Preparing Activity: USACE Superseding
UFGS-32 01 17 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 32 01 16.70

COLD-MIX REUSED ASPHALT PAVING
05/18

NOTE: This guide specification covers the requirements for recycled cold-mix asphalt mixture.

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 item(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 if the work is included in one lump sum contract price for the entire work covered by the invitation for bids. This paragraph may be revised to combine the payment for cold-mix recycled mixture, rejuvenator (if needed), and emulsified asphalt cement, when separate payment for emulsified asphalt cement material is not considered warranted based on local experience and job conditions. Lump sum contracts can be used when the total job does not exceed 17,000 square meters 20,000 square yards or 1000 metric tons tons.

1.1.1 Measurement

****
NOTE: Where in place mixing is used, measurement will be in square meters yards of accepted work.
****

Cold-mix recycling paid for will be the number of [metric tons tons] [square meters yards] used in the accepted work. Aggregates will be paid for by the number of [metric tons tons] [square meters yards] used in the accepted work. The recycling agent will be paid for by the number of [liters gallons] [metric 2000-pound tons] of material used in accepted work. The emulsified asphalt cement will be paid for by the number of [liters gallons] [metric 2000-pound tons] of material used in accepted work. Determine the number of liters gallons of emulsified asphalt cement used either by measuring the material at a temperature of 15.6 degrees C 60 degrees F or by correcting the amount measured at another temperature to liters gallons at 15.6 degrees C 60 degrees F, using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for the emulsified asphalt.

1.1.2 Payment

The quantities of recycled paving mixture, aggregates, recycling agent, and emulsified asphalt cement, determined as provided above, will be paid for at respective contract unit prices per [metric ton ton] [square meter yard] for paving mixture and aggregates and per [liter gallon] [metric ton ton] for recycling agent and emulsified asphalt cement. If deficiencies in the finished product exceed specified tolerances, no payment will be made for such areas of pavement until the defective areas are corrected and accepted by the Contracting Officer.

1.2 REFERENCES

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

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

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

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 88	(2013) Standard Method of Test for Particle Size Analysis of Soils

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D977	(2019a; E 2019) Standard Specification for Emulsified Asphalt
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2397/D2397M	(2019a) Standard Specification for Cationic Emulsified Asphalt

ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4944	(2018) Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D5505	(2014) Classifying Emulsified Recycling Agents
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

****

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

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

****

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

SD-03 Product Data

Aggregates

Asphalt Emulsion

Recycling Agent

Job-Mix Formula (JMF); G[, [_____]]

SD-04 Samples

Samples

Cold Recycled Mixtures

SD-06 Test Reports

Testing

1.4 QUALITY CONTROL

1.4.1 Sampling and Testing

Perform sampling and testing by using a commercial testing laboratory or Contractor facilities, upon approval by the Contracting Officer. No work requiring testing will be permitted until the testing facilities have been inspected and approved. The first inspection will be at the expense of the Government. Cost incurred by the Government for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor.

1.4.2 Samples

Submit samples from the existing pavement obtained from at least two locations to provide representative samples of the pavement. Take recyclable asphalt pavement and aggregate samples for laboratory tests in accordance with ASTM D75/D75M. Take samples of the emulsified asphalt

cement (bituminous material) [and recycling agent] in accordance with ASTM D140/D140M.

1.4.3 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph ACCEPTABILITY OF WORK.

1.5 EQUIPMENT, TOOLS AND MACHINES

Allow the Contracting Officer access, at any time, to all equipment used to produce the cold-recycled mixture; this can involve checking the adequacy of the equipment used, inspecting the operation of the equipment, and verifying weights, mixture proportions, and the character and physical properties of the materials used for construction. Plant, machines, tools, and miscellaneous equipment to be used on the production and placement of the cold recycled mixture must be approved by the Contracting Officer. Tentative approval of specific items will be made only after adequacy of the plant, machines, tools, and miscellaneous equipment has been demonstrated in full-scale production.

1.5.1 Central Plant Mixing

****

NOTE: This paragraph and paragraph In-Place Mixing should be left in only when it is desired to give the Contractor a choice between central plant mix and in-place methods.

****

Provide a mixing plant designed, coordinated, operated to produce mixture within the JMF, and capable of producing recycled mixture at a minimum rate of [136] [_____] Mg [150] [_____] tons per hour. Equip the plant with a positive means to control the amount of asphalt, water, [recycling agent,] and time of mixing.

1.5.2 In-Place Mixing

Use equipment for in-place mixing construction that will produce mixture within the JMF. Use mixing equipment that is equipped with positive means to control the amount of asphalt[, recycling agent,] and water added and is capable of producing a homogeneous mixture.

1.5.3 Straightedge

Furnish and maintain at the site, in good condition, one 3.66 meter 12 foot straightedge for each mechanical spreader. Make straightedge available for Government use. Use straightedges constructed of aluminum or other lightweight metal with blades of box or box-girder cross section and with flat bottom reinforced to insure rigidity and accuracy. Use straightedge with handles to facilitate movement on pavement.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not construct recycled cold-mix course in rain or on a layer which contains free water either within the layer or on its surface. Construct recycled cold-mix courses only when the atmospheric temperature is 10 degrees C 50 degrees F or above.

PART 2 PRODUCTS

2.1 RECLAIMED ASPHALT PAVEMENT (RAP)

****

NOTE: Cold-mix recycling could include the use of existing RAP material stockpiles. If this condition exists, the desired material properties must be included below. The gradation of the existing stockpile will need to be determined.

****

Provide RAP consisting of material obtained from cold milling or from removal and crushing of the existing asphalt pavement. The maximum particle size of the RAP material must never exceed half the thickness of the compacted cold mix layer. When lifts of 75 mm 3 inches or more are used, the maximum particle size of the RAP material must not exceed a maximum of 38 mm 1-1/2 inch and a minimum of 90 percent of the RAP must pass a 25 mm 1 inch sieve.

2.2 AGGREGATES

****

NOTE: Delete this paragraph when new or additional aggregates are not required as part of the recycling project. When required, new aggregates may be added to produce an aggregate gradation that meets the desired end product. Gradations for base course, stabilized base course or intermediate asphalt mixture course should be specified in Table I below. For airfields, cold recycled mixture will only be used for base course material or lower levels in the pavement structure. The choice of which gradation to specify should be based on the type, quality, and uniformity of the RAP material available for use. The gradation of the recycled mixture must be determined on the aggregate recovered from an extraction or ignition test.

The gradation may require only that a maximum aggregate particle size not be exceeded or it may be more detailed, requiring further processing or adjustment with new aggregates to meet the desired gradation. The tolerances applied to this gradation should follow standard tolerances given for aggregates or asphalt aggregate mixtures when used in similar situations. When the recycled mixture is intended to be used as an intermediate or binder course (for non airfield areas), the gradation tolerances should follow those given in UFC 3-250-03, Table "Aggregate Gradations for Bituminous Concrete Pavements," for low-pressure tires. When the recycled mixture is to be used as a base course, an exact JMF aggregate gradation is not normally given and therefore tolerances are not required. The only requirement is that the gradation must stay within the gradation range specified.

****

Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screening, natural sand, and mineral filler, as required. The portion of materials retained on the 4.75 mm No. 4 sieve will be known as coarse aggregate, the portion passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve will be known as fine aggregate, and the portion passing the 0.075 mm No. 200 sieve will be known as mineral filler. The combined recycled aggregate gradation must conform to the gradation specified in TABLE I. TABLE I is based on aggregates of uniform specific gravity; the percentage passing various sieves may be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentage passing various sieves may be changed by the Contracting Officer when the specific gravity of the aggregates varies by more than 0.2.

TABLE I. COMBINED RECYCLED AGGREGATE GRADATION	
Sieve Size	Percent Passing
[_____]	[_____]

2.2.1 Coarse Aggregate

****

NOTE: The values of percentage of loss will be based on knowledge of aggregates in the area which have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years. Typically, RAP will come from existing pavement being repaved and aggregate from RAP will not be tested except for gradation. New aggregates will meet required properties described in this section. Cold mix layers will always be overlaid with hot mix layers or bituminous surface treatment.

****

New coarse aggregate will consist of clean, sound, durable particles meeting the following requirements.

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

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

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

d. Crushed gravel retained on the 4.75 mm No. 4 sieve and each coarser sieve containing at least 75 percent by weight of crushed pieces having one or more fractured faces with the area of each face equal to at least 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of fractures must be at least 30 degrees to count as two fractured faces.

e. Essentially cubical particle shape of crushed aggregates. Provide aggregate that contains no more than 20 percent by weight of flat and

elongated particles in any sieve size when determined in accordance with ASTM D4791.

2.2.2 Fine Aggregate

Provide new fine aggregate consisting of clean, sound, durable particles including natural sand or crushed stone, slag, or gravel that meets requirements for wear and soundness specified for coarse aggregate. Fine aggregate produced by crushing gravel must have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion larger than the 0.600 mm No. 30 sieve. This requirement applies to the material before blending with natural sand, when blending is necessary. Quantity of new natural sand to be added to the intermediate course mixtures must not exceed 25 percent by weight of new coarse and new fine aggregate and material passing the 0.075 mm No. 200 sieve. Provide natural sand that is clean and free from clay and organic matter. The percentage of loss must not exceed [_____] after five cycles of the soundness test performed in accordance with ASTM C88, using magnesium sulfate.

2.2.3 Mineral Filler

Use mineral filler conforming to ASTM D242/D242M. Determine grain size in accordance with AASHTO T 88.

2.3 ASPHALT EMULSION

****

NOTE: The material being recycled may contain sufficient asphalt binder to meet the specification requirements. In this case, only water will be added as a lubricant to improve compaction. When additional asphalt binder is needed grade SS-1 or CSS-1 should be specified in moderate or cold climates. Grade SS-1h or CSS-1h should be specified in hotter climates such as the southern or southwestern areas of the United States. Medium set, high float, or other types of emulsions may be used with open graded mixtures or in instances where previous experience with these types of emulsions has provided good results.

****

Asphalt, if required, must be an emulsified asphalt, Grade [_____] conforming to [ASTM D977] [ASTM D2397/D2397M].

2.4 WATER

Generally, any potable water will be acceptable for diluting the asphalt emulsion. Prior to construction, mix a sample of the water intended for use on the job with a sample of the emulsion at the ratio to be used in the project. If any adverse effect is observed on the emulsion, use a new source of water.

2.5 RECYCLING AGENT

****

NOTE: Depending on the material properties of the

existing asphalt cement binder and the type and method of recycling used, an appropriate type of recycling agent (rejuvenator) will be selected. An emulsified recyling agent should be selected according to ASTM D5505. The type of rejuvenator specified must match the recycling process used. The recycling agent selected should be capable of decreasing the viscosity of the reclaimed asphalt cement to levels that approach the viscosity values of asphalt cement in new asphalt concrete pavements for that area or region. Delete this paragraph if a recycling agent is not required.

****

Use [_____] recycling agent selected in accordance with ASTM D5505. Submit notification on sources from which aggregates, emulsified asphalt cement and recycling agent are to be obtained within 15 days after contract award.

2.6 JOB-MIX FORMULA (JMF)

****

NOTE: The mix design primarily establishes the amount of asphalt binder and recycling agent (if used) to be added to the mixture, and then establishes the amount of water to insure optimum compaction conditions. The optimum asphalt content (this includes the recycling agent, if used) is determined based on hot compacted samples because this produces the density that will ultimately be obtained in the field. Ideally, the water content should be selected to provide maximum density based on samples compacted at the mixture temperature (ambient air temperature) which will be encountered during construction.

Prior to bidding the contract, the designer may want to sample and obtain the material properties of the asphalt and aggregates in the existing pavement. This information is required to allow the development of a JMF and to allow for estimates of emulsified asphalt cement and/or recycling agent type and quantities required. The need for new aggregates to meet JMF requirements may also be determined. For lump sum bidding, a reasonable estimate of required quantities of materials will be needed.

****

Submit the JMF for the recycled mixture to the Contracting Officer for acceptance after the award of the contract and at least [30] [_____] days prior to placement of recycled mixture. Samples will be compacted using 50 blows with Marshall equipment or 50 gyrations with the Superpave gyratory compactor. Prior to compaction mixes will be heated to temperatures equivalent to hot mix asphalt and the mix will be designed to provide 3-4 percent air voids in the compacted mixture. Mixes will be compacted at expected construction temperature to determine optimum moisture content. No payment will be made for cold recycled mixtures produced prior to the completion and acceptance of the JMF. The formula

will indicate the gradation of the aggregate and a definite percentage of water [,recycling agent] and asphalt emulsion to be added to the mixture.

2.6.1 Gradation Tolerances

****

NOTE: Eliminate the corresponding material size and tolerance values to agree with sieve sizes specified in Table 1. Eliminate these completely if no new aggregate is added and no specific JMF gradation is developed.

****

The tolerances allowed on the gradation are as follows:

Material	Tolerance, Plus or Minus
Aggregate passing the 4.75 mm No. 4 or larger sieve	4 percent
Aggregate passing the 2.36, 1.18, 0.6, and 0.3 mm Nos. 8, 16, 30, and 50 sieves	3 percent
Aggregate passing the 0.15 and 0.074 mm Nos. 100 and 200 sieves	1 percent

2.6.2 Asphalt Content

The JMF will be allowed an asphalt content tolerance of 0.3 percent. The asphalt content may be adjusted by the Contractor to improve paving mixture, without adjustment in contract unit price when approved by the Contracting Officer. Select the optimum asphalt content to provide the tabulated properties when samples are compacted at 120 degrees C 250 degrees F using 50 blows of the Marshall hammer or 50 gyrations with the Superpave gyratory compactor.

Property		Requirement (50 blows)
Voids in total mix, percent		3-5
Voids filled with bitumen, percent		75-85

2.6.3 Water Content

Select the water content to provide maximum dry density when samples are prepared at the optimum asphalt content and compacted with 50 blows/gyrations at ambient temperature. When no asphalt binder is added to the mixture, select the water content to provide maximum dry density. Prepare samples with water contents, in 0.5 percent intervals, from 0 to 2.5 percent (water content may be increased to achieve maximum density). After compaction, place the samples in an oven at 60 degrees C 140 degrees F for 96 hours. After cooling to ambient temperature, determine the dry density according to ASTM D2726/D2726M. Select the optimum moisture

content as the moisture content that provides maximum density.

PART 3 EXECUTION

3.1 CONDITION OF EXISTING SURFACE

Correct areas in the existing pavement that provide indications of underlying structural deficiencies (alligator cracking or depressions) prior to the completion of the recycling process.

3.2 CONSTRUCTION METHODS

****

NOTE: Depending on the type of recycling desired the following paragraphs should be edited to remove the undesired method. The following can remain in its entirety when the type of construction used is to be a Contractor's option.

****

Use only RAP materialthat meets the requirements given in paragraph RECLAIMED ASPHALT PAVEMENT prior to mixing.

3.2.1 Central Plant Mixing

Introduce the required amount of bituminous material for each batch, or calibrated amount of continuous mixing, into the mixer to meet the requirements of the JMF. Mix the material in a manner that provides a uniform dispersion of the emulsified asphalt, recycling agent if used, and water and achieves a thorough coating (visually) of all aggregate particles. If this process requires excessive mixing, resulting in premature breaking of the emulsified asphalt, shorten the mixing times as approved by the Contracting Officer. Use a mixing process that thoroughly coats all particles.

3.2.2 Test Section

****

NOTE: Use of a test section is recommended for all recycled mixtures, especially for central-plant mix recycling. The following paragraph is written for placing central-plant mix with a paver and must be edited when another type of recycling is used.

****

Prior to the start of the recycling project, prepare a sufficient quantity of mixture to construct a test section at least 15 meters 50 feet long, two spreader widths wide and of thickness to be used in the project. Place, spread, and roll the mixture with the equipment to be used in the project and in accordance with requirements specified above. This test section will be tested and evaluated as a lot conforming to all specification requirements. If approved by the Contracting Officer, the test section may be located in one of the less critical areas of the project. Otherwise, it will be located outside the project area. If tests results are satisfactory, the test section will remain in place as part of the completed pavement if constructed in the project pavement area. If tests indicate that the pavement does not conform to specification requirements, remove the test section and dispose of the material offsite. Make necessary adjustments to the plant and placing

operations and rolling procedures immediately, and construct another test section, all at no additional cost to the Government. Construct additional test sections, as necessary and as directed. Sample and test additional test sections for conformance with specification requirements. In no case will full production of the recycled mixture begin without approval of the Contracting Officer.

3.2.3 In-Place-Mixing

****

NOTE: In-place recycling can be divided into either partial- or full-depth recycling. Partial-depth recycling involves only a portion of the asphalt bound layers and normally involves recycling to a depth of 50 to 100 mm 2 to 4 inches. Full-depth recycling involves all asphalt bound layers and often portions of the underlying base course layer.

****

Produce a uniform blend of the RAP, new aggregate (when required), asphalt emulsion, recycling agent, water, and a mixture containing the required amounts of emulsified asphalt and water as given in the JMF when using the in-place recycling process.

3.3 PLACEMENT

3.3.1 Spreaders

Provide spreading equipment capable of spreading material uniformly; and resulting in a surface that meets the grade and smoothness requirements when compacted. Unless otherwise directed, begin spreading along the centerline of areas paved on a crowned section, or on the high side of areas with a one-way slope, in the direction of major traffic flow. Spray contact surfaces of previously constructed pavement, curbs, manholes, and other structures with a thin coat of bituminous material conforming to Section 32 12 13 BITUMINOUS TACK AND PRIME COATS. Place the recycled mixture without segregation.When segregation occurs during placement, suspend the spreading operation until the cause is determined and corrected. When placing by hand, dump and distribute the mixture into place and spread with lutes in a uniformly loose layer of such thickness to conform to the required grade and thickness when compacted. During hand spreading, carefully place each shovelful of mixture by dropping the material in place by turning the shovel over in a manner to prevent segregation. Do not place the mixture by throwing or broadcasting.

3.3.2 Placement with a Paver

Place the recycled asphalt mixture with a self-propelled asphalt paver or similar equipment containing a vibrating or tamping screed. Operate the paver so that the course being laid will be smooth and continuous without pulling or tearing.

3.3.3 Layer Thickness and Curing

****

NOTE: The minimum layer thickness allowed should be at least twice the size of the maximum aggregate particle of the RAP or aggregate. The maximum layer thickness may vary from 100 to 150 mm 4 to 6 inches.

However, it is typically recommended to not exceed 100 mm 4 inch layer unless there is a good reason to use a thicker layer. Constructing layers thicker than 100 mm 4 inches makes it more difficult to compact, more difficult to control smoothness, and more time to cure. The curing period should range from 7 to 14 days, depending on climatic conditions. The hotter and drier the weather, the shorter the curing period. Generally, the cure period should be about 2 days for each 25 mm 1 inch of lift thickness. The water content of the recycled mixture should be below 1.5 percent prior to placing additional layers or a wearing surface.
****

Construct each layer of compacted mixture at least [_____] mm inches but no more than [_____] mm inches in thickness. Allow each layer of recycled mixture to cure for [_____] days before placing a succeeding layer, unless a shorter curing period is approved in writing by the Contracting Officer.

3.3.4 Windrows

When windrows are used, construct them of such size and shape to allow adequate mixing of materials without segregation, ensuring that the required thickness of pavement can be constructed.

3.4 COMPACTION OF MIXTURE

Conduct compaction of the mixture to satisfy density, grade, and smoothness requirements. Roll bituminous mixtures until all roller marks are eliminated, and a field density of at least 88 percent of the theoretical maximum density has been obtained when tested in accordance with ASTM D2041/D2041M.

3.4.1 Operation of Rollers and Tampers

Provide the sufficient number, weight, and type of rollers to obtain the required density. Begin initial rolling of the recycled mixture as the emulsion is starting to break. Vibratory rolling will be allowed to achieve required density. Use finish rolling with a steel-wheel roller to remove any existing roller marks.

3.4.2 Correcting Deficient Areas

Remove mixture that becomes contaminated with foreign material, or is defective in any way, to the full thickness of the course. Cut the hole with sides vertical and perpendicular to each other, with one side parallel to the direction of traffic. Do not skin patch rolled areas to correct low areas and do not be mill rolled areas to correct high areas. Place fresh paving mixture in holes in sufficient quantity to produce a finished surface conforming to grade and smoothness requirements. Aerate paving mixture, if necessary, and compact to the density specified herein. Provide competent workmen capable of performing all work incidental to the correction of deficiencies and defects.

3.5 JOINTS

Provide joints of the same texture, density, and smoothness as other sections of the course. Carefully make joints between old and new

pavements or between successive days' work to ensure continuous bond between old and new sections of the course.

3.5.1 Transverse Joints

Pass the roller over the unprotected end of freshly laid mixture only when laying of the course has been discontinued. Cut back the edge of the previously laid course to expose even, vertical surface for the full thickness of the course. Rake the fresh mixture against the joints, thoroughly tamp, and then roll.

3.5.2 Longitudinal Joints

Construct longitudinal joints which are uniform, and without mixture segregation. When directed by the Contracting Officer, cut back the longitudinal joint to expose an even, vertical surface for the full thickness of the course.

3.6 EDGES OF PAVEMENT

Make edges of pavement straight and true to required lines. After final rolling, cut off and square excess material and dispose of as directed.

3.7 TRAFFICKING

Trafficking on newly placed cold recycled mixtures will not be allowed prior to completion of compaction and the curing period.

3.8 ACCEPTABILITY OF WORK

3.8.1 Testing

Perform field tests in sufficient numbers to ensure that the specifications are being met. Submit copies of test results within 24 hours of completion of tests. Submit copies of test reports for aggregate source, not less than [30] [_____] days before the material is required in the work. Certified copies of the emulsified asphalt cement and/or recycling agent manufacturer's test reports indicating compliance with applicable specified requirements, will be placed not less than [30] [_____] days before material is required in the work. Testing is the Contractor's responsibility and performed by an approved commercial laboratory. Perform the following tests at the appropriate time, as the minimum acceptable for each type of operation.

3.8.1.1 Mixture Properties

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NOTE: The mixture should normally be sampled and tested twice a day or for every 4 hours of production or placement.

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Obtain a sample of the recycled mixture for every [_____] hours of placement of the mix. Determine the asphalt content of the mix according to ASTM D2172/D2172M or ASTM D6307. Provide asphalt content of the recycled material within the tolerance given in paragraph JOB-MIX FORMULA. Determine the gradation of the extracted aggregate in accordance with ASTM C117 and ASTM C136/C136M. Provide extracted gradation meeting the JMF and the corresponding tolerances.

3.8.1.2 Density Testing

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NOTE: The frequency of testing for the maximum theoretical density (ASTM D2041/D2041M) should be tied to the frequency of the field nuclear test readings. Depending on the anticipated construction methods used, a nuclear density test should be performed about every 500 square meters yards of recycled mixture placed. Generally, one ASTM D2041/D2041M test should be conducted for every 4 nuclear tests and four ASTM D2041/D2041M tests should be performed for each full day of production.

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Conduct field density tests in accordance with ASTM D6938 or ASTM D1556/D1556M. When ASTM D6938 is used, perform testing by the direct transmission method. Accomplish the calibration of the nuclear test device by testing in accordance with ASTM D1556/D1556M as described in paragraph "Calibration" of ASTM D6938. Tests performed in accordance with ASTM D6938 result in a wet unit weight of material. Determine the moisture content of the recycled mixture by ASTM D2216, ASTM D4643, ASTM D4944, or ASTM D4959. Perform calibration testing in an area representative of the entire project in regards to materials and compactive effort. Perform a minimum of three of these tests and take at least three nuclear readings near each of these areas. Calibrate each nuclear device accordingly. Each day recalibrate the used nuclear devices in the manner stated above or the selected area preserved and the devices calibrated in the same approximate locations each day. Express the field density as a percentage of the maximum theoretical density in accordance with ASTM D2041/D2041M. Furnish all tools, labor, and materials for obtaining samples and refilling sample locations. Perform a minimum of one nuclear field density test for every [_____] [metric tons tons] [square meters yards] of mixture placed.

3.8.1.3 Grade Conformance

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NOTE: For cold-recycled mixtures used only as a base course in aircraft traffic areas, such as airfield runways and taxiways, intervals between grade-conformance tests should not exceed 8 m 25 feet. This should be the procedure for wide non airfield pavement such as parking lots. For roads, the intervals between grade-conformance tests should not exceed 8 m 25 feet longitudinally and should be at transverse intervals as appropriate.

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Take measurements for deviation from grade by running lines of levels at intervals of [_____] meters feet longitudinally and [_____] meters feet transversely to determine the elevation of the completed pavement. Provide finished and completed surface conforming within 15 mm 0.05 foot to lines, grades, cross section, and dimensions shown on the drawings.

3.8.1.4 Surface Smoothness

Take measurements for deviation from surface smoothness with a 3.66 meter

12 foot straightedge. Do not deviate more than 10 mm 3/8 inch from the testing edge of the straightedge in the transverse or longitudinal direction. Place the straightedge parallel to the centerline of each lane paved at intervals of [_____] meters feet and perpendicular to the centerline at intervals of [_____] meters feet. Record the locations and deviations from the straightedge of all measurements. Remove defective areas and replace them with fresh paving mixture at no additional cost to the Government.

3.8.2 Material Samples

Obtain a sample of all materials used in the recycled mixture under the supervision of the Contracting Officer. The sample will be retained by the Government.

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