
USACE / NAVFAC / AFCEA UFGS-02708 (August 2004)

Preparing Activity: USACE Superseding
UFGS-02712A (December 1997)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated 22 December 2004

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DIVISION 02 - SITE CONSTRUCTION

SECTION 02708

LIME-STABILIZED BASE COURSE, SUBBASE, OR SUBGRADE

08/04

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SECTION 02708

LIME-STABILIZED BASE COURSE, SUBBASE, OR SUBGRADE 08/04

NOTE: This guide specification covers the requirements for lime stabilization of subgrades, subbases, and base courses for airfield pavements and for roads, streets, and parking areas.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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 81	(1992; R 2000) Cut-Back Asphalt (Rapid-Curing Type)
AASHTO M 82	(1975; R 2000) Cut-Back Asphalt (Medium-Curing Type)
AASHTO T 135	(1997; R 2001) Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
AASHTO T 136	(1997; R 2001) Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2004) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 25	(1999) Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C 50	(2000) Sampling, Sample Preparation, Packaging, and Marking of Lime and Limestone Products
ASTM D 1250	(2004) Petroleum Measurement Tables
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1632	(1996) Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D 1633	(2000) Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2027	(1997; R 2004) Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1997; R 2004) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2922	(2004) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2004) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 490	(1992; R 2001) Road Tar
ASTM D 559	(2003) Wetting and Drying Compacted Soil-Cement Mixtures
ASTM D 560	(2003) Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D 633	(1997; R 2001) Volume Correction Table for Road Tar
ASTM D 75	(2003) Sampling Aggregates
ASTM D 977	(2003) Emulsified Asphalt
ASTM E 11	(2004) Wire Cloth and Sieves for Testing Purposes

1.2 DEFINITIONS

1.2.1 Lime-Stabilized Course

Lime-stabilized course, as used in this specification, is a mixture of lime and in-place or select borrow material uniformly blended, wetted, and thoroughly compacted to produce a pavement course which meets the criteria set forth in the plans and this specification.

1.2.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as percent laboratory maximum density.

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy 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 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, Machines, and Tools
Mix Design

List of proposed equipment to be used in performance of construction work including descriptive data. Mix design at least [_____] days before it is to be used.

Waybills and Delivery Tickets

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used.

SD-06 Test Reports

Sampling and Testing
Field Density

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within [24] [_____] hours after the tests are performed. Certified copies of test results of materials and sources not less than [30] [_____] days before material is required for the work.

1.4 MEASUREMENT FOR PAYMENT

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Method of measurement not applicable to the job conditions will be deleted. If bituminous material is to be paid for separately, select the desired

method of measurement. Paragraph Select Material will be deleted and reference to select material in article Basis for Payment will be deleted when select material is not required from borrow areas.

1.4.1 Lime Stabilization

Measurement will be by the square meter yard of work completed and accepted.

1.4.2 Lime

Measurement will be by the number of metric tons 2000 pound tons of lime used in the completed and accepted work. No measurement will be made for wasted lime or lime used in work determined defective.

1.4.3 Bituminous Material

Bituminous material to be paid for will be measured in the number of [liters gallons of the material used in the accepted work, corrected to liters at 16 degrees C gallons at 60 degrees F in accordance with [ASTM D 633] [ASTM D 1250]. A coefficient of 0.000139 per degree C (0.00025 per degree F) 0.00025 per degree F shall be used for asphalt emulsion.] [metric tons 2000 pound tons of the material used in the accepted work.]

1.4.4 Select Material

Select material will be measured by the [cubic meter yard] [metric ton 2000-pound ton] of material placed and used in the completed and accepted stabilization. No measurement will be made for select material that is wasted or used in work determined defective.

1.5 BASIS FOR PAYMENT

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Method of measurement not applicable to the job conditions will be deleted. If bituminous material is to be paid for separately, select the desired method of measurement.

Lime stabilization, constructed and accepted, including lime, [bituminous material] [and select material] will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. [Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating.] [No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting shall be included in the contract unit price for bituminous material.]

1.6 WAYBILLS AND DELIVERY TICKETS

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed waybills and certified delivery tickets shall be furnished for all lime [and bituminous materials] [and select materials] used in the construction.

1.7 JOB DESCRIPTION

The work specified consists of the construction of a lime-stabilized [base] [subbase] [subgrade] course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes, and typical sections shown in the drawings. Sources of materials shall be selected well in advance of the time when materials will be required in the work.

1.8 STOCKPILING MATERIALS

NOTE: This paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.

Select material, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Before stockpiling material, storage sites shall be cleared and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

1.9 PLANT, EQUIPMENT, MACHINES, AND TOOLS

NOTE: Types of equipment specified but not required for this type of base course will be deleted, and other items of equipment not listed will be added as appropriate.

1.9.1 General Requisites

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. Protective equipment, apparel, and barriers shall be provided to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

1.9.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type with a total weight of not less than 9 metric tons, 10 tons, and a minimum weight of 135 kilograms per millimeter 300 pounds per inch width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

1.9.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have 4 or more tires, each loaded to a minimum of 13.6 metric tons 30,000 pounds and inflated to a minimum pressure of 1.035 MPa.150 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

1.9.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls; and shall be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

1.9.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

1.9.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

1.9.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one [3.05] [3.66] meters ([10] [12] foot) [10] [12] foot straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.10 WEATHER LIMITATIONS

Work on the base course shall not be performed during freezing temperatures. When the temperature is below 5 degrees C, 40 degrees F, the completed base course shall be protected against freezing by a sufficient covering of straw, or by other approved methods, until the course has dried out. Any areas of completed base course that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition without additional cost to the Government. Lime shall not be applied when the atmospheric temperature is less than 5 degrees C.40 degrees F. No lime shall be applied to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls

below 2 degrees C, 35 degrees F, completed lime-treated areas shall be protected against any detrimental effects of freezing.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Lime

Lime shall be a standard brand of [quicklime] [hydrated lime] conforming to the following physical and chemical requirements:

- a. Lime shall be of such gradation that 99-1/2 percent passes a 0.850 mm No. 20 sieve and a minimum of 85 percent passes a 0.150 mm No. 100 sieve.
- b. Combined calcium oxide and magnesium oxide shall be not less than [92 percent] [70 percent].

2.1.2 Bituminous Material

NOTE: Tar or asphalt of one grade or type will be specified.

Material shall conform to one of the following:

2.1.2.1 Cutback Asphalt

[AASHTO M 81] [AASHTO M 82] [ASTM D 2027] [ASTM D 2028], Grade [RC-250] [RC-800] [MC-250] [MC-800].

2.1.2.2 Emulsified Asphalt

ASTM D 977, Type [RS-1] [RS-2].

2.1.2.3 Tar

ASTM D 490, Grade [RT-7] [RT-8] [RT-9] [RT-10].

2.1.3 Material to be Stabilized

NOTE: Soils classified as CH, CL, MH, SC, and GC have potential for lime stabilization; however, it is not recommended to use lime alone for the stabilization of sandy soils. Designer should refer to TM 5-822-14 and TM 5-825-2 for further guidance.

Material to be stabilized shall consist of [in-place material in the area] [approved select material. Select material shall be free of deleterious substances such as sticks, debris, organic matter, and stones greater than 75 mm 3 inches in any dimension. At least 10 percent of the material shall pass the 0.425 mm No. 40 sieve. Plasticity index shall be greater than 12].

2.1.4 Water

Water shall be clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the lime or soil-lime mixture, and shall be subject to approval.

2.2 MIX DESIGN

NOTE: The designer should determine the compressive strength requirement based on the use of the final pavement. Generally, a compressive strength of 1.035 MPa (150 psi) is minimum. Designer should refer to TM's 5-822-14 and 5-825-2 for further guidance, including applicability of stabilization with lime.

The Contractor shall develop and submit for approval a proposed mix design prior to stabilization work. Mix shall be developed using samples of the material to be stabilized. Mix design shall be capable of producing a compressive strength of [_____] [1.035] MPa [_____] [150] psi when compacted to the design percent of laboratory maximum density. Samples shall not show any significant loss of strength after 12 cycles of the durability test.

PART 3 EXECUTION

3.1 LIME STABILIZATION MIXTURE

The material to be stabilized shall be thoroughly pulverized and, when lime is applied in the dry state, the mix shall be thoroughly blended at a moisture content below optimum. After mixing is completed, the proportions of the mixture shall be in accordance with the approved mix design. After blending, water shall be blended into the dry mix in amounts necessary to bring the moisture content to optimum. Field moisture content shall be controlled within plus or minus [2] [_____] percent of optimum. When the stabilized course is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweeper or power brooms except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the area to be stabilized or on pulverized, mixed, or partially mixed material. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF BORROW PITS

NOTE: This paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.

[Borrow pits shall be cleared, stripped and excavated in a manner that exposes vertical faces of the deposit for suitable working depths. Strata of unsuitable materials overlying or occurring in the deposit shall be

wasted. Methods of operating pits and the processing and blending of materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, pits shall be conditioned to drain readily, and be left in a satisfactory condition.] [Borrow material shall be obtained from off site sources.]

3.3 PREPARATION OF AREA TO BE STABILIZED

The area shall be cleaned of debris. The area will be inspected for adequate compaction and shall be capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified.

3.3.1 In-Place Material to be Stabilized

The entire area shall be graded to conform to the lines, grades, and cross sections shown in the plans prior to being processed. Soft or yielding subgrade areas shall be made stable before construction is begun.

3.3.2 In-Place Material to Receive Stabilized Course

[Soft, yielding areas and ruts or other irregularities in the surface shall be corrected. The material in the affected areas shall be loosened and unsatisfactory material removed. Approved select material shall be added where directed. The area shall then be shaped to line, grade, and cross section, and shall be compacted to the specified density.] [Subgrade shall conform to Section 02300 EARTHWORK.] [Subbase course shall conform to Section 02721 SUBBASE COURSES.]

3.3.3 Quantity of Select Material

NOTE: Select material will be described by physical
properties, soil types, and location, as required.
See TM 5-822-14 and TM 5-825-2 for further guidance.
The subparagraph will be deleted if select material
is not required.

Sufficient select material shall be utilized to provide the required thickness of the soil-lime layer after compaction. [Where in-place mixing is to be accomplished, the soil shall be graded and shaped to the approximate section and grade shown before lime stabilization is undertaken.]

3.3.4 Grade Control

Underlying material shall be excavated to sufficient depth for the required stabilized-course thickness so that the finished stabilized course with the subsequent surface course will meet the fixed grade. Finished and completed stabilized area shall conform to the lines, grades, cross section, and dimensions indicated.

3.4 INSTALLATION

3.4.1 Mixed In-Place Method

3.4.1.1 Scarifying and Pulverizing of Soil

Prior to application of lime, the soil shall be scarified and pulverized [to the depth shown] [to a depth of [_____] millimeters.[_____] inches.] Scarification shall be controlled so that the layer beneath the layer to be treated is not disturbed. Depth of pulverizing shall not exceed the depth of scarification.

3.4.1.2 Application of Lime

Pulverized material shall be shaped to approximately the cross section indicated. Lime shall be applied so that when uniformly mixed with the soil, the specified lime content is obtained, and a sufficient quantity of lime-treated soil is produced to construct a compacted lime-treated course conforming to the lines, grades, and cross section indicated. Mechanical spreaders shall be used in applying bulk lime. Distributors shall be used in applying slurry. If lime is spread by hand, the bags shall be spotted accurately on the area being stabilized so that when the bags are opened the lime will be dumped and spread uniformly on the area being processed. No equipment except that used in spreading and mixing shall pass over the freshly applied lime.

3.4.1.3 Initial Mixing

Immediately after the lime has been distributed, the lime and soil shall be mixed. Initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final application and mixing.

3.4.1.4 Water Application and Moist Mixing

Moisture content of the mixture shall be determined in preparation for final mixing. Moisture in the mixture following final mixing shall not be less than the water content determined to be optimum based on dry weight of soil and shall not exceed the optimum water content by more than [2] [_____] percentage points. Water may be added in increments as large as the equipment will permit; however, such increment of water shall be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, mixing shall be continued until the water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the section.

3.4.2 Edges of Stabilized Course

Approved material shall be placed along the edges of the stabilized course in a quantity that will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 300 mm 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course.

3.4.3 Central-Plant Method

**NOTE: Central plant will be specified for mixing
select material for subbase or base course
construction.**

Plant shall be capable of producing a uniform lime-treated mixture at the specified lime and moisture contents. Mixture shall be hauled to the job in trucks equipped with protective covers. Underlying course shall be thoroughly moistened and the mixture then placed on the prepared area in a uniform layer with mechanical spreaders. The layer shall be uniform in thickness and surface contour; and the completed layer, after compaction, shall conform to the required grade and cross section.

3.4.4 Traveling-Plant Method

**NOTE: Traveling plant will be specified for mixing
in-place material for subbase and base course
construction.**

Traveling plant shall move at a uniform rate of speed and shall accomplish thorough mixing of the materials in one pass. Water and lime shall be delivered from supply trucks or bins at a predetermined rate. Windrows of prepared soil-lime mixture shall cover a predetermined width to the indicated compacted thickness.

3.4.5 Layer Thickness

Compacted thickness of the stabilized course shall be [as indicated] [_____] millimeters. [_____] inches.] No layer shall be more than 200 mm 8 inches or less than 75 mm 3 inches in compacted thickness.

3.4.6 Compaction

**NOTE: Density will be based on the material being
stabilized.**

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened and pulverized to the full depth. Compaction shall be started immediately after mixing is completed. During final compaction, the surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. Density of compacted mixture shall be at least [90] [_____] percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. At all times, the speed of the roller shall not cause displacement of the mixture to occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

3.4.7 Finishing

The surface of the top layer shall be finished to the grade and cross section shown. The surface shall be of uniform texture. Light blading during rolling may be necessary for the finished surface to conform to the lines, grades, and cross sections. If the surface for any reason becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, the unsatisfactory portions shall be scarified, reworked, relaid, or replaced as directed. If any portion of the course, when laid, becomes watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained; and then spread, shaped, and rolled as specified above.

3.4.8 Construction Joints

At the end of each phase of construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted as specified.

3.4.9 Curing and Protection

NOTE: It may be advantageous to specify only bituminous curing for pavements that are to receive bituminous surfacing under the contract, in which case moist curing will be deleted, and the first sentence in the paragraph will be modified accordingly. This specification section must be coordinated with other sections covering the various components of the pavement structure.

Immediately after the soil-lime area has been finished as specified above, the surface shall be protected against rapid drying for 7 days [by one of the methods specified below] [_____].

3.4.9.1 Moist Curing

The area shall be moistened by sprinkling and shall be kept moist for the 7-day curing period.

3.4.9.2 Bituminous Material

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

	Degrees C

Cutback asphalt:	
RC-250, MC-250	65-105
RC-800, MC-800	80-125

Degrees C

Emulsified asphalt:

RS-1 _____	25-55
RS-2 _____	45-70

Tar:

RT-7 _____	65-105
RT-8 _____	65-105
RT-9 _____	65-105
RT-10 _____	80-120

Degrees F

Cutback asphalt:

RC-250, MC-250 _____	145-220
RC-800, MC-800 _____	180-255

Emulsified asphalt:

RS-1 _____	75-130
RS-2 _____	110-160

Tar:

RT-7 _____	150-225
RT-8 _____	150-225
RT-9 _____	150-225
RT-10 _____	175-250

Bituminous material shall be uniformly applied by means of a bituminous distributor within a temperature range of [_____] to [_____] degrees C [_____] to [_____] degrees F. Bituminous material shall be applied in quantities of not less than 0.45 liters per square meter 0.1 gallon per square yard nor more than 1.13 liters per square meter 0.25 gallon per square yard. Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. Bituminous material shall be applied only to the top layer. At the time the bituminous material is applied, the surface of the area shall be free of loose or foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, the area shall be sprinkled immediately before the bituminous material is applied. Treated surface shall be [sanded] [dusted] [_____] to prevent the bituminous material from being picked up by traffic.

3.5 SAMPLING AND TESTING

3.5.1 General Requirements

NOTE: Delete reference to source of material if
select material is not required.

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Work requiring testing will not be permitted until the facilities have been inspected and approved. The first inspection will be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Certified copies of the test results shall be furnished to the Contracting Officer.

3.5.2 Results

Results shall verify that the material complies with the specification. When [the source of materials is changed] [deficiencies are found], the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced.

3.5.3 Sampling

All aggregate samples for laboratory testing shall be taken in accordance with ASTM D 75. Samples of lime shall be taken in accordance with ASTM C 50. Specimens for the unconfined compression tests shall be prepared in accordance with ASTM D 1632.

3.5.4 Sieve Analysis

Before starting work, one sample of material to be stabilized shall be tested in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. After the initial test, a minimum of one analysis shall be performed for each [1000] [_____] metric tons [1000] [_____] tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

3.5.5 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318.

3.5.6 Chemical Analysis

Lime shall be tested for the specified chemical requirements in accordance with ASTM C 25. Three tests shall be conducted for each delivery of lime.

3.5.7 Testing

Unconfined compression tests shall be conducted in accordance with ASTM D 1633. Three tests shall be conducted for each mix design tested. Samples shall be cured at a constant moisture content and temperature for 28 days. [Wet-dry tests shall be conducted in accordance with [AASHTO T 135] [ASTM D 559].] [Freeze-thaw tests shall be conducted in accordance with [AASHTO T 136] [ASTM D 560].] Three tests shall be conducted for each mix design tested. Scratch portion of the test shall be omitted.

3.6 FIELD QUALITY CONTROL

Tests shall provide a moisture-density relationship for the lime-soil mixture. Results of field quality control testing shall verify that materials comply with this specification. [When a material source is changed, [the new material shall be tested for compliance] [_____]]. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or repaired, as directed by the Contracting Officer, at no additional cost to the Government.

3.6.1 Thickness Control

NOTE: When subbase or base courses are constructed less than 150 mm (6 inches) in total thickness, a deficiency of 13 mm (1/2 inch) in thickness is considered excessive. Applicable to job conditions, thickness tolerance provisions may be modified as required, restricting all deficiencies to not over 6 mm (1/4 inch).

Completed thicknesses of the stabilized course shall be within 13 mm (1/2 inch) 1/2 inch of the thickness indicated. Where the measured thickness of the stabilized course is more than 13 mm (1/2 inch) 1/2 inch deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the stabilized course is more than 13 mm (1/2 inch) (1/2 inch thicker than indicated, it shall be considered as conforming to the specified thickness requirement. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm (1/4 inch) 1/4 inch of the thickness indicated. Thickness of the stabilized course shall be measured at intervals which ensure one measurement for each [400] [_____] square meters [500] [_____] square yards of stabilized course. Measurements shall be made in 75 mm (3 inch) 3 inch diameter test holes penetrating the stabilized course.

3.6.2 Field Density

Field in-place density shall be determined in accordance with [ASTM D 1556] [ASTM D 2167] [ASTM D 2922]. [When ASTM D 2922 is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication.] ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 at least once per lift for each [_____] square meter [_____] square yard of stabilized material. Calibration curves and calibration tests results shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests. At least one field density test shall be performed for each [250] [_____] square meters [250] [_____] square yards of each layer of base material.

3.6.3 Smoothness Test

NOTE: For subgrade and subbase stabilization, this
paragraph should be deleted.

The surface of a stabilized layer shall show no deviations in excess of 10 mm 3/8 inch when tested with the [3.05] [3.66] meter ([10] [12] foot) [10-] [12-] foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a [3.05] [3.66] meter ([10] [12] foot) [10-] [12-] foot straightedge. Measurements shall also be taken perpendicular to the road centerline at [15] [_____] meter [50-] [_____] foot intervals.

3.7 TRAFFIC

Completed portions of the lime-treated soil area may be opened immediately to light traffic provided the curing is not impaired. After the curing period has elapsed, completed areas may be opened to all traffic, provided the stabilized course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment shall not be permitted on the area during the curing period. Lime and water may be hauled over the completed area with pneumatic-tired equipment if approved. Finished portions of lime-stabilized soil that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner to prevent equipment from marring or damaging completed work.

3.8 MAINTENANCE

Stabilized area shall be maintained in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be corrected as specified herein.

3.9 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of [as directed] [in waste disposal areas indicated].

-- End of Section --