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USACE / NAVFAC / AFCEC / NASA | **UFGS-32 12 17 (April 2008)**
Change 1 - 11/13
Preparing Activity: NAVFAC | **Replacing without change**
UFGS-32 12 17 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2014
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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 12 17

HOT MIX BITUMINOUS PAVEMENT

04/08

-- End of Section Table of Contents --

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SECTION 32 12 17

HOT MIX BITUMINOUS PAVEMENT
04/08

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NOTE: This guide specification covers the requirements for hot-mix asphalt pavement for leveling, binder, and wearing courses using virgin materials.

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).
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****
NOTE: This guide specification is not intended for use in hot-mix recycling.
****

****
NOTE: The following information shall be shown on drawings:

1. Layout and geometry of paving.

2. Cross section and thickness of paving.
****

****
NOTE: Retain only the desired mixes in leveling, binder, and wearing courses. For airfield projects,

aggregate gradations shall be as shown in Table I . For vehicular pavement, show gradations for vehicular pavement from local state highway department (as appropriate to the Marshall Method for Design and Control of Bituminous Paving Mixtures). Generally, the maximum size of aggregate for wearing course should not exceed 40 percent of the designed thickness of the course (i.e., course thickness divided by 2.5); in no case should the aggregate size exceed 25 mm one inch or one-half the thickness of the compacted wearing course or two-thirds the thickness of any binder or leveling course; gradation requirements for the leveling course should be specified to suit the project and may vary from a fine wearing course mix to a coarse binder course mix as dictated by project requirements. When appropriate, the wearing course mix may be specified as an option for the leveling and/or binder course mixes.

****

PART 1 GENERAL

1.1 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 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) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO M 320	(2010) Standard Specification for

	Performance-Graded Asphalt Binder

ASPHALT INSTITUTE (AI)

AI MS-2	(1997 6th Ed) Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C188	(2009) Standard Test Method for Density of Hydraulic Cement
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D1073	(2011) Fine Aggregate for Bituminous Paving Mixtures
ASTM D1188	(2007; E 2010) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D140/D140M	(2009) Standard Practice for Sampling Bituminous Materials
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2011) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D242/D242M	(2009) Mineral Filler for Bituminous Paving Mixtures

ASTM D2726/D2726M	(2013) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3381/D3381M	(2013) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3666	(2013) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4867/D4867M	(2009) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D546	(2010) Sieve Analysis of Mineral Filler for Bituminous Paving Mixtures
ASTM D692/D692M	(2009) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D6927	(2006) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D70	(2009; E 2009) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D75/D75M	(2013) Standard Practice for Sampling Aggregates
ASTM D854	(2010) Specific Gravity of Soil Solids by Water Pycnometer
ASTM D946/D946M	(2009a) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979/D979M	(2012) Sampling Bituminous Paving Mixtures

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[SD-04 Samples

****

NOTE: Include requirements for test section[s] in all projects with 4,500 metric tons 5,000 tons or more of asphaltic concrete. Test sections may be considered necessary and specified in smaller projects if the pavement structure is critical and the cost of a test section is deemed to be justified. Normally, a test section is required only for the wearing course. If it is deemed necessary to test other courses, the specifications must be modified to suit.

****

Bituminous pavement

] SD-05 Design Data

Job-mix formula

Submit a job-mix formula, prepared specifically for this project [within one year of submittal for roads], for approval [by the Government] prior to preparing and placing the bituminous mixture. Design mix using procedures contained in Chapter V, Marshall Method of Mix Design, of AI MS-2. Formulas shall indicate physical properties of the mixes as shown by tests made by a commercial laboratory approved by the Contracting Officer, using materials identical to those to be provided on this project. Submit formulas with material samples. Job-mix formula for each mixture shall be in effect until modified in writing by the Contractor and approved by the Contracting Officer. Provide a new job-mix formula for each source change. Submittal shall include all tests indicated in MIX DESIGN section of this specification.

ASPHALT CEMENT BINDER

MIX DESIGN

SD-06 Test Reports

Specific gravity test of asphalt

Coarse aggregate tests

Weight of slag test

Percent of crushed pieces in gravel

Fine aggregate tests

Specific gravity of mineral filler

Bituminous mixture tests

Aggregates tests

Bituminous mix tests

Pavement courses

Submit in accordance with paragraph entitled "Mock-Up Test Section."

1.3 QUALITY ASSURANCE

1.3.1 Safety Requirements

Provide adequate and safe stairways with handrails to the mixer platform, and safe and protected ladders or other means for accessibility to plant operations. Guard equipment and exposed steam or other high temperature lines or cover with a suitable type of insulation.

[1.3.2 Mock-Up Test Section

****

NOTE: Include requirements for test section[s] in all projects with 4,500 metric tons 5,000 tons or more of asphaltic concrete. Test sections may be considered necessary and specified in smaller projects if the pavement structure is critical and the cost of a test section is deemed to be justified. Normally, a test section is required only for the wearing course. If it is deemed necessary to test other courses, the specifications must be modified to suit.

****

Prior to full production of the [binder and] wearing course[s], prepare a quantity of bituminous mixture according to the job-mix formula. Construct a test section 60 m 200 feet long by not less than 3 m 10 feet wide and of the same compacted depth specified for the construction of the course which the test section represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight

to be used on the remainder of the course represented by the test section. Test not less than two samples of the mixture produced at the plant for gradation, asphalt cement content, stability, flow, air voids, voids in mineral aggregate, and in weight. Obtain not less than three cores from the test strip for density and thickness tests. Check the test section for smoothness and finish surface texture. If the test section should prove to be unsatisfactory, make the necessary adjustments to the mix design, plant operation, transportation, laydown, [and] [or] rolling procedures. Additional test sections, as required, shall be constructed and evaluated for conformance to the specified requirements. When test sections do not conform to specified requirements, remove and replace the bituminous pavement. A marginal quality test section that has been placed in an area of little or no traffic may be left in place. If a second test section also does not meet specified requirements, remove both sections at the Contractor's expense. Full production shall not begin without the Contracting Officer's approval.

]1.3.3 Required Data

Job-mix formula shall show the following:

a. Source and proportions, percent by weight, of each ingredient of the mixture;

b. Correct gradation, the percentages passing each size sieve listed in the specifications for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture;

c. Amount of material passing the 75 micrometers No. 200 sieve determined by dry sieving;

d. Number of blows of hammer compaction per side of molded specimen;

e. Temperature viscosity relationship of the asphalt cement;

f. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight;

g. Asphalt absorption by the aggregate;

h. Effective asphalt content as percent by weight of total mix;

i. Temperature of the mixture immediately upon completion of mixing;

j. Asphalt performance grade [viscosity grade] [penetration range]; and

k. Curves for the [leveling] [binder] [and] wearing course[s].

1.3.4 Charts

Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

1.3.5 Selection of Optimum Asphalt Content

Base selection on percent of total mix and the average of values at the following points on the curves for each mix:

a. Stability: Peak

b. Unit Weight: Peak

c. Percent Air Voids: Median

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.5 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 7 degrees C 45 degrees F for course thicknesses greater than 25 mm one inch and 13 degrees C 55 degrees F for course thicknesses 25 mm one inch or less.

1.6 CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory approved by the Contracting Officer within [12] [_____] months of commencing work.

1.6.1 Mixing Plant

****

NOTE: Insert minimum acceptable capacity. Suggest 25 kg/s 100 tons/hr, except where project schedule requirements need greater production capacities.

****

Design, coordinate, and operate the mixing plant to produce a mixture within the job-mix formula tolerances and to meet the requirements of AASHTO M 156, including additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. Minimum plant capacity shall be [25] [_____] kg/s [100] [_____] tons per hour. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures. The plant and plant site shall meet the requirements of Section 01 57 19.00 20 TEMPORARY ENVIRONMENTAL CONTROLS.

1.6.1.1 Cold Aggregate Feeder

Provide plant with a feeder or feeders capable of delivering the maximum number of aggregate sizes required in their proper proportion. Provide adjustment for total and proportional feed and feeders capable of being locked in any position. When more than one cold elevator is used, feed each elevator as a separate unit and install individual controls integrated with a master control.

1.6.1.2 Dryer

Provide rotary drum-dryer which continuously agitates the mineral aggregate

during the heating and drying process. When one dryer does not dry the aggregate to specified moisture requirements, provide additional dryers.

1.6.1.3 Plant Screens and Bins for Batch and Continuous Mix Plants

Use screen to obtain accurate gradation and allow no bin to contain more than 10 percent oversize or undersize. Inspect screens each day prior to commencing work for plugged, worn, or broken screens. Clean plugged screens and replace worn or broken screens with new screens prior to beginning operations. Divide hot aggregate bins into at least three compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

1.6.1.4 Testing Laboratory

Provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

1.6.1.5 Surge and Storage Bins

Use for temporary storage of hot bituminous mixtures will be permitted under the following conditions:

a. When stored in surge bins for a period of time not to exceed 3 hours.

b. When stored in insulated and heated storage bins for a period of time not to exceed 12 hours. If it is determined by the Contracting Officer that there is an excessive amount of heat loss, segregation and oxidation of the mixture due to temporary storage, discontinue use of surge bins or storage bins.

1.6.1.6 Drum-Dryer Mixer

Do not use drum-dryer mixer if specified requirements of the bituminous mixture or of the completed bituminous pavement course cannot be met. If drum-dryer mixer is prohibited, use either batch or continuous mix plants meeting the specifications and producing a satisfactory mix.

1.6.2 Paving Equipment

1.6.2.1 Spreading Equipment

Self-propelled electronically controlled type, unless other equipment is authorized [by the Contracting Officer]. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 25 and 230 mm per second 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

1.6.2.2 Rolling Equipment

Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

1.6.2.3 Hand Tampers

Minimum weight of 11 kg 25 pounds with a tamping face of not more than 0.032 square meter 50 square inches.

1.6.2.4 Mechanical Hand Tampers

Commercial type, operated by pneumatic pressure or by internal combustion.

PART 2 PRODUCTS

2.1 AGGREGATES

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

2.1.1 Coarse Aggregates

****
NOTE: When coarse and/or fine aggregate available locally is of questionable or unsatisfactory quality, modify paragraphs to allow only specific type(s) of aggregate with a satisfactory performance record.
****

ASTM D692/D692M, except as modified herein. At least 75 percent by weight of aggregate retained on the 4.75 mm No. 4 sieve shall have two or more fractured faces. Percentage of wear, Los Angeles test, except for slag, shall not exceed 40 in accordance with ASTM C131. Weight of slag shall not be less than 1120 kg per cubic meter 70 pounds per cubic foot. Soundness test is required in accordance with ASTM C88; after 5 cycles, loss shall not be more than 12 percent when tested with sodium sulfate or 18 percent when tested with magnesium sulfate.

2.1.2 Fine Aggregate

****
NOTE: When coarse and/or fine aggregate available locally is of questionable or unsatisfactory quality, modify paragraphs to allow only specific

type(s) of aggregate with a satisfactory performance record.

****

ASTM D1073, except as modified herein. Fine aggregate shall be produced by crushing stone, slag or gravel that meets requirements for wear and soundness specified for coarse aggregate. Where necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. Quantity of natural sand to be added shall be approved [by the Contracting Officer] and shall not exceed [15] [_____] percent of weight of coarse and fine aggregate and material passing the 75 micrometers No. 200sieve.

2.1.3 Mineral Filler

Nonplastic material meeting the requirements of ASTM D242/D242M.

2.1.4 Aggregate Gradation

****

NOTE: Delete from Table I, the gradations that will not be used as a part of this project. Generally, the layer thickness should be at least 57 mm (2.25 inches) for gradation 1, 37 mm (1.5 inches) for gradation 2 and 28 mm (1 inch) for gradation 3 shown in Table 2. Use of gradation 3 should be limited to shoulders and leveling courses.

****

The combined aggregate gradation shall conform to gradations specified in Table I, when tested in accordance with ASTM C136 and ASTM C117, and shall 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 I. Aggregate Gradations

	Gradation 1	Gradation 2	Gradation 3
Sieve Size, mm inch	Percent Passing by Mass	Percent Passing by Mass	Percent Passing by Mass
25.0 1	100	---	---
19.0 3/4	76-96	100	---
12.5 1/2	68-88	76-96	100
9.5 3/8	60-82	69-89	76-96
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

Table I. Aggregate Gradations			
	Gradation 1	Gradation 2	Gradation 3
Sieve Size, mm inch	Percent Passing by Mass	Percent Passing by Mass	Percent Passing by Mass
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

2.2 ASPHALT CEMENT BINDER

****

NOTE: Performance Graded (PG) d asphalt binders should be specified wherever available. The same grade PG binder used by the state highway department in the area should be considered as the base grade for the project (e.g. the grade typically specified in that specific location for dense graded mixes on highways with design ESALS less than 10 million). The exception would be that grades with a low temperature higher than PG XX-22 should not be used (e.g. PG XX-16 or PG XX-10), unless the Engineer has had successful experience with them.

Typically, rutting is not a problem on airfield runways. However, the following grade "bumping" should be applied for paving in the runway and taxiway areas: to accommodate for aircraft tire pressure greater than 1.4 MPa 200 psi, increase the high temperature two grades. Each grade adjustment is 6 degrees C. The low temperature grade should remain the same.

****

Asphalt cement binder shall conform to [ASTM D3381/D3381M Table 2, Viscosity Grade [_____]] [AASHTO M 320 Performance Grade (PG) [_____]] [ASTM D946/D946M Penetration Grade [_____]]. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting OfficerEngineer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer Engineer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D140/D140M and in the presence of the Contracting OfficerEngineer. These samples shall be furnished to the Contracting OfficerEngineer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be

composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-2 and the criteria shown in Table II. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost.

2.3.1 JMF Requirements

****

NOTE: In Table II, use a 75 Blow (compactive effort) Marshall Mix for all pavements designed for tire pressures of 690 kPa 100 psi or higher. For pavements designed for tire pressures less than 690 kPa 100 psi, use a 50 Blow Mix. Also, use a 50 Blow Mix for shoulder pavements.

In Table II, delete the column which does not apply, unless the project includes both 75 Blow and 50 Blow mixes.

Select the appropriate gradation and VMA requirements in Table III to be consistent with the gradation chosen in Table I. Delete the other two lines in Table III.

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

Tensile Strength Ratio for San Diego - El Centro, California area and other areas with lower quality aggregate (that meets all other requirements) and low annual rainfall, use 65, otherwise use 75.

****

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

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

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of blows of hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

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

j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with two or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

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

p. Tensile Strength Ratio.

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

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

Table II. Marshall Design Criteria

Test Property	75 Blow Mix	50 Blow Mix
Stability, newtons pounds minimum	*9560 *2150	*6000 *1350
Flow, 0.25 mm 0.01 inch	8-16	8-18
Air voids, percent	3-5	3-5
Percent Voids in mineral aggregate (minimum)	See Table IV See Table III	See Table IV See Table III
TSR, minimum percent	75	75

* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Table III. Minimum Percent Voids in Mineral Aggregate (VMA)**	
Aggregate (See Table 2)	Minimum VMA, percent
Gradation 1	13.0
Gradation 2	14.0
Gradation 3	15.0
** Calculate VMA in accordance with AI MS-2, based on ASTM D2726/D2726M bulk specific gravity for the aggregate.	

2.3.2 Adjustments to JMF

The JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the JMF within the limits specified below to optimize mix volumetric properties. Adjustments to the JMF shall be limited to plus or minus 3 percent on the 12.5 mm, 1/2 inch, 4.75 mm, No. 4, and 2.36 mm No. 8 sieves; plus or minus 1.0 percent on the 0.075 mm No. 200 sieve; and plus or minus 0.40 percent binder content. If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table I; this is acceptable.

2.4 RECYCLED HOT MIX ASPHALT

****
NOTE: Reclaimed Asphalt Pavement (RAP) should not be used for surface mixes, except on shoulders. It can be used very effectively in lower layers, or for shoulders. The Contractor should be able to use RAP, up to 30 percent, as long as the resulting recycled mix meets all requirements that are specified for virgin mixtures. Remove these paragraphs if RAP is not used.
****

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 50 mm 2 inches. The recycled HMA mix shall be designed using procedures contained in AI MS-2. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP shall be limited to 30 percent.

2.4.1 RAP Aggregates and Asphalt Cement

The blend of aggregates used in the recycled mix shall meet the requirements of paragraph AGGREGATES. The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D2172/D2172M

using the appropriate dust correction procedure.

2.4.2 RAP Mix

****
NOTE: The appropriate test should be selected to conform to the grade of new asphalt specified. If a penetration grade is specified, use penetration test. If a viscosity grade is specified, use a viscosity test. If a PG asphalt binder is specified, use the dynamic shear rheometer and bending beam tests.
****

The blend of new asphalt cement and the RAP asphalt binder shall meet the [penetration] [viscosity] [dynamic shear rheometer at high temperature and bending beam at low temperature] requirements in paragraph ASPHALT CEMENT BINDER. The virgin asphalt cement shall not be more than two standard asphalt material grades different than that specified in paragraph ASPHALT CEMENT BINDER.

2.5 SOURCE QUALITY CONTROL

Employ a commercial laboratory approved by the Contracting Officer to perform testing. The laboratory used to develop the JMF and the laboratory used to perform all sampling and testing shall meet the requirements of ASTM D3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

2.5.1 Tests

Perform testing in accordance with the following:

a. Specific Gravity Test of Asphalt: ASTM D70

b. Coarse Aggregate Tests:

(1) Bulk Specific Gravity: ASTM C127

(2) Abrasion Loss: ASTM C131

(3) Soundness Loss: ASTM C88

c. Weight of Slag Test: ASTM C29/C29M

d. Percent of Crushed Pieces in Gravel: Count by observation and weight

e. Fine Aggregate Tests:

(1) Bulk Specific Gravity: ASTM C128

(2) Soundness Loss: ASTM C88

f. Specific Gravity of Mineral Filler: ASTM C188 or ASTM D854

g. Bituminous Mixture Tests:

(1) Bulk Specific Gravity: ASTM D1188 or ASTM D2726/D2726M

(2) Theoretical Maximum Specific Gravity: ASTM D2041/D2041M

(3) Tensile Strength Ratio: ASTM D4867/D4867M

2.5.2 Specimens

ASTM D6927 for the making and testing of bituminous specimens with the following exceptions:

****
NOTE: At the text below, for traffic with tire pressures 690 kPa 100 psi and over and also for primary roads and streets, specify 75 blows; for tire pressures less than 690 kPa 100 psi and for secondary roads, streets, and parking areas, specify 50 blows.
****

a. Compaction: Apply [75 blows of the hammer to each flat face of the specimens for mix numbers [_____] and [_____]] [and 50 blows for mix numbers [_____] and [_____]].

b. Curves: Plot curves for the [leveling,] [binder,] [and] wearing course[s] to show the effect on the test properties of at least four different percentages of asphalt on the unit weight, stability, flow, air voids, and voids in mineral aggregate; each point on the curves shall represent the average of at least four specimens.

c. Cooling of Specimen: After compaction is completed, allow the specimen to cool in air to the same temperature approximately as that of the water, 25 degrees C 77 degrees F, to be used in the specific gravity determination.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Preparation of Asphalt Binder Material

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C 325 degrees F when added to the aggregates. Modified asphalts shall be no more than 174 degrees C 350 degrees F when added to the aggregate.

3.1.2 Preparation of Mineral Aggregates

Store different size aggregate in separate stockpiles so that different sizes will not mix. Stockpile different-sized aggregates in uniform layers by use of a clam shell or other approved method so as to prevent segregation. The use of bulldozers in stockpiling of aggregate or in feeding aggregate to the dryer is prohibited. Feed aggregates into the cold elevator by means of separate mechanical feeders so that aggregates are graded within requirements of the job-mix formulas and tolerances specified. Regulate rates of feed of the aggregates so that moisture content and temperature of aggregates are within tolerances specified herein. Dry and heat aggregates to the temperature necessary to achieve the mixture determined by the job mix formula within the job tolerance specified. Provide adequate dry storage for mineral filler.

3.1.3 Preparation of Bituminous Mixture

Accurately weigh aggregates and dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. In batch mixing, after aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods and continue mixing for a period of not less than 20 seconds, or as long as required to obtain a homogeneous mixture. The time required to add or spray asphalt into the mixer will not be added to the total wet-mixing time provided the operation does not exceed 10 seconds and a homogeneous mixture is obtained. When a continuous mixer is employed, mixing time shall be more than 35 seconds to obtain a homogeneous mixture. Additional mixing time, when required, will be as directed by the Contracting Officer. When mixture is prepared in a twin-pugmill mixer, volume of the aggregates, mineral filler, and asphalt shall not extend above tips of mixer blades when blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch or continuous mix plant produced mixtures, waste the mix and withdraw the aggregates in the hot bins immediately and return to the respective stockpiles; for drum-dryer mixer plants, waste the mix, including that in surge or storage bins that is affected by free moisture.

3.1.4 Transportation of Bituminous Mixtures

Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck. If air temperature is less than 16 degrees C 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

3.1.5 Surface Preparation of Underlying Course

Prior to the laying of the asphalt concrete, clean underlying course of

foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary. During the placement of multiple lifts of bituminous concrete, each succeeding lift of bituminous concrete shall have its underlying lift cleaned and provided with a bituminous tack coat if the time period between the placement of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty. [Remove grass and other vegetative growth from existing cracks and surfaces.]

3.1.6 Spraying of Contact Surfaces

Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent, conforming to Section 32 12 21 BITUMINOUS ROAD-MIX SURFACE COURSE. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

3.2 PLACEMENT

3.2.1 Machine Spreading

****

NOTE: See Table IV for minimum spreading temperatures depending on temperatures of existing base course and thickness of layer being placed.

TABLE IV

MINIMUM SPREADING TEMPERATURES

Base Temp. in Degrees C (*)	Wearing, Binder, or Leveling Course Thickness, (mm)							
	13	19	25	38	50	75	88	100
-7 - 0 (**)	---	---	---	---	---	---	135 (**)	127 (**)
0 - 4 (**)	---	---	---	---	146	138	132	127
4 - 10	---	---	---	149	141	135	129	124
10 - 16	---	---	149	146	138	132	127	124
16 - 21	---	149	143	141	135	129	124	121
21 - 27	149	143	141	138	132	129	124	121
27 - 32	143	138	135	132	129	127	121	121
32	138	135	132	129	129	124	121	121

* Note: Base on which mix is placed.

TABLE IV

MINIMUM SPREADING TEMPERATURES

Base Temp. in Degrees C (*)	Wearing, Binder, or Leveling Course Thickness, (mm)							
	13	19	25	38	50	75	88	100
-7 - 0 (**)	---	---	---	---	---	---	135 (**)	127 (**)

** Note: Increase by 8 degrees when placement is on base or subbase containing frozen moisture. Normally, hot mix paving is not allowed on base temperatures below 7 degrees C.

TABLE IV

MINIMUM SPREADING TEMPERATURES

Base Temp. in Degrees F (*)	Wearing, Binder, or Leveling Course Thickness, (Inches)							
	1/2	3/4	1	1 1/2	2	3	3 1/2	4
20-32 (**)	---	---	---	---	---	---	275 (**)	260 (**)
+32-40 (**)	---	---	---	---	295	280	270	260
+40-50	---	---	---	300	285	275	265	255
+50-60	---	---	300	295	280	280	260	255
+60-70	---	300	290	285	275	265	255	250
+70-80	300	290	285	280	070	265	255	250
+80-90	290	280	275	270	265	260	250	250
+90	280	275	270	265	265	255	250	250

* Note: Base on which mix is placed.

** Note: Increase by 15 degrees when placement is on base or subbase containing frozen moisture. Normally, hot mix paving is not allowed on base temperatures below 45 degrees F.

****

The range of temperatures of the mixtures at the time of spreading shall be between [121] [_____] degrees C and 149 degrees C [250] [_____] degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section,

grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 3 m 10 feet, except where the edge lanes require strips less than 3 m 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than [9] [_____] m [30] [_____] feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

3.2.2 Shoveling, Raking, and Tamping After Machine-Spreading

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct irregularities in alignment left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

3.2.3 Hand-Spreading in Lieu of Machine-Spreading

In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between [121] [_____] and 149 degrees C [250] [_____] and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread hot mixture with rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

3.3 COMPACTION OF MIXTURE

****
NOTE: Insert appropriate percent density; normally, 96 percent for pavements subject to vehicular traffic and 97 percent for pavements subject to aircraft traffic.
****

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with

a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least 300 mm one foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least [_____] percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D6927. During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

3.4 JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.4.1 Transverse

Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. Transverse joints in adjacent lanes shall be offset a minimum of 600 mm 2 feet.

3.4.2 Longitudinal Joints

Space 150 mm 6 inches apart. Do not allow joints to coincide with joints of existing pavement or previously placed courses. Spreader screed shall overlap previously placed lanes 50 to 75 mm 2 to 3 inches and be of such height to permit compaction to produce a smooth dense joint. With a lute, push back mixture placed on the surface of previous lanes to the joint edge. Do not scatter mix. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture

against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

3.5 FIELD QUALITY CONTROL

****
NOTE: The Contractor shall normally conduct all sampling and testing at his expense, as stated in the Quality Control section. There may be certain special occasions where the Government will conduct sampling and testing. In those cases, so state that sampling and testing will be conducted by the Government.
****

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NOTE: Employ a commercial laboratory approved by the Contracting Officer to perform all sampling and testing. The laboratory used shall meet the requirements of ASTM D3666 and as indicated in SOURCE QUALITY CONTROL section.
****

3.5.1 Sampling

3.5.1.1 Aggregates At Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D75/D75M [at the source] [from each stockpile]. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 22 kg 50 pounds. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

3.5.1.2 Cold Feed Aggregate Sampling

Take two samples daily from the belt conveying materials from the cold feed. Collect materials in three increments at random to make a representative composite sample of not less than 22 kg 50 pounds. Take samples in accordance with ASTM D75/D75M.

3.5.1.3 Coarse and Fine Aggregates

Take a 22 kg 50 pound sample from the cold feed at least once daily for sieve analyses and specific gravity tests. Additional samples may be required to perform more frequent tests when analyses show deficiencies, or unacceptable variances or deviations. The method of sampling is as specified herein for aggregates.

3.5.1.4 Mineral Filler

ASTM D546. Take samples large enough to provide ample material for testing.

3.5.1.5 Pavement and Mixture

Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of

pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D979/D979M.

3.5.2 Testing

3.5.2.1 Aggregates Tests

a. Gradation: ASTM C136.

b. Mineral Filler Content: ASTM D546.

c. Abrasion: ASTM C131 for wear (Los Angeles test). Perform one test initially prior to incorporation into the work and each time the source is changed.

3.5.2.2 Bituminous Mix Tests

Test one sample for each 455 metric tons 500 tons, or fraction thereof, of the uncompacted mix for extraction in accordance with ASTM D2172/D2172M; perform a sieve analysis on each extraction sample in accordance with ASTM C136 and ASTM C117. Test one sample for each [455] [_____] metric tons [500] [_____] tons or fraction thereof for stability and flow in accordance with ASTM D6927. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D4867/D4867M.

3.5.2.3 Pavement Courses

Perform the following tests:

a. Density: For each [910] [_____] metric tons [1000] [_____] tons of bituminous mixture placed, determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D6927. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record in a manner approved by the Contracting Officer the project areas represented by the laboratory densities. From each representative area recorded, determine field density of pavement by averaging densities of 100 mm 4 inch diameter cores obtained from [leveling,] [binder, and] wearing course[s]; take one core for each [1672] [_____] square meters [2000] [_____] square yards or fraction thereof of course placed. Determine density of laboratory prepared specimens and cored samples in accordance with ASTM D1188 or ASTM D2726/D2726M, as applicable. Separate pavement layers by sawing or other approved means. Maximum allowable deficiency at any point, excluding joints, shall not be more than 2 percent less than the specified density for any course. The average density of each course, excluding joints, shall be not less than the specified density. Joint densities shall not be more than 2 percent less than specified course densities and are not included when calculating average course densities. When the deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

b. Thickness: Determine thickness of [binder and] wearing courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 6 mm 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness.

Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

c. Smoothness: Straightedge test the compacted surface of [leveling,] [binder, and] wearing course[s] as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Unevenness of [leveling and] [binder] course[s] shall not vary more than 6 mm in 3 m 1/4 inch in 10 feet; variations in the wearing course shall not vary more than 3 mm in 3 m 1/8 inch in 10 feet. Correct each portion of the pavement showing irregularities greater than that specified.

****
NOTE: Regarding the text below, the Engineering Field Division (EFD) will determine whether the Contracting Officer or the Contractor will perform the survey. At the option of EFD, this subparagraph may be deleted entirely.
****

d. Finished Grades: Finish grades of each course placed shall not vary from the finish elevations, profiles, and cross sections indicated by more than 13 mm 1/2 inch. Finished surface of the final wearing course will be tested [by the Contracting Officer] by running lines of levels at intervals of [8] [_____] m [25] [_____] feet longitudinally and transversely to determine elevations of completed pavement. Within 45 days after completion of final placement, [perform a level survey at the specified grid spacing and plot the results on a plan drawn to the same scale as the drawings. Elevations not in conformance with the specified tolerance shall be noted on the plan in an approved manner. The survey shall be performed by a registered land surveyor.] [The Contracting Officer will inform the Contractor in writing of paved areas that fail to meet the final grades indicated within the specified tolerances.] Correct deficient paved areas by removing existing work and replacing with new materials that meet the specifications. Skin patching for correcting low areas is prohibited.

e. Finish Surface Texture of Wearing Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be removed and replaced with new materials.

3.6 PROTECTION

Do not permit vehicular [and aircraft] traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 50 degrees C 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

-- End of Section --