UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 11 26

HOT-MIX BITUMINOUS BASE COURSE FOR ROADS AND STREETS

05/20

PART 1 GENERAL

1.1 UNIT PRICES
1.1.1 Measurement
1.1.2 Basis for Payment
1.2 REFERENCES
1.3 SUBMITTALS
1.4 QUALITY CONTROL
1.4.1 Qualifications
1.4.2 Test Results
1.4.3 Batch Tickets
1.4.4 Aggregates
1.4.5 Mineral Filler
1.4.6 Bituminous Materials
1.5 ENVIRONMENTAL REQUIREMENTS
1.6 ACCEPTANCE
1.6.1 Tolerances
1.6.2 Test Section

PART 2 PRODUCTS

2.1 AGGREGATES
2.1.1 Coarse Aggregates
2.1.1.1 Aggregate Wear
2.1.1.2 Aggregate Loss
2.1.1.3 Fractured Faces
2.1.1.4 Flat and Elongated Pieces
2.1.1.5 Dry Weight of Crushed Slag
2.1.2 Fine Aggregates
2.1.3 Mineral Filler
2.1.4 Liquid Limit and Plasticity Index
2.2 BITUMINOUS MATERIALS
2.2.1 Asphalt Cement
2.3 AGGREGATE GRADATION
2.4 COMPOSITION OF MIXTURE
2.4.1 Job-Mix Formula (JMF)

2.4.1.1 Develop the JMF
2.4.1.2 Option
2.4.2 JMF Requirements
2.4.2.1 Adjustment to JMF
2.5 RECYCLED ASPHALT PAVEMENT
2.5.1 RAP Aggregates and Asphalt Cement
2.5.2 RAP Mix
2.6 EQUIPMENT, TOOLS, AND MACHINES
2.6.1 Bituminous Plant
2.6.2 Mixing Plants
2.6.3 Asphalt Paver
2.6.4 Hauling Equipment
2.6.5 Rollers
2.6.6 Straightedge

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING COURSE
3.2 MIXING
3.2.1 Preparation of Mineral Aggregates
3.2.2 Preparation of Bituminous Mixtures
3.2.3 Water Content of Aggregates
3.2.4 Storage of Bituminous Paving Mixture
3.3 TRANSPORTATION OF BITUMINOUS MIXTURE
3.4 PLACING
3.4.1 Tack Coat
3.4.2 Offsetting Joints in Bituminous Base Course
3.4.3 Use of Laydown Machine
3.4.4 Placing Strips Succeeding Initial Strips
3.4.5 Hand Spreading in Lieu of Machine Spreading
3.5 COMPACTION OF MIXTURE
3.5.1 Correcting Deficient Areas
3.6 JOINTS
3.6.1 General
3.6.2 Transverse Joints
3.6.3 Longitudinal Joints
3.7 EDGES OF PAVEMENT
3.8 QUALITY CONTROL
3.8.1 Sampling
3.8.2 In-Place Density
3.8.3 Laboratory Air Voids and Theoretical Maximum Density
3.8.4 Plan Grade
3.8.5 Surface Smoothness
3.8.6 Temperatures
3.9 PROTECTION OF PAVEMENT

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA | **UFGS-32 11 26 (May 2020)**

Preparing Activity: USACE | **Superseding UFGS-32 11 26 (August 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION 32 11 26

HOT-MIX BITUMINOUS BASE COURSE FOR ROADS AND STREETS
05/20

****

NOTE: This guide specification covers the requirements for hot-mix bituminous base course for road and street pavements.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

Use Section 32 12 16.16 ROAD-MIX ASPHALT PAVING to specify wearing or surface courses for roads and streets.

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: These paragraphs will be deleted when lump sum payment is desired.

****

1.1.1 Measurement

The amount paid for will be the number of metric 2000-pound tons of bituminous mixture used in the accepted work. Weigh bituminous mixture after mixing. No payment will be made for defective areas until corrected.

1.1.2 Basis for Payment

The quantities of bituminous base course will be paid for at the respective contract unit prices in the bid schedule. Payment will constitute full compensation for preparing and reconditioning the underlying layer; for furnishing all material, equipment, plant, and tools; and for all labor and other incidentals necessary to complete the work required by this section.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C183/C183M	(2015) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D1856	(2009; R 2015) Recovery of Asphalt from Solution by Abson Method
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials

ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6373	(2016) Standard Specification for Performance Graded Asphalt Binder
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sources of Aggregates

Job Mix Formula; G[, [_____]]

SD-06 Test Reports

Sources of Aggregates

Bituminous Materials

Test Section; G[, [_____]]

Service Record; G[, [_____]]

SD-09 Manufacturer's Field Reports

Batch Tickets

1.4 QUALITY CONTROL

1.4.1 Qualifications

****

NOTE: Include bracketed sentence for Corps-managed projects.

****

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM D3666, including all applicable test procedures. Do not start work requiring testing until the facilities have been inspected and approved. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project. [In addition, all contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Articl for costs and scheduling.]

1.4.2 Test Results

Verify that materials comply with the specification. When a material source is changed, test the new material for compliance. When deficiencies are found, repeat the initial analysis and retest the material already placed to determine the extent of unacceptable material. Replace or repair all in-place unacceptable material to conform to the contract requirements. Submit copies of field tests results within [24] [_____] hours after the tests are performed and certified copies of tests results for approval not less than [30] [_____] days before material is required for the work.

1.4.3 Batch Tickets

Provide batch tickets in accordance with AASHTO M 156.

1.4.4 Aggregates

****

NOTE: Satisfactory service record for an aggregate will be determined based on the aggregate's ability to resist polishing, raveling, stripping, and degradation under traffic and climate conditions similar to that expected during its use. If performance data indicate that an aggregate is susceptible to one or more of the above-mentioned problems, mitigate the problem or reject that source of aggregate.

****

Select sources of aggregates and submit a plan for operation of a new source of aggregates at least 45 [_____] days in advance of starting production. If a previously developed source is selected, submit test results with evidence that central plant hot-mix bituminous pavements constructed with the aggregates have had a satisfactory service record of at least 5 years under similar climatic conditions. Include in the service record a tabulation of aggregate gradation and quality test results, typical hot-mix asphalt mix design using the aggregate, and a list of representative paving projects using the aggregate. Make such tests and other investigations as necessary to determine whether or not aggregates meeting the requirements specified can be produced from the proposed sources. Sample aggregates in accordance with ASTM D75/D75M and test them at the start of production.

1.4.5 Mineral Filler

Sample mineral filler in accordance with ASTM C183/C183M.

1.4.6 Bituminous Materials

Select sources where bituminous materials are obtained in advance of time when materials will be required in the work. Sample bituminous materials in accordance with ASTM D140/D140M. Submit test results not less than 30 [_____] days before such material is required for use in the work.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not construct bituminous courses when the underlying course contains free surface water, or when temperature of the surface of the underlying

course is below 5 degrees C 40 degrees F, unless otherwise directed.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of bituminous base course is based on compliance with the tolerances presented in Table 1. Remove and replace bituminous base course represented by the failing tests or submit repair plan for approval.

TABLE 1	
Attribute	Measurement
Plant Mixture	
Delivery to Laydown Machine	Minimum 121 deg C 250 deg F
Laboratory Air Voids	3 to 5 percent
Finished Mat	
Mat Density (avg of 4 cores/lot)	Minimum 92 percent of TMD
Joint Density (avg of 4 cores/lot)	Minimum 90.5 percent of TMD
Grade	plus/minus 15 mm 0.05 foot
Smoothness	plus/minus 10 mm 3/8 inch
Longitudinal Joint Offset	Minimum 300 mm 1 foot
Transverse Joint Offset	Minimum 600 mm 2 feet

1.6.2 Test Section

At the start of plant operation, prepare a quantity of the mixture sufficient to construct a test section at least 30 meters 100 feet long and two spreader widths wide. Place, spread, and compact the mixture with equipment to be used in the project and in accordance with requirements specified herein. Construct a cold joint between spreader widths. Test and evaluate the test section and conform to all specified requirements. If tests indicate that the pavement does not conform to the tolerances of Table 1, remove and construct additional test sections and sample for conformance to specification requirements. Do not start production of the bituminous base course mixture without approval.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregates consisting of crushed stone, crushed slag, crushed gravel screenings, sand, and mineral filler, as required. The portion of these materials retained on the 4.75 mm No. 4 sieve is classified as coarse aggregate; the portion passing the 4.75 mm No. 4 sieve and retained

on the 0.075 mm No. 200 sieve, as fine aggregate; and the portion passing the 0.075 mm No. 200 sieve, as mineral filler.

2.1.1 Coarse Aggregates

Provide coarse aggregates consisting of clean, sound, durable fragments of crushed stone, crushed slag, or crushed gravel meeting the following requirements:

2.1.1.1 Aggregate Wear

Percentage of wear not exceeding 40 after 500 revolutions, as determined in accordance with ASTM C131/C131M.

2.1.1.2 Aggregate Loss

****

NOTE: Use the magnesium-sulfate soundness test to exclude aggregates known to be unsatisfactory or for evaluating aggregates from new sources. Insert the percentage of loss will in the blanks based on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years and will assure that aggregates from new sources will be equal to or better than these aggregates.

****

Percentage of loss not exceeding 18 [_____] after five cycles performed in accordance with ASTM C88, using magnesium sulfate.

2.1.1.3 Fractured Faces

At least 75 percent by weight of coarse aggregate containing two or more fractured faces produced by crushing when tested in accordance with ASTM D5821.

2.1.1.4 Flat and Elongated Pieces

Particle shape essentially cubical and containing not more than 20 percent, by weight, of flat particles and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.

2.1.1.5 Dry Weight of Crushed Slag

Dry weight of crushed slag not less than 1200 kg/cubic meters 75 pcf as determined in accordance with ASTM C29/C29M.

2.1.2 Fine Aggregates

Provide fine aggregates consisting of clean, durable natural sands; manufactured sands prepared by crushing stone, slag, or gravel, or any combination of natural and manufactured sands. Natural sands consist of grains of clean, hard, durable rock. Limit the quantity of uncrushed material to a maximum of 25 percent by weight of total aggregate.

2.1.3 Mineral Filler

Mineral filler conforming to ASTM D242/D242M.

2.1.4 Liquid Limit and Plasticity Index

Measure liquid limit and plasticity index on the portion of the aggregate passing the 0.425 mm No. 40 sieve in accordance with ASTM D4318. Requirements apply to the individual aggregate fractions and the combined blend in the completed base course. Provide aggregates classified as either nonplastic or having a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.2 BITUMINOUS MATERIALS

2.2.1 Asphalt Cement

****

NOTE: Specify Performance Grade (PG) asphalt wherever available. When selecting PG asphalt cements, it is recommended that 98 percent reliability be used. For low volume roads, use a 50 percent reliability. Also, consider local experience of State Department of Transportation and availability of desired asphalt grade.

****

Provide asphalt cement binder conforming to ASTM D6373 Performance Grade (PG) [_____].[As an alternate, provide ASTM D3381/D3381M Viscosity Grade [_____] or ASTM D946/D946M penetration grade [_____] asphalt cement.]

2.3 AGGREGATE GRADATION

****

NOTE: Delete from Table 1 the gradations that will not be used as a part of this project. Use of gradation 3 is limited to shoulders and leveling courses. Use Section 32 12 16.16 ROAD-MIX ASPHALT PAVING to specify wearing or surface courses for roads and streets.

Generally, the minimum compacted layer thickness for gradation No. 1 would be at least 57 mm 2.25 inches, the minimum compacted layer thickness for gradation No. 2 would be at least 37.5 mm 1.5 inches, and the minimum compacted layer thickness for gradation No. 3 would be at least 25 mm 1.0 inch.

****

Provide mineral aggregate of such size that percentage composition by weight, as determined by ASTM C136/C136M, conforms to the gradation specified in TABLE 2, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

TABLE 2. AGGREGATE GRADATION			
Percent Passing			
Sieve Size (mm)	Gradation 1	Gradation 2	Gradation 3
25 1 inch	100	---	---
19 3/4 inch	90-100	100	---
12.5 1/2 inch	68-88	90-100	100
9.5 3/8 inch	60-82	72-88	90-100
4.75 No. 4	45-67	53-73	58-78
2.36 No. 8	32-54	38-60	40-60
1.18 No. 16	22-44	26-48	28-48
0.60 No. 30	15-35	18-38	18-38
0.30 No. 50	9-25	11-27	11-27
0.15 No. 100	6-18	6-18	6-18
0.075 No. 200	3-6	3-6	3-6

2.4 COMPOSITION OF MIXTURE

****

NOTE: For state DOT Superpave mixes, specify the design ESALs from site-specific traffic studies or the following:

Design ESALs (millions)	Typical Roadway Application
< 0.3	Very light traffic; no trucks (local/county roads, city streets)
0.3 to < 3	Medium traffic (collector roads, most county roads)
3 to 30	High traffic (most of interstate system, climbing lanes, truck weigh stations)

Specify the nominal maximum aggregate size (NMAS) in accordance with state DOT guidance.

****

2.4.1 Job-Mix Formula (JMF)

2.4.1.1 Develop the JMF

Provide an asphalt mix composed of a mixture of well-graded aggregate,

mineral filler if required, and asphalt binder. Size the aggregate fractions, handle in separate size groups, and combine in such proportions that the resulting mixture meets the grading requirements of Table 2. Submit proposed JMF; do not produce hot-mix asphalt for payment until a JMF has been approved. Design the hot-mix asphalt in accordance with Marshall or Superpave procedures and the criteria shown in Table 3. Use the hand-held hammer to compact the specimens for Marshall mix design. Design Superpave mixes with the number of gyrations specified in Table 3, unless the DOT option is chosen. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M, is less than 75, reject the aggregates or treat the asphalt mixture with an approved anti-stripping agent. Add the amount of anti-stripping agent sufficient to produce a TSR of not less than 75. Provide an antistrip agent, if required, at no additional cost. Provide sufficient materials to produce 90 kg 200 pound of blended mixture for verification of mix design at least 14 days prior to construction of test section.

2.4.1.2 Option

A currently used DOT Superpave hot mix may be used in lieu of developing a Marshall hot mix design as described herein. Design the Superpave volumetric mix in accordance with AI MS-2 and ASTM D6925. Provide a nominal maximum aggregate size (NMAS) of [37.5] [25.0] [19.0] [12.5] [9.5] mm [1-1/2] [1] [3/4] [1/2] [3/8] inch. Other DOT hot mix design methods may be suitable, as approved. Select the number of compaction gyrations, Ndes, based on a design traffic of [_____] equivalent single axle loads (ESALs).

2.4.2 JMF Requirements

****

NOTE: In Table 3, use a 75 Blow or 75 gyration compactive effort for all asphalt mixtures designed for tire pressures of 690 kPa 100 psi or higher. For mixtures designed for tire pressures less than 690 kPa 100 psi, use a 50 Blow or 50 gyration compactive effort. Also, use a 50 Blow or 50 gyration compactive effort for shoulder pavement mixtures.

In Table 3, delete the column which does not apply, unless the project includes both 75 Blow or 75 gyration and 50 Blow or 50 gyration mixes. If both mixes are used on a project, identify which mix is applicable to which location.

Select the appropriate gradation and VMA requirements in Table 3 to be consistent with the gradation chosen in Table 2 and delete the other two lines.

Remove item u., below if RAP is not used in the job.

****

Submit in writing the job mix formula for approval at least 30 [_____] days prior to the start of the test section including as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt binder.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt performance grade [viscosity grade] [penetration grade].

e. Number of blows of hand-held hammer per side of molded specimen. (NA for Superpave)

f. Number of gyrations of Superpave gyratory compactor, (NA for Marshall mix design)

g. Laboratory mixing temperature.

h. Lab compaction temperature.

i. Temperature-viscosity relationship of the asphalt cement.

j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

k. Graphical plots of stability (NA for Superpave), flow (NA for Superpave), air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

l. Specific gravity and absorption of each aggregate.

m. Percent natural sand.

n. Percent particles with 2 or more fractured faces (in coarse aggregate).

o. Fine aggregate angularity.

p. Percent flat or elongated particles (in coarse aggregate).

q. Tensile Strength Ratio(TSR).

r. Antistrip agent (if required) and amount.

s. List of all modifiers and amount.

t. Correlation of hand-held hammer with mechanical hammer (NA for Superpave).

u. Percentage and properties (asphalt content, binder properties, and aggregate properties) of reclaimed asphalt pavement (RAP) in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

Table 3. Mix Design Criteria

Test Property	50 Blows or Mix Gyrations	75 Blows or Mix Gyrations
Stability, N pounds, minimum (NA for Superpave)	*60001350	*80001800

Table 3. Mix Design Criteria		
Test Property	50 Blows or Mix Gyrations	75 Blows or Mix Gyrations
Flow,0.25 mm 0.01 inch, (NA for Superpave)	8-18	8-16
Air voids, percent	3-5	3-5
Percent Voids in mineral aggregate (VMA),(minimum)		
Gradation 1	14.0	14.0
Gradation 2	15.0	15.0
Gradation 3	16.0	16.0
TSR, minimum percent	75	75
* This is a minimum requirement.		
** Calculate VMA in accordance with AI MS-2, based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate.		

2.4.2.1 Adjustment to JMF

The JMF for each mixture is in effect until a new formula is approved in writing. Should a change in sources of any materials be made, perform a new mix design and obtain approval before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No. 4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50 sieves; and plus or minus 1 percent on the 0.15 mm No. 100 sieve. Adjustments to the JMF are limited to plus or minus 1.0 percent on the 0.075 mm No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

2.5 RECYCLED ASPHALT PAVEMENT

****

NOTE: If RAP is not permitted, include the first sentence in brackets and delete the following sets of brackets and text. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 30 percent of the total asphalt content.

****

[RAP is not permitted.] [Provide recycled asphalt consisting of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. Recycled Asphalt Shingles (RAS) are not permitted.

Provide RAP of a consistent gradation, asphalt content, and properties obtained from on-base stockpiles or asphalt pavement milled under this contract. Maintain RAP stockpiles free from contamination, including coal-tar sealers. When RAP is fed into the plant, limit the maximum RAP chunk size to 50 mm 2 inches. The individual aggregates in a RAP chunk are not to exceed the maximum size aggregate of the gradation specified in Table 1. Design the recycled asphalt mixture using procedures contained in AI MS-2. Provide RAP job mix that meets the requirements of paragraph COMPOSITION OF MIXTURE. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 30 percent of the total asphalt content.]

2.5.1 RAP Aggregates and Asphalt Cement

[Provide a blend of aggregates used in the recycled mix that meet the requirements of paragraph AGGREGATES. Establish the percentage of asphalt in the RAP for the mixture design according to ASTM D2172/D2172M using the appropriate dust correction procedure.]

2.5.2 RAP Mix

[Select the virgin asphalt binder as described below:

a. For 0-20 percent recycled binder content - no change in virgin binder selection.

b. For 20+ to 30 percent recycled binder content - select virgin binder one grade softer than normal for both the high and low temperature limits, i.e., PG 64-22 would soften to PG 58-28.]

2.6 EQUIPMENT, TOOLS, AND MACHINES

2.6.1 Bituminous Plant

Provide a bituminous plant of such capacity to produce the quantities of bituminous mixtures required for the project within the completion time of the contract. Provide hauling equipment, paving machines, rollers, miscellaneous equipment, and tools in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output. Provide a sufficient number of adequately trained personnel during paving operations to produce a pavement meeting the requirements in this specification.

2.6.2 Mixing Plants

Provide mixing plants in accordance with AASHTO M 156 which are automatic or semiautomatic controlled, commercially manufactured units designed, coordinated, and operated to consistently produce a mixture within the job-mix formula (JMF). Prequalify drum or batch mixers at the production rate to be used during actual mix production. The prequalification tests include extraction in accordance with ASTM D2172/D2172M and recovery of the asphalt binder in accordance with ASTM D1856.

2.6.3 Asphalt Paver

Provide asphalt pavers which are self-propelled, with an activated screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade, with sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. Provide a receiving

hopper of sufficient capacity to permit a uniform spreading operation and equipped with a distribution system to place the mixture uniformly in front of the screed without segregation and produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. If screed extensions are used to increase the paving width, provide auger extensions to distribute the hot mix along the additional screed length. Equip the paver with a control system capable of automatically maintaining the specified screed elevation. Automatically actuate the control system from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

2.6.4 Hauling Equipment

Provide trucks for hauling hot-mix asphalt having tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a release agent specifically designed for use with hot mix asphalt. Provide each truck with a suitable cover to protect the mixture from adverse weather. When necessary to maintain the mixture at the specified temperature, insulate or heat truck beds and securely fasten covers (tarps).

2.6.5 Rollers

Provide the number, type, and weight of rollers sufficient to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate or displacement of the asphalt mixture.

2.6.6 Straightedge

Furnish and maintain at the site, in good condition, one 3.7 meter 12 foot straightedge for each bituminous paver for use in testing the finished surface. Construct straightedges of aluminum with blades of box or box-girder cross section and a flat bottom reinforced to insure rigidity and accuracy. Provide handles to facilitate movement on pavement.

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING COURSE

****

NOTE: If the underlying surface to be paved is an unbound granular layer, apply a prime coat, especially if this layer will be exposed to weather for an extended period of time prior to covering with an asphalt mixture.

If the underlying surface to be paved is an existing asphalt or concrete layer, apply a tack coat to ensure an adequate bond between layers.

****

Prior to placing the bituminous base course, clean the underlying surface of foreign or objectionable matter. Apply a [prime coat] [tack coat] in accordance with 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.2 MIXING

3.2.1 Preparation of Mineral Aggregates

Place and maintain each aggregate stockpile in such a manner to prevent segregation. Regulate rates of feed of aggregates so that the moisture content and temperature of aggregates will be within tolerances specified herein. Provide dry storage for mineral filler.

3.2.2 Preparation of Bituminous Mixtures

****

NOTE: For Performance Graded (PG) asphalt cements, insert the plant temperature range from the Table below into the last sentence of the following paragraph.

Performance Graded Asphalt Plant Mixing Temperatures	
Binder Grade	**Mixing Temp Range (Deg C) (Deg F)**
PG 46-28	**115 - 146240 - 295**
PG 46-34	**115 - 146240 - 295**
PG 46-40	**115 - 146240 - 295**
PG 52-28	**115 - 149240 - 300**
PG 52-34	**115 - 149240 - 300**
PG 52-40	**115 - 149240 - 300**
PG 52-46	**115 - 149240 - 300**
PG 58-22	**127 - 154260 - 310**
PG 58-28	**127 - 154260 - 310**
PG 58-34	**127 - 154260 - 310**
PG 64-22	**129 - 160265 - 320**
PG 64-28	**129 - 160265 - 320**
PG 64-34	**129 - 160265 - 320**
PG 67-22	**135 - 163275 - 325**
PG 70-22	**138 - 166280 - 330**
PG 70-28	**135 - 163275 - 325**

Performance Graded Asphalt Plant Mixing Temperatures	
Binder Grade	**Mixing Temp Range (Deg C) (Deg F)**
PG 76-22	**141 - 168285 - 335**
PG 76-28	**138 - 166280 - 330**
PG 82-22	**143 - 171290 - 340**

****

Convey aggregates, mineral filler, and bitumen into the mixer in proportionate quantities required to meet the JMF. Set the mixing time as required to obtain a uniform coating of the aggregate with the bituminous material. Limit the temperature of bitumen at time of mixing not to exceed 150 degree C 300 degrees F. Maintain the temperature of aggregate and mineral filler in the mixer within the range of [_____] to [_____] degree C [_____] to [_____] degrees F when bitumen is added. Overheated and carbonized mixtures or mixtures that foam will be rejected.

3.2.3 Water Content of Aggregates

Perform drying operations to reduce the water content of mixture to less than 0.75 percent. Conduct the water content test in accordance with ASTM D2216. If the water content is determined on individual hot bin samples, calculate the water content as a weighted average based on composition of blend.

3.2.4 Storage of Bituminous Paving Mixture

Store the mixture according to the requirements of AASHTO M 156. Empty uninsulated surge bins at the end of each working day. If excessive heat loss, segregation,or oxidation of the stored asphalt mixture is observed, discontinue the use of the surge bin.

3.3 TRANSPORTATION OF BITUMINOUS MIXTURE

Transport the bituminous mixture from the paving plant to the site in trucks having tight, clean, smooth beds lightly coated with an approved release agent to prevent adhesion of mixture to truck bodies. Drain excessive release agent prior to loading. Cover each load with canvas or other approved material of ample size to protect mixture from weather and prevent loss of heat. Reject loads that have crusts of cold, unworkable material or have become wet by rain. Do not haul over freshly placed material.

3.4 PLACING

Do not place bituminous mixtures without ample time to complete placement and compaction during daylight hours, unless artificial lighting is provided.

3.4.1 Tack Coat

Spray contact surfaces of previously constructed pavement, curbs, manholes, and similar structures with a tack coat conforming to the

requirements of Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.4.2 Offsetting Joints in Bituminous Base Course

Place the bituminous base course so that longitudinal joints are offset from joints in the underlying course by at least 300 mm 1 foot. Offset transverse joints by at least 600 mm 2 feet from transverse joints in the underlying course.

3.4.3 Use of Laydown Machine

Reject mixtures having temperatures less than 121 degrees C 250 degrees F when delivered to the laydown machine. Adjust the laydown machine and regulate the speed so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface conforms to the cross section, grade, and contour indicated. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture as nearly continuous as possible, and adjust the speed of placing to permit proper compaction. When segregation occurs in the mixture during placing, suspend the laydown operation until the cause is determined and corrected. Correct irregularities in alignment of the course left by the laydown machine by trimming directly behind machine. Immediately after trimming, thoroughly compact the edges of the course by tamping laterally with a lute. Do not permit distortion of the course during tamping.

3.4.4 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after the initial strip has been spread and compacted as specified below, overlap the screed of the laydown machine 12 to 25 mm 1/2 to 1 inch over the previously placed strip and sufficiently high so that compaction will produce a smooth, dense joint. Use a lute to push back the mixture placed on the edge of the previously placed strip to the edge of the strip being placed. Do not broadcast material onto the mat. Remove and waste excess mixture.

3.4.5 Hand Spreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, spread the mixture by hand. Prevent segregation during spreading. Do not broadcast material onto the mat. Remove and waste excess mixture. Maintain grade and smoothness tolerances presented in Table 1.

3.5 COMPACTION OF MIXTURE

Begin compaction as soon after placing as the mixture will bear roller without undue displacement. Do not permit delays in compacting the freshly placed mixture. After the initial rolling, perform preliminary tests of the crown, grade, and smoothness. Correct deficiencies so that the finished course will conform to requirements for the grade and smoothness specified in subpart: ACCEPTANCE. After meeting crown, grade, and smoothness requirements, continue rolling until a mat density of at least 92 percent of the theoretical maximum density (TMD) determined in accordance with ASTM D2041/D2041M is obtained. Roll the joints until until a joint density of at least 90.5 percent of the theoretical maximum density (TMD) determined in accordance with ASTM D2041/D2041M is obtained. Thoroughly compact areas inaccessible to rollers with hot hand tampers.

3.5.1 Correcting Deficient Areas

Remove mixtures that become contaminated or are defective. Do not permit skin patching of an area that has been rolled. Cut holes the full thickness of the base course so that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Spray sides with tack coat conforming to requirements of Section 32 12 13 BITUMINOUS TACK AND PRIME COATS. Place hot mix asphalt in the holes in sufficient quantity so that the finished surface will conform to grade, smoothness, and density requirements.

3.6 JOINTS

3.6.1 General

Carefully construct joints between old and new pavements or between successive day's work or joints that have become cold to establish a continuous bond between old and new sections of the course. Construct joints having the same texture, density, and smoothness as other sections of the course. Clean contact surfaces of previously constructed pavements that have become coated with dust, sand, or other objectionable material by brushing or cut back with approved power saw, as approved. Spray the surface against which new material is placed with a thin, uniform coat of tack coat conforming to requirements of Section 32 12 13 BITUMINOUS TACK AND PRIME COATS. Apply the material far enough in advance of placement of the fresh mixture to insure adequate curing. Take care to prevent damage or contamination of sprayed surface.

3.6.2 Transverse Joints

Pass the roller over the unprotected end of freshly placed mixture only when placing of the course is discontinued or when delivery of the mixture is interrupted to the extent that the unrolled material may become cold. In all cases, cut back the edge of the previously placed course a mimimum of 50 mm 2 inches to expose an even, straight, vertical surface for the full thickness of the course. In continuing placement of the strip, position the mechanical spreader on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.6.3 Longitudinal Joints

Cut back edges of a previously placed strip that have cooled or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective. In all cases, cut back the edge of the previously placed course a mimimum of 50 mm 2 inches to expose an even, straight, vertical surface for the full thickness of the course.

3.7 EDGES OF PAVEMENT

Neatly trim outside edges adjacent to shoulders.

3.8 QUALITY CONTROL

Perform tests in sufficient numbers and at the locations and times directed to ensure that materials, mixtures and compaction meet specified requirements. Obtain samples of finished pavement, including samples that span the longitudinal joint. Sample bituminous materials during

construction when shipments of bituminous materials are received or when necessary to assure that some condition of handling or storage has not been detrimental to the bituminous material.

3.8.1 Sampling

Obtain plant mix and in-place samples on a lot and sublot basis. Each full day's production or a maximum of 900 metric tonnes 1000 tons is considered a lot. Divide the lot into four (4) equal sublots and obtain random samples in accordance with ASTM D3665 within each sublot. Obtain plant mix samples from the haul truck or from behind the paver. Test for grade and smoothness on a total lot basis.

3.8.2 In-Place Density

Take one random core (100 mm 4 inches or larger in diameter) from the mat (interior of the lane) of each sublot, and one random core from the joint (immediately over joint) of each sublot, with each random core the full thickness of the layer being placed. When the random core is less than 25 mm 1 inch thick, do not include in the analysis. In this case, take another random core. After air drying to a constant weight, determine the density of each core in accordance with ASTM D2726/D2726M. Determine percent compaction using the TMD. Evaluate for acceptance in accordance with subpart: ACCEPTANCE. Remove and replace unacceptible lots.

3.8.3 Laboratory Air Voids and Theoretical Maximum Density

Calculate laboratory air voids by determining the bulk density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method of ASTM D2726/D2726M and determining the theoretical maximum density of each sublot sample using ASTM D2041/D2041M. Use the latest theoretical maximum density value to calculate the laboratory air voids for each sublot. Evaluate for acceptance in accordance with subpart: ACCEPTANCE. Complete and report all laboratory air void tests within 24 hours after completion of construction of each lot.

3.8.4 Plan Grade

Provide finished surfaces conforming, within tolerances specified, to the lines, grades, and cross sections indicated. Do not permit finished surfaces to vary more than the tolerances provided in subpart: ACCEPTANCE from the plan gradeline and elevation established and approved at the site. Maintain finished surfaces flush with finished surfaces of abutting pavements. Do not permit deviations from the plan gradeline and elevation in areas of pavements where closer conformance with plan grade and elevation is required for the proper functioning of drainage and other appurtenant structures involved.

3.8.5 Surface Smoothness

Provide finished surfaces not deviating from the testing edge of a straightedge more than the tolerances of subpart: ACCEPTANCE in any direction.

3.8.6 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job

site.

3.9 PROTECTION OF PAVEMENT

After final rolling of the pavement, do not permit vehicular traffic of any kind until the pavement has cooled to ambient temperature.

-- End of Section --