901 G STREET	OMAHA, NE 68117	402-733-4100
			402-733-5774 **(FAX)**
COOTS MATERIALS CO INC	1700 WEST D STREET	VINTON, IA 52349	319-472-4480
			319-472-4485 **(FAX)**
CORELL RECYCLING	200 SOUTH 13TH STREET	WEST DES MOINES, IA 50265	515-223-8010
CRAWFORD QUARRY CO	HWY 94 NW-POB 1027	CEDAR RAPIDS, IA 52046	319-396-5705
CROELL REDI MIX	POB 430	NEW HAMPTON, IA 50659	641-394-3770

**APPROVED PRODUCERS
WITH QC PROGRAMS**

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
D			
DAVE'S SAND & GRAVEL INC	RR 2-POB 58A	HARTLEY, IA 51346	712-834-2515
DOUDS STONE INC	13133 ANGLE RD SUITE B-POB 187	OTTUMWA, IA 52501	641-683-1671 641-683-1673 **(FAX)**
DUININCK BROS INC	408 6TH ST-POB 208	PRINSBURG, MN 56281	320-978-6011
E			
ESTHERVILLE ROCK & GRAVEL CO	POB 97	ESTHERVILLE, IA 51344-0097	712-362-3506 800-379-7263 (T-F)
F			
FALK L R- CONSTRUCTION CO	227 W 4TH STREET-POB 189	ST ANSGAR, IA 50472-0189	641-713-4569
FALKSTONE LLC	227 W 4TH STREET-POB 189	ST ANSGAR, IA 50472-0189	641-713-4569
FLEWELLING SAND & GRAVEL	1157 HWY 140	MOVILLE, IA 51039	712-873-3174
FLOYD RIVER MATERIALS	32138 HICKORY AVE	SIOUX CITY, IA 51101	712-233-1111
FORT CALHOUN STONE CO	7001 US HWY 75-POB 284	BLAIR, NE 68008	402-426-4254 402-468-4380 402-468-4388 **(FAX)**
FORT DODGE ASPHALT CO	2516 7TH AVENUE SOUTH	FORT DODGE, IA 50501	515-573-3124
FRED CARLSON COMPANY	POB 48	DECORAH, IA 52101	563-382-4249
G			
GEHRKE QUARRIES INC	POB 521	ELDORA, IA 50627	641-858-3821 641-858-2564 **(FAX)**
GRAY QUARRIES INC	POB 386	HAMILTON, IL 62341	217-847-2712
GREENE LIMESTONE CO	1211 SOUTH MAIN ST-POB 687	CHARLES CITY, IA 50616	641-228-4255 641-228-4061 (Shop)
H			
HAHN READY MIX	POB 1107	MUSCATINE, IA 52761	563-263-6467
HALLETT MATERIALS CO	5550 NE 22ND STREET-POB3365	DES MOINES, IA 50316	515-266-9928 515-266-9857 **(FAX)** 800-838-2615 (WIA)
HANK STALP GRAVEL CO	1598 RIVER ROAD	WEST POINT, NE 68788	402-372-5491 800-372-5491 (T-F) 402-372-5477 **(FAX)**
HEARTLAND ASPHALT INC	2601 SOUTH FEDERAL AVENUE	MASON CITY, IA 50401	641-424-1733
HECKETT-MULTISERV	C/O NSS-HWY 38 & GREENS ROAD	WILTON, IA 52778	563-732-4010 563-732-4011 **(FAX)**
HECKETT MULTISERV WEST	C/O NSW-POB 474	STERLING, IL 61081	815-626-3316 815-626-9306 **(FAX)**
HEIMES EXCAVATING & UTIL CO	9144 SOUTH 147TH STREET	OMAHA, NE 68138	402-894-1000
HIGMAN SAND & GRAVEL INC	16485 HWY 12-POB 109	AKRON, IA 51001	712-568-2181
HORSFIELD MATERIALS, INC.	505 EAST MAIN ST-POB 305	EPWORTH, IA 52045	563-876-3335
I			
IDEAL SAND CO	3902 MT PLEASANT ST-POB 416	WEST BURLINGTON, IA 52655	319-754-4747
IOWA DRAINAGE INC	703 E. GILMAN ST- POB 7	SHEFFIELD, IA 50475	641-892-4330
IRON MOUNTAIN TRAPROCK CO	POB 9137	IRON MOUNTAIN, MO 63650	573-734-6106
J			
J W READY MIX & CONST	3111 270TH STREET	SAC CITY, IA 50583	712-662-4239

**APPROVED PRODUCERS
WITH QC PROGRAMS**

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
K			
KERFORD LIMESTONE CO	36110 FLETCHER STREET	WEEPING WATER, NE 68463	402-267-2415 402-267-5240 **(FAX)**
KNIFE RIVER	POB 229	STRATFORD, IA 50249	515-838-2475 515-838-2472 **(FAX)**
KNOCKS BUILDING SUPPLIES	302 NORTH SIDE	PARKERSBURG, IA 50665	319-278-4868
KRUSE PAVING INC	POB 899	LAKEFIELD, MN 56150	507-662-5205 507-662-6725 **(FAX)**
KRUSE ROCK & GRAVEL	1401 T AVENUE-POB 466	MILFORD, IA 51351	712-338-9084 888-808-7625 (T-F) 712-338-2031 **(FAX)**
KUHLMAN CONSTRUCTION CO	325 MAIN-POB 126	COLESBURG, IA 52035	563-856-3535 800-772-1731 (T-F) 563-856-5505 **(FAX)**
L			
L G EVERIST INC	POB 9	DELL RAPIDS, SD 57022	605-428-5419 605-428-3012 **(FAX)**
L&M SAND & GRAVEL INC	426 2ND AVENUE NE	LE MARS, IA 51031	712-546-5359
L&W QUARRIES INC	POB 335	CENTERVILLE, IA 52544	641-437-4830 641-437-4837 **(FAX)**
LA HARV CONST CO INC	POB 267	FOREST CITY, IA 50436	641-581-3643
LESSARD CONTRACTING INC	POB 705	SERGEANT BLUFF, IA 51054	712-252-4131
LINWOOD MINING & MINERALS CORP	5401 VICTORIA AVE, SUITE 110	DAVENPORT, IA 52807	563-359-8251 800-798-8251 (T-F) 563-344-3730 **(FAX)**
LOUNSBURY LANDSCAPING	6000 RACCOON RIVER DR	WEST DES MOINES, IA 50266	515-225-7100
LUNDELL CONSTRUCTION CO., INC	1420 EAST RICHLAND	STORM LAKE, IA 50588	712-732-4059
LYMAN-RICHEY SAND & GRAVEL	4315 CUMING STREET	OMAHA, NE 68131	402-558-2727
M			
MALLARD SAND & GRAVEL	POB 638	VALLEY, NE 68064	402-359-5287
MANATT'S INC	1755 OLD 6 ROAD-POB 535	BROOKLYN, IA 52211	641-522-9206 641-522-9407 **(FAX)** 641-522-5594 **(FAX)**
MANATT'S SAND & GRAVEL	1928 340TH STREET-POB 87	TAMA, IA 52339	641-484-4022
MARENGO READY MIX INC	POB 121	MARENGO, IA 52301-0121	319-642-3811
MARTIN MARIETTA AGGREGATES	11252 AURORA AVENUE	DES MOINES, IA 50322	515-254-0030 800-332-5433 (T-F) 515-254-0035 **(FAX)**
MARTIN MARETTA AGGREGATES	POB 629	VALLEY, NE 68064	402-359-4088
MATX INC	110 CLUBRIDGE PLACE	COLORADO SPRINGS, CO 80906	
MCALISTER AGGREGATES LLC	1924 HWY 141- POB 157	BAYARD, IA 50029	800-642-6653 712-651-2018 **(FAX)**
MIELKE'S QUARRY	13303 SPOOK CAVE RD	MCGREGOR, IA 52157	563-539-4227
MILESTONE MATERIALS	920 10TH AVE NORTH-POB 189	ONALASKA, WI 54650	608-783-6411 608-783-4311 **(FAX)**
MOBERLY STONE CO	POB 582	MOBERLY, MO 65270	660-277-4419 660-277-4790 **(FAX)**
MOLO SAND & GRAVEL CO	123 SOUTHERN AVENUE	DUBUQUE, IA 52001	563-557-7540
MYRL & ROY'S PAVING INC	1300 NORTH BAHNSON AVENUE	SIOUX FALLS, SD 57103	605-334-3204 605-334-0468 **(FAX)**

**APPROVED PRODUCERS
WITH QC PROGRAMS**

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
N			
NATURAL MATERIALS, L.L.C.	1408A HWY 44, SUITE 800	HARLAN, IA 51537	712-755-2563 712-755-5344 **(FAX)**
NELSTAR	210 WALNUT	MERIDEN, IA 51037	712-443-8832
NEW ULM QUARTZITE QUARRY	ROUTE 5-POB 21	NEW ULM, MN 56073	507-354-2925 507-359-7870 **(FAX)**
NORRIS AGGREGATES CO	219 3RD ST-POB 190	CAMERON, MO 64429	816-324-0310
NORTH IA SAND & GRAVEL INC	18237 KILLDEER AVENUE	MASON CITY, IA 50401	641-424-5591 641-423-1894 **(FAX)**
NORTHWEST MATERIALS	1648 LAINSON AVENUE	FORT DODGE, IA 50501	515-573-8921
NORTHWEST R/M CONCRETE INC	6340 180TH STREET	OCHEYEDAN, IA 51354	712-758-3683
NU AGGREGATES	300 NORKA DRIVE	AKRON, IA 51001	712-568-2181
O			
ORTONVILLE STONE CO	POB 67	ORTONVILLE, MN 56278	320-839-6131
P			
PATRICK M. PINNEY CONTRACTORS	1915 FLOYD BLVD-POB 5107	SIOUX CITY, IA 51102	712-252-2774
PAUL NIEMANN CONST CO	24541 150TH STREET-POB 128	SUMNER, IA 50674-0128	563-578-3261 563-578-3263 **(FAX)**
PBI CONST	4953 D AVE	MARCUS, IA 51035	712-376-4886
PEDERSON BROTHERS	POB 606	HARMONY, MN 55939-0606	507-498-3377
PELLA CONST CO LTD	POB 25	PELLA, IA 50219	641-628-3840
PERSINGER SAND & GRAVEL	3281 LUCAS AVENUE	SMITHLAND, IA 51056	712-889-2258
PERU QUARRY	2431 ST. CHARLES ROAD	WINTERSET, IA 50273	515-462-4801
PETERSON CONTRACTORS INC	104 BLACKHAWK-POB A	REINBECK, IA 50669	319-345-2713
PETTENGILL CONC & GRAVEL INC	800 NORTH BOONE	ROCK RAPIDS, IA 51246	712-472-2571
PRAIRIE SAND & GRAVEL	POB 210	PRAIRIE DU CHIEN, WI 53821	608-326-6471
PRESTON READY MIX CORP	POB 399	PRESTON, IA 52069	563-689-3381
Q			
QUALITY CONCRETE CO	327 17TH AVENUE SOUTH	CLINTON, IA 52732	563-242-3524
R			
RANDALL TRANSIT MIX CO	1343 HWY 105-POB 153	NORTHWOOD, IA 50459-0153	641-324-1063
RECYCLED AGGREGATE PROD CO	2131 18TH STREET	SIOUX CITY, IA 51105	712-252-7732
REDINGS GRAVEL & EXCAVATING CO	2001 EAST OAK STREET	ALGONA, IA 50511	515-295-3661
REILLY CONSTRUCTION CO	110 MAIN STREET-POB 99	OSSIAN, IA 52161	563-532-9211 563-532-9759 **(FAX)**
RIEHM CONSTRUCTION CO INC	2340 9TH STREET SW	WAUKON, IA 52172	563-568-3314
RIVER BEND ENTERPRISES	3000 ASHERTON AVENUE	NASHUA, IA 50658	641-435-2436
RIVER CITY STONE INC	3747 CONSTRUCTORS COURT-POB 160	KEILER, WI 53812-0160	608-568-3433
RIVER PRODUCTS CO INC	3273 DUBUQUE ST NE- POB 2120	IOWA CITY, IA 52244-2120	319-354-1090 319-353-6606 **(FAX)**
RIVERSTONE GROUP INC	1701 5TH AVENUE	MOLINE, IL 61265	309-757-8250 309-757-8257 **(FAX)**
ROCK VALLEY GRAVEL CO	1315 17TH AVENUE-POB 9	ROCK VALLEY, IA 51247	712-476-2063
ROCKY MOUNTAIN ENTERPRISES	6515 COUNTY HIGHWAY H	ATHENS, WI 54411	715-257-1440 715-257-1140 **(FAX)**
ROHLIN CONST CO INC	POB 137	ESTHERVILLE, IA 51344	712-362-3549
ROVERUD CONST CO INC	601 E. MAIN ST-POB 606	SPRING GROVE, MN 55974	507-498-3376 800-622-7625 (T-F) 507-498-5835 **(FAX)**

**APPROVED PRODUCERS
WITH QC PROGRAMS**

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
S			
S&A CONSTRUCTION LTD	POB 20	ALLENDALE, MO 64420	660-786-2233
S&G MATERIALS	4213 SAND ROAD SE	IOWA CITY, IA 52240	319-354-1667
SCHILDBERG CONSTRUCTION CO	POB 358	GREENFIELD, IA 50849	641-743-2131
SCHMILLEN CONST INC	4772 C AVENUE	MARCUS, IA 51035-0488	712-376-2249
SHELL ROCK PRODUCTS	22281 WALNUT AVENUE	SHELL ROCK, IA 50670	319-885-4302
SHIPLEY CONTRACTING	2671 240TH STREET	FORT MADISON, IA 52625	319-372-1804
SIEH SAND & GRAVEL	101 WEST 18TH STREET-POB 1503	SPENCER, IA 51301	712-836-2244 712-262-4580
SOUTHERN MN CONST CO, INC.	1100 MARCUS ST-POB1100	FAIRMONT, MN 56031	507-235-3321
SPENCER QUARRIES	25341 430TH AVENUE	SPENCER, SD 57374	605-246-2344
STENSLAND GRAVEL CO	1741 ASHLEY AVE	LARCHWOOD, IA 51241	712-477-2280
STERZINGER CRUSHING INC	3273 290TH AVE	TAUNTON, MN 56291	
STONER SAND	RR 2	RIDGEWAY, MO 64481	660-824-4211
SWAN ROCK & SAND PRODUCTS, LLC	27453 210TH AVE-POB125	EDDYVILLE, IA 52553	641-658-2474 641-777-1233 (CELL)
T			
TIEFENTHALER AG-LIME INC	11975 HAWTHORNE AVENUE-POB 157	BREDA, IA 51436	712-673-2686
U			
ULLAND BROTHERS INC	2400 MYERS ROAD	ALBERT LEE, MN 56007	507-373-1960 507-433-1819
W			
WAYNE T HANSEN CORP	13 COUNTRY ESTATES	ALGONA, IA 50511	515-295-5573
WEATHERTON CONTRACTING	307 N 16TH ST-POB151	BERESFORD, SD 57004	605-763-2078
WEBER STONE CO INC	12791 STONE CITY ROAD	ANAMOSA, IA 52205	319-462-3581 319-462-3585 **(FAX)**
WELDEN AGGREGATES INC	POB 832	IOWA FALLS, IA 50126	641-648-5142 641-648-5142 **(FAX)**
WENDLING QUARRIES INC	POB 230	DEWITT, IA 52742	563-659-9181 563-659-3393 **(FAX)**
WEST DES MOINES SAND CO	10500 SW 52ND STREET	DES MOINES, IA 50265	515-287-2340
WESTERN ENGINEERING COMPANY	POB 350	HARLAN, IA 51537	712-755-5191
WETHERELL EXCAV & TRUCKING	POB 582	STORM LAKE, IA 50588	712-732-4059 712-732-2839 **(FAX**
WILTGEN CONSTRUCTION CO	113 EAST MAIN STREET-POB 817	CALMAR, IA 52132	563-562-3301 800-365-3301 (T-F)
WINN CORP SAND & GRAVEL	28825 290TH STREET	OLLIE, IA 52576	641-667-3471
WRIGHT MATERIALS CO	1127 HWY 69-POB 244	BELMOND, IA 50421	641-444-3920
Z			
ZUPKE SAND & GRAVEL	17963 150TH STREET	RANDALIA, IA 52164	563-428-4444

The term "material allowance" is used to designate material which will later be incorporated in the project and ultimately paid at contract unit prices. The term "unincorporated material" is used for material ordered for use on the project, but not used. Payment for material ordered, but not used and taken over by the contracting authority must be paid by change order. (Refer to *Construction Manual 2.36* for procedure used to process a change order.)

2.52 PAYMENT FOR UNEXPECTED CLASS 12 ROCK EXCAVATION

When Class 12 excavation is unexpectedly encountered and there is no contract item for Class 12, the quantity of Class 12 will be paid for as Extra Work. (Refer to *Construction Manual 2.36* for procedure used to process a Change Order.)

Approval for Work

- CASE I (Contract has an item for Class 10.)
  Specification 2102.14A establishes a price of ten times the Class 10 contract unit price for unexpected Class 12 excavation.
- CASE II (Contract does not have an item for Class 10.)
  In this case a change order price will have to be negotiated.

  NOTE: When the contract contains items for special categories of Class 12, such as Class 12 (channel) or Class 12 (boulders), these items are not considered as representing normal Class 12 roadway and borrow excavation work.

2.53 PRICE ADJUSTMENT GUIDE FOR REASONABLY CLOSE CONFORMING, REASONABLY ACCEPTABLE, AND DEFICIENT WORK

Every effort should be made to prevent substandard work and/or noncomplying material from being incorporated into the project. However, when work and/or materials are deemed to be noncomplying, *Specifications 1105 and 1101* give authority to the project engineer for determining if construction work or materials are acceptable and/or within reasonably close conformity to the plans and specifications. Therefore, the project engineer must decide whether deficient work is to be removed and replaced or left in place with a price adjustment. Unusual situations or circumstances may warrant consultation with the Office of Construction and the Office of Materials.

NOTE: A price adjustment is no substitute for specification compliance and "unacceptable work" shall always be removed and replaced with acceptable work. Further, contractors need to be given an option of removing deficient work and replacing with acceptable work in lieu of a price adjustment.

Price adjustments of $100 or less need not be formalized in a change order.

Guide Schedules for Price Adjustments

A. Gradation

Unless otherwise specified, variations in the gradation of aggregates shall be price adjusted as prescribed by "Aggregate Deviation Price Adjustments," in *Appendix 2-34(A)*. These adjustments apply to variations in gradations for:

- Portland Cement Concrete
- Hot Mix Asphalt

When aggregates are mixed with asphaltic materials, price adjustments shall apply to the mix only.

B. PCC Slump, Air Content, and Rain Damage

1. Concrete Slump Price Adjustments are prescribed in *Appendix 2-34(B)*. Concrete Air Content, Water Cement Ratio, Vibrator Frequency, Certified Plant Inspection, and Late Curing Application Price Adjustments are prescribed in *Appendix 2-34(C)*.

2. Rain Damaged Portland Cement Concrète
When rain damage occurs, removal and replacement may be required by the project engineer in accordance with *Specification 2301.19*. However, damage must be determined to be severe enough to warrant such action. Contact the District Construction Engineer and the Office of Construction for assistance, if needed.

If work is allowed to remain, *Specification 1109.03 C* requires the project engineer to determine "... a modification of the contract unit price." The following CASES shall be used for determining rain damage price adjustments. NOTE: Price adjustments are applied to an entire area encompassing the damage. (This means full width placed when damage occurred, beginning at the first transverse joint before any damage and ending at the first transverse joint after damage.)

ADJUSTMENT SCHEDULE

CASE I (Payment is 95% of contract unit price.)
Transverse texture is absent from practically all of surface area. Surface appearance may have a "sandy" appearance or may be "pock" marked from the rain droplets. An occasional edge repair may be required due to excess edge slump or from edge rounding. Small areas along edge may have coarser particles of fine aggregate exposed. Surfaces finished in the rain or after a rain are also included in Case I.

CASE II (Payment is 90% of contract unit price.)
Transverse texture is totally absent from the surface and cement mortar has been eroded to an extent that coarser particles of the fine aggregate fraction are generally exposed. Some slight troughs or depressions are apparent, exposing coarse aggregate particles, but this damage is confined to a limited area or randomly spread intermittently throughout damaged area. Some edge repairs may be required to restore eroded edges. Surface mortar that was removed by rain water, but later replaced or supplemented with plastic concrete is included in Case II since a cold joint or sand lens with minimal portland cement paste contact may have been inadvertently incorporated into the slab.

CASE III (Payment is 85% of contract unit price.)
Surface mortar has been practically all removed to an extent that coarse particles of the coarse aggregate fraction are visible. Considerable erosion of edges has occurred, but not to an extent that pavement width is affected. Intermittent edge repair may be required as well as some surface patching of slight troughs or depressions that may have formed in pavement surface due to flowing water. Pavement that has been rain damaged with no attempt of covering or protection by the contractor is also included in Case III.

Severe rain damage may require "localized area" repair by bridge deck overlay procedures. Full depth removal and replacement may be required if edge damage is severe. Severe cases of rain damage should be referred to the Office of Construction for review prior to determination of repair or replacement.

In addition to above described price adjustments and repairs, slab surfaces with missing, omitted, or damaged transverse texturing shall have texture re-established by grinding prior to acceptance by project engineer.

C. "L" Joint Tie Steel Deficiencies
Tolerance problems with "L" joint tie steel shall be corrected according to procedures established in *Construction Manual 9.26*. (Note: "BT" and "KT" deficiencies usually require field correction.)

An adjustment in the contract unit price shall be made for out of tolerance "L" joint tie steel areas. This price adjustment should be a reduction of 5% to the contract unit price per m^2 (sq. yd.) for affected areas. It should be applied to a computed effective area bounded by one half the distance to closest adjacent "in tolerance" (in each direction) multiplied by the placement width. This price adjustment is intended not to apply to individual out of tolerance tie steel.

D. Bridge Floor Overlay price adjustments are prescribed in *Appendix 2-34(D)*.

E. Macro texture adjustments will be determined by the project engineer on a case-by-case basis depending on severity and amount of surface area involved.

For texture depth measurement criteria, refer to *Construction Manual 9.43*. Texture depths less than 1.5 mm 1/16 inch) shall be corrected by sawing in grooving or diamond grinding. Texture depth exceeding 4.5 mm (3/16 inch) may require price adjustment as directed by the project engineer. Price adjustments for over depth grooving are found in *Appendix 2-34(E)*.

F. Traffic Control
1. Price adjustments may be applied for failure to comply with traffic control requirements in the contract documents. Contract price adjustments will be determined by the project engineer, based on magnitude and frequency of violations. A suggested sliding scale is $250 for the first violation, $500 for the second violation, $1000 for the third, etc. progressively doubling the amount of each following violation. See flowchart in Appendix 2-15 for further guidance.

Price adjustment violations will be counted from first violation through last violation for an entire contract. It is a prime contractor's responsibility to ensure a safe work zone for all construction activities regardless of work in progress or who is doing that work. Therefore, violations will accumulate against the "contract" and not be separated or individualized by subcontractor.

Examples of situations where a price adjustment would be appropriate include:

- Failure to maintain traffic control devices (costs incurred by the contracting authority may be recovered against this item)
- Working without proper traffic control setup
- Unauthorized crossing of interstate or other multilane divided highway median

- Use of unauthorized, substandard, or non-standard traffic control items such as incorrect sign sheeting or unapproved floodlights
- Violations of, or failure to comply with, traffic control requirements in the contract documents

It is not intended that minor deficiencies be price adjusted if corrected in a timely manner. In addition to price adjustments, project engineers may suspend work for irresponsible and/or repeated failure to conduct construction activities using proper traffic control procedures.

2. Failure to maintain traffic control devices and signs on a daily basis continues to be a concern of the Department. Price adjustments are appropriate for failure to adequately maintain these devices and signs. To determine an appropriate daily price adjustment for lack of maintenance, the total bid price for the traffic control item should be divided by the number of working days allowed on the contract. This calculated amount should then be divided in two to determine an appropriate daily maintenance value. This daily maintenance value would be the appropriate price adjustment for failure to maintain traffic control devices and signs.

   The daily maintenance price adjustment calculated below is in addition to other traffic control price adjustments.

   An example calculation to determine this daily maintenance value follows:

   Traffic control bid item amount (TC) = $25,000
   Number of contract working days (WD) = 100
   Daily maintenance price adjustment (PA)
   PA = (TC/WD)/2
   PA = ($25,000/100)/2 = (250)/2 = $125
   PA = $125

3. Occasionally contractors fail to provide the required certified traffic control technician or have the daily traffic control diary completed during the construction of the project.

   - An appropriate price adjustment for failure to provide a certified traffic control technician is 5% of the traffic control bid item price or $250, whichever is greater.
   - An appropriate price adjustment for failure to provide a traffic control diary for review during construction activities is an additional 5% of the traffic control bid item or $250, whichever is less.
   - An appropriate price adjustment for failure to submit to the engineer upon project completion a traffic control diary is an additional 5% of the traffic control bid item price or $250, whichever is greater.
   - These price adjustments are independent of each other and are also in addition to other traffic control price adjustments.

4. When a flagger is incorrectly flagging according to the Flagger's Handbook, as referenced in Standard Specification 2528.10, the project should have the Flagger bid item price adjusted. This price adjustment should be one half of the daily unit bid price for the Flagger item.

Examples of situations where a flagger price adjustment would be appropriate include:

- Incorrect flagging procedures
- Nighttime flagging without a correctly lighted flagger station or without appropriate nighttime flagging equipment or apparel
- Incorrect, inappropriate, or incomplete flagger attire
- Use of incorrect paddle (STOP/SLOW or SLOW/SLOW)
- Failure to carry their flagger training card

When an untrained flagger is used in violation of the specifications, the flagger shall not be measured and paid. The flagger shall continue to flag for the remainder of the day and a trained flagger shall be substituted the next day. Unattended flagger stations are a severe violation of the specifications and should be price adjusted per Item 1 price adjustments.

These price adjustments are also in addition to other traffic control price adjustments.

G. Asphalt

1. Liquid Asphalt

a. Viscosity or Penetration

When noncomplying tests occur, determine the quantity affected. Average all noncomplying quality control tests and use that average in conjunction with *Appendix 2-34(F)* to determine if, or how much, price adjustment is warranted.

b. Residue

The determination of compliance for emulsions used as prime and tack coats shall be based on residue percentage. Undiluted emulsion contains a minimum of 57% asphalt residue. Emulsion diluted with one part emulsion to one part water shall contain a minimum of 28.5% residue.

When noncomplying tests occur, determine the quantity affected. Average all noncomplying quality control tests and use that average in conjunction with *Appendix 2-34(G)* to determine if, or how much, price adjustment is warranted.

2. Asphalt Binder - Viscosity

When a noncomplying viscosity test occurs, establish the quantity of material affected. This quantity may be the total asphalt binder used that day, unless intermediate quality measurements have been made during the day. The quantity affected shall be in relation to the proportion of noncomplying samples to the total number of asphalt binder samples obtained that day.

Example:

Total samples taken during the day	=	5
Number of failing samples for the day	=	2
Total asphalt binder used that day	=	200 Mg (tons)
Quantity affected = (2 ÷ 5) x 200	=	80 Mg (tons)

Noncomplying test results for the day shall be averaged to determine the amount of deviation from specification requirements. This average will be used to apply the appropriate percent of payment for the quantity affected. Use Adjustment schedule in *Appendix 2-34(H)* to obtain the applicable payment adjustment.

The materials, both liquid asphalt and asphalt binder, are used on the basis of certification. The follow-up acceptance testing is performed to verify the compliance so work will not be delayed pending the test results. However, if the material has not been incorporated and acceptance tests indicate noncompliance, the material will be rejected.

Unless indicated otherwise in the contract documents, the contractor must use performance graded (PG) asphalt binders. If a performance graded asphalt binder is used but the properties do not comply with specifications, consult with the Office of Materials, the Office of Construction, and the District Materials Engineer for appropriate resolution. A price adjustment may or may not be appropriate depending upon the circumstances involving each situation. Price adjustment schedules, similar to those existing for noncomplying asphalt viscosity, won't be established until more experience with PG asphalt binders is obtained.

3. Asphalt Binder Content
The determination for compliance with the specifications of the asphalt binder content control shall be made for periods not exceeding one day in length. Determinations shall be made for shorter time intervals when noncompliance for the shorter intervals has occurred.

The specifications for hot mix asphalt construction require the contractor to maintain the asphalt binder content within plus or minus 0.3 percentage points of the percent intended. The percent intended is given on the job-mix formula sheet issued by the Office of Materials in Ames.

If the tank stick results indicate that a noncomplying asphalt binder content has been obtained and a price adjustment is necessary, it is recommended that the Guide for Adjustment in *Appendix 2-34(I)* be used to determine an adjustment. The adjustment will be made on the quantity of HMA mixture affected. It is not applied to the asphalt binder. No payment will be made for asphalt binder used in a mixture in excess of tolerance specified.

Excessive asphalt binder content can result in low lab voids which can, in turn, result in a high potential for pavement failure due to flushing and rutting. When the deviation from intended asphalt binder content is greater than 0.3% and the lab voids for the lot are extremely low, the District Materials Engineer should be consulted regarding the rutting potential of the pavement. In cases where severe rutting or flushing develops or is likely to develop, removal and replacement of the noncomplying HMA pavement should be considered in lieu of price adjustment.

The Guide for Adjustment in *Appendix 2-34(I)* is intended to be used for tank-stick measurement results. When the asphalt binder quantity involved is 200 Mg (tons) or less, tank-stick measurements lack precision and cannot be used as a basis for determining asphalt binder content, noncompliance, and assigning price adjustments. In this case, the average of tank-stick measurement results from the day before and the day after may be used to provide further verification.

The procedures listed in *Materials I.M. 508* and *I.M. 509* should be followed closely in making tank-stick measurement calculations.

The contractors are cautioned to observe the following procedures in order to help insure accuracy of the determinations:

a. Keep the storage tank level and in good condition
b. Make sure that the asphalt binder in the surge tank is exactly the same level each time that measurements are made
c. Try not to drain the asphalt binder level in the tanks into the heater coil area when measurements are made
d. See that rail cars and transport trucks are completely unloaded or any unused asphalt binder returned is weighed or measured

To eliminate misunderstandings and uncertainties, it is strongly urged that an authorized representative of the contractor observe all sampling and tank-stick measurements and check all calculations. A contractor's representative should also be requested to initial or sign the field book or record sheet containing the measurements and results as they are made.

4. Segregation in Hot Mix Asphalt Pavement
   When mixture segregation occurs in the pavement such that the composition and quality of the mixture required by specification are not uniformly attained, the sections judged deficient may be required to be removed and replaced as defective work. An adjustment in contract price may be made for deficient work for the cases described in the following schedule.
   a. Pavement Surface
      The adjustments in contract price are to be applied to the entire paver lane width and lift thickness between extreme areas of segregation. Price adjustment shall apply only to the payment for the HMA mixture. Price adjustments are defined in *Appendices 2-34(K.1) and 2-34(K.2)*.

ADJUSTMENT SCHEDULE

Case I (Payment is 80% of contract unit price.)
When uniform surface texture and mixture composition is evident (by visual observation) except for occasional and random areas of segregation, the mix shall be subject to price adjustment if the area determined segregated equals or exceeds 3 square meters per metric station (1 sq. yard per station) per paver width (length determined by longitudinal distance both directions from segregated area).

Case II (Payment is 50% of contract unit price.)
When a nonuniform surface texture and mixture composition is evident (by visual observation) and there is a regular interval of numerous areas of segregation connected or nearly connected with longitudinal traces of segregation, the mix shall be subject to price adjustment if the total area segregated equals or exceeds 9 square meters per metric station (3 sq. yards per station) per paver lane width (length determined by longitudinal

distance both directions from the extreme ends of areas of segregation).

Case III Longitudinal Streaks (Payment is 80% of contract unit price.) When a nonuniform surface texture and mixture composition is evident (by visual observation) and in the form of longitudinal streaks of 75 mm (3 inches) or more in width, the mix shall be subject to price adjustment if the segregation occurs at a rate that exceeds 3 square meters per metric station (1 sq. yard. per station). The rate is determined by multiplying approximate width by length of the streaks to determine area and dividing by the length of the streaks (in stations). Longitudinal streaks most commonly occur with the windrow-pickup process, particularly when resurfacing superelevated curves. Streaks are typically seen in the wheelpath areas and occasionally in the center of the lane. Streak widths typically vary from 75 to 300 mm (3 to 12 inches) and may be continuous or intermittent. This type of segregation results in longitudinal cracking.

More severe surface and mixture segregation may require corrective procedures as:

- full width thin layer 25 mm (1 inch) thick resurfacing or
- removal of HMA mixture course with no extra payment and replacement with construction that fully complies

Note: Determination of segregation is to be by visual observation in accordance with current specifications. The engineer may consider further verification through coring and extraction tests and/or through the application of *Materials I.M. 381*, "Method of Test for Evaluating Segregation in Hot Mix Asphalt Using a Nuclear Density Gauge." However, Materials I.M. 381 should still be considered as under development and results from this test as advisory only. The determination as to whether segregation exists is based on visual examination. Segregation case examples are illustrated in *Appendices 2-34(K.1) and 2-34(K.2)*.

b. Fillets & Runouts
This price adjustment procedure does not apply to fillets, bridge runouts, or other hand-worked areas outside of the normal paver lane width.

c. Base & Intermediate Courses
The price adjustment percentages shall be reduced as indicated in Appendices 2-34(K.1) and 2-34(K.2) for all base or intermediate courses, except when such mixture is specified and used as the surface course.

d. Procedure for Determination of Price Adjusted Quantities
The segregation case examples shown in *Appendices 2-34(K.1) and 2.34(K.2)* illustrate a concept that may be used to define the severity of segregation and appropriate price adjustment factor. It is not required, however, to physically measure each area of segregation to determine a quantity of HMA mixture that is subject to price adjustment. The intent is to define the quantity subject to price adjustment by identifying the number of truckloads in which segregated areas are evident. This obviously takes some judgment to decide how large or severe an area must be before it is price adjusted. The 1 square meter (sq. yard) area shown in examples is a "rule-of-thumb." Most importantly, segregated areas that exhibit an obvious

concentration of coarse aggregate resulting in a nonuniform open texture should be price adjusted.

Whenever segregation occurs, the contractor shall be advised immediately and the inspector must document the deficiency with a Noncompliance Notice. The notice should reference the applicable specification and indicate the project engineer will review the work to determine the acceptability of the work. It is recommended that a Noncompliance Notice be issued when segregation is initially observed with final evaluation and price adjustment determined later but prior to project acceptance.

Timeliness is important for two reasons. First, the contractor must take corrective action immediately. Failure to do so should result in suspension of work. Secondly, early identification of unacceptable work allows for resolution of any disputes before there is an "implied" acceptance. *Construction Manual 1.12* discusses the enhancement of working relationships by timely notification of unacceptable work.

For streak type segregation, it will be necessary to identify and tabulate the location and length of the segregated streak areas subject to price adjustment and base the price adjustment on the mix quantity within the beginning and ending station limits of the streaks.

Normally this procedure should be repeated for each day from header to header on the day following placement. Each day's run can be tabulated showing a summary of affected Megagrams (tons) of HMA mixture subject to price adjustment.

5. Filler/Bitumen Ratio
For Marshall mixes, the filler/bitumen ratio is determined by dividing the percentage of cold feed material passing the 75 µm (#200) sieve by the total percentage of asphalt binder used, as determined by tank stick or by actual mass (weight) of asphalt binder used. For Gyratory mixes, the filler/bitumen ratio is determined by dividing the cold feed material passing the 75 µm (#200) sieve by the "effective" percentage of asphalt binder used, which takes into account asphalt binder absorbed by the aggregate. See *Materials I.M. 501* for additional information, including applicable equations and example calculations.

For recycled mixes, the percentage asphalt binder is to be determined by addition of percent by tank-stick plus percent in salvaged material as set by job mix (% intended less additional).

The determination for compliance with the specification shall be made for periods not exceeding one day in length. The average of all tests for the lot shall be used to determine the filler/bitumen ratio.

When the filler/bitumen ratio for an HMA mixture exceeds the maximum established by specification for that material, the affected material will be considered noncomplying and subject to price adjustment.

The adjustment schedules in *Appendix 2-34(J)* are to be used as a guide for price adjustment of the quantity of material affected. The adjustment will apply to the HMA mixture only.

The above schedules are to be applied in lieu of the 75 µm (#200) sieve adjustment for excess or lack of fines listed under Gradation.

6. Field Density
   Compaction requirements and price adjustments for noncomplying field density are covered in the current specifications for Hot Mix Asphalt Mixtures. The price adjustment is applied to the unit price for HMA mixture only.

H. Adjustments for Other Contract Administration Issues
Price adjustments for noncomplying work are occasionally appropriate when the issue relates to other incidental items in the contract documents. Price adjustments shall not be considered unless there is willful or repeated reoccurrences indicating lack of due consideration on the contractor's part. In such cases, the following will apply:
- Provide a clear and concise notification to all parties involved with the incident. (This could be a verbal notification or a written noncompliance without price adjustment.)
- Subsequent violations would result in additional noncompliances and could be reason for price adjustments starting at $100, then $250, $500 etc. (progressively doubling the amount of each following violation).

NOTE: It is NOT intended that minor deficiencies be price adjusted if corrected in a timely manner. Situations and circumstances will dictate how this portion should be applied.

I. Steel H-Pile Weight Deficiency
Materials I.M. 467 specifies a mass tolerance of 2.5 percent on steel H-pile weight deficiency. Steel H-pile that are deficient by more than 2.5 percent of theoretical weight should not be accepted for incorporation into the work except when:
- The need for the steel H-pile is immediate and considered critical by the project engineer.
- Replacement of steel H-pile is not reasonably possible due to short supply and availability.

In the above cases, the project engineer may decide to approve the use of deficient steel H-pile and apply a price adjustment in contract unit price for the material as prescribed by "Steel H-Pile Weight Deficiency Price Adjustments" in *Appendix 2-34(L)*.

2.54 PRICE ADJUSTMENT CHANGE ORDERS

Price adjustment deductions are processed by change orders using an 8xxx change number. If additional price adjustments come up later, a second change order must be prepared; but such increases or decreases are processed as 7xxx change numbers. (Refer to *Construction Manual 2.36* for information about processing change orders.)

3.07 REQUIREMENTS FOR MONITORING THE CERTIFIED PLANT INSPECTION PROGRAM AND QUALITY MANAGEMENT - ASPHALT (QM-A)

The monitoring requirements listed in the appendices are intended to be the minimum for HMA or PCC plant operation. Field problems may necessitate increased monitoring. For PCC plant inspection, all monitoring requirements, except for plant calibration, will be performed by construction personnel. For HMA projects, monitoring responsibilities are shared between the plant monitor, grade inspector, and materials personnel. Materials personnel will primarily monitor activities involved with HMA materials production process and quality such as plant calibration, QM-A lab operation, contractor field process control, and for QM-A projects, will resolve discrepancies between the District Materials Lab and Contractor Lab results. Construction personnel will be primarily involved in administration and inspection activities. Materials engineers and resident construction engineers may mutually coordinate and shift responsibilities between personnel on an individual project basis to achieve the most efficient use of their respective personnel and minimize unproductive time spent at the contractor's HMA plant. See *Construction Manual 3.20* for responsibilities of project acceptance sampling and testing.

On certified plant inspection projects, it is a requirement for the plant monitor to be a certified technician for the type of work involved.

QM-A requirements can be considered an expansion of the certified plant program for HMA. In addition to normal certified plant inspection duties, under QM-A the contractor is also required to design and submit their own mix designs for agency approval. At the plant, the contractor is required to analyze and control mix production properties through frequent field testing, based on specified gyratory or Marshall mix design criteria.

For a QM-A project, the plant monitor must be a certified HMA technician. This certification is obtained by attending the Level I HMA course and passing the required examinations.

It is imperative that project engineers maintain an adequate staff of trained, experienced plant monitors. This can be accomplished by having employees participate in the appropriate technician training and certification programs and pass the examinations.

Certified plant inspection will apply to items of work as defined in *Specification 2521.03*. Any items of work excluded from certified plant inspection will be as noted in contract documents. Work excluded from certified plant inspection will also be excluded from QM-A requirements.

In the event the contractor's certified HMA technician is absent, the contractor must contact consultants or other available certified technicians to arrange for inspection.

For duties performed by the certified HMA technician on QM-A projects, the contractor must also contact consultants or other sources for available certified technicians in cases of absenteeism. Because of the laboratory skills necessary to perform this work and the decision making authority as a representative of the contractor, it is not possible or appropriate for the project engineer to provide certified HMA technician services to the contractor in cases of unexpected absences. If the contractor fails to provide certified HMA technicians as required by specification, work covered by QM-A shall be suspended until the project is properly staffed.

Portland Cement Concrete Paving Plant Monitoring

Appendix 3-2 lists the minimum monitoring requirements. A plant monitor will normally be assigned to each project with duties split between plant and grade inspection. Plant monitor should schedule work so the plant can be visited daily during production. The amount of time spent at the plant will depend on the overall quality control at the production plant.

Test beams for determining flexural strengths are to be transported from the grade to the plant site by contracting agency personnel.

Structural Concrete Plant Monitoring

Appendix 3-3 lists the minimum monitoring requirements. The project engineer and contractor should agree in advance whether aggregate gradations, moisture, and specific gravity tests will be waived for concrete which is furnished at a maximum rate of 20 m^3 (25 cubic yards) per day. This determination should be in accordance with *Materials I.M. 528.*

Ready mix tickets shall be prepared and signed by the certified plant inspector.

Test beams for determining flexural strengths are to be transported from the grade to the plant site by contracting agency personnel. The certified plant inspector is responsible for curing and storage of the beams. Contracting agency personnel are responsible for testing and reporting results.

Hot Mix Asphalt Paving Plant Monitoring

Appendix 3-4 lists the monitoring requirements. Responsibilities are shared between the plant monitor, grade inspector, and materials personnel. A plant monitor will normally be assigned to each project with duties split between plant and grade inspection, and may also be assigned to multiple projects under construction at the same time. The plant monitor should schedule work so that the plant can be visited daily during production, as required by *Appendix 3-4.* The amount of time spent at the plant, beyond minimum requirements, will depend on the overall quality control at the production plant. The project inspector will be providing production and placement information to be entered on the daily plant report.

Visits by the project inspector to the plant laboratory for exchange of information and to perform administrative activities will normally be done daily.

The plant monitor will typically be responsible for performing the density testing on HMA core samples.

Plant Reports

The project engineer should make arrangements with the certified technician for timely distribution of plant reports. On QM-A projects, the contractor shall FAX a copy of the daily plant report and QM-A Summary Sheet to the District Materials Engineer on a daily basis. The original and all copies of the plant report shall be kept at the plant until all documentation is completed. Normally, this will be the day following the end of the reporting period. Review and distribution of the reports will be made by the project engineer. This distribution will include a copy to be returned to the certified technician. Prompt consultation with the certified technician and monitor shall follow any significant error or omission.

Documentation

A documentation sample for the plant monitor is contained in *Appendix 3-5*. A separate field book should be set up on each project to document plant inspection. Some flexibility in the suggested format may be necessary depending on project size, type of plant, and if QM-A applies. It is important to document discrepancies and corrective action taken by contractor.

A copy of this documentation must be furnished to the District Materials Engineer (DME) at the time of project acceptance. Also include the certified technician's name, certificate number, and statement from the monitor regarding the work performance of certified technician. It may be necessary to consult with the DME regarding contractor technician performance for Marshall testing duties on a QM-A project. A sample format for providing this documentation is contained in *Appendix 3-6*.

Specification Violations

Failing test results are to be recorded on the daily plant report by the plant inspector. Verbal notification of such failing results shall precede completion of paperwork to assure timely changes.

Failing test results on QM-A projects related to specified moving averages will be noted on the certified HMA technician data sheets and quality control charts. Special notes on these failures will also be reported in the comment section of the daily plant report. When average points move outside the specification limit, HMA mix production operations shall cease until the contractor proposes meaningful corrective action. The corrective action must be discussed with the DME prior to production start-up.

The plant monitor will convey to the responsible project inspector all specification violations, discrepancies in results with the plant inspector, and improper procedures and equipment used by the plant inspector. The project inspector will issue noncompliance notices for failing test results and inadequate testing procedures or equipment.

In order to use the contractor quality control test results for the acceptance decision, they must be validated by agency verification tests. It is important to notify the contractor and the DME when the results do not compare within the validation criteria in the Materials IM. The lot of material cannot be accepted until the validation issue is resolved by the DME.

All improper procedures, unresolved test discrepancies, or failure to perform inspection duties will be considered by the DME for possible decertification or other appropriate corrective action.

The role of the plant monitor is vital in assuring the DME is aware of any deficient or otherwise unsatisfactory work of the certified technician.

Testing Equipment & Supplies
Certain testing equipment is available for purchase from Department stock. Producers should refer to HMA and PCC Plant Inspection Manuals for specific information and Office of Materials Lab contacts. A list of equipment suppliers is included in the plant manuals.

Necessary plant inspection forms will be furnished to the producer at no cost. The producer can request these through the DME or project engineer. It is a good idea for the plant monitor to carry a supply of forms and make these available to the producers as needed.

The plant monitor can utilize contractor-furnished equipment for testing required at the plant site. HMA core density testing will most likely be done using the same balance, water bath, and thermometer as the contractor. Verification gradation testing should be done at a separate laboratory from the contractor's if possible.

Samples

Verification samples are to be taken by agency personnel or by contractor personnel when directed and witnessed by agency personnel. Materials IM 204 will indicate when contractor sampling assistance is required.

Verification samples that are not tested should be retained until the lot has been accepted.

If required by contract documents, transportation of secured verification samples to the District Materials Lab shall be performed by the contractor.

It is also important to note that each individual holding a certification and performing sampling and testing that is included in the acceptance process must participate in the Independent Assurance Program. While it is the responsibility of the Central and/or District Materials Offices to track independent assurance testing that has been performed, it is the responsibility of the individual holding the certification to ensure that they are being included in the IAP.

> Example: An individual is certified in AGG I & II, PCC I & II and HMA I or HMA Sampler. The individual maintains all of the certifications over a three year period but is only involved in verification testing for HMA including aggregate gradations, sampling of HMA mix on the grade, and sampling and testing of HMA density cores during that timeframe. The individual should be sure that they are being included in the IAP for each of the sampling and testing tasks that they perform throughout that three year period. This would include sampling and testing of aggregates, sampling of HMA, and sampling and testing of HMA density cores. The individual would not need to be included in the IAP for the PCC certifications that they hold unless sampling and testing is being performed using those certifications.

3.22 CONTRACTOR ASSISTED SAMPLING AND VALIDATION OF CONTRACTOR TEST RESULTS

Verification sampling of the following materials will be done by contractor personnel as directed and witnessed by agency personnel:

PCC and Compacted HMA Cores
Aggregates for gradation
Asphalt Binder
Uncompacted HMA Mixture from behind the paver

Materials IM 204 lists the minimum frequency and IM method to be used for sampling. If the contractor is required to transport the samples, the agency personnel will seal the sample with a security tag before giving it contractor.

Quality control sampling and testing for the following materials and tests may be used in the acceptance decision:

HMA Mixture properties	IM 511
Aggregate gradation	IM 511 or IM 527 and IM 528
Smoothness testing	IM 341

For the quality control test result to be used in the acceptance decision, it must be compared to the agency verification test result. Unless the test results compare satisfactorily (are validated), the quality control test results can not be used in the acceptance decision. There is a dispute resolution process the Engineer or District Materials Engineer can use to resolve the test result differences.

Evaluation of Test Results

Specification 1105.04 requires project engineers to determine if project work is acceptable and within reasonably close conformity with contract documents. If the work is not in reasonably close conformity, the project engineer is permitted to allow the work to remain in place if it is reasonably acceptable and to provide an adjustment in the contract unit price for work that is deficient. However, the contractor may elect to remove the deficient work with no extra payment and replace it with construction that complies.

Whenever deviations from specification limits or tolerances occur, whether the deviation is to the extent that payment adjustments will be made or not, the contractor shall take immediate corrective action that will insure subsequent compliance. If immediate corrective action is not taken, the inspector will stop the work.

When test results are within specifications but continuously near the limits or tolerances on any sieve, the inspector will inform the contractor that corrective action would be advisable and document this advice in the project diary. Work will not be stopped, pending such corrective action, unless noncompliance has occurred.

3.50 WEIGHING EQUIPMENT FOR DETERMINATION OF PAY QUANTITIES

Specification 2001.07 describes equipment and procedures to be used when payment for an item of the contract is based on actual weight. Aggregates are generally weighed in the delivery vehicle on a platform scale. Hot Mix Asphalt mixtures may be weighed over platform scales, in silos on load cells, in weigh hoppers, or by counting batches. The specifications no longer provide for converting volume measurements to weight.

Weight Tickets

The contractor shall provide a weight ticket for each load showing the required weight information for the procedure being used, the project number or contract description, the truck number, the date, and the type of material.

The required data to be automatically printed on the weight tickets will vary according to the method of measurement (weigh hopper, silos on load cells, batch scales, or platform scales) and type of system (automatic or semi-automatic).

Automatic or Semi-Automatic Weighing

- For weigh hoppers, batch scales, or silos on load cells, all tickets printed automatically shall include the gross weight, empty weight of the hopper or weight not discharged, net weight of material for each drop, and the total net weight for the load. When weighed under the semi-automatic procedure, the weighmaster may include on the ticket the calculated total net weight.
- For batch scales, the batch weight and batch count are to be automatically printed under both procedures. The total net weight may be printed with a system or calculated by a weighmaster with a semi-automatic system.
- For truck platform scales, all scale tickets printed automatically shall include gross weight, tare weight of the truck, and net weight of the load. For semi-automatic weighing the printer shall print the gross weight, and the weighmaster shall conduct all weighing and may enter by hand or by printer the tare weight of the truck and calculate the true net weight.

Manual Weighing

- For manual weighing of loaded trucks (project quantities less than 10,000 Mg [10,000 tons]), scale equipment on truck platform scales may or may not include a mechanical ticket printer. A weighmaster shall include the gross and tare weights and calculate the net weight on the scale ticket. The engineer may arrange for weighing to be witnessed.

The inspector will collect the accompanying load ticket for each load of material on its arrival at the work site and check to see that the ticket has been validated by the scale inspector when such scale inspection is required. The inspector will observe each load of delivered material to detect any obvious deficiencies in quality or in quantity and reject any loads which are unsatisfactory.

The inspector will sign or initial the scale ticket for each accepted load to verify the material was delivered and accumulate the tickets on a daily basis for determination of pay quantities. Quantities for each day's operation shall be totaled and checked against the contract records and any discrepancy promptly resolved.

The requirement that an inspector personally receive all load tickets at the time of delivery may be relaxed only in cases of very small quantities or intermittent deliveries under conditions where the project engineer or inspector can visually determine the approximate quantity delivered.

On hot mix asphalt projects, it is permissible for a contractor's employee to collect the tickets and place them on a clipboard. An inspector must be present at the laydown operations at all times and observe the collection of the tickets.

Truck Platform Scale Approval

The specifications require that scales for weighing loaded trucks shall meet the requirements of the Iowa Department of Agriculture. A platform scale used for measurement of items such as crushed stone, base and subbase material, and hot mix asphalt mixtures, contracted for and measured by the Megagram (ton), shall be inspected by the Iowa Department of Agriculture.

Permanent scales, so inspected, have an official stamp conspicuously displayed.

Temporary scales, so inspected, have the same official stamp. If the scale is at a temporary plant location or quarry, the inspection may be identified by a certified report and affidavit. A copy of the "Portable Scale Report" to be used for portable scales is included in *Appendix 3-7*. Use of the certified report and affidavit is subject to the following special limitations, and with these limitations inspection is official by the Iowa Department of Agriculture.

- The scale is inspected by a registered scale technician. A report is then prepared that certifies the scale complies with State of Iowa regulations. A copy of the report shall be forwarded to the Iowa Department of Agriculture.
- It is effective for 90 days at the same location; however, the effective period does not extend beyond the spring thaw.
- Inspections made in the spring are after frost leaves the ground.
- The certified report and affidavit shall expire when the scale is moved.

Weigh Hopper, Batch Scales, & Load Cell Approval

Weigh hoppers, batch scales, and load cells will be checked for accuracy against truck platform scales that meet the requirements of the Iowa Department of Agriculture during calibration and during use as described below.

The contractor shall have, reasonably available upon request, at least 10 standard 25 kg (50 pound) test weights for the purpose of testing and calibrating weighing equipment. Whenever scales are checked with standard weights, the data showing scale readings versus increments of known standard loads should be recorded in the field notebook or on a calibration form and become a part of the permanent job record. It is the intention that contractor's personnel will be responsible for adding and removing the weights. Inspection personnel shall witness and document calibration or other scale checks.

When automatic or semi-automatic weighing is used, continuous direct observation of the weighing process by a scale inspector is not required. When weighing is not continuously observed, sufficient random checks should be made to assure the project engineer that the contractor's weighing procedures are accurate and the true net weight is recorded. This includes both verification weighing and check weighing.

Verification weighing is defined as a second weighing of the same load on the same scale, and applies only to truck platform scales. At least one verification weighing should be made daily when the pay quantity is weighed on truck platform scales.

Verification weighings are made to determine the repeatability of truck platform scales. The verification weight should not be different from the initial weight by more than 0.1%.

Check weighing is defined as a second weighing of the same load on another certified truck platform scale. Check weighings shall be made to determine the accuracy for all types of weighing equipment. For check weighing of weigh hoppers, load cells or batch weight tickets, it will be necessary to also get the tare weight of the delivery truck and consider a suitable fuel adjustment to determine the accuracy of the total net weight. Recognizing that in a batch plant some material may remain in the mixing chamber after a drop, the results of two check weighings may be averaged.

Check weighing for truck platform scales should not be different from the initial weight by more than 3%. Check weighing for weigh hoppers, batch scales, and silos on load cells shall not be less than the initial weight by more than 45 kg (100 pounds).

One check weighing should be performed on the first day of hot mix asphalt production or aggregate weighing. One additional random check weighing should be performed for project quantities exceeding 4,536 Mg (5,000 tons). If these check comparisons had been made for another project within the time stipulated, documentation in the project diary will be satisfactory and separate checks will not be required.

If the check shows weighings that compare within the tolerances allowed, the scales should be considered satisfactory.

If the check shows weighings that do not compare within the tolerances allowed, the scales should be considered satisfactory only after the following additional investigations show it as warranted:

(1) The scale can be checked against another platform scale.

(2) The deviation of each scale from the true weight can be determined from the scale calibration prepared during the inspection if available. The scale operator is given this calibration, but is not required to keep it. The tolerance to be maintained is 1.8 kg per 900 kg (2 pounds per 1,000 pounds).

    If one scale is heavy just within this tolerance and the other scale is light just within this tolerance, a difference in compared weights for a 23 Mg (50,000 pounds) load can be 90 kg (200 pounds) and still be legal and satisfactory. Some allowance should be made for actual difference in weight because of gasoline 0.84 kg/L (7 pounds/gallon) if there is sufficient distance between scales.

For true verification and check weighing, selection of random loads shall be done without advance warning to the contractor. Allow a reasonable fuel adjustment, if appropriate.

Where random checks show errors beyond the tolerances specified in the specifications, the project engineer should review the weighing procedures used by the contractor and may require that the scales be inspected. The contractor shall take prompt action to make necessary repairs. Should errors continue to be discovered, it will be necessary to suspend further weighing until the weighing procedures are correct and accurate. Further investigation is necessary when the error exceeds the tolerance in either the plus or minus direction.

Scale Checks for Sensitivity

- **Batch Scale, Hopper Scale, and Load Cells**
  The sensitivity should be checked at least once during a normal working day by placing a weight equal to one-tenth percent the batch weight 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.

  Specified scale tolerance limits should be checked by periodically witnessing the batch weighing operation. 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.

  Refer to *Materials I.M. 508* for automatic batch weighing equipment settings and/or adjustments.

- **Truck Platform Scales**
  The following paragraphs apply to permanent platform scales as well as portable platform scales.
  A. The working parts of scales (platform and beam linkage) must operate freely to preserve the scales accuracy and sensitivity. The scale should be kept clean on and under the platform to assure accuracy.
  B. Each scale should be *checked for sensitivity initially (0.1 percent of the quantity being weighed) and at least once each working day by carefully balancing the scale*, then observing if movement of the equilibrium indicator is discernible upon application of a weight equal to one of the minimum gradations but not more than 9 kg (20 pounds).

Truck Platform Scale Use

Each truck to be weighed shall be tared daily. Taring of trucks should be on a random basis during the day's operation, using the previous day's tare weight until a new tare weight for that day is determined. No truck may be used for hauling material paid for on a weight basis until tared.

Use of Weighmasters

In order to make more productive use of contract inspection personnel, a program has been implemented whereby contractors and/or producers will furnish weighmasters *(Code of Iowa, Chapter 214, Section 6-8)* to conduct the weighing of highway construction materials. The specifications presently limit the weighmaster requirement to weighing of hot mix asphalt mixtures and aggregates under procedures for semi-automatic weighing and manual weighing of loaded trucks.

- **Weighmaster's Oath**
  To be qualified, a weighmaster must sign an oath. A copy of the "Oath of Weighmaster" is included in *Appendix 3-8*. Personnel desiring to become a weighmaster may obtain additional forms and procedures from the Iowa Department of Agriculture's Division of Weights and Measures, Des Moines, Iowa.
- **Responsibilities**
  The weighmaster must be the person actually operating the weighing and recording equipment. He/she shall include on the scale ticket the tare weight and the calculated true net weight. The weighmaster shall sign the ticket for the first weighing each day and initial subsequent tickets. The project engineer may arrange for weighing to be witnessed. If witnessed, the witness will also initial the ticket.

Weighmaster will daily establish tare weights of all delivery vehicles weighed in a truck platform scale. These tare weights will be established at random times throughout the day in accordance with procedures set up with project inspection personnel. A list of these weights will be provided to the engineer on request. When weighing in trucks, the weighmaster shall enter the truck tare weight by hand or this information can be printed out where it can be entered directly to the automatic weigh recorder.

Misrepresentation of weights or weighing equipment that is known to be inaccurate will result in the removal of the weighmaster from the approved list maintained by the Iowa Department of Agriculture. No further material will be hauled to the project from the site of the infraction until another weighmaster is provided or the equipment repaired to meet the standards of the Department of Agriculture Certification Program.

CHAPTER 8
HOT MIX ASPHALT (HMA) PAVEMENT, BASES, AND SUBBASES

8.00 TABLES AND REPORT FORMS

8.01 TABLES FOR BITUMINOUS MATERIALS AND HMA CONSTRUCTION

Reference tables are included in *Office of Materials Instructional Memorandum (I.M.) Volume II.* Available tables include:

Number	Description
T-101	Aggregate Delivery Conversion Table
T-102	Temperature-Volume Corrections for Asphaltic Materials
T-103	Temperature-Volume Corrections for Asphaltic Materials
T-104	Gauging Table for Horizontal Cylindrical Tanks
T-108	Temperature-Volume Corrections for Emulsified Asphalts
T-108A	Temperature-Volume Corrections for Diluted Emulsified Asphalts
T-203	General Aggregate Source Information

8.02 REPORT FORMS

Construction inspection personnel are responsible for field sampling and testing in accordance with requirements of *Materials I.M. 204* and those outlined in *Construction Manual Chapters 2 and 3.* Forms are supplied for reporting test results, submitting samples, and as inspector work sheets.

Under the certified plant inspector program and Quality Management - Asphalt (QM-A) program, specific sampling and testing will be done by contractor's representative (as directed and witnessed by contracting authority) per *Materials I.M. 213 and Construction Manual 3.07, 3.21, & 3.22.* Plant inspectors and other certified HMA technicians must also be familiar with applicable Materials I.M.'s.

Form Identification and Use

- "Daily HMA Plant Report" (Form 800241) documents daily plant operation, job control testing, HMA mix property results, and material placement for HMA production and placement. A computerized version of this form is available and its use should be encouraged to reduce errors although the handwritten form is still available. Copies should be sent to the Office of Materials, the District Materials Office, the project engineer, and the contractor. A copy of the form is included in *Appendix 8-3.*
- "Identification of Sample for Test" (Form 820193) must accompany all samples submitted to Central Materials Laboratory and District Materials Laboratories.
- "Noncompliance Notice" (Form 830245) is used to report project test results, workmanship, or other items in violation of specifications. Copies are to be given to project engineer and contractor.

8.10 ACCEPTANCE AND TESTING

8.11 FIELD TESTS AND CERTIFICATION OF MATERIALS

Sampling and testing are required to determine whether quality of materials and construction are in reasonably close conformance with plans and specifications.

Project inspectors shall identify and inspect all materials received on a project before they are incorporated into work. Inspectors shall determine that proper inspection reports or certifications are on hand, and that no unusual alterations in characteristics of materials due to handling or other causes occurred.

Guide schedules attached to *Materials I.M. 204* contain various field tests and sampling frequencies on asphalt materials and mixtures.

The Quality Management - Asphalt (QM-A) program was started in 1992 with the goal of improving the overall quality of HMA produced and giving the contractor the responsibility for mix design, sampling, testing, and making mix adjustments. In other words, contractors assumed start-to-finish responsibility for the product they produce and place. QM-A is the implementation of contractor process control for HMA mix production and placement. Field tests and certifications are the same for conventionally administered projects and QM-A projects. The major differences are the increased frequency of HMA sampling and testing, who performs the work, and contractor responsibility for conceiving and implementing mix changes to achieve specification compliance. Most administrative questions involving QM-A projects can be answered by referring to *Materials I.M. 511* and the current specifications for Hot Mix Asphalt Mixtures.

Nearly all primary and interstate HMA tonnage is typically constructed under QM-A specifications. It is intended that QM-A be applied to HMA on all interstate contracts and all other contracts with more than 5000 Mg (tons) of HMA. State park, institution, maintenance and other projects utilizing small HMA quantities will not typically be QM-A.

Asphalt Materials

Acceptance of asphalt materials will be on the basis of certification from an approved refinery or distribution terminal source. Formal approval of a source is to be issued by the Office of Materials. Refer to *Materials I.M. 437* for additional information.

Each shipment invoice covering certified materials delivered to a project shall have a signed certification statement as to type and grade, specific gravity or mass per liter, load quantity, batch number or other identification, project number, and compliance with appropriate Iowa DOT specifications. Copy of this invoice shall be furnished to project engineer or project inspector for review and filing.

Aggregates

Aggregate production and inspection are covered in detail by *Materials I.M.'s 204 and 209*. Acceptance for quality will be based on source monitoring and test results on assurance or project samples. Acceptance of mixture gradation is outlined in *Construction Manual 2.53 and 3.22.*

8.12 RESPONSIBILITY AND DOCUMENTING HMA MIXTURE PROPORTIONING CHANGES

Specification 2303 and *Materials I.M.'s 510 and 511* give explicit guidelines that shall be followed for controlling HMA mixtures. They establish job mix criteria and corrective procedures to be followed when mixture characteristics are changed from the job mix formula during mix production.

District Materials Engineers have primary responsibility for authorizing changes made by the contractor to keep the mixture characteristics within all *Specification* and *I.M.* guidelines. They will inform project engineer of changes and follow up with written documentation. Each of these parties may designate a representative to approve desired change.

On QM-A projects, contractor has sole responsibility for making mix changes; however, District Materials Engineer or project engineer must be kept informed and involved in these changes. Mix change decisions must be an interactive process between contractor and agency.

The project engineer must also insure that required changes are implemented as soon as possible when mixture characteristics fall outside *Specification 2303* and *Materials I.M. 510 Appendix A* limits. On each working day, project engineer shall determine if work for previous working day was within *Specification* and *I.M.* guidelines. If not, immediately consult with District Materials and the contractor to assure corrective action is taken.

Adjusting Asphalt Binder Contents

For determining whether asphalt binder content is within required guidelines, refer to *Specification 2303.* Limits are given for the air voids that are determined daily on a specimen in the District Materials Laboratory. This will be calculated by District Materials according to *Materials I.M.'s 321* and *501*, based on the Rice Procedure as per *Materials I.M. 350*. Project engineer or designated representative (probably plant inspector) must get these air voids daily from District Materials.

When test results for air voids (field and/or lab) are outside the limits given in *Specification 2303*, project engineer needs to contact District Materials to initiate changes in HMA mixture. When asphalt binder content changes are considered to adjust air voids, caution must be used to assure that adequate film thickness required in *Materials I.M. 510 Appendix A, Table 1* is maintained. When the resulting film thickness is outside the specified range, procedures given in *Construction Manual Appendix 2-34 (Table M)* should be used to determine the appropriate price adjustment. Reductions in asphalt binder content must not reduce the target below the calculated minimum allowable asphalt binder content. Documentation of changes should be on "Daily HMA Plant Report" (Form 800241).

On QM-A projects, job mix control is done essentially the same way except the contractor is responsible for sampling, testing, reporting results, and making appropriate mix changes. Also, HMA mix sampling and testing is performed up to four times per day at the HMA plant site so immediate results are available. For QM-A, the contractor is responsible for making meaningful mix changes before the lab void running average goes out of compliance. When a lab void running average goes out of compliance, the contractor must shut down and implement changes intended to correct the noncomplying voids. If the contractor fails to shut down voluntarily, the project engineer may shut down the contractor until corrective action is taken. A price adjustment for failure to shut down or make timely and meaningful mix proportion changes may be appropriate. The project engineer should coordinate closely with the District Materials Engineer for a resolution when lab voids are noncomplying on a QM-A project. Lab voids will be monitored daily by District Materials, but the project engineer must also remain informed of the test results.

Work using HMA mixtures with air voids outside the limits shall be avoided. If District Materials cannot be reached in a timely manner, project engineer shall change asphalt binder content as necessary to stay within *Specification 2303* guidelines and report this change to District Materials as soon as possible. Such changes will be reviewed later by District Materials and shall be documented by plant inspector on "Daily HMA Plant Report."

Documenting Corrective Action for Noncomplying Air Voids Test on Specimens Taken from Constructed Pavement

Materials I.M. 204 also requires project engineers to report tests for field air voids on mix samples from compacted roadway on "Daily HMA Plant Report." *Specification 2303* stipulates the required range for these tests.

Range given for these voids is the average of all tests for each day's construction calculated by plant inspector.

When tests for these air voids are outside required range, density results shall first be reviewed. Example: If density results should be on lower range but still passing, perhaps air voids will fall within range specified by increasing density. After review of density and testing procedures, Materials forces shall be notified to consider changes in mix proportions. If conflicts develop between lab and field voids, concentrate on achieving proper lab voids. Generally there won't be a problem keeping field voids within specification if lab voids are on target.

When noncomplying tests for air voids in specimens taken from constructed pavement occur, project engineer will notify District Materials. Plant inspector will document noncompliance on "Daily HMA Plant Report" containing the noncomplying test results.

In response, District Materials Engineer will inform project engineer what changes in mix proportions, if any, should be made. District Materials Engineers will furnish project personnel written documentation for the decision or action taken.

Adjusting Aggregate Proportions

Contractor must occasionally adjust aggregate proportions to consistently comply with job mix target gradation tolerance and to correct calibration errors.

Contractors shall initiate and make changes necessary to insure compliance under guidelines set forth by *Specification 2303* and *Materials I.M.'s 510* and *511*. Contractor shall not be allowed to make such changes without prior approval of project engineer.

For QM-A projects, the contractor shall also initiate and make appropriate changes. Although this must be done as an interactive procedure with project engineer, approval of the project engineer for these changes is not necessary as long as results are within the constraints of specifications and *Materials I.M.'s*.

Proportion changes of up to 5 percent for each material may be approved without delaying operations for qualifying tests. District Materials should be contacted when desired change is between 5 and 10 percent for each material. Single changes greater than 10 percent require a new mix design unless waived by project engineer.

Specification 2303 and *I.M.'s 510* and *511* provide many of the guidelines needed for making mix change decisions. Project engineers are expected to reference these documents and communicate closely with District Materials prior to, during, and after the need for decisions concerning mix proportion changes so problems can be avoided.

Proportion changes shall be documented by plant inspector on "Daily HMA Plant Report."

Filler/Bitumen Ratio

Specification 2303 and *Materials I.M. 510 Appendix A* give explicit guidelines that shall be followed in relation to filler/bitumen ratio. For Marshall mixes, the filler/bitumen ratio is determined by dividing the percentage of cold feed material passing the 75 µm (#200) sieve by the total percentage of asphalt binder used, as determined by tank stick or by actual mass (weight). For Gyratory mixes, the filler/bitumen ratio is determined by dividing the cold feed material passing the 75 µm (#200) sieve by the "effective" percentage of asphalt binder used, taking into account asphalt binder absorbed by the aggregate. See *Materials I.M. 501* for additional information, including applicable equations and example calculations.

Plant inspector should determine how a proportion change will affect the filler/bitumen ratio before allowing contractor to make such a change.

If filler/bitumen ratio is outside the limits established in *Specification 2303 and I.M. 510 Appendix A*, a "Noncompliance Notice" (Form 820245) shall be issued immediately. If additional verification samples are taken, they must be run and an average calculated.

Plant inspector will then refer to *Construction Manual 2.53*. The average of all verification tests for the lot shall be used to determine filler/bitumen ratio.

When filler/bitumen ratio for an HMA mixture falls outside the limits established by specification for that material, the affected material will be considered noncomplying and subject to price adjustment. See *Construction Manual Appendix 2-34 (Table J)* for additional guidance.

8.13 DENSITY CONTROLS FOR HMA CONSTRUCTION

Uncompacted HMA Samples

Specifications for HMA require each layer to be compacted to a density not less than a given percentage of laboratory density representing that particular lot.

On non QM-A projects, a comparative laboratory density shall be determined for each lot from mixture samples obtained as prescribed by *Materials I.M. 322*. The contract documents will normally require that the contractor transport samples to the District Materials Lab. Such deliveries shall be done promptly. Prompt delivery requires that the contractor obtain hot box samples within several hours after daily production begins for immediate delivery to the District Materials Lab. Normally, the first hot box sample must be delivered by noon to report results the same day. District Materials personnel will perform the laboratory density tests. The contractor should deliver the first split aggregate sample with the hot box each day if gradation acceptance testing is performed in the District Materials Lab.

District Materials will promptly communicate test results back to inspection forces so they may be used to calculate comparative percentages. If more than one sample is used to determine laboratory densities for any lot with the same mixture, an average of that lot's laboratory densities shall be used.

If a laboratory density is not available from District Materials for a particular day's sample, the daily control shall be based on laboratory density for previous day's construction using the same mixture.

On QM-A projects, up to four paired hot box samples per day will be obtained by the contractor, as directed and witnessed by certified agency personnel (HMA Level I or HMA Sampler Plus). One of each paired sample is then transported to the field lab for quality control testing. The hot box samples must be taken from behind the paver as prescribed by *I.M. 322*, by a technician with either HMA Level I or HMA Sampler certification. The grade inspector or plant monitor directs and witnesses contractor sampling to ensure it is properly done by appropriately certified personnel. The contractor will also transport the verification portion of the paired hot box samples, the split cold feed verification samples, and asphalt binder verification samples to the District Materials Lab on a daily basis. The inspector or plant monitor must properly identify and secure all verification samples with tamper-proof devices prior to transport by contractor personnel. No security measures are required if custody of samples is maintained by agency personnel.

An average of all laboratory compacted gyratory or Marshall specimens from the daily hot box samples will be used to determine the degree of field density. The specification for Hot Mix Asphalt Mixtures describes how to calculate laboratory density for the lot when less than four hot box samples are obtained for a lot.

Compacted HMA Samples

Density of pavement is determined from core samples cut by contractor, normally on the working day following construction.

Seven samples shall be cut from each lot of construction. For surface courses designed 25 mm (1 inch) or less in thickness, each one-half day's construction is designated as a lot. Each full day's production may be separated into two lots for determinations of quality index (density). This must be agreed to at preconstruction conference.

Specifications also describe a statistical procedure for field density evaluation together with a formula and schedule for payment adjustments when noncompliance occurs. Project inspection personnel shall observe the following when using the statistical procedure. These procedures are valid for all HMA projects.

- Contractor is required to take prescribed number of samples at locations selected and marked out by project inspector. Project inspector or monitor (HMA Level I or HMA Sampler Plus certified) will direct and witness the core sampling. A circle approximately 400 mm (16") in diameter is adequate for identification of sampling location. The core should be taken from within the area identified. It is not appropriate for contractor to use a nuclear device to "hunt" for a particular spot to sample; coring locations are no longer random when a nuclear device is used in this fashion.

- Sample locations should be selected randomly within areas designated by specifications. This may be accomplished by casting a die, using a random number generator, table of random numbers, or drawing lots. If lots are used, the lot drawn shall be replaced each time before drawing again to insure that the same relative location has a chance to be selected for each individual drawing. A core will not be taken less than 300 mm (1 foot) from the edge of a given pass of the finishing machine. Procedure for identifying random locations should provide for the potential to obtain a core sample at any distance 300 mm (1 foot) or greater from the edge. Similarly, random cores are not to be taken within 300 mm (1 foot) of runouts, day's work joints or structures. For pavement sections with a paved (or partially paved) shoulder placed concurrently with mainline lane, the random location should be based on a distance 300 mm (1 foot) or greater from the lane line (painted edgeline location). In other words, the paved shoulder area is excluded from the random core sampling area (lot) for the mainline lane. A spreadsheet for determining random core sample locations is available from the Office of Construction.

- If layer being sampled adheres to a lower layer, it may be necessary to sample through two or more layers or full depth. Contractor will need to remove the extra depth by sawing the sample with a masonry saw. It may be necessary to cool sample by refrigeration or ice to prevent damage during sawing. It is important that core bits be kept sharp.

- Each sample shall be inspected carefully by the contractor and inspector prior to testing (preferably at the time of core drilling). Be sure core sample is representative of density of mixture placed. If damage is noticeable or if sample is thinner or thicker than specifications allow, discard without testing and take another to replace it.

- The project inspector or plant monitor is responsible for performing tests required to determine density of core samples. This typically involves measuring, placing in water bath, drying, and weighing of cores. For most efficient use of time, other plant monitor duties may be performed while the core samples are drying. To be qualified to perform core density testing, the inspector or plant monitor must have obtained either HMA Level I or HMA Sampler Plus certification.

- If test indicates that density is less than specified percentage, sample shall be retested to insure accuracy. However, after a sample is tested, resampling of individual locations shall not be done.

- Tests on density samples give lower results if samples are damaged during handling. Contractors and project inspectors are advised to use extreme care when taking, transporting, and preparing cores for testing.

- Samples should be transported on hard flat surfaces to avoid loss of density by distortion. Core samples must be identified and secured by the inspector in a tamper-proof container prior to transport by contractor personnel. If necessary to store samples, storage should be in a cool place and on a hard flat surface.

- Specifications also require contractor to take density samples as promptly as practical. Samples should be taken no later than the working day following construction. If contractors are unable to comply with this timing, project inspectors shall stop construction until contractors are able to do so.

- Refer to *Materials I.M.'s 501 and 508* and Specifications for determination of "outlier" field density values.

- Project inspector shall report lot failures to project engineer and contractor on the day tests are performed.

Procedures for Construction of Test Strips

The specification entitled "Test Strip Construction for Class 1A and 1B Compaction" requires the contractor to construct a test strip for both intermediate and surface course mixtures subject to Class 1A compaction. Specifications further require test strips for surface course mixes requiring Class 1B (primary road) compaction. Test strips are used to evaluate properties of HMA mixture and identify an effective rolling pattern. For Class 1B compaction, field density compliance is not typically a problem, therefore documentation of a test strip rolling pattern and nuclear gauge evaluation is optional for the contractor. Test strips for Class 1B compaction on surface courses are required primarily to allow evaluation and adjustment of mix properties, particularly lab voids, before the mix is placed as a surface course.

Proper construction and documentation of test strip is the responsibility of the contractor. Documentation of test strip development and final rolling pattern should be provided by contractor to inspector.

The specifications outline several steps that must be followed to construct a test strip. Documentation of this procedure is required. If properly performed, compacting a control test strip using a nuclear gauge will establish a rolling pattern that achieves required density. Personnel participating in tests must include roller operators, nuclear gauge operator, paving supervisor, project inspector, and District Materials personnel. The following procedure describes steps to be taken by the contractor to effectively construct a test strip.

- Pre-size roller train
  It is extremely important to properly balance roller capacity with paver speed. The paver speed is generally controlled by asphalt plant production rate in megagrams (tons) per hour. This assumes adequate trucks are available for continuous production. Determine paver speed by considering megagrams (tons) delivered to paver and mat thickness and width. Assume paver operates 50 minutes each hour.

  Vibratory rollers are typically used for breakdown rolling. Determine frequency (vibrations per minute) of roller which establishes maximum permissible rolling speed in meters (feet) per minute to assure 35 impacts/m (10 impacts per foot). Contractor should provide this roller information. It can be checked with a tachometer available from the Central Materials Office.

  Estimate number of coverages of each roller to achieve required density. Determine number of passes necessary to accomplish estimated coverages considering width of roller. A coverage requires sufficient side-by-side passes to cover entire mat width once. Include the catch-up pass.

Knowing maximum roller speed and number of coverages estimated to achieve density, determine total meters per minute (m/min) of full width mat that roller can effectively compact. Assume 80% roller efficiency.

$$\text{m/min (completed)} = \frac{\text{roller speed (m/min)}}{\text{number of passes for estimated coverages required}}$$

Compare m/min completed of roller to paver speed. If m/min completed is greater than paver speed in m/min, roller is adequate. If m/min completed is less than paver speed, additional rollers must be provided or paver speed must be reduced to equal or less than roller capacity.

Example:
Mat width = 3.5 m (11.5 feet)
Compacted thickness = .05 m (2 inches)
Production rate = 135 Mg/h (150 tons/hour)
Roller width = 1.83 m (6 feet)
Frequency = 2400 VPM

Assumptions:
Paver will operate 50 minutes per hour.
Roller efficiency is 80%.
Compacted density equals 2 350 kg/cu m (146.7 pcf).
Density will be achieved with 3 coverages.

A. Determine paver speed to match production

$$\frac{\text{135 Mg/h (150 tons/hour)}}{\text{60 mins./hour}} = \text{2.25 Mg/min (2.5 tons/min.)}$$

$$\frac{\text{2.25 Mg/min (2.5 tons/min.)}}{\text{2.350 Mg/cu m}} = \text{.96 cu m/min (34.08 cubic ft./min.)}$$

$$\frac{\text{.96 cu m/min}}{\text{3.5 m (mat width) x .05 m (thickness)}} = \text{5.5 m/min}$$

Minimum paver speed = (60/50) (5.5 m/min) = 6.6 m/min (21.65 ft./min.)

B. Determine maximum permissible speed of roller

$$\frac{\text{2400 VPM}}{\text{35 impacts/m}} = \text{68 m/min (207 ft./min.)}$$

C. Determine total m/min of full width mat that can be compacted with three coverages.

Roller width = 1.83 m (6 feet)
A 0.15 m overlap per pass requires three passes per coverage. Nine passes required for three coverages.

Note: A catch-up pass is not needed in this case because third pass on third coverage will end at paver end of compacted area.

Completed m/min= $\frac{68 \text{ m/min}}{9 \text{ passes}}$ x 0.80 (efficiency) = 6 m/min (18 ft./min.)

Paver speed 6.6 m/min. Roller capacity is inadequate for the indicated paver speed, and appropriate changes to increase roller capacity will be necessary.

Above example considers a vibratory breakdown roller. From experience, we know a rubber-tired intermediate roller is typically needed to achieve interstate density requirements. Same procedure can be used to calculate capacity of rubber roller and compare to paver speed. The only difference is that roller speed is not based on impacts per meter, but rather effectiveness as determined by nuclear gauge testing.

Uniform operation of paver is a critical factor in obtaining consistent density results and smooth pavement. If paver is operated at erratic or excessive speed in short intervals, satisfactory results are difficult to achieve. When an excessive number of trucks arrive at paver simultaneously, paver operators are tempted to increase paver speed and quickly unload all waiting trucks, then stop paver, and await their return or next group. It is better to maintain appropriate paver speed and thereby assist in respacing the trucks. This does not sacrifice production, but maintains uniform rate of production which allows roller operator to maintain rolling speed and still keep up with paver.

- Estimate lab density of plant produced mix
  May be slightly higher than job mix lab density depending on aggregate gradation control, aggregate degradation in dryer, and asphalt binder control.

- Check equipment
  Determine and record sizes of all rollers to be used for project. Vibration frequency (discussed earlier), amplitude setting, roller scale weights, tire inflation pressures, tire sizes and contact pressure must be known and documented. Minimum of 550 kPa (80 psi) contact pressure is required. The specifications require an information plate attached to each roller which shows tire size and ply; and correlation of wheel load and tire pressure with contact pressure.

- Select test site
  Wait until approximately 90 Mg (100 tons) of mix have been produced so plant has stabilized. Test area should be about 100 m (328 feet) long where roller may be tested without being interrupted by ramps, bridges, interchanges, etc. Mark off section and record stationing.

  Establish at least three points where nuclear testing will occur. Record location of these points.

- Establish preliminary rolling pattern
  Remember, goal is to establish a roller pattern which will consistently obtain required density. To meet this requirement, it will be necessary to adjust operating techniques until desired results are obtained. Variables may include vibration frequency, amplitude, roller speed, contact pressure, number of coverages, and roller operating zone.

Change only one variable at a time. Always select a combination that will allow rollers to complete at least the same m/min of completed mat as the paver is producing.

All operating techniques are governed by mix behavior during the rolling process. It will vary from job-to-job and from lift-to-lift.

- Running test
  Using predetermined rolling pattern and placing roller in preselected roller zone, begin compacting mat. Locate nuclear gauge on mat at established locations and take reading. Short nuclear counts are normally used initially, so testing does not interfere with rolling.

  Continue rolling and checking density until effective pattern is established. Develop density growth curves for each roller pattern used. Plot density vs. number of passes on graph paper. Contractor should provide copies of this documentation, including description and location of pattern used, to project inspector.

  After a successful pattern is identified, complete rolling pattern again in another area and take longer nuclear counts to verify results. Document the successful pattern to be used in field book.

  Test strip needs to be established under the same production conditions that will prevail during normal paving operations, such as mix temperature and production rate.

- Cut cores
  After mat has cooled or been iced, cut cores for acceptance. Specifications allow one extra core (8 total) to be cut in test strip area. Lowest core density is discarded. This recognizes the potential for inconsistent results when performing a test strip.

- Correlate nuclear readings with core results
  Allows for more accurate monitoring of density with nuclear device during production.

- Monitor Use of Selected Pattern
  Each day project inspector shall check rolling pattern, including paver speed and roller coverages, and record in field book.

Resolving Density - Void Conflicts
Project inspector should be aware that field laboratory and compacted voids will be tightly controlled. This may require more compactive effort and even higher average density for compliance. Field control will not be more than 8% voids in compacted layer. Become familiar with other controls by reading *Materials I.M. 511* and asking questions of District Materials personnel.

For the case where specified density is met, but field laboratory voids or pavement voids are outside designated limits for more than one day, inspector should request a test strip. Test area should be a straight run of about 100 m (110 yards). Contractor will select combination of rollers to be used and preliminary rolling pattern. Nuclear gauge readings would normally be taken after each pass or series of passes.

Inspector would only observe this process. Documentation of type and amount of compactive effort shall be recorded. Inspector will then select and mark out 5 random core sites within test site. Density cores taken by contractor would be tested and results reported as soon as possible.

Cooperation between project inspector, District Materials, and contractor is essential to reach a timely solution. If all anticipated results are not met, further experimenting with a different combination of rollers and operation should be performed. Changes in gradation may be one of the first items looked at by District Materials. Changes in asphalt binder content would be one of the last items. Relief from minimum laboratory voids specified may only be approved by Office of Materials.

8.14 TESTING FOR SMOOTHNESS

Appropriate references for acceptable smoothness of HMA surfaces are *Specification 2316 and Materials I.M. 341.*

Equipment for smoothness testing includes the 7.6 m (25-foot) California profilograph, rolling surface checker (bump cart), and 3 m (10-foot) straightedge. Pavement surfaces to be tested for smoothness with the 7.6 m (25-foot) profilograph are identified in *Specification 2316.01*. The contractor may choose to use a profilograph, in lieu of bump cart or straight edge, to check additional pavement areas for bumps. Unless the contract documents specifically indicate otherwise, paved shoulders are not considered part of the pavement surface and therefore are excluded from profilograph or bump cart testing, although reasonable smoothness from a workmanship standpoint would still apply. The contractor is responsible for providing the profilograph and for performing the testing.

Contractor should be encouraged to test directly behind the finish roller to allow correction of an identified 13 mm (0.5 inch) bump by re-rolling while mixture is still hot enough to be affected.

Use of Straightedge and Rolling Surface Checker

Pavement smoothness specification does not relieve contractor of responsibility for proper rolling and workmanship. Each pavement layer is to be inspected visually to insure that surface is free of roller marks and distortion. Transverse joints are to be checked with a 3 m (10-foot) straightedge. Surface courses inspected with a rolling surface checker shall meet 3 mm (1/8 inch) tolerance. For lower courses, 6 mm (1/4 inch) smoothness tolerance may be used.

Contracting authority will continue to provide rolling surface checker and conduct testing on all surfaces not tested by profilograph. However, corrections for surface irregularities shall be made, if possible, before mixture has cooled to 66 degrees C (150 degrees F). A large percentage of irregularities can be corrected by finish rollers above this temperature.

When rolling surface checker is used, it should be operated immediately behind finish rollers. Mixture buildup on the wheels of surface checking straightedge should be regularly removed.

The inspector operating the surface checking straightedge should also observe surface to insure that all roller marks or roller wheel depressions are smoothed out during the finish rolling. The inspector should observe the longitudinal joints carefully to insure that they have been smoothly rolled as specifications require. If surface is not being finished as specifications require, inspector shall stop construction until contractor takes corrective action.

8.15 CHECKING TRANSVERSE JOINTS FOR SMOOTHNESS

The specifications require use of a 3 m (10-foot) straightedge for checking surface, intermediate, and base course transverse joints for smoothness. Inspectors shall use straightedge according to the following procedure:

1. The first check with the straightedge is made before saw cut. Straightedge is used to determine where full thickness of layer ends and tapered portion begins. Inspector shall require that saw cut be located in full thickness of layer. All of the layer extending beyond the saw cut, including tapered portion, is then removed.

   While the joint is being constructed and checked, inspector shall require the finishing machine to be stopped approximately 10 to 15 m (30 to 50 feet) from the joint. Construction shall not be permitted to continue until the checking has been completed. This permits repaving of the joint, with finishing machine, if straightedge should indicate a poor riding surface has been constructed.

2. The second check with the straightedge is made after finishing machine has constructed the new layer, but before rolling. Straightedge is used to locate irregularities in newly constructed layer and any irregularities found that must be corrected by hand tools. When straightedge indicates no high or low spots, compaction should be permitted with initial roller.

3. The third check with the straightedge is across the joint between cold pavement and hot mixture after compacted with initial roller. This third check indicates whether the correct amount of material has been placed. For instance, if freshly rolled layer is too high, it indicates too much material has been placed. If freshly rolled layer is too low, it indicates not enough hot mixture has been placed.

   For that reason, high or low transverse joints are not usually corrected by additional rolling. Instead, corrections should be made by cutting or filling rolled surface while mixture is still warm and can be manipulated. If there are unusually high or low areas after rolling, paths must be shoveled through the pavement for finishing machine tracks. Finishing machine is then backed up to the joint and paving operation is started again.

   Above procedure shall be repeated as necessary until straightedge indicates that a good riding joint has been constructed. If repeated repaving operations cause mixture to cool to the extent that reuse becomes impractical, it should be removed and wasted.

4. The final procedure for insuring proper construction at transverse joints is checking for true edge alignment. Edge of the freshly rolled layer should be carefully trimmed by hand tools until it matches the alignment of adjoining cold pavement.

8.20 MEASUREMENTS AND PAYMENT COMPUTATIONS

8.21 ASPHALT BINDER

When payment for an HMA mixture is based on megagrams (tons), payment will be made for asphalt binder as a separate item. Compensation will be made for all megagrams (tons) of asphalt binder incorporated into the construction within specification tolerances. This includes payment for asphalt binder from Recycled Asphalt Pavement (RAP) that is incorporated into the project. The specifications address payment for asphalt binder in Classified or Unclassified RAP when provided from a contractor-owned stockpile or from RAP furnished by the contracting authority.

Megagrams (tons) of asphalt binder paid is not deducted from megagrams (tons) of HMA mixture measured for payment. When payment for HMA mixture is based on square meters (square yards), no separate payment is made for asphalt binder. The contractor includes cost of asphalt binder as part of cost per unit area.

Asphalt binder will be measured for payment by tank stick measurement or calibrated meter reading. Asphalt binder supplier weigh tickets for liters (gallons) of asphalt binder delivered to the plant site are not acceptable for pay quantity, but the asphalt binder quantity added to the storage tank shall be computed from a supplier certified transport ticket accompanying each load. Use of supplier certified transport tickets makes it unnecessary for the contractor to have a second asphalt binder storage tank on site for sticking asphalt binder deliveries or for the transports to weigh at a nearby scale before and after delivery.

Under the certified plant inspection program, the plant monitor will observe tank stick measurements on the first day of mix production and a minimum of once per week thereafter. When a flow meter is used for measuring the quantity, the plant monitor will observe a 4-hour tank measurement and compare the outage to the 4-hour metered quantity.

When small quantities, normally 45 Mg (50 tons) or less, of asphalt binder are involved, design plan may state that asphalt binder is considered incidental to HMA. Check bid item subnotes for this reference.

For specific mixes used as patching materials, or in an alternate bid situation, no payment will be made for asphalt binder. Examples include surface partial, full depth patches, and detour pavement.

Tank Measurement and Asphalt Binder Content Determination

For continuous plants, drum mixing plants, or batch plants where asphalt binder is proportioned through a calibrated metering pump, certified plant inspectors measure the asphalt binder for payment. This shall be done by daily initial and final tank stick measurement or meter readings, and computing asphalt binder added to the storage tank during the day from certified supplier transport tickets.

At batch plants, automatic or semi-automatic printouts record actual weight of asphalt binder in each separate batch, this quantity may be used for payment.

Volume measurements will be converted to weights by computation. The amount in storage at beginning of project will be measured or estimated by inspector and added to amount measured for payment. Asphalt binder remaining in storage at end of project and amount otherwise not used in the work will be measured or estimated by inspector and deducted from amount measured for payment.

Refer to *Materials I.M. 509* for correct procedures in tank stick measurement and asphalt binder determination. "Daily Virgin AC Tank Measurement Sheet" (Forms E216 and M216) is to be used by plant inspector to compute final net asphalt binder pay quantity and percent asphalt binder by tank stick.

Any corrections should be reported to contractor and recorded on daily report forms. Upon project completion, the completed "Daily Virgin AC Tank Measurement Sheet" (Forms E216 and M216) shall be incorporated in project file.

Measuring Asphalt Binder for Small Quantities
By mutual agreement, the method of measuring asphalt binder for payment may be modified when small quantities or intermittent operations are involved.

If a recorded weight is not available, quantity may be calculated from intended asphalt binder percent with HMA plant meter results providing further verification. For small quantities on a given day, the previous day's tank stick may be used as a check.

Project inspector should document procedure selected and reasons for doing so.

Asphalt Binder Quantities and Pay Adjustments
Asphalt binder contract quantities for a project are estimated based on a basic asphalt binder content for mixture size and type. Target asphalt binder percentage to be used is then set by job mix formula. Where it is anticipated that quantity of asphalt binder used will result in a substantial change as defined in *Construction Manual 2.36*, a change order shall be written prior to accomplishing the work. Project engineer is responsible for checking asphalt binder percentage established by job mix and initiating the change order.

When noncomplying Dynamic Shear Rheometer (DSR) Stiffness tests occur, payment for asphalt binder incorporated into affected HMA mixture is subject to price adjustment per the provisions of *Construction Manual 2.53*. Also, refer to this section for the guide schedule for adjustment in HMA mixture payment for deviation in asphalt binder content from specified tolerance.

8.22 TARGET VALUES FOR ASPHALT BINDER CONTENT IN JOB MIXES

The 0.3 percent tolerance specified for asphalt binder content is provided for reasonable individual variances only. Whenever regular and repeated variances from target values occur, project engineer shall insist on quick and corrective action by contractor to secure proportions at target values, not simply within tolerance.

The previous paragraph applies specifically to asphalt binder content, but similar specification requirements and definitions also apply to aggregate tolerance and target values. Refer to *Materials I.M. 508*.

8.23 WEIGHING OF HMA MATERIALS

Specification 2001.07B covers equipment and procedures for weighing of HMA materials. When automatic or semi-automatic weighing is used, continuous direct observation of the weighing process by a scale inspector is not required. For manual weighing of loaded trucks, project engineer may assign a scale inspector. This normally occurs only when accuracy in the weighing procedures is in question.

When witnessing is required, scale inspector should be positioned near contractor's scale operator so weighing can be closely observed. Contractor's representative shall write the scale tickets and present them individually to scale inspectors for their signatures or initials before each truck leaves the plant.

Inspection personnel should refer to *Construction Manual 3.50* and *Materials I.M. 508* for witnessing and verification requirements and inspector duties.

8.30 EQUIPMENT USE AND INSPECTION

8.31 INSPECTION AT HMA PLANTS

District Materials Engineers typically provide oversight responsibilities for inspection and/or monitoring at HMA plants. They should assure themselves that plant inspectors are qualified and have been informed about their specific duties. This should include, but not be limited to, frequency of tests, information to be recorded, and samples to be obtained and submitted to Central Materials and District Materials Laboratories.

Plant inspectors should be placed in charge of all plant inspection. Their personal duties include checks of stockpile handling, equipment settings, mixture appearance, and supervision of scale inspectors and assistant plant inspectors. Plant inspectors should be instructed to avoid spending prolonged periods in the laboratory trailer.

Refer to *Materials I.M. 508 and Construction Manual 3.07* for HMA plant inspection requirements and documentation.

All HMA production, including HMA for patching, will be covered by certified plant inspection unless otherwise excluded by contract documents. The contractor shall furnish and be responsible for certified plant inspection in accordance with *Materials I.M. 213.* There is no certified plant inspection exclusion for small amounts of HMA; however, the project engineer may approve combining several days of low production into a single lot for sampling, testing, and acceptance. This is commonly done for patching projects where up to a weeks' worth of low daily HMA production may be combined into a single lot. Plant monitor requirements are identified in *Construction Manual 3.07.*

On Quality Management - Asphalt (QM-A) projects, the contractor's certified HMA technician is responsible for meeting all sampling, testing, and documentation requirements as set forth by the current specification. For some contractors, this person may also be responsible for certified plant inspector duties as well. It should be possible for two people to handle both QM-A and Certified Plant Inspection (CPI) responsibilities on a typical HMA resurfacing or paving project. If the contractor fails to staff a project adequately for QM-A and CPI activities to be accomplished in a thorough, timely, and proper manner, a noncompliance should be issued. It is not a requirement that the certified HMA technician personally obtain the hot box samples from behind the paver. This operation can be assigned to any of the contractor's personnel as long as that person is a certified HMA sampler. This allows the certified HMA technicians to spend their time in the lab rather than on the road, providing for more efficient use of technician time as well as timelier test results. The certified HMA technician should maintain good communication with the plant monitor and District Materials personnel on test results and mix changes.

Plant monitor requirements for QM-A projects are also described in *Construction Manual 3.07.*

8.32 INSPECTING THE MIXING TIME OF HMA PLANTS

Project engineer is responsible to insure that mixing time is inspected on continuous plants and on batch plants.

Necessary action shall be taken to insure compliance with mixing time requirements. Inspectors shall check mixing time when work begins on the project and thereafter as they consider necessary to insure compliance. Inspector's diary must show when it is done and calculations used. Inspection procedure is described in *Materials I.M. 508* and should be followed carefully.

If mixing time is found to be deficient, inspector shall see that contractor increases it to specified amount. For continuous plants, this is done by decreasing megagrams (tons) output or by increasing pugmill contents.

Materials personnel will give assistance in determining the mixing time as a component of the plant calibration process.

8.40 GENERAL CONSTRUCTION

8.41 UNSTABLE SUBGRADES AND SUBBASES

Specification 2109.03 for natural subgrade and various types of subbases requires contractor to immediately repair rutting or other damage occurring from hauling operations. Inspectors shall not permit HMA to be placed over any distorted subgrade or subbase.

Whenever batch trucks or other paving equipment cause rutting of subbase or subgrade in HMA placement area, such that layer being placed does not conform to design dimensions, inspectors shall immediately stop construction. Construction shall not be permitted to resume until distorted subgrade or subbase is repaired.

Locating Unstable Areas

Contractors and inspectors are required to locate by proof rolling, unstable areas in advance to avoid distortion under equipment. Wet, unstable areas can be dried out before starting placement of HMA to avoid unanticipated and costly work shutdowns.

Locating wet or soft areas in advance can be accomplished by testing finished subgrade or subbase with a loaded truck. When distortions are observed under truck, subbase and subgrade can be dried out and reworked *(Specification 2109.03)*.

Construction of HMA pavement should not proceed unless testing gives a reasonable indication that distortions will not occur during construction of overlying pavement.

Determining Cause

During spring and early summer, unstable subgrades caused by high moisture contents are encountered statewide. This condition is usually seasonal and tends to improve as warmer, dryer summer weather stabilizes subgrade. Additional pavement thickness is not justified to bridge over these particular soft subgrades because of their seasonal nature.

When evaluating individual cases of instability, experienced judgment is advisable because of the similarity in outward appearances between moisture in subgrade due to seasonal conditions and more serious causes such as frost boil, unsuitable material, etc.

If excess seasonal moisture is encountered, dry subgrade by overdepth aeration and recompaction.

Overdepth Aeration and Recompaction

Treatment may be paid by change order provided project engineer authorizes its use, and work is closely monitored by inspector.

Specification 2109.03 requires contractors to aerate and recompact distorted areas in subbase at their expense. For a natural subgrade, contractors are required, if necessary, to repair distorted areas by scarifying to a depth up to 150 mm (6 inches), aerating, and recompacting at their expense. Overdepth aeration and recompaction below the top 150 mm (6 inches) shall be paid for as extra work.

When repair, aeration, and recompaction are required to correct damage from contractor's operation, all necessary repair will normally be done at contractor's expense. However, if project engineer determines that additional depth of aeration and recompaction are needed, that should be paid by change order.

Information accompanying such change order shall include a breakdown of time and equipment involved with authorized extra work.

Special Treatments
When unusual problems are encountered with unstable subgrades or subbases, District should contact Office of Construction for assistance.

8.42 STAKING METHOD FOR HMA PAVEMENTS

Refer to "Inspector's Handbook for Construction Survey" for instructions on construction staking for HMA paving.

8.43 GUIDELINE STRINGS AND EDGE ALIGNMENT

Inspector should make frequent measurements to insure guideline string has been correctly set and maintained. Nails used to secure guideline string shall be at intervals close enough to eliminate chords on curves and other irregularities.

Guideline strings placed on two-lane HMA pavement should be located by measuring from redhead nails placed on centerline. Placement of lower HMA layer will cover redheads. For succeeding lifts, guideline string should be located by measuring from exposed nails used to hold string for each previous lift.

When resurfacing two-lane PCC pavement, contractors may locate guideline strings on shoulders along outer edges. This is done by measuring out from one of the pavement edges at intervals of approximately 150 m (500 feet), then tightening string and using intermediate nails to secure string. To insure that parallel alignment is used for adjacent lane, guideline string for that lane shall be located by measuring across pavement from nails used to secure first string.

When city streets or other multilane pavements are being surfaced, guideline strings shall be inspected according to procedure described in *Construction Manual 8.54*.

True edge alignment controls correct lap at longitudinal joint. If insufficient lap, joint will lack density resulting in raveling and joint deterioration. Excessive lap produces an objectionable wide scab of mixture on the surface next to the centerline joint, resulting in unacceptable appearance.

An intended lap of 25 mm (1 inch) with a variance of 12.5 mm (1/2 inch) will normally be the optimum overlap for longitudinal joint construction. To maintain these close variances, adjacent lane must be constructed with true edge alignment.

Finishing machine operator shall follow guideline string exactly. If machine goes off line for any reason, it shall be adjusted back onto the line immediately. It is incorrect to smooth out the edge alignment by coming back onto the line gradually. This results in long stretches where incorrect lap at longitudinal joint will occur. When batch trucks bump finishing machines off line on curves, movement is usually down slope of curve. If machine is brought back on line gradually, an objectionable, long, straight chord will result in what is supposed to be curved edge alignment.

Irregular edge alignment due to any cause, including adjustments of finishing machine, shall be corrected at once by hand tools. When corrections in edge alignment are unable to be made promptly after they occur, inspector shall require finishing machine to be stopped until workers catch up with making corrections.

When constructing handworked areas such as driveway run outs and bridge approach tapers, edge alignment may become irregular during rolling because small high and low spots in handworked surface tend to extend in width unevenly. Edge alignment of handworked areas can be made true by first rolling the surface with a steel-tired roller, then immediately trimming the edge with hand tools while mixture is still hot and workable.

8.44 LONGITUDINAL JOINTS

To obtain adequate compaction at longitudinal joints, contractor shall place sufficient thickness of mix to compensate for 20 to 25 percent reduction in thickness that normally occurs from rolling. If thickness is insufficient prior to rolling, joint will usually be smooth in appearance but lack density because of inadequate compaction.

The vertical face of exposed, longitudinal joints must be tacked before the adjacent lane is placed. This treatment is very important to insure a seal at the joint. No tack coat shall be sprayed on surface of lane being matched. Shields on distributor spray bar will help protect adjacent lane.

If overlap is maintained at approximately 25 mm (1 inch) and thickness of joint is correct, brooming or raking is not necessary to obtain a good joint. However, occasional corrections with hand tools may be necessary. When handwork is completed, excess material should be wasted as opposed to scattered on lane being constructed.

When automatic screed controls are used, short joint matching shoe shall not be permitted except when placing a single lift of 38 mm (1 1/2 inches) in thickness or less; or for placement in conjunction with heater scarification work. The specified 9 m (30-foot) ski device shall be used for joint matching on each layer for all other situations.

Short joint matching shoes produce joints with smoother appearances than 9 m (30-foot) ski devices. However, they do not contribute toward a smoother riding surface.

Careful adherence to inspection procedures described in *Construction Manual 8.43* will insure true edge alignment, which is essential for correct construction of longitudinal joints.

8.45 TACK COATS USING EMULSIONS

For Dilution

SS-1, SS-1H, CSS-1, and CSS-1H grades are specified. Dilution of emulsion is required if non-uniform tack applications are experienced. Dilute at 1:1 ratio, i.e., 1 L emulsion to 1 L water (1 gallon emulsion to 1 gallon water).

Application Rate for Diluted Emulsion

For diluted material, double the rates of undiluted material application.
Example: 0.14 to 0.23 L/sq m (0.03 to 0.05 gallons/square yard) undiluted increased to 0.272 to 0.454 L/sq m (0.06 to 0.10 gallons/square yard) dilute emulsion.

Sample for Compliance
Sample emulsion at spray bar of distributor with bar valve in a circulating position.

Measurement for Pay
Net liters (gallons) of undiluted emulsion.

Keep in mind, undiluted emulsion must contain a minimum of 57% asphalt residue, therefore diluted emulsion must contain a minimum of 28.5% residue.

Settlement of Diluted Emulsions
Varying residue rates of diluted emulsion may be related to blending of original emulsion or settlement while in storage. To minimize this problem, the following steps are recommended:

- Contractor emulsion delivered to storage should be gently circulated prior to pumping into distributor truck.
- If contractor obtains emulsion directly from terminal, the emulsion should be gently circulated prior to use each day.

Material in a storage tank can be circulated with a large diameter, slow turning propeller, or by pumping from top to bottom. Only a small amount of agitation is necessary. Forced air should not be used for agitation since it may cause the emulsion to break.

8.50 BASE, INTERMEDIATE, AND SURFACE COURSES

8.51 HMA WEDGE CONSTRUCTION FOR SUPERELEVATION OF CURVES

HMA wedge courses are placed on resurfacing projects to correct or increase the superelevation of existing roadway curves. Project plans will identify required rate of super and transition lengths. To establish wedge thickness and sequence of placement, the existing transition, super, and profile must be determined by field measurements. For survey and staking procedures, refer to "Inspector's Handbook for Construction Survey."

Placement of wedge courses should be with single lane width finishing machines. Use of full width pavers can result in excess wedge material on the low side of curve, plus crown correction problems in the transition. When correcting superelevation on resurfacing projects, 70% of transitioning will normally be accomplished in advance of curve PC and beyond curve PT, 30% will be in curve.

Newer method of wedge construction utilizes automatic screed and slope features of HMA finisher. This method requires less survey and grade reference.

Automatic Slope Control

Present day finishing machines have automatic screed controls which allow desired cross slope to be set and then varied during machine movement.

Existing super and desired super must be known prior to wedging. Difference in cross slope percentage determines amount of wedge material. Total proposed thickness of finished wedge at the high side divided by 75 mm (3 inches) will give the number of course passes in wedge operation. Total percent of slope change divided by number of course passes will establish slope percentage for each pass.

EXAMPLE:

Proposed Superelevation Rate		8%
Minus Existing Superelevation Rate	-	4%
TOTAL PERCENT CHANGE	=	4%

Total Proposed Wedge Thickness on High Side of Curve

4% x 7.2 m (24 feet) = 288 mm (11.5 inches)

Number of Proposed 75 mm (3-Inch) Passes to Construct Wedge

$$\frac{288\text{ mm }(11.5\text{ inches})}{75\text{ mm }(3\text{ inches})} = 3.84\text{ Passes (Use 4 Passes)}$$

$$\text{Percent Slope Change Each Pass} = \frac{4\%}{4\text{ Passes}} = 1\%\text{ Per Pass}$$

Proposed Schedule for Laying with Automatic Slope Control:

Pass No.	Percent	High SideThickness
Existing	4	
1	5	63 mm (2.5 inches)
2	6	75 mm (3 inches)
3	7	75 mm (3 inches)
4	8	75 mm (3 inches)
	TOTAL =	288 mm (11.5 inches)

Lath are placed on shoulder to mark beginning of transition, "X" distance, "Y" distance, and each 1% of change in slope percentage.

Placement of Wedge

To insure that each wedge of curve is constructed in its proper place, a guideline string shall be used for each lift. Top of final wedge for curve is directly over outside edge of pavement. Since edge of wedge has a 1:1 slope, the remaining inches of mat thickness to be laid are also the distance from edge of base to edge of lift being laid.

EXAMPLE:

If total thickness of wedge on the high side is 200 mm (8 inches) on first pass of 75 mm (3 inches), screed will have to be extended 125 mm (5 inches) beyond edge of base.

On second pass of 75 mm (3 inches), screed will have to be extended 50 mm (2 inches) beyond edge of base.

On third pass of 50 mm (2 inches), screed should be same width as the original pavement's edge.

Sequence of Placement

First pass should be in transition section on the high side. Assuming proposed transition is 70 m (230 feet) and 4 total passes are proposed, start first pass approximately 75% or 52.5 m (172 feet) of this length into transition; second pass at 50% or 35 m (115 feet); and third pass at 25% or 17.5 m (57 feet). Each beginning pass is started with automatic slope control set at existing slope.

As laydown machine moves forward, dial slope into screed proportionally until desired slope for that pass is obtained. Check actual slope obtained and make very small adjustments if necessary. Let this slope ride the full length of curve. Reverse procedure for end of curve transition.

First pass is a leveling type operation. High and low spots on existing pavement will result in variable mat thickness. Average depth as per above example will be 63 mm (2.5 inch) thickness at the high side and a 5% slope to centerline. Because of existing super and crown in pavement, two passes of the high side of curve could be done before one pass of the lower side would be necessary, thus also preventing inverse crown situations.

An additional 15 mm (1/2 inch) thickness should be placed at centerline, so longitudinal joint may be constructed and rolled with flat steel rollers on curve. This will give a slight crown to superelevated section.

Inspector should be constantly checking slope using 1 m (4 foot) level and ruler. If desired slope is not obtained on a pass, then adjust slope and thickness of next pass. Final pass should always be made at final superelevation rate.

8.52 LAYING WIDTHS FOR HMA

Plans for HMA projects will show the overall dimensions of finished pavement.

When spreading layers of HMA 38 to 50 mm (1.5 to 2 inches) in thickness, a typical 7.2 m (24 feet) pavement will broaden 50 to 100 mm (2 to 4 inches) in width during rolling. Therefore, laydown width before rolling would typically require 75 mm (3 inches) less than final design width. An intended lap of 25 to 50 mm (1 to 2 inches) at longitudinal joint is necessary for proper joint construction. Use of a cutoff shoe when matching a longitudinal joint is not acceptable.

When using finishing machines that spread pavement full width, inspectors shall insure that contractors adjust spreading width so final dimensions conform to dimensions specified in project documents.

Finishing machine screed extensions are usually available in 150 mm (6 inch) increments. Where standard screed extensions are utilized to increase paver width by more than 300 mm (1 foot), paver auger shall also be extended. Many newer pavers are equipped with automatic screed extensions which can be adjusted to conform to required width for most resurfacing situations. Some paver models have automatic auger extensions as well.

The specifications require longitudinal joints on multi-lift resurfacing projects to be stacked directly over each other rather than offset. For full depth HMA paving, offset must be no more than 75 mm (3 inches). A diagram of properly stacked joints is in *Appendix 8-1*.

When city streets or other multilane pavements are being surfaced, laying widths shall be inspected according to procedure described in *Construction Manual 8.54*.

8.53 SPREAD RATES FOR HMA BASE, INTERMEDIATE, AND SURFACE COURSES

Inspector shall check contract quantities for accuracy.

In general, spread rates for HMA shall be determined using contract megagrams (tons) as a basis. Estimated unit weight from design standards used to calculate contract quantities will provide sufficient material for construction of design thickness for most mixtures used in the state.

Where "average thickness" is specified on plans, the spread rate shall not be increased. This avoids construction of spots which are significantly more than design thickness, provided contract quantities have been calculated correctly.

If contract quantity is not sufficient to construct required thickness, notify the District. The District will adjust the spread rate as necessary to attain design thickness.

For lower layers on resurfacing projects, automatic controls should not be adjusted repeatedly based on megagram (ton) yields taken at short intervals. Automatic controls should be allowed to correct for irregularities in underlying base without frequent adjustments. Accordingly, the spread rate for individual truckloads will sometimes vary substantially from contract rate because of irregularities in old base. However, over longer distances, 500 m (1640 feet) or more, taking both sides of the pavement into account, inspectors should select a general spread rate that compares as closely as possible with contract quantities.

For paved shoulders or other construction where dimensions are controlled by specified elevations, existing structures, or other unusual requirements, spread rates shall be adjusted as necessary.

8.54 HMA RESURFACING ON CITY STREETS

When a city street or other pavement involving more than two lanes for finishing machine is surfaced with HMA, certain procedures and principles produce a finished product with a high quality appearance and smooth riding qualities. Although details may vary in individual projects, the preferred approach utilizes procedures described in this section.

In addition to basic work of base repair, cleaning, and tacking, leveling shall be spread to correct lack of drainage, poor riding qualities, and ensure that no longitudinal joints occur in an inverted crown (except in rare cases when drainage is not adjacent to curb).

Correct construction of longitudinal joints is associated with straight lines and a uniform minimum lap of each lane over adjacent lanes.

Preliminary Layout

- Establish working centerline by dividing street at end of each block.
- If laying HMA to face of curb is required at 30.5 m (100-foot) intervals on right and left sides, measure and record distance from working centerline to face of curb.
- Offset working centerline to stakes in parking area or to painted X's on sidewalk. Also cross-tie all fixtures to be covered with HMA.
- Plan the laying procedure using measurements from working centerline to face of right and left curbs. Planned procedure should be drawn up showing width of each lane, cutoff necessary from entire machine width, and guideline string offset from established centerline.
- Guideline string for planning purposes should be 300 mm (1 foot) from edge of screed. At least 75 mm (3 inches) should be allowed between each curb and edge of screed for irregularities.

If possible, plan the laying procedures so all street widths can be resurfaced with both intermediate and surface courses using the same basic machine width. This eliminates installing and removing screed extensions during construction. Use cut-off shoe for varying the widths, but make the last lane the entire machine width with no cutoff used.

Most laydown machines are now equipped with hydraulic screed extensions, eliminating the concern of matching lane widths to fixed screed extensions and greatly simplifying layout procedures.

Width of lanes for different width streets should be planned so inside lanes may be laid continuously. This eliminates many transverse joints and gives the job a better continuous appearance.

Inspector shall adapt designed cross section to existing street measurements. Lane widths should be planned to ensure screed edge will not drag on face of curb.

Provisions should be made to ensure straight longitudinal joints with a uniform lap of approximately 25 mm (1 inch) of each lane over adjacent lanes.

Because the narrowest dimension from working centerline to face of curb controls the above factors, that dimension shall be used as the basis for construction. All wider dimensions are filled with HMA along the curb by bleeding the mix from outer edge of finishing machine as necessary.

Construction

Inspector shall carefully lay out and thoroughly check lane widths and guideline string offsets before construction begins. This eliminates errors which cause time loss to contractor. Basic purposes of layout are to:

- Provide straight longitudinal joints with a uniform minimum lap of one lane over adjacent lanes.
- Keep edge of screed from dragging on face of curb.

Although all construction should work toward those ends, it is often necessary to vary procedures as work progresses. Lane widths shown on plans are widths of at least one of the lanes after the first lane is placed and before the last one is placed. Lane with adjusted width is normally the next-to-last lane placed. This is important if closing lane (which must be the entire machine width without a cutoff shoe) is to be placed without an excessive, unsightly lap at longitudinal joints. Because of widening under rolling, it is also necessary to vary width between guideline string and edge of screed to provide desired joint lap.

A lap of 25 mm (1 inch) at longitudinal joint is recommended. To eliminate confusion, guideline string should be placed as shown on planned procedure. On all but the first lane placed, measurement between edge of screed and guideline should be adjusted until desired 25 mm (1 inch) lap is obtained. On the first lane placed, edge of screed should be exactly 300 mm (1 foot) from guideline string.

Use of guideline string is required by specification. Curb, gutterline, or edge of previously constructed lane are not acceptable substitutes. String shall be accurately set and maintained. Contractor shall appoint a knowledgeable full-time person each day to mark working centerline from offset line with crayon. Guideline string is then set by measuring from working centerline.

Hard steel nails are the only thing which can usually be driven between bricks or cracks in old pavement to hold guideline string.

Edge alignment of each lane determines trueness of longitudinal joints. For satisfactory joint construction and uniform alignment, inspector shall require handwork wherever needed to straighten unevenly placed edges.

When resurfacing an old street, the shape of finished pavement should be kept in mind. It is nearly impossible to make a longitudinal joint inversely crowned without leaving objectionable roller marks. It may be necessary to raise inside edge of certain lanes more than intended thickness to provide slight crown at joint.

When the street under construction makes a right angle turn, paving shall proceed through intersection. Finishing machine will make a joint along the edge (which shall be sawed if allowed to cool) instead of turning the corner.

Thickness Taper at Curb Line

Thickness tapers are sometimes designed at outer edges of HMA resurfacing adjacent to existing curbs to maintain gutter depth and still permit full resurfacing thickness as wide as possible.

Thickness tapered sections of surface layers shall be constructed with finishing machines whenever possible. Thickness tapers at outer edges of intermediate layers may be constructed by hand methods or a wing plate, since they will be covered by surface layers and not affect drainage.

Inspector shall insure that finishing machines are used for constructing tapers whenever plans provide sufficient width.

Extending Paver Width

Many HMA paving machines are now equipped with hydraulic strikeoff extensions. If extensions do not contain a screed plate with vibration as required under *Specification 2001.19*, they shall not be used to increase width of spread of HMA mixture except in lieu of a wing blade or handwork, and for short irregular areas.

8.55 COLD WEATHER HMA CONSTRUCTION

The specifications contain limitations for placement of HMA and liquid bitumen under cold weather conditions. These restrictions apply to pavement surface temperature and time of year, and vary according to whether layer is surface course, lower intermediate, or base course, and nominal lift thickness.

Cold weather construction problems may show up in the form of mat raveling, low density, high voids, segregation, slippage, or failure of tack coat to break. Project engineer and inspector should be aware of other weather-related conditions which may further limit placement.

After October 1, it is appropriate to require tarping and insulation of truck bodies especially if hauls exceed 20 –25 km (approximately 12 –15 miles). Cold pockets of mix in trucks or in corners of the paver hopper can pass through the paver without breaking up. These cold clumps can drag under the screed and disfigure the mat. Clumps of cold material should be removed from the mat and the mat surface repaired before being compacted. Insulated truck bodies can help minimize or reduce this problem.

Rubber tired rollers must be well skirted and the tires kept hot during cold weather construction to prevent pick-up of fines from the mat surface. Rubber tire rollers should be kept moving as much as possible on the hot mat so the tires don't cool down and start picking up. Rapid cooling of the mix due to placement on a cold base can also result in checking (hairline cracks) in the mat surface under the action of the steel rollers.

Base temperature is the single greatest factor in the rate of cool down for freshly placed HMA mat. Consequently, base temperature has direct affect on recommended minimum laydown temperature and rolling time available to obtain specified density. See tables in Appendix 8-2, developed by National Asphalt Pavement Association, which illustrate this relationship.

Wind velocity, air temperature, and cloud cover are additional factors that affect the cooling rate of HMA. "PaveCool" is a software program that may be used to determine approximate cooling rates and resulting "time available for compaction" for hot mix asphalt pavement considering these variables. The latest version of the program is available to download through links provided on the Construction Office websites found on DOTNET and world wide web (www), or by clicking this PaveCool link on the Electronic Reference Library (ERL) version of this document. A disk copy of the program may be obtained by contacting the Central Construction Office.

Use of emulsion tack coats is required prior to October 1. For work after that date, a cutback asphalt may be used. Cold surface temperatures cause emulsions to lose tackiness and increase breakage (curing) time resulting in higher risk of mat slippage.

Temperature Determination for Placing HMA and Liquid Bitumens
The specifications limit the placement of HMA or liquid bitumens when a shaded portion on road surface is less than a specified temperature.

The following method shall be used to determine the temperature on road surface:

- Select representative portion of road surface to be covered by HMA or liquid bitumen. If all of road surface is subjected to direct sunlight, test location should be in sunlight. If portions of road surface are shaded, test location should be in shade.
- Lay thermometer directly on road surface in test location and shade test location temporarily while taking temperature. Inspector performing test may need to stand so thermometer is shaded by shadow. To insure a condition of equilibrium, thermometer should remain in test location no less than five minutes.

8.56 RELEASE AGENTS AND SOLVENTS

HMA mixing, transporting, and placement equipment, particularly truck bodies and paver hoppers, must be kept clean and free from HMA buildup. *Specifications 2001.01 and 2001.03* address approved methods and materials. Diesel fuel or distillate is not approved for use in any fashion as an HMA release agent for truck bodies, paving equipment, or tools on DOT projects since contamination from petroleum based solvents is extremely detrimental to the performance of HMA. Approved release agents listed in *Materials I.M. 491.15* should be used to keep HMA from building up in truck bodies and other equipment.

Release agents are not solvents. They are generally not effective as cleaning agents. There may be times when a contractor must resort to use of a petroleum based solvent for cleaning certain items of equipment. This is not allowed on DOT property due to concerns with contamination of property or HMA. Truck bodies or paving equipment cleaned with a distillate should not be allowed for use for HMA hauling or placement for a minimum of 5 hours after cleaning.

8.60 RUMBLE STRIPS IN HMA SHOULDERS

8.61 CONSTRUCTION CONSIDERATIONS – MILLED RUMBLE STRIPS

Milling has become the method of choice for installing rumble strips in HMA shoulders. The process utilizes a milling machine to produce shallow concave depressions in the HMA shoulder surface. The milled surface is then sealed with asphalt emulsion to prevent intrusion of water into the HMA shoulder. Milling provides the benefits of a more consistent pattern and depth, while increasing the "rumbling" warning to errant motorists. Milling allows for better compaction of the HMA shoulder, and eliminates the problem of tearing and raveling associated with other methods of producing shoulder rumble strips. While this technique overcomes many of the previous problems with rumble strip construction, there are other issues requiring the attention of both contractor and inspector in order to achieve the desired results.

Standard Road Plans RH-61 and RH-62 show configurations and details for shoulder rumble strips on Interstates and Expressways, respectively. Details for rumble strips on paved shoulders of two-lane roadways are shown on *Standard Road Plan RH-63*. The grinding pattern itself is the same for all three situations, utilizing an industry standard width, depth, and spacing. Differences lie in the distance offset from the paintline and the "skip" pattern specified for two-lane roadways and the outside shoulder of expressways. Grinding dimensions and alignment of the pattern should be randomly checked and adjusted, if necessary. Rumble strips are typically placed on mainline HMA shoulders only, with the pattern omitted at specified locations near intersections and ramps & loops.

Milling equipment variations can result in differences in the rumble strip construction operation. The cutting head must be capable of providing a smooth cut, without tearing or snagging the HMA pavement. Multiple cutting heads and electronic controls can speed the process and eliminate variability in milling depth and pattern, especially at the beginning of each set of strips on shoulders of two-lane roadways and the outside shoulder of expressways.

All loose material resulting from the milling operation must be removed from the shoulder on a daily basis. Some milling machines are equipped with a vacuum system to assist in this effort. Millings may be used as fillet material adjacent to the paved shoulder or may become property of the contractor and properly disposed of off the project. Specific plans may require the millings to be taken to a designated location.

Bituminous Fog Seal, meeting the requirements of *Specification 2308*, is used to coat the rumble strips and thereby reduce premature deterioration of the milled surface. Asphalt emulsion is typically placed on the milled rumble strips only, unless the contract documents call for sealing the entire shoulder.

8.62 CONSTRUCTION CONSIDERATIONS – ROLLED RUMBLE STRIPS

Numerous variables associated with constructing rolled rumble strips have contributed to moderate inconsistency in depth and tearing that occur during placement. These deficiencies, combined with advantages provided by other recently adopted installation methods, have nearly eliminated use of rolled rumble strips on HMA shoulders. Rolled rumble strips are only to be used when specifically called for in the contract documents.

After the first day of shoulder resurfacing, most contractors/inspectors should be able to identify adjustments needed to produce uniform indentations in fresh HMA. Contractor may "practice" construction of rolled rumble strips while placing lower lifts of shoulder resurfacing. This is a good idea for inexperienced project personnel or unfamiliar mixes.

Two primary problems associated with constructing rolled rumble strips in HMA shoulders are groove depth uniformity and mat tearing/cracking.

Groove depth uniformity is dependent upon uniformity of mat density and temperature at the time rumble strips are placed. Class 2 compaction is required for shoulders. This is simply a specified roller pattern. Normal overlap associated with compaction operations tends to produce short areas where indentations are shallow compared to the majority of grooves. This is not objectionable as long as length is minimized and limited to 7.5± m (25± feet).

For mainline surface mixes placed on the inside shoulder, it's more difficult to achieve adequate depths of grooves. It may be necessary to reduce the number of passes of the rubber-tired roller so 30 mm (0.1 foot) depth is achieved. Typically, this reduction would be one pass, from six passes down to five passes.

Higher mat temperatures are required to get adequate groove depth for mainline surface mixes with high crushed particle contents. Rolling with the rumble strip drum roller should generally follow immediately behind the intermediate rubber-tired roller.

Lower temperatures are appropriate for base mixes on the outside shoulder. Temperatures ranging from 60 to 65 degrees C (140 - 150 degrees F) should produce acceptable depths.

Mat tearing/cracking is also controlled by placement of rumble strips at appropriate temperatures. Rolling at high temperatures tends to induce more cracking than lower temperatures. Forward speed of roller must also be as slow as possible to help minimize tearing of hot HMA. Some contractors are now using a steel roller with projections on the drive drum rather than a small diameter trailer drum. This type of equipment is less sensitive to mat temperature and tends to produce more uniform indentations with less cracking and tearing. When the trailer drum system is used, a narrow temperature range may exist to achieve adequate depth without excessive tearing.

Excessive tearing can usually be partially closed by a static pass with a steel-tired roller. Again, it is very important to make this pass while mat is warm enough to close cracks without eliminating groove depths.

Some contractors have also added supplemental weights to the rumble strip roller to assist in producing acceptable groove depth. This may be accomplished by adding water to rear drum or fastening metal weights to rear of roller.

Most contractors have added a third drum to a conventional two-axle tandem steel roller. This supplemental drum has half sections of pipe welded at 200 mm (8 inch) spacing with tapered ends to produce grooves. It is mounted on rear of roller so it can be hydraulically pushed down onto fresh HMA mat. Amount of downward force is generally limited by maintaining enough weight in drive axle to move roller; therefore, additional weight as noted above is usually beneficial.

A lift thickness of at least 50 mm (2 inches) is needed to produce acceptable groove depths without weakening bond with lower layer. 75 mm (3 inches) should provide further protection against cracks developing through the entire lift.

8.70 INSPECTOR'S GUIDE - HMA PAVING & RESURFACING

Review all applicable plans, Specifications, Road Standards, Materials I.M.'s, and Construction Manual chapters. Prepare field books.

Check traffic control, work zone length, flaggers, signing, pilot car operations.

Check project quantities to insure accuracy.

Are job mix designs approved?

Obtain necessary inspection equipment and review sampling & testing procedures *(Materials I.M.'s 322, 323, & 337)* & frequencies *(Materials I.M. 204)*.

Locate and reference fixtures to be adjusted prior to placing final layer *(Specification 2303.03G)*.

Stake wedge courses *(Construction Manual 8.51)*.

Does equipment meet applicable requirements?
- Trucks *(Specification 2001.03)*
- Tampers *(Specification 2001.04)*
- Rollers *(Specification 2001.05)*
- Material Bins *(Specification 2001.06)*
- Weighing Equip. *(Specification 2001.07)*
- Distributors *(Specification 2001.12)*
- Spreaders *(Specification 2001.13)*
- Brooms *(Specification 2001.14)*
- Trenchers *(Specification 2001.18)*
- Pavers *(Specification 2001.19)*

Check paver screed for proper crown and excessive wear. Are automatic grade and slope controls operational *(Specification 2001.19)*?

Check frequency of vibratory rollers to assure 30-40 impacts/m (10-12 impacts/foot) with a reed-type tachometer.

Is rubber-tired roller required? Verify 550 kpa (80 psi) contact pressure *(Specification 2001.05)*.

Are enough rollers in use to obtain required density and smooth out bumps, ridges, and marks in surface?

Are tarps or insulated truck boxes required? Check for improper use of cleaning solvents *(Specifications 2001.01, 2001.03, and 2303.03D, Materials I.M. 491.15)*.

Check hand equipment. Lutes, rakes, and shovels should be of the type designed for use on HMA mixtures and heavy enough to do the job.

Check distributor spray bar height and nozzle angle. Is the distributor tank calibrated

(Specification 2001.12)?

Determine if correct type and rate of tack coat is being applied *(Specifications 2303.02E and 2303.03B)*.

Is the tack coat coverage continuous and uniform? Is the exposed vertical face (first side placed) of longitudinal joint properly tacked *(Specification 2303.03B)*?

Check each truckload of mix for proper weigh ticket *(Specification 2001.07)*.

Is mix being placed at correct temperature range? Check surface temperature *(Specifications 2303.03C and 2303.03D, and Construction Manual 8.55)*.

Is paver hopper near full at all times? Check flow gates and augers. Lifting paver hopper wings should only occur when the hopper is relatively full and the mix in the wings is not excessively cool.

Compare paver speed to plant output to reduce amount of stopping. Consistent speed results in more consistent pavement properties.

Check width, depth, and cross-slope, and compare to spread width typical and typical section as per plan.

Check and record yield based on megagrams (tons) of mix required compared to megagrams (tons) of mix used. (Recommend checks at 2-hour intervals)

Is guideline string accurately set and maintained *(Construction Manual 8.43)*?

Are transverse and longitudinal joints constructed properly *(Construction Manual 8.15, 8.43, and 8.44)*? Check transverse joints with a 10' straightedge; contractor must make necessary corrections with hand tools prior to compaction *(Specification 2303.03F)*.

Is surface texture uniform, dense, and free from irregularities, tearing, steel roller marks, check cracks, solvent spots, and segregation *(Specifications 2303.03D and 2303.03E)*?

Check smoothness with surface checker when profilometer smoothness *(Specification 2316.01B)* is not required. Encourage profilometer use in these areas when possible.

Are temporary runouts and fillets in compliance with applicable standards?

Is rock fillet placed *(Specifications 1107.09B.3 and 2121.07B)* without damaging edge of pavement? Blading existing aggregate up to form the fillet is not acceptable.

~~Obtain~~ Direct and witness hot box (loose mix) samples *(Materials I.M. 322)* and tack sample *(Materials I.M. 323)*. Identify and secure verification samples for transport.

Determine and mark random core locations. Direct and witness core drilling by the contractor. Inspect and verify the validity of cores for testing (proper thickness & condition). Be sure core holes are properly filled. Take possession of cores, transport cores to field laboratory, and perform density testing *(Construction Manual Appendix 3-4)*. The core samples may be transported by the contractor with proper sample identification and tamper-proof security measures in place.

Timeliness of core sampling, transportation, and density testing is critical to the contractor's operations. Good communication between the inspector and the contractor is essential for success!

Think safety! Use proper equipment, wear protective clothing, and be aware of contractor's operations.

Additional Requirements for Interstate Projects
Is the rolling pattern established by the test strip maintained and documented *(Construction Manual 8.13)*? Are HMA properties determined to be acceptable prior to proceeding?

Do milled shoulder rumble strips conform to *Standard Road Plan RH-61*? Check rumble strip dimensions for depth, width, and alignment (offset from paintline). Verify removal of milled material and uniform application of asphalt emulsion (fog seal) when specified.

Do inside and outside shoulder tapers and maximum drop-off comply with plan details?

Additional Requirements for Full-Depth Paving
Has grade and alignment staking been completed and checked?

Is subgrade constructed according to plan, stable, and corrected to within tolerance *(Specification 2109)*? Check subgrade according to *Construction Manual 8.41*.

Any stringline offsets referenced to permanent stakes?

Additional Requirements for Winter Shutdown
Are all scarified surfaces covered with at least one full lift of HMA *(Specification 2214.05)*?

Are all cold-in-place recycled surfaces covered with at least on full lift of HMA *(Specification 2318.05)*?

Are temporary runouts properly constructed, with length of runout appropriate for lift thickness, and located adjacent to one another *(Specification 2303.03F)*?

Has granular shoulder material been brought up to the pavement edge, at full shoulder width and design cross-slope *(Specification 2121.07)*?

Has the contractor placed all required edgelines and symbols *(Specification 2527.03)*?

8.80 USE OF SPECIAL EQUIPMENT

Material Transfer Vehicles

Material transfer vehicles (MTVs) provide mix surge capacity, which allows more constant paver speed and more efficient paving operation. These vehicles operate in front of or beside the paver and receive loads of hot HMA from delivery trucks. They perform as a mobile 20 - 30 Mg (22 – 33 tons) HMA surge bin that re-mixes HMA and continually feeds the paver hopper. Use of these vehicles results in smoother pavement by minimizing paver stops and eliminating trucks bumping into the paver. More uniform surface texture and pavement density is also achieved, as mixture and temperature segregation are virtually eliminated by remixing capabilities of common MTV models.

Use of MTVs is restricted to closed construction work zones. Applicable permits must be obtained for moving the vehicles to and from the project on the open highway for compliance with Code of Iowa weight laws. Do not allow the contractor to operate this equipment on the open road.

There is currently one model of MTV approved for use in Iowa. The equipment and limitations are as follows:

BARBER-GREENE MTV-3500
This vehicle weighs 34 500 kg (76,600 pounds) empty with a maximum additional 31 500 kg (35 tons) mix storage capacity. It has four axles with large flotation tires. The front two axles have 17.5R x 25 flotation tires and rear two axles have 20.5R x 25 flotation tires. Tire pressure is 345 - 450 kpa (50 - 65 psi) inflation.

An empty MTV-3500 can safely cross all bridges that are not load-restricted, subject to the following conditions:

- Vehicle cannot be centered in its own lane.
- Gross weight cannot exceed listed empty weight of 34 500 kg (76,600 pounds).
- Vehicle speed cannot exceed 8 kph (5 mph).

A partially loaded MTV-3500 can safely cross all bridges that are not load-restricted, subject to the following conditions:

- Vehicle must be centered on bridge with no other vehicles on the bridge.
- Gross weight cannot exceed 45 000 kg (100,000 pounds) - approximately one-third hopper.
  NOTE: This situation should be avoided. We prefer the contractors anticipate the need to cross a bridge and have the MTV empty by the time they reach the bridge.
- Speed of the vehicle on the bridge cannot exceed 8 kph (5 mph).
- An MTV-3500 shall not cross any load-restricted bridge without prior approval from the Office of Construction.
- Pavement on which the MTV-3500 operates must be at least 200 mm (8 inches) in thickness. It shall not be operated on shoulders, subbases, or lower lifts of HMA pavement without prior approval from the project engineer.

Other Material Transfer Vehicles

Due to the possibly excessive high axle loads and tire contact pressure, material transfer vehicles other than the Barber Greene MTV-3500 must be approved by the Office of Design and Office of Bridges and Structures prior to use on a particular project. Approval for use can be requested through the Office of Construction.

Pavements

Conditions and restrictions for use of other MTVs on primary and interstate pavements are similar to those for the MTV-3500 as described in the previous section. An analysis of the existing pavement structural numbers by the Office of Design is required prior to MTV approval. This analysis is requested by the contractor through the project engineer.

Bridges

An analysis by the Office of Bridges and Structures of each bridge to be crossed is required if the vehicle exceeds the allowable weight formula for bridges. This evaluation is based on the MTV in an unloaded condition and must be performed prior to crossing any bridges. The analysis is also requested by the contractor through the project engineer.

Following are the procedures to be followed in regards to obtaining MTV approval:

1. Contractor requests permission from project engineer to use MTV on a specific project, preferably no later than at the preconstruction meeting. The contractor must provide the make and model of MTV, and any additional information needed for analysis.

2. Project engineer forwards the request to Central Construction, who will arrange for reviews, as needed, by the Office of Bridges & Structures and Office of Design.

3. The Office of Bridges & Structures will perform an analysis of existing bridge structures within the project limits and provide specific requirements regarding MTV operation across the structures. Please note that unless specifically stated otherwise, the MTV must be near empty when crossing all bridge structures.

4. The Office of Design (Pavement section) will analyze the existing pavement and provide recommended hopper loads and suitability of MTV use for placing underlying base and intermediate HMA courses. Similar analysis will be made for surface course of single-lift resurfacing projects.

5. Central Construction will report results of above analyses to project engineer, who informs the contractor.

The DOT intends to take a "permissive" approach in regards to allowing MTV use on the surface course of multiple lift HMA resurfacing projects. This will provide increased potential for continuous MTV use in the area of the pavement where the MTV's improvements to mat quality are most beneficial. However, the MTV hopper load may be limited, based on results of the pavement analysis.

MTV use in conjunction with HMA placement must be closely monitored, and discontinued if evidence of detrimental distresses in the base or underlying pavement result. Such distresses would typically show up as deformation or rutting of base in full depth paving, or cracking and joint movement in existing pavement during an overlay. The contractor is responsible for repairing any damage to existing pavement or base caused by MTV operation.

Mat Smoothness Machine

Several contractors have used Cedarapids CR MS-3 Mat Smoothness Machines on paving and resurfacing projects. This is an HMA material receiving hopper and elevator that deposits hot HMA into the paver hopper. Use of this equipment allows for a more consistent paver operation by providing some surge capacity for paver, only on a much smaller scale than MTVs. In some cases, it can also help re-mix material and minimize segregation.

It weighs approximately 8 500 kg (18,800 pounds) empty and has a hopper capacity of 1.7 cu m (2.22 cubic yards). Weight restrictions are not a concern with this piece of equipment.

Even with MTVs or the CR MS-3, the paver hopper should be kept relatively full at all times. If the hopper is allowed to draw down too far, coarse aggregate collected in the sides and corners of the paver hopper might be drawn down and create streaks of segregation in the mat surface.

Windrow Pick-Up Equipment

Many Iowa contractors are equipped to construct HMA resurfacing and paving projects using windrow pick-up equipment. This process is allowed by specification.

With this process, hot HMA is deposited in a windrow onto the pavement surface using bottom dump trailers. A windrow pick-up elevator deposits the material into the paver hopper. Again, the primary advantages are contractor efficiency, uniform speed of operation, and elimination of delivery trucks bumping into the paver.

Segregation has occurred on several projects on which this equipment was used. Truckload and longitudinal strip type segregation are potential problems. The contractor should balance their HMA delivery with the mat placement rate to keep the paver hopper at a nearly uniform level, which helps avoid segregation. Balancing delivery and placement also minimizes the need to either feed the hopper additional mix or remove excess windrow material with a mini-loader. The windrow should be placed to feed the center of the windrow pick-up machine. A windrow that is improperly located can place an eccentric force on the pick-up machine, which can force the paver to lose proper centerline alignment. It's also important for the contractor to pick up all windrow material from the pavement surface, and not allow the windrow to extend more than two truckloads in front of the paver to avoid excessive cooling of the mix.

It's been shown that this process can be used successfully for the lower lift of a full depth pavement; however, it's important to make sure the pick-up machine does not disturb (pick up) the subgrade or subbase material.

If streak type segregation is suspected, a trench can be sawed transversely across the lane and the profile viewed for voids and/or a non-uniform aggregate matrix. Cores can also be cut to ascertain if segregation is present. If segregation is determined to exist, costs of the coring or sawing will be at the contractor's expense.

Normal HMA laydown temperature limitations apply to this process.

DIVISION 20. EQUIPMENT REQUIREMENTS

This Division consists of requirements for equipment used on various types of construction and maintenance as set forth in the following sections.

Section 2001. General Equipment Requirements

2001.01 GENERAL.

Equipment shall be subject to approval of the Engineer and shall be maintained in satisfactory working condition. Except as provided in Article 1105.12, G, equipment operating on pavement or on primed or unprimed subgrade, subbase, or base course shall not exceed the legal axle load, as defined herein. Tractors with lugs shall not be used for manipulating or spreading subbase or base material except when traveling on uncompacted material deposited by spreaders or spreader boxes.

Equipment that comes in contact with bituminous materials or bituminous mixtures shall be kept 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, the equipment shall be allowed to drain for a minimum of 5 hours after cleaning. Cleaning agents shall be collected and disposed of in accordance with Federal and State regulations.

2001.02 FIELD LABORATORY.

Field laboratories shall comply with requirements of Section 2520.

2001.03 TRUCKS FOR TRANSPORTING BITUMINOUS MIXTURES.

Trucks for transporting bituminous mixtures shall be 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. All trucks for transporting hot mixes shall have a cover of canvas or other suitable material, but covering will not normally be required between May 15 and October 1.

2001.04 MECHANICAL TAMPERS.

In areas inaccessible to rollers where compaction is required and hand tamping is not permitted, a mechanical tamper of a size suitable for the work shall be used. Pneumatic tampers shall not be operated at pressures lower than recommended by the manufacturer.

2001.05 ROLLERS.

Rollers shall be subject to restrictions imposed in the specifications for the various types of construction. Rollers which are not in good repair, or which are not designed to do the work required fully and satisfactorily, shall not be used. They shall be subject to approval of the Engineer. Rollers shall comply with the following requirements:

A. Soil Compaction Rollers.

Sheepsfoot type rollers shall consist of one or more drums having studs or feet projecting not less than 6-1/2 inches (165 mm) from the surface of the drum. The roller shall be loaded so that not less than 200 psi (140 g/mm^2) is exerted on a single row of feet parallel to the axle of the drum.

B. Self Propelled, Smooth, Steel Tired Rollers.

Self propelled, smooth, steel tired rollers may be of the 3 wheel type, 2 axle tandem type, or 3 axle tandem type. For natural subgrade, rollers shall not be less than the 3 ton (2.7 Mg) weight class.

For hot asphalt mixtures, the driving drum shall not be less than 60 inches (1500 mm) in diameter. On tandem type rollers, the driving drum shall be capable of being filled with liquid ballast, and the Engineer may require that it be partially or entirely filled.

For all other types of work, the rollers shall be of a weight class not less than 8 tons (7.3 MG), and the driving drum shall be loaded to produce a compactive effort not less than 200 pounds per inch (3.5 kg/mm) of width of the roller. When required by the Engineer, the steering drum shall also be weighted to 200 pounds per inch (3.5 kg/mm) of width of the steering drum.

C. Self Propelled, Pneumatic Tired Rollers.
Self propelled, pneumatic tired rollers shall have tires not smaller than the 7.50 x 15 size.

For hot asphalt mixtures, the rollers shall be capable of producing contact pressures of 80 psi (550 kPa) and shall be operated when specified or directed by the Engineer. The 80 psi (550 kPa) contact pressure shall be obtainable with a legal axle load.

For all other types of work, the rollers shall be loaded to produce a compactive effort not less than 200 pounds per inch (3.5 kg/mm) of width of the roller, based on the maximum ground contact width. The tire inflation pressure used shall not be less than 60 psi (410 kPa). Rollers complying with the requirements for hot asphalt mixtures may also be used.

The tire pressures shall not vary more than 5 psi (35 kPa). An information plate shall be attached to each roller, which shows the tire size and ply and the correlation of wheel load and tire pressure with contact pressure. The roller shall be equipped with wheel sprinklers, scrapers, or mats, and during cooler weather, protective skirting around the tires.

D. Pull Type, Pneumatic Tired Rollers.
Pull type, pneumatic tired rollers shall have tires not smaller than the 7.50 x 15 size. The rollers shall be loaded to produce a compactive effort not less than 200 pounds per inch (3.5 kg/mm) of width of the roller, based on the maximum ground contact width. The tire inflation pressure used shall not be less than 60 psi (410 kPa).

E. Trench Rollers.
Trench rollers used in trench operations shall have a compacting roller of a width not less than 15 inches (380 mm). The rollers shall be equipped 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.

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 (4.5 kg/mm) of width of the tire. Pneumatic tired rollers shall be operated with an inflation pressure not less than 60 psi (410 kPa).

F. Self Propelled Vibratory Rollers.
Self propelled vibratory rollers shall be suitable for the use intended. The manufacturer's handbook should be available to the operator. The speed of the roller shall be controlled so there is a minimum of 10 impacts per linear foot (35 impacts per meter).

Other types of rollers will be considered for approval by the Engineer.

2001.06 MATERIAL BINS.
For the purpose of this Article, the word "bin" shall be defined as any structure in which materials are stored. The requirements shall apply to any bin that an inspector, while performing sampling or inspection duties, might work upon or beneath.

Each part of each bin, including foundations and connections, shall have adequate strength to withstand any stress to which it might be subjected while in use.

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 (mass).

A. Weighing Equipment.
Weighing equipment for measuring a pay item shall meet requirements of the Iowa Department of Agriculture. Truck weighing equipment shall be of sufficient length to weigh, at one time, the maximum truck and trailer combination, or separate equipment shall be situated so that both truck and trailer can be weighed at the same time. Upon request, the Contractor shall make available, at least 10 standard 50 pound (22.68 kg) test weights and suitable cradles and platforms for the purpose of testing weighing equipment.

Weighing equipment shall be accurate to 2 pounds per 1000 pounds of weight (2 kg per 1000 kg) sensitive to a weight (mass) equal to 0.1% of the quantity being weighed but not less than a weight (mass) equal to one of the minimum graduations on a beam or dial scale and not to exceed 20 pounds (10 kg). When electronic devices such as load cells, computers, and printers are a part of the weighing equipment, they shall be sealed or otherwise protected to prevent any unauthorized adjustment. Any weighing system which has been tampered with may be rejected from further use until the system has been checked and/or recalibrated. Contractors using electronic type weighing equipment and devices shall 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.

All trucks to be weighed shall be initially tared before being loaded. These trucks shall be tared daily thereafter, preferably on a random time basis. The tare for the previous day shall be used until a new tare is determined.

A scale ticket shall accompany each load to be furnished to the Engineer for project records. A scale ticket shall also be furnished when tares are determined, for verification and check weighing. Verification weighing is defined as a second weighing of the same load on the same equipment. Check weighing is defined as a second weighing of the same load on different weighing equipment. Check weighing shall be performed on a certified truck scale. Scale tickets, as a minimum, shall identify project number, date, truck number and type of material. They also shall include a total net weight (mass).

Except for automatic weighing, a weighmaster, as defined in Chapter 214, Code of Iowa, shall weigh all loads or load increments. The weigh master, or operator for automatic weighing, shall sign the first scale ticket of each day and shall initial all subsequent tickets or cause them to be printed by automatic equipment.

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 (mass) should not be different from the initial weight (mass) by more than 0.1%. When check weighing on a platform scale, the check weight (mass) should not be different from the initial weight (mass) by more than 0.3%. When the material is not weighed in the truck, (such as weighing in a weigh hopper or from initial and final weighing of a weigh silo) check weighing shall be made on a certified truck scale and the net check weight (mass) should not be different from the initial net weight (mass) by more than 100 pounds (45 kg). A suitable fuel adjustment may be made.

If the weight (mass) is not within these tolerances, the Engineer may adjust the weight (mass) of loads previously weighed on the weighing equipment that day and the previous day by the difference greater than the specified tolerance. Verification and check weighings shall be made at no additional cost to the Contracting Authority.

B. Special Procedures for Asphalt Mixtures, Aggregates, and Binders.
Automatic or semi automatic weighing shall be used on projects with contract quantities of asphalt mixtures totaling 10,000 tons (10,000 Mg) or more; or aggregates totaling 10,000 tons (10,000 Mg) or more from a single source.

1. Automatic Weighing.
The weighing equipment shall be self balancing and shall include an automatic weight (mass) recorder. All tickets shall be printed automatically with net weight (mass) and all weights (mass) needed to determine total net weight (mass).

2. Semi Automatic Weighing.
The weighing equipment may be self balancing or manually balanced. Equipment shall include an automatic weight (mass) recorder which will not print until the equipment is balanced, and which prints the gross weight (mass) or the batch weights (mass) and number of batches. For weigh hoppers, the printout shall include the empty weight (mass) after each discharge.

For measurement of asphalt binders by tank stick or in-line flow meter, the Contractor shall meet the requirements of Materials I.M. 509 for calibration and measurement.

For asphalt mixtures, the Contractor shall furnish to the Engineer each day, a total quantity of mixture used for the project. The Contractor shall furnish daily totals to the Engineer for all mixture quantities produced and not incorporated into the project. This total shall also identify the quantity of asphalt binder used but not incorporated.

2001.08 EQUIPMENT FOR PREWETTING AGGREGATES AND AGGREGATE MIXTURES.
The equipment shall comply with one of the following:

A. Standard Mixer.
The equipment used for this purpose shall provide accurate control of the proportions of water and aggregate, and positive, thorough mixing of the materials. Dow boxes will be approved as a Standard Mixer.

B. Pugmill Mixer.
When this equipment is specified, it shall provide accurate control of the proportions of water and aggregate and shall be designed so that the material can be retained in the mixing chamber under vigorous mixing action for at least 15 seconds. If the mixer is the continuous flow type, it shall have twin mixing shafts and shall be 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 distributor mounted on a truck or trailer equipped with pneumatic tires shall be used for applying water to the roadway.

The distributor shall be equipped with an adequate pressure pump and flush or spray bars to distribute water evenly over the intended area.

Distributors shall have a spray bar with correct size and pattern of nozzles, a means to maintain uniform nozzle pressure, a means to control application rates between 0.05 to 0.50 gallon per square yard (0.20 to 2.50 L/m^2), and a positive sprayer shutoff mechanism.

Distributors used for trench operations shall 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.
Water supply equipment, including pipe lines and water trucks, shall be of a capacity and nature to insure an ample supply and sufficient pressure for all the requirements of the work. When pumping is necessary, backup pumping equipment may be required.

2001.11 EQUIPMENT FOR HEATING BITUMINOUS MATERIALS.
Equipment for heating bituminous material shall have adequate capacity to heat the material to the temperatures specified. Heating shall be under control and shall be accomplished by circulating steam or a liquid through coils in the car or tank, by electric heat, by circulating the bituminous material through a separate heating unit, or by other means so that no flame is applied to metal with which the bituminous material comes in contact. The heating equipment shall be equipped with an accurate thermometer which will indicate the temperature of the bituminous material in the unit in which heat is being applied. The heating equipment shall not damage the bituminous material by local overheating or by contamination with the material used for the transfer of heat.

Equipment for heating asphalt binder shall insure continuous circulation between the storage tank and the mixer during the operating period. All pipe lines shall be jacketed or insulated to prevent heat loss.

2001.12 EQUIPMENT FOR DISTRIBUTING BITUMEN.
Distributors shall be mounted on motor trucks or trailers. They shall be subject to the restrictions imposed in the specifications for the various types of construction. Distributors which are not in good repair or which are not designed to do the work required shall not be used. Distributors and trucks shall be subject to the approval of the Engineer.

Distributors shall be equipped with adequately sized burners and flues for heating the bituminous material and with means for circulating the material in the tank when the burners are in operation. They shall be equipped with adequate and safe catwalks or ladders for use in making stick measurements.

Each unit shall be equipped with an accurate thermometer for indicating the temperature of the bitumen in the tank, a tachometer operated by a wheel independent of the truck wheels, a calibrated or verified measuring stick, a quick opening gate in the dome of the distributor tank, and quick cutoff valves at the nozzles or other means for reversing the direction of flow through the nozzles.

The power for the pressure pump shall be supplied by a unit independent of the one which provides motive power for the distributor. However, pressure equipment which is dependent on the motive power may be approved provided special devices are installed to insure that variation from the designated rates of application will not exceed 0.02 gallon per square yard (0.10 L/m^2). The pressure system shall have capacity sufficient to produce a uniform, fine, even spray from all the nozzles for the maximum width of the spray bar used. It shall be capable of distributing bitumen at rates varying from 0.03 to 0.50 gallon per square yard (0.15 to 2.50 L/m^2). The size of the nozzles shall be such that bitumen may be spread in a uniform coating without the forward speed exceeding 20 mph (30 km/h).

The spray bars shall be adjustable for the widths of application required by the work. They shall be equipped with a means of lateral shifting during the application of bitumen of at least 6 inches (150 mm) each way from the center position. They shall be adjustable vertically to insure uniform transverse application of the bitumen. Distributors used for applying bituminous seal coat binder bitumen shall be equipped with a positive means for maintaining a constant nozzle height, within " 1/2 inch (15 mm), during discharge of the load. If dollies are used for maintaining the constant nozzle height, the spray bar mounting shall be adjustable vertically.

The Contractor shall provide, with each distributor, the manufacturer's instructions for use which shall include 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 (liters per square meter) for tachometer readings, spray bar pressure, or pump revolutions, and for various widths of spray bars.

The tanks of all distributors that have not been previously checked shall be calibrated or verified before being initially used and after any damage or alteration which may affect the calibration. Distributors shall be calibrated initially at the Iowa DOT Materials Laboratory. Verification of a manufacturer's calibration may be made by the Iowa DOT Materials Laboratory or by a District Materials Office. Distributor calibrations shall be certified annually by either the Iowa DOT Materials Laboratory or District materials personnel; if they are found to have inaccurate calibrations, they shall be recalibrated by the Iowa DOT Materials Laboratory before further use.

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.
Non-self-propelled cover aggregate spreaders shall have a mechanical feed of a length at least equal to the width to which aggregate is spread at a single passage of the spreader. They shall be 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. The spreaders shall be equipped so that they may be filled and moved without discharging aggregate.

B. Self-Propelled Cover Aggregate Spreaders.
Self-propelled cover aggregate spreaders shall, in addition to the requirements of Article 2001.13, A, comply with the following:

1. They shall be self-propelled and shall be mounted on pneumatic tires.

2. The width of spread shall be not less than 13 feet (3.9 m).

3. Cutoff plates shall be provided to permit the width of spread to be reduced in increments of 1 foot (0.3 m) from the maximum to 4 feet (1.2 m).

4. The unit shall be capable of spreading aggregate of 1 inch (25 mm) maximum size at any rate desired from 3 to 50 pounds per square yard (1.5 to 27 kg/m^2) of surface covered.

5. A hopper having a capacity not less than 5 tons (4.5 Mg), integral with the spreader unit, shall be provided to receive aggregate from transporting vehicles without the wheels of such vehicles coming in contact with uncovered bitumen on the road surface. Suitable conveyors shall convey the aggregate from the hopper to the spreading element. Augers or agitators shall distribute aggregate uniformly to the spreading element without segregation of aggregate particles.

6. Power shall be adequate to propel the spreader at uniform speed on gradients up to 6%.

C. Sand Spreader.
The spreader used for sand cover of tack and seal coat shall have 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.
The material used in base widening shall be placed by machine without being dumped on the pavement. The machine shall spread the base materials in a uniform layer of the desired thickness and width in a uniformly loose condition. Wheels of the spreader shall be located so they do not operate on the 1 foot (0.3 m) width of pavement where curb has been removed.

2001.14 BROOMS.
Brooms shall be of the rotary type, and the broom shall be driven by an auxiliary motor or by a power takeoff from the power plant of the unit propelling the broom.

2001.15 MOTOR GRADERS.
Motor graders used in trimming edges of subbases or bases shall be equipped 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.
Scarifying equipment used shall be designed and operated to loosen the material to the depth specified.

2001.17 PULVERIZING EQUIPMENT.
Pulverizing equipment shall be designed and operated to pulverize the material to the degree specified.

2001.18 TRENCH EXCAVATING MACHINES.
The equipment used shall be a machine designed for the required purpose. The equipment used to excavate shall be capable of excavating the material to the full, normal design depth and suitable width.

2001.19 ASPHALT PAVING MACHINE.
All asphalt mixtures to be placed 8 feet (2.4 m) or more in width shall be spread by a self- propelled finishing machine which will receive the hot mixture and spread the mixture in a layer of uniform density to the desired elevation.

The finishing machine shall consist of a tractor unit and a screed unit.

The tractor unit will provide the motive power and may be mounted on crawler treads or pneumatic tires. If mounted on pneumatic tires, sufficient inflation pressure shall be maintained to keep vertical movement to a minimum. The length of crawler treads or distance between axles, if mounted on pneumatic tires, shall be sufficient to allow the tractor unit to pass over small irregularities in the base without abrupt vertical movement. The tractor unit shall have dual controls to permit operation of the finishing machine from either side.

The screed unit shall be attached to the tractor unit in such a manner that it is free floating on the mixtures being placed. It shall be equipped with vibrators or tampers for giving the initial consolidation to the material, and this equipment shall be operated at the frequency recommended by the manufacturer. The screed unit shall be adjustable to the crown of the finished surface, and shall be equipped with an approved device which will indicate the slope of crown. A screed extension may be used, provided it has a screed plate with vibration. If the extension exceeds 1 foot (0.3 m), the auger shall also be extended. Other extensions will be allowed only for use in placing fillets or short or irregular tapers. The screed unit operation shall produce a smooth surface, free from surface tears or voids, and within the permissible variation specified for the type of work involved.

Machines which operate with rollers on the freshly placed mixture shall not be used.

At least a 2 foot (0.6 m) straightedge shall be provided for checking the installation of screed extensions.

Unless otherwise provided, the finishing machine shall have 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 (25 mm) or less in thickness.

5. Special leveling 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.

The automatic controls shall have grade and slope control systems which shall operate with an approved grade reference system. The controls shall work in conjunction with a ski type device, traveling stringline, or other approved, self contained grade referencing system. The self contained grade referencing system shall not be less than 30 feet (9 m) in length. Both the grade and slope controls shall be adequately sensitive and in proper working order at all times, however, during malfunctions the Engineer may permit the completion of the day's work using manual controls. When placing a single lift only, with a thickness of 1 1/2 inches (40 mm) or less, or for placement in conjunction with heater scarification work, a special commercial joint matching shoe may be used when constructing longitudinal joints on surface courses.

Finishing machines or pavement widening machines for placing the final lift of paved shoulders shall have an automatic grade and slope control system approved by the Engineer. The joint matching shoe may be used when placing any paved shoulder.

Machines for spreading mixtures on other areas less than 8 feet (2.4 m) in width shall be subject to approval of the Engineer. Machines which are less than standard size for highway work shall not be used except with permission of the Engineer.

Use of material transfer vehicles shall be subject to approval by the Engineer based on bridge and pavement structural evaluation of resultant axle and wheel loads.

When a windrow pick-up process is used, the process shall be controlled to produce a windrow that is uniform and does not extend more than two truck dumps ahead of the paver. All hot mix material shall be picked up from the windrow and deposited in the paver. Windrow placement shall be balanced to maintain a uniform quantity of material in the paver hopper.

2001.20 EQUIPMENT FOR WEIGHING AND PROPORTIONING PORTLAND CEMENT CONCRETE MATERIALS.

Weighing and proportioning equipment shall meet the requirements of this Article. The Engineer shall be allowed 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. This equipment may be used on miscellaneous concrete pours, described in Materials I.M. 534, less than 50 cubic yards (50 cubic meters) per day. 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. Coarse aggregate sampling facilities which permit collecting representative portions of a ribbon or stream will be required at the proportioning plant site. The sampling point shall be as designated by the Engineer and shall be prior to loss of individual material identity in the proportioning mixing process and after delivery to the plant or after delivery to a plant site stockpile, whichever is nearest the mixer. Personnel, test weights, and equipment for calibration of the plant and for verifying accuracy of proportions shall be furnished by the Contractor. Arrangements for weighing water to calibrate the water meter shall be made by the Contractor.

A. Proportioning Equipment.

Proportioning equipment shall comply with the following requirements:

1. The equipment shall be accurate to 0.5% of the batch weight (mass).

2. The equipment shall be sufficiently sensitive so that 0.1% of the batch weight (mass) or 2 pounds (1 kilogram), whichever is greater, will be detectable.

3. The equipment shall weigh each individual material within " 1.0% of the batch weight (mass) and return to zero within " 0.5% of the batch weight (mass).

4. The equipment shall be protected from air currents, vibration, etc. which may affect the accuracy of weighing. All fulcrums, clevises, and similar working parts shall be kept clean and in proper working condition.

5. There shall be reasonably available upon request, at the plant site, standard test weights for calibrating weight equipment according to the following table:

Nominal Scale Capacity lb (kg)	**Minimum Test Weights (Mass) Required Total lb (kg)**
0 to 500 (0 to 225)	2 @ 50 lbs. Ea (2 @ 22.68 kg ea.)
Over 500 to 5000 (Over 225 to 2250)	500 (225)
Over 5000 to 10,000 (Over 2250 to 4500)	1000 (450)
Over 10,000 (Over 4500)	2000 (900)

Suitable devices shall be made available for conveniently applying test loads.

6. Cement shall be weighed in an independent hopper. The weigh hoppers shall have a dust tight seal between the charging mechanism and the batching hopper which will not affect the accuracy of weighing, and a discharge hose or device which will prevent the loss of cement during discharge. Any part of the discharge device which comes in contact with the receiving equipment shall not be supported by the weigh hopper. Cement hoppers shall be equipped with a vibrator and with a vent which will adequately release any air pressure which may affect weighing.

7. Fly ash and GGBFS shall be weighed in accordance with 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.

8. Automatic weighing equipment shall be set and operated with the following interlocks:

a) The charging mechanism cannot be opened until the equipment has returned to zero balance within " 0.5% of the batch weight (mass).
b) The charging mechanism cannot be opened if the discharge mechanism is open.

c) 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 (mass).

When automatic weighing equipment is required, manual controls may be used for emergencies. Manual controls will be permitted no longer than 1 working day after automatic batching equipment failure.

When automatic weighing equipment is required, fly ash shall be weighed in accordance with the requirements for cement.

B. Water Measuring Equipment.
Water shall be measured with equipment which will clearly indicate the volume or weight (mass) being measured with an accuracy of 2 pounds (1 kg) or " 1.0%, whichever is greater. The equipment shall be arranged so that the accuracy of the measurement will not be affected by variations in pressure of the water supply line. Unless water is measured by weight (mass), the Contractor shall provide

containers in which the entire quantity of water required for one batch of concrete may be weighed for calibration purposes.

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.

C. Equipment for Admixtures.
Equipment for dispensing liquid admixtures shall be accurate within " 3.0% of the quantity required. The visual inspecting chamber requirement may be waived in lieu of admixture dispensing systems utilizing positive electronic flow metering and computer controlled delivery that prevents improper admixture incorporation into the mix. Dispensing equipment shall have a means for routine diversion of a measured quantity into a suitable vessel for calibration and for periodic verification of the batch quantity.

When liquid admixtures are proportioned and introduced into the mix, the equipment and procedures shall meet the following requirements:

1. Each individual admixture shall be measured and automatically introduced separately into the mixer with the mixing water.

2. The dispenser shall be equipped with a measuring chamber which provides a means of determining the batch quantity by visual inspection.

D. Equipment for Volumetric Proportioning.
Volumetric proportioning equipment shall meet the applicable requirements of ASTM C 685, Sections 5, 6, 7, and 8 and the applicable requirements of Article 2413.03, B. This equipment shall be calibrated each time, when in the opinion of the Engineer, material or condition changes may affect the calibration. It is not intended that this equipment be used in lieu of conventional drum mixing equipment normally used for structures and paving applications. 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.
The mixing equipment shall meet requirements of this Article for the type specified. The Engineer shall be allowed 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.

A. Construction or Stationary Mixer.
Only batch type mixers shall be used.

The total volume of the batch shall not exceed the designated size of the mixer or the rated capacity as shown on the manufacturer's rating plate.

After all solid materials are assembled in the drum, the mixing time shall be a minimum of 60 seconds and a maximum of 5 minutes. The mixing time may be increased by the Engineer if the mixer efficiency tests show that the concrete is not satisfactory for uniformity or strength. The minimum mixing time shall be indicated by an accurate timing device which shall be automatically started when the mixer is fully charged, and when applicable, shall lock the discharge chute until the expiration of the required time. Mixers shall be operated at the speed recommended by the manufacturer as mixing speed. The batch shall be charged into the mixer so that some water will enter in advance of cement and aggregates, and all water shall be in the mixing chamber by the end of the first 25% of the specified mixing time.

The mixing drums of tilting drum mixers shall be operated at an angle no steeper than that recommended by the mixer manufacturer. Mixers shall not be used if the drum is not clean or if the mixing blades are damaged or badly worn.

When a construction or stationary mixer is used for mixing pavement concrete the quantities of fine aggregate, coarse aggregate, cement, mineral admixture, liquid admixture and water for each batch shall be automatically documented on individual batch tickets or on a daily summary. The time of discharge for each batch shall also be recorded automatically. These proportioning documents shall become property of the Contracting Authority.

B. Truck Mixer and Agitator.
The capacities and mixing capabilities shall be as defined in ASTM C 94, and each unit shall have an attached plate containing the information described therein. The plate may be issued by the Truck Mixer Manufacturers Bureau; if not, compliance shall be determined by an independent, recognized laboratory as defined in Article 4103.01, and complete test results may be required. The mixer or agitator capacity shall not be exceeded, and the mixing and agitator speeds shall be within the designated limits. Truck mixers shall be equipped with a reliable reset revolution counter. If truck mixers are used for mixing while in transit, the revolution counter shall register the number of revolutions at mixing speed.

An authorized representative of the concrete producer shall certify that the interior of the mixer drum is clean and reasonably free of hardened concrete, that the fins or paddles are not broken or worn excessively, that the other parts are in proper working order, and that the unit has been checked by the representative within the previous 30 calendar day period to substantiate this certification. The current, signed certification shall be with the unit at all times.

For bridge floor concrete, the required mixing shall be between 70 and 90 revolutions. For other structural concrete and pavement concrete, the required mixing shall be between 60 and 90 revolutions with satisfactory preblending of the materials or between 70 and 90 revolutions without preblending. The mixing shall be at the rate designated by the manufacturer. The mixing rate shall be of a duration between the above stated limits, to produce uniform, thoroughly mixed concrete.

The Engineer may inspect mixer units at any time to assure compliance with certification requirements, and 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 (20 mm) 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.

C. Continuous Mixer.
A continuous mixer used in conjunction with volumetric proportioning may be approved as provided in Article 2001.20, D.

2001.22 PLANT EQUIPMENT FOR HOT MIX ASPHALT MIXTURES.
The plant equipment shall 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, and it shall be equipped to produce uniform mixtures of required composition, heated to the desired temperature. The plant shall conform to the following requirements for the respective type.

A. Aggregate Feeders for Dryer or Drum Mixer.
Except for mineral filler added without heating, each aggregate shall be accurately fed by a mechanical means to a central elevator or conveyor in the proportion prescribed by the formula. Feeders shall be of the belt type and be equipped with adjustable gates or adjustable drive systems that can be calibrated and controlled satisfactorily. The feeder throats shall be of sufficient size to

insure positive and continuous flow. All feeders shall be mechanically or electrically interlocked during operation. On some types of feeders, revolution counters capable of registering to a tenth of a revolution may be necessary for accurate calibration and control and may be required. When drum mixing plants are used, the central conveyor shall be equipped with a continuous weighing system with a recorder that can be monitored by the plant operator. The weighing system shall be interlocked with the asphalt control unit.

If a drum mixing plant is used for recycling, a dual weigh belt system will be required to control delivery of virgin aggregates and recycled material to the dryer. The system shall be 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. Included in this system shall be recorders that will record the total amount of material being delivered by each belt system separately. The belt weighing controls shall be connected to a totalizer which is interlocked with the asphalt delivery system in a manner which will assure that asphalt delivered to the mix is at all times within " 0.3% of the intended amount. The system shall be subject to approval of the Engineer. A schematic diagram of the control system shall be furnished for the Engineer's information prior to plant calibration.

B. Dryer and Drum Mixer.
The plant shall be equipped with means for drying and heating the aggregate and/or mixture. Heating shall be controlled to avoid damage to the aggregate and asphalt. Operation of the equipment shall be controlled so the desired temperature is maintained as specified.

C. Screens.
The plant shall be equipped with adequate means to remove objectionable oversize and foreign material from the aggregate before entering into the hot aggregate bin or drum.

D. Bins.
The plant shall have aggregate bins of sufficient capacity to insure uniform and continuous operation. The aggregate storage shall be 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. When mineral filler is added without heating, adequate additional dry storage shall be provided for the mineral filler, and provisions shall be made for proportioning the filler uniformly in the desired proportion for the mixture.

E. Equipment for Heating and Storing Bituminous Materials.
Article 2001.11 shall apply. Unless the asphalt binder is supplied to the project from transports measured by weight (mass), duplicate storage facilities shall be provided, each of sufficient capacity to permit complete unloading of a tank car or truck transport at a single operation. Filling and withdrawal of material from each tank shall be conducted as a separate, definite operation which will permit the Engineer to measure the quantity of asphalt binder used from each tank for each cycle of operation. Each storage tank shall be installed and maintained in a level position. Measurement devices and gauging tables shall be furnished so accurate determinations of quantities used and stored can be made at regular intervals.

Suitable means shall be provided for maintaining the specified temperature of the asphalt binder in the pipe lines, meters, weighing buckets, spray bars, and other containers and flow lines.

The system shall 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.
Satisfactory means, by weighing, metering, or volumetric measurements, shall be provided to obtain the proper amount of asphalt binder. All measuring devices shall be operated within a delivery tolerance of 1.5%.

1. **Batch Plants.**

For batch plants, the quantity of asphalt binder for each batch shall be weighed on equipment meeting the appropriate requirements of Article 2001.07, A, or shall be measured by an approved automatic batch metering system. When used for proportioning only, the equipment shall meet the appropriate requirements of Article 2001.20.

The means of heating shall be sufficiently flexible so it will not affect the weighing. The container shall be arranged 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 deposited on a flow or spreader sheet, the sheet shall be heated and shall have sufficient slope to discharge promptly into the mixer.

2. Continuous Plants.
Continuous plants shall use a pump to supply asphalt binder to the mixer, which is constructed to be under a positive pressure sufficient to maintain uniform delivery from the pump. The pressure shall be maintained within " 0.5 psi (5 kPa) of the mean operating pressure.

Accurate pressure gauges shall be installed in readily accessible locations in lines feeding the metering pump and the mixer spray bars. The gauges shall be such size that the normal operating pressure can be easily read to the nearest psi (10 kPa).

The mixer unit shall be equipped with a surge tank or a deaeration chamber for supplying a constant pressure flow of asphalt binder to the metering pump. The surge tank or the deaeration chamber shall be approved by the Engineer and shall be of dimensions and capacity to provide the pressure specified. The capacity shall be at least a 6 minute supply of asphalt binder at the normal mixing rate of the mixer unit. The surge tank or the deaeration chamber shall 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 to ensure deaeration and escape of any air bubbles that may be present. When the surge tank system is used, the pressure at the spray bar shall not be greater than 20 psi (140 kPa). When a deaeration chamber system is used, the pressure difference between the return line and the spray bar shall not be greater than 20 psi (140 kPa). Separate return lines shall be provided for each tank.

3. Drum Mixing Plants.
Drum mixing plants shall use 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. A totalizing flow meter shall be placed in the line between the metering pump and mixer unit. The asphalt control unit shall be interlocked with the aggregate weighing system specified in Article 2001.22, A, and shall be equipped to automatically adjust for variation in aggregate delivery. The plant shall be operated with automatic controls except when approved by the Engineer. The asphalt control unit shall be equipped so the plant operator can monitor and adjust the flow rate of aggregate or asphalt binder.

G. Thermometer Equipment.
An accurate, registering pyrometer or other approved thermometric instrument shall be installed in the discharge chute of the dryer or drum mixer in a manner so that the temperature of the heated aggregate or mixture is automatically indicated. This instrument shall be located 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.
The plant shall be equipped with positive means to govern and maintain the time of mixing.

I. Dust Collector.
Proper housings, mixer covers, and dust collecting systems and returns shall be installed and properly maintained. The method of returning dust collected by dry type collection systems to the hot aggregate mixture shall be subject to the approval of the Engineer. If not required in the mixture, the bag house

fines shall be removed from the project and plant site. When wet type collection systems are used, the Contractor shall remove all wet material from the project and plant site.

J. Hot Aggregate Proportioning.
Batch plant equipment shall include a means for accurately weighing 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. The weighing hopper shall be supported so it will not be easily thrown out of alignment or adjustment. Gates on bins and hoppers shall be constructed to prevent leakage when closed.

Mineral filler which is added cold shall be proportioned separately from a hopper and arranged to be fed uniformly into the heated aggregate before delivery to the feeder for the mixer.

For batch plants, the quantity of aggregate for each batch shall be weighed on equipment meeting the appropriate requirements of Article 2001.07, A. When used for proportioning only, the equipment shall meet the appropriate requirements of Article 2001.20.

The requirements of this Paragraph J do not apply to drum mixing plants.

K. Mixer.
The mixer shall comply with the following:

1. Batch Mixer.
A batch mixer shall be a twin shaft pugmill and shall be capable of producing a uniform mixture within the job mix or other specified limits. The clearance of the blades from all fixed and moving parts shall not exceed 3/4 inch (20 mm), and the orientation of the blades shall be as recommended by the manufacturer. If not enclosed, the mixer shall be equipped with a dust hood to prevent loss of dust by dispersion. The mixer shall be constructed to prevent leakage of contents until the batch is to be discharged. The mixer shall have an accurate time lock to control the operation of a complete mixing cycle by locking the weighing hopper gate when the mixer is charged and until the mixer gate is closed at the completion of the cycle. It shall also lock the outlet of the asphalt binder delivery system throughout the dry mixing period and the mixer gate throughout the dry and wet mixing periods.

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. Control of the timing shall be flexible and capable of being set at intervals of not more than 5 seconds. A mechanical batch counter shall be installed as part of the timing device and shall be designed to register only completely mixed batches.

For recycling, batch plant equipment shall be modified 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, and with no preheating necessary.

The recycled material may be added to the hot elevator with no preheating necessary. In any method where preheating is being done, the equipment must be specifically designed for this purpose.

Any proportioning system shall also meet the requirements of Paragraph A.

When the heat transfer method is used, the new aggregate shall be superheated so that, when combined with the recycled material, the temperature of the resultant mixture will meet all requirements for mixing and placing the hot mixture.

Each plant modified for recycling mixtures shall initially be subject to approval of the Engineer.

2. Continuous Mixer.
A continuous mixer shall be an approved twin shaft pugmill capable of producing uniform mixtures within the job mix or other specified limits. The paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of mix. The mixer shall be equipped with a discharge hopper holding approximately 1 ton (1 Mg) and discharging intermittently by means of quick acting gates. Distance to the receiving vehicle shall be regulated to minimize segregation.

Satisfactory means shall be provided 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. This control shall be accomplished by interlocking mechanical means or by any positive method for accurate control. The equipment shall include an accurate revolution counter, operating continuously during production.

The plant shall be equipped with positive means to govern and maintain a constant time of mixing.

3. Drum Mixer.
A drum mixer shall be capable of producing uniform mixtures within the job mix or other specified limits. The aggregate, asphalt binder, and additives, when furnished, shall be introduced continuously and uniformly and shall be subject to control of the plant operator. The mixture shall be discharged continuously and uniformly onto an elevator or conveyor that discharges into a hot mixture storage unit meeting requirements of Article 2001.22, L. The mixing shall be continued until the asphalt binder is uniformly distributed, and the aggregate particles are uniformly coated.

The plant may be modified with a pugmill coater added to the drum mixer. When so modified, the coater must be inclined and positioned as an integral built-in unit, located between the drum and the hot elevator of the plant setup. The asphalt binder, and additives when furnished, shall be introduced continuously and uniformly at the lower end of the coater, subject to control by the plant operator. Each modified plant shall be initially subject to approval of the Engineer.

For recycling, drum mixing equipment shall be modified to process recycled mixtures in accordance with Paragraph A.

L. Hot Mixture Storage.
When the hot mixture is not hauled immediately to the project and placed, suitable bins shall be provided. These bins shall be either surge bins to balance production capacity with hauling and placing capacity, or storage bins which are heated and/or insulated and which have a controlled atmosphere around the mixture. Either type of bin shall be round or octagonal in shape, shall be designed for the intended use, shall fill using an enclosed system unless skip conveyors are used, shall dump material directly into trucks through quick opening and quick closing gates, and shall not result in significant segregation, damage, or cooling. Affixed to each bin and visible to the loading operator shall be an indicating or control device which will allow control of material remaining in the bin.

When surge bins are used, the holding time shall be limited to 4 hours.

Hot mixture placed in storage bins shall be used within 24 hours of production unless otherwise approved by the Engineer.

M. Safety Requirements.
Adequate and safe stairways, platforms, and guarded ladders to plant units shall be placed at points required for accessibility to sampling locations and other plant operations. All gears, pulleys, chains, sprockets, and other moving parts shall be guarded and protected. Ample and unobstructed passage for personnel shall be maintained at all times in and around the truck loading area. This area shall be protected from falling material. Bins shall comply with requirements of Article 2001.06.

N. Plant Calibrations.

Personnel, weighing devices, test weights, and equipment for calibration of the plant and for verifying accuracy of proportions shall be furnished by the Contractor. Sufficient space shall be provided between aggregate feeds and elevators to permit taking of samples of the discharge for accurate calibration and control of rate of feed. Samples of sufficient size, for calibration and checking of proportions, shall be weighed. Truck sampling and weighing will be acceptable. The Engineer shall be allowed 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. The Engineer's representative shall indicate witnessing the calibration by signing the calibration documents and charts.

C. Pavement Widening.
The quantity of PCC Pavement Widening, in square yards (square meters), will be the quantity shown in the contract documents. The thickness of the pavement will be determined as provided in Article 2301.34.

D. Shoulders.
The quantity of Type A, B, and C Shoulders, in stations (meters), will be the quantity shown in the contract documents. Finishing of earth shoulders will not be measured separately but shall be considered as incidental work included in construction of shoulders. Construction of Type D shoulder shall be considered as incidental to excavation and will not be measured for payment.

E. Removal of Flumes.
Article 2213.14, B, shall apply.

F. Portland Cement Concrete Pavement Samples.
Article 2301.34, I, shall apply.

2302.14 BASIS OF PAYMENT.

A. Excavation, Class 13, for Widening.
Article 2213.15, C, shall apply.

B. Removal of Curb.
Article 2213.15, A, shall apply.

C. Pavement Widening.
The Contractor will be paid the contract unit price for PCC Pavement Widening per square yard (square meter) as provided in Article 2301.35. This payment shall be full compensation for construction of the pavement widening and all other work not paid for under other items.

D. Shoulders.
The Contractor will be paid the contract unit price for Type A, B, and C Shoulders per station (meter). Construction of Type D shoulder shall be considered as incidental to excavation and shall be included in the contract unit price for excavation.

E. Removal of Flumes.
Article 2213.15, B, shall apply.

F. Portland Cement Concrete Pavement Samples.
Article 2301.35, I, shall apply.

Section 2303. Hot Mix Asphalt Mixtures

2303.01 DESCRIPTION.
This work shall consist of mixture design, production, placement, and compaction of HMA using proper quality control practices for the construction of surface, intermediate, or base course on a prepared subbase, base, or pavement, to the proper dimensions specified in the contract documents.

Supplemental Specifications for Quality Control Program for Small HMA Paving Quantities shall apply for HMA bid items with 1000 tons (1000 Mg) or less.

The Contractor shall be responsible for all aspects of the project, provide quality control management and testing, and maintain the quality characteristics specified.

Quality Management - Asphalt (QM-A) shall apply to contracts with HMA quantities of 5000 tons (5000 Mg) or greater and all Interstate contracts. The Contractor shall follow the procedures and meet the criteria established in Article 2303.02, Section 2521, and Materials I.M. 510 and 511.

For contracts with less than 5000 tons (5000 Mg) quality control will be the responsibility of the Engineer. The Contractor shall be responsible for the mix design. This does not change the mix requirements from gyratory to Marshall, unless specified in the contract documents.

2303.02 MATERIALS AND EQUIPMENT.
Materials used in these mixtures shall meet the following requirements:

A. Asphalt Binder.
The Performance Graded asphalt binder, PG XX -XX, will be specified in the contract documents to meet the climate, traffic, and pavement conditions. The asphalt binder shall meet the requirements of Section 4137.

B. Aggregates.

1. Individual Aggregates.
Virgin mineral aggregate shall meet the following requirements:

VIRGIN MINERAL AGGREGATES		
Mixture	**Aggregate Type**	**Aggregate Requirements**
Base	Type B	Section 4127
Intermediate and Surface	Type B	Section 4127
Intermediate and Surface	Type A	Section 4127

When the frictional classification of the coarse aggregate is required, the contract documents will specify the friction level and location. The friction aggregate shall be furnished from sources identified in Materials I.M. T-203.

For friction classification L-2, at least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve shall be Type 4 or better friction aggregate; and at least 25% of the combined aggregate retined on the No. 4 (4.75 mm) sieve shall be Type 2 or better friction aggregate.

For friction classification L-3, at least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve shall be Type 4 or better friction aggregate; and at least 45% of the combined aggregate retained on the No. 4 (4.75 mm) sieve shall be Type 3 or better friction aggregate. If Type 2 is used in place of Type 3, the minimum shall be 30% of the combined aggregate retained on the No. 4 (4.75 mm) sieve.

For friction classification L-4, at least 50% of the combined aggregate retained on the No. 4 (4.75 mm) sieve shall be Type 4 or better friction aggregate.

2. Blended Aggregates.
The blended aggregates shall meet the combined aggregate requirements in Materials I.M. 510.

When mixtures include RAP, the blended mineral aggregate gradation shall be a mixture of extracted RAP aggregate combined with virgin aggregate.

C. Recycled Asphalt Pavement.
RAP shall be from a source designated in the contract documents, a certified stockpile, or unclassified RAP furnished by the Contractor subject to the following limitations:

1. Designated RAP.
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. The Contractor is responsible for salvaging this material unless otherwise specified in the contract documents. The RAP not used shall be incorporated into other parts of the project or placed in active stockpiles as directed in the contract documents.

The Contracting Authority will test samples of this material. For mix design purposes, the amount of asphalt binder in the RAP will be based on extraction tests. The Contractor shall designate the exact proportions of RAP material in the hot mix within the allowable range.

When the work is completed, the Contractor shall return unused material to the stockpile or other designated location, rebuild the stockpile, and restore the area, in accordance with Article 1104.08.

Test information, if known, will be included in the contract documents.

2. Certified RAP
The RAP shall be from a known source and of the proper quality for the intended use, with no material added from other sources during the time in stockpile. The Contractor shall certify to this before use. RAP from not more than two known sources at a time will be allowed.

Certified RAP may be used in the base and intermediate course of mixes for which the RAP aggregate qualifies. RAP may also be used in surface courses when authorized by the Engineer. Not more than 30% of the asphalt binder in a final surface course mixture shall come from the RAP.

A certified RAP stockpile shall be sealed or protected in accordance with Materials I.M. 505.

3. Unclassified RAP.
Up to 10% of unclassified RAP may be incorporated into intermediate mixes for under 3,000,000 ESALs and all base mixes with the following safeguards:

a. Unclassified RAP shall not be used in surface courses.

b. Unclassified RAP shall not be used in intermediate or base mixtures containing designated or certified RAP.

c. The Engineer will inspect the unclassified RAP stockpile visually for uniformity. Unclassified RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or environmentally restricted materials shall not be used, unless approved by the Engineer. If foreign material is discovered in any unclassified stockpile, the Engineer may stop the continued use of the pile.

d. Representative samples will be taken by the Engineer. These samples are to be tested for gradation and asphalt content.

e. No credit will be given for crushed particles.

f. Stockpiles, when used, shall be worked in such a manner that the materials removed are representative of a cross section of the pile as approved by the Engineer.

D. Hot Mix Asphalt Mixture.

The surface course is the upper lift for a wearing surface of a designated thickness. The intermediate course is the next lower lift or lifts of a designated thickness. Leveling, strengthening, and wedge courses shall be of the intermediate course mixture. The base course is the lift or lifts placed on a prepared subgrade or subbase.

The job mix formula (JMF) is the percentage of each material, including the asphalt binder, to be used in the HMA mixture. The JMF gradation shall be within the control points specified for the particular mixture designated and shall establish a single percentage of aggregate passing each required sieve size.

If the asphalt binder demand for the combination of aggregates submitted for an acceptable mix design exceeds the basic asphalt binder content by more than 0.75%, the mix design will include an economic evaluation prepared by the Contractor. This evaluation will be based on past job mix history, possible aggregate proportion changes, and aggregate availability and haul costs for any changes or substitutions considered.

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. The following values, based on mixture size and type, shall apply.

BASIC ASPHALT BINDER CONTENT (%)					
Mixture Size	**Aggr. Type**	**1 inch (25 mm)**	**3/4 inch (19 mm)**	**1/2 inch (12.5 mm)**	**3/8 inch (9.5 mm)**
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

The HMA mixture designed shall meet gyratory design and mixture criteria corresponding to the design level specified in the contract documents. The Engineer may approve the substitution of any mixture which meets requirements for a higher mixture than specified in the contract documents at no additional cost to the Contracting Authority. Shoulders placed as a separate operation shall be HMA 2,000,000 ESAL base mixture. For outside shoulders on Interstate projects, the Contractor has the option to substitute the mainline intermediate or surface mixture for a specified base mixture at the Contractor's expense.

The Contractor shall prepare gyratory HMA mixture designs for all base, intermediate, and surface mixtures. The gyratory design procedure used shall follow the procedure outlined in Materials I.M. 510. The gyratory mixture designs submitted shall comply with Materials I.M. 510.

The gyratory compactor used for design and field control shall meet the AASHTO protocol for Superpave gyratory compactors. Compactors for which compliance with this protocol is pending may be used at the discretion of the District Materials Engineer.

E. Other Materials.

1. Tack Coat.
Tack coat may be SS-1, SS-1H, CSS-1, or CSS-1H. Mixing of CSS and SS grades will not be permitted. RC-70 and MC-70 may also be used after October 1, at the Contractor's option.

2. Anti-strip Agent.
On Primary highways designated for over 10,000,000 ESALs and all Interstate highways, if 25% or more of the plus No. 4 (4.75 mm) (virgin and RAP) aggregate is gravel, quartzite, granite, trap rock, steel slag, or other siliceous aggregate (not a limestone or dolomite), anti-strip agent will be required in the affected mixture unless the minimum requirements for moisture sensitivity are met.

On all other Primary highways, if 25% or more of the plus No. 4 (4.75 mm) (virgin and RAP) aggregates or more than 40% of the total (virgin and RAP) aggregates is quartzite, granite, or other siliceous aggregates (not limestone or dolomite) which is obtained by crushing from ledge rock, anti-strip agent will be required in the affected mixtures requiring Type A aggregate unless the minimum requirements for moisture sensitivity are met.

Anti-strip agent will not be required for base repair, patching, or temporary pavement.

When anti-strip agent is required based on aggregate source, the Contractor may arrange for moisture sensitivity evaluation of the proposed HMA mixture design according to AASHTO T 283, "Resistance of Compacted Bituminous Mixture to Moisture-Induced Damage." When results of this evaluation on mixtures without anti-strip agent indicate the minimum requirements for moisture sensitivity of 80% tensile strength ratio (TSR) with visual confirmation are met, anti-strip agent will not be required. Confirmation of AASHTO T 283 test results will be completed by the Central Materials Laboratory during the initial production and placement of the mix. The Contractor will be subject to the provisions of Section 1105 for mixture placed without anti-strip agent prior to completion of the AASHTO T 283 confirmation testing.

When a liquid anti-strip additive or aggregate treatment is used, confirmation of the AASHTO T 283 test results will be completed by the Central Materials Laboratory during the initial production and placement of the mix. The Contractor will be subject to the provisions of Section 1105 for mixture placed with liquid anti-strip additive or aggregate treatment prior to completion of the AASHTO T 283 confirmation testing.

One of the following anti-strip agents shall be used:

a. Hydrated Lime.
Hydrated lime shall meet the requirements of AASHTO M 303, Type I. Section 4193 shall not apply. Hydrated lime will not be considered part of the aggregate when determining the job mix formula and the filler/bitumen ratio.

b. Liquid Anti-strip Additives.
Liquid anti-strip additives blended into the asphalt binder shall be approved for each JMF. The approval will be based on the following conditions:

1) Asphalt binder supplier shall provide test results that the additive does not negatively impact the asphalt binder properties, including short term and long term aged properties.

2) The AASHTO T 283 test is required and must satisfy 80% TSR when compared to the dry strength of specimens prepared with asphalt binder not containing the anti-strip additive. The design shall establish the optimum additive rate.

3) A change in the source of asphalt binder or aggregates will require a re-evaluation of the AASHTO T 283 test. When there is a significant change in the aggregate proportions, the Engineer may require a re-evaluation of the AASHTO T 283 test.

c. Polymer-based Liquid Aggregate Treatments.
Polymer-based liquid aggregate treatments shall be approved for each JMF. The approval will be based on the following conditions:

1) The AASHTO T 283 test is required and shall satisfy 80% TSR when compared to the dry strength of specimens prepared with and without the aggregate treatment. The design shall establish the optimum additive rate.

2) A change in the source of asphalt binder or aggregates will require a re-evaluation of the AASHTO T 283 test.

3. Sand for Tack Coats.
Sand shall meet requirements of Section 4109, Gradation No. 1.

4. Fabric Reinforcement.
Fabric reinforcement shall meet requirements of Article 4196.01, D.

F. Equipment
The Contractor shall provide sufficient equipment of the various types required to produce, place, and compact each layer of HMA mixture as specified.

Equipment shall meet requirements of Section 2001 with the following modifications:

1. Plant Calibration.
Each plant scale and metering system shall be calibrated before work on a contract begins. Calibration equipment shall meet the manufacturer's guidelines and Materials I.M. 508. 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. Calibration data shall be available at the plant.

Each aggregate feed shall be calibrated throughout an operating range wide enough to cover the proportion of that material required in the JMF. A new calibration shall be made each time there is a change in size or source of any aggregate being used.

For continuous and drum mixing plants, the asphalt binder metering pump shall be calibrated at the operating temperature and with the outlet under pressure equal to that occurring in normal operations.

Each plant scale and metering system shall be calibrated before work on a contract begins. 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.

Calibration curves shall be available in the plant laboratory. New calibration curves shall be made each time there is a change in size or source of any aggregate being used. On all plants, aggregate samples shall be taken in accordance with Materials I.M. 204 to determine that materials are being proportioned in accordance with the specifications.

2. Paver.
Article 2001.19 shall apply. Spreaders, as 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.
For initial and intermediate rolling, self-propelled, steel tired, pneumatic tired, or vibratory rollers meeting requirements of Article 2001.05, B, C, or F, shall be used. Their weight (mass) or tire pressure may be adjusted when justified by conditions.

For finish rolling, self propelled, steel tired rollers or vibratory rollers in the static mode meeting requirements of Article 2001.05, B or F, shall be used.

4. Scales.
Article 2001.07, B, shall apply to all paving operations regardless of the method of measurement.

2303.03 CONSTRUCTION.

A. Maintenance of the Subgrade and Subbase.
The Contractor is responsible for the maintenance of the completed subgrade and subbase to the required density, true cross section, and smooth condition, prior to and during subsequent construction activities. If rutting or any other damage occurs to the subgrade or subbase as a result of hauling operations, the Contractor shall immediately repair the subgrade and subbase, and such repair will include, if necessary, removal and replacement at the Contractor's expense.

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, representing an increase in cost of repair of damage, if any, caused by such traffic.

B. Preparation of Existing Surfaces.

1. Cleaning.
The existing surface shall be cleaned and prepared in accordance with Article 2212.04, A.

2. Tack Coats.
Tack coats shall be applied when the entire surface area on which the coat is to be applied is free of moisture. They shall not be applied when the temperature on the surface being covered is less than 25EF (-4EC).

The Contractor shall place a tack coat to form a continuous, uniform film on the area to be covered. Unless otherwise directed, the tack coat shall be spread at an undiluted rate of 0.02 to 0.05 gallon per square yard (0.1 to 0.2 L/m^2). The tack coat emulsion may be diluted with water to improve application.

Tack coat shall be adequately cured prior to placement of the HMA to assure bond to the underlying surface and avoid damage of the HMA being placed. If the tack coat surface becomes dirty from weather or traffic, the surface shall be thoroughly cleaned and, if necessary, retacked. A light application of sand cover may also be required, but this is anticipated only for excessive application rates, breakdowns, and short sections remaining at the end of a day's run.

On highways being constructed under traffic, safety and convenience to the public without soiling their vehicles shall be a controlling factor. Tack coat applications shall be limited in length, to minimize inconvenience to the public. They shall be kept within the hot mixture placing work area that is controlled by flaggers at each end, and shall be planned so that they will be covered with hot mixture when the work area is opened to traffic at the end of the day's work.

The vertical face of exposed, longitudinal joints shall be tacked as a separate operation, before the adjoining lift is placed, at a rate from 0.10 to 0.15 gallon per square yard (0.5 to 0.7 L/m^2). The vertical surfaces of all fixtures, curbs, bridges, or cold mixture with which the hot mixture will come in contact shall be lightly painted or sprayed to facilitate a tight joint with the fresh mixture.

3. Fabric Reinforcement.
When fabric reinforcement is required, the locations will be designated in the contract documents. Fabric shall not be placed on a wet or damp surface or when the road surface is less than 50EF (10EC). Fiberglass fabric shall be applied only with an adhesive recommended by the manufacturer. Fabrics with an adhesive backing shall be placed in accordance with the manufacturer's recommendations.

Other fabrics shall be placed with a heavy coat of the asphalt binder grade used in the HMA applied at a rate of 0.20 to 0.25 gallons per square yard (0.9 to 1.1 L/m^2) and at a temperature between 295EF and 315EF (145EC and 160EC).

The fabric reinforcement shall be placed in accordance with the contract documents (full width or individual crack or joint treatment). The fabric shall be placed immediately following the adhesive or asphalt binder placement under the fabric. Placement may be by hand or by a mechanical method specifically designed for this purpose. Precautions shall be taken to avoid wrinkles in the fabric and to insure that air bubbles are removed without breaking the fabric. Wrinkles or folds which cannot be removed by brushing shall be cut and lapped to provide a smooth surface.

Additional adhesive or asphalt binder may be required to produce a tight, bonded surface. When applied full lane width, the minimum transverse and longitudinal lap shall be 12 inches (300 mm).

The Contractor shall avoid application of the tack coat over longitudinally placed fabric. Traffic shall not be allowed over the fabric during placement and during curing of the adhesive material to avoid damage to the fabric. A light application of HMA mix material may be hand sprinkled on the fabric to prevent damage from necessary equipment traffic.

Fabric that is damaged or soiled prior to HMA overlay shall be repaired at no additional cost, when directed by the Engineer. Sanding, at no additional cost, may also be required by the Engineer during this period.

C. Handling, Production, and Delivery.

1. Hot Mix Asphalt Plant Operation.
The plant operation shall comply with the following requirements:

a. Handling Mineral Aggregate and RAP.
The various aggregate products used shall be kept separate, and adequate provisions shall be made to prevent intermingling. Stockpiling and processing shall be handled in a manner that will ensure uniform incorporation of the aggregate into the mix.

The various aggregates shall be separately fed by feeders to the cold elevator in their proper proportions and at a rate to permit correct and uniform temperature control of heating and drying operations.

b. Handling Asphalt Binder.
The asphalt binder shall be brought to a temperature of 260EF to 330EF (125EC to 165EC) before being measured for mixing with the aggregates. The temperature between these limits may be further regulated according to the characteristics of the mixture, method of proportioning, and viscosity of the asphalt binder. Modified asphalt binder should be heated according to the suppliers recommendations.

c. **Handling Anti-stripAgnets.**

1) Hydrated Lime.
The lime shall be accurately proportioned by a method acceptable to the Engineer.

a) Added to a Drum Mixer.
The hydrated lime shall be added at the rate of 0.75% by weight (mass) of the total aggregate (virgin and RAP) for Interstate and Primary projects. The hydrated lime shall be added to a drum mixer by one of the following methods:

(1) Added to the virgin aggregate on the primary feed belt, as a lime water slurry.
(2) Thoroughly mixed with the total combined aggregate if the aggregate contains at least 3% total moisture.

(3) Added to the Type 2 or Type 3 virgin aggregate in a moist condition, and then mixed with the total combined virgin aggregate.

Alternative methods for mixing must be reviewed and approved by the Engineer. Hydrated lime shall not be introduced directly into a drum mixer by blowing or auguring.

b) Added to a Batch Plant.
Hydrated lime shall be added at the rate of 0.5% by weight (mass) of total aggregate (virgin and RAP) for Interstate and Primary projects. It shall be introduced to a batch plant by one of the following methods:

(1) Placed on the recycle belt which leads directly into the weigh hopper.
(2) Added directly into the pugmill.
(3) Added directly into the hot aggregate elevator into the hot aggregate stream.
In any case, the lime must be introduced prior to the start of the dry mix cycle.

c) Added to the Aggregate Stockpile.
Hydrated lime shall be added at a rate established by the AASHTO T 283 test. The hydrated lime shall be added to the source aggregates defined in Article 2303.02, E, 2, thoroughly mixed with sufficient moisture to achieve aggregate coating, and then placed in the stockpile.

When either method b or c above for a batch plant is used, the hydrated lime will be considered part of the JMF.

2) Liquid.
When liquid anti-strip additives are used, the equipment used to store, measure, and blend the additive with the asphalt binder shall comply with the anti-strip supplier's recommended practice. 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 additive, the Contractor assumes the material certification responsibilities of the asphalt binder supplier. The shipping ticket shall report the type and amount of additive and the time of injection. The asphalt supplier shall provide the Contractor and Engineer with the shelf life criteria defining when the anti-strip additive maintains its effectiveness. Binder that has exceeded the shelf life criteria shall not be used.

When polymer-based liquid aggregate treatment is used, the Contractor shall comply with the manufacturer's current recommended specifications and guidelines.

d. Production of Hot Mix Asphalt Mixtures.

The exact proportions of the various materials shall be regulated within the limits specified so as to produce a satisfactory bituminous coating and mixture. The aggregates shall first be mixed dry, then the asphalt binder shall be added. In batch plants, the asphalt binder shall be added in an evenly spread sheet over the full length of the mixer box. In continuous plants, the asphalt binder shall be sprayed evenly into the aggregate by a positive pressure spray within the first 30% of the length of the mixer box. In drum mixing plants, the asphalt binder shall be sprayed evenly into the aggregate by a positive pressure spray. Coating aids may be added, subject to approval of the Engineer.

The mixer shall be operated so that the mixture is of consistently uniform temperature and, as discharged from the mixer, will not vary more than 20EF (11EC). The temperature of the mixtures shall not exceed 330EF (165EC) unless approved by the Engineer.

The rate of production shall not exceed the manufacturer's rated capacity of the mixer and shall provide uniform coating. Dry mixing time for batch mixers shall be not less than 5 seconds. Wet mixing time for batch mixers shall be not less than 25 seconds. For continuous mixers, the mixing time shall be at least 30 seconds.

All handling and manipulation of the hot mixture from the mixer to the final spread on the road shall be controlled so that a uniform composition is maintained and segregation of coarser particles is minimized. The segregation shall be minimized to the extent that it cannot be visibly observed in the compacted surface. The Contractor shall only apply approved release agents to trucks and equipment as specified in Article 2001.01.

The mixture temperature shall be sufficient to allow for the specified compaction and density to be attained. HMA shall not be discharged into the paver hopper when its temperature is less than 245EF (120EC) for a nominal layer thickness of 1 1/2 inches (40 mm) or less and 225EF (110EC) for a nominal layer thickness of more than 1 1/2 inches (40 mm).

Except for an unavoidable delay or breakdown, delivery of hot HMA to any individual spreading unit shall be continuous and uniform and at a rate sufficient to provide as continuous an operation of the spreading unit as practical. The paver hopper shall, at all times, be kept sufficiently full to prevent non-uniform flow of the mixture to the screed.

D. Placement.

The surface of each layer shall be cleaned in accordance with Article 2212.04, A, and, if necessary, retacked to provide bond with the succeeding course. If bumps or other significant irregularities appear or are evident in the intermediate course or other lower course, they are to be corrected before the final lift is placed.

HMA mixtures shall not be placed on a wet or damp surface and shall not be placed when the temperature of the road surface is less than shown in the table below. The Engineer may further limit placement if, in the Engineer's judgment, other conditions are detrimental to quality work. HMA mixtures shall not be placed after November 15, except with approval of the Engineer.

ALL BASE AND INTERMEDIATE COURSE LIFTS OF HMA MIXTURES	
Nominal Thickness - inches (mm)	**Road Surface Temperature, EF (EC)**
1 1/2 (40)	40 (4)
2-3 (60-80)	35 (2)
Over 3 (Over 80)	25 (-4)

ALL SURFACE COURSE LIFTS OF HMA MIXTURES	
Nominal Thickness - inches (mm)	**Road Surface Temperature, EF (EC)**
1 (30)	50 (10)
1 1/2 (40)	45 (7)
2 and greater (50 and greater)	40 (4)

When placing the mixture, the forward speed of the finishing machine shall be at a rate to provide a continuous uniform operation with the least amount of stopping.

A wire or string line shall be used to guide the finishing machine and to maintain alignment. Edge alignment irregularities shall be corrected by hand methods immediately after they occur.

The contract documents will show the total thickness to be placed. Spreading of the mixture shall be at such a rate that, when compacted, the layer(s) will be substantially of the thickness and dimensions required to produce the required thickness. The minimum layer thickness shall be based on the following:

Design Mix Size - inches (mm)	Minimum Lift Thickness - inches (mm)
3/8 (9.5)	1 (25)
1/2 (12.5)	1 1/2 (40)
3/4 (19)	2 (50)
1 (25)	3 (75)

The compacted thickness of the top layer shall not be greater than 3 inches (75 mm). This restriction shall not apply to HMA shoulders. The maximum compacted thickness of lower layers may exceed 4 inches (100 mm) if it is demonstrated that the thicker layers have satisfactory density. The riding characteristics of the thicker layers shall be within reasonably close conformance to that expected from a 3 inch (75 mm) layer. Each layer shall be completed to full width before succeeding layers are placed.

While operating on the road surface, use of kerosene, distillate, other petroleum fractions, or other solvents, for cleaning hand tools or for spraying the paver hopper will not be permitted. Containers of cleaning solution shall not be carried on or near the paver. When a solvent is used, the paver shall not be used for at least 5 hours after this cleaning. The Contractor shall be responsible for collecting and removing all cleaning materials and cleaning residue from the project and plant site. The cleaning material and residue shall become the property of the Contractor.

Whenever practicable, all mixtures shall be spread by a finishing machine. Irregular areas may be spread by hand methods. The hot mixture shall be spread uniformly to the desired depth with hot shovels and rakes. Loads shall not be dumped faster than they can be spread properly. Workers shall not stand on the loose mixture while spreading. After spreading, the hot mixture shall be carefully smoothed to remove all segregated coarse aggregate and rake marks. Rakes and lutes used for hand spreading and smoothing shall be of the type designed for use on HMA mixtures.

Unless stated elsewhere in the contract documents when placing two adjacent lanes, not more than one day of normal plant production shall be paved in a lane before the adjacent lane(s) is paved. The adjacent lane shall be placed to match the first lane during the next day of plant production. The Contractor shall not spread more mixture than can be compacted in the specified working hours of the same working day. At the close of each working day, the roadbed shall be free of any construction equipment.

Prior to opening a lane to traffic, fillets or full width granular shoulders shall be placed in accordance with Article 2121.07, B. The material shall be placed adjacent to and equal in thickness to the resurfacing. Fillet removal shall be incidental to the HMA mixture.

E. Compaction.
Each layer shall be promptly and thoroughly compacted. Mechanical tampers shall be used for areas inaccessible to the rollers.

The overall rolling procedure and compactive effort shall produce a surface free of ridges, marks, or bumps and shall be subject to approval of the Engineer.

There are two classes of compaction, Class I and Class II. Class I compaction is intended for use on Interstate highways, and most Primary and Secondary highways. Class II compaction is intended for paved shoulders, temporary crossovers, onsite detours, and for other situations where Class I is not specified.

For Class I compaction, the roadway density (percent of laboratory density) will be based on the density obtained from the Quality Control Program for that day's mixture.

1. **Class I Compaction.**

   a. **Class IA Compaction.**
   Class IA compaction shall be used for intermediate and surface courses for the traffic lanes of Interstate highways, including Interstate-to-Interstate ramps, and Primary highways as specified. Compaction shall be a minimum of 96% of laboratory density. The average air void level of the roadway density specimens shall not exceed 8.0%.

   b. **Class IB Compaction.**
   Class IB compaction shall be used for all Interstate and Primary bases. Class IB will also be required on Primary travel lanes intermediate and surface courses, and ramps connecting to Interstate and Primary highways when Class IA compaction is not specified. Compaction shall be to a minimum of 95% of laboratory density. The average air void level of the roadway density specimens shall not exceed 8.0%.

   c. **Class IC Compaction.**
   Class IC compaction shall be used for HMA base widening, shoulder resurfacing when specified, traffic lanes of Secondary highways and any other traffic lanes when Class IA and IB are not specified. Compaction shall be a minimum of 94% of laboratory density. The average air void level of the roadway density specimens shall not exceed 8.0%.

   d. **Test Strip Construction for Class IA and IB Compaction.**
   For Class IA compaction at the start of intermediate course placement and for Class IA and Class IB compaction prior to the start of surface course placement, the Contractor shall construct a test strip for the purpose of evaluating properties of the HMA mixtures and for identifying an effective rolling pattern. For multiple lifts using the same mix requiring Class IA compaction, when the thickness of the second lift varies from the first lift by 1 1/2 inches (40 mm) or more, a test strip for the second lift shall be performed. When the contract documents specify both intermediate and surface courses, a surface course test strip shall be placed in lieu of intermediate mix in a section of intermediate course prior to actual surface course placement. The test strip shall be applied to each mixture which has a plan quantity of at least 3000 tons (3000 Mg).

The quantity of HMA mixture subject to Class IA compaction, produced and placed for test strip production, will be limited to 750 tons (750 Mg) for lift thicknesses of 2 inches (50 mm) or less, and 1000 tons (1000 Mg) for lift thicknesses greater than 2 inches (50 mm). After test strip placement, further mixing and laydown operations will be suspended until the laboratory test results of the plant produced mixture and core densities are available.

Only one test strip will be allowed for each mixture. At the direction of the Engineer, additional test strips may be required if a complying HMA mixture or rolling pattern was not established.

Procedures and documentation to be followed during construction of the test strip shall allow the Engineer and the Contractor to confirm mixture design properties and effectiveness of compaction procedures.

The test strip production control shall meet the requirements of Article 2303.04, B, 2. The number of density core samples obtained for the test strip will be increased by one and the low core result will not be used in the Quality Index (Q.I.) density formula for payment for the test strip quantity.

2. Class II Compaction.
For all rollers, the initial contact with the hot mixture shall be made by the power driven wheels or roll.

The initial rolling shall be done at a temperature so the mixture will compact without excessive distortion. Except on longitudinal joints and super-elevated curves, rolling with the initial roller shall begin at the outer edges of the pavement, and each successive pass shall progress inward toward the center line. Each reverse trip shall lap all but 4 to 6 inches (100 to 150 mm) of the previous track. When reversing direction, the initial roller shall stop at an angle with the longitudinal direction.

Following the initial rolling, the layer shall be given an intermediate rolling with a pneumatic tired roller before the temperature falls below 225EF (110EC). The intermediate roller shall cover the entire area not less than six times. A finish, steel tired roller shall be used to smooth out all marks and roughness in the surface.

Mechanical tampers or other approved compaction methods shall be used for areas inaccessible to the rollers.

F. Joints and Runouts.
Longitudinal joints for courses on resurfacing projects shall be constructed directly above the longitudinal joint in the existing pavement. The offset distance between longitudinal joints in succeeding courses of full depth HMA paving shall be not more than 3 inches (75 mm). The spreading of hot mixtures along longitudinal joints shall be adjusted to secure complete joint closure and full compression of the mixture with a smooth surface and joint after compaction.

Transverse construction joints in succeeding courses shall be separated by not less than 6 feet (1.6 m). The use of wood or metal headers to form the edge of the joint during rolling of the fresh mixture will not be permitted. The header shall be sawed to a straight line at right angles to the center line so that a full thickness vertical edge will be provided before continuing paving. The Contractor shall provide a 10 foot (3 m) straightedge for checking transverse construction joints for smoothness. Variations in the surface at transverse joints, as indicated by the straightedge, shall be corrected by hand methods before compaction.

When a transverse construction joint is open to traffic, a temporary runout of 10 feet (3 m) in length per 1 inch (25 mm) of lift thickness shall be installed. Suitable paper or burlap should be used under the taper to prevent adhesion. Sand, dirt, or wood shall not be used for this purpose.

When required to end paving for winter shutdown, runouts shall be located adjacent to each other. A winter shutdown runout of 25 feet (8 m) in length per 1 inch (25 mm) of lift thickness shall be installed.

For temporary runouts open to traffic for periods greater than 4 weeks and winter shutdown runouts, the Contractor may reduce the amount of top size aggregate in the transition taper. The temporary runouts and winter shutdown runouts shall be removed before commencement of paving. Runout removal shall be incidental to the HMA mixture.

G. Miscellaneous Operations.

1. Leveling and Strengthening Courses.
The contract documents will show the thickness of the courses to be placed. Strengthening and leveling courses will be placed as indicated in the contract documents. These courses shall be of the same mixture specified for the base or intermediate course.

When the width of any strengthening or leveling layer is 8 feet (2.4 m) or more, the layer shall be spread by a finishing machine.

Leveling courses shall be compacted using Class II compaction procedures, except all passes shall be made with a pneumatic roller.

2. Wedge Courses.
Wedge courses used to secure desired super-elevation of curves shall be constructed of the base or intermediate mixture, and when possible, shall be spread by a finishing machine. In placing wedge course, the maximum thickness of individual layers, when compacted, shall not exceed 3 inches (75 mm), and care shall be used to avoid crushing the coarse aggregate. Wedge courses shall be placed to the full width of pavement.

On curves which require the placement of wedge courses, the Contractor will be required to stage the shoulder construction on the super elevated curves. After completion of each day's wedge placement operations and prior to suspending construction activities for that day, a full width shoulder shall be constructed on the high side up to the elevation of the completed wedge course. All necessary staging of shoulder construction will be considered incidental to shoulder construction.

3. Fixtures in the Pavement Surface.
All utility accesses, intakes, or other fixtures encountered within the area to be covered by HMA shall be adjusted to conform to the final adjacent finished surface. Unless otherwise indicated in the plans, the Contractor shall have the option of adjusting fixtures between placement of the surface course and the layer preceding the surface course, or adjusting the fixture after placement of the surface course using a composite patch or PCC patch.

PCC and HMA patch material shall conform to the requirements of Section 2529. Patches shall be of sufficient size to accommodate the structure being adjusted.

Patches shall be square in shape and oriented diagonally to the direction of traffic flow. Elevation of the adjusted fixture and patch shall not be higher than or more than 1/4 inch (6 mm) below that of the surrounding pavement surface.

4. Fillets for Intersecting Roads and Driveways.
When fillets are designated in the contract documents for driveways to homesteads and commercial establishments and at intersecting roads, the surface adjacent to the pavement being surfaced shall be shaped, cleaned of loose material, and tack coated. On this coated surface, the hot mixture shall be placed and compacted in layers equal to the adjacent layer and extended from the edge of pavement as shown in the plans. Fillets at intersecting roads shall be placed and compacted at the same time as the adjacent layer. Entrance fillets that are 8 feet (2.4 m) or wider

may be placed as a separate operation. Paving of fillets 8 feet (2.4 m) or more in width shall be with a self propelled finishing machine described in Article 2001.19. The Engineer may approve other equipment for placement of fillets, based on a demonstration of satisfactory results.

5. Stop Sign Rumble Strips.
If the plans include the bid item Rumble Strip Panel (In Full Depth Patch), Section 2529 shall apply. 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.

6. Paved HMA Shoulders.
Compaction of paved HMA shoulders shall be accomplished using one of the following methods:

a. Class II compaction (Article 2303.03, E, 2),

b. Rolling pattern established during the first day of shoulder placement to achieve Class 1C compaction (Article 2303.03, E, 1), or

c. Same rolling pattern established for mainline lanes, as determined by density coring.

Shoulder area will not be included in calculations for density price adjustment on mainline. Shoulder area may be subject to price adjustment for failure to adhere to the established roller pattern.

2303.04 QUALITY CONTROL PROGRAM.

A. Mix Design – Job Mix Formula.

The JMF for each mixture shall be the responsibility of the Contractor.

The Contractor shall submit completed JMF using the computer format of Form 956 to the materials laboratory designated by the Contracting Authority for approval. The Contractor shall submit supporting documentation demonstrating the design process was followed and how the recommended JMF was determined, including an economic evaluation when required. Documentation shall include trial and final proposed aggregate proportions (Form 955) and corresponding gyratory data. The Contractor shall also submit sufficient loose mixture and individual material samples for approval of the design.

The JMF shall be prepared by personnel who are Iowa DOT certified in bituminous mix design.

If the JMF is not satisfactory, the Contractor shall submit another JMF for review. An approved JMF will be required prior to beginning plant production. The Contractor will be charged $1000 for each JMF approval requested and performed which exceeds two per mix size, type, and proposal item on any individual project or group of tied projects.

B. Plant Production.

The Contractor shall perform the sampling and testing to provide the quality control of the mixture during plant production. Certified Plant Inspection as described in Section 2521 will be required on all HMA plant production. All personnel performing production quality control testing shall be certified by the Department.

Easy and safe access shall be provided to the location in the plant where samples are to be taken.

A "significant mix change" is defined as a single occurrence of an aggregate interchange of greater than 5%, a single occurrence of an asphalt content change greater than 0.2%, or any deletion or introduction of a new material into the mix.

1. Sampling and Testing.
Asphalt binder shall be sampled and tested to verify the quality of the binder grade. Asphalt binder samples shall be taken, at random times, as directed and witnessed by the Engineer in accordance with Materials I.M. 204.

Aggregate gradation control shall be based on cold feed gradation.

Aggregate samples shall be taken, at random times, as directed and witnessed by the Engineer in accordance with Materials I.M. 204 and secured in accordance with I.M. 511 to determine that materials are being proportioned in accordance with the specifications.

The hot HMA mixture shall be sampled, at random locations, as directed and witnessed by the engineer, in accordance with Materials I.M. 322 and secured in accordance with Materials I.M. 511.

The Contractor shall provide the Engineer assistance with material sampling for verification testing. When the Engineer notifies the Contractor that a sample shall be taken, the Contractor shall obtain the sample within 15 minutes.

Each day's production of a mix design shall be considered a lot. When the anticipated quantity for the day is 2000 tons (2000 Mg) or more, that day's production shall be divided into four sublots, the first sublot of each day shall be the first 500 tons (500 Mg) produced. The remaining anticipated quantity for the day shall be divided into three sublots of equal size.

When the anticipated mix design quantity for the day is less than 2000 tons (2000 Mg), the first daily sublot shall be the first 500 tons (500 Mg) produced. Additional daily sublots of 750 tons (750 Mg) each will be established for mix production exceeding the first 500 tons (500 Mg).

The maximum number of paired hot HMA mixture samples required for acceptance of a lot will not exceed four.

Paired samples shall not be taken from the first 100 tons (100 Mg) of mix produced each day or the first 100 tons (100 Mg) of mix following a significant mix change.

The Contractor shall test the quality control sample of each production paired sample as follows:

Two gyratory specimens shall be prepared and compacted in accordance with Materials I.M. 325G and the results averaged to determine sample results.

Density shall be determined for each specimen in accordance with Materials I.M. 321.

The Contractor's field quality control laboratory compaction shall be used for field density control. The laboratory density for field control will be the bulk specific gravity of compacted mixture (G_{mb}) at N_{design}. Bulk specific gravity at N_{design} will be determined by compacting specimens to N_{max} and back calculating the bulk specific gravity at N_{design}.

The Theoretical Maximum Specific Gravity of the uncompacted mixture shall be determined in accordance with Materials I.M. 350 or other test methods recognized by AASHTO or ASTM.

The laboratory air voids shall be determined in accordance with Materials I.M. 501.

When liquid anti-strip additives are used, the Contractor shall satisfy one of the following methods to regulate the quantity of additive.

a. The Contractor shall present Certification that the equipment used to measure and blend the liquid anti-strip additive meets the anti-strip supplier's recommended practice, that the equipment is directly tied to the asphalt binder supply system, and that the equipment has been calibrated to the equipment manufacturer's guidelines.

b. The Contractor shall test the binder to measure the quantity of liquid anti-strip additive in the binder every 5000 tons (5000 Mg) of HMA production. The supplier's test method shall be approved by the Engineer prior to use of the test.

c. The Contractor shall run AASHTO T 283 during production. If the Contractor is unable to certify or test for the presence and quality, the Contractor shall run AASHTO T 283 each 10,000 tons (10,000 Mg) of production to measure the effectiveness of the additive. The test results shall satisfy 80% TSR when compared to the dry strength of specimens prepared with asphalt binder containing the anti-strip additive.

2. Production Control.
After the JMF is established, the combined aggregate furnished for the project, the quantity of asphalt binder and laboratory air voids should consistently conform to the JMF, as target values, and shall be controlled within the production tolerances given in Table 2. Plant production must be controlled such that the plant produced HMA mixture will meet mixture design criteria for Air Voids and VMA at N_{design} gyrations of the gyratory compactor within the test tolerances give in the table. The slope of the gyratory 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.

The gyratory mix design gradation control points for the size mixture designated in the project plans will not apply to plant production control.

Table 2 – Production Tolerances

Measured Characteristic	Target value	Specification Tolerance
Cold feed gradation No. 4 (4.75 mm) and larger sieves	by JMF	" 7.0
Cold feed gradation No. 8 (2.36 mm)	by JMF	" 5.0
Cold feed gradation No. 30 (600 Fm)	by JMF	" 4.0
Cold feed gradation No. 200 (75 Fm)	by JMF	" 2.0 [1]
Daily asphalt binder content	by JMF	" 0.3
Field laboratory air voids	4.0 [2]	-0.5 / +1.0 [3]
VMA [4]	by JMF	" 1.0 [5]
(1) Based on single test unless otherwise noted.		
(2) The filler/bitumen ratio of the plant produced mixture will be maintained between 0.6 and 1.4.		
(3) Unless otherwise specified		
(4) Based on the moving average of four test values		
(5) Restricted to an asphalt film thickness as specified for the level of HMA mixture		
(6) Based on the daily lot average		

The Contractor shall strive for the target value of the percent air void and asphalt binder by adjusting gradation and asphalt binder content.

The Contractor shall produce a mixture of uniform composition conforming to the JMF. If, during production, the Contractor determines from quality control testing that adjustments are necessary to the JMF to achieve the specified properties, adjustments to the JMF target gradation and asphalt binder content values may be made.

Adjustments to the JMF aggregate proportions and asphalt binder content shall be made as a result of the interactive process between the Contractor and the Engineer. The Contractor's adjustment recommendations shall prevail, provided all specifications and established mix design criteria are being met for plant production.

The voids in the mineral aggregate (VMA) and estimated film thickness shall be measured for specification compliance every day of HMA production.

Quality control charts in accordance with Materials I.M. 511 shall be available and kept current showing both individual test results and moving average values. Moving averages shall be based on four consecutive test results. Moving averages may only restart in the event of a mandatory plant shutdown for failure to maintain the average within the production tolerance. Control charts shall include a target value and specification tolerances.

Laboratory voids for individual tests shall be calculated according to Materials I.M. 501, using the individual density and individual maximum specific gravity determined for each sample. The moving average of laboratory voids shall be the average of the last four individual laboratory voids.

The Contractor shall monitor the test results and to make mix adjustments, when appropriate, to keep the mixture near the target values. The Contractor shall notify the Engineer whenever the process approaches a specification tolerance limit. One moving average point for laboratory air voids outside the specification tolerance limit shall be cause to cease operations. The Contractor shall assume the responsibility to cease operations, including not incorporating produced material which has not been placed. The process shall not be started again until the Contractor notifies the Engineer of the corrective action proposed.

C. Construction.

1. Density.

Density samples shall be taken from the compacted mixture and tested not later than the next working day following placement and compaction.

A lot shall be considered as one layer of one mixture 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.

The Engineer may waive sampling for density provided compaction has been thorough and effective in the following situations:

- **a.** when the day's operation is not more than 2500 square yards (2500 m^2),
- **b.** when the day's operation is not more than 500 tons (500 Mg),
- **c.** when the mixture is being placed in irregular areas, or
- **d.** when placing wedge or strengthening courses.

Density samples shall be taken and will be tested for each lot in accordance with Materials I.M. 204. The length laid in each lot will be divided into approximately equal sublots and one sample shall be obtained at a random location, as directed and witnessed by the Engineer in each sublot.

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. Samples shall not be taken less than 1 foot (300 mm) from the edge of a given pass of the placing equipment, from run-outs or from day's work joints or structures.

The quality index for density of each lot shall be determined by the following formula:

$$QI_{DENSITY} = \frac{\left(\text{Average } G_{mb}\right)_{\text{FIELD LOT}} - \left(\left(\%\text{ Density}\right)_{\text{SPECIFIED}} \times \left(\text{Average } G_{mb}\right)_{\text{LAB LOT}}\right)}{\left(\text{Standard Deviation } G_{mb}\right)_{\text{FIELD LOT}}}$$

where $QI_{Density}$ = Quality Index for density
G_{mb} = bulk Specific Gravity of the mixture

When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective.

If one of the density test values from a lot is an outlier, identified in accordance with the procedure described in Materials I.M. 501, the outlier value shall not be used to determine the quality index. The quality index shall be determined using the remaining density test values.

If only one laboratory density value is obtained that day, combine that value with the next day's test results to evaluate both days' production. If two or more laboratory density values are obtained that day, then the average of those tests alone shall be used. If a significant mix change has been made, only the appropriate laboratory density values should be used with the corresponding density cores.

2. Thickness.
The thickness of the completed course will be measured to the nearest 1/8 inch (3 mm), exclusive of seal coat, by measurement of cores. All areas of uniform and similar thickness and width for the project will be divided into lots.

The frequency specified for taking density samples from the surface lift will be used when measuring for completed thickness. However, samples that may not be tested for density because they are less than 70% of the intended thickness shall be used for thickness, and in these particular instances, the additional samples of sufficient thickness that are used for density tests shall not be measured for thickness. Thickness samples will be taken full depth of the completed course and after measurement, the density samples for the top layer shall be removed by the Contractor from the core. If any of the measurements for a lot is less than the designated thickness, the quality index for thickness of that lot will be determined by the following formula:

(English)

$$Q.I._{Thickness} = \frac{AvgerageThickness_{Measured} - (Thickness_{Plan} - 0.5)}{Max.Thickness_{Measured} - MinimumThickness_{Measured}}$$

(Metric)

$$Q.I._{Thickness} = \frac{AverageThickness_{Measured}(Thickness_{Plan} - 12.7)}{Max.Thickness_{Measured} = MinimumThickness_{Measured}}$$

When the day's operation is 2500 square yards (2500 m^2) or less, or the mixture is being placed in irregular areas or next to structures, the Engineer may waive sampling for thickness provided there is reasonable assurance that the pavement conforms to the required thickness. When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective.

3. Smoothness
Smoothness of the surface course shall be in accordance with Section 2316.

D. Sampling and Testing.

The Contractor shall maintain and calibrate the quality control testing equipment with prescribed procedures. Sampling and testing shall conform to 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 lab shall be qualified.

All quality control samples and field lab gyratory specimens used for acceptance shall be identified, stored, and retained by the contractor until the lot is accepted. The Contracting Authority will prescribe the method of securing the identity and integrity of the verification samples in accordance with Materials I.M. 511. All verification samples shall be stored by the contractor for the Contracting Authority until delivery to the Contracting Authority's lab.

All samples shall be identified by a system approved by the Engineer.

1. Individual Materials and Loose Mixture.

All samples of asphalt binder, aggregate, and tack coat material, shall be identified, secured, and promptly delivered to the appropriate laboratory, as designated by the Engineer.

Paired samples of loose HMA mixture shall be taken in accordance with Materials I.M. 322, each box of the pair weighing at least 30 pounds (14 kg). The Contractor's quality control tests for mixture properties shall be conducted on representative portions of the mix, from the quality control sample of each sublot.

Samples shall be split for specimen preparation in accordance with Materials I.M. 357.

Paired sampling may also be accomplished by taking a bulk sample and immediately splitting the sample in accordance with Materials I.M. 322 on the grade.

All test results and calculations shall be recorded and documented on data sheets approved by the Contracting Authority. Specific test results shall be recorded on the Daily Plant Report provided by the Contracting Authority. The Daily Plant Report shall also include a description of quality control actions taken (adjustment of cold feed percentages, changes in JMF, etc.). The Contractor shall FAX, or deliver by other method approved by the Engineer, the Daily Plant Report to the Engineer and designated laboratory daily. A copy of the electronic file containing project information generated during the progress of the work shall be furnished to the Engineer at project completion.

When sampling for AASHTO T 283, the Contractor shall obtain a 50 pound (25 kg) sample in accordance with Materials I.M. 322. The Engineer will select, at random, the sample location. The Contractor shall split the sample and deliver half to the Central Materials Laboratory.

2. Compacted Pavement Cores.

The Contractor shall cut and trim samples under the direction of and witnessed by the Engineer for tests of density, thickness, or composition, by sawing with a power driven masonry saw or by drilling a minimum 4 inch nominal diameter core. The surfaces shall be restored by the Contractor the same day. The core holes shall be dried, filled with the same type of material, and the material properly compacted. Pavement core samples will be identified, taken possession of by the Engineer, and delivered to the Contractor's quality control field laboratory.

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.

The compacted HMA pavement will be tested in a timely manner by the engineer's personnel who are Iowa DOT Certified to perform the test.

The minimum number of cores taken shall be in accordance with Materials I.M. 204, Appendix F.

The core locations will be determined by the Engineer.

The cores shall be prepared and tested in accordance with Materials I.M. 320, 321, and 337.

3. Verification, and Independent Assurance Testing.
The Contractor's quality control test results from paired samples 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.

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 in accordance with Materials I.M. 511.

The Engineer will select, at random, one or more of the daily hot mix 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.

The Engineer will test each lot of cores. These will be tested at the Contractor's field quality control laboratory. Cores may also be tested by the Contractor, but the Contractor's test results will not be used for material acceptance.

All personnel and laboratories performing tests used in the acceptance of material shall participate in the statewide Independent Assurance Program in accordance with Materials I.M. 208.

2303.05 METHOD OF MEASUREMENT.

A. Hot Mix Asphalt Mixture.

1. Measurement by Weight (Mass).
When measurement is by weight (mass), the quantity of Hot Mix Asphalt Mixture of the type specified will be expressed in tons (megagrams) and determined from the weight (mass) of individual loads, including fillets, measured to the nearest 0.01 tons (0.01 Mg).

Loads may be weighed in trucks, weigh hoppers, or from the weight (mass) from batch plants computed by count of batches in each truck and batch weight (mass). Article 2001.07 applies. The weights (mass) of various loads shall be segregated into the quantities for each pay item.

2. Measurement by Area.
When payment is based on square yards (square meters), the quantity of Hot Mix Asphalt Mixture of the type specified, will be the quantity shown in the contract documents to the nearest 0.1 square yard (0.1 m^2).

When constructing shoulders on a basis of payment of square yards (square meters), inspection of the profile and elevation will be based on the completed work relative to the pavement edge; the Contractor shall be responsible for the profile and elevation of the subgrade and for thickness.

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, or when placed as a separate operation, from scale tickets. If the substitute mixture placed on the shoulder is for an intermediate course fillet only, the quantity in the fillet shall be included for payment in the quantity placed in the adjacent intermediate course.

Removal of fillets shall be incidental to the contract unit price for the mixture.

B. Asphalt Binder.
The amount of asphalt binder used from batch plants, continuous plants, or drum mixing plants, shall be by stick measurement in the Contractor's storage tank or by in-line flow meter reading, in accordance with Article 2001.07, B. The asphalt binder quantity added to the storage tank shall be computed from a supplier certified transport ticket accompanying each load. The quantity of asphalt binder not used in the work will be deducted.

When the quantity of asphalt binder in a batch is measured by weight (mass) and is separately identified by automatic or semi-automatic printout, the Engineer may compute from this printout the quantity of asphalt binder used.

By mutual agreement, this method may be modified when small quantities or intermittent operations are involved.

The Engineer will calculate and exclude the quantity of asphalt binder used in mixtures in excess of the tolerance specified in Article 2303.04, B, 2.

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.
The quantity of asphalt binder in RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP, based on an assumed asphalt binder content of 5% of the dry RAP weight (mass).

The quantity of asphalt binder in RAP, which is incorporated into the mix, will be included in the quantity of asphalt binder used.

The quantity of asphalt binder in unclassified RAP will not be measured for payment.

D. Anti-strip Agent.
Hydrated lime incorporated in HMA mixtures will not be measured separately. The quantity will be based on tons (megagrams) of HMA mixture with anti-strip agent added.

E. Tack Coat.
Tack Coat shall be considered incidental to HMA, and will not be measured separately.

F. Fabric Reinforcement.
The quantity of Fabric Reinforcement, in square yards (square meters), to the nearest 0.1 square yard (0.1 m^2), will be the quantity shown in the contract documents.

G. Adjustment of Fixtures.
The Engineer will count the number of fixtures adjusted to the finished grade.

H. Hot Mix Asphalt Pavement Samples.
HMA Pavement Samples of any finished pavement furnished according to Article 2303.04 D, or required elsewhere in the contract documents, will not be individually counted for payment.

2303.06 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 shall not be paid for separately, but shall be 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. Any pollution control testing shall be at the Contractor's expense. The

installation of temporary Stop Sign Rumble Strips will not be paid for separately, but shall be considered incidental to the price bid for the HMA course for which it is applied.

A. Hot Mix Asphalt Mixture.
The Contractor will be paid the contract unit price for Hot Mix Asphalt Mixture of the type specified per ton (megagram) or square yard (square meter).

Surface course test strip placement in an intermediate lift will be paid for at the contract unit price for Hot Mix Asphalt Mixture, Surface Course, per ton (megagram).

Payment will be adjusted by the following percentages for the quality index for density determined for the lot:

Quality Index (Density) 7 Samples [1]	Percent of Full Payment
greater than 0.72	100
0.40 to 0.72	95
0.00 to 0.39	85
Less than 0.00	75 Maximum

[1] Or 6 samples and 1 outlier. Only one outlier will be allowed.

When the basis of payment is by area, payment will be further adjusted by the appropriate percentage according to the quality index for thickness determined for that lot and the following table:

Quality Index (Thickness) 7 Samples	Percent of Payment (Previously Adjusted for Density)
greater than 0.34	100
0.14 to 0.34	95
0.00 to 0.13	85
Less than 0.00	75 Maximum

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 paid for according to Article 1105.04.

When liquid anti-strip agent is used and production quality control testing for AASHTO T 283 is required, the payment for HMA will be adjusted according to the following table:

Percent TSR	Percent of Full
Greater than 79	100
79 to 70	90
Less than 70	75 maximum

B. Asphalt Binder.
For the number of tons (megagrams) of asphalt binder used in the work, measured as provided in Article 2303.05, B, the Contractor will be paid the contract unit price per ton (megagram).

Payment for asphalt binder will be for all new asphalt binder and the asphalt binder in RAP salvaged from the project, the Contracting Authority owned stockpile, or certified Contractor owned stockpiles, which is incorporated in the mixture.

When scarification of asphalt material is required and is paid for on the basis of square yards (square meters) and no other use of the RAP is specified, the RAP shall become the property of the Contractor, and the Contractor shall not be charged for the asphalt binder in that material.

When the basis of payment for HMA is in square yards (square meters), compensation for asphalt binder will be included in the contract unit price per square yard (square meter).

C. Recycled Asphalt Pavement.
RAP which is 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.
When anti-strip agent is required according to Article 2303.02, E, 2, the incorporation of the anti-strip agent into the HMA mixture will be considered as extra work ordered by the Engineer. Payment will be made at the rate of $1.00 per ton (megagram) of HMA mixture in which the anti-strip agent is incorporated. This payment will be full compensation for designing, adding, and testing for anti-strip agent.

E. Fabric Reinforcement.
The Contractor will be paid the contract unit price for Fabric Reinforcement per square yard (square meter). This payment shall be full compensation for furnishing all materials, labor, and equipment necessary for installing the fabric as required, including the adhesive or heavy tack coat of asphalt binder used as the adhesive.

F. Adjustment of Fixtures.
For the number of fixtures adjusted to the finished grade line, the Contractor will be paid the contract unit price for each. If the contract contains no price for adjustment of fixtures, this work will be paid for as provided in Article 1109.03, B.

G. Hot Mix Asphalt Pavement Samples.
For cutting HMA pavement samples to determine density or thickness according to the specifications, when either of these is the responsibility of the Contractor, and elsewhere when required by the contract documents, the Contractor will be paid the lump sum contract price. This lump sum payment shall be full compensation for furnishing all such samples for all courses or items of work, and for delivery of samples as specified in Article 2303.04, D.

Section 2304. Detour Pavement

2304.01 DESCRIPTION.
This work shall consist of furnishing and placing a temporary or permanent hard surface composed of PCC or HMA to carry traffic during construction of permanent pavement.

2304.02 MATERIALS.
The Contractor has the option of using PCC or HMA for the detour pavement. The option used shall meet the following requirements.

A. PCC.
The PCC option shall meet the requirements of Section 2301 for Class A PCC Pavement. Class 2 durability coarse aggregate, or better, as defined in Article 4115.04, shall be used.

For median crossovers, the PCC option shall meet the requirements of Section 2301 for Class C PCC Pavement. Class 3 durability coarse aggregate, or better, as defined in Article 4115.04, shall be used.

SS-01042
(Replaces SS-01014)

Iowa Department of Transportation

SUPPLEMENTAL SPECIFICATIONS

FOR

HOT MIX ASPHALT

(GYRATORY MIX DESIGN FOR LOCAL SYSTEMS)

Effective Date
October 17, 2006

THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SUPPLEMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

01042.01 DESCRIPTION.

This work shall consist of mixture design, production, placement, and compaction of hot mix asphalt (HMA) mixture using proper quality control practices for the construction of surface, intermediate, or base course on a prepared subbase, base, or pavement, to the proper dimensions specified in the contract documents.

The surface course is the upper lift for a wearing surface of a designated thickness. The intermediate course is the next lower lift or lifts of a designated thickness. Leveling, strengthening, and wedge courses shall be of the intermediate course mixture. The base course is the lift or lifts placed on a prepared subgrade or subbase.

The Contractor shall be responsible for all aspects of the project, provide quality control management and testing, and maintain the quality characteristics specified.

Quality Management - Asphalt (QM-A) shall apply to contracts with HMA quantities of 5000 tons (5000 Mg) or greater. The Contractor shall meet the requirements of Section 2521 of the Standard Specifications and Materials I.M. 510 and 511.

On contracts with less than 5000 tons (5000 Mg), the Contractor has the option to perform mix design and quality control. If the Contractor does not exercise this option the Engineer will be responsible for the mix design and quality control utilizing the Supplemental Specification for Hot Mix Asphalt (Marshall Mix Design). This does not change the mix requirements from gyratory to Marshall. The Supplemental Specification for Hot Mix Asphalt (Marshall Mix Design) is available is available from:

Office of Contracts
Iowa Department of Transportation
800 Lincoln Way
Ames, IA 50010
Phone (515) 239-1414

Terminology in this Supplemental Specification was changed from previous Specifications as follows:

- “hot mix asphalt” was “asphalt cement concrete”
- “asphalt binder” was “asphalt cement”
- “intermediate course” was “binder course”
- “gyratory mix design” was “Superpave mix design”
- “ESAL level and mix size” was “mix type and class”

01042.02 MATERIALS AND EQUIPMENT.

Materials used in these mixtures shall meet the following requirements:

A. Asphalt Binder.
The Performance Graded asphalt binder, PG XX –XX, will be specified in the contract documents to meet the climate, traffic, and pavement conditions. The asphalt binder shall meet the requirements in AASHTO MP1.

B. Aggregates.

1. Individual Aggregates.
The aggregate type shown in Materials I.M. 510, Appendix A, shall be used unless specified in the plans.

Virgin mineral aggregate shall meet the following requirements:

VIRGIN MINERAL AGGREGATES

Mixture	Aggregate Type	Aggregate Requirement
Base	B	Section 4126
Intermediate and Surface	B	Section 4126
Intermediate and Surface	A	Section 4127

When the frictional classification of the aggregate is specified, the contract documents will specify the amount, position in the structure, locations, and types specified. The aggregate shall be furnished from a source identified in Materials I.M. T-203 as having the specified frictional classification.

2. Blended Aggregates.
It is the Contractor's option to design mixes outside the “restricted zone.”

When the size of mixture is not specified, 1/2 inch (12.5 mm) mixture shall be used.

The blended aggregates shall meet the following combined aggregate requirements.

Aggregate Gradation Control Points								
	Mix Size - Control Points (% passing)							
	1 inch (25 mm)		3/4 inch (19 mm)		1/2 inch (12.5 mm)		3/8 inch (9.5 mm)	
Sieve Size	**min.**	**max.**	**min.**	**max.**	**min.**	**max.**	**min.**	**max.**
1 1/2 inch (37.5 mm)	100							
1 inch (25 mm)	90	100	100					
3/4 inch (19 mm)		90	90	100	100			
1/2 inch (12.5 mm)				90	90	100	100	
3/8 inch (9.5 mm)						90	90	100
No. 4 (4.75 mm)								90
No. 8 (2.36 mm)	19	45	23	49	28	58	32	67
No. 200 (75 μm)	1	7	2	8	2	10	2	10

Consensus Properties					
Design ESALs (millions)	**Layer**	**Minimum Percent Crushed**	**Fine aggr Angularity**	**Sand Equivalent**	**Flat & Elongated**
< 0.1	all	(1)	---	40	---
0.1 – 0.3	surface intermediate base	(1)	---	40	---
0.3 – 1.0	surface intermediate base	(1)	40 40 ---	40	10

(1) – The minimum percent crushed shown in Materials I.M. 510, Appendix A, shall be used unless specified in the plans.

C. Recycled Asphalt Pavement.
RAP shall be from a source designated in the contract documents, a certified stockpile, or unclassified reclaimed asphalt pavement furnished by the Contractor subject to the following limitations:

1. Designated RAP.
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. The Contractor is responsible for salvaging this material unless otherwise specified in the contract documents. The RAP not used shall be incorporated into other parts of the project or placed in active stockpiles as directed in the contract documents.

The Contracting Authority will test samples of this material. For mix design purposes, the amount of asphalt binder in the RAP will be based on extraction tests. The Contractor shall designate the exact proportions of RAP material in the hot mix within the allowable range.

When the work is completed, the Contractor shall return unused material to the stockpile or other designated location, rebuild the stockpile, and restore the area, in accordance with Article 1104.08 of the Standard Specifications.

Test information, if known, will be included in the contract documents.

2. Certified RAP.
The RAP must be from a known source and of the proper quality for the intended use, with no material added from other sources during the time in stockpile. The Contractor must certify to this before use. RAP from not more than two known sources at a time will be allowed.

Certified RAP may be used in the base and intermediate course of mixes for which the RAP aggregate qualifies. RAP may also be used in surface courses when authorized by the Engineer. Not more than 30% of the asphalt binder in a final surface course mixture shall come from the RAP.

A certified RAP stockpile shall be sealed or protected in accordance with Materials I.M. 505.

3. Unclassified RAP.
Up to 10% of unclassified RAP may be incorporated into HMA intermediate mixes for under 3,000,000 ESALs and all base mixes with the following safeguards:

a. Unclassified RAP shall not be used in surface courses.

b. Unclassified RAP shall not be used in intermediate or base mixtures containing designated or certified RAP.

c. The Engineer must inspect the unclassified RAP stockpile visually for uniformity. Unclassified RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or environmentally restricted materials shall not be used, unless approved by the Engineer. If foreign material is discovered in any unclassified stockpile, the Engineer may stop the continued use of the pile.

d. Representative samples will be taken by the Engineer. These samples are to be tested for gradation and asphalt content.

e. No credit will be given for crushed particles.

f. Stockpiles, when used, shall be worked in such a manner that the materials removed are representative of a cross section of the pile.

D. Hot Mix Asphalt Mixture.
The job mix formula (JMF) is the percentage of each material, including the asphalt binder, to be used in the HMA mixture. The JMF gradation shall be within the control points specified for the particular mixture designated and shall establish a single percentage of aggregate passing each required sieve size.

If the asphalt binder demand for the combination of aggregates submitted for an acceptable mix design exceeds the basic asphalt binder content by more than 0.75%, the mix design will include an economic evaluation prepared by the Contractor. This evaluation will be based on past job mix history, possible aggregate proportion changes, and aggregate availability and haul costs for any changes or substitutions considered.

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. The following values, based on mixture size and aggregate type, shall apply.

BASIC ASPHALT BINDER CONTENT (%)

Mixture Size	Aggregate Type	1 inch (25 mm)	3/4 inch (19 mm)	1/2 inch (12.5 mm)	3/8 inch (9.5 mm)
Intermediate and Surface	A	4.75	5.50	6.00	6.00
Intermediate and Surface	B	5.25	5.75	6.00	6.25
Base	B	5.25	6.00	6.00	6.25

The Engineer may approve the substitution of any mixture which meets requirements for a higher mixture than specified in the contract documents at no additional cost to the Contracting Authority.

The Contractor shall prepare gyratory HMA mixture designs for all base, intermediate, and surface mixtures. The gyratory design procedure shall follow the procedure in Materials I.M. 510. The gyratory mixture designs submitted shall comply with the following criteria.

DESIGN ESALs (million)	LAYER	COMPACTION LEVELS			REQUIRED DENSITY (% of Gmm)			VFA[1]	FILM THICK (μm)	F:B
		N_{ini}	N_{des}	N_{max}	N_{ini} (max)	N_{des} (target) [air voids]	N_{max} (max)			
< 0.1	All	7	68	104	92.5	97.0 [3.0]	98.5	75-85	8-13	0.6-1.4
0.1 – 0.3	Surface	7	68	104	92.0	96.5 [3.5]	98.0	70-80	8-13	0.6-1.4
	Intermediate				92.0	96.5 [3.5]	98.0	70-80		
	Base				92.5	97.0 [3.0]	98.5	75-85		
0.3 – 1.0	Surface	7	76	117	90.5	96.0 [4.0]	98.0	65-78	8-15	0.6-1.4
	Intermediate				90.5	96.0 [4.0]		65-78		
	base	7	68	104	92.0	96.5 [3.5]		70-80		

(1) VFA is recommended criteria, but not required for mix design approval.

Mix Size	3/8 inch (9.5 mm)	1/2 inch (12.5 mm)	3/4 inch (19 mm)	1 inch (25 mm)
Minimum VMA (%)	15.0	14.0	13.0	12.0

The gyratory compactor used for design and field control shall meet the AASHTO PP 38 protocol. Compactors for which compliance with this protocol is pending may be used at the discretion of the District Materials Engineer.

The HMA mixture designed shall meet gyratory design and mixture criteria corresponding to the size of the mixture and the 20 year design traffic level (ESALs) for the project or an appropriate design level as specified in the contract documents.

E. Other Materials.

1. Tack Coat.
Tack coat may be SS-1, SS-1H, CSS-1, or CSS-1H. Mixing of CSS and SS grades will not be permitted. RC-70 and MC-70 may also be used after October 1, at the Contractor's option.

2. Hydrated Lime.
Hydrated lime shall meet the requirements of AASHTO M 17, except that the gradation shall be determined in accordance with AASHTO T 11. Section 4193 of the Standard Specifications shall not apply. Hydrated lime will not be considered part of the aggregate when determining the JMF and the filler/bitumen ratio.

If more than 50% of the total (virgin and RAP) aggregates is quartzite, granite, or other siliceous aggregates (not limestone or dolomite) which is obtained by crushing from ledge rock, hydrated lime will be required in the affected surface mixtures for routes over 300,000 ESALs.

Hydrated lime will not be required for base repair, patching, or temporary pavement.

When hydrated lime is required based on aggregate source, the Contractor may arrange for moisture sensitivity evaluation of the proposed HMA mixture design according to AASHTO T 283. When results of this evaluation indicate more than 80% tensile strength retained (TSR), hydrated lime will not be required. Confirmation of AASHTO T 283 test results will be completed by the Central Materials Laboratory during placement of the test strip.

3. Sand for Tack Coats.
Sand shall meet requirements of Section 4109, Gradation No. 1 of the Standard Specifications.

4. Fabric Reinforcement.
Fabric reinforcement shall meet requirements of Article 4196.01, D, of the Standard Specifications.

F. Equipment.
The Contractor shall provide sufficient equipment of the various types required to produce, place, and compact each layer of HMA mixture as specified.

Equipment shall meet requirements of Section 2001 of the Standard Specifications with the following modifications:

1. Plant Calibration.
When the plant is completely assembled and before any mixture is produced, each aggregate feed shall be calibrated throughout an operating range wide enough to cover the proportion of that material required in the JMF.

For continuous and drum mixing plants, the asphalt binder metering pump shall be calibrated at the operating temperature and with the outlet under pressure equal to that occurring in normal operations.

Each plant scale and metering system shall be calibrated before work on a contract begins. 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.

Calibration curves shall be available in the plant laboratory. New calibration curves shall be made each time there is a change in size or source of any aggregate being used. On all plants, aggregate samples shall be taken in accordance with Materials I.M. 204 to determine that materials are being proportioned in accordance with the specifications.

2. Paver.
Article 2001.19 of the Standard Specification shall apply. When placing paved shoulders, spreaders described in Article 2001.13, D, of the Standard Specifications, may be used for all but the top lift.

3. Rollers.
For initial and intermediate rolling, self-propelled, steel tired, pneumatic tired, or vibratory rollers meeting requirements of Article 2001.05, B, C, or F, of the Standard Specifications shall be used. Their weight (mass) or tire pressure may be adjusted when justified by conditions.

For finish rolling, self propelled, steel tired rollers or vibratory rollers in the static mode meeting requirements of Article 2001.05, B or F, of the Standard Specifications, shall be used.

4. Scales.
Article 2001.07, B, of the Standard Specifications shall apply to all paving operations regardless of the method of measurement.

01042.03 CONSTRUCTION

A. Surface Preparation.

The existing surface shall be cleaned and prepared in accordance with Section 2212 of the Standard Specifications.

1. Maintenance of the Subgrade and Subbase.

The Contractor is responsible for the maintenance of the completed subgrade and subbase to the required density, true cross section, and smooth condition, prior to and during subsequent construction activities. If rutting or any other damage occurs to the subgrade or subbase as a result of hauling operations, the Contractor shall immediately repair the subgrade and subbase, and such repair will include, if necessary, removal and replacement at the Contractor's expense.

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 self imposed limit, the Contracting Authority will pay repair costs set by the Engineer, representing an increase in cost of repair of damage, if any, caused by such traffic.

2. Tack Coats.

Tack coats shall be applied when the entire surface area on which the coat is to be applied is free of moisture. They shall not be applied when the temperature on the surface being covered is less than 25°F (-4°C).

The Contractor shall place a tack coat on the area to be covered, and unless otherwise directed, the tack coat shall be spread at an undiluted rate of 0.02 to 0.05 gallon per square yard (0.1 to 0.2 L/m^2). The tack coat emulsion may be diluted with water to improve application. A light application of sand cover may also be required, but this is anticipated only for excessive application rates, breakdowns, and short sections remaining at the end of a day's run.

On highways being constructed under traffic, safety and convenience to the public without soiling their vehicles shall be a controlling factor. Tack coat shall be adequately cured prior to placement of the HMA. Tack coat applications shall be limited in length, to minimize inconvenience to the public. They shall be kept within the hot mixture placing work area that is controlled by flaggers at each end, and shall be planned so that they will be covered with hot mixture when the work area is opened to traffic at the end of the day's work. If the tack coat surface becomes dirty from weather or traffic, the surface shall be thoroughly cleaned and, if necessary, retacked.

The vertical face of exposed, longitudinal joints shall be tacked as a separate operation, before the adjoining lift is placed, at a rate from 0.10 to 0.15 gallon per square yard (0.5 to 0.7 L/m^2). The vertical surfaces of all fixtures, curbs, bridges, or cold mixture with which the hot mixture will come in contact shall be lightly painted or sprayed to facilitate a tight joint with the fresh mixture.

3. Fabric Reinforcement.

When fabric reinforcement is required, the locations will be designated in the contract documents. Fabric shall not be placed on a wet or damp surface or when the road surface is less than 50°F (10°C). Fiberglass fabric shall be applied only with an adhesive recommended by the manufacturer. Fabrics with an adhesive backing shall be placed in accordance with the manufacturer's recommendations.

Other fabrics shall be placed with a heavy coat of the asphalt binder grade used in the HMA mixture applied at a rate of 0.20 to 0.25 gallons per square yard (0.9 to 1.1 L/m^2) and at a temperature between 295°F and 315°F (145°C to 160°C).

The fabric reinforcement shall be placed in accordance with the contract documents (full width or individual crack or joint treatment). The fabric shall be placed immediately following the adhesive or asphalt binder placement under the fabric. Placement may be by hand or by a mechanical method specifically designed for this purpose. Precautions shall be taken to avoid wrinkles in the fabric and to insure that air bubbles are removed without breaking the fabric. Wrinkles or folds which cannot be removed by brushing shall be cut and lapped to provide a smooth surface.

Additional adhesive or asphalt binder may be required to produce a tight, bonded surface. When applied full lane width, the minimum transverse and longitudinal lap shall be 12 inches (300 mm).

The Contractor shall avoid application of the tack coat over longitudinally placed fabric. Traffic shall not be allowed over the fabric during placement and during curing of the adhesive material to avoid damage to the fabric. A light application of HMA mix material may be hand sprinkled on the fabric to prevent damage from necessary equipment traffic.

Fabric that is damaged or soiled prior to HMA overlay shall be repaired at no additional cost to the Contracting Authority, when directed by the Engineer. Sanding, at no additional cost to the Contracting Authority, may also be required by the Engineer during this period.

B. Handling, Production, and Delivery.

1. Hot Mix Asphalt Plant Operation.
The plant operation shall comply with the following requirements:

a. Handling Mineral Aggregate and RAP.
The various aggregate products used shall be kept separate, and adequate provisions shall be made to prevent intermingling. Stockpiling and processing shall be handled in a manner that will ensure uniform incorporation of the aggregate into the mix.

The various aggregates shall be separately fed by feeders to the cold elevator in their proper proportions and at a rate to permit correct and uniform temperature control of heating and drying operations.

b. Handling Asphalt Binder.
The asphalt binder shall be brought to a temperature of 260°F to 330°F (125°C to 165°C) before being measured for mixing with the aggregates. The temperature between these limits may be further regulated according to the characteristics of the mixture, method of proportioning, and viscosity of the asphalt binder. Modified asphalt binder should be heated according to the suppliers recommendations.

c. Handling Hydrated Lime.
The lime must be accurately proportioned by a method acceptable to the Engineer.

1) Hydrated Lime Added to a Drum Mixer.
The hydrated lime shall be added at the rate of 0.75% by weight (mass) of the total aggregate (virgin and RAP). The hydrated lime shall be added to a drum mixer by one of the following methods:

a) Added to the virgin aggregate on the primary feed belt, as lime water slurry.

b) Thoroughly mixed with the total combined aggregate if the aggregate contains at least 3% total moisture.

c) Added to the Type 2 or Type 3 virgin aggregate in a moist condition, and then mixed with the total combined virgin aggregate.

Alternative methods for mixing must be reviewed and approved by the Engineer. Hydrated lime shall not be introduced directly into a drum mixer by blowing or augering.

2) Hydrated Lime Added to a Batch Plant.
Hydrated lime shall be added at the rate of 0.5% by weight (mass) of total aggregate (virgin and RAP). It shall be introduced to a batch plant by one of the following methods:

a) Placed on the recycle belt which leads directly into the weigh hopper.

b) Added directly into the pugmill.

c) Added directly into the hot aggregate elevator into the hot aggregate stream. In any case, the lime must be introduced prior to the start of the dry mix cycle.

When any of the above methods for a batch plant is used, the hydrated lime will be considered part of the JMF.

d. Production of Hot Mix Asphalt Mixture.
The exact proportions of the various materials shall be regulated within the limits specified so as to produce a satisfactory bituminous coating and mixture. The aggregates shall first be mixed dry, then the asphalt binder shall be added. In batch plants, the asphalt binder shall be added in an evenly spread sheet over the full length of the mixer box. In continuous plants, the asphalt binder shall be sprayed evenly into the aggregate by a positive pressure spray within the first 30% of the length of the mixer box. In drum mixing plants, the asphalt binder shall be sprayed evenly into the aggregate by a positive pressure spray. Coating aids may be added, subject to approval of the Engineer.

The mixer shall be operated so that the mixture is of consistently uniform temperature and, as discharged from the mixer, will not vary more than 20°F (11°C). The temperature of the mixtures shall not exceed 330°F (165°C) unless approved by the Engineer.

The rate of production shall not exceed the manufacturer's rated capacity of the mixer and shall provide uniform coating. Dry mixing time for batch mixers shall be not less than 5 seconds. Wet mixing time for batch mixers shall be not less than 25 seconds. For continuous mixers, the mixing time shall be at least 30 seconds.

2. Handling and Delivery.
All handling and manipulation of the hot mixture from the mixer to the final spread on the road shall be controlled so that a uniform composition is maintained and segregation of coarser particles is minimized. The segregation shall be minimized to the extent that it cannot be visibly observed in the compacted surface. The Contractor shall only apply approved release agents to trucks and equipment as specified in Article 2001.01 of the Standard Specifications.

The mixture temperature shall be sufficient to allow for the specified compaction and density to be attained. HMA shall not be discharged into the paver hopper when its temperature is less than 245°F (120°C) for a nominal layer thickness of 1 1/2 inches (40 mm) or less and 225°F (110°C) for a nominal layer thickness of more than 1 1/2 inches (40 mm).

Except for an unavoidable delay or breakdown, delivery of hot HMA to any individual spreading unit shall be continuous and uniform and at a rate sufficient to provide as continuous an operation of the spreading unit as practical. The paver hopper shall, at all times, be kept sufficiently full to prevent non-uniform flow of the mixture to the screed.

C. Placement.
The existing surface and the surface of each layer shall be clean and free from foreign matter when each succeeding layer is placed. Any surface which becomes dirty shall be cleaned by the Contractor and, if necessary, retacked to provide bond with the succeeding course. If bumps or other significant irregularities appear or are evident in the intermediate course or other lower course, they are to be corrected before the final lift is placed.

HMA mixtures shall not be placed on a wet or damp surface and shall not be placed when the temperature of the road surface is less than shown in the table below. The Engineer may further limit placement if, in the Engineer's judgment, other conditions are detrimental to quality work. HMA mixtures shall not be placed after November 15, except with approval of the Engineer.

ALL BASE AND INTERMEDIATE COURSE LIFTS OF HMA MIXTURES

Nominal Thickness Inches (mm)	Road Surface Temperature °F (°C)
1 1/2 (40)	40 (4)
2-3 (60-80)	35 (2)
Over 3 (80)	25 (-4)

ALL SURFACE COURSE LIFTS OF HMA

Nominal Thickness Inches (mm)	Road Surface Temperature °F (°C)
1 (30)	50 (10)
1 1/2 (40)	45 (7)
2 (50) and greater	40 (4)

When placing the mixture, the forward speed of the finishing machine shall be slowed as necessary to provide the least amount of stopping.

A wire or string line shall be used to guide the finishing machine and to maintain alignment. Edge alignment irregularities shall be corrected by hand methods immediately after they occur.

The contract documents will show the total thickness to be placed. Spreading of the mixture shall be at such a rate that, when compacted, the layer(s) will be substantially of the thickness and dimensions required to produce the required thickness. The minimum layer thickness is three times the designated mix size. The compacted thickness of the top layer shall not be greater than 3 inches (75 mm). This restriction shall not apply to HMA shoulders. The maximum compacted thickness of lower layers may exceed 4 inches (100 mm) if it is demonstrated that the thicker layers have satisfactory density. The riding characteristics of the thicker layers shall be within reasonably close conformance to that expected from a 3 inch (75 mm) layer. Each layer shall be completed to full width before succeeding layers are placed.

At the close of each working day, the roadbed shall be free of any construction equipment. The Contractor shall not spread more mixture than can be compacted and finished in daylight hours of the same working day.

While operating on the road surface, use of kerosene, distillate, other petroleum fractions, or other solvents, for cleaning hand tools or for spraying the paver hopper will not be permitted. Containers of cleaning solution shall not be carried on or near the paver. When a solvent is used, the paver shall not be used for at least 5 hours after this cleaning. The Contractor shall be responsible for collecting and removing all cleaning materials and cleaning residue from the project and plant site. The cleaning material and residue shall become the property of the Contractor.

Whenever practicable, all mixtures shall be spread by a finishing machine. Irregular areas may be spread by hand methods. The hot mixture shall be spread uniformly to the desired depth with hot shovels and rakes. Loads shall not be dumped faster than they can be spread properly. Workers shall not stand on the loose mixture while spreading. After spreading, the hot mixture shall be carefully smoothed to remove all segregated coarse aggregate and rake marks. Rakes and lutes used for hand spreading and smoothing shall be of the type designed for use on HMA mixtures.

D. Compaction.

Each layer shall be promptly and thoroughly compacted. Mechanical tampers shall be used for areas inaccessible to the rollers.

The overall rolling procedure and compactive effort shall produce a surface free of ridges, marks, or bumps and shall be subject to approval of the Engineer.

There are two classes of compaction, Class I and Class II. Class I compaction is intended for use on Secondary highways. Class II compaction is intended for resurfacing paved shoulders, temporary crossovers, runarounds, and for other situations where Class I is not specified.

For Class I compaction, the roadway density (percent of laboratory density) will be based on the density obtained from the Quality Control Program for that day's mixture.

1. Class I Compaction.

a. Class IA Compaction.

Compaction shall be a minimum of 96% of laboratory density. The average air void level of the roadway density specimens shall not exceed 8.0%.

b. Class IB Compaction.

Class IB compaction shall be used when Class IA compaction is not specified. Compaction shall be to a minimum of 95% of laboratory density. The average air void level of the roadway density specimens shall not exceed 8.0%.

c. Class IC Compaction.

Class IC compaction shall be used for traffic lanes of Secondary highways, HMA base widening, shoulder resurfacing, and any other HMA course when Class IA and IB are not specified. Compaction shall be a minimum of 94% of laboratory density. The average air void level of the roadway density specimens shall not exceed 8.0%.

d. Rolling Patterns for Class IA and IB Compaction.

For Class IA compaction at the start of intermediate course placement and for Class IA and Class IB compaction prior to the start of surface course placement, the Contractor shall construct a test strip for the purpose of evaluating properties of the HMA mixtures and for identifying an effective rolling pattern. For multiple lifts using the same mix requiring Class IA compaction, when the thickness of the second lift varies from the first lift by 1 1/2 inches (40 mm) or more, a test strip for the second lift shall be performed. When the contract documents specify both intermediate and surface courses, a surface course test strip shall be placed in lieu of intermediate mix in a section of intermediate course prior to actual surface course placement. This will be paid for at the contract unit price for the surface mix. The test strip shall be applied to each mixture which has a plan quantity of at least 1500 tons (1500 Mg).

The quantity of HMA mixture subject to Class IA compaction, produced and placed for test strip production, will be limited to 500 tons (500 Mg) for lift thicknesses of 2 inches (50 mm) or less, and 750 tons (750 Mg) for lift thicknesses greater than 2 inches (50 mm). After test strip placement, further mixing and laydown operations will be suspended until the laboratory test results of the plant produced mixture and core densities are available.

Only one test strip will be allowed for each mixture. At the direction of the Engineer, additional test strips may be required if a successful rolling pattern was not established.

Procedures and documentation to be followed during construction of the test strip shall allow the Engineer and the Contractor to verify mixture design and effectiveness of compaction procedures.

The number of density core samples obtained for the test strip will be increased by one and the low core result will not be used in the Quality Index (Q.I.) density formula for payment for the test strip quantity.

2. Class II Compaction.
For all rollers, the initial contact with the hot mixture shall be made by the power driven wheels or roll.

The initial rolling shall be done at a temperature so the mixture will compact without excessive distortion. Except on longitudinal joints and super-elevated curves, rolling with the initial roller shall begin at the outer edges of the pavement, and each successive pass shall progress inward toward the center line. Each reverse trip shall lap all but 4 to 6 inches (100 mm to 150 mm) of the previous track. When reversing direction, the initial roller shall stop at an angle with the longitudinal direction.

Following the initial rolling, the layer shall be given an intermediate rolling with a pneumatic tired roller, and before the temperature falls below 225°F (110°C). The intermediate roller shall cover the entire area not less than six times. A finish, steel tired roller shall be used to smooth out all marks and roughness in the surface.

Mechanical tampers shall be used for areas inaccessible to the rollers.

3. Joints.
Longitudinal joints for courses on resurfacing projects shall be constructed directly above the longitudinal joint in the existing pavement. The offset distance between longitudinal joints in succeeding courses of full depth HMA paving shall be not more than 3 inches (75 mm). Transverse construction joints in succeeding courses shall be separated by not less than 6 feet (1.6 m). The spreading of hot mixtures along longitudinal joints shall be adjusted to secure complete joint closure and full compression of the mixture with a smooth surface and joint after compaction. At transverse joints, the cold mixture of the layer shall be sawed to a straight line at right angles to the center line so that a full thickness, a true surface, and a vertical edge will be provided.

The Contractor shall provide a 10 foot (3 m) straightedge for checking transverse joints for smoothness. Variations in the surface at transverse joints, as indicated by the straightedge, shall be corrected by hand methods before compaction.

Suitable paper or burlap should be used under the taper at end-of-day's run transverse joints to prevent adhesion. Sand, dirt, or wood shall not be used for this purpose. Use of wood or metal headers to form the edge of the joint during rolling of the fresh mixture will not be permitted.

When temporary transverse construction joints will be open to traffic for periods greater than 4 weeks, the Contractor may reduce the amount of top size aggregate in the transition taper.

E. Miscellaneous Operations.

1. Leveling and Strengthening Courses.
The contract documents will show the thickness of the courses to be placed. Strengthening and leveling courses will be placed as indicated in the contract documents. These courses shall be of the same mixture specified for the base or intermediate course.

When the width of any strengthening or leveling layer is 8 feet (2.4 m) or more, the layer shall be spread by a finishing machine.

Leveling courses shall be compacted using Class II compaction procedures with a pneumatic roller.

2. Wedge Courses.
Wedge courses used to secure desired super-elevation of curves shall be constructed of the base or intermediate mixture, and insofar as possible, shall be spread by a finishing machine. In placing wedge course, the maximum thickness of individual layers, when compacted, shall not exceed 3 inches (75 mm), and care shall be used to avoid crushing the coarse aggregate. Wedge courses shall be placed to the full width of pavement.

3. Fixtures in the Pavement Surface.
All utility accesses, catch basins, valve holes, or other fixtures encountered within the area to be covered by HMA shall be adjusted to conform to the final adjacent finished surface. Unless otherwise indicated in the plans, the Contractor shall have the option of adjusting fixtures between placement of the surface course and the layer preceding the surface course, or adjusting the fixture after placement of the surface course using a composite patch or PCC patch.

PCC and HMA patch material shall conform to the requirements of Section 2529 of the Standard Specifications. Patches shall be of sufficient size to accommodate the structure being adjusted. Patches shall be square in shape and oriented diagonally to the direction of traffic flow. Elevation of the adjusted fixture and patch shall not be higher than or more than 1/4 inch (6 mm) below that of the surrounding pavement surface.

4. Fillets for Intersecting Roads and Driveways.
When fillets are designated in the contract documents for driveways to homesteads and commercial establishments and at intersecting roads, the surface adjacent to the pavement being surfaced shall be shaped, cleaned of loose material, and tack coated. On this coated surface, the hot mixture shall be placed and compacted in layers equal to the adjacent layer and extended from the edge of pavement as shown in the plans. Fillets at intersecting roads shall be placed and compacted at the same time as the adjacent layer. Entrance fillets that are 8 feet (2.4 m) or wider may be placed as a separate operation. Paving of fillets 8 feet (2.4 m) or more in width shall be with a self propelled finishing machine described in Article 2001.19 of the Standard Specifications. The Engineer may approve other equipment for placement of fillets, based on a demonstration of satisfactory results.

01042.04 QUALITY CONTROL PROGRAM

A. Mix Design – Job Mix Formula (JMF).
The JMF for each mixture shall be the responsibility of the Contractor.

The Contractor shall submit completed JMF using the computer format of Form 956 to the materials laboratory designated by the Contracting Authority for approval. The Contractor shall submit supporting documentation demonstrating the design process was followed and how the recommended JMF was determined, including an economic evaluation when required. Documentation shall include trial and final proposed aggregate proportions (Form 955) and corresponding gyratory data. The Contractor shall also submit sufficient loose mixture and individual material samples for approval of the design.

The JMF shall be prepared by personnel who are Iowa DOT certified in bituminous mix design.

If the JMF is not satisfactory, the Contractor shall submit another JMF for review. An approved JMF will be required prior to beginning plant production. The Contractor will be charged $500 for each JMF approval requested and performed which exceeds two per mix size, type, and proposal item on any individual project or group of tied projects.

B. Plant Production.
The Contractor shall perform the sampling and testing to provide the quality control of the mixture during plant production. Certified Plant Inspection according to Section 2521 of the Standard Specifications will be required. All personnel performing production quality control testing shall be certified by the Department.

Easy and safe access shall be provided to the location in the plant where samples are to be taken.

"A significant mix change" is defined as a single occurrence of an aggregate interchange of greater than 5%, a single occurrence of an asphalt content change greater than 0.2%, or any deletion or introduction of a new aggregate into the mix.

1. Sampling and Testing.
Aggregate gradation control shall be based on cold feed gradation.

The hot HMA mixture shall be sampled, at random, from the roadway, behind the paver, prior to compaction, in accordance with Materials I.M. 322.

Each day's production shall be considered a lot. When the anticipated quantity for the day is 2000 tons (2000 Mg) or more, that day's production shall be divided into four sublots, the first sublot of each day shall be the first 500 tons (500 Mg) produced. The remaining anticipated quantity for the day shall be divided into three sublots of equal size.

When the anticipated quantity for the day is less than 2000 tons (2000 Mg), the first daily sublot shall be the first 500 tons (500 Mg) produced. Additional daily sublots of 750 tons (750 Mg) each will be established for mix production exceeding the first 500 tons (500 Mg).

The maximum number of samples required for a day's production will not exceed four.

Samples shall not be taken from the first 100 tons (100 Mg) of mix produced each day or the first 100 tons (100 Mg) of mix following a significant mix change.

Each production sample shall be tested as follows:

a) Two gyratory specimens shall be prepared and compacted in accordance with AASHTO PP28-97 and the results averaged to determine sample results.

b) Density shall be determined for each specimen in accordance with Materials I.M. 321.

c) The Contractor's field quality control laboratory compaction shall be used for field density control. The laboratory density for field control will be the bulk specific gravity of compacted mixture (G_{mb}) at N_{design}. Bulk specific gravity at N_{design} will be determined by compacting specimens to N_{max} and back calculating the bulk specific gravity at N_{design}.

d) The Theoretical Maximum Specific Gravity of the uncompacted mixture shall be determined in accordance with Materials I.M. 350 or other test methods recognized by AASHTO or ASTM.

e) The laboratory air voids shall be determined in accordance with Materials I.M. 508 and 510.

2. Production Control.
After the JMF is established, the combined aggregate furnished for the project, the quantity of asphalt binder and laboratory air voids should consistently conform to the JMF, as target values, and shall be controlled within the production tolerances given in the table below. Plant production must be controlled such that the plant produced HMA mixture will meet mixture design criteria for Air Voids and VMA at N_{design} gyrations of the gyratory compactor within the single test tolerances given in the table.

The mix design gradation control points for the size mixture designated in the project plans will not apply to plant production control.

PRODUCTION TOLERANCES

Measured Characteristic	Target value	Specification Tolerance
Cold feed gradation No. 4 (4.75 mm) and larger	by JMF	± 7.0
Cold feed gradation No. 8 (2.36 mm)	by JMF	± 5.0
Cold feed gradation No. 30 (600 µm)	by JMF	± 4.0
Cold feed gradation No. 200 (75 µm)	by JMF	± 2.0 (1)
Daily asphalt binder content	by JMF	± 0.3
Field laboratory air voids	(2)	-0.5 / +1.0 (3)
VMA (4)	by JMF	± 1.0 (5)

(1)- The filler/binder ratio of the plant produced mixture will be maintained between 0.6 and 1.4.
(2)- As specified for the level of HMA mixture.
(3)- Based on the moving average of four test values
(4)- Restricted to an asphalt film thickness as specified for the level of HMA mixture design.
(5)- Based on the daily lot average

The Contractor shall strive for the target value of the percent air void and asphalt binder by adjusting gradation and asphalt binder content.

The Contractor shall produce a mixture of uniform composition conforming to the JMF. If, during production, the Contractor determines from quality control testing that adjustments are necessary to the JMF to achieve the specified properties, adjustments to the JMF target gradation and asphalt binder content values may be made.

Adjustments to the JMF aggregate proportions and asphalt binder content shall be made as a result of the interactive process between the Contractor and the Engineer. The Contractor's adjustment recommendations shall prevail, provided all specifications and established mix design criteria are being met for plant production.

The voids in the mineral aggregate (VMA) and estimated film thickness shall be measured for specification compliance every day of HMA production.

Quality control charts shall be available and kept current showing both individual test results and moving average values. Moving averages shall be based on four consecutive test results. Control charts shall include a target value and specification tolerances. As a minimum, the following values shall be plotted on Iowa DOT Materials approved control charts as indicated below:

Laboratory density (each point being an average of two specimens).

Laboratory air voids (plotted to nearest 0.1%)

Asphalt binder content (plotted to nearest 0.1%)

Cold feed gradation (No. 4, No. 8, No. 30, and No. 200 (4.75 mm, 2.36 mm, 600 µm, 75 µm) sieves)

Maximum specific gravity (Rice) (Materials I.M. 350).

Laboratory voids for individual tests shall be calculated according to Materials I.M. 510, using the individual density and individual maximum specific gravity determined for each sample. The moving average of laboratory voids shall be the average of the last four individual laboratory voids.

The Contractor shall monitor the test results and to make mix adjustments, when appropriate, to keep the mixture near the target values. The Contractor shall notify the Engineer whenever the process approaches a specification tolerance limit. One moving average point for laboratory air voids outside the specification tolerance limit shall be cause to cease operations. The Contractor shall assume the responsibility to cease operations, including not incorporating produced material which has not been placed. The process shall not be started again until the Contractor notifies the Engineer of the corrective action proposed.

C. Construction.

1. Density.

Density samples shall be taken from the compacted mixture and tested not later than the next working day following placement and compaction.

A lot shall be considered as one layer of one mixture 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. When the day's operation is 2500 square yards (2500 m^2) or less, or the day's operation is 500 tons (500 Mg) or less, or when the mixture is being placed in irregular areas, or for wedge, leveling, or strengthening courses, the Engineer may waive sampling for density provided compaction has been thorough and effective.

Seven density samples will be taken for each lot. The length laid in each lot shall be divided into seven approximately equal sections and one sample will be obtained at a random location in each section.

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. Samples shall not be taken less than 1 foot (300 mm) from the edge of a given pass of the placing equipment or from run-outs or areas adjacent to day's work joints or structures.

The quality index for density of each lot shall be determined by the following formula:

$$QI_{DENSITY} = \frac{(\text{Average } G_{mb})_{FIELD\ LOT} - \left((\%\text{Density})_{SPECIFIED} \times (\text{Average } G_{mb})_{LAB\ LOT}\right)}{(\text{Std Dev } G_{mb})_{FIELD\ LOT}}$$

where G_{mb} = bulk Specific Gravity of the mixture

When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective.

If one of the density test values from a lot is an outlier, identified in accordance with the procedure described in Materials I.M. 508, the outlier value shall not be used to determine the quality index. The quality index shall be determined using the remaining density test values.

If only one laboratory density value is obtained that day, combine that value with the next day's test results to evaluate both days' production. If two or more laboratory density values are obtained that day, then the average of those tests alone shall be used. If a significant mix change has been made, only the appropriate laboratory density values should be used with the corresponding density cores.

2. Thickness.

The thickness of the completed course will be measured to the nearest 1/8 inch (3 mm), exclusive of seal coat, by measurement of cores. All areas of uniform and similar thickness and width for the project will be divided into lots.

The frequency specified for taking density samples from the surface lift will be used when measuring for completed thickness. However, samples that may not be tested for density because they are less than 70% of the intended thickness shall be used for thickness, and in these particular instances, the additional samples of sufficient thickness that are used for density tests shall not be measured for thickness. Thickness samples will be taken full depth of the completed course and after measurement, the density samples for the top layer shall be removed by the Contractor from the core. If any of the measurements for a lot is less than the designated thickness, the quality index for thickness of that lot will be determined by the following formula:

$$QI_{THICKNESS} = \frac{\text{Average Thickness}_{MEASURED} - (\text{Thickness}_{PLAN} - 0.50)}{\text{Maximum Thickness}_{MEASURED} - \text{Minimum Thickness}_{MEASURED}}$$

When the day's operation is 2500 square yards (2500 m^2) or less, or the mixture is being placed in irregular areas or next to structures, the Engineer may waive sampling for thickness provided there is reasonable assurance that the pavement conforms to the required thickness. When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective.

D. Sampling and Testing.

The Contractor shall calibrate and correlate the testing equipment with prescribed procedures. Sampling and testing shall conform with specified testing procedures as listed in the Materials I.M. and applicable Specifications. When the results from a lab are used for product acceptance, the lab shall be qualified.

All samples shall be identified, stored and retained by the Contractor for the Contracting Authority until the lot is accepted. The Contracting Authority may acquire these samples for comparative, verification, or assurance testing.

All samples shall be identified by a system approved by the Engineer.

1. Loose Material Requirements.
All samples of asphalt binder and tack coat material, shall be identified and promptly delivered to the appropriate laboratory, as designated by the Engineer.

Samples of loose HMA mixture shall be taken behind the paver, weigh at least 50 pounds (25 kg), and shall be transported to the test facility in a way to retain heat to facilitate sample splitting procedures. The tests for mixture properties shall be conducted on representative portions of the mix, split from the larger sample of mix. After splitting of the sample is completed in the Contractor's QM-A laboratory, the remainder of the sample, approximately 30 pounds (15 kg) shall be retained for laboratory testing by the laboratory designated by the Contracting Authority.

When requested by the Engineer, normally once per day, an additional 50 pounds (25 kg) box sample will be required for correlation and validation testing.

Samples shall be split in accordance with Materials I.M. 357.

All test results and calculations shall be recorded and documented on data sheets approved by the Contracting Authority. Specific test results shall be recorded on a daily summary sheet approved by the Contracting Authority. The Daily Quality Control Summary Sheet shall also include a description of quality control actions taken (adjustment of cold feed percentages, changes in JMF, etc.). The Contractor shall FAX, or by other method approved by the Engineer, the daily quality control summary sheet to the appropriate Iowa DOT District Materials Engineer or Engineer daily. A copy of the electronic file containing project information generated during the progress of the work shall be furnished to the Engineer at project completion.

2. Finished Pavement Requirements.
The Contractor shall cut samples from any course or finished pavement for tests of density, thickness, or composition, by sawing with a power driven masonry saw or by drilling a minimum 4 inch (100 mm) nominal diameter core. The surfaces shall be restored by the Contractor the same day. The core holes shall be dried, filled with the same type of material, and the material properly compacted. Pavement core samples shall be identified and delivered to the Contractor's quality control field laboratory.

The compacted HMA pavement shall be tested by Contractor's personnel who are Iowa DOT Certified in QM-A bituminous quality control.

The minimum number of cores taken shall be in accordance with the following Materials I.M. 204~~, Appendix A-V, and Materials I.M. 204 Supplemental~~.

The core locations will be determined by the Engineer.

The cores shall be prepared and tested in accordance with the following Materials I.M. 320, 321, and 337.

3. Acceptance, Correlation, and Quality Assurance Testing.
The Contractor's quality control test results will be compared and correlated to the Engineer's test results on a regular basis using guidelines and tolerances set forth in Materials I.M. 208, Appendix C; 216; and 511.

If satisfactory correlation exists between the Contractor's test results and the Engineer tests, the Contractor's results will be used. Disputes between the Contractor's and Engineer's test results, on one sample or one test of one sample, will be resolved by repeated testing of the same sample or additional testing of another sample. When repeated and/or additional sampling fails to resolve a dispute, a third materials laboratory designated by the Contracting Authority will act as a reference laboratory and perform additional testing as necessary to resolve the dispute.

The Engineer will select, at random, a split portion of one or more of the daily hot mix production samples. Some or all of the samples selected will be tested in the materials laboratory designated by the Engineer. The Engineer will test as many of the samples as necessary to establish a correlation.

The Engineer will select one daily set of cores at random each week. These will be tested at the materials laboratory designated by the Engineer. Cores from the initial production will also be tested by the Contractor and the Engineer for correlation and validation of results.

01042.05 METHOD OF MEASUREMENT

The Engineer will measure the quantities of the various items of work involved in placement of bituminous mixtures in accordance with the following provisions:

A. Hot Mix Asphalt Mixture.

1. Measurement by Weight (Mass).
When measurement is by weight (mass), the quantity of mixture will be expressed in tons (megagrams) and determined from the weight (mass) of individual loads measured to the nearest 0.01 tons (0.1 Mg). Loads may be weighed in trucks, weigh hoppers, or from the weight (mass) from batch plants computed by count of batches in each truck and batch weight (mass). Article 2001.07 of the Standard Specifications applies. The weights (mass) of various loads shall be segregated into the quantities for each pay item.

2. Measurement by Area.
When payment is based on square yards (square meter), the area of each lot will be computed to the nearest 0.1 square yard (0.1 m^2) from surface dimensions measured to the nearest 0.1 foot (30 mm). When the average measured width of the lot is equal to or greater than the plan width, the computed area will be based on the plan width. When the average measured width is less than plan width, the computed area will be based on the measured width.

When constructing shoulders on a basis of payment of square yards (square meters), inspection of the profile and elevation will be based on the completed work relative to the pavement edge; the Contractor shall be responsible for the profile and elevation of the subgrade and for thickness.

B. Asphalt Binder.
The amount of asphalt binder used from batch plants, continuous plants, or drum mixing plants, shall be by stick measurement in the Contractor's storage tank or by in-line flow meter reading. The asphalt binder quantity added to the storage tank shall be computed from a supplier certified transport ticket accompanying each load. The quantity of asphalt binder not used in the work will be deducted.

When the quantity of asphalt binder in a batch is measured by weight (mass) and is separately identified by automatic or semi-automatic printout, the Engineer may compute from this printout the quantity of asphalt binder used.

By mutual agreement, this method may be modified when small quantities or intermittent operations are involved.

The Engineer will calculate and exclude the quantity of asphalt binder used in mixtures in excess of the tolerance specified in Article 01042.04, B, 2, of this Supplemental Specification.

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.
The quantity of asphalt binder in RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP, based on an assumed asphalt binder content of 5% of the dry RAP weight (mass).

The quantity of asphalt binder in RAP, which is incorporated into the mix, will be included in the quantity of asphalt binder used.

The quantity of asphalt binder in unclassified RAP will not be measured for payment.

D. Hydrated Lime.
Hydrated lime incorporated in HMA mixtures shall be considered incidental to HMA and will not be measured.

E. Tack Coat.
Tack Coat shall be considered incidental to HMA, and will not be measured separately.

F. Fabric Reinforcement.
The Engineer will calculate to the nearest 0.1 square yards (0.1 m^2) on the roadway surface dimensions measured to the nearest 0.1 foot (30 mm) for the fabric reinforcement placed in acceptable condition.

G. Adjustment of Fixtures.
The Engineer will count the number of fixtures adjusted to the finished grade.

H. Hot Mix Asphalt Pavement Samples.
HMA Pavement Samples of any finished pavement furnished according to Article 01042.04, D, of this Supplemental Specification, or required elsewhere in the contract documents, will not be individually counted for payment.

01042.06 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 shall not be paid for separately, but shall be included in the contract unit price for the HMA mixes used. The application of hydrated lime, tack coat, and sand cover aggregate are incidental and will not be paid for separately. Any pollution control testing shall be at the Contractor's expense.

A. Hot Mix Asphalt Mixture.
For the quantity of each class and category of mixture, including fillets, the Contractor will be paid the respective contract unit price. Payment will be adjusted by the following percentages for the quality index for density determined for the lot:

Quality Index (Density) 7 Samples [(1)]	Percent of Full Payment
greater than 0.72	100
0.40 to 0.72	95
0.00 to 0.39	85
less than 0.00	75 Maximum

[(1)] Or 6 samples and 1 outlier (Only one outlier will be allowed).

When the basis of payment is by area, payment will be further adjusted by the appropriate percentage according to the quality index for thickness determined for that lot and the following table:

Quality Index (Thickness) 7 Samples	Percent of Payment (Previously Adjusted for Density)
greater than 0.34	100
0.14 to 0.34	95
0.00 to 0.13	85
less than 0.00	75 Maximum

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 paid for according to Article 1105.04 of the Standard Specifications.

B. Asphalt Binder.
For the number of tons of asphalt binder used in the work, measured as provided in Article 01042.25, B, of this Supplemental Specification, the Contractor will be paid the contract unit price per ton (megagram).

Payment for asphalt binder will be for all new asphalt binder and the asphalt binder in RAP salvaged from the project, the Contracting Authority owned stockpile, or certified Contractor owned stockpiles, which is incorporated in the mixture.

When scarification of asphalt material is required and is paid for on the basis of square yards (square meters) and no other use of the RAP is specified, the RAP shall become the property of the Contractor, and the Contractor shall not be charged for the asphalt binder in that material.

When the basis of payment for HMA is in square yards (square meters), compensation for asphalt binder will be included in the contract unit price per square yard (square meter).

C. Recycled Asphalt Pavement.
RAP which is 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. Fabric Reinforcement.
For the number of square yards (square meters) of fabric reinforcement installed, the Contractor will be paid the contract unit price. This payment shall be full compensation for furnishing all materials, labor, and equipment necessary for installing the fabric as required, including the adhesive or heavy tack coat of asphalt binder used as the adhesive.

E. Adjustment of Fixtures.
For the number of fixtures adjusted to the finished grade line, the Contractor will be paid the contract unit price for each. If the contract contains no price for adjustment of fixtures, this work will be paid for as provided in Article 1109.03, B, of the Standard Specifications.

F. Hot Mix Asphalt Pavement Samples.
For cutting HMA pavement samples to determine density or thickness according to the specifications, when either of these is the responsibility of the Contractor, and elsewhere when required by the contract documents, the Contractor will be paid the lump sum contract price. This lump sum payment shall be full compensation for furnishing all such samples for all courses or items of work, and for delivery of samples as specified in Article 01042.04, D, of this Supplemental Specification.

SS-01045
(Replaces SS-01039)

Iowa Department of Transportation

SPECIFICATIONS

FOR

RECYCLED ASPHALT PAVEMENT (RAP)

Effective Date
October 17, 2006

THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SUPPLEMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

This specification applies to projects on the Primary Road System only. It may apply to other projects when specifically identified in the contract documents.

Replace all of Article 2303.02, C with the following:

C. Recycled Asphalt Pavement.

RAP is salvaged asphalt pavement. RAP shall be from a source designated in the contract documents, a Classified RAP stockpile, or Unclassified RAP furnished by the Contractor. The designations Classified and Unclassified are exclusively for the use of RAP in HMA.

The Contractor shall identify each RAP stockpile and document Classified RAP stockpiles as directed in Appendix A. Information required for documentation of Classified RAP material in a stockpile for future use in HMA shall include 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; and description of stockpile location and quantity. Additional material shall not be added to a Classified RAP stockpile without the approval of the District Materials Engineer.

The Engineer may reject a RAP stockpile for non-uniformity based on visual inspection. Stockpiles shall be worked in such a manner that the materials removed are representative of a cross section of the pile.

Stockpiles of RAP shall be placed on a base sufficient to prevent contamination as directed in Appendix A. RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or environmentally restricted materials shall not be used. RAP stockpiles may include PCC ~~patches~~ (not to exceed 10% of the stockpile ~~pavement surface area~~) from patches or composite pavement that was milled as part of the asphalt pavement ~~may be included in the stockpile~~.

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. The Contractor is responsible for salvaging this material. Unless otherwise specified in the contract documents, RAP not used in HMA shall become the property of the Contractor.

For HMA mix design purposes, the Contracting Authority will test samples of the RAP. The aggregate gradation and amount of asphalt binder in the RAP will be based on the Contract Authority's extraction tests. When the amount of RAP binder exceeds 20% of the total asphalt binder, the asphalt binder grade shall be changed as directed in Materials I.M. 510.

1. Classified RAP.

Classified RAP is from a documented source with the aggregate meeting the appropriate quality requirements in Materials I.M. 510, and properly stockpiled.

Classified RAP may be used in the base, intermediate, and surface mixtures for which the RAP aggregate qualifies. The surface course may use up to 15% of Classified RAP. The Contractor may ~~shall obtain the Engineer's approval to~~ use more than 15% of Classified RAP for the surface course when there is quality control sampling and testing of the RAP meeting the requirements in Appendix A. Not more than 30% of the total asphalt binder in the surface mix shall come from the RAP.

2. Unclassified RAP.

Any stockpiled RAP not meeting the requirements of Classified RAP or from an unknown source shall be designated as Unclassified RAP. For Interstate and Primary projects, up to 10% Unclassified RAP may be used in HMA base and shoulder mixtures. For Primary projects, up to 10% Unclassified RAP may be used for equal to or less than 1,000,000 ESAL intermediate mixtures. For all other projects, up to 10% Unclassified RAP may be used in HMA base, intermediate, and shoulder mixtures. There will be ~~is~~ no friction aggregate credit or aggregate crushed particles credit for Unclassified RAP.

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.

Replace all of Article 2303.05, C with the following:

C. Recycled Asphalt Pavement.

The quantity of asphalt binder in classified or unclassified RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP, based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction test.

The quantity of asphalt binder in classified or unclassified RAP, which is incorporated into the mix, will be included in the quantity of asphalt binder used.

Replace the second paragraph of Article 2303.06, B with the following:

Payment for asphalt binder will be for all new asphalt binder and the asphalt binder in the RAP which is incorporated in the mixture.

The quantity of asphalt binder in classified or unclassified RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP. This will be based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction test.

Appendix A – Instructions for RAP for HMA Mixtures (Supersedes Materials I.M. 505)

GENERAL

This Appendix describes requirements for processing, storing, documenting, and sampling & testing of RAP intended for use in HMA mixtures.

All notifications and documentation shall be submitted to the District Materials Engineer based on the District responsible for the location of the initial RAP stockpile.

PROCESSING

RAP suitable for HMA shall be processed by milling and/or crushing to a maximum particle size of 1.5 inches (37.5 mm). The Contractor shall notify the Engineer and District Materials Engineer 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 HMA 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 two-bin cold feed.

STORAGE

Stockpiles shall be placed on a base with adequate drainage, constructed in layers to minimize RAP segregation and ensure a workable face.

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.

All RAP stockpiles shall be identified by maps of stockpile areas and signs placed in or near each stockpile.

DOCUMENTATION of CLASSIFIED RAP STOCKPILES

Stockpiled RAP material will only be considered Classified RAP 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.

- Form 820009r (see Appendix B) is completed by the RAP owner and a copy is forwarded to the District Materials Engineer within 10 calendar days of completing the stockpile.
- Any special handling, treatment or conditions of the RAP or it's 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 District Materials Engineer 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 completed by the District Materials Engineer.

Notify the District Materials Engineer 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 Form 820009r and submitted to the District Materials Engineer within 10 calendar days of completing the relocation. Reprocessing a Classified RAP stockpile may require additional sampling, testing, and new Form 820009r with reassignment of a RAP Identification Number.

Before January 1st of each year, the ~~c~~Contractor shall update Form 820009r on the status of each Classified RAP stockpile. Report the estimated quantity of RAP removed for the construction season completed and the available RAP in each stockpile for future use.

SAMPLING AND TESTING

Mix Design

A certified Level I Aggregate Technician shall obtain the samples. Samples for mix design testing shall be obtained from at least 3 locations. 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 District Materials Engineer prior to sampling.

Samples for mix design obtained from the RAP stockpile are the most representative, but not always possible when the mix designs are performed. When stockpile samples are not available, RAP samples shall be obtained by milling a minimum of 50 feet (15 m) of project length at each sample location. Other methods of sampling for mix design, including coring or air-hammer patch areas, may only be used with the approval of the District Materials Engineer.

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 (15 kg) 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.

Quality Control

When RAP quality control is required, the Contractor shall 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.
- HMA Plant – The Contractor shall obtain a representative sample of RAP from the HMA plant RAP feed belt for each lot of HMA 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.

Appendix B – Classified RAP Stockpile Report (Form 820009r)

820009r (December 2005)

Classified RAP Stockpile Report			**RAP Stockpile ID #**		
Stockpile Owner:					
SOURCE OF RAP	Project No.		Dates of Removal		
Route No.	From		To		
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		Aggregate Type	
1 / 2			
3 / 8	Pb =	Crushed Particles	%
No. 4			
No. 8	Gsb =	Aggr Friction Type 2	%
No. 16			
No. 30	Abs% =	Aggr Friction Type 3	%
No. 50			
No. 100	FAA =	Aggr Friction Type 4	%
No. 200			

Shaded boxes to be completed by the District Materials Engineer

Stockpile Owner Representative		Date
District Materials Representative		Date

SS-01049
(Replaces SS-01036)

Iowa Department of Transportation

SUPPLEMENTAL SPECIFICATIONS

FOR

QUALITY CONTROL PROGRAM FOR SMALL HMA PAVING QUANTITIES

Effective Date
April 17, 2007

THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SUPPLEMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

01049.01 GENERAL.

This Supplemental Specification applies to work on the Interstate, Primary, and Secondary road systems and defines the quality control programs for contracts with HMA mixtures. These requirements will not apply to mixtures used for HMA patching.

For each ~~approved HMA job mix formula applied to a combined contract quantity~~ HMA mixture bid item of more than 1000 tons (1000 Mg), all requirements of Article 2303.04 of the Standard Specifications shall apply.

For each ~~approved HMA job mix formula applied to a combined contract quantity~~ HMA mixture bid item of 1000 tons (1000 Mg) or less shall be defined as small quantities and shall meet the requirements of this Supplemental Specification.

01049.02 QUALITY CONTROL FOR SMALL QUANTITIES.

A. Mix Design.

The Job Mix Formula (JMF) shall be prepared by the Contractor and approved by the Engineer prior to HMA production. The mix design shall comply with Article 2303.02 of the Standard Specifications and Materials I.M. 510.

B. Plant Production.

The calibration of the HMA production plant for the JMF shall be current and not more than 12 months old.

The Contractor shall use certified asphalt binder and approved aggregate sources meeting the JMF. The plant shall maintain an asphalt binder log to track the date and time of binder delivery. The HMA delivery tickets shall identify the JMF.

The Contractor shall monitor the quality control test results and make adjustments to keep the mixture near the target JMF values.

C. Construction.
Density measurements shall be taken of the compacted mixture, except when Class II compaction is specified. The Contractor's field quality control laboratory compaction shall be used for field density control as specified in Article 2303.04 of the Standard Specifications. The Engineer may accept the density of the compacted layer based on cores or density gauge. The Engineer may waive density measurement provided the compaction has been thorough and effective. Density measurements of the compacted mixture shall be taken no later than the next working day following placement and compaction.

For small quantities, a lot will be the entire quantity of each HMA mixture bid item.

The quality index for density will not apply to small quantities.

D. Sampling and Testing.
Material sampling and testing is for production quality control only. Acceptance of mixture is based on Contractor certification. The Contractor shall perform a minimum of one aggregate cold-feed and one loose HMA test per lot. Sampling and testing of loose HMA is only required for mechanically placed mixture. All sampling and testing procedures shall follow the Standard Specifications and Materials I.M.s using certified technicians and qualified testing equipment. The Engineer may approve alternative sampling procedures. The sample shall be taken between the first 100 to 200 tons (100 to 200 Mg) of production. No split samples for agency ~~correlation~~ verification testing are required.

Asphalt binder will be accepted based on the asphalt supplier's shipment certification. No binder sampling or testing is required.

No material sampling or testing is required for daily HMA production of less than 100 tons (100 Mg) on any project.

E. Certification.
The Contractor shall provide a certification for the production of any mixture in which the requirements in this Supplemental Specification for small quantities are applied. The test results and certification statement shall be placed on the Daily HMA Plant Report (Form 800241). The Daily HMA Plant Report for certified HMA may be submitted at the end of the project for all certified HMA quantities, or submitted at intervals for portions of the certified quantity. The certification statement shall be as follows:

> "The HMA mixture contains certified asphalt binder and approved aggregate as specified in the approved mix design and was produced in compliance with the provisions of SS-01049.02, Quality Control for Small HMA Paving Quantities."

01049.03 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.

A completed Daily HMA Plant Report with the certification statement is required for ~~acceptance~~ 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. Payment for the quality control requirements for small quantities will not be measured separately and shall be considered incidental to the items of HMA mixtures in the contract.

Iowa Department of Transportation

DEVELOPMENTAL SPECIFICATIONS

FOR

HOT MIX ASPHALT MIXTURES - JOB MIX FORMULA APPROVAL BY TEST STRIP METHOD

Effective Date
August 20, 2002

THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

01003.01 DESCRIPTION

This work shall consist of the production of HMA mixture by the Contractor in limited amounts for the purpose of confirming the properties of the mixture and subsequent approval of the Job Mix Formula (JMF). This procedure shall apply to all paving mixtures with plan quantities of at least 5000 tons (5000 Mg) except shoulders, detours, temporary pavement, patching, or base widening. A JMF approved for a project may be used on other projects without additional test strip confirmation, provided that production quality control test results show consistent compliance with the requirements. These Developmental Specifications are intended to modify the specification requirements for test strips to establish roller patterns in Article 2303.03, D, of the Standard Specifications and the requirements for JMF approval in Article 2303.04, A, of the Standard Specifications.

Prior to constructing the test strip, the Contractor must submit a laboratory tested JMF for each mixture to be approved for use on the project.

01003.02 MATERIALS

The aggregates and asphalt binder used in the construction of the test strip shall be the same materials as identified on the laboratory JMF.

01003.03 CONSTRUCTION

The Contractor has the option of constructing a test strip on the project, or off site. When constructed on the project, the test strip for the intermediate course shall be placed as part of the base course or intermediate course; and test strips for surface courses shall be placed as part of the intermediate course. Test strips on the project will be limited to a maximum of 1250 tons (1250 Mg). The Contractor may elect to make adjustments to the mixture proportions during the construction of the test strip in order to refine the JMF. Upon completion of the test strip, production of the JMF mixture being evaluated shall cease for the project until test results are provided to the Engineer and the JMF is approved.

The Contractor shall provide documentation of the compaction procedures used. At the direction of the Engineer, additional test strips may be required if a successful rolling pattern was not established.

01003.04 QUALITY CONTROL

A. Sampling
The Contractor must notify the Engineer at least 24 hours in advance of placing the test strip. The Contractor shall obtain at least three 60 pound (27 kg) loose HMA samples from the test strip in accordance with Materials I.M. 322. The Contractor shall obtain at least one sample of the cold feed aggregate for gradation testing. If a change is made to the aggregate proportions during the placement of the test strip the Engineer may require additional cold feed samples. All samples shall be split and retained for verification

The Engineer may require the Contractor to submit samples of the individual aggregate stockpiles, when needed to confirm the aggregate properties shown on the JMF.

The number of density core samples obtained for the test strip will be increased by one and the low core result will not be used in the Quality Index (Q.I.) density formula for payment for the test strip quantity.

If the specifications for the surface mixture require an anti-strip agent, the test strip for the surface mixture will be used to evaluate the effectiveness of, or need for, the anti-strip agent. When moisture sensitivity testing is required, approval of the JMF includes compliance of the moisture sensitivity testing. In this case, the Contractor must construct the surface test strip far enough in advance of placing the surface course so that moisture sensitivity testing can be completed prior to placing the surface course. The Engineer may require extra mixture samples be obtained for the evaluation of anti-strip agents.

B. Testing
The Contractor shall test at least two of the uncompacted HMA samples obtained for JMF analysis and approval. The Contractor shall test at least one cold feed aggregate sample for gradation. The Engineer will select split samples to test for JMF review.

If the Contractor has agreed to use the ignition oven method for gradation control, calibration of the oven for each mixture shall be accomplished prior to or during test strip construction. The Contractor shall test at least one of the uncompacted HMA samples in the ignition oven and perform a gradation of the resulting aggregate sample.

C. JMF Approval
Approval of the JMF will be based on testing of plant produced mixture for compliance with Article 2303.02 of the Standard Specifications.

- If the test strip test results show reasonable compliance with the mix design requirements, the JMF will be approved and the Contractor may proceed with full production.
- If the tests indicate the JMF needs adjustment and the Contractor can demonstrate a reasonable probability to meet the requirements, the Contractor will be allowed one days full production to adjust the mixture and establish compliance with the specified mixture criteria. If compliance is not established after one day's production, the Contractor shall construct additional test strips as needed to prove the acceptability of the JMF.
- If the test strip test results indicate that extraordinary adjustments are needed to bring the mixture into compliance, the Contractor shall construct a second test strip to prove the acceptability of the JMF. If the test strip results from the second test strip fail to comply, the Contractor shall submit a new laboratory tested JMF prior to placing a third test strip for approval.

- If the Contractor elects to change aggregate sources, a new laboratory tested JMF must be submitted prior to constructing a test strip for approval of the JMF.

JMF approval will normally be granted the same day that acceptable test results are provided to the Engineer.

The Engineer may examine the correlation of test results between the Contractor and the District Materials Laboratory; however, noncorrelation will not be used as the sole basis for rejection of the JMF. When noncorrelation occurs for one or more tests, the District Materials Laboratory test results for those tests will be used for evaluation of the JMF. Correlation will be established before the Contractor's test results can be used for acceptance of the mixture.

01003.05 METHOD OF MEASUREMENT

The Engineer will measure the quantities of the various items of work involved in the construction of the test strips in accordance with Article 2303.05 of the Standard Specifications. Test strips constructed off site will not be measured for payment.

01003.06 BASIS OF PAYMENT

The Contractor will be paid the contract unit price for the HMA mixture and the asphalt binder incorporated into the test strip on the project in accordance with Article 2303.06 of the Standard Specifications. Test strips constructed off site will not be paid for. Intermediate course mixture incorporated into the base course as a test strip will be paid for at the contract unit price for intermediate mixture. Surface mixture incorporated into the intermediate course as a test strip will be paid for at the contract unit price for surface mixture.

SP-010223
(New)

Iowa Department of Transportation

SPECIAL PROVISION

FOR

HMA 100M ESAL INTERMEDIATE AND SURFACE MIXTURES

Adair County
IM-080-2(169)87--13-01

Iowa County
IM-080-6(241)205--13-48

Effective Date
March 15, 2005

THE STANDARD SPECIFICATIONS, SERIES OF 2001, ARE AMENDED BY THE FOLLOWING ADDITIONS AND MODIFICATIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

010223.01 DESCRIPTION

This specification contains provisions that shall modify, supplement, and expand the requirements of the Contract Plans, Section 2303 of the Standard Specifications including its supplements for Hot Mix Asphalt Mixtures, and DS-01003, Hot Mix Asphalt Mixtures – Job Mix Formula Approval by Test Strip Method.

010223.02 BLENDED AGGREGATES.

Article 2303.02, B, of the Standard Specifications shall be modified as follows: The gradation maximum control point at the No. 8 sieve for surface and intermediate mixtures shall be 34% passing for the ¾-inch mixture size and 39% for the ½-inch mixture size. All other control points as specified in Materials I.M. 510 still apply.

010223.03 CONSTRUCTION DENSITY

Article 2303.04, C, of the Standard Specifications shall be modified as follows: Field density results shall be reported within 4 hours of the start of the next work day. If the density quality index (QI) is less than 0.00, the Contractor shall immediately perform a new test strip on the next 1250 tons to demonstrate that the paving operation can achieve a density QI above 0.72. Placement of HMA shall cease until the results of the test strip are reported and approved by the Engineer.

010223.04 JOB MIX APPROVAL BY TEST STRIP METHOD

DS-01003, Job Mix Approval by Test Strip Method shall be modified as follows:

1. The initial test strip for the intermediate mixture will be limited to one day of full production, not to exceed 2500 tons. If a second test strip is required for the intermediate mixture, it will be limited to 1250 tons.
2. The initial test strip for the intermediate mixture shall be sampled and tested at the normal frequencies specified in Article 2303.04, B, 1, of the Standard Specifications. One additional sample shall be taken during the first 1250 tons of initial test strip production.
3. If the second test strip for the intermediate mixture fails, the third test strip shall be placed in the adjacent lane.
4. Documentation of the rolling pattern during construction of any test strip shall include mix temperature behind the paver, density growth curves, and any mixture or compaction adjustments.

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