
USACE / NAVFAC / AFCEC / NASA UFGS-32 12 21 (August 2008)

Preparing Activity: USACE Superseding
UFGS-32 12 21 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2015

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08/08

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SECTION 32 12 21

BITUMINOUS ROAD-MIX SURFACE COURSE 08/08

NOTE: This guide specification covers the
requirements for bituminous road-mix surface course.

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).

PART 1 GENERAL

1.1 UNIT PRICES

NOTE: This paragraph will be deleted when all the
work is included in one job (lump sum) contract
price.

1.1.1 Measurement

1.1.1.1 Surface Course

NOTE: This paragraph will be used when the surface
course consists of only new aggregates or of
aggregates existing on the roadway. When new
aggregate is to be mixed with aggregate existing on

the roadway, an additional subparagraph will be inserted in paragraph Measurement as follows:

New Aggregates: The amount of approved new aggregate to be paid for will be the number of cubic meters yards used in the completed and accepted surface course.

The square meters yards of surface course shall be the number of square meters yards of completed and accepted surface course.

1.1.1.2 Bituminous Material

Bituminous material to be paid for shall be the number of [metric 2000 pound tons] [liters gallons of the material used in the accepted work, as determined by the Contracting Officer, corrected to liters gallons at 15.6 degrees C 60 degrees F in accordance with [ASTM D633] [ASTM D1250]]. [A coefficient of expansion of 0.00045 per degree C 0.00025 per degree F shall be used for asphalt emulsions.]

1.1.2 Payment

The amount of pavements and quantities of bituminous material, determined as specified in paragraph Measurement, will be paid for at the respective contract unit prices in the bid schedule on which the contract is based, which payment will constitute full compensation for preparing or reconditioning subgrade or base course; furnishing all plant, materials, equipment, and tools; correcting unsatisfactory areas; and the labor and incidentals necessary to complete the work required by this section of the specifications.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills or delivery tickets, during the progress of the work. Before the final statement is allowed, file with the Contracting Officer certified waybills and delivery tickets for all the bituminous and paving materials used in the construction covered by this section of specifications.

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 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.

ASTM INTERNATIONAL (ASTM)

ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C183/C183M	(2015) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM D1073	(2011) Fine Aggregate for Bituminous Paving Mixtures
ASTM D1250	(2008) Standard Guide for Use of the Petroleum Measurement Tables
ASTM D140/D140M	(2015) Standard Practice for Sampling Bituminous Materials
ASTM D2026/D2026M	(2015) Cutback Asphalt (Slow-Curing Type)
ASTM D2027/D2027M	(2013) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2015) Cutback Asphalt (Rapid-Curing Type)
ASTM D2397/D2397M	(2013) Standard Specification for Cationic Emulsified Asphalt
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D4318	(2010; E 2014) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D490	(1992; R 2011) Road Tar
ASTM D633	(2011) Volume Correction Table for Road Tar
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM D977	(2013; E 2014) Emulsified Asphalt

1.3 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.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

SD-06 Test Reports

Tests

1.4 ENVIRONMENTAL REQUIREMENTS

Construct bituminous courses only when the surface is dry. Do not construct the bituminous course when the atmospheric or aggregate temperature is below 5 degrees C 40 degrees F.

PART 2 PRODUCTS

2.1 AGGREGATES

NOTE: These paragraphs include the requirements for new aggregates that are to be placed on the roadway and used for the road-mix surface. These new aggregates, when processed, shall conform to one of the gradings specified in TABLE I. However, there may be instances where the aggregate in place as an integral part of the graded roadbed or as previously constructed base or surface courses may be satisfactory for the road-mix surface. In general, almost any gradation or type of densely graded material that is predominantly granular in character will serve satisfactorily. If the existing material is deficient in quality or quantity, new material from an outside source may be blended with existing roadbed material.

a. Where it is determined that sufficient material of satisfactory quality can be salvaged from the roadbed for use in the surface course, the following paragraph will be substituted for paragraph AGGREGATES:

AGGREGATES shall consist of aggregates salvaged from roadway as specified in paragraph PREPARATION OF BASE COURSE AND AGGREGATE. The Contractor is not responsible for the grading and quality of any material salvaged from the roadway and used in the road-mix surface, except the removal of oversized material. Any particles of salvaged aggregate appearing in the surface at the time of laydown and finishing of the road-mix surface that will be retained on a 37.5 mm 1-1/2 inch sieve shall be removed.

b. When aggregate material in place in the roadbed is deficient in quantity and quality, the Contracting Officer will determine the grading and amount of new coarse aggregate, fine aggregate, and mineral filler or combinations thereof that will be specified to be incorporated with existing material. New materials will, in general, conform with requirements specified in paragraphs AGGREGATES and COMPOSITION OF MIXTURE. New materials will be so graded that, when blended in the amount specified with the material salvaged from the roadway, the grading of the combined material will conform to a specific gradation selected from TABLE I. In order to accomplish this, it may be necessary to include in this section individual gradations for either new coarse aggregate, fine aggregate, mineral filler, or combinations thereof that shall be blended with salvaged material to produce a satisfactory road-mix surface. The following paragraph will be

substituted for the first part of paragraph
AGGREGATES when new aggregates are to be added to
the existing placed material:

AGGREGATES shall consist of a mixture of aggregates
salvaged from the roadbed and of new material. The
new aggregate shall consist of a mixture of [coarse
and fine aggregate] [fine aggregate and mineral
filler] [coarse aggregate, fine aggregate, and
mineral filler], each conforming to the respective
quality and grading requirements specified
hereinafter and when combined with aggregate
salvaged from roadbed, shall conform to the
requirements of paragraph COMPOSITION OF MIXTURE.

Provide aggregates consisting of a mixture of coarse aggregate, fine
aggregate, and mineral filler complying with the requirements specified
hereinafter.

2.1.1 Coarse Aggregate

NOTE: The type of coarse aggregates applicable to
local conditions will be retained, and the
inapplicable paragraphs will be deleted.

Coarse aggregate shall consist of the following:

[2.1.1.1 Crushed Stone

Crushed stone consisting of hard durable fragments which are free from soft
or disintegrated pieces, vegetable matter, lumps or balls of clay, adherent
coatings of clay, and other objectionable matter, and having a percentage
of wear not exceeding 50 after 500 revolutions, as determined by
ASTM C131/C131M.

][2.1.1.2 Crushed Gravel

Crushed gravel consisting of clean, tough, durable fragments, free from an
excess of flat, elongated, soft, or disintegrated pieces, and free from
fragments coated with dirt or other objectionable matter. At least 50
percent by weight of the particles retained on 4.75 mm No. 4 sieve shall
have two or more fractured faces. The crushed gravel shall have a
percentage of wear not exceeding 50 after 500 revolutions, as determined by
ASTM C131/C131M.

][2.1.1.3 Crushed Slag

Crushed slag shall be an air-cooled, blast furnace product having a dry
weight of not less than 1100 kg per cu m 70 pcf consisting of angular
fragments which are reasonably uniform in density, free from dust, and
without an excess of thin, elongated pieces, and other objectionable
matter. The weight per cubic meter foot of slag aggregate shall be
determined by ASTM C29/C29M. The slag aggregate shall have a percentage of
wear not exceeding 50 after 500 revolutions, as determined by
ASTM C131/C131M.

12.1.2 Fine Aggregate

Provide fine aggregate conforming to ASTM D1073. Quantity of natural sand shall not exceed 25 percent of the total aggregate. The gradations specified in ASTM D1073 may be adjusted to meet local materials as directed. That portion of the fine aggregate, including any blended filler, passing a 0.425 mm No. 40 sieve shall have a plasticity index not exceeding 6 as determined by ASTM D4318, a liquid limit not exceeding 25 as determined by ASTM D4318, and a clay content not to exceed 5 percent after washing and straining.

2.1.3 Mineral Filler

Provide mineral filler conforming to ASTM D242/D242M.

2.2 BITUMINOUS MATERIALS

NOTE: Only the types, grades, and designations applicable to climatic and other job conditions will be retained. When emulsions are used, the moisture-content requirement for the aggregate will be selected in accordance with specific job conditions. The moisture content at the time the emulsified asphalt is applied will be such that a uniform coating will be retained on all aggregate particles without the bitumen running off the particles. The moisture content will not exceed 3 percent by weight and will be reduced sufficiently by aeration to allow the emulsion to break prior to compaction. The compacted mixture will be allowed to cure until the moisture content does not affect the stability of the finished mixture prior to opening for traffic. When cutbacks are used, the moisture will not be in excess of 2 percent. The moisture content of the aggregate before mixing will be carefully controlled by laboratory tests.

Bituminous materials shall conform to [ASTM D490] [ASTM D977] [ASTM D2026/D2026M] [ASTM D2027/D2027M] [ASTM D2028/D2028M] [ASTM D2397/D2397M], Grade [_____] Designation [_____].

2.3 COMPOSITION OF MIXTURE

NOTE: Coordinate this paragraph with the specified requirements in paragraph AGGREGATES.

Consult CEMP-ET on test method to be used and indicate below.

Provide aggregate for the surface course so graded that the percentage composition by weight, as determined by laboratory tests, will conform to the grading shown in TABLE I. The percentage of bituminous material by weight of the total mixture to be used for preparing the bituminous mixtures shall be as determined by the Contractor and approved by the Contracting Officer. The composite mixture shall show no stripping when

tested in accordance with [_____].

2.3.1 Job-Mix Formula

Do not produce any bituminous mixture until a job-mix formula has been prepared and approved by the Contracting Officer. The formula shall indicate the percentage of each sieve-fraction of aggregate and the percentage of bitumen. For the job-mix formula allow tolerances given in TABLE II. No deviation from the approved job-mix formula will be permitted without prior approval.

2.3.2 Gradation Limits for Aggregates

Gradation limits for aggregates in TABLE I are master ranges to govern mixes and represent the maximum and minimum for all cases. The approved formula will provide for a gradation of job aggregates within these master ranges. Deviation from the gradation of the approved formula will be allowed, provided that variations from the formula in any one run do not exceed the tolerances as given in TABLE II.

TABLE I. GRADATION (PERCENT BY WEIGHT PASSING) AND RANGE OF BITUMINOUS CONTENT				
Bituminous Mixture	Sieve Designation Square-Mesh Sieves	No. 1	No. 2	No. 3
Aggregate	25 mm1 inch	100	---	---
	19 mm3/4 inch	85-100	100	---
	12.5 mm1/2 inch	---	82-100	100
	9.5 mm3/8 inch	61-90	68-93	82-100
	4.75 mmNo. 4	43-79	48-82	57-88
	2.36 mmNo. 8	32-68	36-70	42-76
	1.18 mmNo. 16	26-56	27-60	32-64
	0.600 mmNo. 30	18-44	20-48	22-52
	0.300 mmNo. 50	13-33	15-38	16-40
	0.150 mmNo. 100	9-22	10-25	10-27
	0.075 mmNo. 200	5-12	5-12	5-12
Bituminous (Percent by Weight of total mixture)	---	5.0-8.0	5.0-8.5	5.0-9.0

TABLE I. GRADATION (PERCENT BY WEIGHT PASSING) AND RANGE OF BITUMINOUS CONTENT				
Bituminous Mixture	Sieve Designation Square-Mesh Sieves	No. 1	No. 2	No. 3
NOTE: The range of bituminous material shown represents the normal range of bituminous material contained in the design mix composed of nonabsorptive aggregates after evaporation of the lighter constituents. The upper limit may be raised, when approved, when absorptive aggregates are used.				

TABLE II. JOB MIX FORMULA TOLERANCES (PERCENT)	
Mineral	Tolerances Plus or Minus
Aggregate passing 4.75 mm No. 4 or larger sieve	7
Aggregate passing 2.36, 1.18, 0.6, 0.3 mm No. 8, 16, 30, and 50 sieves	5
Aggregate passing 0.150 and 0.075 mm No. 100 and 200 sieves	2
Bitumen	0.4

- a. Take samples from the prepared aggregate as windrowed after blending and test them for conformity with the requirements herein. Take a sufficient number of samples from the windrowed aggregate so that each sample will represent not more than 1000 square meters yards of finished surface course, but in no case take fewer than five samples for any day of production. Samples shall represent equal amounts of material.
- b. Do not apply bituminous materials on a run until a sieve analysis of the samples is made and the run is approved. A run is defined as that length of aggregate windrowed along the road and considered a convenient unit based on total job requirements or on daily capacity of the mixing unit or units, as determined by the Contracting Officer. The gradation of aggregate in the formula may be changed to meet specific field conditions without adjustment to contract unit prices.

2.3.3 Quantity of Bituminous Material

The percentage, by weight, of bituminous materials required for each run shall be approved by the Contracting Officer. The percentage of bituminous material will be computed on the basis of laboratory tests of samples of the approved aggregate and bituminous material, and on the field sieve analysis of samples taken from the windrowed blended aggregate for each run. The job-mix formula may be changed to meet specific field conditions without adjustments to contract unit prices.

PART 3 EXECUTION

3.1 SYSTEM EQUIPMENT

NOTE: This paragraph will be modified, based on local conditions, to include only those types of equipment that are required by the method or methods of construction to be employed.

Maintain equipment, plant, and tools used in the performance of the work in a satisfactory working condition at all times. Provide access to the Contracting Officer, at all times, to the equipment and plant to insure proper operation and compliance with specifications.

3.1.1 Traveling-Plant Mixer

Provide a self-propelled or tractor-drawn traveling-plant mixer capable of maintaining a uniform rate of travel. The plant shall be mounted on wheels or tread equipment of such type as will not overload or damage the subgrade or base course when the mixer is loaded to capacity. The device for picking up aggregates from windrows shall be such as to pick up only the windrowed aggregate, leaving the base clean. The pick-up and elevator shall be entirely enclosed to prevent the wind from removing the fine and filler aggregate. The equipment for proportioning the aggregate and bituminous material shall accurately measure the specified amounts of material for the mix while the machine is in operation, and shall be equipped with devices for accurately proportioning the filler added to the mixture. The plant shall be capable of thoroughly combining the aggregates and bituminous material into a uniform mixture, completely coating all particles of aggregate, and shall be capable of depositing the processed mixture on the base course.

3.1.2 Bituminous Distributor

Provide a bituminous distributor with pneumatic tires of such width and number that the load produced on the base course will not exceed 11.6 kg per mm 650 pounds per inch of tire width. The distributor shall be so designed and equipped as to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates from 0.23 to 0.91 L/square meter 0.05 to 2.0 gallons/square yard, with a specified rate not exceeding 5 percent. Include with the distributor equipment a separate power unit for the bitumen pump, fully circulating spray bars, a tachometer, pressure gauges, volume-measuring devices, a thermometer for reading the temperature of the tank contents, and a hose attachment suitable for applying bituminous material to spots missed by the distributor. The distributor shall be equipped for circulation and agitation of the bituminous material during the heating process. Provide heating equipment capable of maintaining the bituminous material at the specified temperature.

3.1.3 Heating Equipment for Storage Tanks

Maintain specified temperature with heating equipment for storage tanks, but direct flame shall not be applied to walls of storage tank or transfer lines. Fix an armored thermometer with a range from 65 to 200 degrees C 150 to 400 degrees F to the tank so that the temperature of the bituminous material can be determined at all times.

3.1.4 Blade Graders

Provide self-powered blade graders for windrowing aggregate, for mixing, and for spreading processed material. Each grader shall have a wheelbase

not less than 5.18 m 17 feet, a blade not less than 3.66 m 12 feet long, and be equipped with pneumatic tires. Blade graders, weighing at least 7 metric tons 8 tons, shall be adequately powered in order to perform the work properly.

3.1.5 Power Rollers

Provide power rollers which are steel-wheel or pneumatic-tired types conforming to the following requirements:

3.1.5.1 Steel-Wheel

Steel-wheel rollers shall be either tandem or three-wheel type weighing not less than 4.5 metric tons 5 tons, and equipped with adjustable scrapers. The rollers, which may be static or vibratory, shall be equipped with watertanks and sprinkling apparatus, to be used when necessary, to keep the wheels wet preventing adherence of the bituminous material to the wheels.

3.1.5.2 Pneumatic-Tired

Provide self-propelled pneumatic-tired rollers equipped with not less than 9 wheels mounted on 2 axles in such manner that the rear tires will not follow in the tracks of the forward group. The pneumatic-tired rollers shall also be equipped with suitable beams or platforms for ballast loading and loaded to provide required compaction. Inflate the tires uniformly to not less than 310 kPa 45 psi.

3.1.6 Mechanical Spreaders

Provide equipment for spreading, shaping, and finishing consisting of approved, self-contained, power machines capable of taking the bituminous mixture directly from the discharge end of traveling plant and spreading the mixture at the required application rate.

3.1.7 Tractors

Tractors shall be of the crawler type equipped with street plates or flat treads.

3.1.8 Miscellaneous Equipment

Disk, spike-tooth, or spring-tooth harrows, multiple-blade or retread mixers, small tools, and other equipment shall be the required types.

3.1.9 Safety Precautions

[Do not permit smoking, or open flames within 8 m 25 feet of heating, distributing, or transferring operations of cutback bituminous materials.]
[When tar is used, a full-face, organic, vapor-type respirator and protective creams shall be used by personnel exposed to fumes.]

3.2 PLACING AND WINDROWING AGGREGATE

Haul aggregate to the paving site in approved trucks. Deposit the aggregate on the prepared base course or subgrade from trucks equipped or supplemented with suitable measuring and spreading devices. Proportion the amount of aggregate and mineral filler by weighing with suitable equipment, or by the use of other methods or devices, as approved. Thoroughly mix the aggregate, and mineral filler by windrowing and turning with a blade

grader, as directed. The aggregate shall then be bladed into uniform windrows in such quantity and proportions as to provide sufficient aggregate to produce a finished course of the specified compacted thickness. Mixing of the aggregate with shoulder material, segregation in pockets or otherwise, and mixing with the base course or subgrade shall be prevented.

3.3 RECONDITIONING OF BASE COURSE

NOTE: When the base course is existing or consists of a base course placed under terms of another contract, the following paragraph will be substituted for paragraph PLACING AND WINDROWING AGGREGATE.

[Scarify lightly and blade the existing base course to a uniform grade and to the cross section shown, and then roll or water and roll, as directed. Depressions shall be filled and weak portions of the base course shall be strengthened with new aggregate.]

3.4 PREPARATION OF BASE COURSE AND AGGREGATE

NOTE: When all the aggregates in the bituminous road-mix are to be obtained from the roadway, the following paragraph will be substituted for paragraph PLACING AND WINDROWING AGGREGATIVE.

[The surface of the roadway shall first be scarified lightly, and then bladed to a uniform grade and to the cross section shown on the drawings. The reshaped surface shall then be scarified to the depth necessary to provide the amount of aggregate required for the bituminous mixtures, and in such manner as to leave a foundation stratum of undisturbed material, and parallel, both in profile and cross section, to the proposed finished surface. Blade the loosened material into a windrow at the side of the road. The undisturbed understratum shall be rolled, or watered and rolled until a satisfactory foundation for the surface course is provided. The windrow and aggregate shall be broken up and thoroughly mixed by turning with a blade grader, and then bladed into uniform windrows of such size as to provide a finished surface course of the specified compacted thickness.]

NOTE: When aggregates to be used in the surface course are to be a combination of new material and material obtained from the existing surface, the following paragraph will be substituted for paragraph PLACING AND WINDROWING AGGREGATE.

[The surface of the roadway shall first be scarified lightly and bladed to a uniform grade and to the cross section shown on the drawings. The reshaped surface shall then be scarified again to such depth as indicated and in such manner as to leave a foundation stratum of undisturbed material, parallel, both in profile and cross section, to the surface course. New aggregate of the quality and gradation conforming with paragraph AGGREGATES shall be spread over the loosened existing aggregate in the required quantities. New aggregate shall be hauled to the paving

site in approved trucks. The new and old aggregate shall then be thoroughly blended by harrowing and blading, after which all the thoroughly mixed aggregate shall be bladed into a uniform windrow at the side of the road.

The undisturbed understratum shall be graded, rolled, or watered and rolled until a satisfactory foundation for the surface course is provided.]

3.5 MIXING WINDROWED AGGREGATE AND BITUMINOUS MATERIAL

3.5.1 Travel-Plant Method

NOTE: The application temperatures will be selected from the following charts and inserted in the blanks provided:

Liquid Asphalt	Degrees C Degrees F
RC-250, MC-250, SC-250	63-104 145-220
RC-800, MC-800, SC-800	82-107 180-225
SC-3000	102-143 215-290
Tar	Degrees C Degrees F
RT-5, RT-6	27-66 80-150
RT-7, RT-8, RT-9	66-107 150-225
Emulsified Asphalt	Degrees C Degrees F
All	24-71 75-160

The windrowed aggregate shall be mixed with bituminous material, by means of a traveling mixing plant, and the mixture shall be deposited in a windrow ready for spreading. The bituminous material shall be heated to the specified temperature within the range of [_____] degrees C F and [_____] degrees C F prior to application. When approved, the mixture shall be deposited in a mechanical spreader and spread in accordance with paragraph SPREADING AND SHAPING. The quantity of bituminous material will be determined in accordance with the procedure in paragraph COMPOSITION OF MIXTURE, and then introduced into the mixer. Regulate the machine's rate of travel and the amount of mixing so that the mixing operation will completely and uniformly coat all the particles of aggregate, and will produce a homogeneous mixture. The mixture shall not be spread until the mixing is complete and satisfactory. Should the mixture show an excess or a deficiency of any materials, correct the unsatisfactory condition by the addition of the required aggregate or bituminous material, followed by remixing. Should the mixture show uneven distribution of bituminous

material, correct the unsatisfactory condition by remixing. If directed, the material shall be harrowed or disked, and all compressed masses of material shall be broken up.

3.5.2 Blade Method

Prior to the application of bituminous material, spread the windrowed aggregates for the wearing surface in a uniform layer over the existing surface. Add bituminous material of the type, grade, or designation specified in paragraph BITUMINOUS MATERIALS to the aggregate at the temperature specified, and at the rate or rates determined by the Contracting Officer in accordance with paragraph COMPOSITION OF MIXTURE. Apply the bituminous material by means of bituminous distributors. Immediately following the application of the bituminous material, the treated aggregate shall be mixed by an approved method. Mixing shall be continued until the bituminous material is uniformly distributed throughout the mass and the aggregate particles are uniformly and completely coated. During the mixing, take care to avoid cutting into the underlying base or contaminating the bituminous mixture with earth or other objectionable matter. When operations are interrupted, the mixed or partially mixed material shall be bladed into a uniformly sized windrow or windrows in such manner that this material will not interfere with subsequent operations, will not be mixed with any untreated aggregate, and will not become contaminated with unsatisfactory material. Upon completion of the final mixing operations, the mixed material will be examined by the Contracting Officer. Should the mixture show an excess or deficiency of bituminous material, correct the unsatisfactory condition by the addition of required aggregate or bituminous material, followed by remixing. Should the mixture show uneven distribution of bituminous material, correct the unsatisfactory condition by remixing. Continue the mixing until the mixture is complete and satisfactory.

3.6 PROCEDURE WITH THICKENED EDGE

Make a triangular cut conforming to the dimensions indicated at each edge of the surfacing. Place the excavated material on the shoulder in a small windrow against which the mixture will be spread. The trench area shall be primed in accordance with Section 32 12 10 BITUMINOUS TACK AND PRIME COATS prior to spreading of the bituminous mixture. Fill the trench with bituminous mixture and thoroughly roll it by means of the grader wheels, prior to the spreading of the surface course.

3.7 SPREADING AND SHAPING

After being satisfactorily mixed and aerated as directed, spread the bituminous material and mineral aggregate from the windrow upon the base course or primed surface in a layer of uniform thickness conforming to the lines and grades and typical sections indicated. Do not start spreading until an inspection of the subgrade or base course has been made, and any necessary reconditioning has been completed, as directed. The bituminous mixture shall not be spread when the surface is damp or when the mixture contains visible free moisture. The mixture shall be aerated until the volatile content is reduced to the point where the mixture can be spread on the roadway, and compacted to a stable pavement course that will withstand normal traffic without rutting, scuffing, raveling, or other detrimental effects. The mixture on sections of pavement showing any of these defects shall be loosened, further aerated, and recompact to a stable pavement course. Spread the mixed material to the required width in layers, by a self-powered blade grader, as directed. In spreading from a windrow, take

care to prevent cutting into the underlying subgrade or base course. If necessary, a layer of mixture approximately 13 mm 1/2 inch thick shall be left at the bottom of the windrow to prevent damage to the base course. After approximately one-half of the material has been spread, the remaining shall be windrowed. The material spread shall be rolled once, and then planed with a blade grader to remove high spots. The remaining material shall then be spread and rolled to the depth and width indicated. During the spreading and compacting, the surface shall be dragged or bladed, as necessary, to fill any ruts and to remove corrugations, waves, or other irregularities.

3.8 ROLLING FINISHED SURFACE

NOTE: Consult CEMP-ET on test method to be used and indicate below.

Roll the surface after all layers have been satisfactorily spread. Final rolling shall be done by means of power-driven rollers. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the rear wheel of the roller. Alternate trips of the roller shall be of slightly different lengths. Control the speed of the roller so that lateral displacement of the mixture does not occur. Light blading or floating of the surface with a blade grader during the rolling period may be required. Continue rolling until all roller marks are eliminated, the surface is of uniform texture, and the mixture is compacted to at least 92 percent of maximum density as determined by [_____]. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but an excess of water will not be permitted. The rollers shall be in good condition, suitable for rolling asphalt, and shall be operated by experienced rollermen. At all places not accessible to the roller, the mixture shall be thoroughly tamped with hand tampers. Should the surface of the surface course for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portions shall be torn up, reworked, relaid, or replaced at no additional cost to the Government. Should any portion of the surface, when laid, become water soaked for any reason, the portion shall be torn up at once, and the mix therefrom placed in a windrow and aerated until the moisture content is within the limits specified. The mixture shall then be spread, shaped, and rolled as specified.

3.9 SHAPING OF EDGES

While the surface is being compacted and finished, trim the outside edges neatly to line.

3.10 GRADE CONTROL

The finished and completed surface course shall conform to the lines, grades, cross section, and dimensions indicated. Maintain the lines and grades, as indicated, by means of line and grade stakes placed in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.11 SURFACE SMOOTHNESS AND THICKNESS TESTING

Follow tolerances for surface smoothness and thickness as specified in paragraph SAMPLING AND TESTING.

3.12 SAMPLING AND TESTING

Sampling and testing are the responsibility of the Contractor. Perform sampling and testing by an approved commercial testing laboratory, or by the Contractor, subject to approval.

3.12.1 Sources of Materials

Select in advance of the time required for use in the work, the source of materials for the wearing course. [Perform tests to determine the suitability of the proposed materials and submit copies of test results, within 24 hours after completion of tests] [Supply samples of the proposed aggregates] not less than [_____] days before materials are required for the work.

3.12.2 Field Testing

3.12.2.1 Aggregate and Bitumen Sampling

Perform sampling of the aggregate and bitumen in accordance with ASTM D75/D75M for coarse and fine aggregates, ASTM C183/C183M for mineral filler, and ASTM D140/D140M for bituminous material. Test the materials for compliance with paragraph AGGREGATES, paragraph BITUMINOUS MATERIALS, and paragraph COMPOSITION OF MIXTURE.

3.12.2.2 Asphalt Sampling

Obtain samples of the asphalt mixture for each 400 metric tons tons of pavement produced and tested for compliance with paragraph COMPOSITION OF MIXTURE.

3.12.2.3 Testing

Perform tests for surface smoothness in accordance with paragraph Tolerances at intervals of not more than [_____] meters feet along the surface of the finished pavement.

3.12.3 Testing of Windrowed Aggregate

Measure the windrowed aggregate, and any adjustments of quantities necessary to produce the specified thickness of the course shall be made as directed. Samples of the windrowed aggregate shall then be taken to be tested for conformance with gradation requirements of this section of the specifications, and any necessary adjustments in gradation shall be made, as directed.

3.12.4 Moisture Content of Windrowed Aggregate

NOTE: Only the types, grades, and designations applicable to climatic and other job conditions will be retained. When emulsions are used, the moisture-content requirement for the aggregate will be selected in accordance with specific job conditions. The moisture content at the time the emulsified asphalt is applied will be such that a uniform coating will be retained on all aggregate particles without the bitumen running off the particles. The moisture content will not exceed 3

percent by weight and will be reduced sufficiently by aeration to allow the emulsion to break prior to compaction. The compacted mixture will be allowed to cure until the moisture content does not affect the stability of the finished mixture prior to opening for traffic. When cutbacks are used, the moisture will not be in excess of 2 percent. The moisture content of the aggregate before mixing will be carefully controlled by laboratory tests.

Immediately prior to distributing bituminous material, sample and test for moisture content the windrowed aggregate. If the moisture content is in excess of [2] [3] percent, the aggregate shall be aerated without degradation of the aggregate, until the moisture content is within the limits specified.

3.12.5 Tolerance

Take suitably sized core samples to determine the thickness of the completed pavement at intervals of not more than [_____] meters feet along the surface. Replace the area where samples were removed from the pavement, at no additional expense to the Government.

3.12.5.1 Surface-Smoothness Requirements

Test the surface course longitudinally and transversely with a 3.6 m 12 foot straightedge. Place the straightedge parallel to and perpendicular to the centerline at [_____] intervals along the surface. The finished surface of the surface course shall show no deviation greater than 6.4 mm 1/4 inch from the 3.6 m 12 foot straightedge. Correct surface irregularities in excess of those specified above as directed, without additional cost to the Government.

3.12.5.2 Thickness Requirements

The thickness of the pavement shall not vary from that shown by more than 6.4 mm 1/4 inch. Correct a variation in thickness in excess of 6.4 mm 1/4 inch as directed, without additional cost to the Government.

-- End of Section --