DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

OFFICE OF MATERIALS AND TESTING

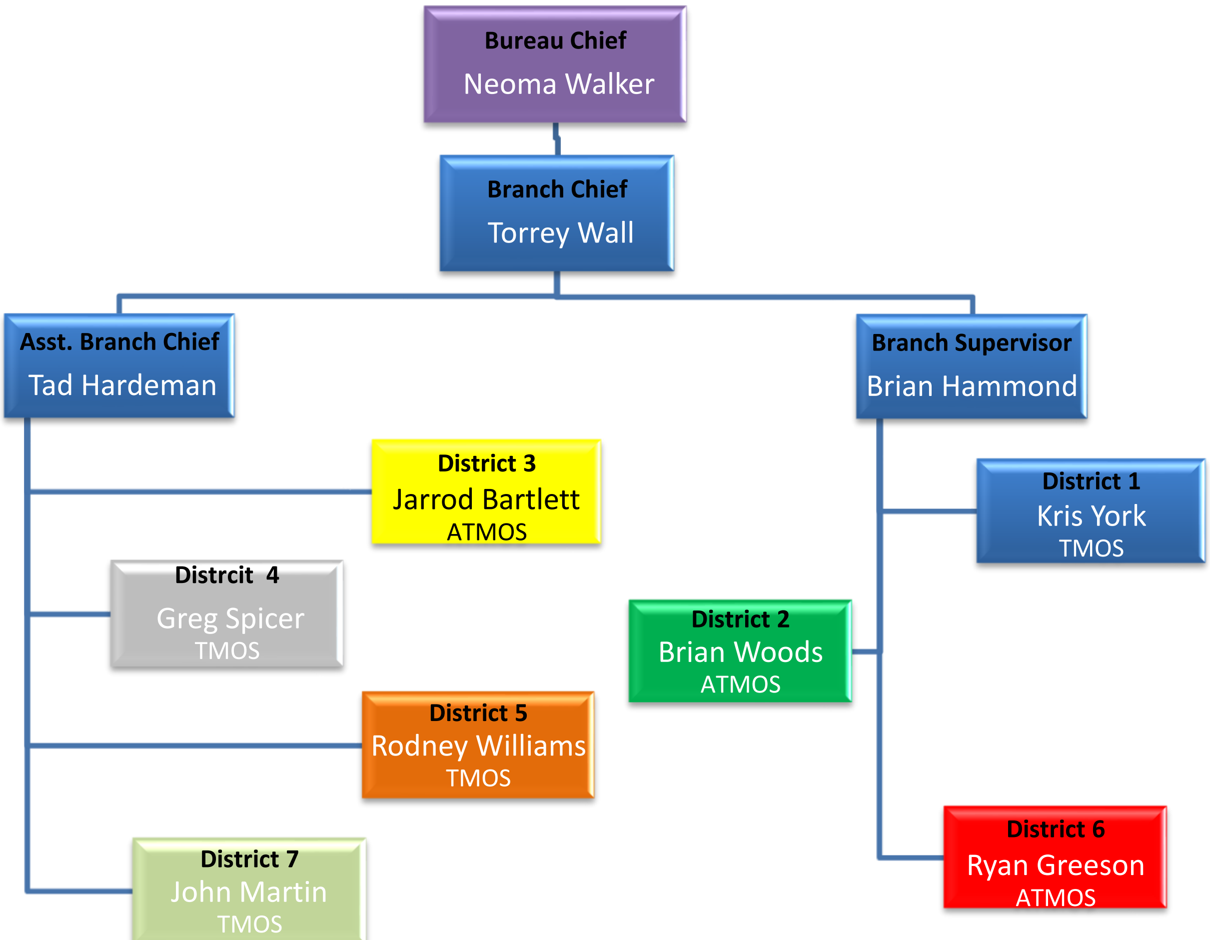
Testing Management

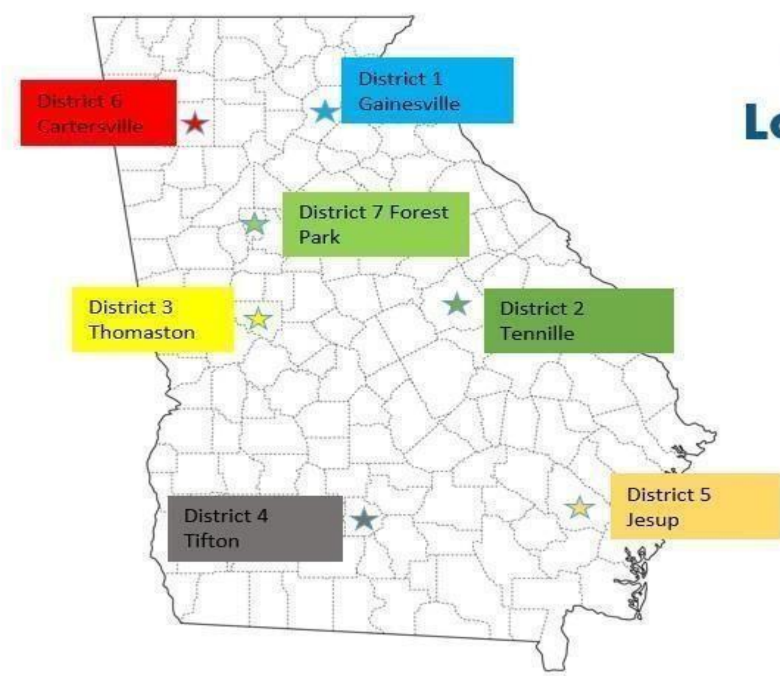
RTT

Roadway Testing
Technician
Certification Study
Guide

2022 Version

Testing Management





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Georgia Department of Transportation's (GDOT's) Up to Date Specifications and Test Methods can be located on GDOT's Website at link: http://www.dot.ga.gov/PS/Business/Source
Test methods and specifications in this study guide are up to date as of this publications revised date and will be used for this exam.

- **Note:** *Due to copyright laws, AASHTO Test Procedures are not provided. AASHTO Procedures may be obtained at* https://compass.astm.org
  External Companies (Non-GDOT) must provide their employees their own copy of AASHTO Standards due to the copyright laws

SECTION 1

INTRODUCTION

INTRODUCTION

I. PURPOSE

The purpose of this study guide is to provide information that is required to learn the necessary procedures and standards established by the Department to become qualified in the field of Sampling, Testing and Inspection responsibilities. The Sampling and Testing procedures and Standards Specifications were established to insure that high quality materials that meet Specifications are incorporated into the work and that construction achieves the specified end. The evidence of testing is an "approved" test report.

The purpose and necessity for evidence of tests completed should be understood by all Contractors, Engineers and Technicians of the Department. It should not be thought that the purpose and only result of testing are pieces of paper (test reports). However, this evidence of testing is needed and important, for it is the record of performed tasks. A test report must give complete, clear and precise results.

It is the Contractor's responsibility to control the materials and construction in such a manner that the specifications are met. It is the Materials Technician and Engineer's responsibility to evaluate materials and construction to verify that Specifications are met.

All information included within this guide will aid in the success of Roadway Testing Technicians becoming proficient performing the essential tasks for Sampling, Testing and Inspection of materials used in roadway construction.

SECTION 2

GDOT/RTT CERTIFICATION PROCESS

GDOT/RTT CERTIFICATION PROCESS

The process for the Roadway Testing Technician to become certified through the Department to perform Acceptance Testing for GDOT projects is as follows:

RTT – The RTT written exam will be administered by the Technical College System of Georgia. Available dates and times for exams can be requested through the Technical Colleges in Georgia. GDOT OMAT/TM Branch will administer the performance exam. The information for the locations of the written exams is located in this section.

The respective Testing Management Operations Supervisor (TMOS) will manage the performance exam and will be available to provide assistance to the RTT in attaining his or her certification. The following is a list of the districts and the respective TMOS/ATMOS and their telephone numbers.

District 1	Gainesville, GA	Kris York	770-531-5873
District 2	Tennille, GA	Brian Woods, ATMOS	478-553-3464
District 3	Thomaston, GA	Jarrod Bartlett, ATMOS	706-646-6614
District 4	Tifton, GA	Greg Spicer	770-531-5873
District 5	Jesup, GA	Rodney Williams	912-530-4471
District 6	Cartersville, GA	Ryan Greeson, ATMOS	678-721-5366
District 7	Forest Park, GA	John Martin	404-608-4839

Questions in relation to the RTT certification process or re-certification of a technician should be directed to:

Neoma Walker, PE	Bureau Chief	404-608-4805
Torrey Wall	Branch Chief	706-646-6614
Tad Hardeman	Asst. Branch Chief	706-646-6614

Performance Examination

The performance examination will be administered by the Georgia Department of Transportation's Office of Materials and Testing staff at the Branch Laboratory associated with each of the Department's Field Districts.

The performance examination is closed-book and requires actual demonstration of the required standards. The examinee is judged on his/her ability to correctly perform or describe all the required procedures. The performance exam must be taken within 90 days of the written exam or the entire test will have to be re-taken.

During the examination the examinee will be judged on their ability to perform or describe all required procedures for each of the GDOT standards based on the criteria in the Performance Examination Checklists.

Re-Examination

It is the examinee's responsibility to request are-examination.

To protect GDOT's QCT RTT Examinations from frivolous trial-and-error attempts and to encourage the examinee to properly prepare for testing, the following allowances are required.

- After first failed examination, the examinee must wait 30 days before re-testing.
- After second failed examination, the examinee must wait 90 days before re-testing.
- After third failed examination, the examinee must wait 12 months before re-testing.

Recertification

Technicians are not required to have any continuous education credit hours to maintain their RTT Certification after they have successfully passed the written and practical exams and become certified.

Regardless of re-certification status, for the purpose of fulfilling the requirements of SOP 30 as required by the FHWA, active technicians (those who performed acceptance testing in the last calendar year) are required to have an IA evaluation during each calendar year.

Technical College Contact Information

College	Name	Number	Email
Albany	Matt Trice	229-430-6618	mtrice@albanytech.edu
Athens	John Usry	706-357-0050	jusry@athenstech.edu
Atlanta	Araceli Flores	404-225-4681	aflores1@atlantatech.edu
Augusta	Laura Giddings	706-771-5705	lgiddings@augustatech.edu
Central Ga	Melanie Bradley	478-2183289	mbradley@centralgatech.edu
Chattahoochee	Tammy Huffstetler	770-975-4041	tammy.hufstetler@chattahoochee.edu
Coastal Pines	Anna McCrea	912-287-5854	amccrea@coastalpines.edu
Columbus	Michelle Shaw	706-649-1558	mshaw@columbustech.edu
GA Northwestern	Patty Hart	706-272-2980	phart@gntc.edu
GA Piedmont	Angela Cooper	404-297-9522, ext.1829	coopera@gptc.edu
Gwinnett	Gwen Moran	678-226-6609	Gmoran@gwinnetttech.edu
Lanier	Joan Lee	770-5336995	jlee2@laniertech.edu
North GA	Leslie Foster	706-754-7715	lfoster@northgatech.edu
Oconee Fall Line	Katrina Veal	478-275-6592	klveal@oflt.edu
Ogeechee	Kristen Waters	912-871-1693	kdwaters@ogeecheetech.edu
Savannah	Lisa Kuyk	912-443-4148	lkuyk@savannahtech.edu
South GA	Tami Blount	229-931-2040	tblount@southgatech.edu
Southeastern	Susan Rustin	912-538-3197	srustin@southeasterntech.edu
Southern Crescent	Steve Hendrix	678-972-9443	shendrix@sctech.edu
Southern Regional *(Moultrie campus)*	Jena Willis	229-217-4257	jmwillis@southernregional.edu
Southern Regional *(Bainbridge campus)*	Susanne Reynolds	229-243-3011	sreynolds@southernregional.edu
Southern Regional *(Thomasville campus)*	Ruby Barron	229-227-2579	rbarron@southernregional.edu
West GA	NO TESTING	n/a	n/a
Wiregrass	Christy Cobb	229-468-2218	Christy.cobb@wiregrass.edu

SECTION 3

SAMPLING AND TESTING REQUIREMENTS

SAMPLING AND TESTING REQUIREMENTS

SECTION I

This section of the study guide covers the requirements for sampling and testing of the materials being used in the construction work. It is the responsibility of the Testing Management personnel technical services (on certain items I. A. can take acceptance) to sample and test all materials as frequently as necessary to assure that all materials being used conform to the specifications. The requirements set forth in this section are not arrived at for the purpose of producing voluminous files, but have been determined from experience and/or research which have shown that generally materials with normal uniformity can be sampled at the rates shown with the assurance that the materials being used are represented by tests. Where materials exhibit non-uniformity, as shown by either, it is expected that the frequency of testing will be increased.

The Technician must use judgment in completing the sample card for the item "quantity represented." Whereas minor deviations in quantity represented and used is not of great importance from a total tested - total used standpoint, the important item is proper testing of all materials being used. This must be reflected in reasonably accurate estimates of the quantity of materials the sample is taken from. Where materials from a stockpile, plant, etc., are being used on more than one contract, any sample may represent material for all contracts simply by including separate sample cards for each contract. If a sample is taken to represent more than one contract, the total quantity represented on the separate cards should not exceed the allowed quantity represented by any sample as shown in this Section. A reasonably accurate estimate should be made of the quantities being used at that time on each project and the total quantity shown for the sample should be reduced percentage-wise for each card. As an example, if woven wire fabric for fence is being used from the same stockpile for three contracts, a single sample may be submitted with sample cards for all three contracts including with the sample. If about 40 percent of the woven wire fabric was going to Project A and the other 60 percent about equally divided between Project B and C, and since Section 643 allows a sample to represent 50 rolls; then the card for Project A would show the sample representing 20 rolls; Project B and C sample cards would show the sample representing 15 rolls each. Where more than one project is let in the same contract, one sample card showing all the projects of that contract that the material is being used on will be sufficient. Therefore, when separate projects are let under a single contract, one card listing all the applicable projects is sufficient and when separate projects are let under separate contracts, a card for each project must be submitted with the sample.

Proper evaluation of test results is dependent upon usage of the materials in many instances. Therefore, the sample card submitted with each sample should identify under "to be tested for," the materials by construction specification number or pay item number and the materials reference number. As an example, No. 89 stone being used in bituminous seal should be identified on the sample card as "Section 424, Article 800.01" and if this same material was used in asphaltic concrete, it would be identified as "Section 400, Article 802.02." This same scheme should be used on project control test reports filled out in the field.

This additional identification should minimize problems in evaluating the test results and in the final materials audit required for submission of the "Materials Certificate."
Certain materials are pretested by inspectors from the Central Laboratory or by our authorized inspection agency and stamped or tagged with the "GDT" or inspection agency inspection number. Sampling requirements for these materials are specified in the Manual. Occasionally, additional materials, not mentioned in the Manual as such, may be pretested. Any pretested materials may be used without further testing provided they are satisfactory from a visual inspection and information sufficient to identify the shipment is submitted to the Central Laboratory. Any pretested material may be sampled and tested at the option of the Field Engineer.

In order that all material used in the work conform to the Specifications, any material not field tested should be submitted to the Laboratory sufficiently in advance to be tested and reported prior to use.

Any samples specified in this Section to be submitted to the Branch Laboratory may be submitted to the Central Laboratory.

This Section outlines the minimum sampling and testing requirements by Construction Section. All Materials set forth for use in each construction section are described separately. Where the materials are being used at the same time for more than one construction item, notation should be made in the project materials records and on the sample cards.

Material which fails according to the specification should not be resampled for compliance unless there is evidence of faulty sampling or testing. By continual resampling, it is obvious that passing samples could be obtained. All resampling should be approved by the Testing Management Supervisor.

SECTION 4

207

EXCAVATION AND BACKFILL FOR MINOR STRUCTURES

Section 207—Excavation and Backfill for Minor Structures

207.1 General Description

This work includes excavating, backfilling, or disposing of materials required to install a bridge culvert, box culvert, pipe, arch culvert, headwall and retaining wall according to the Specifications, the Plans, and the Engineer.

207.1.1 Definitions

General Provisions 101 through 150.

207.1.2 Related References

A. Standard Specifications

Section 104—Scope of Work

Section 109—Measurement and Payment

Section 205—Roadway Excavation

Section 206—Borrow Excavation

Section 208—Embankments

Section 810—Roadway Materials

Section 812—Backfill Materials

B. Referenced Documents

GDT 7

207.1.3 Submittals

General Provisions 101 through 150.

207.2 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Foundation Backfill Material—Type I	Subsection 812.2.01
Foundation Backfill Material—Type II	Subsection 812.2.02
Imperfect Trench Backfill Material—Type III	Subsection 812.2.03

207.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

207.3 Construction Requirements

207.3.1 Personnel

General Provisions 101 through 150.

207.3.2 Equipment

General Provisions 101 through 150.

207.3.3 Preparation

General Provisions 101 through 150.

207.3.4 Fabrication

General Provisions 101 through 150.

207.3.5 Construction

A. Locations and Elevations

The Engineer will determine final locations and elevations of the structure. The locations and elevations shown on the Plans are approximate.

B. Excavation

The Engineer will determine the minimum requirements for length and depth of excavation for each structure. Assume the responsibility for the cost of installing necessary sheeting and bracing.

When excavating, follow these requirements:

- Excavate through rock or boulder formations to at least 1 ft (300 mm) below the bottom of the structure, except for where the entire concrete or masonry structure rests on solid rock.
- Backfill with Type I or Type II material to the proper subgrade elevation.
- As the embankment is constructed, excavate and place pipe on the new embankment. Pipe may be placed incrementally on steep gradients.
- Cut surfaces at structure trenches to prevent damage to the adjacent pavement when existing paved areas will be retained.
- Saw pavements deep enough to cause the edges to break in straight lines.
- Ensure that the width, depth, and vertical walls of an excavated imperfect trench conform to Plan details and dimensions within 2 in (50 mm).
- Dispose of surplus and unsuitable materials as directed by the Engineer.
- Consider excavated material as unclassified excavation according to Section 205, except that the Department will not pay for excavation for minor structures.
- Include the cost of fulfilling these requirements in the price bid for the pipe.

C. Backfill

Obtain backfill materials that meet the Specifications from sources approved by the Engineer.

1. Foundation Backfill Materials, Types I and II

   Use the following materials as shown on the Plans or as directed by the Engineer:

   a. Use Type I material in dry structure trenches and Type II material in wet trenches.

   b. Use Type I material as a finishing course for Type II material when permitted by the Engineer.

   c. Backfill excavations beyond the specified limits with the same type of material required for the adjacent area; however, the Department will not measure excess backfill material for payment.

   d. Place Type I and Type II backfill material in layers of no more than 6 in (150 mm) loose.

   e. Compact each layer as follows:

      1) Type I Backfill Material: Compact to 95 percent of the theoretical dry density determined by GDT 7.

      2) Type II Backfill Material: Compact to a satisfactory uniform density as directed by the Engineer.

2. Imperfect Trench Backfill Material, Type III

   Place this material as loose uncompacted backfill over pipe structures as shown on the Plans where imperfect trench backfill is specified.

3. Normal Backfill

Ensure that normal backfill material meets the requirements of Subsection 810.2.01, Class I or II. Place and compact according to Section 208 except as follows:

a. Do not place rock more than 4 inches (100 mm) in diameter within 2 ft (600 mm) of any drainage structure.

b. For backfill behind retaining walls, use a pervious material that meets the requirements of Case I or Case II as follows:

   1) Case I. Case I refers to backfills for retaining walls that support roadbeds and parking areas.

      Ensure that the backfill conforms to Section 208. Do not place rock more than 4 in (100 mm) in diameter within 2 ft (600 mm) of the retaining wall or finished surface.

   2) Case II. Case II refers to backfills for retaining walls that do not support roadbeds or parking areas.

      Ensure that the backfill conforms to the requirements of Case I above, except compact the backfill to the density of the adjacent soil.

D. Pavement Replaced

Replace pavement removed at structure trenches in kind where adjacent pavements will be retained. An equal or better material may be used when approved by the Engineer.

Backfill and maintain a smooth riding surface until repaving is complete.

207.3.6 Quality Acceptance

General Provisions 101 through 150.

207.3.7 Contractor Warranty and Maintenance

General Provisions 101 through 150.

207.4 Measurement

A. Excavation

The following considerations are not measured for payment:

- Excavation for minor structures, including undercut for backfill materials as shown on the Plans
- Excavation for an imperfect trench which is required at locations specified in the Plans but which is not measured for payment
- Removal of water
- Removal of material from any area required to be reexcavated
- Excavation and backfill of temporary drainage ditches

B. Extra Depth Excavation

The following extra depth excavations are not measured for payment:

1. Extra depth excavation because of Contractor negligence
2. Extra depth excavation (required by the Engineer) below the original Plan elevation of the bottom of the footing or the flow line of a culvert pipe that does not exceed 3 ft (1 m)

If the Engineer relocates the structure or orders the elevation of the bottom of the footing or the flow line of the pipe to be lowered or undercut more than 3 ft (1 m), the Contractor will be compensated for the extra depth excavated below the 3 ft (1 m) limit according to Subsection 104.04 and Subsection 109.05.

Calculate the width of extra depth excavation using the diameter of the pipe or the width of the footing plus 2 ft (600 mm).

The length of extra depth excavation is equal to the length of that portion of the structure that is lowered more than 3 ft (1 m) below Plan elevation.

C. Backfill Materials Types I, II, and III

1. Types I and II

   These materials (in place and accepted) are measured in cubic yards (meters) compacted.

   Lateral measurements are confined to an area bounded by vertical planes lying not more than 1 ft (300 mm) outside of and parallel to the limits of the structure.

   Length and depth measurements are confined to the dimensions of compacted material in place as specified by the Engineer. Materials placed outside the above limitations are not measured for payment.

2. Type III

   The Department measures Type III material (complete, in place, and accepted) in cubic yards (meters).

   Lateral measurements of Type III material are confined to an area bounded by vertical planes lying directly above the outside walls of the structure.

   Longitudinal measurements are confined to the length of treatment installed as specified. Measurements of depth are the dimensions shown on the Plans or as directed.

D. Normal Backfill

This Item is not measured separately, but is included in the measurement of the Items of excavation from which normal backfill materials are obtained.

207.4.01 Limits

General Provisions 101 through 150.

207.5 Payment

A. Excavation for Minor Structures

This Item will not be paid for separately except as provided in Subsection 207.4.B.

B. Sheeting and Bracing

Sheeting and bracing will not be paid for separately unless these materials are left in place at the written direction of the Engineer. In this case, the Contractor will be paid at invoice cost plus 10 percent.

C. Backfill Materials

Backfill material Type I, (measured as shown in Subsection 207.4.C.1) will be paid for according to Section 205 or Section 206.

The Department will pay for Types II and III separately at the Contract Unit Price per cubic yard (meter). This payment is full compensation for furnishing the materials from sources inside or outside the right-of-way, loading, unloading, hauling, handling, placing, and compacting the material.

D. Normal Backfill

This Item will not be paid for directly but will be paid at the Unit

Price for the applicable excavation item from which the normal backfill materials are obtained.

Payment will be made under:

Item No. 207	Foundation backfill material, type II	Per cubic yard (meter)
Item No. 207	Imperfect trench backfill material, type III	Per cubic yard (meter)

207.5.01 Adjustments

General Provisions 101 through 150.

SECTION 5

208

EMBANKMENT

Section 208—Embankments

208.1 General Description

This work includes placing embankments, backfilling structures, and constructing earth berms and surcharges with suitable material excavated under Section 204, Section 205, Section 206, and Section 207.

Complete the work according to the lines, grades, and typical cross- sections shown on the Plans or established by the Engineer.

The work also includes preparing areas by backfilling stump holes and correcting surface irregularities where the embankment is to be constructed. This includes forming, compacting, and maintaining the embankment and placing and compacting approved material where unsuitable material has been removed.

Payment for this work is included in other appropriate Pay Items unless a specific Pay Item is set up in the Contract.

Apply all provisions of Section 161 to the work in this Section.

Perform Shoulder Construction according to Section 216.

208.1.1 Definitions

General Provisions 101 through 150.

208.1.2 Related References

C. Standard Specifications

Section 161—Control of Soil Erosion and

Sedimentation Section 201—Clearing and Grubbing

Right-of-Way Section 204—Channel Excavation

Section 205—Roadway Excavation

Section 206—Borrow Excavation

Section 207—Excavation and Backfill for Minor Structures

Section 209—Subgrade Construction

Section 216—Unpaved Shoulders

Section 810—Roadway Materials

Section 811—Rock Embankment

Section 813—Pond Sand

D. Referenced Documents

GDT 7

GDT 20

GDT 21

GDT 24a

GDT 24b

GDT 59

GDT 67

208.1.3 Submittals

General Provisions 101 through 150.

208.2 Materials

Embankment material classes are defined in Section 810, Section 811, and Section 813. The material incorporated into the roadway will be subject to the following limitations:

A. Embankment Material

Use embankment material classified as Class I, II, III, V, or VI except as noted below:

1. Inundated Embankments

   A Special Provision in the Proposal will contain required gradation and other characteristics of materials for constructing embankments through reservoirs.

2. Intermittently Inundated Embankments

   Build intermittently inundated embankments using any material suitable for embankment.

3. Embankments at Structures

   Use Class I or II embankment materials within 10 ft (3 m) of any bridge structure. Class IIIC1 material may be used in Districts 6 and 7. Class IIIC2 or IIIC3 material may only be used in Districts 6 and 7 if approved by the Office of Materials and Research, Geotechnical Engineering Bureau. Ensure that materials do not contain rock larger than 3 in (75 mm) for any dimensions.

B. Rock Embankment

Ensure that rock embankment placed as indicated on the Plans meets the requirements of Section 811 unless specified otherwise in the Plans or in the Special Provisions.

C. In-Place Embankment

Construct in-place embankment with Class I, II, III, V, or VI material.

D. Backfill Material

Use Class I or Class II backfill material furnished and stockpiled as defined in Subsection 810.2.01.A. Class IIIC1 material may be used in Districts 6 and 7. Class IIIC2 or IIIC3 material may only be used in Districts 6 and 7 if approved by the Office of Materials and Research, Geotechnical Engineering Bureau.

A Pond Sand Embankment

Use pond sand that meets the requirements of Section 813 as embankment material. Material is subject to the following approval limitations:

d. Pond sand will be approved on a stockpile basis only.

e. Pond Sand will not be approved for Type I or normal backfill materials or for backfill for mechanically stabilized walls.

f. Pond sand shall be encapsulated, when used as fill, with 2 ft (600 mm) of soil on the slopes and 3 ft (1 m) of soil on top.

g. Pond sand shall not be used on sidehill fills or fill widenings where any ofthe following conditions exist:

   1) The proposed fill slope is steeper than 2:1.

   2) The thickness of the proposed fill at its thinnest point, as measured perpendicularly from the new fill line to the existing ground slope/fill slope, is less than 7 ft (2.1 m), including 2 ft (600 mm) of soil cover.

   3) The fill height exceeds 30 ft (9 m).

208.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

208.3 Construction Requirements

208.3.1 Personnel

General Provisions 101 through 150.

208.3.2 Equipment

General Provisions 101 through 150.

208.3.3 Preparation

General Provisions 101 through 150.

208.3.4 Fabrication

General Provisions 101 through 150.

208.3.5 Construction

1 Benching Excavation for Embankment

This work includes excavating material forming benches in the existing ground beneath proposed embankments. Form benches to increase the bond between the existing ground and the proposed embankment.

This work is required where embankments are placed on hillsides or against existing embankments, which will be indicated on the Plans.

Construct the benches approximately 12 ft (3.7 m) wide unless otherwise shown on the Plans. Use material removed in the excavation in the embankments. The Department will make no additional payment for this work.

2 Embankments

Follow these requirements when constructing embankments:

a Preparation for Embankments

Before starting embankment construction, clear and grub the embankment area according to Section 201 and install Drainage Structures according to Section 550.

2) Depressions and Undercut Areas

Fill depressions below the ground surface and undercut areas with suitable material. Remove unsuitable or unstable material and compact according to Subsection 208.3.05.B.1.c before beginning embankment construction.

3) Scarification and Other Preparation

Plow and scarify the entire area upon which the embankment is to be placed (except inundated areas) at least 6 in (150 mm) deep.

Before placing the embankment, recompact loosened soil to the approximate density of the underlying soil. Cut benches as specified in Subsection 208.3.05.A.

C. Compaction Under Shallow Fills

When the depth of fill and surfacing is 3 ft (1 m) or less, compact the original ground compact at least 1 ft (300 mm) deep to at least 95 percent of the maximum laboratory dry density as determined from representative samples of the compacted material using, GDT 7, GDT 24a, GDT 24b, or GDT 67 whichever applies.

The in-place density of the compacted fill will be determined according to GDT 20, GDT 21, or GDT 59, whichever applies.

a. Embankments Over Existing Roads, Parking Areas, and Floors

Thoroughly plow or scarify all portions of existing unpaved roads and flexible pavements. Destroy cleavage planes before placing the embankment.

Remove the old pavement with rigid surfaces if the new embankment is not more than 3 ft (1 m) high.

Break remaining rigid pavements that are within 10 ft (3 m) of the finished grade so that no section larger than 10 ft^2 (1 m^2) remains intact.

E. Embankment Formation

Use the following requirements when constructing the embankment formation:

Layer Construction

Except as noted in Subsection 208.3.05.B.2.d, construct the embankments in parallel layers. Deposit the material and spread in horizontal layers not more than 8 in (200 mm) thick, loose measurement, for the full width of the cross-section. Use motor graders, bulldozers, or other approved equipment to keep layers uniform. Compact the layers using a sheepsfoot roller. The Engineer may permit the use of vibratory rollers whenever the embankment soils consist of Class IA1, IA2, or IA3 materials.

Moisture Content

Compact each layer within the range of optimum moisture content to achieve the compaction specified below.

Do not construct successive layers on previous layers that exhibit excessive pumping under construction equipment regardless of compaction.

Dry material if it contains too much moisture. Ensure the moisture content is sufficient for stability and compaction.

Add water if the material is too dry and uniformly mix it with the soil for stability and compaction. The Department will not measure water added to the material under this requirement for payment. It is considered incidental to the satisfactory completion of the work.

Degree of Compaction

Compact the embankment at bridge structures to at least 100 percent of the maximum laboratory dry density. Compact for the full depth of the embankment, beginning at the toe of the slope and extending 100 ft (30 m) from the end of the bridge.

Compact embankment other than at bridge structures to at least 95 percent of the maximum laboratory dry density to within 1 ft (300 mm) of the top of the embankment. Compact the top 1 ft (300 mm) of the embankment to at least 100 percent of the maximum laboratory dry density.

If grading and paving are let in separate contracts, the paving Contractor shall recompact the top 6 in (150 mm) to at least 100 percent of the maximum laboratory density.

The maximum laboratory dry density will be determined from representative samples of the compacted material using GDT 7, GDT 24a, GDT 24b, or GDT 67, whichever applies. The in-place density of the compacted fill will be determined according to GDT 20, GDT 21, or GDT 59, whichever is applicable.

A Special Conditions

Follow these special requirements:

5. Build layers as parallel as possible. In certain cases the Engineer may permit steeper slopes at ends of the embankments.
6. In swamp or inundated areas that will not support the equipment, build the lower part of the fill by dumping successive loads in layers no thicker than necessary to support the hauling equipment.
7. Build and compact the remainder of fills in layers as specified above.

B Embankments at Structures

Use Class I or II material when constructing embankments over and around pipes, culverts, arches, and bridges according to Subsection 810.2.01.A.1. Class IIIC1 material may be used in Districts 6 and 7.

5. Compact the material as specified in Subsection 208.3.05.B.2.c.
6. Place the specified material on both sides of bridge structures for a distance of at least 10 ft (3 m).

NOTE: Do not place rock larger than 4 in (100 mm) diameter within 2 ft (600 mm) of any drainage structure.

Before any traffic is allowed over any structure, provide a sufficient depth of material over and around the structure to protect it from damage or displacement.

C Method of Handling Classes of Soils

Handle the different classes of soils using the following methods:

5. Class IIB3and Better Soils

   Distribute and compact these soils in 8 in (200 mm) uniform layers over the entire width of the embankment. Use these soils (when available in sufficient quantities) in the top 1 ft (300 mm) of the roadbed. Reserve these soils for this purpose when directed by the Engineer.

6. Class IIB4 Soils

   Distribute and compact these soils in 8 in (200 mm) layers over the entire width of the embankment. If Class IIB3 or better soils are available in borrow pits, use these soils in the top 12 inch (300 mm) of subgrade. Class IIB4 soils may be used in the top 12 inch (300 mm) of subgrade if approved by the Office of Materials and Research, Geotechnical Engineering Bureau.

7. Class III Soils

   Class IIIC1 soils may be used in Districts 6 and 7 within the top 12 inch (300 mm) of subgrade if approved by the Office of Materials and Research, Geotechnical Engineering Bureau. Do not use Class IIIC2, IIIC3 or IIIC4 soils within the top 12 inch (300 mm) of subgrade unless a stabilizing agent approved by the Engineer is added, or if approved by the Office of Materials and Research, Geotechnical Engineering Bureau. Class IIIC4, chert clay soils in District 6 with less than 55 percent passing the No. 10 (2 mm) sieve may be used for subgrade.

8. Class IV Soils

   Do not use these soils in embankments. Waste these soils or (when designated in the Plans or directed by the Engineer) stockpile them and use them for blanketing fill slopes.

9. Class V Soils

   Place these soils in the same manner as Class IIB4 soils. Pulverize large particles to obtain the proper compaction.

10. Class VI Rock

Place rock in uniform layers not over 3 ft (1 m) thick and distribute it over the embankments to avoid pockets. Fill voids with finer material.

Do not place rock larger than 6 in (150 mm) in diameter within 3 ft (1 m) of the finished surface of the embankment.

Do not place rock larger than 6 in (150 mm) in diameter within 2 ft (600 mm) of the outer limits of proposed posts or utility poles.

Do not place rock at bridge end bents within 10 ft (3 m) of pile locations.

All Classes

Place mixtures of the above classes together with random material such as rock, gravel, sand, cinders, slag, and broken-up pavement so that coarse particles are dumped near the outer slopes and finer particles near the center of the roadway.

Produce a gradual transition from the center to the outside. If material is too large to place in 8 in (200 mm) layers, treat it as rock or break it down and place it in 8 in (200 mm) layers.

a. Embankment Consolidation at Bridge Ends

When consolidating embankments at bridge ends, use the following specifications:

a When a waiting period is required in the Plans or by Special Provision, place end fills at bridges in time for consolidation readings to indicate that both the fill and the natural ground have reached the desired degree of stability.

b Delay constructing bridge portions during the period of consolidation as shown on the Plans or as required by a Special Provision.

The Plans or the Special Provisions will indicate the estimated time required to reach consolidation.

The Engineer may extend or shorten this waiting period based on settlement readings taken on points placed in the fills. The longer or shorter waiting period will not constitute a valid claim for additional compensation.

Follow these specifications when extending a waiting period:

1) Extending an estimated waiting period may lead to increasing the Contract time. If the Contract is on a calendar day or completion date basis, the Department may increase the calendar days equal to the maximum number of calendar days involved in the extension.

2) When a time extension causes additional delay due to seasonal changes, the Engineer may recompute the time extension on an available day basis.

When the Contract is on an available day basis, the time increase will be equal to the greatest number of available days involved in the extension.

3) When time charges on separate Bridge Contracts are controlled by Special Provisions that set forth the availability of bridge sites, extending an estimated waiting period controls the availability of that bridge site only; time charges will be adjusted according to the Special Provision.

c Construct the embankment at bridge ends full-depth to the subgrade template (except for the stage construction providing a bench for the end bent) unless otherwise stated in the Plans and compact thoroughly before driving a piling at bridge ends.

The minimum acceptable length of completed full-depth embankment is equal to the maximum width of fill between slope stakes at the end of the bridge. The Department will measure the minimum length of full-depth embankment along the roadway centerline away from the end-of-bridge Station.

1) In-Place Embankment

Construct embankments designated on the Plans and in the Proposal as “In-Place Embankment” using either a hydraulic or conventional dry land construction method and using materials obtained from within the construction limits of the Right-of -Way or from borrow pits, whichever is appropriate.

Regardless of the method of construction, the Department will measure the entire embankment for payment as in-place embankment.

b) Construction

Build embankments according to this Section when hydraulic or conventional dry land construction methods are used.

Furnish equipment suitable for the method chosen to complete the work. Equipment is subject to the Engineer's approval.

When using a hydraulic method is used, conform to these additional requirements:

a. Using baffles for construction is permitted as long as the embankment slopes are not steeper than indicated on the Plans.

b. Use of excess material placed outside the prescribed slopes to raise the fill is permitted.

c. Leave openings in the embankments at the bridge site as indicated on the Plans.

   Dredge material that invades the openings or existing channels at no additional expense to the Department. Provide the same depth of channel at mean low water as existed before the construction of the embankment.

d. Do not excavate or dredge material within 500 ft (150 m) of the toe of the embankment or existing structures, unless otherwise shown on the Plans.

e. Place in-place embankment in areas previously excavated below the ground line in a uniform mass beginning at one end of the excavated area and continuing to the other end of the operation. Avoid forming of muck cores in the embankment.

f. Construct the embankment at the farthest points along the roadway from the bridge ends and progress to the end of the excavation area beyond the toe of the slope of endrolls at bridge ends.

g. Remove timber used for temporary bulkheads or baffles from the embankment.

h. Fill and thoroughly compact the holes.

 Maintenance

Maintain the embankment at grade until it has been completed and accepted. Assume responsibility for slides, washouts, settlement, subsidence, or mishaps to the work while under construction.

Keep constructed embankment stable and replace displaced portions before Final Acceptance of the entire Contract.

Remove and dispose of excess materials, including fill, detours, and erosion deposits placed outside the prescribed slopes in wetland areas.

 Permits

Obtain (at no additional expense to the Department) necessary permits or licenses from the appropriate authorities to operate dredges and other floating equipment in waters under their jurisdiction, unless otherwise provided for in the Contract.

 Erosion Control

In addition to the provisions of Section 161, follow additional erosion, siltation, and pollution control measures specified in the Plans or Special Provisions.

 Rock Embankment

This work includes furnishing materials either from the roadway excavation or other sources and hauling and the placing of rock embankment. Use materials that meet the requirements of Subsection 208.2.B, as shown on the Plans or directed by the Engineer.

Place the rock in uniform layers not over 3 ft (1 m) thick. Distribute rock over the embankment to avoid pockets.

a. Fill voids with rock fines. Do not use rock larger than 6 in (150 mm) for any diameter within 3 ft (1 m) of the finished grade of the embankment, or within 2 ft (600 m) of any structure.

b. Do not place rock at bridge end bents within 10 ft (3 m) of pile locations. Construct rock embankment and adjoining earth embankment concurrently. Ensure that neither is larger than 4 ft (1.2 m) higher than the other at any time.

b. Final Finishing

After constructing the entire embankment, shape the surface of the roadbed and the slopes to reasonably true grade and cross-sections as shown on the Plans or established by the Engineer.

Open ditches, channels, and drainage structures (both existing and those constructed or extended) to effectively drain the roadway. Maintain the embankment areas until Final Acceptance of the Project.

208.3.6 Quality Acceptance

General Provisions 101 through 150.

208.3.7 Contractor Warranty and Maintenance

General Provisions 101 through 150.

208.4 Measurement

The following section details measurement for payment for the work described in this Section:

400.4.1 Except as provided herein, there will be no measurement for payment for the work covered by this Section.

400.4.2 The Department will compute the quantity of in-place embankment or rock embankment using the average end area method, or other acceptable methods, when embankment is in place and accepted.

The quantity will be calculated as the neat volume, above the original ground surface, between the template line shown on the Plans or authorized changes by the Engineer, and the original ground surface.

The original ground surface is determined by conventional field, photogrammetric, or other methods. The Department will not deduct for the volume of culverts and manholes.

In-place embankment necessary for the construction of temporary detours will not be measured for payment and is considered incidental to the completion of the work unless specifically stated otherwise on the Plans.

Where work includes excavating of unstable materials below the ground line, the volume of embankment required for backfill below the ground line is calculated based on the neat line measurement for the cross-section shown on the Plans or established by the Engineer by the average end area method or other acceptable methods.

Where permitted by the Engineer or required by the Plans, material removed from the existing roadbed, special ditches, berm ditches, or dry land borrow pits and used in making embankment will be paid for as in-place embankment regardless of the method of excavation.

208.4.01 Limits

General Provisions 101 through 150.

208.5 Payment

Except as provided for herein, the Department will not make separate payment for placing embankments, backfilling structures, and constructing earth berms, including surcharges.

Payment will be included at the Contract Unit Price for the items covered by Section 204, Section 205, and Section 206. Prices are full compensation for The Work covered by this Section.

The Unit Prices bid per cubic yard (meter) for in-place and rock embankments (when included as Contract bid Items) are full compensation for furnishing suitable material, hauling, placing, compacting, finishing, and dressing according to these Specifications or as directed by the Engineer.

Payment will be made under:

Item No. 208	In-place embankment	Per cubic yard (meter)
Item No. 208	Rock embankment	Per cubic yard (meter)

208.5.01 Adjustments

General Provisions 101 through 150.

SECTION 6

209

SUBGRADE CONSTRUCTION

Section 209—Subgrade Construction

209.1 General Description

This work includes placing, mixing, compacting, and shaping the top 6 in (150 mm) or the Plan-indicated thickness ofthe roadbed in both excavation and embankment areas.

This work also includes subgrade stabilization, select material subgrade, and shoulder stabilization.

209.1.1 Definitions

General Provisions 101 through 150.

209.1.2 Related References

D. Standard Specifications

Section 109—Measurement and Payment

Section 412—Bituminous Prime

Section 803—Stabilizer Aggregate

Section 810—Roadway Materials

Section 815—Graded Aggregate

E. Referenced Documents

GDT 7

GDT 20

GDT 21

GDT 24a

GDT 24b

GDT 59

GDT 67

209.1.3 Submittals

General Provisions 101 through 150.

209.2 Materials

A. Subgrade Materials

If the Plans do not show the source of material for subgrade, the Engineer will direct the Contractor according to the Specifications, or implement a Supplemental Agreement to ensure a satisfactory subgrade.

If the existing roadway excavation or borrow materials are not suitable or available for stabilizing the subgrade, use the quantity of stabilizer materials defined below in Subsection 209.2.B.

B. Subgrade Stabilizer Materials

Material	Section
Type I Stabilizer Aggregate	803.2.01
Type II Stabilizer Aggregate	803.2.02

Material	Section
Class IIB3 or Better Soil	810.2.01.A.1
Type III Stabilizer Aggregate	803.2.03
Type IV Stabilizer Sand	803.2.04

C. Select Material Subgrade

Material	Section
Class IIB3 or Better Soil	810.2.01.A.1
Graded Aggregate	815

D. Shoulder Stabilization

Material	Section
Shoulder Stabilization	803.2.02, Type II

209.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

209.3 Construction Requirements

209.3.1 Personnel

General Provisions 101 through 150.

209.3.2 Equipment

General Provisions 101 through 150.

209.3.3 Preparation

General Provisions 101 through 150.

209.3.4 Fabrication

General Provisions 101 through 150.

209.3.5 Construction

A. Subgrade Construction

Construct subgrade as follows:

1. Plow, harrow, and mix the entire surface of the in-place subgrade to a depth of at least 6 in (150 mm).
2. After thoroughly mixing the material, bring the subgrade to Plan line and grade and compact it to 100 percent of the maximum laboratory dry density.
3. If the subgrade needs to be stabilized, or if a subsequent contract provides for base construction, do not apply density requirement at this stage.

   If a subsequent Contract provides for base construction, eliminate mixing and compact the in-place subgrade to 95 percent of the laboratory maximum dry density.
4. Ensure that the subgrade can firmly support construction equipment before placing subsequent layers of base and paving materials. The subgrade must support construction equipment without excessive movement regardless of compaction.

5. Rework unstable areas of subgrade to a moisture content that will provide stability and compaction. The Engineer may direct the Contractor to proof roll the subgrade with a loaded dump truck.
6. Compact the subgrade using a sheepsfoot roller.

   Where the subgrade soils are predominantly sands, the Engineer may permit the use of vibratory rollers.

B. Subgrade Stabilization

Construct a stabilized subgrade according to Plans or as directed:

a Undercut and dispose of the amount of subgrade material that will be displaced with the aggregate or selected material according to the Engineer's direction.

b Leave material off the subgrade in fill sections requiring stabilization.

c Place the amount of material specified in Subsection 209.2.B. on the subgrade as specified on the Plans or established by the Engineer.

d Thoroughly incorporate the material into the existing subgrade to a depth of 6 in (150 mm), or as indicated on the Plans. Plow, disk, harrow, blade, and then mix with rotary tillers until the mixture is uniform and homogeneous throughout the depth to be stabilized.

e Finish the stabilized subgrade to the Plan line, grade, and cross-section. Compact it to 100 percent of the maximum laboratory dry density as defined in Subsection 209.3.06.

Plant mixing is permitted as an alternative to the mixed-in-place method.

f Eliminate the mixing and scarifying method before compaction in undercut areas where Type III Stabilizer Aggregates are specified, unless otherwise specified by the Engineer.

C. Select Materials Subgrade

Place select materials as follows:

a Place a uniform blanket of select material consisting of Class I or II soil or graded aggregate on the prepared subgrade (according to Plan dimensions or as directed by the Engineer).

b Use the select material reserved from the grading or borrow operations. If material is not available through this source, obtain it from other sources.

c Finish and compact the material according to Subsection 209.3.05.A.

D. Shoulder Stabilization

Stabilize the shoulder as follows:

a Spread the stabilizer aggregate at the rate and to the dimensions indicated on the Plans.

b Mix the aggregate with the in-place shoulder material thoroughly to the Plan depth.

c Compact the area thoroughly and finish it to Plan dimensions.

d Prime the stabilized area according to Section 412 when a paving course is required on the shoulders.

E. Finishing Subgrade

When finishing subgrade use the following procedure:

a Leave the underlying subgrade in cuts and fills low enough to accommodate the additional material when the work requires either subgrade stabilization, select material subgrade, or stabilization for shoulders.

b Test short sections in curb and gutter areas might be necessary to obtain the proper elevation.

c Blade the surface of the completed subgrade to a smooth and uniform texture.

209.3.6 Quality Acceptance

The Department will test representative samples of compacted material to determine the laboratory maximum dry density using GDT 7, GDT 24a, or GDT 67 as applicable.

The Department will determine in-place density of the compacted subgrade according to GDT 20, GDT 21, or GDT 59, as applicable.

Ensure that the centerline profile conforms to the established elevations with an acceptable tolerance of ±0.5 in (±13 mm). The acceptable tolerance under a template conforming to the designated cross section shall be ±0.25 in (±6 mm).

Have the Department test the maximum dry density using methods according to Subsection 209.3.05.A. When base construction is not in the same Contract, the tolerances may be 1 in (25 mm), 0.5 in (13 mm), and 95 percent respectively.

209.3.7 Contractor Warranty and Maintenance

General Provisions 101 through 150.

209.4 Measurement

A. Subgrade Construction and Finishing Subgrade

The Department will make no separate measurement or payment for the work described in this Section.

B. Subgrade Stabilization

Subgrade stabilization materials, as defined in Subsection 209.3.05.B is measured by the ton (megagram), cubic yard (meter), or square yard (meter) of the specified thickness if none of the existing Roadway Excavation and/or Borrow Materials are suitable and available for stabilizing the subgrade.

C. Select Material Subgrade

Select materials, conforming to Subsection 209.3.05.C are measured by the cubic yard (meter) in the hauling vehicle, per ton (megagram) according to Subsection 109.01, or by the square yard (meter) of the specified thickness when roadway excavation and/or borrow materials are not available or suitable for this Item.

D. Shoulder Stabilization

Shoulder stabilization is measured by the cubic yard (meter) or ton (megagram) as specified in Subsection 209.4.B.

209.4.01 Limits

General Provisions 101 through 150.

209.5 Payment

A. Subgrade Construction

The Department will make no separate payment for subgrade construction or for finishing subgrade.

B. Subgrade Stabilization

Subgrade stabilization complete and accepted according to Subsection 209.3.05.B will be paid for at the Contract Unit Price per cubic yard (meter), per ton (megagram), or per square yard (meter). This price is full compensation for furnishing the materials, hauling, placing, mixing, compacting, and finishing the stabilized subgrade.

C. Select Material Subgrade

Select material complete, accepted, and measured according to Subsection 209.4.C will be paid for at the Contract Unit Price per cubic yard (meter), per ton (megagram), or per square yard (meter). This price is full compensation for furnishing the material where required, hauling, placing, mixing, compacting and finishing the select material subgrade

SECTION 7

210

GRADING COMPLETE

Section 210—Grading Complete

210.1 General Description

This work includes:

- Excavating of all materials including ditches, undesirable material (including removal and replacement), and borrow (if required)
- Hauling
- Forming embankments
- Constructing shoulders and subgrades
- Finishing, dressing, and disposing of undesirable or surplus material
- Clearing and grubbing according to Section 201 and Section 202 unless these items are established as Pay Items in the Contract
- Removing and disposing of miscellaneous roadway items, including but not limited to curbs, drainage structures, and pavements (unless established as separate contract items)

Ensure that the completed grading work conforms to the horizontal and vertical alignment and typical cross- sections shown on the Plans or as directed by the Engineer.

210.1.1 Definitions

General Provisions 101 through 150.

210.1.2 Related References

F. Standard Specifications

Section 109—Measurement and Payment

Section 201—Clearing and Grubbing Right-of-Way Section 202—Random Clearing and Grubbing Section 204—Channel Excavation

Section 205—Roadway Excavation

Section 206—Borrow Excavation

Section 207—Excavation and Backfill for Minor Structures Section 208—Embankments

Section 209—Subgrade Construction

G. Referenced Documents

General Provisions 101 through 150.

210.1.3 Submittals

General Provisions 101 through 150.

210.2 Materials

Use materials required for grading construction that conform to the requirements of Section 204, Section 205, Section 206, Section 207, Section 208, and Section 209.

210.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

210.3 Construction Requirements

210.3.1 Personnel

General Provisions 101 through 150.

210.3.2 Equipment

Use equipment approved by the Engineer that will not damage base, pavement, or other appurtenances to be retained.

210.3.3 Preparation

Before placing base material, finish the subgrade according to Subsection 209.3.05.E.

210.3.4 Fabrication

General Provisions 101 through 150.

210.3.5 Construction

Perform The Work according to the appropriate portions of Section 201, Section 202, Section 204, Section 205, Section 206, Section 207, Section 208, and Section 209 of the Specifications. Measurement and payment shall be according to the provisions of this Section. See Subsection 210.4 and Subsection 210.5, below.

210.3.6 Quality Acceptance

When the Engineer determines that the existing material in areas where fills are to be placed is undesirable, the Engineer may require the Contractor to remove the undesirable material and replace it with suitable material.

- Compact the replacement materials according to the applicable portions of Section 208.
- In cut areas, where the material below the template line is undesirable for subgrade or shoulders, undercut it to a depth established by the Engineer and replace it with suitable material.
- Compact the replacement materials as specified herein.

210.3.7 Contractor Warranty and Maintenance

General Provisions 101 through 150.

210.4 Measurement

C. Grading Complete

The Work under this Item is not measured separately for payment.

D. Grading Per Mile (Kilometer)

This Item is measured in linear miles (kilometers) along the centerline of the road or the median, including ramps where shown on the Plans.

E. Undercut Excavation

The amount of undercut excavation (when directed by the Engineer and not addressed in the Plans) measured for payment is the product of the length, width, and depth of excavation. Replacement material for undercut excavation is not measured for payment. There will be no separate payment for undercut excavation required by the Plans or rock excavation required under Subsection 205.3.

210.4.01 Limits

General Provisions 101 through 150.

210.5 Payment

B. Grading Complete

This Item completed and accepted will be paid for at the Lump Sum Price bid. Payment is full compensation for all work and materials specified in this Section.

C. Grading Per Mile (Kilometer)

This Item will be paid for at the Contract Unit Price per linear mile (kilometer) complete in place and accepted. This price is full compensation for furnishing the materials and performing the work specified in this Section.

D. Undercut Excavation

Undercutting areas not shown in the Plans when directed by the Engineer will be paid for at the rate of $7.50 per cubic yard ($9.80 per cubic meter) for quantities up to 750 yd^3 (575 m^3).

Quantities exceeding 750 yd^3 (575 m^3) will be considered Extra Work as defined in Subsection 109.05, and will be paid for accordingly. Payment is full compensation for excavating and disposing of undesirable material and supplying, placing, and compacting replacement material.

Payment will be made under:

Item No. 210	Grading complete	Per lump sum
Item No. 210	Grading per mile (kilometer)	Per mile (kilometer)
Item No. 210	Undercut excavation	Per cubic yard (meter)

210.5.01 Adjustments

General Provisions 101 through 150.

SECTION 8

211

BRIDGE EXCAVATION AND BACKFILL

Section 211—Bridge Excavation and Backfill

211.1 General Description

This work includes the following responsibilities:

- Removing materials necessary for the construction of bridge footings and substructures
- Disposing of excess materials and required backfilling, including porous backfill
- Constructing and removing work bridges, cribs, cofferdams, and caissons
- Dewatering, draining, sheeting, and exploratory boring of foundations necessary to complete the work

Excavate and backfill concrete box culverts as specified in Section 207.

211.1.1 Definitions

Foundation: Material on which the footing of the substructure or seal rests.

211.1.2 Related References

H. Standard Specifications

Section 201—Clearing and Grubbing Right-of-Way

Section 207—Excavation and Backfill for Minor Structures

Section 500—Concrete Structures

Section 525—Cofferdams

Section 540—Removal of Existing Bridge

I. Referenced Documents

General Provisions 101 through 150.

211.2 Materials

211.2.01 Delivery, Storage, and Handling

F. Surplus Materials

Dispose of surplus, stockpiled, and excavated materials as directed by the Engineer. Materials may be spread neatly and smoothly on the right-of-way so as not to obstruct the channel of any existing or proposed waterway. Dispose of wasted materials according to Subsection 201.3.05.E.

211.3 Construction Requirements

211.3.1 Personnel

General Provisions 101 through 150.

211.3.2 Equipment

A. Cofferdams and Sheeting

Use necessary protection such as cofferdams and sheeting when working in or near excavations where the surrounding earth could fail and endanger personnel or damage the work.

Use cofferdams or sheeting to prevent undesirable changes in channels and slopes.

Construct, remove, and dispose of cofferdams according to Section 525, regardless of whether they are measured separately for payment.

211.3.3 Preparation

A Preparation of Foundations

Prepare and maintain foundations as follows:

a. Do not subject concrete to the action of water before final setting, except as provided for seal concrete in Subsection 500.3.05.V.

b. Where footings are placed on a slightly sloped foundation of rock or hardpan, key the center of the foundation approximately 1 ft (300 mm) deep throughout an area approximately equal to the dimensions of the column to be placed (unless the Plans require entire footing to be keyed).

c. When the Engineer requires, step the foundation and remove all loose fragments and clean and fill seams as directed.

d. Do not disturb the top of the foundation to ensure that footings are placed on undisturbed material when they are not resting on rock or hardpan foundations.

211.3.4 Fabrication

General Provisions 101 through 150.

211.3.5 Construction

a. Foundations and Footings

The sizes and elevations shown on the Plans are approximate, and are subject to change when directed.

b. Inspection

Provide the Engineer ample opportunity and safe conditions (as determined by the Engineer) to inspect foundations and measure removed materials. Do not place concrete or close foundation areas from view until the area has been inspected and approved.

c. Boring of Foundations and Seals

Bore foundations as requested and in an approved manner so that the foundation's adequacy can be determined by the Engineer. Borings are usually required only for foundations and seals with no piles. All borings shall be made in the Engineer's presence.

Bore to at least 6 ft (1.8 m) deep in rock and 10 ft (3 m) deep in other material, excluding seals. The entire depth of the seal will usually be bored in only one location.

d. Backfill Construction

Follow these requirements when backfilling:

1) General

Backfilling is a part of the work of excavation, except as noted.

Place the backfill in layers not exceeding 1 ft (300 mm) of loose material. Compact the layer before placing the next layer.

Backfill around all substructures except those located within the banks of a stream at normal water level.

Do not jet backfills.

Place backfill material to apply only balanced horizontal loads to a newly placed structure or portion of structure.

Do not backfill portions of structures that do not have backfill on all sides until the concrete has reached the required strength (as determined by the Engineer) to withstand the earth pressures.

2) Intermediate Bents and Piers

Compact backfill for intermediate bents and piers to the approximate density of the surrounding soil.

Begin and complete backfilling around substructures not supported by piling the next workday after placing the lift, if possible. Backfill at least within three calendar days after placement.

Backfill footings before beginning form work on the columns.

Begin backfilling around pile-supported footings and columns after removing forms. Complete as soon as possible but within five calendar days after placing concrete.

C. End Bents and Abutments

Compact backfill for end bents and abutments (including their wingwalls) to the density shown on the Standard Plans or Special Plans.

1. Begin and complete the work no later than five calendar days after placing concrete, unless other time limits are indicated on the Plans.

   If other time limits are indicated, this work may be second stage construction or second stage backfill construction.

2. Step slopes behind abutments, unless otherwise shown, and take precautions to prevent the backfill from wedging against the abutment.
3. Provide drainage behind abutments and their wingwalls as shown on the Plans.
4. Place backfill for abutment footings and portions of walls having fill on both sides of the wall according to Subsection 211.3.05.D.4.

D. Backfill Material

Backfill around intermediate bents and piers with material removed from the excavation, unless the material is unsatisfactory to the Engineer.

1. Ensure that material for end bents and abutments meets the requirements shown on the Standard Plans or Special Plans.

   When suitable material is not available within the immediate vicinity of the bridge within the right-of-way, locate a source acceptable to the Engineer and haul the material to the site.

2. Obtain and place backfill material necessary for end bent and abutment construction— including special backfill material used in constructing mechanically stabilized earth wall abutments.
3. Ensure that material located and hauled to the bridge site meets the requirements of Class I, Class II, or as shown in Subsection 810.2.01.A.1, unless otherwise noted.
4. Ensure that porous backfill (when specified) consists of coarse aggregate size No. 57 as specified in Subsection 800.2.01, or crushed stone drainage material as specified in Subsection 806.2.02.A.

211.3.6 Quality Acceptance

General Provisions 101 through 150.

211.3.7 Contractor Warranty and Maintenance

General Provisions 101 through 150.

211.4 Measurement

A. Bridge Excavation

Bridge excavation is measured for payment as follows:

- Bridge excavation is measured in cubic yards (meters) of bridge excavation acceptably removed.
- No payment is made for materials removed outside the area bounded by vertical planes a maximum of 18 in (450 mm) outside of and parallel to the neat lines of the footings, unless otherwise shown on the Plans.

- No separate measurement is made under the Item of bridge excavation for excavation necessary for end bent construction unless otherwise shown on the Plans.
- Portions of structures removed under Section 540 that fall within the excavation limits are not included in the measurements for bridge excavation.
- The vertical pay dimension is measured from the original ground line. However, for grade separation structures, the vertical pay dimension is measured from the subgrade template of the roadway passing underneath, unless otherwise shown on the Plans.
- The vertical pay dimension for excavation at an intermediate bent (constructed within the limits of a previously placed end roll) includes the portion of the end roll that falls within the excavation limits.
- Each portion of a stepped footing is considered a separate footing (for measurement purposes).
- The bottom of each footing or step will be cross-sectioned by the Engineer (to obtain the elevation of the completed excavation).

B. Bridge Backfill

Bridge backfill is measured for payment as follows:

- No separate measurement is made for bridge backfill.
- Backfill material hauled to intermediate substructure locations according to Subsection 211.3.05.D.4. is not measured as bridge backfill, but is considered a Specification Allowance as set forth in Subsection 211.5.B.
- No allowance is made for material hauled in for use at bridge ends.

211.4.01 Limits

General Provisions 101 through 150.

211.5 Payment

1. Bridge Excavation

This work will be paid for at the Contract Price per cubic yard (meter) complete, or at the Contract Price modified as specified below:

a. The Department will pay for all eligible excavation down to 2 ft (600 mm) below the Plan foundation elevation at the Contract Price for bridge excavation.

b. The amount of payment for excavating lower than 2 ft (600 mm) below the Plan elevation is determined by increasing the Contract Price for bridge excavation as follows:

1 If excavations extend 6 ft (1.8 m) or less below the Plan foundation elevation, payment for excavating the material from 2 ft (600 mm) below the Plan foundation elevation is at the Contract Price plus 50 percent.

2 If excavations extend more than 6 ft (1.8 m) but not more than 10 ft (3 m), payment for excavating the material from 2 ft (600 mm) below the Plan Foundation elevation is at the Contract Price plus 75 percent.

3 If excavations extend more than 10 ft (3 m) below the Plan foundation elevation, payment for excavating the material from 2 ft (600 mm) below the Plan foundation is at the Contract Price plus 100 percent.

2. Bridge Backfill

The Department will not pay for this work separately. Include the cost in other pay items included in the Bridge Contract.

The Department will pay 125 percent of the Contract Price for bridge excavation when the Contractor furnishes and hauls material used as replacement for unsuitable material excavated at intermediate substructure locations. Maximum dimensions and deductions are specified in Subsection 211.4.B.

Payment will be made under:

Item No. 211	Bridge excavation	Per cubic yard (meter)
Item No. 211	Bridge excavation grade separation	Per cubic yard (meter)
Item No. 211	Bridge excavation, stream crossing— no.____	Per cubic yard (meter)
Item No. 211	Porous backfill	Per cubic yard (meter)

211.5.01 Adjustments

General Provisions 101 through 150.

SECTION 9

310

GRADED AGGREGATE CONSTRUCTION

Section 310—Graded Aggregate Construction

310.1 General Description

This work includes constructing a base, subbase or shoulder course composed of mineral aggregates. Construct according to these Specifications and to the lines, grades, thickness, and typical cross-sections shown on the Plans or established by the Engineer.

The provisions of Section 300 apply to this work.

310.1.1 Definitions

General Provisions 101 through 150.

310.1.2 Related References

A. Standard Specifications

Section 105—Control of Work

Section 300—General Specifications for Base and Subbase Courses

Section 412—Bituminous Prime

Section 815—Graded Aggregate

Section 821—Cutback Asphalt

Section 823—Cutback Asphalt Emulsion

B. Referenced Documents

AASHTO T 180

GDT 21

GDT 59

310.1.3 Submittals

General Provisions 101 through 150.

310.2 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Graded aggregate	815
Cutback asphalt, RC-30, RC-70, RC-250 or MC-30, MC-70, MC-250	821.2.01
Cutback Asphalt Emulsion, CBAE-2	823.2.01
Blotter material (sand)	412.3.05.G.3

310.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

310.3 Construction Requirements

310.3.1 Personnel

General Provisions 101 through 150.

310.3.2 Equipment

Provide equipment in satisfactory condition for proper construction of the base, subbase or shoulder course. Use any applicable equipment specified in Subsection 412.3.02, "Equipment" for Bituminous Prime.

310.3.3 Preparation

Prepare the subgrade or subbase as specified in Subsection 300.3.03.C, "Preparing the Subgrade" or Subsection 300.3.03.D, "Preparing the Subbase." Place graded aggregate materials only on dry, thawed subgrade or subbase.

310.3.4 Fabrication

General Provisions 101 through 150.

310.3.5 Construction

A. Placing Material

Use the central plant mix method unless producing aggregates (from an approved source or deposit) that conform to the requirements of Section 815.

Use the following steps to mix base and spread subbase or shoulder course.

Mixing

When blending two sizes of aggregate, proportion the aggregate and water, if needed, into the central plant. Mix until producing a homogeneous and uniform mixture.

Spreading

To obtain the specified thickness, uniformly spread materials to the proper depth with a mixture spreader. Do not use materials containing frost or frozen particles.

One-Course Construction

Lay one course to a maximum thickness of 8 in (200 mm) compacted.

Multiple-Course Construction

If the thickness of the base, subbase or shoulder course exceeds 8 in (200 mm), construct it in 2 or more courses of equal thickness.

B. Compacting Material

Use the following steps to compact and finish a base, subbase, or shoulder course.

Moisture Content

Ensure that the moisture content of materials is uniformly distributed and allows compaction to the specified density.

Unless approved by the Office of Materials and Research, no graded aggregate will be shipped to a project when the moisture content of the material exceeds two percent of optimum moisture.

Compaction

After shaping the spread material to line, grade, and cross-section, roll to uniformly compact the course. If using Group 1 aggregate, roll to at least 98 percent of maximum dry density. If using Group 2 aggregate, roll to at least 100 percent of the maximum dry density.

If using graded aggregate mixtures composed of either group as base for paved shoulders 6 ft (1.8 m) wide or less, compact to at least 96 percent of the maximum dry density.

Regardless of compaction, ensure that the compacted base is sufficiently stable to support construction equipment without pumping. If the base material is unstable from too much moisture, dry and rework the base material. Dry and rework the underlying subgrade, if necessary.

One-Course Construction

a After compaction, shape to the required grade, line, and cross- section.

b Add water as necessary to develop the proper moisture content.

c Roll until the surface is smooth, closely knit, and free of cracks.

d Correct all defects according to Subsection 300.3.06.B, "Repairing Defects."

2. Multiple-Course Construction

After compacting the first course, shape the surface again to line, grade, and cross section.

Add water as necessary to develop the proper moisture content.

Spread and compact the second and any succeeding courses without rolling the first course again.

Finish the surface according to the procedure specified for one-course construction.

3. Irregular Areas

In places inaccessible to the roller, obtain the required compaction with mechanical tampers approved by the Engineer. Apply the same density requirements as stated above in Subsection 310.3.05.B.

c. Finishing

Finish the surface of the subbase for Portland cement concrete pavement or the base of asphaltic concrete pavement with automatically controlled screed equipment when required by Subsection 300.3.02.H, "Fine Grading Machine" of the Specifications. Furnish, install, and maintain the sensing wires needed to control the finish operation as a part of the Pay Item. When automatically controlled screed equipment is not required, fine grading with motor graders is permitted.

Finish immediately after the placing and compacting operations. After finishing, compact the subbase again, according to Subsection 310.3.05.B, "Compacting Material."

d. Protecting the Base, Subbase or Shoulders

Maintain the course until the Engineer determines that it has cured sufficiently and is ready to prime. Maintain by additional wetting, rolling, and blading as necessary. Repair any defects according to Subsection 300.3.06.B, "Repairing Defects."

These protection measures do not relieve the Contractor of maintaining the Work until final acceptance as specified in Section 105.

e. Priming the Base

Apply bituminous prime according to Section 412 unless using:

- Graded aggregate base under Portland cement concrete pavement
- Graded aggregate base under asphaltic concrete 5 in (125 mm) or more in total thickness

310.3.6 Quality Acceptance

1. Compaction Tests

a. Determine the maximum dry density from representative samples of compacted material, according to AASHTO T180, Method D.

b. Determine the in-place density of finished courses according to GDT 21 or GDT 59, where applicable.

2. Finished Surface

Check the finished surface of the base, subbase, or shoulder course as follows:

a. Check the longitudinal surface using a 15 ft (4.5 m) straightedge parallel to the centerline.

b. Check the transverse surface by using one of the following tools:

- A template, cut true to the required cross-section and set with a spirit level on non-superelevated sections

- A system of ordinates, measured from a stringline
- A surveyor's level

Ensure that ordinates measured from the bottom of the template, stringline, or straightedge, to the surface do not exceed 1/4 in (6 mm) at any point. Rod readings shall not deviate more than 0.02 ft (6 mm) from required readings.

Correct any variations from these requirements immediately according to Subsection 300.3.06.B, "Repairing Defects."

C. Thickness Tolerances

Thickness Measurements

Thickness requirements apply to shoulder construction where the Plans specify a uniform thickness, or where the shoulders will be surfaced.

Determine the thickness of the base, subbase, or shoulder course, by making as many checks as necessary to determine the average thickness.

Deficient Thickness

If any measurement is deficient in thickness more than 1/2 in (13 mm), make additional measurements to determine the deficient area.

Correct any area deficient between 1/2 in (13 mm) and 1 in (25 mm) to the design thickness by using one of the following methods according to these Specifications:

- Add additional quantities of the same materials and reconstruct to the required thickness
- Leave in place and accept payment for the materials and area at ½ the Contract Unit Price for the deficient area.

3 Correct any area deficient in thickness by more than 1 inch (25 mm) by adding additional quantities of the same material and reconstructing to the required thickness in accordance with these Specifications.

4 If payment is made by the ton (megagram), payment for additional material to correct deficiencies will be made at the Contract Unit Price with no additional cost to the Department for scarification, mixing or compaction.

5 If payment is made by the square yard (meter), no payment will be made for additional material required to correct deficiencies or for reconstructing deficient work.

3. Average Thickness

The average thickness per linear mile (kilometer) is determined from all measurements within the mile (kilometer) increments except the areas deficient by more than 1/2 in (13 mm) and not corrected.

The average thickness shall not exceed the specified thickness by more than 1/2 in (13 mm).

If the basis of payment is per ton (megagram), and the average thickness for any mile (kilometer) increment exceeds the allowable 1/2 in (13 mm) tolerance, the excess quantity in that increment will be deducted from the Contractor's payments.

The excess quantity is calculated by multiplying the average thickness that exceeds the allowable 1/2 in (13 mm) tolerance by the surface area of the base, subbase, or shoulder.

If the basis of payment is per square yard (meter), no deduction will be made for excess thickness.

310.3.7 Contractor Warranty and Maintenance

General Provisions 101 through 150.

310.4 Measurement

A. Graded Aggregate

Where specified for payment by the ton (megagram), graded aggregate base, subbase or shoulder materials are measured in tons (megagrams), mixed and accepted. When hauling material to the roadway, the actual weight of each loaded vehicle is determined with an approved motor truck scale.

Where specified for payment by the square yard (meter) for a certain thickness, the surface length is measured along the centerline, and the width is specified on the Plans. Measure irregular areas, such as turnouts and intersections, by the square yard (meter).

B. Bituminous Prime

Bituminous prime is not measured for separate payment.

310.4.01 Limits

General Provisions 101 through 150.

310.5 Payment

1. Graded Aggregate

Graded aggregate base, subbase, or shoulder course will be paid for at the Contract Unit Price per ton (megagram) or per square yard (meter), complete, in place, and accepted. This payment shall be full compensation for:

- Materials
- Shaping and compacting the existing roadbed
- Loading, hauling, and unloading
- Crushing and processing
- Mixing
- Spreading
- Watering
- Compacting and shaping
- Maintenance
- Priming, when required
- All incidentals necessary to complete The Work

Payment will be made under:

Item No. 310	Graded aggregate (base, subbase, shoulder course)—including material	Per ton (megagram) or square yard (meter)
Item No. 310	Graded aggregate base and shoulder course— including material	Per ton (megagram) or square yard (meter)

310.5.01 Adjustments

General Provisions 101 through 150.

SECTION 10

400

ASPHALTIC CONCRETE

Section 400—Hot Mix Asphaltic Concrete Construction

400.1 General Description

This work includes constructing one or more courses of bituminous plant mixture on the prepared foundation or existing roadway surface. Ensure the mixture conforms with lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

This section includes the requirements for all bituminous plant mixtures regardless of the gradation of the aggregates, type and amount of bituminous material, or pavement use.

Acceptance of work is on a lot-to-lot basis according to the requirements of this Section and Section 106.

400.1.01 Definitions

Segregated Mixture: Mixture lacking homogeneity in HMA constituents of such magnitude there is a reasonable expectation of accelerated pavement distress or performance problems. May be quantified by measurable changes in temperature, gradation, asphalt content, air voids, or surface texture.

Wearing Course: The upper course of asphaltic concrete placed on a roadway, airport or other asphalt pavement.

Surface Course: The upper course of asphaltic concrete placed on a roadway, airport or other asphalt pavement and also includes the dense-graded asphaltic concrete mixture beneath Open Graded Friction Course (OGFC) or Porous European Mixture (PEM).

Intermediate (Binder) Course: The lift(s) of asphaltic concrete above the base course and below the wearing course.

Asphaltic Concrete Base Course: The lower lift(s) of asphaltic concrete generally placed on graded aggregate base (GAB), soil cement or other stabilized base material.

New Construction: A roadway section more than 0.5 mile (800 m) long that is not longitudinally adjacent to the existing roadway. If one or more lanes are added longitudinally adjacent to the existing lane, the lane(s) shall be tested under the criteria for a resurfacing project. If work is performed on the existing roadway including leveling, grade changes, widening and/or resurfacing then that lane shall be tested under the criteria for a resurfacing project.

Trench Widening: Widening no more than 4 ft. (1.2 m) in width.

Comparison Sample: Opposite quarters of material sampled by the Contractor.

Independent Sample (Quality Assurance Sample): A sample taken by the Department to verify an acceptance decision without regard to any other sample that may also have been taken to represent the material in question.

Referee sample: A sample of the material retained during the quartering process which is used for evaluation if a comparison of Contractor and Departmental split sample test results is outside allowable tolerances.

400.1.02 Related References A.

Standard Specifications

Section 106—Control of Materials

Section 109—Measurement and Payment

Section 152—Field Laboratory Building

Section 413—Bituminous Tack Coat

Section 424—Bituminous Surface Treatment

Section 802—Aggregate for Asphaltic Concrete

Section 828—Hot Mix Asphaltic Concrete Mixtures

B. Referenced Documents

AASHTO T 324

AASHTO T 315

AASHTO T 209

AASHTO T 202

AASHTO T 49

Department of Transportation Standard Operating Procedure (SOP) 15

Department of Transportation Standard Operating Procedure (SOP) 27

Department of Transportation Standard Operating Procedure (SOP) 40

Department of Transportation Standard Operating Procedure (SOP) 46

GDT 38

GDT 39

GDT 42

GDT 59

GDT 73

GDT 78

GDT 83

GDT 119

GDT 125

GDT 126

GDT 134

GSP 15

GSP 21

QPL 1

QPL 2

QPL 7

QPL 26

QPL 30

QPL 39

QPL 41

QPL 45

QPL 65

QPL 67

QPL 70

QPL 77

QPL 88

QPL 91

QPL 92 (A, B, C)

QPL 97

400.1.03 Submittals

A. Invoices

Furnish formal written invoices from a supplier for all materials used in production of HMA when requested by the Department. Show the following on the Bill of Lading:

- Date shipped
- Quantity in tons (megagrams)
- Included with or without additives (for asphalt cement)

Purchase asphaltic cement directly from a supplier listed on Qualified Products List 7 and provide copies of Bill of Lading at the Department's request.

B. Paving Plan

Before starting asphaltic concrete construction, submit a written paving plan to the Engineer for approval. Include the following on the paving plan:

- Proposed starting date
- Location of plant(s)
- Rate of production
- Average haul distance(s)
- Number of haul trucks
- Paver speed feet (meter)/minute for each placement operation
- Mat width for each placement operation
- Number and type of rollers for each placement operation
- Sketch of the typical section showing the paving sequence for each placement operation
- Electronic controls used for each placement operation
- Temporary pavement marking plan

If staged construction is designated in the plans or contract, provide a paving plan for each construction stage.

If segregation is detected, submit a written plan of measures and actions to prevent segregation. Work will not continue until the plan is submitted to and approved by the Department.

C. Job Mix Formula

Submit to the Engineer a written job mix formula proposed for each mixture type to be used based on an approved mix design. Furnish the following information for each mix:

- Specific project for which the mixture will be used
- Source and description of the materials to be used
- Mixture I.D. Number
- Proportions of the raw materials to be combined in the paving mixture
- Single percentage of the combined mineral aggregates passing each specified sieve
- Single percentage of asphalt by weight of the total mix to be incorporated in the completed mixture
- Single temperature at which to discharge the mixture from the plant
- Theoretical specific gravity of the mixture at the designated asphalt content
- Name of the person or agency responsible for quality control of the mixture during production

Do the following to have the Job Mix Formulas approved in accordance with SOP 40 *Approval of Contractor Job Mix Formulas* and to ensure their quality:

1. Submit proposed job Mix Formulas for review at least two weeks before beginning the mixing operations.
2. Do not start hot mix asphaltic concrete work until the Engineer has approved a job mix formula for the mixture to be used. No mixture will be accepted until the Engineer has given approval.

3. Provide mix designs for all SMA, Superpave and 4.75 mm mixes to be used. The Department will provide mix design results for other mixes to be used.
4. After a job mix formula has been approved, assume responsibility for the quality control of the mixtures supplied to the Department according to Subsection 106.01, *Source of Supply and Quantity of Materials*.

D. Quality Control Program

Submit a Quality Control Plan to the Office of Materials and Testing for approval. The Quality Control Program will be included as part of the certification in the annual plant inspection report.

400.2 Materials

Ensure materials comply with the specifications listed in Table 1.

TABLE 1—MATERIALS SPECIFICATIONS

Material	Subsection
Asphalt Cement, Grade Specified	820.2
Coarse Aggregates for Asphaltic Concrete	802.2.02
Fine Aggregates for Asphaltic Concrete	802.2.01
Mineral Filler	883.1
Heat Stable Anti-Stripping Additive	831.2.04
Hydrated Lime	882.2.03
Silicone Fluid (When approved by the Office of Materials and Testing)	831.2.05
Bituminous Tack Coat: PG 58-22, PG 64-22, PG 67-22	820.2
Hot Mix Asphaltic Concrete Mixtures	828
Fiber Stabilizing Additives	819

When approved by the Office of Materials and Testing and required in the Contract, provide Uintaite material, hereafter referred to by the common trade name Gilsonite, as a reinforcing agent for bituminous mixtures. Supply a manufacturer’s certification that the Gilsonite is a granular solid which meets the following requirements:

Softening Point (AASHTO: T-53)	300-350 °F (150-175 °C)
Specific Gravity, 77 °F (25 °C) (AASHTO: T-228)	1.04 ± 0.02
Flash Point, COC (AASHTO: T-48)	550 °F (290 °C) Min.
Ash Content (AASHTO: T-111)	1.0% Max.
Penetration, 77 °F (25 °C), 100 gm., 5 sec. (AASHTO: T-49)	0

400.2.01 Delivery, Storage, and Handling

Storage of material is allowed in a properly sealed and insulated system for up to 24 hours. Ensure Stone Matrix Asphalt (SMA), Open-Graded Friction Course (OGFC), or Porous European Mix (PEM) mixtures are not stored more than 12 hours. Mixtures other than SMA, OGFC, or PEM may be stored up to 72 hours in a sealed and insulated system, equipped with an auxiliary inert gas system, with the Engineer's approval. Segregation, lumpiness, draindown, or stiffness of stored mixture is cause for rejection of the mixture. The Engineer will not approve using a storage or surge bin if the mixture segregates, loses excessive heat, or oxidizes during storage.

The Engineer may obtain mixture samples or recover asphalt cement according to GDT 119 or AASHTO T 324. AASHTO T 315, AASHTO T 202, or AASHTO T 49 will be used to perform viscosity and penetration tests to determine how much asphalt hardening has occurred. AASHTO T-324 will be used to perform Hamburg Wheel Tracking Device testing to determine rutting and moisture damage susceptibility.

A. Vehicles for Transporting and Delivering Mixtures

Ensure trucks used for hauling bituminous mixtures have tight, clean, smooth beds.

Follow these guidelines when preparing vehicles to transport bituminous mixtures:

1. Use an approved releasing agent from QPL 39 in the transporting vehicle beds, if necessary, to prevent the mixture from sticking to the bed. Ensure the releasing agent is not detrimental to the mixture. When applying the agent, drain the excess agent from the bed before loading. Remove from the project any transporting vehicles determined to contain unapproved releasing agents.
2. Protect the mixture with a waterproof cover large enough to extend over the sides and ends of the bed. Securely fasten the waterproof cover before the vehicle begins moving.
3. Insulate the front end and sides of each bed with an insulating material with the following specifications:
    - Consists of builders insulating board or equivalent;
    - Has a minimum "R" value of 4.0; and
    - Can withstand approximately 400 °F (200 °C) temperatures

   Install the insulating material so it is protected from loss and contamination. A "Heat Dump Body" may be used in lieu of insulation of the bed. "Heat Dump Body" refers to any approved transport vehicle capable of diverting engine exhaust and transmitting heat evenly throughout the dump body to keep asphalt at required temperature. Mark the "Heat Dump Body" clearly with "OPEN" and "CLOSE" position at the exhaust diverter. Install a padlock and lock it in the "OPEN" position when the "Heat Dump Body" is used to transport bituminous mixtures.
4. Mark each transporting vehicle with a clearly visible identification number.
5. Create a hole in each side of the bed so the temperature of the loaded mixture can be checked. Ensure the placement of these holes are located to assure the thermometer is being placed in the hot mix asphaltic concrete mixtures.

   Ensure the mixture is delivered to the roadway at a temperature within ± 20 °F (± 11 °C) of the temperature on the job mix formula.

   If the Engineer determines a truck may be hazardous to the project or adversely affect the quality of the work, remove the truck from the project.

B. Containers for Transporting, Conveying, and Storing Bituminous Material

To transport, convey, and store bituminous material, use containers free of foreign material and equipped with sample valves. Bituminous material will not be accepted from conveying vehicles if material has leaked or spilled from the containers.

400.3 Construction Requirements

400.3. 01 Personnel

General Provisions 101 through 150.

400.3.02 Equipment

Hot mix asphaltic concrete plants producing mix for Department use are governed by Quality Assurance for Hot Mix Asphaltic Concrete Plants in Georgia, Laboratory Standard Operating Procedure No. 27.

The Engineer will approve the equipment used to transport and construct hot mix asphaltic concrete. Ensure the equipment is in satisfactory mechanical condition and can function properly during production and placement operations. Place the following equipment at the plant or project site:

A. Field Laboratory

Provide a field laboratory according to Section 152.

B. Plant Equipment

1. Scales

   Provide scales as follows:

   a. Furnish (at the Contractor's expense) scales to weigh bituminous plant mixtures, regardless of the measurement method for payment.
   b. Ensure the weight measuring devices provide documentation complying with Subsection 109.01, *Measurement and Quantities*.
   c. Provide weight devices recording the mixture net weights delivered to the truck when not using platform scales. A net weight system will include, but is not limited to:
      - Hopper or batcher-type weight systems delivering asphaltic mixture directly to the truck
      - Fully automatic batching equipment with a digital recording device
   d. Use a net weight printing system only with automatic batching and mixing systems approved by the Engineer.
   e. Ensure the net weight scale mechanism or device manufacturer, installation, performance, and operation meets the requirements in Subsection 109.01, *Measurement and Quantities*
   f. Provide information on the Project tickets according to Department of Transportation SOP-15.

2. Time-Locking Devices

   Furnish batch type asphalt plants with automatic time-locking devices controlling the mixing time automatically. Construct these devices to ensure the operator cannot shorten or eliminate any portion of the mixing cycle.

3. Surge- and Storage-Systems

   Provide surge and storage bins as follows:

   a. Ensure bins for mixture storage are insulated and have a working seal, top and bottom, to prevent outside air infiltration and to maintain an inert atmosphere during storage. Bins not intended as storage bins may be used as surge bins to hold hot mixtures for part of the working day. However, empty these surge bins completely at the end of the working day.
   b. Ensure surge and storage bins can retain a predetermined minimum level of mixture in the bin when the trucks are loaded.
   c. Ensure surge and storage systems do not contribute to mix segregation, lumpiness, drain-down, or stiffness.
   d. Ensure the scale mechanism or device manufacture, installation, performance, and operation meets the requirements in Subsection 109.01 *Measurement and Quantities*.

4. Controls for Dust Collector Fines

Control dust collection as follows:

a. When collecting airborne aggregate particles and returning them to the mixture, have the return system meter all or part of the collected dust uniformly into the aggregate mixture and waste the excess. The collected dust percentage returned to the mixture is subject to the Engineer's approval.

b. When the collected dust is returned directly to the hot aggregate flow, interlock the dust feeder with the hot aggregate flow, and meter the flow to maintain a constant, proportioned and uniform flow.

5. Mineral Filler Supply System

When mineral filler is required as a mixture ingredient:

a. Use a separate bin and feed system to store and proportion the required quantity into the mixture with uniform distribution.

b. Control the feeder system with a proportioning device meeting these specifications:

- Is accurate to within ± 10 percent of the filler required
- Has a convenient and accurate means of calibration
- Interlocks with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes

c. Provide flow indicators or sensing devices for the mineral filler system and interlock them with the plant controls to interrupt the mixture production if mineral filler introduction fails to meet the required target value after no longer than 60 seconds.

d. Add mineral filler to the mixture as follows, according to the plant type:

- Batch Type Asphalt Plant: add mineral filler to the mixture in the weigh hopper.
- Continuous Plant Using Pugmill Mixers: feed the mineral filler into the hot aggregate before it is introduced into the mixer to ensure dry mixing is accomplished before the bituminous material is added.
- Continuous Plants Using the Drier-Drum Mixers: add the mineral filler to ensure dry mixing is accomplished before the bituminous material is added and ensure the filler does not become entrained into the air stream of the drier.

6. Hydrated Lime Treatment System

When hydrated lime is required as a mixture ingredient:

a. Use a separate bin and feed system to store and proportion the required quantity into the mixture.

b. Ensure the aggregate is uniformly coated with hydrated lime aggregate before adding the bituminous material to the mixture. Ensure the addition of hydrated lime will not become entrained in the exhaust system of the drier or plant.

c. Control the feeder system with a proportioning device meeting these specifications:

- Is accurate to within ± 10 percent of the amount required
- Has a convenient and accurate means of calibration
- Interlocks with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes and to ensure mixture produced is properly treated with lime

d. Provide flow indicators or sensing devices for the hydrated lime system and interlock them with the plant controls to interrupt mixture production if hydrated lime introduction fails to meet the required target value after no longer than 60 seconds.

7. Net Weight Weighing Mechanisms

Certify the accuracy of the net weight weighing mechanisms by an approved registered scale serviceperson at least once every 6 months. Check the accuracy of net weight weighing mechanisms at the beginning of Project production and thereafter as directed by the Engineer. Check mechanism accuracy as follows:

a. Weigh a load on a set of certified commercial truck scales. Ensure the difference between the printed total net weight and weight obtained from the commercial scales is no greater than 4 lbs./1,000 lbs. (4 kg/Mg) of load.

   Check the accuracy of the bitumen scales as follows:

   - Use standard test weights.
   - If the checks indicate printed weights are out of tolerance, have a registered scale serviceperson check the batch scales and certify the accuracy of the printer.
   - While the printer system is out of tolerance and before its adjustment, continue production only if using a set of certified truck scales to determine the truck weights.

b. Ensure plants using batch scales maintain ten 50 lb. (25 kg) standard test weights at the plant site to check batching scale accuracy.

c. Ensure plant scales are used only to proportion mixture ingredients, and not to determine that pay quantities, are within two percent throughout the range.

8. Fiber Supply System

When stabilizing fiber is required as a mixture ingredient:

a. Use a separate feed system to store and proportion by weight the required quantity into the mixture with uniform distribution.

b. Control the feeder system with a proportioning device meeting these specifications:

   - Is accurate to within ± 10 percent of the amount required. Automatically adjusts the feed rate to maintain the material within this tolerance at all times.
   - Has a convenient and accurate means of calibration.
   - Provide in-process monitoring, consisting of either a digital display of output or a printout of feed rate, in pounds (kg) per minute, to verify feed rate.
   - Interlocks with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes.

c. Provide flow indicators or sensing devices for the fiber system and interlock them with the plant controls to interrupt the mixture production if fiber introduction fails or if the output rate is not within the tolerances given above.

d. Introduce the fiber as follows:

   - When a batch type plant is used, add the fiber to the aggregate in the weigh hopper. Increase the batch dry mixing time by 8 to 12 seconds from the time the aggregate is completely emptied into the mixer to ensure the fibers are uniformly distributed prior to the injection of asphalt cement into the mixer.
   - When a continuous or drier-drum type plant is used, add the fiber to the aggregate and uniformly disperse prior to the injection of asphalt cement. Ensure the fibers will not become entrained in the exhaust system of the drier or plant.

9. Crumb Rubber Modifier Supply System

When specified, crumb rubber modifier may be substituted at the Contractor's discretion to produce a PG 76-22 asphaltic cement at the production facility in accordance with Section 820:

a. Use a separate feed system to store and proportion by weight of the total asphaltic cement, the required percentage of crumb rubber into the mixture.

b. Control the feeder system with a proportioning device meeting these specifications:

- Is accurate to within ± 6 percent of the amount required. Automatically adjusts the feed rate to maintain the material within this tolerance at all times.
- Has a convenient and accurate means of calibration.
- Provide in-process monitoring, consisting of either a digital display of output or a printout of feed rate, in pounds per minute, to verify feed rate. Ensure the supply system reports the feed in 1 lb. (454 gr.) increments using load cells enabling the user to monitor the depletion of the modifier. Monitoring the system volumetrically will not be allowed.
- Interlocks with the aggregate weigh system and asphaltic cement pump to maintain the correct proportions for all rates of production and batch sizes.

c. Provide flow indicators or sensing devices for the system and interlock them with the plant controls to interrupt the mixture production if the crumb rubber introduction output rate is not within the ± 6 percent tolerance given above. This interlock will immediately notify the operator if the targeted rate exceeds introduction tolerances. All plant production will cease if the introduction rate is not brought back within tolerance after 30 seconds. When the interlock system interrupts production and the plant has to be restarted, upon restarting operations; ensure the modifier system runs until a uniform feed can be observed on the output display. Ensure all mix produced prior to obtaining a uniform feed is rejected. **d.** Introduce the crumb rubber modifier as follows:

- When a batch type plant is used, add the rubber to the aggregate in the weigh hopper. Increase the batch dry mixing time by 15 to 20 seconds from the time the aggregate is completely emptied into the mixer to ensure the modifiers are uniformly distributed prior to the injection of asphalt cement into the mixer. Increase the batch wet mix time by 15 to 20 seconds to ensure the crumb rubber modifier is uniformly blended with the asphaltic cement.
- When a continuous or drier-drum type plant is used, add the rubber to the aggregate and uniformly disperse prior to the injection of asphalt cement. The point of introduction in the drum mixer will be approved by the Engineer prior to production. Ensure the crumb rubber modifier will not become entrained in the exhaust system of the drier or plant and will not be exposed to the drier flame at any point after induction.

e. No separate measurement and payment will be made if Contractor elects to utilize crumb rubber.

10. Fiber-Reinforcement Supply System

When reinforcement fiber is specified in the contract as a mixture ingredient:

Ensure, that the reinforcement fiber is an approved material and listed on QPL 97" Georgia's List of Approved Reinforcement Fiber". Use a separate Fiber Meetering Device feed system to proportion by weight of the total asphaltic cement, the required percentage of fiber-reinforcement into the mixture.

a. Control the meetering system with a proportioning device meeting these specifications:

- Is accurate to within ± 6 percent of the amount required. Automatically adjusts the feed rate to maintain the material within this tolerance at all times.
- Has a convenient and accurate means of calibration.
- Provides in-process monitoring, consisting of either a digital display of output or a printout of feed rate, in pounds, or (kg) per minute, to verify feed rate
- Interlocks with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes.

b. Provide flow indicators or sensing devices for the fiber system and interlock them with the plant controls to interrupt the mixture production if fiber introduction fails or if the output rate is not within the tolerances given above.

c. Introduce the fiber as follows:

- When a batch type plant is used, add the fiber dossage to the aggregate in the weigh hopper. This may be done with loose fibers and a Fiber Meetering Device or may be done by using premeasured packages that are specifically designed to disintegrate within the mixing cycle. Increase the batch dry mixing time by 8 to 12 seconds from the time the aggregate is completely emptied into the mixer to ensure the fibers are uniformly distributed prior to the injection of asphalt cement into the mixer.
- When a continuous or drier-drum type plant is used, add the fiber to the aggregate or RAP material at the beginning of the mixing cycle and uniformly disperse prior to the injection of asphalt cement. The final configuration of the fibers at the point when mixing begins, should closely resemble the fibers as they are packaged. Pre-distributing the fibers into their individual form should be avoided. Ensure the fibers will not become entrained in the exhaust system of the drier or plant. The producer should inspect their plant for any protrusions that may accumulate fibers and create the potential for fiber clumps.
- When a continuous or drier-drum type plant is used for limited production volumes, the addition of the fibers may be done by using pre-measured packages that are specifically designed to disintegrate within the mixing cycle and adding them directly into the RAP port of the plant. Because this is not an automated process, a written protocol must be supplied by the producer to demonstrate how they will attain the dossage requirement, and documentation must be supplied by the material manufacturer assuring this method will produce the desired random fiber distribution.

C. Equipment at Project Site

1. Cleaning Equipment

   Provide sufficient hand tools and power equipment to clean the roadway surface before placing the bituminous tack coat. Use power equipment complying with Subsection 424.3.02.F, *Power Broom and Power Blower*.

2. Pressure Distributor

   To apply the bituminous tack coat, use a pressure distributor complying with Subsection 424.3.02.B, *Pressure Distributor*.

3. Bituminous Pavers

   To place hot mix asphaltic concrete, use bituminous pavers that can spread and finish courses that are:

   - As wide and deep as indicated on the plans
   - True to line, grade, and cross section
   - Smooth
   - Uniform in density and texture

   a. Continuous Line and Grade Reference Control. Furnish, place, and maintain the supports, wires, devices, and materials required to provide continuous line and grade reference control to the automatic paver control system.

   b. Automatic Screed Control System. Equip the bituminous pavers with an automatic screed control system actuated from sensor-directed mechanisms or devices that will maintain the paver screed at a predetermined transverse slope and elevation to obtain the required surface.

   c. Transverse Slope Controller. Use a transverse slope controller capable of maintaining the screed at the desired slope within ± 0.1 percent. Do not use continuous paving set-ups resulting in unbalanced screed widths or off-center breaks in the main screed cross section unless approved by the Engineer.

   d. Screed Control. Equip the paver to permit the following four modes of screed control. Ensure the method used is approved by the Engineer.

      - Automatic grade sensing and slope control
      - Automatic dual grade sensing

- Combination automatic and manual control
- Total manual control

Ensure the controls are referenced with a taut string or wire set to grade, or with a ski-type device or mobile reference at least 30 ft. (9 m) long when using a conventional ski. Approved non-contacting laser or sonar-type skis listed on QPL 91 "Georgia's List of Approved Non-contacting Laser and Sonar-type Electronic Grade and Slope Controls" may be used in lieu of conventional 30 ft. (9 m) skis. Under limited conditions, a short ski or shoe may be substituted for a long ski on the second paver operating in tandem, or when the reference plane is a newly placed adjacent lane.

Automatic screed control is required on all projects; however, when the Engineer determines that project conditions prohibit the use of such controls, the Engineer may waive the grade control, or slope control requirements, or both.

e. Paver Screed Extension. When the laydown width requires a paver screed extension, use bolt-on screed extensions to extend the screeds, or use an approved mechanical screed extension device. When the screed is extended, add auger extensions to assure a length of no more than 18 in. (0.5 m) from the auger to the end gate of the paver. Auger extensions may be omitted when paving variable widths. Ensure the paver is equipped with tunnel extensions when the screed and augers are extended.

NOTE: Do not use extendible strike-off devices instead of approved screed extensions. Only use a strike-off device in areas that would normally be luted in by hand labor.

4. Compaction Equipment

Ensure that the compaction equipment is in good mechanical condition and can compact the mixture to the required density. The compaction equipment number, type, size, operation, and condition is subject to the Engineer's approval

5. Materials Transfer Vehicle (MTV)

a. Use a Materials Transfer Vehicle (MTV) when placing asphaltic concrete mixtures on projects on the state route system with the following conditions. If a project fails to meet any one of the following conditions, the MTV's use is not required other than during the placement of SMA, PEM and OGFC mixtures. MTVs are required during the placement of SMA, PEM and OGFC mixtures regardless of ADT, project length and mixture tonnage unless waived at the discretion of the Office of Materials and Testing.

1) When to use:

- The two-way ADT is equal to or greater than 6000
- The project length is equal to or greater than 3000 linear feet (915 linear meters)
- The total tonnage (megagrams) of all asphaltic concrete mixtures is greater than 2000 tons (1815 Mg)

2) Where to use:

- Mainline of the traveled way
- Collector/distributor (C/D) lanes on Interstates and limited access roadways
- Leveling courses at the Engineer's discretion **3)** Do not use the MTV for the following conditions:
- A resurfacing project that only 9.5 mm mix is required.
- A project with lane width that is equal or less than 11 ft. (3.4 m).
- A passing lane only project.
- When noted on the plans.

b. Ensure the MTV and conventional paving equipment meet the following requirements:

1) MTV

- Has a truck unloading system which receives mixture from the hauling equipment and independently deliver mixtures from the hauling equipment to the paving equipment.

- Has mixture remixing capability approved by the Office of Materials and Testing and is listed on QPL 88 "Georgia's List of Approved Materials Transfer Vehicles".
- Provides to the paver a homogeneous, non-segregated mixture of uniform temperature with no more than 20 °F (11 °C) difference between the highest and lowest temperatures when measured transversely across the width of the mat in a straight line at a distance of one foot to twenty-five feet (0.3 m to 7.6 m) from the screed while the paver is operating. Ensure that the MTV is capable of providing the paver a consistent material flow that is sufficient to prevent the paver from stopping between truck exchanges.

2) Conventional Paving Equipment

- Has a paver hopper insert with a minimum capacity of 14 tons (13 Mg) installed in the hopper of conventional paving equipment when an MTV is used.

c. If the MTV malfunctions during spreading operations, discontinue placement of hot mix asphaltic concrete after there is sufficient mix placed to maintain traffic in a safe manner. However, placement of hot mix asphaltic concrete in a lift not exceeding 2 in. (50 mm) may continue until any additional hot mix in transit at the time of the malfunction has been placed. Cease spreading operations thereafter until the MTV is operational.

d. Ensure the MTV is empty when crossing a bridge and is moved across without any other Contractor vehicles or equipment on the bridge. Move the MTV across a bridge in a travel lane and not on the shoulder. Ensure the speed of the MTV is no greater than 5 mph (8 kph) without any acceleration or deceleration while crossing a bridge.

400.3.03 Preparation

A. Prepare Existing Surface

Prepare the existing surface as follows:

1. Clean the Existing Surface. Before applying hot mix asphaltic concrete pavement, clean the existing surface to the Engineer's satisfaction.

2. Patch and Repair Minor Defects

Before placing leveling course:

a. Correct potholes and broken areas requiring patching in the existing surface and base as directed by the Engineer.

b. Cut out, trim to vertical sides, and remove loose material from the areas to be patched.

c. Prime or tack coat the area after being cleaned. Compact patches to the Engineer's satisfaction. Material for patches does not require a job mix formula but must meet the gradation range shown in Section 828. The Engineer must approve the asphalt content to be used.

3. Apply Bituminous Tack Coat

Apply the tack coat according to Section 413. The Engineer will determine the application rate, which must be within the limitations in Tables 2A and 2B.

TABLE 2A—APPLICATION RATES FOR BITUMINOUS TACK, GAL/YD² (L/M²)

Tack Uses	Minimum	Maximum
Under OGFC and PEM Mixes	0.06 (0.27)	0.08 (0.36)
All Other Mixes	0.04 (0.18)	0.06 (0.27)

Non-tracking Hot Applied Polymer Modified Tack (NTHAPT) (Note 2)	0.06 (0.27)	0.18 (0.81)
Note 1: On thin leveling courses and freshly placed asphaltic concrete mixes, reduce the application rate to 0.02 to 0.04 gal/yd² (0.09 to 0.18 L/m²). **Note 2: Use higher application rate (0.12 to 0.18) within the minimum and maximum range under OGFC and PEM Mixes**		

TABLE 2B – APPLICATION RATES FOR ANIONIC EMULSIFIED ASPHALT OR CATIONIC EMULSIFIED ASPHALT BITUMINUS TACK, GAL/YD² (L/M²)

Tack-Uses	Minimum	Maximum
New Asphaltic Concrete Pavement to New Asphaltic Concrete Pavement or Thin Lift Leveling	0.05 (0.23)	0.08 (0.36)
New Asphaltic Concrete Pavement (≤ 25% RAP) to Aged Existing Pavement or Milled Surface	0.06 (0.27)	0.10 (0.45)
New Asphaltic Concrete Pavement (> 25% RAP) to Aged Existing Pavement or Milled Surface	0.08 (0.36)	0.12 (0.54)
Non-tracking Emulsified Asphalt	0.07 (0.32)	0.12 (0.54)
CQS-Special Modified Asphalt Emulsion (Note 1)	0.12 (0.54)	0.28 (1.27)
• Allow standard anionic emulsified asphalt or cationic emulsified asphalt to break per emulsion manufacturer's recommendation. Proceed with paving only after the anionic emulsified asphalt or cationic emulsified asphalt has cured to the satisfaction of the Engineer. • Do not use anionic emulsified asphalt or cationic emulsified asphalt, other than CQS-Special Modified Asphalt Emulsion in conjunction with a spray paver, under OGFC or PEM on interstates or limited access state routes.		

Note 1: Use higher application rate (0.22 to 0.28) within the minimum and maximum under OGFC and PEM Mixes

B. Place Patching and Leveling Course

1. When the existing surface is irregular, bring the surface area to the proper cross section and grade with a leveling course of hot mix asphaltic concrete materials.

2. Place leveling at the locations and in the amounts directed by the Engineer.
3. Use leveling course mixtures meeting the requirements of the job mix formulas defined in:
   - Subsection 400.3.05.A, *Observe Composition of Mixtures*
   - Section 828
   - Leveling acceptance schedules in
     Subsection 400.3.06.A, *Acceptance Plans for Gradation and Asphalt Cement Content*
4. If the leveling and patching mix type is undesignated, determine the mix type by the thickness or spread rate according to Table 3, but do not use 4.75 mm mix on interstate projects.
5. If patching is required to correct mat deficiencies in the final surface layer, ensure patches extend full lane width and no less than the length of the affected area as determined by the Engineer.

TABLE 3—LEVELING AND PATCHING MIX TYPES

Thickness	Rate of Spread	Type of Mix
Up to 0.75 in. (19 mm)	Up to 85 lbs./yd² (46 kg/m²)	4.75 mm Mix or 9.5 mm Superpave Type 1
0.75 to 1.5 in. (19 to 38 mm)	85 to 165 lbs./yd²(46 to 90 kg/m²)	9.5 mm Superpave Type 2
1.5 to 2 in. (38 to 50 mm)	165 to 220 lbs./yd² (90 to 120 kg/m²)	12.5 mm Superpave *
2 to 3 in. (50 to 75 mm)	220 to 330 lbs./yd² (120 to 180 kg/m²)	19 mm Superpave **
Over 2.5 in. (64 mm)	Over 275 lbs./yd² (180 kg/m²)	25 mm Superpave

* This mixture may be used for isolated patches no more than 6 in. (150 mm) deep and no more than 4 ft. (1.2 m) in diameter or length.

** This mixture may be used for patching no more than 4 in. (100 mm) deep in limited confined deep mill and patching locations.

400.3.04 Fabrication

General Provisions 101 through 150.

400.3.05 Construction

Provide the Engineer at least one day’s notice prior to beginning construction, or prior to resuming production if operations have been temporarily suspended.

A. Observe Composition of Mixtures

1. Calibration of plant equipment

   If the material changes, or if a component affecting the ingredient proportions has been repaired, replaced, or adjusted, check and recalibrate the proportions.

   Calibrate as follows:

   a. Before producing mixture for the Project, calibrate by scale weight the electronic sensors or settings for proportioning mixture ingredients.
   b. Calibrate ingredient proportioning for all rates of production.

2. Mixture control

Compose hot mix asphaltic concrete from a uniform mixture of aggregates, bituminous material, and if required, hydrated lime, mineral filler, or other approved additive.

Ensure the constituents proportional to produce mixtures meeting the requirements in Section 828. The general composition limits prescribed are extreme ranges within which the job mix formula must be established. Base mixtures on a design analysis that meets the requirements of Section 828.

Ensure the field performance of the in-place mixtures meet the requirements of Subsection 828.2B for Permeability, Moisture Susceptibility, Rutting Susceptibility and Fatigue. In-place mix may be evaluated for compliance with Subsection 828.2.B at the discretion of the State Bituminous Construction Engineer under the following conditions:

- Deviates greater than 10 percent on gradation for mixture control sieves from the approved Job Mix Formula based on Acceptance or Independent Samples.
- Deviates greater than 0.7 percent in asphalt cement content from the approved Job Mix Formula based on Acceptance or Independent Samples.
- The calculated mean pavement air voids result in an adjusted pay factor less than 0.80 or any single sub lot result in mean pavement air voids exceeding 10.5 percent.
- Mix produced not using an approved mix design and/or job mix formula.

Remove and replace any material determined to not meet the requirements established in Section 828.2.B at the Contractor's expense.

If control test results show the characteristic tested does not conform to the job mix formula control tolerances given in Section 828, take immediate action to ensure that the quality control methods are effective.

Control the materials to ensure extreme variations do not occur. Maintain the gradation within the composition limits in Section 828.

B. Prepare Bituminous Material

Uniformly heat the bituminous material to the temperature specified in the job mix formula with a tolerance of ± 20 °F (± 11 °C).

C. Prepare the Aggregate

Prepare the aggregate as follows:

1. Heat the aggregate for the mixture and ensure a mix temperature within the limits of the job mix formula.
2. Do not contaminate the aggregate with fuel during heating.
3. Reduce the absorbed moisture in the aggregate until the asphalt does not separate from the aggregate in the prepared mixture. If this problem occurs, the Engineer will establish a maximum limit for moisture content in the aggregates. When this limit is established, maintain the moisture content below this limit.

D. Prepare the Mixture

Proportion the mixture ingredients as necessary to meet the required job mix formula. Mix until a homogenous mixture is produced.

1. Add Mineral Filler

   When mineral filler is used, introduce it in the proper proportions and as specified in Subsection 400.3.02.B.5, *Mineral Filler Supply System*.

2. Add Hydrated Lime

   When hydrated lime is included in the mixture, add it at a rate specified in Section 828 and the job mix formula. Use methods and equipment for adding hydrated lime according to Subsection 400.3.02.B.6, *Hydrated Lime Treatment System*.

Add hydrated lime to the aggregate by using Method A or B as follows:

Method A—Dry Form—Add hydrated lime in its dry form to the mixture as follows, according to the type of plant:

a. Batch Type Asphalt Plant: Add hydrated lime to the mixture in the weigh hopper or as approved and directed by the Engineer.

b. Continuous Plant Using Pugmill Mixer: Feed hydrated lime into the hot aggregate before it is introduced into the mixer to ensure dry mixing is complete before the bituminous material is added.

Method B—Lime/Water Slurry—Add the required quantity of hydrated lime (based on dry weight) in lime/water slurry form to the aggregate. This solution consists of lime and water in concentrations as directed by the Engineer.

Equip the plant to blend and maintain the hydrated lime in suspension and to mix the hydrated lime with the aggregates uniformly in the proportions specified.

c. Continuous Plant Using Drier-Drum Mixer: Add hydrated lime so to ensure the lime will not become entrained into the air stream of the drier and to ensure thorough dry mixing will be complete before the bituminous material is added.

3. Add Stabilizing Fiber

When stabilizing fiber is included in the mixture, add stabilizing fiber at a rate specified in Section 819 and the Job Mix Formula. Introduce it as specified in Subsection 400.3.02.B.8, *Fiber Supply System*.

4. Add Gilsonite Modifier

When approved by the Office of Materials and Testing and required by the Contract, add the Gilsonite modifier to the mixture at a rate to ensure eight percent by weight of the asphalt cement is replaced by Gilsonite. Use either PG 64-22 or PG 67-22 asphalt cement as specified in Subsection 820.2.01. Provide suitable means to calibrate and check the rate of Gilsonite being added. Introduce Gilsonite modifier by either of the following methods.

a. For batch type plants, incorporate Gilsonite into the pugmill at the beginning of the dry mixing cycle. Increase the dry mix cycle by a minimum of 10 seconds after the Gilsonite is added and prior to introduction of the asphalt cement. For this method, supply Gilsonite in plastic bags to protect the material during shipment and handling and store the modifier in a waterproof environment. Ensure the bags are capable of being completely melted and uniformly blended into the combined mixture.

Gilsonite may also be added through a mineral filler supply system as described in Subsection 400.3.02.B.5, *Mineral Filler Supply System*. Ensure the system is capable of injecting the modifier into the weigh hopper near the center of the aggregate batching cycle so the material can be accurately weighed.

b. For drier-drum plants, add Gilsonite through the recycle ring or through an acceptable means which will introduce the Gilsonite prior to the asphalt cement injection point. The modifier must proportionately feed into the drum mixer at the required rate by a proportioning device which shall be accurate within ± 10 percent of the amount required. Ensure the entry point is away from flames and the Gilsonite will not be caught up in the air stream and exhaust system.

5. Materials from Different Sources

Do not use mixtures prepared from aggregates from different sources intermittently. This will cause the color of the finished pavement to vary.

E. Observe Weather Limitations

Do not mix and place asphaltic concrete if the existing surface is wet or frozen. Do not lay asphaltic concrete OGFC mix or PEM at air temperatures below 60 ºF (16 ºC). When using a MTV, OGFC mix or PEM may be placed at 55 ºF (13 ºC) when approved by the Engineer. For other courses, follow the temperature guidelines in the following table:

TABLE 4—LIFT THICKNESS TABLE

Lift Thickness	Minimum Temperature
1 in. (25 mm) or less	55 °F (13 °C)
1.1 to 2 in. (26 mm to 50 mm)	45 °F (8 °C)
2.1 to 3 in. (51 mm to 75 mm)	40 °F (4 °C)
3.1 to 4 in. (76 mm to 100 mm)	35 °F (2 °C)
4.1 to 8 in. (101 mm to 200 mm)	32 °F (0 °C) and rising. Base material must not be frozen.

F. Perform Spreading and Finishing

Spread and finish the course as follows:
Determine the maximum compacted layer thickness by the type mix being used according to Table 5.

TABLE 5—MIX TYPE MINIMUM, MAXIMUM LAYER AND TOTAL THICKNESS

Mix Type	Minimum Layer Thickness	Maximum Layer Thickness	Maximum Total Thickness
25 mm Superpave	2 1/2 in. (64 mm)	5 in. (125 mm) *	—
19 mm Superpave	1 3/4 in. (44 mm)	3 in. (75 mm) *	—
12.5 mm Superpave	1 3/8 in. (35 mm)	2 1/2 in. (64 mm)**/***	8 in. (200 mm)
9.5 mm Superpave Type 2	1 1/8 in. (29 mm)	1 1/2 in. (38 mm)***	4 in. (100 mm)
9.5 mm Superpave Type 1	7/8 in. (22 mm)	1 1/4 in. (32 mm)	4 in. (100 mm)
4.75 mm Mix	3/4 in. (19 mm)	1 1/8 in. (29 mm)	2 in. (50 mm)
9.5 mm OGFC	75 lbs./yd² (41 kg/m²)	95 lbs./yd² (51 kg/m²)	—
12.5 mm OGFC	85 lbs./yd² (46 kg/m²)	110 lbs./yd² (60 kg/m²)	—
12.5 mm PEM	110 lbs./yd² (60 kg/m²)	165 lbs./yd² (90 kg/m²)	—
9.5 mm SMA	1 1/8 in. (29 mm)	1 1/2 in. (38 mm)	4 in. (100 mm)
12.5 mm SMA	1 3/8 in. (35 mm)	3 in. (75 mm)	6 in. (150 mm)
19 mm SMA	1 3/4 in. (44 mm)	3 in. (75 mm)	—

* Allow up to 6 in. (150 mm) per lift on trench widening. **Allow up to 4 in. (100 mm) per lift on trench widening of ≤ 2 ft. when no overlay is required. ***Place 9.5 mm Superpave and 12.5 mm Superpave up to 4 in. (100 mm) thick for driveway and side road transition.

1. Unload the mixture into the paver hopper or into a device designed to receive the mixture from delivery vehicles.
2. Except for leveling courses, spread the mixture to the loose depth for the compacted thickness or the spread rate. Use a mechanical spreader true to the line, grade, and cross section specified.
3. For leveling courses, use a motor grader equipped with a spreader box and smooth tires to spread the material or use a mechanical spreader meeting the requirements in Subsection 400.3.02.C, *Equipment at Project Site*.
4. Obtain the Engineer's approval for the sequence of paving operations, including paving the adjoining lanes.

   Minimize tracking tack onto surrounding surfaces.
5. Ensure the outside edges of the pavement being laid are aligned and parallel to the roadway center line.
6. For New Construction or Resurfacing Contracts containing multiple lifts or courses, arrange the width of the individual lifts so the longitudinal joints of each successive lift are offset from the previous lift at least 1 ft. (300 mm). This requirement does not apply to the lift immediately over thin lift leveling courses.
7. Ensure the longitudinal joint(s) in the surface course and the mix immediately underneath asphaltic concrete OGFC or PEM are at the lane line(s).

NOTE: Perform night work with artificial light provided by the Contractor and approved by the Engineer.

8. Where mechanical equipment cannot be used, spread and rake the mixture by hand. Obtain the Engineer's approval of the operation sequence, including compactive methods, in these areas.
9. Keep small hand raking tools clean and free from asphalt build up. Do not use fuel oil or other harmful solvents to clean tools during the work.
10. Do not use mixture with any of these characteristics:
    - Segregated
    - Nonconforming temperature
    - Deficient or excessive asphalt cement content
    - Otherwise unsuitable to place on the roadway in the work
11. Remove and replace mixture placed on the roadway that the Engineer determines has unacceptable blemish levels from segregation, raveling, streaking, pulling and tearing, or other deficient characteristics. Replace with acceptable mixture at the Contractor's expense. Do not continually place mixtures with deficiencies.

    Do not place subsequent course lifts over another lift or course while the temperature of the previously placed mix is 140 °F (60 °C) or greater.
12. Obtain the Engineer's approval of the material compaction equipment. Perform the rolling as follows:
    a. Begin the rolling as close behind the spreader as possible without causing excessive distortion of the asphaltic concrete surface.
    b. Continue rolling until roller marks are no longer visible.
    c. Use pneumatic-tired rollers with breakdown rollers on all courses except asphaltic concrete OGFC, PEM and SMA or other mixes designated by the Engineer.
13. If applicable, taper or "feather" asphaltic concrete from full depth to a depth no greater than 0.5 in. (13 mm) along curbs, gutters, raised pavement edges, and areas where drainage characteristics of the road must be retained. The Engineer will determine the location and extent of tapering.

G. Maintain Continuity of Operations

Coordinate plant production, transportation, and paving operations to maintain a continuous operation. If the spreading operations are interrupted, construct a transverse joint if the mixture immediately behind the paver screed cools to less than 250 ºF (120 ºC).

H. Construct the Joints

1. Construct Transverse Joints
   - a. Construct transverse joints to facilitate full depth exposure of the course before resuming placement of the affected course.
   - b. Properly clean and tack the vertical face of the transverse joint before placing additional material.

NOTE: Never burn or heat the joint by applying fuel oil or other volatile materials.

   - c. Straightedge transverse joints immediately after forming the joint.
   - d. Immediately correct any irregularity that exceeds 3/16 in. in 10 ft. (5 mm in 3 m).
2. Construct Longitudinal Joints

   Clean and tack the vertical face of the longitudinal joint before placing adjoining material. Construct longitudinal joints so that the joint is smooth, well-sealed, and bonded.
3. Construction Joint Detail for OGFC and PEM Mixtures

   In addition to meeting joint requirements described above, construct joints and transition areas for 12.5 mm OGFC and 12.5 mm PEM mixtures as follows:
   - a. For projects which do not have milling included as a pay item:
     - 1) Place OGFC mixture meeting gradation requirements of 9.5 mm OGFC as specified in Section 828 on entrance and exit ramp gore areas and end of project construction joints.
       - Taper mixture from 3/8 in. (10 mm) at end of project to full plan depth within maximum distance of spread for one load of mixture.
       - Taper mixture placed on gore areas from thickness of the edge of the mainline to 3/8 in. (10 mm) at the point of the ramp transverse joint.
     - 2) Construct the ramp transverse joint at the point specified in the plans or as directed by the Engineer.
     - 3) Mixture placed in the transition and gore areas will be paid for at the contract unit price for 12.5 mm OGFC or 12.5 mm PEM, as applicable.
   - b. For projects which have milling included as a pay item:
     - 1) Taper milling for a distance of no less than 50 ft. (15 m) to a depth of 2 1/4 in. (59 mm) at the point of the transverse joint.
     - 2) Taper thickness, if needed, of the dense-graded surface mix within the 50 ft. (15 m) distance to 1 1/2 in. (40 mm) at the point of the transverse joint.
     - 3) Taper thickness of the 12.5 mm OGFC or 12.5 mm PEM to 3/4 in. (19 mm) to ensure the material ties in at grade level with the existing surface at the point of the transverse joint

I. Protect the Pavement

Protect sections of the newly finished pavement from traffic until the traffic will not mar the surface or alter the surface texture. If directed by the Engineer, use artificial methods to cool the newly finished pavement to open the pavement to traffic more quickly.

J. Modify the Job Mix Formula

If the Engineer determines that undesirable mixture or mat characteristics are being obtained, the job mix formula may require immediate adjustment.

400.3.06 Quality Acceptance

A. Acceptance Plans for Gradation and Asphalt Cement Content

The Contractor will randomly sample and test mixtures for acceptance on a lot basis. The Department will monitor the Contractor testing program and perform comparison and quality assurance testing. The Contractor's Quality Control Technicians shall participate in the Department's Independent Assurance Systems Basis Program.

1. Determine Lot Amount

   A lot consists of the tons (megagrams) of asphaltic concrete produced and placed each production day. If this production is less than 500 tons (500 Mg), or its square yard (meter) equivalent, production may be incorporated into the next working day. The Engineer may terminate a lot when a pay adjustment is imminent if a plant or materials adjustment resulting in a probable correction has been made. Terminate all open lots at the end of the month, except for materials produced and placed during the adjustment period. The lot will be terminated as described in Subsection 400.5.01, *Adjustments*.

   If the final day's production does not constitute a lot, the production may be included in the lot for the previous day's run; or, the Engineer may treat the production as a separate lot with a corresponding lower number of tests.

2. Determine Lot Acceptance

   Determine lot acceptance as found in Subsection 400.5.01, *Adjustments*.

   The Department will perform the following task:

   Determine the pay factor by using the mean of the deviations from the job mix formula of the tests in each lot and apply it to Table 10 Mixture Acceptance Schedule for Surface Mixes or Table 11 Mixture Acceptance Schedule for Subsurface Mixes, whichever is appropriate. This mean will be determined by averaging the actual numeric value of the individual deviations from the job mix formula, disregarding whether the deviations are positive or negative amounts. Do not calculate lot acceptance using test results for materials not used in the Work. Determine the pay factor for each lot by multiplying the contract unit price by the appropriate pay factor from the Mixture Acceptance Schedule - Table 10 or Table 11. When two or more pay factors for a specific lot are less than 1.0, determine the adjusted payment by multiplying the contract unit price by the lowest pay factor.

   If the mean of the deviations from the job mix formula of the lot acceptance tests for a control sieve or for asphalt cement content exceeds the tolerances established in the appropriate Mixture Acceptance Schedule, and if the Engineer determines that the material need not be removed and replaced, the lot may be accepted at an adjusted unit price as determined by the Engineer. If the Engineer determines that the material is not acceptable to leave in place, the materials shall be removed and replaced at the Contractor's expense.

3. Provide Quality Control Program

   Provide a Quality Control Program as established in SOP 27 which includes:

   - Assignment of quality control responsibilities to specifically named individuals who have been certified by the Office of Materials and Testing
   - Provisions for prompt implementation of control and corrective measures
   - Provisions for communication with Project Manager, Bituminous Technical Services Engineer, and Testing Management Operations Supervisor at all times
   - Provisions for reporting all test results daily through the Office of Materials and Testing computerized Field Data Collection System, AASHTO Trns*port SiteManager, or approved computerized application; other checks, calibrations and records will be reported on a form developed by the Contractor and will be included as part of the project records
   - Notification in writing of any change in quality control personnel

a. Certification Requirements:

- Use laboratory and testing equipment certified by the Department. (Laboratories which participate in and maintain AASHTO accreditation for testing asphaltic concrete mixtures will be acceptable in lieu of Departmental certification.)
- Provide certified quality control personnel to perform the sampling and testing. A Quality Control Technician (QCT) may be certified at three levels:

1) Temporary Certification – must be a technician trainee who shall be given direct oversight by a certified Level 1 or Level 2 QCT while performing acceptance testing duties during the first 5 days of training. The trainee must complete qualification requirements within 30 Georgia Department of Transportation funded production days after being granted temporary certification. A trainee who does not become qualified within 30 Georgia Department of Transportation funded production days will not be re-eligible for temporary certification. A certified Level 1 or Level 2 QCT shall be at the plant at all times during production and shipment of mixture to monitor work of the temporarily certified technician.

2) Level 1 – must demonstrate they are competent in performing the process control and acceptance tests and procedures related to hot mix asphalt production and successfully pass a written exam.

3) Level 2 – must meet Level 1 requirements and must be capable of and responsible for making process control adjustments, and successfully pass a written exam.

- Technician certification is valid for 3 years from the date on the technician's certificate unless revoked or suspended. Eligible technicians may become certified through special training and testing approved by the Office of Materials and Testing. Technicians who lose their certification due to falsification of test data will not be eligible for recertification in the future unless approved by the State Materials and Testing Engineer.

b. Quality Control Management

1) Designate at least one Level 2 QCT as manager of the quality control operation. Ensure the Quality Control Manager meets the following requirements:

- Be accountable for actions of other QCT personnel.
- Ensure all applicable sampling requirements and frequencies, test procedures, and Standard Operating Procedures are followed.
- Ensure all reports, charts, and other documentation are completed as required

2) Provide QCT personnel at the plant as follows:

- If daily production for all mix types is to be greater than 250 tons (megagrams), have a QCT person at the plant at all times during production and shipment of mixture until all required acceptance tests have been completed.
- If daily production for all mix types will not be greater than 250 tons (megagrams), a QCT may be responsible for conducting tests at up to two plants, subject to random number sample selection.
- Have available at the plant, or within immediate contact by phone or radio, a Level 2 QCT responsible for making prompt process control adjustments as necessary to correct the mix.

3) Sampling, Testing, and Inspection Requirements.

a. Provide all sample containers, extractants, forms, diaries, and other supplies subject to approval of the Engineer.

b. Perform daily sampling, testing, and inspection of mixture production that meet the following requirements:

1) Randomly sample mixtures according to GSP 15 and GDT 73 (Method C) and test on a lot basis. In the event less than the specified number of samples are taken, obtain representative 6 in. (150 mm) cores from the roadway at a location where the load not sampled was placed. Take enough cores to ensure minimum sample size requirements are met for each sample needed.

2) Maintain a printed copy of the computer-generated random sampling data as a part of the project records.

3) Perform sampling, testing, and inspection duties of GSP 21.

4) Perform extraction or ignition test (GDT 83 or GDT 125) and extraction analysis (GDT 38). If the ignition oven is used, a printout of sample data including weights becomes a part of the project records. For asphalt cement content only, digital printouts of liquid asphalt cement weights may be substituted in lieu of an extraction test for plants with digital recorders. Calculate the asphalt content from the ticket representing the mixture tested for gradation.

5) Save extracted aggregate, opposite quarters, and remaining material (for possible referee testing) of each sample as follows:

- Store in properly labeled, suitable containers.
- Secure in a protected environment.
- Store for three working days. If not obtained by the Department within three days, they may be discarded in accordance with GSP 21.

6) Add the following information on load tickets from which a sample or temperature check is taken:

- Mixture temperature
- Signature of the QCT person performing the testing

7) Calibrate the lime system when hydrated lime is included in the mixture: •

Perform a minimum of twice weekly during production

- Post results at the plant for review.
- Provide records of materials invoices upon request (including asphalt cement, aggregate, hydrated lime, etc.).

8) Take action if acceptance test results are outside Mixture Control Tolerances of Section 828.

- One sample out of tolerance
  - a. Contact Level 2 - QCT to determine if a plant adjustment is needed.
  - b. Immediately run a process control sample. Make immediate plant adjustments if this sample is also out of tolerance.
  - c. Test additional process control samples as needed to ensure corrective action taken appropriately controls the mixture.
- Two consecutive acceptance samples of the same mix type out of tolerance regardless of Lot or mix design level, or three consecutive acceptance samples out of tolerance regardless of mix type.
  - a. Stop plant production immediately.
  - b. Reject any mixture in storage:
    - Deviating more than 10 percent in gradation from the job mix formula based on the acceptance sample.
    - Deviating more than 0.7 percent in asphalt content from the job mix formula based on the acceptance sample.
  - c. Make a plant correction to any mix type out of tolerance prior to resuming production.
    - Do not send any mixture to the project before test results of a process control sample meets Mixture Control Tolerances.

- Reject any mixture produced at initial restarting that does not meet Mixture Control Tolerances.

NOTE: Determine mixture temperature at least once per hour of production for OGFC and PEM mixes.

4) Comparison Testing and Quality Assurance Program

a. Periodic comparison testing by the Department will be required of each QCT to monitor consistency of equipment and test procedures. The Department will take independent samples to monitor the Contractor's quality control program.

1) Comparison Sampling and Testing

Retain samples for comparison testing and referee testing if needed as described in Subsection 400.3.06.A.3.b.3. Discard these samples only if the Contractor's acceptance test results meet a 1.00 pay factor and the Department does not procure the samples within three working days.

The Department will test comparison samples on a random basis. Results will be compared to the respective contractor acceptance tests, and the maximum difference is as follows:

TABLE 6—ALLOWABLE PERCENT DIFFERENCE BETWEEN DEPARTMENT AND CONTRACTOR ACCEPTANCE TESTS

Sieve Size	Surface	Sub-surface
1/2 in. (12.5 mm)		4.0%
3/8 in. (9.5 mm)	3.5%	4.0%
No. 4 (4.75 mm)	3.5%	3.5%
No. 8 (2.36 mm)	2.5%	3.0%
No. 200 (75 µm)	2.0%	2.0%
A.C.	0.4%	0.5%

1) If test comparisons are within these tolerances:

- Continue production
- Use the Contractor's tests for acceptance of the lot **2)** If test comparisons are not within these tolerances:
- Another Departmental technician will test the corresponding referee sample.
- Results of the referee sample will be compared to the respective contractor and Departmental tests using the tolerance for comparison samples given above.

a. If referee test results are within the above tolerances when compared to the Contractor acceptance test, use the Contractor's test for acceptance of the effected lot.

b. If referee test results are not within the above tolerances when compared to the Contractor acceptance test, the Department will review the Contractor's quality control methods and determine if a thorough investigation is needed.

b. Independent Verification Sampling and Testing

1) Randomly take a minimum of two independent samples from the lesser of five days or five lots of production regardless of mix type or number of projects.

2) Compare test deviation from job mix formula to Mixture Control Tolerances in Section 828. If results are outside these tolerances, another sample from the respective mix may be taken.

If test results of the additional sample are not within Mixture Control Tolerances, the Department will take the following action:

- Take random samples from throughout the subject lot(s) as established in Subsection 400.3.06.A.3.b.3 and use these test results for acceptance and in calculations for the monthly plant rating. Applicable pay factors will apply and the contractor QCT test results will not be included in pay factor calculations nor in the monthly plant rating.
- Determine if the Contractor's quality control program is satisfactory and require prompt corrective action by the Contractor if specification requirements are not being met.
- Determine if the QCT has not followed Departmental procedures or has provided erroneous information.
- Take samples of any in-place mixture represented by unacceptable QCT tests and use the additional sample results for acceptance and in calculations for the monthly plant rating and apply applicable pay factors. The Contractor QCT tests will not be included in the pay factor calculations nor in the monthly plant rating.

NOTE: For leveling or dense graded surface courses less than 110 lb./yd² (60 kg/m²) having quality assurance test results outside the Mixture Control Tolerances of Section 828, use the Department's test results only and applicable pay factors will apply.

B. Compaction

Determine the mixture compaction using either GDT 39, GDT 59, or AASHTO T 331. The method of GDT 39 for "Uncoated Specimens, Dense Graded Mixtures Only" shall not apply when the water absorption of a sample exceeds 2.0 percent, as measured according to AASHTO T 166. In this case, either AASHTO T 331 or the paraffin method of GDT 39 shall apply. The compaction is accepted in lots defined in Subsection 400.3.06. A, *Acceptance Plans for Gradation and Asphalt Cement Content* and is within the same lot boundaries as the mixture acceptance.

1. Calculate Pavement Mean Air Voids

The Department is responsible for pavement mean air void acceptance testing. The Contractor is responsible for establishing all roller patterns and any quality control testing. Upon written request by the Contractor, the Office of Materials and Testing will provide nuclear gauge testing assistance for compaction related issues.

The Department will calculate the pavement air voids placed within each lot as follows: a.

One test per sub-lot.

- Lots > 400 ton (400 Mg) of mix are divided into 5 sub-lots of equal distance.
- Lots ≤ 400 tons (400 Mg) of mix are divided into a sub-lot or sub-lots of equal distance at a rate of one per 100 tons (100 Mg) mix each (Example: 299 tons of mix require 3 sublots and 301 tons of mix require 4 sublots). There will be less than 5 sub-lots.

b. Average the results of all tests run on randomly selected sites in that lot.

c. Select representative sites randomly using GDT 73.

Density tests are not required for asphaltic concrete placed at 90 lbs./yd2 (50 kg/m2) or less, 4.75 mm mix, asphaltic concrete OGFC, PEM, and mixes placed as variable depth or width leveling. Compact these courses to the Engineer's satisfaction. Density tests will not be performed on turn-outs and driveways.

The targeted maximum Pavement Mean Air Void content for all Superpave and Stone Matrix Asphalt mixtures is 5.0 percent. Ensure that the maximum Pavement Mean Air Voids for all Superpave and Stone Matrix Asphalt mixtures does not exceed 7.0 percent. The maximum Pavement Mean Air Voids for 2 ft. shoulder widening is 9.0 percent. The adjustment period for density is four lots or four production days, whichever is less, in order for the contractor to ensure maximum compactive effort has been achieved, which will yield no more than the specified maximum allowed Mean Air Voids. One additional lot or production day of adjustment may be given for a reduction in asphalt cement content on the JMF made by the Office of Materials and Testing for mix designs incorporating the Corrected Optimum Asphalt Content COAC.

If the contractor needs to adjust the mixture to improve density results, a change in the job mix formula may be requested for approval during the adjustment period so long as the following values are not exceeded:

- Coarse pay sieve ± 4%
- No. 8 (2.36 mm) sieve ± 2%
- No. 200 (75 µm) sieve ± 1%
- Asphalt Content ± 0.2%
- All value changes must still be within specification limits.

If the Office of Materials and Testing is satisfied that the contractor has exerted the maximum compactive effort and is not able to maintain Pavement Mean Air Voids at no more than 7.0%, the Engineer may establish a maximum target for Pavement Mean Air Voids.

Ensure mixture placed during the adjustment period for density meets the requirements for a 0.90 pay factor in Table 13 of Subsection 400.5.01.C, *Calculate Mean Pavement Air Voids*. Mixture not meeting these density requirements is paid for using the applicable pay factor.

If the mean air voids of the pavement placed within a lot exceeds 100% of the maximum target air voids, if established, and the Engineer determines that the material need not be removed and replaced, the lot may be accepted at an adjusted unit price as determined by the Engineer.

2. Obtain Uniform Compaction

For a lot to receive a pay factor of 1.00 for compaction acceptance, the air void range cannot exceed 5 percent for new construction or resurfacing projects. The range is the difference between the highest and lowest acceptance test results within the affected lot. If the air void range exceeds these tolerances, apply a Pay Factor of 95%.

The 5% reduced pay factor for the compaction range does not apply in these instances:

- The mixture is placed during the adjustment period as defined in Subsection 400.5.01.A, *Materials Produced and Placed During the Adjustment Period*.
- All air void results within a given lot are less than 7.0%.
- A lot containing two sublot or less.
- On two foot trench widening.
- For sub-surfaces mixes including 19 mm and 25 mm Superpave mixes if all air void results within a given lot are >2.5 % <8 %.

When lots are reevaluated for range penalty, as shown in Subsection 106.03, *Samples, Tests, Cited Specifications*, sampling and testing is according to GDT 73. Request for reevaluation must be made within 5 working days of notification of the lot results. The following procedures apply:

The Department will reevaluate the lot through additional testing by obtaining and testing three additional cores acquired in representative sites selected randomly throughout each sub-lot representing the high and low in-place air voids as detailed in GDT 73. The additional six cores (three cores from each sub-lot will be averaged) will replace the original five core results for range specified requirements only. The original five cores' results will be reported for Pavement Mean Air Voids for the lot. This will be the final evaluation for compaction range for the lot. Lots will not be re-evaluated for range when the Pavement Mean Air Voids result in a lower than 95% pay factor. Ensure requests for reevaluation are made within 5 working days of notification of the lot results.

The Department will determine the payment for each lot by multiplying the Contract Unit Price by the adjusted pay factor shown in the Table 7 Average Air Voids Range Acceptance Schedule:

TABLE 7—AVERAGE AIR VOIDS RANGE FOR ACCEPTANCE SCHEDULE

Pay Factor	Range between High and Low Air Void Original 5 cores	Re-evaluated Range between High and Low Air Void Cores 6 New Cores obtained from High (3 cores) and Low location (3 cores)
100	≤ 5 %	≤ 4.50 %
0.95	> 5 %	> 4.50 %

C. Surface Tolerance

In this specification, pavement courses to be overlaid with an OGFC or PEM are considered surface courses. All OGFC or PEM are to be evaluated after the roadway has been opened to traffic for a minimum of 5 days and a maximum of 15 days. Asphaltic Concrete paving is subject to straightedge and visual inspection and irregularity correction as shown below:

1. Visual and Straightedge Inspection

Paving is subject to visual and straightedge inspection during and after construction operations until Final Acceptance. Locate surface irregularities as follows:

a. Keep a 10 ft. (3 m) straightedge near the paving operation to measure surface irregularities on courses. Provide the straightedge and the labor for its use.

b. Inspect the base, intermediate, and surface course surfaces with the straightedge to detect irregularities.

c. Correct irregularities that exceed 3/16 in. in 10 ft. (5 mm in 3 m) for base and intermediate courses and surface courses.

Mixture or operating techniques will be stopped if irregularities such as rippling, tearing, or pulling occur and the Engineer suspects a continuing equipment problem. Stop the paving operation and correct the problem. Correct surface course evaluations on individual Laser Road Profiler test sections, normally 1mile (1 km) long.

2. Target Surface Profile Smoothness

The Department will use the Laser Road Profiler method to conduct acceptance testing for surface course tolerance according to GDT 126. This testing will be performed only on:

- Surface courses on Projects with mainline traveled way measuring a minimum distance of 1 mile (1600 m)
- Ramps more than 0.5 mile (800 m) long

Combine partial sections measuring less than 0.5 mile (800 m) with the previous full mile for acceptance.

Achieve the smoothest possible ride during construction. Do not exceed the target Laser Road Profiler smoothness index as shown below:

TABLE 8—PAVEMENT SMOOTHNESS TARGET REQUIREMENTS

Construction Description	Smoothness Index

All Asphaltic Concrete OGFC and PEM on interstate including resurfacing and new construction. Asphaltic Concrete OGFC and PEM placed on state routes as new construction.	750
Asphaltic Concrete SMA or dense-graded surface mixtures placed directly beneath the Asphaltic Concrete OGFC or PEM on interstates. Asphaltic Concrete OGFC and PEM placed on state routes as resurfacing. All new construction on state routes with exception of OGFC and PEM as stated above.	825
All other resurfacing on state routes (excluding LARP, PR, airports, etc.)	900
All Urban new construction and resurfacing on state routes within curb and gutter sections located in posted 40 miles per hour (MPH) or less speed zones.	1175

If the target values are not achieved, immediately adjust the operations to meet the target values. Placement operations may be suspended until a remedial plan to comply with target smoothness requirements is submitted and approved by the Engineer if adjustments do not satisfy target smoothness values.

TABLE 9—PAVEMENT SMOOTHNESS CORRECTIVE WORK REQUIREMENT

Construction Description	Smoothness Index
All Asphaltic Concrete OGFC and PEM placed on interstate including resurfacing and new construction. Asphaltic Concrete OGFC and PEM placed on state routes as new construction.	825
Asphaltic Concrete SMA or dense-graded surface mixtures placed directly beneath the Asphaltic Concrete OGFC or PEM on interstates. Asphaltic Concrete OGFC and PEM placed on state routes as resurfacing. All new construction on state routes with exception of OGFC and PEM as stated above.	900
All other resurfacing on state routes (excluding LARP, PR, airports, etc.)	1025
All Urban new construction and resurfacing on state routes within curb and gutter sections located in posted 40 miles per hour (MPH) or less speed zones.	1250

If surface tolerance deficiencies need correction, obtain the Engineer's approval of the methods and type mix used.

3. Bridge Approach Profile Smoothness Quality

The following are subject to a ride quality test of roadway approaching each end of a bridge using the Laser Road Profiler, Rainhart Profiler or Lightweight Profiler:

- A state route with 4 lanes or more
- A 2-lane state route with a current traffic count two-way ADT-2,000 vpd or more
- Locations designated on the plans

All other bridge approaches not meeting the above criteria shall meet the 3/16 in. in 10 ft. (5 mm in 3 m) straightedge requirement. When the distance between the ends of two bridges, the end of a bridge and an intersection, or the end of a bridge and a vertical or horizontal curve is less than 540 ft. (165 m) and locations where the testing vehicle cannot maintain minimum testing speed while taking profile measurements will not be tested and will be subject to straightedge requirements.

The bridge approaches will meet the straightedge requirements.

Test ride quality as follows:

For Resurfacing Projects:

a. The Department will determine a profile smoothness index value using the laser road profiler in accordance with test method GDT 126.

b. The Department will determine the Half Car Simulation (HCS) IRI for each HMA asphalt 1/10th of mile (0.16 km) segments adjacent to each approach slab joint for each lane. The HCS IRI will be reported in 1/20th of mile (0.08 km) segment readings that will be averaged to calculate the final 1/10-mile section, in accordance with GDT 126.

- Correct individual bumps or depression exceeding 3/16 in. in 10 ft. (3 mm in 3 m) straightedge requirement as directed by the Engineer.
- Ensure the profile smoothness index shows an improvement over pre-construction profile smoothness or meets a profile smoothness index of ≤ 1025 mm/km (66 inches/mile) for the average 1/10 mile (0.16 km).

c. Ensure Resurfacing projects meet the profile smoothness index improvement requirement for the specified 1/10th mile (0.16 km) segment of roadway up to the bridge approach/exit slab joint.

In accordance with Section 106.3.A.3, the Contractor may request reevaluation(s) for Laser Road Profiler Test results on Resurfacing Bridge Projects and straightedge measurement(s) on either that fail to meet specified requirements. Request for reevaluation shall be made to the Engineer within 5 working days of notification of failing results. At the Engineer's approval, reevaluation of failing results using the Lightweight Profiler Test, Laser Road Profiler Test and straightedge measurement(s) shall be conducted in conjunction with representatives from the Office of Materials and Testing in accordance with GDT 126 or GDT 134, whichever is applicable. The Department will perform ride quality testing up to two times on the bridge approaches/exits at no cost to the Contractor. For these reevaluations, evaluation of the bridge exit end may be taken testing towards the bridge against traffic if the contractor provides traffic control, at the contractors' expense, upon request.

For All New Construction Projects:

a. The Department will determine a profile index value according to test method GDT 78 or GDT 134.

b. The Department will average the profile index value from the right and left wheelpath for each 100 ft. (30 m) section for each lane.

- Keep the profile index value under 30 in/mile (475 mm/km), correct individual bumps or depressions exceeding 0.2 in. (5 mm) from blanking band on the profilograph trace.

c. Ensure New Construction projects meet the profile index value for the specified 100 ft. (30 m) section of roadway up to the bridge joint.

d. Schedule the ride quality testing on All New Construction projects 5 days before needed by contacting the Office of Materials and Testing. Clean and clear obstructions from the test area.

Correct the sections that do not meet the ride quality criteria of this specification. After correction, these sections are subject to retesting with the Lightweight Profiler. The Engineer direct the type of correction method, which may include:

- Milling
- Grinding
- Removing and replacing the roadway

No additional compensation will be made.

In accordance with Section 106.3.A.3, the Contractor may request reevaluation(s) for Lightweight Profiler Test results on newly construction bridge projects, Laser Road Profiler Test results on resurfacing bridge projects and straightedge measurement(s) on either that fail to meet specified requirements. Request for reevaluation shall be made to the Engineer within 5 working days of notification of failing results. At the Engineer's approval, reevaluation of failing results using the Lightweight Profiler Test, Laser Road Profiler Test and straightedge measurement(s) shall be conducted by representatives from the Office of Materials and Testing in accordance with GDT 134.

The Department will perform ride quality testing up to two times on the bridge approaches at no cost to the Contractor. Additional testing will be charged to the Contractor in accordance with Section 500.5.01.B.

4. Surface Smoothness Acceptance

When recommended by the Office of Materials and Testing, a pay reduction may be accepted in lieu of correction for roadways and bridge approaches that fail to achieve specified smoothness indexes in accordance with SOP 46 "Procedure for Calculating Pay Reduction for Failing Roadway and Bridge Approach Smoothness" Roadway and Bridge Approach Smoothness. The Office of Materials and Testing may recommend a waiver of profile smoothness requirements when improvement over pre-construction smoothness profile exceeds 25 percent for urban roadways, as defined in Table 9.

D. Reevaluation of Lots

When lots are reevaluated as shown in Subsection 106.03, *Samples, Tests, Cited Specifications*, sampling and testing is according to GDT 73. Ensure request for reevaluation are made within 5 working days of notification of the lot results. The following procedures apply:

1. For asphaltic concrete mixtures other than OGFC and PEM mix types, thin lift courses < 110 lbs./yd^2 and mixture paid for as patching, the Department will take the same number of new tests using cores taken at randomly selected locations in accordance GDT 73. The Department will use only these test results for gradation and AC content obtained using these cores for acceptance. For OGFC and PEM mix types, thin lift courses < 110 lbs./yd^2 and mixture paid for as patching, the retained opposite quarter shall be used for mixture acceptance reevaluation when requested by the Contractor. The Department will use the absolute average deviations from the job mix formula for these tests to determine acceptance based on the appropriate column in the Asphalt Cement Content and Aggregate Gradation of Asphalt Concrete Mixture Acceptance Schedule—Table 10 or 11.

2. Compaction Acceptance

   The Department will reevaluate the lot through additional testing by cutting the same number of cores originally obtained and averaging these results with the results from the original density tests. The Department will use the average to determine acceptance according to the Compaction Acceptance Schedule in Subsection 400.5.01.C, *Calculate Pavement Mean Air Voids*.

TABLE 10—MIXTURE ACCEPTANCE SCHEDULE—SURFACE MIXES

Mixture Characteristics	Pay Factor	Mean of the Deviations from the Job Mix Formula							
		1 Test	2 Tests	3 Tests	4 Tests	5 Tests	6 Tests	7 Tests	8 Tests
Asphalt Cement Content (Extraction, Ignition)	1.00	0.00 - 0.70	0.00 - 0.54	0.00 - 0.46	0.00 - 0.41	0.00 - 0.38	0.00 - 0.35	0.00 - 0.32	0.00 - 0.30
	0.95	0.71 - 0.80	0.55 - 0.61	0.47 - 0.52	0.42 - 0.46	0.39 - 0.43	0.36 - 0.39	0.33 - 0.36	0.31 - 0.34
	0.90	0.81 - 0.90	0.62 - 0.68	0.53 - 0.58	0.47 - 0.51	0.44 - 0.47	0.40 - 0.45	0.37 - 0.40	0.35 - 0.37
	0.80	0.91 - 1.00	0.69 - 0.75	0.59 - 0.64	0.52 - 0.56	0.48 - 0.52	0.44 - 0.47	0.41 - 0.44	0.38 - 0.41
	0.70	1.01 - 1.19	0.76 - 0.82	0.65 - 0.69	0.57 - 0.61	0.53 - 0.56	0.48 - 0.51	0.45 - 0.47	0.42 - 0.44
	0.50	1.20 - 1.40	0.83 - 0.85	0.70 - 0.72	0.62 - 0.64	0.57 - 0.59	0.52 - 0.55	0.48 - 0.51	0.45 - 0.48
3/8 in. (9.5 mm) Sieve (12.5 mm OGFC, 12.5 mm PEM, 12.5 mm Superpave)	1.00	0.00 – 9.0	0.00 - 6.6	0.00 - 5.6	0.00 - 5.0	0.00 - 4.6	0.00 - 4.2	0.00 - 3.9	0.00 - 3.6
	0.98	9.1 - 10.0	6.7 - 7.5	5.7 - 6.3	5.1 - 5.6	4.7 - 5.2	4.3 - 4.7	4.0 - 4.4	3.7 - 4.1
	0.95	10.1 - 11.9	7.6 - 8.4	6.4 - 7.0	5.7 - 6.3	5.3 - 5.8	4.8 - 5.3	4.5 - 5.0	4.2 - 4.6
	0.90	12.0 - 13.0	8.5 - 9.3	7.1 - 7.7	6.4 - 6.9	5.9 - 6.3	5.4 - 5.8	5.1 - 5.4	4.7 - 5.0
	0.85	13.1 - 14.0	9.4 - 10.2	7.8 - 8.6	7.0 - 7.6	6.4 - 6.9	5.9 - 6.3	5.5 - 5.9	5.1 - 5.5
	0.80	14.1 - 14.5	10.3 - 10.5	8.7 - 8.9	7.7 - 8.0	7.0 - 7.5	6.4 - 6.8	6.0 - 6.4	5.6 - 6.0
3/8 in. (9.5 mm) Sieve (12.5 mm SMA)	1.00	0.0 - 6.8	0.00 - 5.0	0.00 - 4.2	0.00 - 3.8	0.00 - 3.4	0.00 - 3.2	0.00 - 2.9	0.00 - 2.7
	0.98	6.9 - 7.5	5.1 - 5.6	4.3 - 4.7	3.9 - 4.2	3.5 - 3.9	3.3 - 3.5	3.0 - 3.3	2.8 - 3.1
	0.95	7.6 - 8.9	5.7 - 6.3	4.8 - 5.2	4.3 - 4.7	4.0 - 4.4	3.6 - 4.0	3.4 - 3.8	3.2 - 3.4
	0.90	9.0 - 9.8	6.4 - 7.0	5.3 - 5.8	4.8 - 5.2	4.5 - 4.8	4.1 - 4.4	3.9 - 4.1	3.5 - 3.8
	0.85	9.9 - 10.5	7.1 - 7.6	5.9 - 6.4	5.3 - 5.7	4.9 - 5.2	4.5 - 4.7	4.2 - 4.4	3.9 - 4.1

	0.80	10.6 - 10.9	7.7 - 7.9	6.5 - 6.7	5.8 - 6.0	5.3 - 5.6	4.8 - 5.1	4.5 - 4.8	4.2 - 4.5
No. 4 (4.75 mm) Sieve (9.5 mm OGFC, 9.5 mm Superpave)	1.00	0.00 - 9.0	0.00 - 6.7	0.00 - 5.7	0.00 - 5.2	0.00 - 4.8	0.00 - 4.4	0.00 - 4.1	0.00 - 3.8
	0.98	9.1 - 10.0	6.8 - 7.6	5.8 - 6.3	5.3 - 5.8	4.9 - 5.4	4.5 - 4.9	4.2 - 4.6	3.9 - 4.3
	0.95	10.1 - 11.9	7.7 - 8.5	6.4 - 6.9	5.9 - 6.4	5.5 - 5.9	5.0 - 5.4	4.7 - 5.0	4.4 - 4.7
	0.90	12.0 - 13.0	8.6 - 9.4	7.0 - 7.5	6.5 - 7.0	6.0 - 6.5	5.5 - 5.9	5.1 - 5.5	4.8 - 5.1
Mixture Characteristics	**Pay Factor**	**Mean of the Deviations from the Job Mix Formula**							
		1 Test	**2 Tests**	**3 Tests**	**4 Tests**	**5 Tests**	**6 Tests**	**7 Tests**	**8 Tests**
	0.85	13.1 - 14.0	9.5 - 10.2	7.6 - 8.0	7.1 - 7.6	6.6 - 7.0	6.0 - 6.4	5.6 - 5.9	5.2 - 5.5
	0.80	14.1 - 14.5	10.3 - 10.5	8.1 - 8.3	7.7 - 8.0	7.1 - 7.5	6.5 - 6.9	6.0 - 6.4	5.6 - 5.9
No. 4 (4.75 mm) Sieve (9.5 mm SMA)	1.00	0.00 - 6.8	0.00 - 5.0	0.00 - 4.3	0.00 - 3.9	0.00 - 3.6	0.00 - 3.3	0.00 - 3.1	0.00 - 2.8
	0.98	6.9 - 7.5	5.1 - 5.7	4.4 - 4.7	4.0 - 4.4	3.7 - 4.0	3.4 - 3.7	3.2 - 3.4	2.9 - 3.2
	0.95	7.6 - 8.9	5.8 - 6.4	4.8 - 5.2	4.5 - 4.8	4.1 - 4.4	3.8 - 4.0	3.5 - 3.8	3.3 - 3.5
	0.90	9.0 - 9.8	6.5 - 7.0	5.3 - 5.6	4.9 - 5.2	4.5 - 4.9	4.1 - 4.4	3.9 - 4.1	3.6 - 3.8
	0.85	9.9 - 10.5	7.1 - 7.7	5.7 - 6.0	5.3 - 5.7	5.0 - 5.2	4.3 - 4.8	4.2 - 4.4	3.9 - 4.1
	0.80	10.6 - 10.9	7.8 - 7.9	6.1 - 6.2	5.8 - 6.0	5.3 - 5.6	4.9 - 5.2	4.5 - 4.8	4.2 - 4.4
No. 8 (2.36 mm) Sieve (OGFC, PEM, Superpave and 4.75 mm mixes)	1.00	0.00 - 7.0	0.00 - 5.6	0.00 - 4.8	0.00 - 4.3	0.00 - 4.0	0.00 - 3.6	0.00 - 3.4	0.00 - 3.2
	0.98	7.1 - 8.0	5.7 - 6.3	4.9 - 5.4	4.4 - 4.8	4.1 - 4.5	3.7 - 4.1	3.5 - 3.8	3.3 - 3.6
	0.95	8.1 - 9.0	6.4 - 7.0	5.5 - 6.0	4.9 - 5.3	4.6 - 4.9	4.2 - 4.5	3.9 - 4.2	3.7 - 3.9

	0.90	9.1 - 10.9	7.1 - 7.7	6.1 - 6.6	5.4 - 5.8	5.0 - 5.4	4.6 - 4.9	4.3 - 4.6	4.0 - 4.3
	0.85	11.0 - 12.0	7.8 - 8.5	6.7 - 7.2	5.9 - 6.4	5.5 - 5.8	5.0 - 5.3	4.7 - 5.0	4.4 - 4.6
	0.75	12.1 - 12.5	8.6 - 8.8	7.3 - 7.5	6.5 - 6.8	5.9 - 6.3	5.4 - 5.7	5.1 - 5.3	4.7 - 4.9
No. 8 (2.36 mm) Sieve (12.5 mm SMA, 9.5 mm SMA)	1.00	0.00 - 5.3	0.00 - 4.2	0.00 - 3.6	0.00 - 3.2	0.00 - 3.0	0.00 - 2.7	0.00 - 2.6	0.00 - 2.4
	0.98	5.4 - 6.0	4.3 - 4.7	3.7 - 4.0	3.3 - 3.6	3.1 - 3.4	2.8 - 3.1	2.7 - 2.9	2.5 - 2.7
	0.95	6.1 - 6.8	4.8 - 5.3	4.1 - 4.5	3.7 - 4.0	3.5 - 3.7	3.2 - 3.4	3.0 - 3.2	2.8 - 2.9
	0.90	6.9 - 8.2	5.4 - 5.8	4.6 - 5.0	4.1 - 4.5	3.8 - 4.0	3.5 - 3.7	3.3 - 3.5	3.0 - 3.2
	0.85	8.3 - 9.0	5.9 - 6.4	5.1 - 5.4	4.6 - 4.8	4.1 - 4.4	3.8 - 4.0	3.6 - 3.8	3.3 - 3.4
	0.75	9.1 - 9.4	6.5 - 6.6	5.5 - 5.0	4.9 - 5.1	4.5 - 4.7	4.1 - 4.3	3.9 - 4.0	3.5 - 3.7
No. 8 (2.36 mm) Sieve for OGFC and PEM mixes: When the mean of the deviations from the Job Mix Formula for a particular lot exceeds the tolerance for a 1.00 pay factor in the appropriate column, the lot will be paid for at 0.50 of the Contract Price.									

TABLE 11—MIXTURE ACCEPTANCE SCHEDULE—SUBSURFACE MIXES

Mixture Characteristics	Pay Factor	Mean of the Deviations from the Job Mix Formula							
		1 Test	2 Tests	3 Tests	4 Tests	5 Tests	6 Tests	7 Tests	8 Tests
Asphalt Cement Content (Extraction, Ignition)	1.00	0.00 - 0.80	0.00 - 0.61	0.00 - 0.52	0.00 - 0.46	0.00 - 0.43	0.00 - 0.39	0.00 - 0.36	0.00 - 0.34
	0.95	0.81 - 0.90	0.62 - 0.68	0.53 - 0.58	0.47 - 0.51	0.44 - 0.47	0.40 - 0.43	0.37 - 0.40	0.35 - 0.37
	0.90	0.91 - 1.00	0.69 - 0.75	0.59 - 0.64	0.52 - 0.56	0.48 - 0.52	0.44 - 0.47	0.41 - 0.44	0.38 - 0.41
	0.80	1.01 - 1.19	0.76 - 0.82	0.65 - 0.69	0.57 - 0.61	0.53 - 0.56	0.48 - 0.51	0.45 - 0.47	0.42 - 0.44
	0.70	1.20 - 1.40	0.83 - 0.85	0.70 - 0.72	0.62 - 0.64	0.57 - 0.59	0.52 - 0.55	0.48 - 0.51	0.45 - 0.48

	0.50	1.41 - 1.60	0.86 - 0.88	0.73 - 0.75	0.65 - 0.67	0.60 - 0.63	0.56 - 0.60	0.52 - 0.56	0.49 - 0.52
1/2 in. (12.5 mm) Sieve (25 mm Superpave)	1.00	0.00 - 12.9	0.00 - 8.1	0.00 - 6.9	0.00 - 6.1	0.00 - 5.5	0.00 - 5.0	0.00 - 4.7	0.00 - 4.4
	0.98	13.0 - 14.0	8.2 - 9.1	7.0 - 7.7	6.2 - 6.8	5.6 - 6.1	5.1 - 5.6	4.8 - 5.2	4.5 - 4.9
	0.95	14.1 - 15.0	9.2 - 10.1	7.8 - 8.5	6.9 - 7.5	6.2 - 6.7	5.7 - 6.1	5.3 - 5.7	5.0 - 5.4
	0.90	15.1 - 16.0	10.2 - 11.1	8.6 - 9.3	7.6 - 8.2	6.8 - 7.4	6.2 - 6.7	5.8 - 6.3	5.5 - 5.9
	0.85	16.1 - 17.0	11.2 - 11.5	9.4 - 9.6	8.3 - 8.6	7.5 - 7.8	6.8 - 7.0	6.4 - 6.5	6.0 - 6.1
	0.80	17.1 - 18.0	11.6 - 11.9	9.7 - 9.9	8.7 - 9.0	7.9 - 8.1	7.1 - 7.3	6.6 - 6.8	6.2 - 6.4
1/2 in. (12.5 mm) Sieve (19 mm SMA)	1.00	0.00 - 9.7	0.00 - 6.0	0.00 - 5.2	0.00 - 4.6	0.00 - 4.1	0.00 - 3.8	0.00 - 3.5	0.00 - 3.3
	0.98	9.8 - 10.5	6.2 - 6.8	5.3 - 5.8	4.7 - 5.1	4.2 - 4.6	3.9 - 4.2	3.6 - 3.9	3.4 - 3.7
	0.95	10.6 - 11.2	6.9 - 7.8	5.9 - 6.4	5.2 - 5.6	4.7 - 5.0	4.3 - 4.6	4.0 - 4.3	3.8 - 4.0
	0.90	11.3 - 12.0	7.9 - 8.3	6.5 - 7.0	5.7 - 6.1	5.1 - 5.6	4.7 - 5.0	4.4 - 4.7	4.1 - 4.4
	0.85	12.1 - 12.8	8.4 - 8.6	7.1 - 7.2	6.2 - 6.5	5.7 - 5.9	5.1 - 5.3	4.8 - 4.9	4.5 - 5.6
	0.80	12.9 - 13.5	8.7 - 8.9	7.3 - 7.4	6.6 - 6.8	6.0 - 6.1	5.4 - 5.5	5.0 - 5.1	4.7 - 4.8
3/8 in. (9.5 mm) Sieve (19 mm Superpave, 12.5 mm Superpave)	1.00	0.00 - 10.0	0.00 - 7.5	0.00 - 6.3	0.00 - 5.6	0.00 - 5.2	0.00 - 4.7	0.00 - 4.4	0.00 - 4.1
	0.98	10.1 - 11.9	7.6 - 8.4	6.4 - 7.0	5.7 - 6.3	5.3 - 5.8	4.8 - 5.3	4.5 - 5.0	4.2 - 4.6
	0.95	12.0 - 13.0	8.5 - 9.3	7.1 - 7.7	6.4 - 6.9	5.9 - 6.3	5.4 - 5.8	5.1 - 5.4	4.7 - 5.0
	0.90	13.1 - 14.0	9.4 - 10.2	7.8 - 8.6	7.0 - 7.6	6.4 - 6.9	5.9 - 6.3	5.5 - 5.9	5.1 - 5.5
Mixture Characteristics	**Pay Factor**	**Mean of the Deviations from the Job Mix Formula**							
		1 Test	**2 Tests**	**3 Tests**	**4 Tests**	**5 Tests**	**6 Tests**	**7 Tests**	**8 Tests**

	0.85	14.1 - 14.5	10.3 - 10.5	8.7 - 8.9	7.7 - 8.0	7.0 - 7.5	6.4 - 6.8	6.0 - 6.4	5.6 - 6.0
	0.80	14.6 - 15.0	10.6 - 10.8	9.0 - 9.2	8.1 - 8.4	7.6 - 7.8	6.9 - 7.3	6.5 - 6.8	6.1 - 6.5
No. 4 (4.75 mm) Sieve (9.5 mm Superpave)	1.00	0.00 - 10.0	0.00 - 7.6	0.00 - 6.3	0.00 - 5.8	0.00 - 5.4	0.00 - 4.9	0.00 - 4.6	0.00 - 4.3
	0.98	10.1 - 11.9	7.7 - 8.5	6.4 - 6.9	5.9 - 6.4	5.5 - 5.9	5.0 - 5.4	4.7 - 5.0	4.4 - 4.7
	0.95	12.0 - 13.0	8.6 - 9.4	7.0 - 7.5	6.5 - 7.0	6.0 - 6.5	5.5 - 5.9	5.1 - 5.5	4.8 - 5.1
	0.90	13.1 - 14.0	9.5 - 10.2	7.6 - 8.0	7.1 - 7.6	6.6 - 7.0	6.0 - 6.4	5.6 - 5.9	5.2 - 5.5
	0.85	14.1 - 14.5	10.3 - 10.5	8.1 - 8.3	7.7 - 8.0	7.1 - 7.5	6.5 - 6.9	6.0 - 6.4	5.6 - 5.9
	0.80	14.6 - 15.0	10.6 - 10.8	8.4 - 8.6	8.1 - 8.4	7.6 - 8.0	7.0 - 7.4	6.5 - 6.8	6.0 - 6.3
No. 8 (2.36 mm) Sieve (All mixes except SMA)	1.00	0.00 - 8.0	0.00 - 6.3	0.00 - 5.4	0.00 - 4.8	0.00 - 4.5	0.00 - 4.1	0.00 - 3.8	0.00 - 3.6
	0.98	8.1 - 9.0	6.4 - 7.0	5.5 - 6.0	4.9 - 5.3	4.6 - 4.9	4.2 - 4.5	3.9 - 4.2	3.7 - 3.9
	0.95	9.1 - 10.0	7.1 - 7.7	6.1 - 6.6	5.4 - 5.8	5.0 - 5.4	4.6 - 4.9	4.3 - 4.6	4.0 - 4.3
	0.90	10.1 - 11.9	7.8 - 8.5	6.7 - 7.2	5.9 - 6.4	5.5 - 5.8	5.0 - 5.3	4.7 - 5.0	4.4 - 4.6
	0.85	12.0 - 13.0	8.6 - 8.8	7.3 - 7.5	6.5 - 6.8	5.9 - 6.3	5.4 - 5.7	5.1 - 5.3	4.7 - 4.9
	0.75	13.1 - 14.0	8.9 - 9.1	7.6 - 7.8	6.9 - 7.2	6.4 - 6.6	5.8 - 6.1	5.4 - 5.7	5.0 - 5.3
No. 8 (2.36 mm) Sieve (19 mm SMA)	1.00	0.00 - 6.0	0.00 - 4.7	0.00 - 4.1	0.00 - 3.6	0.00 - 3.4	0.00 - 3.1	0.00 - 2.9	0.00 - 2.4
	0.98	6.1 - 6.8	4.8 - 5.2	4.2 - 4.5	3.7 - 4.0	3.5 - 3.7	3.2 - 3.4	3.0 - 3.2	2.8 - 2.9
	0.95	6.9 - 7.5	5.3 - 5.8	4.6 - 5.0	4.1 - 4.4	3.8 - 4.0	3.5 - 3.7	3.3 - 3.5	3.0 - 3.2

	0.90	7.6 - 8.9	5.9 - 6.4	5.1 - 5.4	4.5 - 4.8	4.1 - 4.4	3.8 - 4.0	3.6 - 3.8	3.3 - 3.5
	0.85	9.0 - 9.8	6.5 - 6.6	5.5 - 5.6	4.9 - 5.1	4.5 - 4.7	4.1 - 4.3	3.9 - 4.0	3.6 - 3.7
	0.75	9.9 - 10.5	6.7 - 6.8	5.7 - 5.9	5.2 - 5.4	4.8 - 5.0	4.4 - 4.6	4.1 - 4.3	3.8 - 4..0

E. Segregated Mixture

Prevent mixture placement yielding a segregated mat by following production, storage, loading, placing, and handling procedures. Ensure needed plant modifications and provide necessary auxiliary equipment. (See Subsection 400.1.01, *Definitions*.)

If the mixture is segregated in the finished mat, the Department will take actions based on the degree of segregation. The actions are described below.

1. Unquestionably Unacceptable Segregation

   When the Engineer determines the segregation in the finished mat is unquestionably unacceptable, follow these measures:

   a. Suspend Work and require the Contractor to take positive corrective action. The Department will evaluate the segregated areas to determine the extent of the corrective work to the in-place mat as follows:

      - Perform extraction and gradation analysis by taking 6 in. (150 mm) cores from typical, visually unacceptable segregated areas.
      - Determine the corrective work according to Subsection 400.3.06.E.3.

   b. Require the Contractor to submit a written plan of measures and actions to prevent further segregation. Work will not continue until the plan is submitted to and approved by the Department.

   c. When work resumes, place a test section not to exceed 500 tons (500 Mg) of the affected mixture for the Department to evaluate. If a few loads show that corrective actions were not adequate, follow the measures above beginning with step 1.a. above. If the problem is solved, work may continue.

2. Unacceptable Segregation Suspected

   When the Engineer observes segregation in the finished mat and the work may be unacceptable, follow these measures:

   a. Allow work to continue at Contractor's risk.

   b. Require Contractor to immediately and continually adjust operation until the visually apparent segregated areas are eliminated from the finished mat. The Department will immediately investigate to determine the severity of the apparent segregation as follows:

      - Take 6 in. (150 mm) cores from typical areas of suspect segregation.
      - Test the cores for compliance with the mixture control tolerances in Section 828.

      When these tolerances are exceeded, suspend work for corrective action as outlined in Subsection 400.3.06.E.3.

3. Corrective Work

   a. Remove and replace (at the Contractor's expense) any segregated area where the gradation on the control sieves is found to vary 10 percent or more from the approved job mix formula, the asphalt cement varies 1.0% or more from the approved job mix formula, or if in-place air voids exceed 13.5% based on GDT 39. The control sieves for each mix type are shown in Subsection 400.5.01.B *Determine Lot Acceptance*.

   b. Subsurface mixes. For subsurface mixes, limit removal and replacement to the full lane width and no less than 10 ft. (3 m) long and as approved by the Engineer.

   c. Surface Mixes. For surface mixes, ensure that removal and replacement is not less than the full width of the affected lane and no less than the length of the affected areas as determined by the Engineer.

   d. Surface tolerance requirements apply to the corrected areas for both subsurface and surface mixes.

400.3.07 Contractor Warranty and Maintenance

A. Contractor's Record

Maintain a dated, written record of the most recent plant calibration. Keep this record available for the Engineer's inspection at all times. Maintain records in the form of:

- Graphs
- Tables
- Charts
- Mechanically prepared data

400.4 Measurement

Thickness and spread rate tolerances for the various mixtures are specified in Subsection 400.4.A.2.b, Table 12, Thickness and Spread Rate Tolerance at Any Given Location. These tolerances are applied as outlined below: **A.**

Hot Mix Asphaltic Concrete Paid for by Weight

1. Plans Designate a Spread Rate

   a. Thickness Determinations. Thickness determinations are not required when the plans designate a spread rate per square yard (meter).

      If the spread rate exceeds the upper limits outlined in the Subsection 400.4.A.2.b, Table 12, *Thickness and Spread Rate Tolerance at Any Given Location*, the mix in excess will not be paid for.

      If the rate of spread is less than the lower limit, correct the deficient course by overlaying the entire lot.

      The mixture used for correcting deficient areas is paid for at the Contract Unit Price of the course being corrected and is subject to the Mixture Acceptance Schedule—Table 10 or 11.

   b. Recalculate the Total Spread Rate. After the deficient hot mix course has been corrected, the total spread rate for that lot is recalculated, and mix in excess of the upper tolerance limit as outlined in the Subsection 400.4.A.2.b, Table 12, *Thickness and Spread Rate Tolerance at Any Given Location* is not paid for.

      The quantity of material placed on irregular areas such as driveways, turnouts, intersections, feather edge section, etc., is deducted from the final spread determination for each lot.

2. Plans Designate Thickness

   If the average thickness exceeds the tolerances specified in the Subsection 400.4.A.2.b, Table 12, *Thickness and Spread Rate Tolerance at Any Given Location*, the Engineer shall take cores to determine the area of excess thickness. Excess quantity will not be paid for.

   If the average thickness is deficient by more than the tolerances specified in the Thickness and Spread Rate Tolerance at Any Given Location table below, the Engineer shall take additional cores to determine the area of deficient thickness. Correct areas with thickness deficiencies as follows:

   a. Overlay the deficient area with the same mixture type being corrected or with an approved surface mixture. The overlay shall extend for a minimum of 300 ft. (90 m) for the full width of the course.

   b. Ensure that the corrected surface course complies with Subsection 400.3.06.C.1, *Visual and Straightedge Inspection*. The mixture required to correct a deficient area is paid for at the Contract Unit Price of the course being corrected.

      The mixture is subject to the Mixture Acceptance Schedule—Table 10 or 11. The quantity of the additional mixture shall not exceed the required calculated quantity used to increase the average thickness of the overlaid section to the maximum tolerance allowed under the following table.

TABLE 12—THICKNESS AND SPREAD RATE TOLERANCE AT ANY GIVEN LOCATION

Course	Thickness Specified	Spread Rate Specified
Asphaltic concrete base course	± 0.5 in. (± 13 mm)	± 55 lbs./yd^2 (30 kg/m^2)

Intermediate and/or wearing course	± 0.25 in. (± 6 mm)	± 27.5 lbs./yd^2 (15 kg/m^2)
Overall of any combination of 1 and 2	± 0.5 in. (± 13 mm)	± 55 lbs./yd^2 (30 kg/m^2)

Note: For asphaltic concrete 9.5 mm OGFC and 12.5 mm OGFC, control the spread rate per lot within 7 lbs./yd^2 (4 kg/m^2) of the designated spread rate. For asphaltic concrete 12.5 mm PEM, control the spread rate per lot within 10 lbs./yd^2 (6 kg/m^2) of the designated spread rate.

Note: Thickness and spread rate tolerances are provided to allow normal variations within a given lot. Do not continuously operate at a thickness of spread rate not specified.

When the plans specify a thickness, the Engineer may take as many cores as necessary to determine the average thickness of the intermediate or surface course. The Engineer shall take a minimum of one core per 1,000 ft. (300 m) per two lanes of roadway. Thickness will be determined by average measurements of each core according to GDT 42.

If the average exceeds the tolerances specified in the *Subsection 400.4.A.2.b, Table 12, Thickness and Spread Rate Tolerance at Any Given Location*, additional cores will be taken to determine the area of excess thickness and excess tonnage will not be paid for.

B. Hot Mix Asphaltic Concrete Paid for by Square Yard (Meter)

1. The thickness of the base course or the intermediate or surface course will be determined by the Department by cutting cores and the thickness will be determined by averaging the measurements of each core.
2. If any measurement is deficient in thickness more than the tolerances given in the table above, additional cores will be taken by the Department to determine the area of thickness deficiency. Correct thickness deficiency areas as follows:
    a. Overlay the deficient area with the same type mixtures being corrected or with surface mixture. Extend the overlay at least 300 ft. (90 m) for the full width of the course.
    b. Ensure the corrected surface course complies with Subsection 400.3.06.C.1, *Visual and Straightedge Inspection*.
    c. The mixture is subject to the Mixture Acceptance Schedule—Table 10 or 11.
3. No extra payment is made for mixtures used for correction.
4. No extra payment is made for thickness in excess of that specified.

C. Asphaltic Concrete

Hot mix asphaltic concrete, complete in place and accepted, is measured in tons (megagrams) or square yards (meters) as indicated in the Proposal. If payment is by the ton (megagram), the actual weight is determined by weighing each loaded vehicle on the required motor truck scale as the material is hauled to the roadway, or by using recorded weights if a digital recording device is used.

The weight measured includes all materials. No deductions are made for the weight of the individual ingredients. The actual weight is the pay weight except when the aggregates used have a combined bulk specific gravity greater than 2.75. In this case the pay weight is determined according to the following formula:

$$T1 = T \times \left\{ \frac{\%\,AC + \left(\frac{\%\ Aggregate \times 2.75}{combined\ bulk\ Specific\ Gravity} \right) + \%\,Y}{100} \right\}$$

Where:

T1	Pay weight, tonnage (Mg)
T=	Actual weight
% AC=	Percent asphalt cement by weight of total mixture
% Aggregate =	Percent aggregate by weight of total mixture minus the hydrated lime
Combined Bulk Sp. Gr.=	Calculated combined bulk specific gravity of various mineral aggregates used in the mixture
% Y=	Percent hydrated lime by weight of mineral aggregate

D. Bituminous Material

Bituminous material is not measured for separate payment.

E. Hydrated Lime

When hydrated lime is used as an anti-stripping additive, it is not measured for separate payment.

F. Field Laboratory

The field laboratory required in this specification is not measured for separate payment.

G. Asphaltic Concrete Leveling

Payment of hot mix asphaltic concrete leveling, regardless of the type mix, is full compensation for furnishing materials, bituminous materials, and hydrated lime (when required) for patching and repair of minor defects, surface preparation, cleaning, hauling, mixing, spreading, and rolling.

Mixture for leveling courses is subject to the acceptance schedule as stated in Subsection 400.3.06.A and Subsection 400.3.06.B.

H. Asphaltic Concrete Patching

Hot mix asphaltic concrete patching, regardless of the type mix, is paid for at the Contract Unit Price per ton (Megagram), complete in place and accepted. Payment is full compensation for:

- Furnishing materials such as bituminous material and hydrated lime (when required)
- Preparing surface to be patched
- Cutting areas to be patched, trimmed, and cleaned
- Hauling, mixing, placing, and compacting the materials

When mixture for patching is paid for by the Department, ensure the mixture is subject to the acceptance schedule as stated in Subsection 400.3.06.A.

400.4.01 Limits

When the asphaltic concrete is paid for by the square yard (meter) and multiple lifts are used, the number and thickness of the lifts are subject to the Engineer's approval and are used to prorate the pay factor for the affected roadway section.

400.5 Payment

When materials or construction are not within the tolerances in this specification, the Contract Price will be adjusted according to Subsection 106.03, *Samples, Tests, Cited Specifications* and Subsection 400.3.06, *Quality Acceptance*.

Hot mix asphaltic concrete of the various types are paid for at the Contract Unit Price per ton (megagram) or per square yard (meter). Payment is full compensation for furnishing and placing materials including asphalt cement, hydrated lime when required, approved additives, and for cleaning and repairing, preparing surfaces, hauling, mixing, spreading, rolling, and performing other operations to complete the Contract Item.

Payment will be made under:

Item No. 400	Asphaltic concrete type Superpave, group-blend, Including polymermodified bituminous materials and hydrated lime	Per ton (megagram)
Item No. 400	Asphaltic concrete type, Superpave, group-blend, including bituminous materials and hydrated lime	Per ton (megagram)
Item No. 400	Asphaltic concrete type Superpave, group-blend, Including bituminous materials, Gilsonite modifier, and hydrated lime	Per ton (megagram)
Item No. 400	_______ inches asphaltic concrete, type Superpave, group-blend including bituminous materials, Gilsonite modifier and hydrated lime	Per square yard (meter)
Item No. 400	Asphaltic concrete type Stone Matrix Asphalt, group-blend, including polymer-modified bituminous materials and hydrated lime	Per ton (megagram)
Item No. 400	Asphaltic concrete type OGFC, group 2 only, including bituminous materials and hydrated lime	Per ton (megagram)
Item No. 400	Asphaltic concrete type OGFC, group 2 only, including polymermodified bituminous materials and hydrated lime	Per ton (megagram)
Item No. 400	Asphaltic concrete type Porous European Mix, group 2 only, including polymer-modified bituminous materials and hydrated lime	Per ton (megagram)

400.5.01 Adjustments

A. Materials Produced and Placed During the Adjustment Period

An adjustment period is allowed at the start of mixing operations for each type of mix placed on the Contract. Asphaltic Concrete OGFC or PEM shall be granted an adjustment period for the first 500 tons (500 Mg) produced for the Contract. A new adjustment period shall not be granted for a change of producer, mix design or asphalt plant location. The adjustment period is provided to adjust or correct the mix and to establish the construction procedures and sequence of operations.

The adjustment period consists of the tons (megagrams) of the affected mix produced and placed on the first day of operation. If this quantity is less than 500 tons (500 Mg), the Engineer may combine the tons (megagrams) produced and placed on the first day of operation with the tons (megagrams) produced and placed on the next production day of the affected mix for the adjustment period.

The material produced and placed during the mixture adjustment period is one lot. If the mix is adjusted during this period, a new lot may be necessary, but a new adjustment period will not be permitted.

This material shall be paid for at 100 percent of the Contract Unit Price provided it meets the minimum requirements for a 1.00 pay factor for asphalt cement content and a 0.90 pay factor for gradation in the Mixture Acceptance Schedule—Table 10 or 11.

If the material placed during the adjustment period fails to meet the above requirements, it will be paid for using the applicable acceptance schedule. However, when mixture used for leveling at a spread rate of 90 lbs./yd² (50 kg/m²) or less is also used for the surface mix at a spread rate greater than 90 lbs./yd² (50 kg/m²), an additional adjustment period will be allowed for compaction only. This material will be paid for at a 1.00 pay factor provided it:

- Meets the minimum requirements for a 1.00 pay factor in the Mixture Acceptance Schedule—Table 10 or 11 for both asphalt content and gradation.
- Meets the minimum requirements for a 0.90 pay factor in Table 13 of Subsection 400.5.01C, *Calculate Mean Pavement Air Voids*.

Mixture which does not meet these requirements shall be paid for using the applicable acceptance schedule.

B. Determine Lot Acceptance

Pay factor adjustments are based on control sieves and asphalt cement content. The control sieves used in the mixture acceptance schedule for the various types of mix are indicated below:

Control Sieves Used in the Mixture Acceptance Schedule	
Asphaltic concrete 25 mm Superpave	1/2 in., No. 8 (12.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 19 mm SMA	1/2 in., No. 8 (12.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 19 mm Superpave	3/8 in., No. 8 (9.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 12.5 mm Superpave	3/8 in., No. 8 (9.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 12.5 mm SMA	3/8 in., No. 8 (9.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 12.5 mm PEM	3/8 in., No. 8 (9.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 12.5 mm OGFC	3/8 in., No. 8 (9.5 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 9.5 mm Superpave	No. 4, No. 8 (4.75 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 9.5 mm SMA	No. 4, No. 8 (4.75 mm, 2.36 mm) sieves and asphalt cement
concrete 9.5 mm OGFC	No. 4, No. 8 (4.75 mm, 2.36 mm) sieves and asphalt cement
Asphaltic concrete 4.75 mm Mix	No. 8 (2.36 mm) sieve and asphalt cement

For projects which do not have milling quantities established as a Pay Item, the Department will pay for 12.5 mm OGFC and PEM placed on ramps and end of project transitions under the appropriate mixture pay item, but the mix shall be subject to the same gradation and control sieve requirements as asphaltic concrete 9.5 mm OGFC. Add polymer-modified bituminous material, hydrated lime, and stabilizing fiber to this mix.

The Department will perform the following tasks:

1. Using the Mixture Acceptance Schedule—Table 10 or 11, determine the mean of the deviations from the job mix formula per test results per lot.
2. Determine this mean by averaging the actual numeric value of the individual deviations from the job mix formula; disregard whether the deviations are positive or negative amounts.
3. Use the Asphalt Cement Content and Aggregate Gradation of Asphalt Concrete Mixture Acceptance Schedule—Table10 to determine acceptance of surface mixes and the Mixture Acceptance Schedule— Table 11 to determine acceptance of subsurface mixes.

On Contracts involving 1,000 tons (1000 Mg) or less of asphaltic concrete, the mixture is accepted for 100 percent payment of the asphaltic concrete Unit Price provided it meets the following:

1. Minimum requirements for a 1.00 pay factor for asphalt cement content and a 0.90 pay factor for gradation in the applicable Mixture Acceptance Schedule—Table 10 or 11.
2. Minimum requirements for a 0.90 pay factor in Table 13 of Subsection 400.5.01C, *Calculate Pavement Mean Air Voids*.

If the material placed on Contracts involving 1,000 tons (1000 Mg) or less of asphaltic concrete does not meet the above requirements, the material will be paid for using the applicable acceptance schedule.

C. Calculate Pavement Mean Air Voids

The Department will determine the percent of maximum air voids for each lot by dividing the pavement mean air voids by the maximum pavement mean air voids acceptable.

The Department will determine the payment for each lot by multiplying the Contract Unit Price by the adjusted pay factor shown in the following Air Voids Acceptance schedule:

TABLE 13 - AIR VOIDS ACCEPTANCE SCHEDULE

Pay Factor	Percent of Maximum Air Voids (Lot Average of Tests)	Percent of Maximum Air Voids (Lot Average all Tests) (for Reevaluations)
1.00	≤100	≤100
0.97	100.1 — 105	100.1 — 104
0.95	105.1 — 112	104.1— 109
0.90	112.1 — 124	109.1 — 118
0.80	124.1 — 149	118.1 — 136
0.70	149.1 —172	136.1 — 153
0.50	172.1 — 191	153.1 — 166

When recommended by the Office of Materials and Testing, Lots receiving less than 0.5 pay factor shall be removed and replaced at the Contractor’s expense.

When the range tolerance is exceeded, the Department will apply a pay factor of 0.95 as described in Subsection 400.3.06.B.2.

D. Asphaltic Concrete for Temporary Detours

Hot mix asphaltic concrete placed on temporary detours not to remain in place as part of the permanent pavement does not require hydrated lime. Hot mix used for this purpose is paid for at an adjusted Contract Price. Ensure the payment for this item covers all cost of construction, maintenance and removal of all temporary mix. Ensure hot mix asphaltic concrete placed as temporary mix meets requirements established in Subsection 400.3.05.F.

Where the Contract Price of the asphaltic concrete for permanent pavement is let by the ton (megagram), the Contract Price for the asphaltic concrete placed on temporary detours is adjusted by subtracting $0.75/ton ($0.85/mg) of mix used.

Where the Contract price of the mix in the permanent pavement is based on the square yard (meter), obtain the adjusted price for the same mix used on the temporary detour by subtracting $0.04/yd² ($0.05/m²) per 1 in. (25 mm) plan depth.

Further price adjustments required in Subsection 400.3.06, *Quality Acceptance*, which are based on the appropriate adjusted Contract Price for mix used in the temporary detour work shall apply should temporary mix be left in place. Ensure hot mix asphalt produced as temporary mix containing no hydrated lime is removed and replaced with permanent mix containing hydrated lime.

E. Determine Lot Payment

Determine the lot payment as follows:

1. When one of the pay factors for a specific acceptance lot is less than 1.0, determine the payment for the lot by multiplying the Contract Unit Price by the adjusted pay factor.
2. When two or more pay factors for a specific acceptance lot are less than 1.0, determine the adjusted payment by multiplying the Contract Unit Price by the lowest pay factor.

If the mean of the deviations from the job mix formula of the tests for a sieve or asphalt cement content exceeds the tolerances established in the Mixture Acceptance Schedule—Table 10 or 11 and if the Engineer determines that the material need not be removed and replaced, the lot may be accepted at an adjusted unit price as determined by the Engineer. If the pavement mean air voids exceed the tolerances established in the Air Voids Acceptance Schedule – Table 13, remove and replace the materials at the Contractor's expense.

If the Engineer determines the material is not acceptable to leave in place, remove and replace the materials at the Contractor's expense.

SECTION 11

GDT 7

DETERMINING MAXIMUM DENSITY OF SOIL

GDT 7

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the relation between moisture content and the theoretical or laboratory maximum dry density. Measure the density in a 1/30 ft³ (0.000943, ± 0.000008 m³) (Reference ASTM D-698 Mold Volume Calibration) mold compacted by a 5.5 lb (2.5 kg) rammer.

B. Apparatus

The apparatus consists of the following:

1. Mold: Use a cylindrical metal mold with an approximate 4 in (101.6, ± 0.408 mm) diameter, 4.6 in (116.43, ± 0.1270 mm) high, and a volume of 1/30 ft³ (0.000943, ± 0.000008 m³). The mold is fitted with a detachable base plate and a removable extension approximately 2.5 in (63 mm) high (WM-05) (see Figure 7-1).

   This volume to be 1/30 cubic ft., 4.59 " (1.060 mm³, 116 mm) (Reference ASTM D-698 Mold Volume Calibration)
2. Rammer: Use a metal rammer with a 2 in (50.8, ± 0.127 mm) diameter, flat circular face, and weighing 5.5 lbs. (2.49 kg). The rammer must be equipped with a suitable arrangement to control the height of drop to a free fall of 12 in (304.8, ± 1.524 mm) above the soil (WR-1).
3. Scales and Balances: Use a scale of 20 kg capacity sensitive to and graduated in 0.1g, and a 500 g capacity balance sensitive to 0.1g.
4. Drying Device: Use a stove or oven capable of rapidly drying the moisture determination samples (WS-12).
5. Straightedge: Use a steel straightedge 12 in (300 mm) long (WS-13-1).
6. Pans or Dishes: Use pie pans or evaporating dishes suitable for drying soil samples (WP-01 or WD-3).
7. Sieve: Use a No. 10 (2.00 mm) sieve that conforms to the "Standard Specifications for Sieves for Testing Purposes," AASHTO M 92 (WS-08-#010).
8. Graduated Cylinder: Use a glass or plastic (WC-5-100) 3.4 oz. (100 ml) graduated cylinder used to measure the mixing water (Bit-04-100).
9. Mallet: Use a wooden mallet or rubber-covered pestle of suitable size (OH-06).
10. Cup: Use an 8 oz (237 ml), seamless tin cup (OC-11) for moisture-constant samples.
11. Extruder (optional): Use a cylindrical piston slightly less than 4 in (100 mm) diameter or similar device for removing compacted specimens from mold.

C. Sample Size and Preparation

1. Break all the soil aggregations without reducing the natural size of individual particles.
2. Select a representative test sample (about 10 lbs. (5 kg)) by quartering or by using a sampler.
3. Dry the sample only enough to sift over a No. 10 (2.00 mm) sieve. Do not sift yet.
4. Weigh the sifted sample and record the weight as the weight of the total sample.
5. Split the sample into two portions with the No. 10 (2.00 mm) sieve.
6. Grind the fraction retained on the No. 10 (2.00 mm) sieve with a rubber-covered pestle or wooden mallet until the aggregations of soil particles are broken up into separate grains.

7. Separate the ground soil into two fractions again with the No. 10 (2.00 mm) sieve.
8. Weigh the fraction retained on the No. 10 (2.00 mm) sieve after the second sieving.

9. Record the weight as the weight of material retained on the No. 10 (2.00 mm) sieve.

D. Procedures

1. Thoroughly mix both fractions that passed the No. 10 (2.00 mm) sieve in both sieving operations.
2. Take a 6.6 lb (3000 g) sample from the minus No. 10 (2.00 mm) material by quartering or by using a sampler.
3. Attach the extension to the cylinder.
4. Compact the sample in the cylinder in three equal layers.
   a. Compact each layer with 25 blows from the rammer dropped from 1 ft (304.8 mm) above the soil.
   b. Rest the mold on a uniform, rigid foundation, such as a concrete block weighing at least 200 lbs (90 kg).
   c. Uniformly distribute the blows over the surface of the compacted layer.
   d. Remove the soil that adheres to the face of the rammer after every 25th blow.
5. After compacting, remove the extension and base plate.
6. Carefully level the compacted soil to the top and bottom of the cylinder with the straightedge.
7. Weigh the cylinder and sample together.
8. Calculate the wet weight of the compacted soil in pounds per cubic foot as follows:

   Wet Weight of Compacted Soil (lbs./ft^3) = $\frac{(Ws-Wc)/453.6}{V}$ or $\frac{(Ws-Wc) * \text{Mold Factor}}{453.6}$ or (Ws-Wc) * C.F.C

   V = Volume in lbs./ft^3 of the Mold as calibrated Using (Reference ASTM D-698 Mold Volume Calibration)

   Mold Factor = calculated 1/volume lbs./ft^3

   C.F.C = Correction Factor Conversion = Mold Factor/453.6

   Ws = weight of the compacted soil and mold, in grams

   Wc = weight of the mold, in grams

   If you weighed in grams, dividing by 453.6 converts grams to pounds. This will give you the wet weight in pounds per cubic foot.
9. Remove the compacted soil from the cylinder and slice it vertically through its center.
10. Take a 100 g sample from the center and weigh it immediately.
11. Dry the sample to a constant weight.
12. Calculate the moisture content of the soil as follows:
13. Moisture (%) = $\frac{A - B}{B}$ x 100

    where:

    A = weight of the wet soil

    B = weight of the dry soil
14. Thoroughly pulverize the remaining material from the compacted sample.
15. Add enough water to increase the moisture content of the soil in predetermined increments (1 percent to 2 percent for sandy soils, 2 percent to 3 percent for clay soils).

a. For a 5.94 lb (2.7 kg) sample, add 0.9 oz (27 ml) of water to increase the moisture content by 1 percent.

b. For a 6.6 lb (3000 g) sample, add 1 oz (30 ml) of water.

16. Repeat steps 1 through 13 again, taking a moisture sample after each determination.
17. Repeat the procedure until the soil becomes very wet and the wet weight of the compacted soil substantially decreases.

E. Calculations (CVP 7)

1. Calculate wet density:

$$\text{Wet Density} = \frac{(Ws - Wc)/453.6}{V} \text{ or } \frac{(Ws - Wc) * \text{Mold Factor}}{453.6} \text{ or } (Ws - Wc) * \text{C.F.C.}$$

where:

V = Volume of the Mold as calibrated Using (Ref. ASTM D-698, CVP 7)

Mold Factor = Calculated 1/volume lbs/ft^3 (Ref. CVP 7)

C.F.C = Correction Factor Conversion (GDOT Correction Factor) = Mold Factor/453.6 (Ref. CVP 7)

Wc = Weight of mold in grams

Ws = Weight of mold + wet soil in grams

2. Calculate percent moisture:

$$\% \text{ Moisture} = \frac{A - B}{B} \times 100$$

where:

A = Weight of wet soil

B = Weight of dry soil

3. Calculate the density (dry weight), in pounds per cubic foot (kilograms per cubic meter), of the compacted soil as follows:

$$\text{English—Dry Density (lb/ft}^3) = \frac{Ww}{M + 100} \times 100$$

where:

Ww = wet weight of the compacted soil, in pounds per cubic foot (Procedures, step D.8)

M = moisture content, in percent, at which the wet weight was determined (Procedures, step D.12)

4. Moisture-Density Relationship
   a. Calculate and record the percent moisture and dry density for each determination in the series.
   b. When using the moisture-density relationship for compaction control:
      i. Plot a moisture-density curve by plotting the dry densities against their respective moisture contents.
      ii. Draw a smooth curve through the resulting points.
      iii. The peak of the curve represents the maximum dry density of the material being tested, and the moisture content at this point represents the optimum moisture content.
   c. For classification purposes, interpret the maximum dry density as the highest density obtained in the test series, and the optimum moisture as the moisture content at that respective density.
5. Correction for Plus No. 10 (2.00 mm) Material

d. If the soil contains material retained on the No. 10 (2.00 mm) sieve and the specifications show density requirements on the total sample, you must correct the maximum dry density to reflect the percentage of Plus No. 10 (2.00 mm) material.

e. When determining maximum densities for compaction control, always correct the densities for the percentage of Plus No. 10 (2.00 mm) material.

f. Use the conversion factors for correcting the density in Tables 1D - 7D, below.

g. Use the conversion factors for correcting the moisture of Minus No. 10 (2.00 mm) for the Plus No. 10 (2.00 mm) 1n Tables 1M - 10M, below.

F. Report

1. Record the maximum dry density and the optimum moisture content of the material being tested as the theoretical or laboratory maximum dry density on Form 495.
2. Send the completed original form to the Office of Materials and Research in Forest Park.
3. Send copies of the form to the Branch Lab and the Area Engineer.
4. Notify the department head of any material that fails.

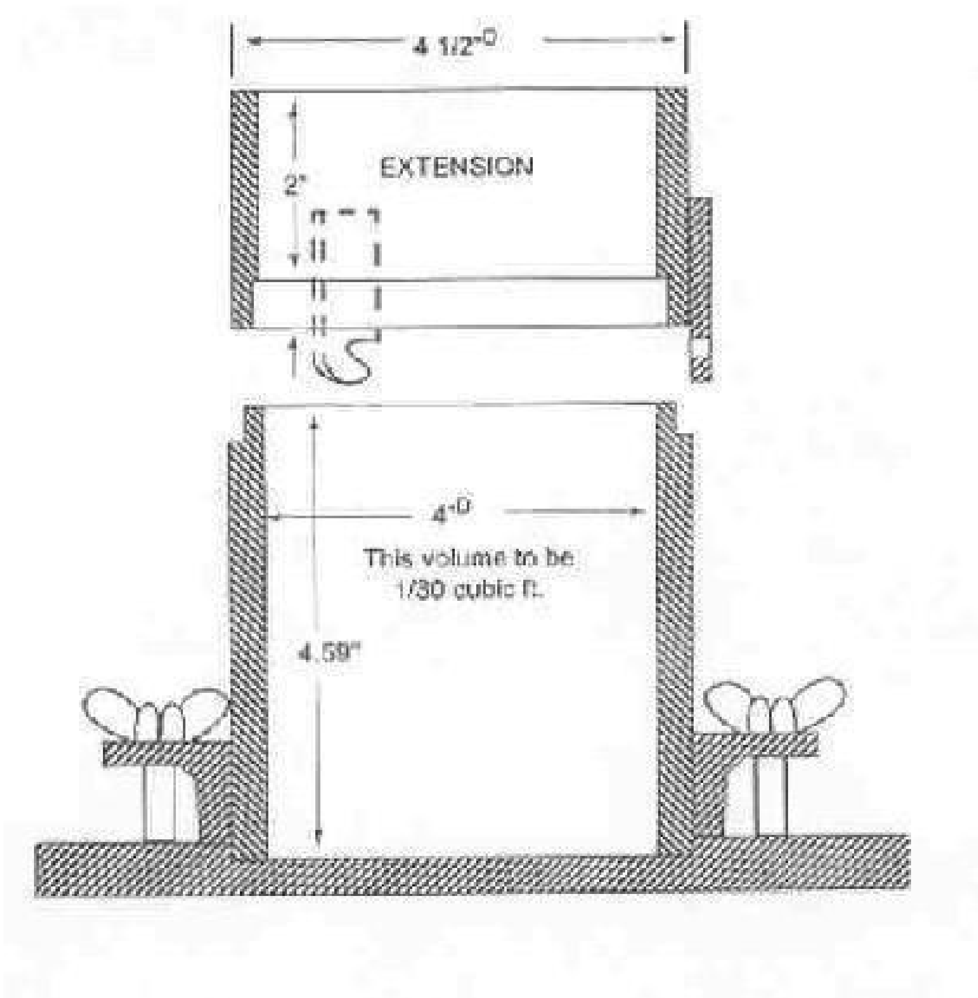

Figure 7-1

TABLE 1D FOR % PLUS NO. 10 IN TOTAL SAMPLE

% Plus No. 10 Material by Weight in Total Sample

-10 Density	1	2	3	4	5	6	7
130	130.1	130.2	130.3	130.4	130.5	130.6	130.7
129	129.1	129.2	129.3	129.4	129.5	129.6	129.7
128	128.1	128.2	128.3	128.5	128.6	128.7	128.8
127	127.1	127.3	127.4	127.5	127.6	127.8	127.9
126	126.1	126.3	126.4	126.5	126.7	126.8	126.9
125	125.2	125.3	125.4	125.6	125.7	125.9	126.0
124	124.2	124.3	124.5	124.6	124.8	124.9	125.1
123	123.2	123.3	123.5	123.6	123.8	124.0	124.1
122	122.2	122.3	122.5	122.7	122.9	123.0	123.2
121	121.2	121.4	121.5	121.7	121.9	122.1	122.2
120	120.2	120.4	120.6	120.7	120.9	121.1	121.3
119	119.2	119.4	119.6	119.8	120.0	120.2	120.4
118	118.2	118.4	118.6	118.8	119.0	119.2	119.4
117	117.2	117.4	117.6	117.9	118.1	118.3	118.5
116	116.2	116.4	116.7	116.9	117.1	117.3	117.6
115	115.2	115.5	115.7	115.9	116.2	116.4	116.6
114	114.3	114.5	114.7	115.0	115.2	115.4	115.7
113	113.3	113.5	113.8	114.0	114.3	114.5	114.8
112	112.3	112.5	112.8	113.0	113.3	113.6	113.8
111	111.3	111.5	111.8	112.1	112.3	112.6	112.9
110	110.3	110.6	110.8	111.1	111.4	111.7	111.9
109	109.3	109.6	109.9	110.1	110.4	110.7	111.0
108	108.3	108.6	108.9	109.2	109.5	109.8	110.1
107	107.3	107.6	107.9	108.2	108.5	108.8	109.1
106	106.3	106.6	106.9	107.3	107.6	107.9	108.2
105	105.3	105.6	106.0	106.3	106.6	106.9	107.3
104	104.3	104.7	105.0	105.3	105.7	106.0	106.3
103	103.3	103.7	104.0	104.4	104.7	105.0	105.4
102	102.4	102.7	103.0	103.4	103.7	104.1	104.4
101	101.4	101.7	102.1	102.4	102.8	103.1	103.5
100	100.4	100.7	101.1	101.5	101.8	102.2	102.6
99	99.4	99.8	100.1	100.5	100.9	101.3	101.6
98	98.4	98.8	99.2	99.5	99.9	100.3	100.7
97	97.4	97.8	98.2	98.6	99.0	99.4	99.8
96	96.4	96.8	97.2	97.6	98.0	98.4	98.8
95	95.4	95.8	96.2	96.6	97.1	97.5	97.9

94	94.4	94.8	95.3	95.7	96.1	96.5	96.9
93	93.4	93.9	94.3	94.7	95.1	95.6	96.0
92	92.4	92.9	93.3	93.8	94.2	94.6	95.1
91	91.5	91.9	92.3	92.8	93.2	93.7	94.1
90	90.5	90.9	91.4	91.8	92.3	92.7	93.2
89	89.5	89.9	90.4	90.9	91.3	91.8	92.3
88	88.5	88.9	89.4	89.9	90.4	90.8	91.3

87	87.5	88.0	88.4	88.9	89.4	89.9	90.4
86	86.5	87.0	87.5	88.0	88.5	89.0	89.4
85	85.5	86.0	86.5	87.0	87.5	88.0	88.5
84	84.5	85.0	85.5	86.0	86.6	87.1	87.6
83	83.5	84.0	84.6	85.1	85.6	86.1	86.6
82	82.5	83.1	86.3	84.1	84.6	85.2	85.7
81	81.5	82.1	82.6	83.1	83.7	84.2	84.8

TABLE 2D FOR % PLUS NO. 10 IN TOTAL SAMPLE

% Plus No. 10 Material by Weight in Total Sample

-10 Density	**8**	**9**	**10**	**11**	**12**	**13**	**14**
130	130.8	130.9	131.0	131.1	131.2	131.3	131.4
129	129.8	130.0	130.1	130.2	130.3	130.4	130.5
128	128.9	129.0	129.2	129.3	129.4	129.5	129.6
127	128.0	128.1	128.3	128.4	128.5	128.6	128.8
126	127.1	127.2	127.3	127.5	127.6	127.7	127.9
125	126.1	126.3	126.3	126.4	126.6	126.9	127.0
124	125.2	125.4	125.5	125.7	125.8	126.0	126.1
123	124.3	124.4	124.6	124.8	124.9	125.1	125.3
122	123.4	123.5	123.7	123.9	124.0	124.2	124.4
121	122.4	122.6	122.8	123.0	123.1	123.3	123.5

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120	121.5	121.7	121.9	122.1	122.2	122.4	122.6
119	120.6	120.8	121.0	121.2	121.4	121.5	121.7
118	119.6	119.8	120.1	120.3	120.5	120.7	120.9
117	118.7	118.9	119.1	119.4	119.6	119.8	120.0
116	117.8	118.0	118.2	118.5	118.7	118.9	119.1
115	116.9	117.1	117.3	117.6	117.8	118.0	118.2
114	115.9	116.2	116.4	116.7	116.9	117.1	117.4
113	115.0	115.3	115.5	115.8	116.0	116.3	116.5
112	114.1	114.3	114.6	114.8	115.1	115.4	115.6
111	113.1	113.4	113.7	113.9	114.2	114.5	114.8
110	112.2	112.5	112.8	113.0	113.3	113.6	113.9
109	111.3	111.6	111.9	112.1	112.4	112.7	113.0
108	110.4	110.7	111.0	111.2	111.5	111.8	112.1
107	109.4	109.7	110.0	110.3	110.6	111.0	111.3
106	108.5	108.8	109.1	109.4	109.8	110.1	110.4
105	107.6	107.9	108.2	108.5	108.9	109.2	109.5
104	106.6	107.0	107.3	107.6	108.0	108.3	108.6
103	105.7	106.1	106.4	106.7	107.1	107.4	107.8
102	104.8	105.1	105.5	105.8	106.2	106.5	106.9
101	103.9	104.2	104.6	104.9	105.3	105.7	106.0
100	102.9	103.3	103.7	104.0	104.4	104.8	105.1
99	102.0	102.4	102.8	103.1	103.5	103.9	104.3
98	101.1	101.5	101.9	102.2	102.6	103.0	103.4
97	100.2	100.5	100.9	101.3	101.7	102.1	102.5
96	99.2	99.6	100.0	100.4	100.8	101.2	101.6
95	98.3	98.7	99.1	99.5	99.9	100.3	100.8
94	97.4	97.8	98.2	98.6	99.0	99.5	99.9
93	96.4	96.9	97.3	97.7	98.1	98.6	99.0
92	95.5	95.9	96.4	96.8	97.3	97.7	98.1
91	94.6	95.0	95.5	95.9	96.4	96.8	97.3

GDT 7

90	93.6	94.1	94.6	95.0	95.5	95.9	96.4
89	92.7	93.2	93.7	94.1	94.6	95.0	95.5
88	91.8	92.3	92.7	93.2	93.7	94.2	94.6
87	90.9	91.3	91.8	92.3	92.8	93.3	93.8
86	89.9	90.4	90.9	91.4	91.9	92.4	92.9
85	89.0	89.5	90.0	90.5	91.0	91.5	92.0
84	88.1	88.6	89.1	89.6	90.1	90.6	91.1
83	87.2	87.7	88.2	88.7	89.2	89.7	90.3
82	86.2	86.8	87.3	87.8	88.3	88.9	89.4
81	85.3	85.8	86.4	89.9	87.4	88.0	88.5

TABLE 3D FOR % PLUS NO. 10 IN TOTAL SAMPLE
% Plus No. 10 Material by Weight in Total Sample

-10 Density	15	16	17	18	19	20	21
130	131.5	131.6	131.7	131.8	131.9	132.0	132.1
129	130.6	130.7	130.8	130.9	131.0	131.1	131.2
128	129.7	129.9	130.0	130.1	130.2	130.3	130.4
127	128.9	129.0	129.1	129.3	129.4	129.5	129.6
126	128.0	128.1	128.3	128.4	128.5	128.7	128.8
125	127.1	127.3	127.4	127.6	127.7	127.9	128.0
124	126.3	126.4	126.6	126.7	126.9	127.0	127.2
123	125.4	125.6	125.7	125.9	126.1	126.2	126.4
122	124.6	124.7	124.9	125.1	125.2	125.4	125.6
121	123.7	123.8	124.0	124.2	124.4	124.6	124.7
120	122.8	123.0	123.2	123.4	123.6	123.7	123.9
119	121.9	122.1	122.3	122.5	122.7	122.9	123.1
118	121.1	121.3	121.5	121.7	121.9	122.1	122.3
117	120.2	120.4	120.6	120.9	121.1	121.3	121.5
116	119.3	119.6	119.8	120.0	120.2	120.5	120.7
115	118.5	118.7	118.9	119.2	119.4	119.6	119.9
114	117.6	117.9	118.1	118.3	118.6	118.8	119.1
113	116.8	117.0	117.3	117.5	117.8	118.0	118.3
112	115.9	116.1	116.4	116.7	116.9	117.2	117.4
111	115.0	115.3	115.6	115.8	116.1	116.4	116.6
110	114.2	114.4	114.7	115.0	115.3	115.5	115.8
109	113.3	113.6	113.9	114.1	114.4	114.7	115.0
108	112.4	112.7	113.0	113.3	113.6	113.9	114.2
107	111.6	111.9	112.2	112.5	112.8	113.1	113.4
106	110.7	111.0	111.3	111.6	111.9	112.3	112.6
105	109.8	110.2	110.5	110.8	111.1	111.4	111.8
104	109.0	109.3	109.6	110.0	110.3	110.6	111.0
103	108.1	108.4	108.8	109.1	109.5	109.8	110.0
102	107.2	107.6	107.9	108.3	108.6	109.0	109.3
101	106.4	106.7	107.1	107.4	407.8	108.2	108.5
100	105.5	105.9	106.2	106.6	107.0	107.3	107.7
99	104.6	105.0	105.4	105.8	106.1	106.5	106.9
98	103.8	104.2	104.5	104.9	105.3	105.7	106.1
97	102.9	103.3	103.7	104.1	104.5	104.9	105.3
96	102.0	102.4	102.8	103.2	103.6	104.0	104.4

GDT 7

95	101.2	101.6	102.0	102.4	102.8	103.2	103.6
94	100.3	100.7	101.1	101.6	102.0	102.4	102.8
93	99.4	99.9	100.3	100.7	101.2	101.6	102.0
92	98.6	99.0	99.4	99.9	100.3	100.8	101.2
91	97.7	98.2	98.6	99.0	99.5	99.9	100.4
90	96.8	97.3	97.8	98.2	98.7	99.1	99.6
89	96.0	96.4	96.9	97.4	97.8	98.3	98.8
88	95.1	95.6	96.1	96.5	97.0	97.5	98.0
87	94.2	94.7	95.2	95.7	96.2	96.7	97.1
86	93.4	93.9	94.4	94.9	95.3	95.8	96.3
85	92.5	93.0	93.5	94.0	94.5	95.0	95.5
84	91.7	92.2	92.7	93.2	93.7	94.2	94.7
83	90.8	91.3	91.8	92.3	90.9	93.4	93.9
82	89.9	90.4	91.0	91.5	92.0	92.6	93.1
81	89.1	89.6	90.1	90.7	91.2	91.7	92.3

TABLE 4D FOR % PLUS NO. 10 IN TOTAL SAMPLE
% Plus No. 10 Material by Weight in Total Sample

-10 Density	22	23	24	25	26	27	28
130	132.2	132.3	132.4	132.5	132.5	132.6	132.7
129	131.4	131.5	131.6	131.7	131.8	131.9	132.0
128	130.6	130.7	130.8	130.9	131.0	131.1	131.2
127	129.8	129.9	130.0	130.1	130.3	130.4	130.5
126	128.9	129.1	129.2	129.4	129.5	129.6	129.8
125	128.1	128.3	128.4	128.6	128.7	128.9	129.0
124	127.3	127.5	127.6	127.8	128.0	128.1	128.3
123	126.5	126.7	126.9	127.0	127.2	127.3	127.5
122	125.7	125.9	126.1	126.3	126.4	126.6	126.8
121	124.9	125.1	125.3	125.5	125.6	125.8	126.0
120	124.1	124.3	124.5	124.7	124.9	125.0	125.0
119	123.3	123.5	123.7	123.9	124.1	124.3	124.5
118	122.5	122.7	122.9	123.1	123.3	123.5	123.7
117	121.7	121.9	122.1	122.4	122.6	122.8	123.0
116	120.9	121.1	121.4	121.6	121.8	122.0	122.2
115	120.1	120.3	120.6	120.8	121.0	121.3	121.5
114	119.3	119.5	119.8	120.0	120.3	120.5	120.7
113	118.5	118.8	119.0	119.3	119.5	119.8	120.0
112	117.7	118.0	118.2	118.5	118.7	119.0	119.3
111	116.9	117.2	117.4	117.7	118.0	118.2	118.5
110	116.1	116.4	116.6	116.9	117.2	117.5	117.8
109	115.3	115.6	115.9	116.2	116.4	116.7	117.0
108	114.5	114.8	115.1	115.4	115.7	116.0	116.3
107	113.7	114.0	114.3	114.6	114.9	115.2	115.5
106	112.9	113.2	113.5	113.8	114.1	114.5	114.8
105	112.1	112.4	112.7	113.1	113.4	113.7	114.0
104	111.3	111.6	111.9	112.3	112.6	112.9	113.3
103	110.5	110.8	111.2	111.5	111.8	112.2	112.5
102	109.7	110.0	110.4	110.7	111.1	111.4	111.8
101	108.9	109.2	109.6	110.0	110.3	110.7	111.0
100	108.1	108.4	108.8	109.2	109.5	109.9	110.3
99	107.3	107.6	108.0	108.4	408.8	109.2	109.5
98	106.5	106.9	107.2	107.6	108.0	108.4	108.8
97	105.7	106.1	106.5	106.9	107.2	107.6	108.0

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96	104.8	105.2	105.6	106.1	106.5	106.9	107.3
95	104.0	104.5	104.9	105.3	105.7	106.1	106.5
94	103.2	103.7	104.1	104.5	104.9	105.3	105.8
93	102.4	102.9	103.3	103.7	104.2	104.6	105.0
92	101.6	102.1	102.5	103.0	103.4	103.8	104.3
91	100.8	101.3	101.7	102.2	102.6	103.1	103.5
90	100.0	100.5	100.9	101.4	101.9	102.3	102.8
89	99.2	99.7	100.2	100.6	101.1	101.6	102.0
88	98.4	98.9	99.4	99.9	100.3	100.8	101.3
87	97.6	98.1	98.6	99.1	99.6	100.0	100.5
86	96.8	97.3	97.8	98.3	98.8	99.3	99.8
85	96.0	96.5	97.0	97.5	98.0	98.5	99.0
84	95.2	95.7	96.2	96.8	97.3	97.8	98.3
83	94.4	94.9	95.5	96.0	96.5	97.0	97.5
82	93.6	94.1	94.7	95.2	95.7	96.3	96.8
81	92.8	93.4	93.9	94.4	95.0	95.5	96.0

TABLE 5D FOR % PLUS NO. 10 IN TOTAL SAMPLE
% Plus No. 10 Material by Weight in Total Sample

-10 Density	29	30	31	32	33	34	35
130	132.8	132.9	133.0	133.1	133.2	133.3	133.4
129	132.1	132.2	132.3	132.4	132.5	132.6	132.7
128	131.4	131.5	131.6	131.7	131.8	131.9	132.1
127	130.6	130.8	130.9	131.0	131.1	131.3	131.4
126	129.9	130.0	130.2	130.3	130.4	130.6	130.7
125	129.1	129.3	129.4	129.6	129.7	129.8	130.0
124	128.4	128.6	128.7	128.9	129.0	129.2	129.3
123	127.7	127.8	128.0	128.2	128.3	128.5	128.6
122	126.9	127.1	127.3	127.4	127.6	127.8	128.0
121	126.2	126.3	126.5	126.7	126.9	127.1	127.2
120	125.4	125.6	125.8	126.0	126.2	126.4	126.5
119	124.7	124.9	125.1	125.3	125.5	125.7	125.9
118	123.9	124.2	124.4	124.6	124.8	125.0	125.2
117	123.2	123.4	123.6	123.8	124.1	124.3	124.5
116	122.5	122.7	122.9	123.1	123.4	123.6	123.8
115	121.7	122.0	122.2	122.4	122.7	122.9	123.1
114	121.0	121.2	121.5	121.7	122.0	122.2	122.4
113	120.3	120.5	120.8	121.0	121.3	121.5	121.8
112	119.5	119.8	120.0	120.3	120.5	120.8	121.1
111	118.8	119.0	119.3	119.6	119.8	120.1	120.4
110	118.0	118.3	118.6	118.9	119.1	119.4	119.7
109	117.3	117.6	117.9	118.2	118.4	118.7	119.0
108	116.6	116.9	117.1	117.4	117.7	118.0	118.3
107	115.8	116.1	116.4	116.7	117.0	117.3	117.6
106	115.1	115.4	115.7	116.0	116.3	116.6	117.0
105	114.3	114.7	115.0	115.3	115.6	115.9	116.3
104	113.6	113.9	114.3	114.6	114.9	115.3	115.6
103	112.9	113.2	113.5	113.9	114.2	114.6	114.9
102	112.1	112.5	112.8	113.2	113.5	113.9	114.2
101	111.4	111.7	112.1	112.5	112.8	113.2	113.5
100	110.6	111.0	111.4	111.7	112.1	112.5	112.8
99	109.9	110.3	110.7	111.0	111.4	111.8	112.2
98	109.2	109.6	109.9	110.3	110.7	111.1	111.5

GDT 7

97	108.4	408.8	109.2	109.6	110.0	110.4	110.8
96	107.7	108.1	108.5	108.9	109.3	109.7	110.1
95	106.9	107.3	107.7	108.2	108.6	109.0	109.4
94	106.2	106.6	107.0	107.4	107.9	108.3	108.7
93	105.4	105.9	106.3	106.7	107.2	107.6	108.0
92	104.7	105.1	105.6	106.0	106.5	106.9	107.3
91	104.0	104.4	104.9	105.3	105.8	106.2	106.6

90	103.2	103.7	104.1	104.6	105.0	105.5	106.0
89	102.5	103.0	103.4	103.9	104.3	104.8	105.3
88	101.7	102.2	102.7	103.2	103.6	104.1	104.6
87	101.0	101.5	102.0	102.5	102.9	103.4	103.9
86	100.3	100.8	101.3	101.7	102.2	102.7	103.2
85	99.5	100.0	100.5	101.0	101.5	102.0	102.5
84	98.8	99.3	99.8	100.3	100.8	101.3	101.9
83	98.1	98.6	99.1	99.6	100.1	100.6	101.2
82	97.3	97.8	98.4	98.9	99.4	100.0	100.5
81	96.6	97.1	97.6	98.2	98.7	99.3	99.8

TABLE 6D FOR % PLUS NO. 10 IN TOTAL SAMPLE
% Plus No. 10 Material by Weight in Total Sample

-10 Density	36	37	38	39	40	41	42
130	133.5	133.6	133.7	133.8	133.9	134.0	134.1
129	132.9	133.0	133.1	133.2	133.3	133.4	133.5
128	132.2	132.3	132.4	132.5	132.6	132.8	132.9
127	131.5	131.6	131.8	131.9	132.0	132.1	132.3
126	130.8	131.0	131.1	131.2	131.4	131.5	131.6
125	130.1	130.3	130.4	130.6	130.7	130.9	131.0
124	129.5	129.6	129.8	129.9	130.1	130.2	130.4
123	128.8	129.0	129.1	129.3	129.4	129.6	129.8
122	128.1	128.3	128.5	128.6	128.8	129.0	129.1
121	127.4	127.6	127.8	127.9	128.1	128.3	128.5
120	126.7	126.9	127.1	127.3	127.5	127.7	127.9
119	126.1	126.3	126.4	126.6	126.8	127.0	127.2

GDT 7

118	125.4	125.6	125.8	126.0	126.2	126.4	126.6
117	124.7	124.9	125.1	125.3	125.6	125.8	126.0
116	124.0	124.3	124.5	124.7	124.9	125.1	125.4
115	123.4	123.6	123.8	124.0	124.3	124.5	124.7
114	122.7	122.9	123.2	123.4	123.6	123.9	124.1
113	122.0	122.3	122.5	122.8	123.0	123.3	123.5
112	121.3	121.6	121.8	122.1	122.4	122.6	122.9
111	120.6	120.9	121.2	121.5	121.7	122.0	122.3
110	120.0	120.2	120.5	120.8	121.1	121.4	121.6
109	119.3	119.6	119.9	120.2	120.4	120.7	121.0
108	118.6	118.9	119.2	119.5	119.8	120.1	120.4
107	117.9	118.2	118.6	118.9	119.2	119.5	119.8
106	117.3	117.6	117.9	118.2	118.5	118.8	119.1
105	116.6	116.9	117.2	117.6	117.9	118.2	118.5
104	115.9	116.2	116.6	116.9	117.2	117.6	117.9
103	115.2	115.6	115.9	116.3	116.6	116.9	117.3
102	114.6	114.9	115.3	115.6	116.0	116.3	116.7
101	113.9	114.2	114.6	115.0	115.3	115.7	116.0
100	113.2	113.6	113.9	114.3	114.7	115.0	115.4
99	112.5	112.9	113.3	113.7	114.0	114.4	114.8
98	111.9	112.2	112.6	113.0	113.4	113.8	114.2
97	111.2	111.6	112.0	112.4	112.8	113.2	113.5
96	110.5	110.9	111.3	111.7	112.1	112.5	112.9
95	109.8	110.2	110.6	111.0	111.4	111.9	112.3
94	109.1	109.5	110.0	110.4	110.8	111.2	111.6
93	108.4	108.9	109.3	109.7	110.2	110.6	111.0
92	107.8	108.2	108.6	109.1	109.5	110.0	110.4
91	107.1	107.5	108.0	108.4	108.9	109.3	109.8

GDT 7

90	106.4	106.9	107.3	107.8	108.2	108.7	109.2
89	105.7	106.2	106.7	107.1	107.6	108.1	108.5
88	105.1	105.5	106.0	106.5	107.0	107.4	107.9
87	104.4	104.9	105.4	105.8	106.3	106.8	107.3
86	103.7	104.2	104.7	105.2	105.7	106.2	106.7
85	103.0	103.5	104.0	104.5	105.0	105.5	106.0
84	102.4	102.9	103.4	103.9	104.4	104.9	105.4
83	101.7	102.2	102.7	103.2	103.8	104.3	104.8
82	101.0	101.5	102.1	102.6	103.1	103.6	104.2
81	100.3	100.9	101.4	101.9	102.5	103.0	103.6

TABLE 7D FOR % PLUS NO 10 IN TOTAL SAMPLE
% PLUS NO 10 Material by Weight Total Sample

-10 Density	43	44	45
130	134.2	134.3	134.4
129	133.6	133.7	133.8
128	133.0	133.1	133.2
127	132.4	132.5	132.6
126	131.8	131.9	132.0
125	131.1	131.3	131.4
124	130.5	130.7	103.8
123	129.9	130.1	130.2
122	129.3	129.5	129.7
121	128.7	128.8	139.0
120	128.0	128.2	128.8
119	127.4	127.6	127.8
118	126.8	127.0	127.2
117	126.2	126.4	126.6
116	125.6	125.8	126.0
115	125.0	125.2	125.4
114	124.4	124.6	124.8
113	123.8	124.0	124.3
112	123.1	123.4	123.7
111	122.5	122.8	123.1
110	121.9	122.2	122.5
109	121.3	121.6	121.9
108	120.7	121.0	121.3
107	120.1	120.4	120.7
106	119.5	119.8	120.1
105	118.8	119.2	119.5
104	118.2	118.6	118.9
103	117.6	118.0	118.3
102	117.0	117.4	117.7
101	116.4	116.8	117.1
100	115.8	116.1	116.5
99	115.2	115.5	115.9
98	114.6	114.9	115.3
97	113.9	114.3	114.7
96	113.3	113.7	114.1
95	112.7	113.1	113.5
94	112.1	112.5	112.9

GDT 7

93	111.4	111.9	112.3
92	110.8	111.3	111.7
91	110.2	110.7	111.1
90	109.7	110.1	110.5
89	109.0	109.5	109.9
88	108.4	108.9	109.3
87	107.8	108.3	108.7
86	107.2	107.6	108.1
85	106.5	107.0	107.5
84	105.9	106.4	107.0
83	105.3	105.8	106.4
82	104.7	105.2	105.8
81	104.1	104.6	105.2

— 10

TABLE 1M MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No.
(FOR + 10 ABSORPTION OF 1%)
% Plus No. 10 Material by Weight in Total Sample

-10 Moisture	5	10	15	20	25
40	38.1	36.1	34.2	32.2	30.3
39	37.1	35.2	33.3	31.4	29.5
38	36.2	34.3	32.5	30.6	28.8
37	35.2	33.4	31.6	29.8	28.0
36	34.3	32.5	30.8	29.0	27.3
35	33.3	31.6	29.9	28.2	26.5
34	32.4	30.7	29.1	27.4	25.8
33	31.4	29.8	28.2	26.6	25.0
32	30.5	28.9	27.4	25.8	24.3
31	29.5	28.0	26.5	25.0	23.5
30	28.6	27.1	25.7	24.2	22.8
29	27.6	26.2	24.8	23.4	22.0
28	26.7	25.3	23.9	22.6	21.3
27	25.7	24.2	23.1	21.8	20.5
26	24.8	23.5	22.3	21.0	19.8
25	23.8	22.6	21.4	20.2	19.0
24	22.9	21.7	20.6	19.4	18.3
23	21.9	20.8	19.7	18.6	17.5
22	21.0	19.9	18.9	17.8	16.8
21	20.0	19.0	18.0	17.0	16.0
20	19.1	18.1	17.2	16.2	15.3
19	18.1	17.2	16.3	15.4	14.5
18	17.2	16.3	15.5	14.6	13.8
17	16.2	15.4	14.6	13.8	13.0
16	15.3	14.6	13.8	13.0	12.3
15	14.3	13.6	12.9	12.2	11.5
14	13.4	12.7	12.1	11.4	10.8
13	12.4	11.8	11.2	10.6	10.0
12	11.5	11.0	10.4	9.8	9.3
11	10.5	10.0	9.5	9.0	8.5
10	9.6	9.1	8.7	8.2	7.8
9	8.6	8.2	7.8	7.4	7.0
8	7.7	7.3	7.0	6.6	6.3
7	6.7	6.4	6.1	5.8	5.5
6	5.8	5.5	5.3	5.0	4.8

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5	4.8	4.6	4.4	4.2	4.0
4	3.9	3.7	3.6	3.4	3.3
3	2.9	2.8	2.7	2.6	2.5
2	2.0	1.9	1.9	1.8	1.8

TABLE 2M MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No.
(FOR + 10 ABSORPTION OF 1%)
% Plus No. 10 Material by Weight in Total Sample

-10 Moisture	30	35	40	45
40	28.3	26.4	24.4	22.5
39	27.6	25.7	23.8	21.9
38	26.9	25.1	23.2	21.4
37	26.2	24.4	22.6	20.8
36	25.5	23.8	22.0	20.3
35	24.8	23.1	21.4	19.7
34	24.1	22.5	20.8	19.2
33	23.4	21.8	20.2	18.6
32	22.7	21.2	19.6	18.1
31	22.0	20.5	19.0	17.5
30	21.3	19.9	18.4	17.0
29	20.6	19.2	17.8	16.4
28	19.9	18.6	17.2	15.9
27	19.2	17.9	16.6	15.3
26	18.5	17.3	16.0	14.8
25	17.8	16.6	15.4	14.2
24	17.1	16.0	14.8	13.7
23	16.4	15.3	14.2	13.1
22	15.7	14.7	13.6	12.6
21	15.0	14.0	13.0	12.0
20	14.3	13.4	12.4	11.5
19	13.6	12.7	11.8	10.9
18	12.9	12.1	11.2	10.4
17	12.2	11.4	10.6	9.8
16	11.5	10.8	10.0	9.3
15	10.8	10.1	9.4	8.7
14	10.1	9.5	8.8	8.2
13	9.4	8.8	8.2	7.6
12	8.7	8.2	7.6	7.1
11	8.0	7.5	7.0	6.5
10	7.3	6.9	6.4	6.0
9	6.6	6.2	5.8	5.4

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8	5.9	5.6	5.2	4.9
7	5.2	4.9	4.6	4.3
6	4.5	4.3	4.0	3.8
5	3.8	3.6	3.4	3.3
4	3.1	3.0	2.8	2.7
3	2.4	2.3	2.2	2.1
2	1.7	1.7	1.6	1.6

TABLE 3M MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No.
(FOR + 10 ABSORPTION OF 2%)
% Plus No. 10 Material by Weight in Total Sample

-10 Moisture	5	10	15	20	25
40	38.1	36.2	34.3	32.4	30.5
39	37.2	35.3	33.5	31.6	29.8
38	36.2	34.4	32.6	30.8	29.0
37	35.3	33.5	31.8	30.0	28.3
36	34.3	32.6	30.9	29.2	27.5
35	33.4	31.7	30.1	28.4	26.8
34	32.4	30.8	29.2	27.6	26.0
33	31.5	29.9	28.4	26.8	25.3
32	30.5	29.0	27.5	26.0	24.5
31	29.6	28.1	26.7	25.2	23.8
30	28.6	27.2	25.8	24.4	23.0
29	27.7	26.3	25.0	23.6	22.3
28	26.7	25.4	24.1	22.8	21.5
27	25.8	24.5	23.3	22.0	20.8
26	24.8	23.6	22.4	21.2	20.0
25	23.9	22.7	21.6	20.4	19.3
24	22.9	21.8	20.7	19.6	18.5
23	22.0	20.9	19.9	18.8	17.8
22	21.0	20.0	19.0	18.0	17.0
21	20.1	19.1	18.2	17.2	16.3
20	19.1	18.2	17.3	16.4	15.5
19	18.2	17.3	16.5	15.6	14.8
18	17.2	16.4	15.6	14.8	14.0
17	16.3	15.5	14.8	14.0	13.3
16	15.3	14.6	13.9	13.2	12.5
15	14.4	13.7	13.1	12.4	11.8
14	13.4	12.8	12.2	11.6	11.0
13	12.5	11.9	11.4	10.8	10.3
12	11.5	11.0	10.5	10.0	9.5
11	10.6	10.1	9.7	9.2	8.8

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10	9.6	9.2	8.8	8.5	8.0
9	8.7	8.3	8.0	7.6	7.3
8	7.7	7.4	7.1	6.8	6.5
7	6.8	6.5	6.3	6.0	5.8
6	5.8	5.6	5.4	5.2	5.0
5	4.9	4.7	4.6	4.4	4.3
4	3.9	3.8	3.7	3.6	3.5
3	3.0	2.9	2.9	2.8	2.8
2	2.0	2.0	2.0	2.0	2.0

—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10

Sample

TABLE 4M

(FOR + 10 ABSORPTION OF 2%)

% Plus No. 10 Material by Weight in Total

-10 Moisture	30	35	40	45
40	28.6	26.7	24.8	22.9
39	27.9	26.1	24.2	22.4
38	27.2	25.4	23.6	21.8
37	26.5	24.8	23.0	21.3
36	25.8	24.1	22.4	20.7
35	25.1	23.5	21.8	20.2
34	24.4	22.8	21.2	19.6
33	23.7	22.2	20.6	19.1
32	23.0	21.5	20.0	18.5
31	22.3	20.9	19.4	18.0
30	21.6	20.2	18.8	17.4
29	20.9	19.6	18.2	16.9
28	20.2	18.9	17.6	16.3
27	19.5	18.3	17.0	15.8
26	18.8	17.6	16.4	15.2
25	18.1	17.0	15.8	14.7
24	17.4	16.3	15.2	14.1
23	16.7	15.7	14.6	13.6
22	16.0	15.0	14.0	13.0
21	15.3	14.4	13.4	12.5
20	14.6	13.7	12.8	11.9
19	13.9	13.1	12.2	11.4
18	13.2	12.4	11.6	10.8
17	12.5	11.8	11.0	10.3
16	11.8	11.1	10.4	9.7
15	11.1	10.5	9.8	9.2
14	10.4	9.8	9.2	8.6
13	9.7	9.2	8.6	8.1
12	9.0	8.5	8.0	7.5
11	8.3	7.9	7.4	7.0
10	7.6	7.2	6.8	6.4
9	6.9	6.6	6.2	5.9
8	6.2	5.9	5.6	5.3
7	5.5	5.3	5.0	4.8

—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10

Sample

6	4.8	4.6	4.4	4.2
5	4.1	4.0	3.8	3.7
4	3.4	3.3	3.2	3.1
3	2.7	2.7	2.6	2.6
2	2.0	2.0	2.0	2.0

TABLE 5M

(FOR + 10 ABSORPTION OF 3%)

% Plus No. 10 Material by Weight in Total

-10 Moisture	**5**	**10**	**15**	**20**	**25**
40	38.2	36.3	34.5	32.6	30.8
39	37.2	35.4	33.6	31.8	30.0
38	36.3	34.5	32.8	31.0	29.3
37	35.3	33.6	31.9	30.2	28.5
36	34.4	32.7	31.1	29.4	27.8
35	33.4	31.8	30.2	28.6	27.0
34	32.5	30.9	29.4	27.8	26.3
33	31.5	30.0	28.5	27.0	25.5
32	30.6	29.1	27.7	26.2	24.8
31	29.6	28.2	26.8	25.4	24.0
30	28.7	27.3	26.0	24.6	23.3
29	27.7	26.4	25.1	23.8	22.5
28	26.8	25.5	24.3	23.0	21.8
27	25.8	24.6	23.4	22.2	21.0
26	24.9	23.7	22.6	21.4	20.3
25	23.9	22.8	21.7	20.6	19.5
24	23.0	21.9	20.9	19.8	18.8
23	22.0	21.0	20.0	19.0	18.0
22	21.1	20.1	19.2	18.2	17.3
21	20.1	19.2	18.3	17.4	16.5
20	19.2	18.3	17.5	16.6	15.8
19	18.2	17.4	16.6	15.8	15.0
18	17.3	16.5	15.8	15.0	14.3
17	16.3	15.6	14.9	14.2	13.5
16	15.4	14.7	14.1	13.4	12.8
15	14.4	13.8	13.2	12.6	12.0
14	13.5	12.9	12.4	11.8	11.3
13	12.5	12.0	11.5	11.0	10.5
12	11.6	11.1	10.7	10.2	9.8

—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10

Sample

11	10.6	10.2	9.8	9.4	9.0
10	9.7	9.3	9.0	8.6	8.3
9	8.7	8.4	8.1	7.8	7.5
8	7.8	7.5	7.3	7.0	6.8
7	6.8	6.6	6.4	6.2	6.0
6	5.9	5.7	5.6	5.4	5.3
5	4.9	4.8	4.7	4.6	4.5
4	4.0	3.9	3.9	3.8	3.8
3	3.0	3.0	3.0	3.0	3.0
2	2.1	2.1	2.2	2.2	2.3

TABLE 6M

(FOR + 10 ABSORPTION OF 3%)

% Plus No. 10 Material by Weight in Total

-10 Moisture	**30**	**35**	**40**	**45**
40	28.9	27.1	25.2	23.4
39	28.2	26.4	24.6	22.8
38	27.5	25.8	24.0	22.3
37	26.8	25.1	23.4	21.7
36	26.1	24.5	22.8	21.2
35	25.4	23.8	22.2	20.6
34	24.7	23.2	21.6	21.1
33	24.0	22.5	21.0	19.5
32	23.3	21.9	20.4	19.0
31	22.6	21.2	19.8	16.4
30	21.9	20.6	19.2	17.9
29	21.2	19.9	18.6	17.3
28	20.5	19.3	18.0	16.8
27	19.8	18.6	17.4	16.2
26	19.1	18.0	16.8	15.7
25	18.4	17.3	16.2	15.1
24	17.7	16.7	15.6	14.6
23	17.0	16.0	15.0	14.0
22	16.3	15.4	14.4	13.5
21	15.6	14.7	13.8	12.9
20	14.9	14.1	13.2	12.4
19	14.2	13.4	12.6	11.8
18	13.5	12.8	12.0	11.3

—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10

Sample

17	12.8	12.1	11.4	10.7
16	12.1	11.5	10.8	10.2
15	11.4	10.8	10.2	9.6
14	10.7	10.2	9.6	9.1
13	10.0	9.5	9.0	8.5
12	9.3	8.9	8.4	8.0
11	8.6	8.2	7.8	7.4
10	7.9	7.6	7.2	6.9
9	7.2	6.9	6.6	6.3
8	6.5	6.3	6.0	5.8
7	5.8	5.6	5.4	5.2
6	5.1	5.0	4.8	4.7
5	4.4	4.3	4.2	4.1
4	3.7	3.7	3.6	3.6
3	3.0	3.0	3.0	3.0
2	2.3	2.4	2.4	2.5

TABLE 7M—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10
(FOR + 10 ABSORPTION OF 4%)
% Plus No. 10 Material by Weight in Total Sample

-10 Moisture	5	10	15	20	25
40	38.2	36.4	34.6	32.8	31.0
39	37.3	35.5	33.8	32.0	30.3
38	36.3	34.6	32.9	31.2	29.5
37	35.4	33.7	32.1	30.4	28.8
36	34.4	32.8	31.2	29.6	28.0
35	33.5	31.9	30.4	28.8	27.3
34	32.5	31.0	30.5	28.0	26.5
33	31.6	31.1	28.7	27.2	25.8
32	30.6	29.2	27.8	26.4	25.0
31	29.7	28.3	27.0	25.6	24.3
30	28.7	27.4	26.1	24.8	23.5
29	27.8	26.5	25.3	24.0	22.8
28	26.8	25.6	24.4	23.2	22.0
27	25.9	24.7	23.6	22.4	21.3
26	24.9	23.8	22.7	21.6	20.5
25	24.0	22.9	21.9	20.8	19.8
24	23.0	22.0	21.0	20.0	19.0
23	22.1	21.1	20.2	19.2	18.3
22	21.1	20.2	19.3	18.4	17.5
21	20.2	19.3	18.5	17.6	16.8
20	19.2	18.4	17.6	16.8	16.0
19	18.3	17.5	16.8	16.0	15.3
18	17.3	16.6	15.9	15.2	14.5
17	16.4	15.7	15.1	14.4	13.8
16	15.4	14.8	14.2	13.6	13.0
15	14.5	13.9	13.4	12.8	12.3
14	13.5	13.0	12.5	12.0	11.5
13	12.6	12.1	11.7	11.2	10.8
12	11.6	11.2	10.8	10.4	10.0
11	10.7	10.3	10.0	9.6	9.3
10	9.7	9.4	9.1	8.8	8.5
9	8.8	8.5	8.3	8.0	7.8
8	7.8	7.6	7.4	7.2	7.0
7	6.9	6.7	6.6	6.4	6.3
6	5.9	5.8	5.7	5.6	5.5
5	5.0	4.9	4.9	4.8	4.8
4	4.0	4.0	4.0	4.0	4.0
3	3.1	3.1	3.2	3.2	3.3
2	2.1	2.2	2.3	2.4	2.5

TABLE 8M—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10
(FOR + 10 ABSORPTION OF 4%) %
Plus No. 10 Material by Weight in Total Sample

-10 Moisture	**30**	**35**	**40**	**45**
40	29.2	27.4	25.6	23.8
39	28.5	26.8	25.0	23.3
38	27.8	26.1	24.4	22.7
37	27.1	25.5	23.8	22.2
36	26.4	24.8	23.2	21.6
35	25.7	25.4	22.6	21.1
34	25.0	23.5	22.0	20.5
33	24.3	22.9	21.4	20.0
32	23.6	22.2	20.8	19.4
31	22.9	21.6	20.2	18.9
30	22.2	20.9	20.6	18.3
29	21.5	20.3	19.0	17.8
28	20.8	19.6	18.4	17.2
27	20.1	19.0	17.8	16.7
26	19.4	18.3	17.2	16.1
25	18.7	17.7	16.6	15.6
24	18.0	17.0	16.0	15.0
23	17.3	16.4	15.4	14.5
22	16.0	15.7	14.8	13.9
21	15.9	15.1	14.2	13.4
20	15.2	14.4	13.6	12.8
19	14.5	13.8	13.0	12.3
18	13.8	13.1	12.4	11.7
17	13.1	12.5	11.8	11.2
16	12.4	11.8	11.2	10.6
15	11.7	11.2	10.6	10.1
14	11.0	10.5	10.0	9.5
13	10.3	9.9	9.4	9.0
12	9.6	9.2	8.8	8.4
11	8.9	8.6	8.2	7.9
10	8.2	7.9	7.6	7.3
9	7.5	7.3	7.0	6.8
8	6.8	6.6	6.4	6.2
7	6.1	6.0	5.8	5.7
6	5.4	5.3	5.2	5.1
5	4.7	4.7	4.6	4.6
4	4.0	4.0	4.0	4.0

3	3.3	3.4	3.4	3.5
2	2.6	2.7	2.8	2.9

TABLE 9M—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10
(FOR + 10 ABSORPTION OF 5%)

% Plus No. 10 Material by Weight in Total Sample

-10 Moisture	5	10	15	20	25
40	38.3	36.5	34.8	33.0	31.3
39	37.3	35.6	33.9	32.2	30.5
38	36.4	34.7	33.1	31.4	29.8
37	35.4	33.8	32.2	30.6	29.0
36	34.5	32.9	31.4	29.8	28.3
35	33.5	32.0	30.5	29.0	27.5
34	32.6	31.1	29.7	28.2	26.8
33	31.6	30.2	28.8	27.4	26.0
32	30.7	29.3	28.0	26.6	25.3
31	29.7	28.4	27.1	25.8	24.5
30	28.8	27.5	26.3	25.0	23.8
29	27.8	26.6	25.4	24.2	23.0
28	26.9	25.7	24.6	23.4	22.3
27	25.9	24.8	23.7	22.6	21.5
26	25.0	23.9	22.9	21.8	20.8
25	24.0	23.0	22.0	21.0	20.0
24	23.1	22.1	21.2	20.2	19.3
23	22.1	21.2	20.3	19.4	18.5
22	21.2	20.3	19.5	18.6	17.8
21	20.2	19.4	18.6	17.8	17.0
20	19.3	18.5	17.8	17.0	16.3
19	18.3	17.6	16.9	16.2	15.5
18	17.4	16.7	16.1	15.4	14.8
17	16.4	15.8	15.2	14.6	14.0
16	15.5	14.9	14.4	13.8	13.3
15	14.5	14.0	13.5	13.0	12.5
14	13.6	13.1	12.7	12.2	11.8
13	12.6	12.2	11.8	11.4	11.0
12	11.7	11.3	11.0	10.6	10.3
11	10.7	10.4	10.1	9.8	9.5
10	9.8	9.5	9.3	9.0	8.8
9	8.8	8.6	8.4	8.2	8.0
8	7.9	7.7	7.6	7.4	7.3
7	6.9	6.8	6.7	6.6	6.5
6	6.0	5.9	5.9	5.8	5.8
5	5.0	5.0	5.0	5.0	5.0
4	4.1	4.1	4.2	4.2	4.3
3	3.1	3.2	3.3	3.4	3.5
2	2.2	2.3	2.5	2.6	2.8

TABLE 10M—MOISTURE CORRECTION OF MINUS NO. 10 FOR % PLUS No. 10 (FOR + 10 ABSORPTION OF 5%) %
Plus No. 10 Material by Weight in Total Sample

-10 Moisture	30	35	40	45
40	29.5	27.8	26.0	24.3
39	28.8	27.1	25.4	23.7
38	28.1	26.5	24.8	23.2
37	27.4	25.8	24.2	22.6
36	26.7	25.2	23.6	22.1
35	26.0	24.5	23.0	21.5
34	25.3	23.9	22.4	21.0
33	24.6	23.2	21.8	20.4
32	23.9	22.6	21.2	19.9
31	23.2	21.9	20.6	19.3
30	22.5	21.3	20.0	18.8
29	21.8	20.6	19.4	18.2
28	21.1	20.0	18.8	17.7
27	20.4	19.3	18.2	17.1
26	19.7	18.7	17.6	16.6
25	19.0	18.0	17.0	16.0
24	18.3	17.4	16.4	15.5
23	17.6	16.7	15.8	14.9
22	16.9	16.1	15.2	14.4
21	16.2	15.4	14.6	13.8
20	15.5	14.8	14.0	13.3
19	14.8	14.1	13.4	12.7
18	14.1	13.5	12.8	12.2
17	13.4	12.8	12.2	11.6
16	12.7	12.2	11.6	11.1
15	12.0	11.5	11.0	10.5
14	11.3	10.9	10.4	10.0
13	10.6	10.2	9.8	9.4
12	9.9	9.6	9.2	8.9
11	9.2	8.9	8.6	8.3
10	8.5	8.3	8.0	7.8
9	7.8	7.6	7.4	7.2
8	7.1	7.0	6.8	6.7
7	6.4	6.3	6.2	6.1
6	5.7	5.7	5.6	5.6
5	5.0	5.0	5.0	5.0
4	4.3	4.4	4.4	4.5
3	3.6	3.7	3.8	3.9

GDT 7

2	2.9	3.1	3.2	3.4

SECTION 12

GDT 21

DETERMINING FIELD DENSITY OF SOILS CONTAINING>45% RETAININED ON 2MM SIEVE (OR >10% RETAINED ON 25MM SIEVE)

GDT 21

A. Scope

For a complete list of GDTs, see the Table of Contents.

This method of test covers the procedures for determining the in-place density of soil-aggregate mixtures in embankments, cuts, subgrades, subbases, bases, etc., where the percent of material retained on the No. 10 (2 mm) sieve is 45 or more, or where the percent of material retained on the 1 in (25 mm) sieve is 10 percent or more.

B. Apparatus

1. Ring—A steel ring 12 in (304.8 mm) in diameter (mold or extension WM-06).
2. Sand—Any clean, dry sand graded to pass at least a No. 10 (2 mm) sieve but with no clay or silt.
3. Straightedge—A steel straightedge, 24 in (610 mm) long (WS13-2).
4. Drying Device—A stove or oven capable of rapidly drying the moisture determination samples.
5. Scales and Balances—A scale of at least 100 lb. (45.36 kg) capacity, sensitive to 2 oz; and a 20 kg balance with an accuracy of 1 g or 0.1 percent of the sample being tested.
6. Density Mold—A 12 in (304.8 mm) mold (WM06).
7. Bucket—A 12 in (304.8 mm) measure (WM-02) (optional).
8. Miscellaneous Tools
    a. Soil auger (optional) (WA-3)
    b. Trowel (optional) (WT-07)
    c. Containers (large pie pans or baking pans) (WP- 12)
    d. Spoon (WS-14)
    e. Brush (2 in or 3 in (50.8 or 76.2 mm) paint brush) (OB-02)
    f. Small pie pans or evaporating dishes (WP-01 or WD-3)
    g. Scoop (WS-03)
    h. Chisel
    i. Hammer or mallet (wooden mallet WM-01)

C. Sample Size and Preparation

Before making density measurements, calibrate the sand to determine its weight in pounds per cubic foot (kilograms per cubic meter). Perform the sand calibration in a manner designed to duplicate the method of pouring the sand into the sample hole.

NOTE: Perform the calibration with extreme care—a small error in the weight per cubic foot (meter) of the sand will cause a large error in the in-place density calculation.

1. Weigh the empty volume mold.

NOTE: Calibrate by using a 12 in (304.8 mm) density mold with base plate attached or by using a 1/2 ft^3 (0.0142 m^3) bucket.

2. Pour the sand into the mold or bucket until it is full. Use a method comparable to that used in pouring in the sample hole. Strike off the sand level with the top.
3. Weigh the filled mold or bucket and record as gross weight of mold and plate (or bucket) and sand. Determine the weight of sand used by subtracting weight of mold and plate (or bucket).
4. Repeat the above operations 3 times and average the weight of the sand.
5. Calculate the density of the sand.

D. Procedures

You must excavate density samples and then determine the volume of the density hole.

1. Excavating Density Samples
   a. Prepare the surface of the location to be tested so that it is a level plane. Remove all loose material on the surface from an area large enough to place the 12 in (304.8 mm) ring.
   b. Seat the 12 in (304.8 mm) ring on the surface and mark an outline of the ring.
   c. Dig the in-place material out through the ring by using the right outline as a guide to the full depth of the course being tested. Ensure that the sides of the hole are approximately vertical.
   d. Place the material from the hole in the large container, being very careful not to lose any of the material. Take care not to loosen or disturb the materials surrounding the hole. Remove and retain all the loosened material for the full depth.

NOTE: If the course being tested has a specified thickness, you may measure the thickness at this time.

   e. Immediately weigh the material removed from the hole before moisture is lost. Record the weight as weight of wet material from the hole.
   f. Weigh a representative sample of approximately 2,000 grams of the wet material for moisture determination. Record as weight of wet sample. Dry this sample and weigh, recording as weight of dry sample. Calculate as moisture content.
2. Determining Volume of Density Hole
   a. Place more than enough calibrated density sand needed to fill the sample hole into a container or sack and weigh. Record this weight as initial weight of sand and container.
   b. Fill the sample hole with the sand. Pour the sand from the container or sack using a method comparable to that used in calibrating the sand. Pour slowly and evenly until the sand is approximately 1 in (25.4 mm) below the top of the hole.

   Use a small container (such as a tin cup) to complete the filling. Replace all unused sand into the container or sack. You may level the sand even with the top of the hole using the hand or small straightedge, but never compress or vibrate the sand.
3. Weigh the container with the remaining sand. Determine the weight of sand used to fill the sample hole by subtracting the weight of the remaining sand and container from the original weight of sand and container. Record this weight as weight of sand used.

E. Calculations

1. Calculate the density of sand from calibration as follows:

Density of Sand = Pounds per cubic feet

$$\frac{Wt - Wm}{454 \times V}$$

Where:

Wt = weight of mold, plate and sand, or bucket and sand

Wm = weight of mold and plate or bucket

V = volume of mold or bucket in cubic feet*

Density of Sand = kilograms per cubic meter

$$\frac{Wt - Wm}{1000 \times V}$$ where

Where:

V = volume of mold or bucket in cubic meters*

***NOTE: Mold volume is .3927 ft^3 (0.0111 m^3), bucket volume is 0.5 ft^3 (0.0142 m^3).**

2. Calculate the in-place wet density of the material removed, in pounds per cubic foot (kilograms per cubic meter), by the following:

   In-Place Wet Density, pounds per cubic foot (kilograms per cubic meter) =

   $$\frac{W_W \times D_S}{W_S}$$

   W_w = wet weight of material from hole

   Ds = density of sand

   W_s = weight of sand used

3. Calculate the moisture content as follows:

   Moisture Content, % =

   $$\left(\frac{A-B}{B}\right) \times 100$$

   A = weight of wet sample

   B = weight of dry sample

4. Calculate the in-place dry density of the material removed from the hole, as follows:

   In-Place Dry Density, pounds per cubic foot (kilograms per cubic meter) =

   $$\frac{D_W \times 100}{100+M}$$ where

   D_w = in-place wet density

   M = moisture content in percent

5. The percent compaction is calculated from the maximum dry density as determined by GDT 24 or AASHTO T 180 Method D whichever is applicable and the above in-place dry density using the following formula:

   $$\% \text{ Compaction} = \frac{\text{in place dry density lb./ft}^3 \text{ (kg/m}^3\text{) x 100}}{\text{maximum dry density lb./ft}^3 \text{ (kg/m}^3\text{)}}$$

NOTE: If the material being compacted contains less than 45% plus No. 10 (2 mm), but more than 10% retained on the 1 in (25 mm) sieve, determine the maximum dry density for use in compaction control according to GDT 7 or GDT 67 whichever is applicable.

F. Report

No report is listed for this method.

SECTION 13

GDT 39

SPECIFIC GRAVITY OF COMPRESSED BITUMINOUS MATERIAL

GDT 39

A. Scope

For a complete list of GDTs see the Table of Contents.

Use this test method to determine bulk specific gravity of specimens of compacted bituminous mixtures. These procedures are described:

Uncoated Specimens, Dense Graded Mixtures Only

Paraffin Coated Specimens

AASHTO T 331 is an approved alternative method to Paraffin Coating method.

B. Apparatus

The apparatus consists of the following:

Balance: Use a balance having a capacity of 10 lb (4.5 kg) or more and sensitive to 0.0002 lbs (0.1 g) or less.

Apparatus: The suspension apparatus shall be constructed to enable the unit (wire basket or container) and the specimen to be immersed in water suspended by wire from the center of a weighing device to a depth sufficient to cover it and the test specimen during weighing.

Water bath or Container: for immersing specimens in water while suspended under a weighing device. The water bath or container shall be equipped with an overflow outlet to maintaining a constant water level.

L. Sample Size and Preparation

1. Make test specimens from either laboratory-molded bituminous mixtures or cut or cored compacted pavements. Do not distort, bend, or crack specimens during and after removal from pavement or mold.
2. Store specimens in a safe, cool place.
3. Ensure specimens are free from foreign materials such as seal coat, tack coat, foundation material, soil, or paper. Separate specimens from other pavement layers by sawing.

M. Procedures

1. Uncoated Specimens

Note: When roadway cores are saturated with water, conduct the following steps in this order: 4, 5, 1, 2, 3, and 6.

G. Dry the specimen to a constant weight. Constant weight is attained when further drying at 110 °, ± 9 °F (43.5 °, ± 5 °C) will not alter the weight 0.0002 lbs (0.1 g).

H. Cool the specimen to room temperature.

I. **Weigh the uncoated specimen**.
   1. Determine the dry weight of the specimen to the nearest 0.0002 lbs (0.1g).
   2. Designate this weight as “A”.

J. **Weigh the specimen in water.**
   1. Place the specimen on an immersed ~~in~~ suspension device, in water, at room temperature for 1 to 4 minutes or until a constant weight is obtained.
   2. Leave the specimen in the water and weigh to the nearest 0.0002 lbs (0.1 g).
   3. Designate this weight as “C”.

K. **Weigh the surface-dry specimen.**
   1. Remove the specimen from the water.

f. Dry the surface by blotting with a damp cloth (*damp is when no water can be wrung out*).

g. Weigh the specimen to determine the surface-dry weight.

h. Designate this weight as “B”.

h. **Calculate the bulk specific gravity of the uncoated test specimen as follows:**

$$\text{Bulk Specific Gravity} = \frac{A}{B-C} \text{ where}$$

A = weight of dry sample in air in grams

B = weight of surface-dry sample in air in grams

C = weight of sample in water in grams

I. **Calculate the percent of water absorbed by the specimen (on a volume basis) as follows:**

$$\text{Percent of Water Absorbed by Volume} = \left[\frac{(B-A)}{(B-C)}\right] * 100$$

If the percent of water absorbed by the specimen as calculated exceeds 2.0 percent, use the Paraffin Coating Method to determine Bulk Specific Gravity. AASHTO T 331 is the recommended alternative to the Paraffin Coating Method for specimens with water absorbed results that exceeds 2.0 percent of water by volume.

D. Paraffin Coating

Dry the specimen to a constant weight. Constant weight is attained when further drying at 110°, ± 9° F (43.5 °, ± 5 °C) will not alter the weight 0.0002 (0.1 g).

Cool the specimen to room temperature.

Weigh the uncoated specimen.

Determine the dry weight of the specimen to the nearest0.0002 (0.1g).

Designate this weight as “A”.

Weigh the coated specimen.

Preheat the paraffin to 130 ° to 150 °F (54 ° to 66 °C).

Coat the test specimen on all surfaces with paraffin thick enough to seal all surface voids. Apply the coat in one of two ways: either use a paint brush to apply the hot paraffin or dip the specimen in the heated paraffin and brush more on to seal all pin-point holes.

Determine the dry weight of the test specimen at room temperature. Weigh to the nearest 0.0002 lbs (0.1 g).

Designate this weight as “D”.

Note: If you want to use the specimen for further tests that require removing the paraffin coating, dust the specimen with talc before applying the paraffin.

C. Weigh the coated specimen in water.

1. Place the paraffin-coated specimen in the wire basket.
2. Immerse the basket in water at room temperature.
3. Weigh to the nearest 0.0002 (0.1 g).
4. Designate this weight as “C”.

H. Calculate the bulk specific gravity of the test specimen as follows:

$$\text{Bulk Specific Gravity} = \frac{A}{\left[(D - C) - \left[\frac{(D - A)}{0.90}\right]\right]}$$

A = Weight in grams of the specimen before paraffin coating in air

D = Weight in grams of the paraffin-coated specimen in air

C = Weight in grams of the paraffin-coated specimen in water

b. = Bulk specific gravity of the paraffin

C Calculations

Determine the density of a specimen taken from compacted mixture as follows:

Roadway Core Density = Bulk Specific Gravity of Specimen * Specific Gravity of Water (62.4)

Determine the in-place air voids of a specimen taken from compacted mixture as follows:

{(100) – [(Density of Specimen ÷ Theoretical density) * (100)]}

NOTE: Target Specific Gravity is the Actual Specific Gravity as shown on the job mix formula or the Specific Gravity obtained on the project control strip.

B Report

13. Calculate the specific gravity to the nearest 0.001.
14. Report density to the nearest 0.1 on form OMR-TM-150 and 159-5
15. Report voids to the nearest 0.1 on Form OMR-TM-150 and 159-5.

SECTION 14

GDT 59

TESTING DENSITY OF ROADWAY MATERIALS WITH NUCLEAR GAUGE

GDT 59

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the in-place density of roadway materials using a nuclear moisture and density gauge.

Note: This method should not be used to apply pay factors less than 1.00 for Asphaltic Concrete.

B. Apparatus

The apparatus consists of the following:

1. Surface Moisture and Density Gauge
2. Standard Block
3. Drill Rod and handle
4. Base Plate
5. Manufacturer's Instruction Manual
6. Shipping or Storage Case with required Labeling

C. Gauge Operation

1. To operate the nuclear gauge, follow the procedures shown in the Manufacturer's Instruction Manual accompanying each gauge.
2. Establish both density and moisture standard counts at least at the beginning of each day of testing. Take the moisture standard count more frequently if the humidity changes considerably between test sites.
3. Allow the gauge to warm up for 5 minutes before reading the counts.
4. Take the standard counts at least 10 ft (3 m) from any large object such as a wall, vehicle or heavy equipment and at least 33 ft (10 m) from any other radioactive source.
5. Test with the deepest mode the conditions and material thickness will allow.
6. It is critical to the accuracy of the test that the gauge rest flat on the surface of the material being tested. Excessive voids cracks or small depressions should be filled with sand, cement or native fines taking care to fill only the voids. Remove excess fines to ensure the gauge rest on the material being tested and not the added fines.
7. Do not utilize the in-place moisture from the gauge when the material is excessively wet or dry. A “flame dry” moisture shall be utilized for determining In-Place moisture in these cases. In all cases, take extreme care when testing material which is excessively wet or dry.

Note: Excessively wet material is when the material is spongy, boggy, or near saturation as shown by the zero air voids line in the Family of Curves in GDT 67. Excessively dry material is when the material is dusty, cracked, crusty, or when the moisture content falls below the bottom of the slope lines in GDT 67.

D. Gauge Calibration

1. The direct transmission and backscatter moisture charts may be used as they appear, but you will need to adjust both direct transmission and backscatter moisture for aggregate base and sand bituminous, and backscatter density on asphalt concrete. The procedures for making these adjustments are outlined in the following paragraphs.
2. Backscatter Density for Asphaltic Concrete
3. Make a field adjustment based on a correlation test with cores. You may use the adjustment for subsequent testing and on later projects with the same set of conditions.
4. Asphaltic concrete less than 1-1/4 in (32 mm) thick: Field-calibrate to each type of underlying material, such as asphaltic concrete, surface treatment, soil-cement, etc. Establish another adjustment for any change in the source of aggregate or type of mix being placed.

   Note*** For thickness less than 1-1/4 in (32 mm) consider GDT-39 as the preferred method for determining density.
5. Asphaltic Concrete greater than 1-1/4 in (32 mm) thick: Field-calibrate to each mix ID number and material thickness placed. (Approved Field calibrations may be utilized on multiple projects when pavement conditions are near identical in terms of mix type, thickness and underlying pavement structure.)

6. Direct Transmission Density and Backscatter Moisture
    a. Make field adjustments for direct transmission density and backscatter moisture for aggregate bases, subbases, and drainage material for each source.
    b. Verify the theoretical density and Optimum Moisture for aggregate bases, subbases, and drainage material by performing at least one AASHTO T 180 Method D comparison each year for each active quarry.
7. Site Preparation for Subgrade, Embankment, and Backfill
    a. Remove material to a depth greater than the deepest penetration of the compaction equipment when sheep-foot rollers are utilized. The area should be at least 2 ft^2 (0.2 m^2) and plane enough so the gauge bottom touches the material.
    b. Pat native fines into minor depressions or surface voids with the base plate.
    c. Subtract gauge wet density from the gauge moisture pcf to obtain the dry density.
    d. Divide the gauge dry density by the maximum dry density from the appropriate page of the GDT-67 curves for compaction.

E. Procedures

1. Correlation Tests

    Adjust field densities and moistures by comparing the nuclear gauge test and the conventional test—total density, wet density, or moisture in pounds per cubic foot (kilograms per cubic meter), whichever applies. a. Direct Transmission and Backscatter Density

    1) Perform a minimum of three nuclear density and three conventional density tests to determine density offset.

        Note: Five tests are preferred for asphaltic concrete mixes

    2) Locate the conventional test site directly beneath the center of the gauge for cores and 2 inches behind the drill rod hole for GDT-20 or GDT-21.

    b. Correction (Offset) of the Nuclear Gauge to Conventional Density Tests

    1) Ensure materials are within the acceptable specifications and tolerances
        a) For asphalt concrete, perform correlation testing provided; the mixture meets the allowable mixture control tolerances of Specification 828; the mixture meets compaction and air void requirements of Specification 400.
        b) For aggregate base, ensure the materials are meeting gradation and density requirements of the appropriate Specifications. Do not perform correlation testing on unstable materials.
    2) Determine the average of the nuclear gauge densities.
    3) Obtain the average conventional densities.

        Note: To convert the specific gravity of cores to pcf, multiply the specific gravity by 62.4 pcf.

    4) Use the average conventional densities and average nuclear gauge densities in pcf to determine the needed density result.
    5) Subtract the average gauge densities in step E.1.b.2 by the average conventional densities in step E.1.b.3 to get the needed offset. If the average conventional density is higher than the average gauge density the offset will be positive (+). If the average conventional density is lower than the average gauge density the offset will be negative (-).
    6) Add or subtract the offset factor from each density for that material.
    7) Use the offset factor to calculate each nuclear gauge density.
    8) Compare nuclear and conventional results. If the averages differ by more than 0.5 pcf, check your values and recalculate. If recalculation fails, recalibrate.
2. Moisture Correlation of the Nuclear Gauge

    Determine the moisture content in aggregate bases and subbases.

    Note: Moisture correlation is not typically required for subgrade, backfill and embankment materials.

a. Moisture Correlation Procedure for Aggregate Bases and Subbases

1) Perform a minimum of three nuclear gauge moisture/density tests and three flame dry moisture tests to determine gauge offset.
2) The flame dry samples are to be taken from the material directly below the gauge and wet weights obtained immediately to ensure accuracy of moisture content.
3) Test for direct transmission density at each location to determine the moisture offset in pcf as follows.

Where:

A = In-place wet density by direct transmission

B = Percent moisture by drying a sample of material from the appropriate depth

C = Corrected in-place dry density

D = In-place moisture (pcf) by flame dry

E = Original gauge moisture (pcf)

a) Correct in-place dry density by flame dry moisture (for each of three sites)

$$C=\left[\frac{A}{100+B}\right] X\ 100$$

b) Calculate in-place moisture (pcf) by flame dry (for each of three sites)

$$D=A-C$$

c) Determine moisture offset

Moisture Offset= (Average Original Gauge Moisture (pcf)) - (Average In-place Moisture (pcf)by Flame Dry)

d) Subtract the average in-place moisture (pcf) by flame dry (D) from the average original gauge moisture (pcf) to get the needed offset. If the average flame dry is higher than the average gauge moisture the offset will be positive (+). If the average flame dry is lower than the average gauge moisture the offset will be negative (-).

3. Density Analysis

a. Backscatter (density of asphaltic concrete and moisture content of embankment and bases) 1) Place the gauge securely and flat on the test site. 2) Check density for 1 minute.

b. Direct Transmission (wet density of bases and soils)

1) Bases, and subbases, place the base plate on the test site.
2) Drive the drill pin through the guide hole at least 2 in (50 mm) deeper than the depth to be tested.
3) When required pat native fines into minor depressions or surface voids with the base plate.
4) Move the plate and lower the source rod into the hole to the desired test depths (2, 4, 6, 8 10, 12 in [50, 100, 150, 200, 250, 300 mm]).

E. Calculations

1. Asphaltic Concrete:

$$\%\ Voids = \left[1 - \frac{In\text{-}place\ Density}{Theoretical\ Density}\right] X\ 100$$

2. Bases, Subbases, Subgrade, Backfill, and Embankment

a. Dry density, wet density, and moisture are in pounds per cubic foot (kilograms per cubic meter). Use the following formula to calculate Dry Density directly from Gauge readings.

$$Dry\ Density = Wet\ Density - Moisture\ (pcf)$$

Use the following formula to correct the In-Place dry density based on the flame dry moisture content.

$$Corrected\ Dry\ Density = \left[\frac{Wet\ Density}{100 - \%\ Moisture}\right] X\ 100$$

$$\%\ Moisture = \left[\frac{Moisture\ (pcf)}{Dry\ Density}\right] X\ 100$$

$$\%\ Compaction = \left[\frac{In - place\ Dry\ Density}{Max\ Dry\ Density}\right] X\ 100$$

b. Moisture Determination by Drying

You may test the soil and aggregate moisture by drying approximately 1.1 lb (500 g) of wet soil or 4.4 lbs (2000 g) of material containing coarse aggregate. Calculate moisture content to the nearest 0.1percent as follows:

$$\%\ Moisture = \left[\frac{A - B}{B}\right] X\ 100\ where$$

A = Weight of wet sample

B = Weight of dry sample

Note: When you use the Family of Curves in GDT 67 to determine the maximum dry density, use the one-point proctor moisture as the in-place moisture, provided you have not added water to the material.

3. Precision

a. The results of two backscatter moisture, backscatter density, or direct transmission density tests without moving the gauge should be within ± 0.5 pcf.

b. Results of comparison tests between two nuclear gauges, using identical gauge orientations on the same test site, should be within ± 1.5 pcf for density of asphaltic concrete or wet density of other material.

F. Report

Report compaction and moisture to the nearest 0.1 percent on the appropriate form for the construction method and materials involved.

SECTION 15

GDT 67

FAMILY OF CURVES METHOD FOR DETERMING MAXIMUM DENSITY OF SOILS

GDT 67

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the relation between moisture content and density of soils using the Families of Moisture-Density Curves and the One-Point Proctor Test. See Table set 1 for the Family A Curve, Table set 2 for the Family B Curve, and Table set 3 for the Family C Curve.

This method establishes the "theoretical" maximum dry density for soils having less than 45 percent retained on the No. 10 (2.00 mm) sieve. You may use this method in lieu of GDT 7 and GDT 24a for classification purposes and field compaction control of embankment, subgrade, and soil bases.

B. Apparatus

The apparatus is the same as outlined in GDT 7 with the following addition:

1. Mold Support: Use a concrete block at least 4 in (102 mm) thick, with a bottom surface area not less than 100 in² (64,520 mm²) and weighing not less than 35 lbs (15.9 kg). Place the block on the roadway to support the mold during compacting.

   The upper surface of the block is formed to fit a specific mold base plate, so carefully clean the base and place it on the block the same way each time. Do not rest the block on soil that is considerably above optimum or pumping. Exercise caution to prevent any motion of the mold, or any part of it, during the compaction.
2. Curves: The Office of Materials and Research has established three Families of Moisture and Density Curves, lettered A, B, and C, for use with materials found within the State. The families are:
   - Family A materials are predominately sandy materials.
   - Family B materials are sand and clayey sand.
   - Family C materials are sand-clay, sandy-silty clay, silty clay, micaceous clay, shale, saprolite, and cherty clay.

C. Sample Size and Preparation

1. One-Point Proctor
   a. Take the sample from the roadway and break up any clumps.
   b. Thoroughly mix the sample with the appropriate quantity of water to bring it near optimum. 1) If the material is above optimum, dry 2,000 or 3,000 g.
      2) Let the sample cool.
      3) Thoroughly mix back enough water to bring it near optimum moisture (follow the precautions in step 2).
   c. Compact the prepared material in three layers into the 1/30 ft³ (0.0009 m³) density mold. (Reference ASTM D-698 Mold Volume Calibration)
      1) Compact each layer with 25 blows from the 5.5 pound (2.5 kg) rammer dropped from 12 in (300 mm) above the soil.
2. Precautions
   a. **Material Too Wet**
      1) Occasionally the "wet density" versus "moisture" plot will fall above the top of the slope lines. This indicates that the material is excessively wet and must be dried to fit the curve. 2) Dry the entire samples to a constant weight.
      2) Let the samples cool.
      3) Mix the material to a uniform moisture content (without visible clay lumps) and re-compact it to

determine a new wet density and moisture content.

4) Do not add the dry soil used to determine the moisture content to the entire sample.

Material Too Dry

1) If the material is too dry, the plot of "wet density" versus "moisture" will fall below the slope lines of the curve. When this occurs, do not extend the slope lines to the plotted point.
2) Mix the soil with appropriate amount of water to a uniform condition and recompact it.
3) Determine the new wet density and moisture content.

Nuclear Gauge Moisture

1) If you change the soil moisture content for the One-Point Proctor before compacting the sample into the mold, you must dry a sample for the One-Point Proctor.
2) If the in-place moisture percent is within +1 percent or -3 percent of optimum moisture, you may use the nuclear gauge moisture in the in-place density or one-point determination.
3) If the in-place moisture percent is outside +1 percent or -3 percent of optimum moisture, do not use the nuclear gauge moisture unless you correct the gauge.

D. Procedures

1. Family Section

   Determine the type of material tested by visual inspection or gradation analysis, if available, and select the appropriate family of curves.

2. One-Point Proctor

   a. Determine the wet density of the One-Point Proctor in pounds per cubic foot from the proper family density chart or as follows:

   Wet Weight of Compacted Soil (lbs/ft^3) = $\frac{(Ws-Wc)/453.6}{V}$ or $\frac{(Ws-Wc) * \text{Mold Factor}}{453.6}$ or (Ws-Wc) * C.F.C

V = Volume of the Mold as calibrated Using (Ref. ASTM D-698, CVP 7)

Mold Factor = Calculated 1/volume lbs/ft^3 (Ref. CVP 7)

C.F.C = Correction Factor Conversion (GDOT Correction Factor) = Mold Factor/453.6 (Ref. CVP 7)

Ws = weight of the compacted soil and mold, in grams

Wc = weight of the mold, in grams

If you weighed in grams, dividing by 453.6 converts grams to pounds. This will give you the wet weight in pounds per cubic foot.

b. Determine the moisture content in the mold.

1) Take a 1.1 lb (500 g) sample of the wet material equally from all three layers of the compacted soil.

Note: If you took the moisture sample from the material before compacting it in the mold, determine the wet weight and compact the sample quickly, before the material dries further.

2) Dry to a constant weight and calculate the percent moisture as follows:

$$\% \text{ Moisture} = \frac{A - B}{B} \times 100$$

where:

A = Weight of wet soil

B = Weight of dry soil

3) Use the moisture percent determined by a surface moisture and density gauge on the in-place material in-place for the One Point Proctor moisture content if you did not adjust the moisture of the sample (follow the precautions in Sample Size and Preparation, step 2).

3. Plot the Maximum Dry Density and Optimum Moisture
   a. Plot “wet density” versus “moisture” as determined from the One-Point Proctor on the appropriate family of curves. The plot should fall on or between the slope lines to be a valid test.
   b. Follow a line from the plotted points, parallel to the existing slope lines, to the line of optimums.
   c. The percent moisture directly under this point of intersection is considered the optimum moisture.
   d. From the line of optimums, follow parallel with the straight diagonal lines to the “zero air voids” curve. This curve shows the dry density in pounds per cubic foot (kilograms per cubic meter). The point of intersection is considered the maximum dry density of the material.

Correction for Plus No. 10 (2.00 mm) Material

a. When determining maximum densities for compaction control, correct the densities when it appears to exceed 15% of Plus No. 10 (2.00 mm) material retained.

b. Use the conversion factors for correcting the density in Tables 1D - 7D, found in GDT-7

c. Use the conversion factors for correcting the moisture of Minus No. 10 (2.00 mm) for the Plus No. 10 (2.00 mm) 1n Tables 1M - 10M, found in GDT-7.

E. Calculations (CVP 7 http://www.dot.ga.gov/PS/Materials)

1. Calculate wet density:

$$\text{Wet Density} = \frac{(W2 - W1)/453.6}{V} \quad \text{or} \quad \frac{(W2 - W1) * \text{Mold Factor}}{453.6} \quad \text{or} \quad (W2 – W1) * \text{C.F.C.}$$

where:

V = Volume of the Mold as calibrated Using (Ref. ASTM D-698, CVP 7)

Mold Factor = Calculated 1/volume lbs/ft^3 (Ref. CVP 7)

C.F.C = Correction Factor Conversion (GDOT Correction Factor) = Mold Factor/453.6 (Ref. CVP 7)

W1 = Weight of mold in grams

W2 = Weight of mold + wet soil in grams

2. Calculate percent moisture:

$$\% \text{ Moisture} = \frac{A - B}{B} \times 100$$

where:

A = Weight of wet soil

B = Weight of dry soil

3. Calculate the density (dry weight), in pounds per cubic foot (kilograms per cubic meter), of the compacted soil as follows:

$$\text{English—Dry Density } (lb/ft^3) = \frac{Ww}{M + 100} \times 100$$

4. Ensure accuracy of the numbers.
   a. The values for Maximum Dry Density and Optimum Moisture as determined from any “Family of

Curves" should be within 3 lb/ft³ (48 kg/m³) dry density and 2 percent moisture of that obtained by GDT 7. For laboratory testing, out of every 10 soil samples tested by GDT 67, take 1 sample and run GDT 7 and GDT 67 to verify that these results are within the allowable tolerances stated above. If these results are not within the acceptable range, GDT 7 must be run for density and optimum moisture until results return to acceptable range.

If you question the compaction at any specific area, take samples and use GDT 7 to perform a theoretical density test.

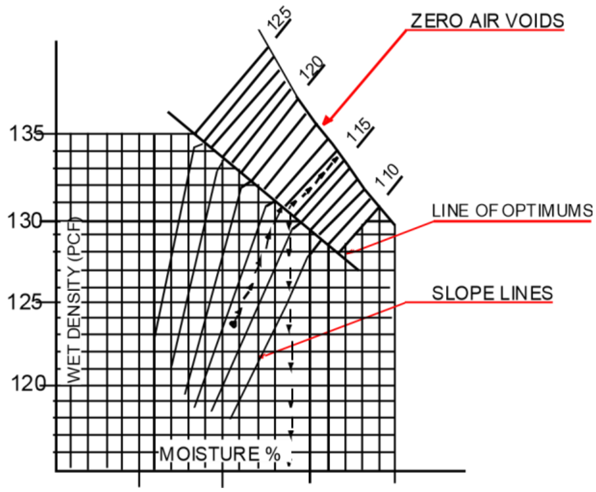
5. Check operator precision.

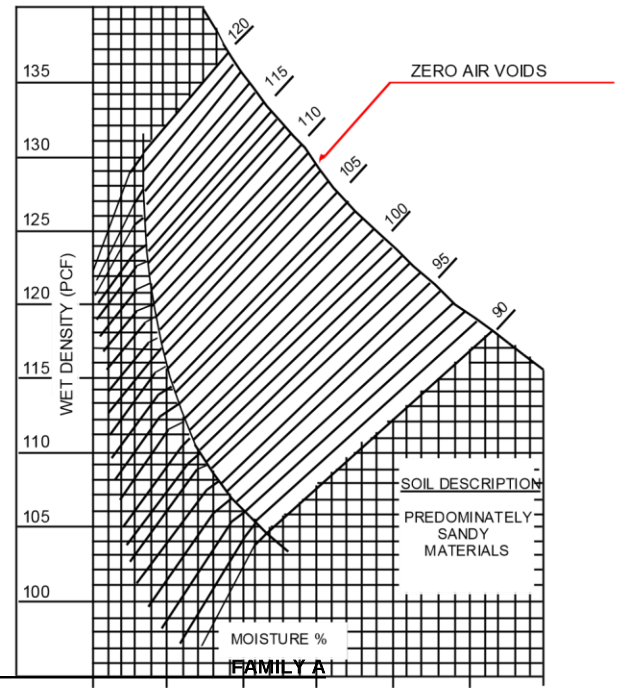
   a. For repeat testing of a specific material to be valid and within a 95 percent confidence level, the operator must be within the following limits using any Family of Curves for maximum dry density and optimum moisture:

	Single Operator	**Multiple Operators**
Maximum Dry Density- PCF (kg/m^3)	2.0	3.0
Optimum Moisture (%)	1.0	2.0

F. Report

Report the wet density and the percentage moisture for the material on Form 386.





ONE POINT PROCTOR	FAMILY OF CURVES
	Optimum Moisture = 13-7%

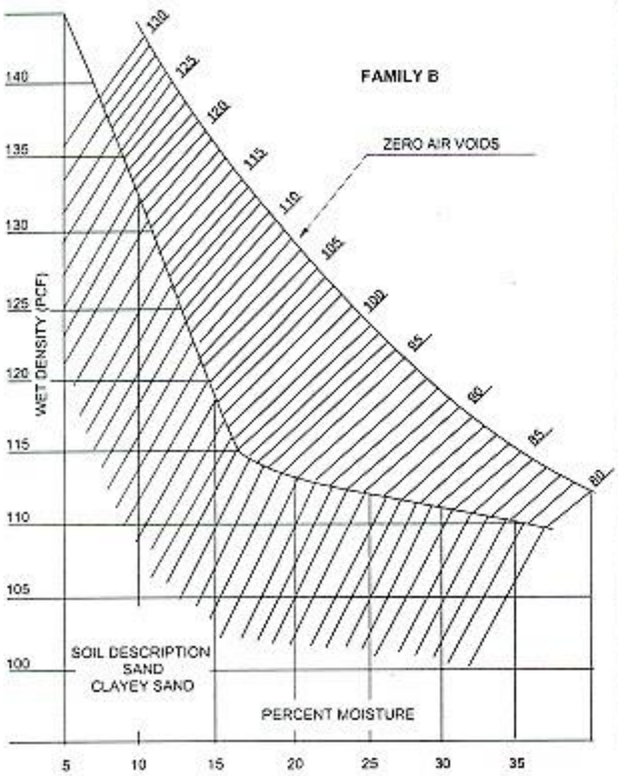
CURVE

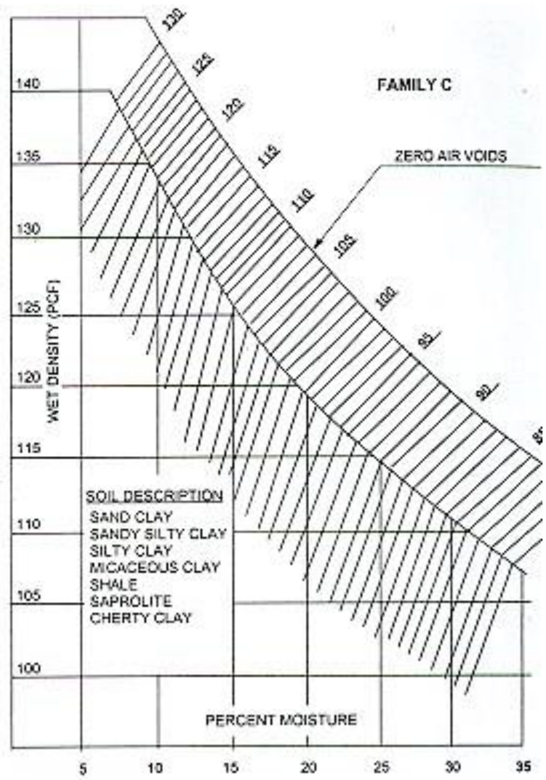
5 10 15 20

EXAMPLE

Wet Density = 124 PCF Maximum Dry Density = 115-5 PCF

5 10 15 20 25 30 35


FAMILY B
ZERO AIR VOIDS
WET DENSITY (PCF)
SOIL DESCRIPTION
SAND
CLAYEY SAND
PERCENT MOISTURE


FAMILY C
ZERO AIR VOIDS
WET DENSITY (PCF)
SOIL DESCRIPTION
SAND CLAY
SANDY SILTY CLAY
SILTY CLAY
MICACEOUS CLAY
SHALE
SAPROLITE
CHERTY CLAY
PERCENT MOISTURE

GDT 67 Table Set 1—Family of Curves, Theoretical Density-Moisture Chart

Table 1 A Curve; Table A Overview

Wet Density (pcf)	**% Moisture**	
	5.0-10.0	10.5-15.5
98.5 to 107.0	A-1	A-2
107.5 to 116.0	A-3	A-4
116.5 to 125.0	A-5	A-6
125.5 to 131.0	A-7	X

Table 2 A Curve; Table A-1

	5.0	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
98.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.3 14.9	91.8 15.3
99.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.4 14.8	92.1 15.0
99.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.7 14.6	92.3 14.9
100.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	93.2 14.3	92.6 14.6
100.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	94.0 14.0	93.5 14.2	93.0 14.5
101.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	94.3 13.8	94.0 14.0	93.2 14.3
101.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	94.6 13.7	94.2 13.9	93.4 14.2
102.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	94.7 13.6	94.5 13.7	94.0 14.0
102.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	95.5 13.3	95.1 13.4	94.8 13.6	94.3 13.8
103.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	96.0 13.1	95.5 13.3	95.0 13.5	94.6 13.7
103.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	96.4 12.8	95.8 13.1	95.3 13.3	94.9 13.5
104.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	97.2 12.5	96.8 12.7	96.2 12.9	95.8 13.1	95.1 13.4
104.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	98.2 12.2	97.5 12.4	97.1 12.5	96.5 12.8	96.1 13.0	95.5 13.3
105.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	98.6 12.0	98.1 12.2	97.7 12.4	97.0 12.7	96.5 12.8	96.0 13.0
105.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	99.0 11.9	98.6 12.0	98.0 12.3	97.4 12.4	96.8 12.7	96.3 12.9
106.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	100.1 11.5	99.6 11.6	99.0 11.9	98.4 12.1	97.9 12.3	97.3 12.5	96.6 12.8
106.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	100.2 11.4	99.9 11.5	99.3 11.7	98.8 12.0	98.2 12.2	97.8 12.3	97.1 12.5
107.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	101.0 11.2	100.6 11.3	99.8 11.5	99.3 11.7	98.7 12.0	98.1 12.2	97.7 12.4

Table 3 A Curve; Table A-2

	10.5	**11.0**	**11.5**	**12.0**	**12.5**	**13.0**	**13.5**	**14.0**	**14.5**	**15.0**	**15.5**
98.5	91.4 15.4	91.2 15.5	90.6 15.7	90.5 16.1	90.4 16.2	90.2 16.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
99.0	91.8 15.2	91.3 15.4	91.1 15.6	90.7 16.0	90.5 16.1	90.2 16.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
99.5	92.0 15.1	91.6 15.3	91.4 15.4	91.0 15.7	90.7 16.0	90.3 16.3	90.1 16.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
100.0	92.2 14.9	91.9 15.2	91.6 15.3	91.2 15.5	90.8 15.8	90.6 16.1	90.3 16.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
100.5	92.6 14.6	92.1 15.0	91.8 15.2	91.5 15.4	91.0 15.6	90.7 16.0	90.5 16.1	90.1 16.5	0.0 0.0	0.0 0.0	0.0 0.0
101.0	92.8 14.5	92.3 14.9	92.0 15.1	91.6 15.3	91.1 15.6	90.8 15.8	90.6 16.1	90.3 16.3	0.0 0.0	0.0 0.0	0.0 0.0
101.5	93.2 14.3	92.6 14.6	92.3 14.9	91.8 15.2	91.5 15.4	91.0 15.6	90.7 16.0	90.5 16.1	90.1 16.5	0.0 0.0	0.0 0.0
102.0	93.6 14.2	93.0 14.5	92.6 14.6	92.2 14.9	91.8 15.2	91.3 15.4	90.9 15.7	90.6 16.1	90.3 16.3	90.0 16.6	0.0
102.5	94.0 14.0	93.3 14.3	92.9 14.5	92.3 14.9	92.0 15.1	91.6 15.3	91.1 15.6	90.7 16.0	90.5 16.1	90.2 16.4	0.0 0.0
103.0	94.3 13.8	93.8 14.1	93.3 14.3	92.6 14.6	92.3 14.9	91.8 15.2	91.5 15.4	91.0 15.6	90.7 16.0	90.4 16.2	90.0 16.6
103.5	94.6 13.2	94.2 13.9	93.6 14.3	93.0 14.5	92.6 14.6	92.0 15.1	91.7 15.3	91.3 15.4	90.9 15.7	90.5 16.1	90.2 16.4
104.0	94.9 13.5	94.4 13.8	94.0 14.0	93.4 14.2	93.0 14.5	92.4 14.8	92.0 15.1	91.6 15.3	91.2 15.6	90.7 16.0	90.1 16.5
104.5	95.1 13.4	94.7 13.6	94.3 13.8	93.8 14.1	93.1 14.4	92.7 14.6	92.3 14.9	91.8 15.2	91.5 15.4	91.0 15.6	90.7 16.0
105.0	95.5 13.3	95.0 13.5	94.7 13.6	94.2 13.9	93.7 14.2	93.1 14.4	92.7 14.6	92.1 15.1	91.7 15.3	91.4 15.4	90.8 15.8
105.5	95.8 13.1	95.3 13.3	95.0 13.5	94.5 13.7	94.0 14.0	93.3 14.3	92.9 14.5	92.5 14.8	92.1 15.0	91.5 15.4	91.1 15.6
106.0	96.3 12.9	95.8 13.1	95.3 13.3	94.8 13.6	94.4 13.8	94.0 14.0	93.3 14.3	92.9 14.5	92.4 14.8	92.0 15.1	91.6 15.3
106.5	96.7 12.8	96.1 13.0	95.7 13.2	95.0 13.5	94.7 13.6	94.3 13.8	93.8 14.1	93.2 14.3	92.8 14.5	92.3 14.9	91.9 15.2
107.0	97.0 12.7	96.4 12.8	96.1 13.0	95.5 13.3	95.1 13.4	94.7 13.6	94.1 14.0	93.7 14.2	93.1 14.4	92.6 14.6	92.3 14.9

Table 4 A Curve; Table A-3

	5.0	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
107.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	101.4 11.0	101.0 11.2	100.1 11.4	99.7 11.6	99.1 11.8	98.6 12.0	97.9 12.3
108.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	101.7 10.9	101.3 11.1	100.8 11.3	100.0 11.5	99.4 11.7	99.1 11.8	98.4 12.1
108.5	0.0 0.0	0.0 0.0	0.0 0.0	102.9 10.7	102.2 10.8	101.7 10.9	101.1 11.2	100.7 11.3	99.9 11.5	99.3 11.7	98.9 11.9
109.0	0.0 0.0	0.0 0.0	0.0 0.0	103.2 10.6	102.7 10.7	102.3 10.8	101.6 11.0	101.1 11.2	100.5 11.3	99.9 11.5	99.4 11.6
109.5	0.0 0.0	0.0 0.0	0.0 0.0	103.7 10.6	103.1 10.6	102.6 10.7	102.0 10.9	101.4 11.0	100.9 11.2	100.4 11.4	99.6 11.6
110.0	0.0 0.0	0.0 0.0	104.4 10.2	104.0 10.3	103.5 10.4	103.1 10.6	102.4 10.7	102.0 10.9	101.3 11.1	100.9 11.3	100.0 11.5
110.5	0.0 0.0	0.0 0.0	104.9 10.1	104.2 10.2	103.7 10.4	103.4 10.5	102.7 10.7	102.3 10.8	101.7 10.9	101.1 11.2	100.6 11.3
111.0	0.0 0.0	0.0 0.0	105.3 10.0	104.9 10.1	104.1 10.3	103.7 10.4	103.1 10.6	102.7 10.7	102.3 10.8	101.6 11.0	101.0 11.2
111.5	0.0 0.0	0.0 0.0	105.6 9.9	105.2 10.0	104.6 10.2	104.1 10.3	103.6 10.4	103.0 10.6	102.5 10.7	102.1 10.8	101.4 11.1
112.0	0.0 0.0	0.0 0.0	106.4 9.7	105.6 9.9	105.0 10.1	104.5 10.2	103.9 10.3	103.5 10.4	103.0 10.6	102.4 10.7	102.0 10.9
112.5	0.0 0.0	0.0 0.0	106.7 9.7	106.2 9.8	105.3 10.0	105.0 10.1	104.2 10.2	103.8 10.3	103.4 10.4	102.8 10.6	102.3 10.8
113.0	0.0 0.0	0.0 0.0	107.2 9.6	106.7 9.7	105.7 9.9	105.4 10.0	104.9 10.1	104.2 10.2	103.7 10.3	103.3 10.5	102.7 10.7
113.5	0.0 0.0	0.0 0.0	107.4 9.6	107.0 9.7	106.3 9.8	105.6 9.9	105.1 10.1	104.7 10.1	104.0 10.3	103.7 10.3	103.2 10.6
114.0	0.0 0.0	0.0 0.0	107.9 9.5	107.5 9.6	106.9 9.7	106.4 9.7	105.6 9.9	105.2 10.0	104.7 10.1	104.0 10.3	103.6 10.4
114.5	0.0 0.0	0.0 0.0	108.2 9.5	107.8 9.5	107.2 9.6	106.8 9.7	106.0 9.8	105.5 10.0	105.0 10.1	104.4 10.2	104.0 10.3
115.0	0.0 0.0	109.4 9.4	109.0 9.4	108.2 9.5	107.7 9.5	107.2 9.6	106.7 9.7	106.2 9.8	105.5 10.0	105.0 10.1	104.6 10.2
115.5	0.0 0.0	109.7 9.3	109.4 9.4	108.9 9.4	108.0 9.5	107.6 9.5	107.0 9.7	106.5 9.7	105.8 9.9	105.4 10.0	105.0 10.1
16.0	0.0 0.0	110.1 9.3	109.6 9.3	109.1 9.4	108.4 9.4	107.9 9.5	107.5 9.6	107.0 9.7	106.4 9.7	105.8 9.9	105.4 10.0

Table 5 A Curve; Table A-4

	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
107.5	97.6 12.4	96.9 12.7	96.4 12.8	95.8 13.1	95.4 13.3	94.9 13.5	94.6 13.7	94.0 14.0	93.6 14.2	93.1 14.4	92.7 14.6
108.0	98.0 12.3	97.3 12.5	96.8 12.7	96.4 12.8	95.9 13.1	95.3 13.3	94.9 13.5	94.5 14.3	94.0 14.0	93.5 14.2	93.1 14.4
108.5	98.4 12.1	97.8 12.3	97.3 12.5	96.8 12.7	96.3 12.9	95.8 13.1	95.3 13.3	94.6 13.7	94.3 13.8	94.0 14.0	93.8 14.1
109.0	99.0 11.9	98.2 12.2	97.7 12.4	97.2 12.5	96.7 12.8	96.1 13.0	95.7 13.2	95.3 13.3	95.0 13.5	94.5 14.3	94.0 14.0
109.5	99.3 11.7	98.7 12.0	98.1 12.2	97.7 12.4	97.1 12.5	96.6 12.7	96.2 12.9	95.7 13.2	95.3 13.3	95.0 13.5	0.0 0.0
110.0	99.6 11.6	99.1 11.8	98.6 12.0	98.0 12.3	97.6 12.4	97.1 12.5	96.6 12.7	96.2 12.9	95.9 13.1	95.5 13.3	0.0 0.0
110.5	100.0 11.5	99.4 11.7	99.1 11.8	98.5 12.0	98.1 12.2	97.6 12.4	97.2 12.5	96.7 12.8	96.3 12.9	0.0 0.0	0.0 0.0
111.0	100.6 11.3	99.9 11.5	99.5 11.7	99.0 11.9	98.7 12.0	98.1 12.2	97.6 12.4	97.3 12.5	96.9 12.7	0.0 0.0	0.0 0.0
111.5	101.0 11.2	100.4 11.4	99.8 11.5	99.5 11.7	99.0 11.9	98.5 12.0	98.3 12.2	97.8 12.3	0.0 0.0	0.0 0.0	0.0 0.0
112.0	101.4 11.0	100.9 11.2	100.3 11.4	99.8 11.5	99.5 11.7	99.1 11.8	98.8 12.0	98.3 12.1	0.0 0.0	0.0 0.0	0.0 0.0
112.5	101.8 10.9	101.3 11.1	100.8 11.2	100.3 11.4	99.9 11.5	99.6 11.6	99.2 11.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
113.0	102.3 10.8	101.8 10.9	101.3 11.1	100.8 11.3	100.4 11.4	99.4 11.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
113.5	102.7 10.7	102.2 10.8	101.7 10.9	101.3 11.1	100.9 11.2	100.5 11.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
114.0	103.1 10.6	102.6 10.7	102.2 10.8	101.8 10.9	101.4 11.0	101.2 11.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
114.5	103.6 10.5	103.1 10.6	102.7 10.7	102.2 10.8	101.9 10.9	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
115.0	104.0 10.4	103.6 10.5	103.3 10.5	102.8 10.7	102.5 10.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
115.5	104.6 10.2	104.0 10.4	103.7 10.4	103.4 10.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
116.0	105.0 10.1	104.5 10.2	104.1 10.3	103.8 10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6 A Curve; Table A-5

	5.0	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
116.5	0.0 0.0	110.7 9.2	110.1 9.3	109.4 9.3	108.9 9.4	108.2 9.5	107.7 9.5	107.5 9.6	106.9 9.7	106.3 9.8	105.8 9.9
117.0	0.0 0.0	111.1 9.1	110.5 9.2	110.0 9.3	109.4 9.3	108.9 9.4	108.3 9.4	107.8 9.5	107.3 9.6	106.9 9.7	106.3 9.8
117.5	0.0 0.0	111.3 9.1	110.8 9.2	110.4 9.3	109.6 9.3	109.2 9.4	108.7 9.4	108.1 9.5	107.5 9.6	107.2 9.6	106.8 9.7
118.0	112.8 9.0	112.2 9.0	111.8 9.1	110.8 9.2	110.3 9.3	109.6 9.3	109.1 9.4	108.8 9.4	108.0 9.5	107.6 9.5	107.2 9.6
118.5	113.1 9.0	112.7 9.0	112.0 9.1	111.1 9.2	110.4 9.3	110.1 9.3	109.4 9.3	109.0 9.4	108.5 9.4	108.0 9.5	107.6 9.5
119.0	113.8 9.0	113.3 9.0	112.5 9.1	112.0 9.1	111.1 9.2	110.5 9.2	110.1 9.3	109.5 9.3	109.0 9.4	108.6 9.4	108.0 9.5
119.5	114.3 8.9	113.7 9.0	113.3 9.0	112.4 9.1	111.9 9.1	110.9 9.2	110.4 9.3	110.1 9.3	109.5 9.3	109.1 9.4	108.6 9.4
120.0	115.2 8.8	114.8 8.9	113.6 9.0	113.0 9.0	112.3 9.1	111.9 9.1	111.0 9.2	110.4 9.3	110.1 9.3	109.6 9.3	109.2 9.4
120.5	115.6 8.8	115.0 8.9	114.1 8.9	113.4 9.0	112.8 9.0	112.2 9.1	111.8 9.1	110.9 9.2	110.5 9.3	110.0 9.3	109.6 9.3
121.0	117.1 8.7	116.6 8.7	114.9 8.8	114.0 8.9	113.3 9.0	112.7 9.0	112.1 9.4	111.6 9.1	111.0 9.2	110.4 9.3	110.0 9.3
121.5	117.4 8.7	117.0 8.7	115.1 8.8	114.7 8.9	113.8 9.0	113.4 9.0	112.5 9.1	112.0 9.1	111.4 9.1	110.9 9.2	110.5 9.3
122.0	118.7 8.7	117.2 8.7	116.6 8.7	115.0 8.9	114.6 8.9	113.9 8.9	113.3 9.0	112.6 9.0	112.0 9.1	111.5 9.1	111.0 9.2
122.5	119.0 8.7	118.3 8.7	117.8 8.7	115.5 8.8	114.9 8.8	114.1 8.9	113.5 9.0	113.1 9.0	112.6 9.0	112.0 9.1	111.8 9.1
123.0	119.2 8.6	118.8 8.7	117.3 8.7	116.7 8.7	115.4 8.8	114.8 8.9	114.2 8.9	113.8 9.0	113.0 9.0	112.8 9.0	112.4 9.1
123.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	113.5 9.0	113.1 9.0	112.9 9.0
124.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	114.1 8.9	113.5 9.0	113.1 9.0
124.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	114.4 8.9	114.1 8.9	113.8 9.0
125.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.9 8.8	114.6 8.9	114.2 8.9

Table 7 A Curve; Table A-6

	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
116.5	105.5 10.0	105.0 10.1	104.7 10.2	104.3 10.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
117.0	105.8 9.9	105.6 9.9	105.3 10.0	104.9 10.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
117.5	106.3 9.8	106.0 9.8	105.7 9.9	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
118.0	109.6 9.7	106.5 9.7	106.2 9.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
118.5	107.3 9.6	107.1 9.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
119.0	107.7 9.5	107.4 9.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
119.5	108.3 9.4	107.8 9.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
120.0	109.0 9.4	108.5 9.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
120.5	109.3 9.4	109.0 9.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
121.0	109.8 9.3	109.6 9.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
121.5	110.2 9.3	110.0 9.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
122.0	110.9 9.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
122.5	111.7 9.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
123.0	112.4 9.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
123.5	112.9 9.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
124.0	113.1 9.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
124.5	113.8 9.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
125.0	114.2 8.9	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 8 A Curve; Table A-7

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
125.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	115.3 8.8	115.0 8.8	114.8 8.8
126.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	115.8 8.8	115.5 8.8	115.3 8.8
126.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.3 8.8	115.7 8.8	115.7 8.8
127.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.7 8.7	116.4 8.8	116.4 8.8
127.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	117.1 8.7	117.0 8.7	117.0 8.7
128.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	117.5 8.7	117.3 8.7	117.3 8.7
128.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	118.0 8.6	117.7 8.7	117.6 8.7
129.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	118.5 8.6	118.2 8.6	118.1 8.6
129.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.0 8.6	118.8 8.6	118.7 8.6
130.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.4 8.6	119.3 8.6	119.2 8.6
130.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.8 8.6	119.7 8.6	119.7 8.6
131.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	120.2 8.5	119.8 8.6	119.8 8.6

GDT-67 Table Set 2— Family of Curves, Theoretical Density-Moisture Chart, B Curve

Table 1: B Curve – Table B Overview

Wet Density (pcf)	% Moisture					
	4.0–10.0	**10.5-15.5**	**16.0-21.0**	**21.5-26.5**	**27.0-32.0**	**32.5-37.5**
98.5 to 111.0	X	B-1	B-2	B-3	B-4	B-5
111.5 to 120.0	B-6	B-7	B-8	B-9	B-10	B-11
120.5 to 129.0	B-12	B-13	B-14			
129.5 to 137.5	B-15	B-16	X	X	X	X
138.0 to 1440	X	X	X	X	X	X

Table 2: B Curve – Table B-1

	10.5	**11.0**	**11.5**	**12.0**	**12.5**	**13.0**	**13.5**	**14.0**	**14.5**	**15.0**	**15.5**
98.5 to 109.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
110.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	97.8 17.5	97.1 17.9
110.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	98.0 17.4	97.5 17.8
111.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	98.8 17.0	98.3 17.2	97.8 17.5

Table 3: B Curve – Table B-2

	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0
98.5 to 106.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
107.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.5 22.0	92.0 22.5	91.8 23.0	91.2 23.5	90.8 24.0
107.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.7 21.8	92.4 22.1	91.8 22.8	91.3 23.4	90.9 23.8
108.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	93.9 20.8	93.4 21.1	92.9 21.5	92.5 22.0	92.0 22.5	91.8 23.0	91.2 23.5
108.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	94.0 20.5	93.5 21.0	92.9 21.5	92.7 21.8	92.4 22.1	91.8 22.8	91.3 23.4
109.0	0.0 0.0	0.0 0.0	95.0 19.5	94.7 19.9	94.2 20.3	94.0 20.5	93.5 21.0	93.2 21.3	92.6 22.0	92.3 22.2	91.8 23.0
109.5	0.0 0.0	95.6 19.0	95.0 19.5	94.6 20.0	94.4 20.2	94.0 20.5	93.6 21.0	93.5 21.0	92.7 21.8	92.5 22.1	91.8 22.8
110.0	96.5 18.3	96.0 18.8	95.5 19.0	95.0 19.5	94.5 20.0	94.3 20.3	93.9 20.7	93.5 21.0	93.0 21.5	92.7 22.0	91.2 22.5
110.5	96.9 18.0	96.3 18.3	95.7 18.7	95.1 19.5	94.7 20.0	94.4 20.1	94.0 20.5	93.6 21.0	93.3 21.1	92.7 21.8	92.5 22.2
111.0	97.1 17.8	96.5 18.2	96.0 18.6	95.4 19.2	95.0 19.5	94.5 20.0	94.2 20.3	94.0 20.6	93.4 21.0	92.8 21.8	92.5 22.1

Table 4: B Curve – Table B-3

	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5
98.5 to 105.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
106.0	0.0 0.0	0.0 0.0	0.0 0.0	89.0 26.1	88.7 26.5	88.4 27.0	88.0 27.3	87.7 27.8	87.2 28.4	86.9 28.9	86.5 29.3
106.5	0.0 0.0	89.8 25.3	89.5 25.5	89.2 26.0	88.9 26.3	88.5 26.8	88.2 27.2	87.9 27.5	87.5 28.1	87.0 28.7	86.7 29.1
107.0	90.2 24.6	90.0 25.0	89.7 25.4	89.2 25.8	89.0 26.1	88.7 26.6	88.3 27.0	88.0 27.3	87.7 27.8	87.3 28.3	86.8 28.9
107.5	90.6 24.2	90.2 24.8	89.8 25.2	89.5 25.5	89.2 26.0	88.8 26.4	88.5 26.8	88.1 27.1	87.9 27.6	87.4 28.2	87.0 28.8
108.0	90.8 24.0	90.2 24.6	90.0 25.0	89.7 25.4	89.2 25.8	89.0 26.1	88.7 26.6	88.3 27.0	88.0 27.0	87.7 27.8	87.3 28.3
108.5	90.9 23.8	90.6 24.2	90.1 24.8	89.8 25.2	89.5 25.5	89.1 26.0.	88.8 26.4	88.5 26.9	88.0 27.4	87.9 27.6	87.4 28.2
109.0	91.3 23.4	90.8 24.0	90.5 24.5	90.0 25.0	89.8 25.2	89.5 25.8	89.2 26.0	88.7 26.5	88.5 27.0	88.0 27.5	87.5 28.0
109.5	91.3 23.2	91.0 23.7	90.5 24.0	90.0 25.0	89.9 25.1	89.5 25.5	89.3 26.0	88.8 26.5	88.5 26.9	88.0 27.5	87.6 28.0
110.0	91.7 23.0	91.2 23.4	90.8 24.0	90.5 24.5	90.1 24.9	89.9 25.1	89.5 25.8	89.0 26.1	88.7 26.5	88.5 27.0	88.0 27.5
110.5	91.8 22.9	91.5 23.1	90.8 23.9	90.6 24.1	90.5 24.4	90.0 25.0	89.6 25.5	89.3 25.8	88.8 26.4	88.5 27.0	88.1 27.2
111.0	92.1 22.6	91.7 23.0	91.4 23.3	90.8 23.9	90.5 24.5	90.2 24.8	89.8 25.2	89.5 25.7	89.0 26.2	88.6 26.6	88.4 27.0

Table 5: B Curve – Table B-4

	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0
98.5 to 104.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
105.0	0.0 0.0	0.0 0.0	84.6 31.2	84.2 31.7	83.8 32.1	83.5 32.6	83.1 33.1	82.8 33.7	82.3 34.5	82.0 34.9	81.5 35.5
105.5	0.0 0.0	0.0 0.0	84.9 31.0	84.4 31.5	84.0 32.0	83.6 32.5	83.2 33.0	83.0 33.4	82.5 34.0	82.1 34.5	81.8 35.1
106.0	86.0 30.0	85.5 30.4	85.0 30.8	84.6 31.2	84.2 31.7	83.9 31.7	83.5 32.6	83.1 33.1	82.8 33.7	82.3 34.4	81.9 34.9
106.5	86.1 29.8	85.7 30.2	85.1 30.6	84.9 31.0	84.4 31.4	84.0 32.0	83.7 32.5	83.3 33.0	82.8 33.6	82.4 34.1	82.1 34.5
107.0	86.3 29.4	86.0 30.0	85.4 30.4	85.0 30.8	84.6 31.3	84.3 31.6	83.9 32.1	83.4 32.8	83.0 33.0	82.7 33.8	82.3 34.3
107.5	86.5 29.2	86.1 29.8	85.5 30.3	85.1 30.6	84.9 31.0	84.4 31.4	84.0 32.0	83.7 32.5	83.3 33.0	82.9 33.4	82.5 34.0
108.0	86.8 28.9	86.3 29.4	86.0 30.0	85.4 30.4	85.0 30.8	84.6 31.3	84.3 31.6	83.9 32.1	83.4 32.8	83.0 33.3	82.7 33.8
108.5	87.0 28.8	86.4 29.1	86.1 29.8	85.5 30.3	85.1 30.6	84.9 31.0	84.4 31.4	84.0 32.0	83.7 32.5	83.2 33.0	82.9 33.4
109.0	87.2 28.4	86.9 28.9	86.5 29.4	86.0 30.0	85.5 30.4	85.0 30.7	84.7 31.2	84.5 31.4	84.0 32.0	83.6 32.6	83.2 33.1
109.5	87.4 28.1	87.0 28.6	86.5 29.2	86.2 29.8	85.7 30.2	85.2 30.5	85.0 31.0	84.6 31.3	84.0 32.0	83.8 32.4	83.4 31.1
110.0	87.5 28.0	87.4 28.2	86.9 28.9	86.5 29.2	86.0 30.0	85.5 30.3	85.0 30.8	84.8 31.0	84.5 31.4	84.0 32.0	83.6 32.5
110.5	87.8 27.8	87.5 28.0	87.0 28.6	86.7 29.0	86.4 29.5	86.0 30.1	85.5 30.4	85.0 30.8	84.7 31.3	84.3 31.7	83.8 32.1
111.0	88.0 27.5	87.6 28.0	87.4 28.4	86.6 29.0	86.5 29.2	86.3 29.6	85.9 30.1	85.1 30.5	84.8 31.0	84.5 31.4	84.0 31.9

Table 6: B Curve – Table B-5

	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5
98.5 to 103.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
104.0	0.0 0.0	80.5 36.5	80.3 37.0	80.2 37.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
104.5	0.0 0.0	80.6 36.5	80.4 36.8	80.1 37.1	80.0 37.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
105.0	81.1 35.9	80.9 36.0	80.5 36.5	80.2 37.0	80.1 37.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
105.5	81.3 35.6	81.0 36.0	80.7 36.3	80.4 36.6	80.2 37.1	80.0 37.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
106.0	81.5 35.5	81.1 35.8	80.9 36.0	80.5 36.5	80.3 37.0	80.0 37.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
106.5	81.7 35.3	81.4 35.6	81.0 36.0	80.7 36.3	80.4 36.8	80.2 37.1	80.0 37.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
107.0	81.9 35.0	81.5 35.5	81.1 35.8	80.9 36.0	80.5 36.5	80.3 37.0	80.1 37.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
107.5	82.1 34.6	81.8 35.1	81.9 35.7	81.0 36.0	80.7 36.3	80.4 36.8	80.3 37.0	80.0 37.5	0.0 0.0	0.0 0.0	0.0 0.0
108.0	82.3 34.3	81.9 35.0	81.5 35.5	81.1 35.8	80.9 36.0	80.5 36.5	80.3 37.0	80.1 37.3	0.0 0.0	0.0 0.0	0.0 0.0
108.5	82.5 34.0	82.1 34.6	81.8 35.1	81.3 35.7	81.0 36.0	80.7 36.3	80.4 36.8	80.3 37.0	80.0 37.4	0.0 0.0	0.0 0.0
109.0	82.9 33.5	82.4 34.0	82.1 34.5	81.8 35.0	81.3 35.7	81.0 36.0	80.5 36.5	80.3 36.8	80.1 37.0	80.0 37.4	0.0 0.0
109.5	83.0 33.4	82.5 34.0	82.2 34.5	82.0 35.0	81.6 35.5	81.2 35.8	81.0 36.0	80.5 36.5	80.3 37.0	80.0 37.3	0.0 0.0
110.0	83.5 33.0	83.0 33.4	82.5 34.0	82.1 34.6	82.0 35.0	81.5 35.2	81.3 35.5	81.0 36.0	80.5 36.5	0.0 0.0	0.0 0.0
110.5	83.5 32.7	83.1 33.0	82.9 33.5	82.7 34.0	82.3 34.4	82.0 34.8	81.6 35.4	81.4 35.5	0.0 0.0	0.0 0.0	0.0 0.0
111.0	83.9 32.3	83.5 32.7	83.4 33.0	83.0 33.5	82.6 34.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 7: B Curve – Table B-6

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	5.0	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
111.5 to 118.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
118.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	109.5 13.0
119.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	110.2 12.9
119.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	110.3 12.8
120.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	112.2 12.4	111.9 12.5	111.2 12.6

Table 8: B Curve – Table B-7

	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
111.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	99.4 16.6	99.0 16.8	98.5 17.1	97.8 17.5
112.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	100.1 16.2	99.6 16.4	99.2 16.6	98.8 16.8	98.2 17.2
112.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	100.5 16.2	99.8 16.4	99.4 16.6	99.0 16.8	98.5 17.0
113.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	101.5 15.8	101.0 16.0	100.1 16.2	99.6 16.5	99.3 16.6	98.6 17.0
113.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	101.8 15.7	101.2 15.9	100.4 16.1	100.0 16.2	99.5 16.6	99.0 16.8
114.0	0.0 0.0	0.0 0.0	0.0 0.0	103.0 15.1	102.9 15.3	102.0 15.6	101.4 15.8	101.0 16.0	100.5 16.2	99.9 16.4	99.4 16.6
114.5	0.0 0.0	0.0 0.0	0.0 0.0	104.0 15.0	103.4 15.1	102.5 15.4	101.8 15.8	101.0 16.0	100.6 16.1	99.0 16.8	99.5 16.6
115.0	0.0 0.0	0.0 0.0	105.3 14.5	104.5 14.8	103.7 15.0	103.0 15.3	102.5 15.4	101.5 15.8	101.0 16.0	100.4 16.2	99.8 16.3
115.5	0.0 0.0	0.0 0.0	105.5 14.4	105.0 14.6	104.0 15.0	103.3 15.1	102.5 15.4	101.8 15.8	101.5 15.8	101.0 16.0	100.2 16.2
116.0	0.0 0.0	106.5 14.0	106.0 14.2	105.4 14.5	104.7 14.8	103.5 15.1	103.0 15.3	102.4 15.5	101.8 15.8	101.5 15.8	100.5 16.0
116.5	0.0 0.0	106.9 13.9	106.0 14.2	105.6 14.4	105.0 14.6	104.3 14.9	103.4 15.1	102.5 15.5	102.0 15.7	101.5 15.8	101.0 16.0
117.0	0.0 0.0	107.5 13.8	106.5 14.0	105.5 14.4	105.2 14.5	104.6 14.8	103.5 15.1	102.0 15.7	101.8 15.5	101.5 15.7	101.3 15.8
117.5	0.0 0.0	107.5 13.8	107.0 13.9	106.4 14.1	105.5 14.4	105.0 14.6	104.4 14.8	103.4 15.1	103.0 15.3	102.5 15.5	102.0 15.7
118.0	108.4 13.5	108.0 13.6	107.5 13.8	106.8 13.9	106.0 14.2	105.2 14.5	104.8 14.8	104.0 15.0	103.4 15.1	102.9 15.3	102.2 15.6
118.5	108.9 13.3	108.2 13.6	107.5 13.8	106.9 13.9	106.4 14.1	105.5 14.4	105.0 14.6	104.2 14.9	103.7 15.1	103.4 15.1	102.5 15.4
119.0	109.3 13.1	108.5 13.5	108.0 13.6	107.3 13.8	106.7 14.0	106.0 14.2	105.5 14.4	104.9 14.7	104.3 14.9	103.6 15.0	103.1 15.3
119.5	109.8 13.0	109.0 13.2	108.3 13.4	107.4 13.8	107.0 13.9	106.2 14.1	105.4 14.4	105.0 14.6	104.8 14.7	104.1 15.0	103.5 15.1
120.0	110.3 12.8	109.5 13.1	108.5 13.4	108.0 13.6	107.5 13.8	106.9 13.9	106.2 13.1	105.5 14.4	105.0 14.5	104.6 14.8	104.1 15.0

Table 9: B Curve – Table B-8

	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0
111.5	97.5 17.7	97.0 18.0	96.2 18.7	95.7 18.9	95.0 19.5	94.7 20.0	94.4 20.1	94.0 20.6	93.6 21.0	93.0 21.5	92.7 21.9
112.0	97.8 17.5	97.2 17.8	96.5 18.3	96.0 18.8	95.7 19.0	95.0 19.5	94.7 20.0	94.4 20.2	94.0 20.6	93.5 21.0	93.0 21.5
112.5	98.0 17.4	97.5 17.7	97.0 18.0	96.4 18.5	95.9 18.8	95.2 19.4	94.7 19.8	94.5 20.0	94.0 21.6	93.6 21.0	93.1 21.3
113.0	98.2 17.3	97.8 17.5	97.2 17.8	96.5 18.2	96.0 18.7	95.5 19.0	95.0 19.5	94.7 20.0	94.5 20.1	94.0 20.6	93.5 21.0
113.5	98.4 17.1	98.0 17.4	97.5 17.7	97.0 18.0	96.3 18.5	96.0 18.7	95.5 19.0	95.0 19.5	94.6 20.0	94.3 20.3	93.9 20.7
114.0	99.0 16.8	98.4 17.2	97.8 17.5	97.1 17.9	96.9 18.3	96.0 18.7	95.8 18.8	95.4 19.2	95.0 19.6	94.6 20.0	94.2 20.5
114.5	99.0 16.8	98.7 17.0	98.0 17.4	97.6 17.7	97.0 18.0	96.6 18.3	96.0 18.7	95.7 18.8	95.4 19.3	94.9 19.6	94.4 20.1
115.0	99.3 16.6	99.0 16.8	98.5 17.1	98.0 17.4	97.3 17.7	96.9 18.0	96.6 18.3	96.2 18.5	95.9 18.7	95.3 19.3	95.0 19.5
115.5	99.6 16.5	99.3 16.6	99.0 16.8	98.4 17.2	97.8 17.5	97.4 17.7	97.0 18.0	96.5 18.4	96.2 18.5	95.7 18.8	95.4 19.3
116.0	100.0 16.4	99.6 16.5	99.1 16.7	98.7 17.0	98.3 17.3	97.7 17.6	97.4 17.7	97.0 18.0	96.6 18.3	96.4 18.4	96.1 18.4
116.5	100.4 16.2	100.0 16.4	99.4 16.5	99.0 16.8	98.7 17.0	98.3 17.3	97.7 17.6	97.5 17.6	97.4 17.7	96.9 18.0	96.6 18.3
117.0	101.0 16.0	100.3 16.3	99.9 16.4	99.5 16.5	99.0 16.8	98.7 17.0	98.4 17.2	98.3 17.3	0.0 0.0	0.0 0.0	0.0 0.0
117.5	101.3 16.8	100.9 16.0	100.1 16.3	99.8 16.4	99.4 16.5	99.3 16.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
118.0	101.7 15.7	101.3 15.8	101.0 16.0	100.4 16.2	100.0 16.4	99.9 16.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
118.5	102.1 15.5	101.7 15.7	101.3 15.8	101.0 16.0	100.5 16.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
119.0	102.7 15.3	102.6 15.4	101.7 15.6	101.4 15.7	101.2 15.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
119.5	103.1 15.2	102.7 15.3	102.4 15.4	102.0 15.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
120.0	103.6 15.0	103.3 15.1	103.0 15.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 10: B Curve – Table B-9

	21.5	**22.0**	**22.5**	**23.0**	**23.5**	**24.0**	**24.5**	**25.0**	**25.5**	**26.0**	**26.5**
111.5	92.3 22.2	91.8 22.9	91.3 23.4	91.0 23.7	90.6 24.1	90.4 24.5	90.0 25.0	89.6 25.4	89.4 25.9	88.8 26.4	88.5 26.9
112.0	92.8 22.0	92.0 22.6	91.7 23.0	91.4 23.5	90.8 23.8	90.6 24.2	90.2 24.8	89.9 25.1	89.6 25.5	89.1 26.0	88.8 26.4
112.5	92.8 21.9	92.5 22.1	92.0 22.6	91.7 23.0	91.1 23.5	90.8 23.9	90.5 24.3	90.3 24.7	89.7 25.2	89.3 25.8	89.1 26.0
113.0	93.0 21.5	92.8 21.9	92.4 223.	92.0 22.7	91.6 23.1	91.1 23.5	90.8 23.8	90.5 24.3	90.0 25.0	89.7 25.3	89.5 25.6
113.5	93.3 21.1	93.0 21.5	92.7 21.9	92.3 22.2	91.9 22.7	91.5 23.1	91.2 23.2	90.8 23.8	90.6 24.3	90.2 25.0	89.8 25.3
114.0	93.9 20.7	93.3 21.1	92.8 21.7	92.6 21.8	92.3 22.2	91.9 22.7	91.8 22.9	91.4 23.3	90.8 23.8	90.7 23.9	90.6 24.3
114.5	94.5 20.4	94.0 20.6	93.6 20.9	92.8 21.7	92.7 21.8	92.4 22.3	92.0 22.6	91.8 22.8	0.0 0.0	0.0 0.0	0.0 0.0
1150	95.0 20.0	94.6 20.4	94.0 20.6	93.9 20.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
115.5	95.1 19.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
116.0 to 129.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 11: B Curve – Table B-10

	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0
111.5	88.2 27.2	88.0 27.5	87.5 28.0	87.1 28.5	86.8 28.9	86.5 29.3	86.1 29.8	85.8 30.1	85.4 30.4	84.7 31.0	84.5 31.4
112.0	88.5 26.7	88.2 27.1	87.9 27.6	87.6 28.0	87.1 28.6	86.9 28.2	86.5 29.3	86.0 29.9	85.8 30.1	85.3 30.5	84.9 31.0
112.5	88.8 26.4	88.7 26.5	88.1 27.3	88.0 27.5	87.6 28.0	87.1 28.4	86.9 28.7	86.4 29.4	86.1 29.8	0.0 0.0	0.0 0.0
113.0	89.2 26.0	88.9 26.3	88.7 26.5	88.3 27.1	87.8 27.5	87.6 27.6	87.5 28.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
113.5	89.7 25.4	89.5 25.6	89.2 26.0	89.0 26.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
114.0 to 129.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 12: B Curve – Table B-11

	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5
111.5	84.3 31.6	83.9 32.2	83.7 32.4	83.6 33.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
112.0	84.7 31.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
112.5 to 129.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 13: B Curve – Table B-12

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
120.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	113.0 12.2	112.2 12.4	111.3 12.6
121.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	113.0 12.2	112.5 12.4	111.5 12.5
121.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	114.0 11.9	113.5 12.0	112.8 12.2	112.0 12.4
122.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	114.7 11.8	114.0 12.0	113.0 12.2	112.5 12.4
122.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	115.0 11.7	114.1 11.9	113.5 12.1	113.0 12.2
123.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	115.5 11.6	114.8 11.8	114.0 12.0	113.5 12.1
123.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.0 11.4	115.5 11.5	115.0 11.7	114.3 11.9	113.5 12.0
124.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.3 11.2	116.0 11.4	115.4 11.6	114.6 11.7	114.0 12.0
124.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.7 11.1	116.0 11.4	115.5 11.5	115.0 11.7	114.5 11.8
125.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	117.0 11.0	116.5 11.1	116.0 11.4	115.5 11.5	115.0 11.7
125.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	117.5 11.0	116.9 11.1	116.1 11.4	115.5 11.5	115.0 11.7
126.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	118.5 10.7	117.6 11.0	117.1 11.0	116.5 11.2	116.0 11.3	115.5 11.5
126.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	118.8 10.6	118.2 10.8	117.5 11.0	117.0 11.1	116.2 11.3	115.8 11.5
127.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.0 10.5	118.6 10.6	117.5 10.8	117.0 11.1	116.5 11.2	116.0 11.3
127.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	120.2 10.0	119.6 10.3	118.8 10.5	118.3 10.6	117.3 11.0	117.0 11.1	116.5 11.2
128.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	120.5 10.0	120.0 10.1	119.2 10.3	118.8 10.5	118.0 10.8	117.5 11.0	116.8 11.1
128.5	0.0 0.0	0.0 0.0	0.0 0.0	122.0 9.6	121.0 10.0	120.5 10.0	119.5 10.3	119.0 10.5	118.5 10.6	117.8 10.9	117.2 11.0
129.0	0.0 0.0	0.0 0.0	0.0 0.0	122.5 9.5	121.0 10.0	120.5 10.0	120.0 10.1	119.0 10.5	118.8 10.5	118.1 10.8	117.5 11.0

Table 14: B Curve – Table B-13

	10.5	**11.0**	**11.5**	**12.0**	**12.5**	**13.0**	**13.5**	**14.0**	**14.5**	**15.0**	**15.5**
120.5	110.8 12.8	109.8 13.0	109.0 13.2	108.5 13.8	107.7 13.8	107.0 13.9	106.5 14.0	105.9 14.4	105.5 14.4	105.0 14.6	104.6 14.8
121.0	111.0 12.7	110.3 12.8	109.5 13.0	108.7 13.1	108.0 13.6	107.5 13.8	106.3 13.9	105.8 14.3	105.8 14.3	105.3 14.5	104.9 14.7
121.0	111.2 12.6	110.5 12.8	109.8 13.0	108.8 13.2	108.5 13.5	107.6 13.7	107.1 13.9	106.6 14.1	106.1 14.1	105.8 14.3	105.3 14.5
122.0	111.5 12.5	111.0 12.7	110.4 12.8	109.5 13.0	108.6 13.5	108.0 13.6	107.5 13.8	107.0 14.0	106.6 14.0	106.1 14.1	105.8 14.3
122.5	112.0 12.5	111.2 12.6	110.5 12.8	110.0 13.0	109.0 13.2	108.5 13.5	108.0 13.6	107.7 13.9	107.0 13.9	106.7 14.0	106.5 14.0
123.0	112.5 12.3	111.5 12.5	111.0 12.8	110.3 12.8	109.7 13.0	109.0 13.2	108.5 13.5	108.0 13.7	107.6 13.7	107.4 13.7	106.9 13.9
123.5	113.0 12.2	112.2 12.4	111.2 12.6	110.5 12.8	110.0 13.0	109.5 13.0	108.8 13.4	108.4 13.6	108.1 13.6	107.7 13.6	107.6 13.7
124.0	113.5 12.1	112.5 12.3	111.8 12.5	111.0 12.7	110.5 12.8	109.8 13.0	109.3 13.2	108.8 13.5	108.5 13.5	108.3 13.5	107.9 13.6
124.5	113.8 12.0	113.0 12.2	112.2 12.4	111.5 12.5	111.0 12.7	110.2 12.9	109.7 13.0	109.3 13.1	109.0 13.3	108.8 13.4	108.5 13.5
125.0	114.2 11.8	113.5 121.	113.0 12.2	112.0 12.5	111.2 12.5	110.7 12.7	110.2 12.9	109.6 13.0	109.3 13.1	109.2 13.3	109.1 13.3
125.5	114.5 11.8	114.0 12.0	113.0 12.2	112.5 12.3	112.0 12.5	111.2 12.6	110.7 12.7	110.2 12.9	109.8 13.0	109.4 13.1	0.0 0.0
126.0	115.0 11.6	114.0 12.0	113.7 12.0	113.0 12.2	112.5 12.5	111.8 12.4	111.1 12.5	110.7 12.7	110.2 12.9	109.9 13.0	0.0 0.0
126.5	115.4 11.5	114.5 11.8	114.0 12.0	113.5 12.0	113.0 12.3	112.2 12.4	111.7 12.4	111.1 12.6	111.0 12.7	0.0 0.0	0.0 0.0
127.0	115.5 11.5	115.0 11.6	114.5 11.8	114.0 12.0	113.4 12.1	112.8 12.3	112.4 12.3	112.1 12.4	112.0 12.4	0.0 0.0	0.0 0.0
127.5	116.0 11.3	115.5 11.5	115.0 11.6	114.3 11.8	114.0 12.0	113.4 12.1	113.2 12.2	113.1 12.2	0.0 0.0	0.0 0.0	0.0 0.0
128.0	116.2 11.3	115.8 11.5	115.5 11.5	114.7 11.7	114.4 11.8	114.1 11.9	113.8 12.0	113.7 12.0	0.0 0.0	0.0 0.0	0.0 0.0
128.5	116.5 11.1	116.0 11.3	115.7 11.5	115.1 11.5	114.9 11.6	114.6 11.7	114.4 11.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
129.0	117.0 11.1	116.5 11.1	116.1 11.3	115.6 11.4	115.4 11.5	115.1 11.6	115.0 11.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 15: B Curve – Table B-14

	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0
120.5	104.1 14.9	103.7 15.0	103.4 15.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
121.0	104.4 14.8	104.1 14.9	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
121.5	105.0 14.6	104.7 14.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
122.0	105.3 14.5	105.1 14.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
122.5	105.9 14.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
123.0	106.4 14.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
123.5	107.2 13.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
124.0 to 129.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 16: B Curve – Table B-15

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
129.5	0.0 0.0	0.0 0.0	0.0 0.0	122.5 9.5	122.0 9.6	121.0 10.0	120.5 10.0	120.0 10.1	119.0 10.5	118.8 10.6	118.0 10.8
130.0	0.0 0.0	0.0 0.0	123.8 9.2	123.0 9.5	122.1 9.5	121.5 9.8	120.5 10.0	120.2 10.0	119.5 10.3	119.0 10.5	118.5 10.6
130.5	0.0 0.0	0.0 0.0	124.0 9.1	123.2 9.3	122.5 9.6	122.0 10.0	121.0 10.0	120.5 10.0	120.0 10.1	119.0 10.5	118.9 10.5
131.0	0.0 0.0	0.0 0.0	124.5 9.0	123.9 9.1	123.0 9.5	122.4 9.5	121.9 9.6	120.9 10.0	120.5 10.0	120.0 10.1	119.5 10.3
131.5	0.0 0.0	125.5 8.6	125.0 8.9	124.0 9.1	123.1 9.3	122.9 9.5	122.0 9.6	121.0 10.0	120.5 10.0	120.0 10.1	119.5 10.3
132.0	0.0 0.0	126.0 8.5	125.0 8.9	124.5 9.0	123.9 9.1	123.0 9.5	122.5 9.5	122.0 9.6	121.0 10.0	120.5 10.0	120.3 10.0
132.5	0.0 0.0	126.5 8.4	125.5 8.6	125.0 8.9	124.2 9.2	123.8 9.1	123.0 9.5	122.5 9.5	121.5 9.8	121.0 10.0	120.5 10.0
133.0	0.0 0.0	126.9 8.2	126.0 8.5	125.0 8.9	124.5 9.0	124.0 9.1	123.5 9.2	122.5 9.5	122.0 9.5	121.5 9.5	121.5 9.9
133.5	0.0 0.0	127.2 8.1	126.5 8.4	125.5 8.6	125.0 8.9	124.5 9.0	124.0 9.1	123.2 9.5	122.8 9.4	122.3 9.5	121.7 9.7
134.0	0.0 0.0	127.5 8.0	126.9 8.2	126.0 8.5	125.5 8.8	124.8 8.9	124.5 9.0	124.2 9.0	124.0 9.1	123.0 9.5	122.4 9.5
134.5	0.0 0.0	127.8 8.0	127.0 8.1	126.5 8.4	125.5 8.6	125.0 8.9	124.7 8.9	124.2 9.0	124.0 9.1	123.4 9.3	123.0 9.4
135.0	128.8 7.7	128.4 7.8	127.5 8.0	126.9 8.2	126.2 8.4	125.6 8.6	125.0 8.9	124.5 9.0	124.5 9.0	124.1 9.1	123.9 9.2
135.5	129.0 7.7	128.6 7.8	128.0 8.0	127.2 8.1	126.9 8.2	126.0 8.5	125.5 8.6	125.0 8.9	124.3 8.9	124.5 9.0	124.3 9.0
136.0	129.6 7.4	129.0 7.7	128.5 7.8	128.0 8.0	127.0 8.1	126.8 8.2	126.0 8.5	125.8 8.5	125.2 8.7	124.9 8.9	124.8 8.9
136.5	130.0 7.3	129.5 7.4	129.0 7.7	128.5 7.8	127.5 8.0	127.0 8.1	126.5 8.4	126.4 8.5	126.0 8.5	125.6 8.6	0.0 0.0
137.0	130.5 7.1	129.8 7.3	129.3 7.5	128.9 7.8	128.0 8.0	127.5 8.0	127.0 8.1	126.8 8.3	126.4 8.4	126.2 8.4	0.0 0.0
137.5	131.0 7.0	130.5 7.1	129.5 7.4	129.0 7.7	128.5 7.8	128.0 8.0	127.5 8.0	127.3 8.0	126.9 8.3	0.0 0.0	0.0 0.0

Table 17: B Curve – Table B-16

	10.0	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
129.5	117.5 11.0	117.0 11.0	116.6 11.2	116.1 11.3	115.9 11.4	115.6 11.5	115.5 11.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
130.0	118.0 10.8	117.5 11.0	117.1 11.1	116.8 11.2	116.6 11.3	116.2 11.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
130.5	118.5 10.6	118.0 10.7	117.6 10.9	117.3 11.0	117.0 11.1	116.9 11.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
131.0	118.8 10.6	118.4 10.7	118.0 10.7	117.8 10.9	117.6 10.9	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
131.5	119.4 10.4	118.9 10.5	118.5 10.6	118.3 10.7	118.2 10.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
132.0	119.8 10.3	119.4 10.4	119.1 10.5	118.9 10.5	118.8 10.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
132.5	120.2 10.1	119.9 10.2	119.7 10.3	119.3 10.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
133.0	121.1 9.8	120.4 10.0	120.2 10.1	120.1 10.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
133.5	121.2 9.8	121.0 9.9	120.6 10.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
134.0	122.0 9.7	121.9 9.8	121.8 9.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
134.5	122.6 9.5	122.5 9.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
135.0	123.5 9.3	123.4 9.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
135.5	124.2 9.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
136.0	124.8 8.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
136.5 to 137.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 18: B Curve – Table B-17

	4.0	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**
138.0	0.0 0.0	132.6 6.6	131.5 6.9	130.8 7.0	130.0 7.3	129.5 7.4	129.0 7.8	128.6 7.8	128.3 7.9	127.9 8.0	127.5 8.1
138.5	0.0 0.0	132.6 6.5	132.0 6.8	131.5 6.9	130.8 7.1	130.0 7.3	129.6 7.4	129.2 7.8	128.8 7.6	128.7 7.7	128.2 7.6
139.0	0.0 0.0	133.3 6.4	132.6 6.5	131.8 6.8	131.2 7.0	130.5 7.2	130.0 7.3	129.6 7.5	129.2 7.7	129.3 7.6	0.0 0.0
139.5	0.0 0.0	134.0 6.2	132.6 6.5	132.0 6.8	131.5 6.9	131.0 7.0	130.5 7.2	130.1 7.3	129.8 7.4	129.5 7.4	0.0 0.0
140.0	0.0 0.0	134.0 6.2	133.3 6.4	132.6 6.5	132.0 6.8	131.5 6.9	131.0 7.0	130.7 7.2	130.3 7.3	130.30 7.3	0.0 0.0
140.5	0.0 0.0	134.5 6.1	134.0 6.2	133.0 6.5	132.5 6.5	132.0 6.8	131.6 6.9	131.3 7.0	131.2 7.0	0.0 0.0	0.0 0.0
141.0	135.0 6.0	134.5 6.1	134.0 6.2	133.5 6.3	132.8 6.5	132.5 6.5	132.1 6.7	131.9 6.8	131.7 6.8	0.0 0.0	0.0 0.0
141.5	135.5 5.8	135.0 6.0	134.5 6.1	134.0 6.2	133.5 6.3	133.0 6.5	132.8 6.5	132.6 6.5	0.0 0.0	0.0 0.0	0.0 0.0
142.0	135.8 5.7	135.2 5.8	134.5 6.1	134.3 6.2	134.0 6.2	133.6 6.4	133.4 6.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
142.5	136.2 5.6	135.5 5.7	135.0 6.0	134.8 6.0	134.5 6.0	134.1 6.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
143.0	136.5 5.5	136.0 5.6	135.5 5.7	135.2 5.9	135.0 6.0	134.7 6.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
143.5	137.0 5.3	136.5 5.5	135.8 5.7	135.5 5.7	135.4 5.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
144.0	137.5 5.1	137.0 5.2	136.5 5.5	136.3 5.5	135.9 5.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

GDT-67 Table Set 3—Family of Curves; Theoretical Density-Moisture Chart, C Curve

Table 1: C Curve; Table C Overview

Wet Density (pcf)	% Moisture					
	4-0-10.0	10.5-15.5	16.0-21.0	21.5-26.5	27.0-32.0	32.5-37.5
98.5 to 108.0	X	X	C-1	C-2	C-3	C-4
108.0 to 117.0	X	C-5	C-6	C-7	C-8	
117.5 to 126.0	C-9	C-10	C011			X
126.5 to 135.0	C-12	C-13	X	X	X	X
135.5 to 144.0	C-14	X	X	X	X	X

Table 2: C Curve; Table C-1

	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0
98.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
105.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.3 24.7
105.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	92.4 24.6
106.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	93.6 23.7	93.1 24.0	92.6 24.4
106.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	94.2 23.3	93.7 23.7	93.3 23.9	92.7 24.4
107.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	95.7 22.1	95.0 22.7	94.4 23.1	93.9 23.5	93.5 23.8	92.6 24.3
107.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	95.8 22.1	95.2 22.4	94.5 23.1	93.9 23.5	93.7 23.7	93.0 24.1
108.0	0.0	0.0	0.0	0.0	96.9 21.5	96.2 21.8	95.2 22.4	94.7 22.9	94.0 23.4	93.8 23.6	93.0 24.1

Table 3: C Curve; Table C-2

	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5
98.5 to 101.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
102.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	86.4 29.3	85.8 29.8	85.4 30.1
102.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	86.6 29.0	85.9 29.6	85.5 30.0
103.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	87.8 28.0	87.5 28.3	87.1 28.6	86.6 29.0	86.2 29.1	85.5 30.0
103.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	88.6 27.4	87.9 27.9	87.5 28.3	87.1 28.6	86.6 29.0	86.2 29.4	85.7 29.9
104.0	0.0 0.0	90.9 25.8	90.1 26.4	89.4 26.9	88.8 27.2	88.0 27.9	87.6 28.0	87.2 28.6	86.7 28.9	86.3 29.3	85.8 29.3
104.5	0.0 0.0	91.0 25.7	90.3 26.3	89.5 26.8	89.0 27.1	88.4 27.5	87.8 28.0	87.4 28.4	86.9 28.8	86.4 29.2	86.0 29.6
105.0	92.0 24.9	91.3 25.5	90.6 26.0	89.8 26.6	89.3 27.0	88.5 27.5	88.0 27.9	87.5 28.3	87.1 28.6	86.6 29.0	86.2 29.4
105.5	92.1 24.8	91.3 25.5	90.7 25.9	90.0 26.5	89.3 27.0	88.7 27.3	88.2 27.7	87.5 28.3	87.2 28.6	86.8 28.8	86.3 29.3
106.0	92.1 24.0	91.4 25.4	90.8 25.8	90.1 26.4	89.6 26.8	88.8 27.2	88.3 27.7	87.7 28.2	87.4 28.4	87.0 28.7	86.5 29.2
106.5	92.2 24.7	91.5 25.3	91.0 25.7	90.2 26.3	89.6 26.8	89.0 27.1	88.4 27.5	87.8 28.0	87.4 28.4	87.2 28.6	86.6 29.0
107.0	92.3 24.7	91.8 25.0	91.2 25.5	90.6 26.0	90.0 26.5	89.2 27.0	87.9 27.2	88.1 27.8	87.7 28.2	87.2 28.6	86.7 28.9
107.5	92.6 24.4	91.9 25.0	91.3 25.5	90.7 25.9	90.1 26.4	89.4 26.9	88.9 27.2	88.3 27.7	87.8 28.0	87.3 28.5	86.9 28.8
108.0	92.8 24.3	92.0 24.9	91.7 25.1	90.9 25.8	90.3 26.3	89.7 26.7	89.2 27.0	88.5 27.5	88.1 27.8	87.6 28.2	87.2 28.6

Table 4: C Curve; Table C-3

	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0
98.5 to 99.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
100.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	80.2 34.5	0.0 0.0	0.0 0.0
100.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	82.1 33.0	81.1 33.5	80.9 33.8	80.4 34.2	80.0 34.6	0.0 0.0
101.0	0.0 0.0	0.0 0.0	83.6 31.5	83.1 31.9	82.6 32.3	82.1 32.9	84.6 33.2	81.0 33.7	80.5 34.0	80.3 34.4	0.0 0.0
101.5	84.6 30.8	84.0 30.8	83.7 31.5	83.4 31.7	82.6 32.3	82.4 32.6	81.6 33.2	81.4 33.4	80.6 34.0	80.5 34.2	79.8 34.8
102.0	84.8 30.2	84.3 31.0	83.7 31.4	83.5 31.5	82.8 32.1	82.5 32.4	82.0 32.9	81.5 33.4	80.8 33.9	80.5 34.2	80.0 34.6
102.5	84.8 30.2	84.5 30.8	83.7 31.4	83.5 31.5	82.9 32.1	82.6 32.8	82.0 32.9	81.5 33.3	81.0 33.7	80.6 34.0	80.1 34.5
103.0	85.1 30.3	84.5 30.8	83.9 31.2	83.6 31.5	83.1 31.9	82.6 32.3	82.2 32.7	81.7 33.2	81.3 33.4	80.7 34.0	80.3 34.4
103.5	85.2 30.2	84.7 30.7	84.0 31.2	83.7 31.4	83.2 31.8	82.6 32.3	82.3 32.7	81.8 33.1	81.4 33.4	80.9 33.9	80.3 34.4
104.0	85.3 30.2	84.8 30.7	84.3 31.0	83.8 31.3	83.4 30.7	82.8 32.1	82.5 32.4	82.1 32.9	81.6 33.2	81.2 33.6	80.6 34.1
104.5	85.4 30.1	85.0 30.4	84.5 30.8	84.0 31.2	83.6 31.5	83.1 31.9	82.6 32.3	82.3 32.7	81.7 33.2	81.3 33.4	80.7 34.0
105.0	85.6 30.0	85.2 30.2	84.7 30.7	84.2 31.0	83.7 31.4	83.3 31.7	82.7 32.2	82.4 32.6	81.9 33.0	81.5 33.3	80.8 33.9
105.5	85.7 29.9	85.3 30.2	84.8 30.7	84.3 31.0	83.8 31.3	83.5 31.5	82.8 32.1	82.6 32.3	82.1 32.9	81.7 33.2	81.1 33.7
106.0	85.9 29.7	85.5 30.0	85.0 30.4	84.6 30.8	84.0 31.2	83.7 31.4	83.1 31.9	82.7 32.2	82.2 32.7	81.9 33.0	81.2 33.5
106.5	86.0 29.6	85.3 30.0	85.1 30.3	84.8 30.7	84.1 31.1	83.8 31.3	83.2 31.8	82.9 32.1	82.4 34.6	82.1 32.9	81.5 33.3
107.0	86.1 29.5	85.8 29.8	85.3 30.2	85.0 30.4	84.4 30.9	84.0 31.5	83.6 31.5	83.1 31.9	82.6 32.3	82.3 32.7	81.8 33.0
107.5	86.6 29.0	86.0 29.6	85.6 30.0	85.1 30.3	84.7 31.7	84.1 31.1	83.7 31.4	83.3 31.7	82.8 32.1	82.4 32.6	82.0 32.9
108.0	86.7 28.9	86.2 29.4	85.7 29.9	85.3 30.2	84.8 30.7	84.6 30.8	83.9 31.2	83.6 31.5	83.0 32.0	82.7 32.2	82.2 32.7

Table 5: C Curve; Table C-4

	32.5	**33.0**	**33.5**	**34.0**	**34.5**	**35.0**	**35.5**	**36.0**	**36.5**	**37.0**	**37.5**
98.5 to 103.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
103.5	80.0 34.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
104.0	80.2 34.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
104.5	80.3 34.4	79.9 34.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
105.0	80.6 34.1	80.0 34.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
105.5	80.7 34.0	80.3 34.4	79.9 34.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
106.0	80.8 33.9	80.5 34.2	80.2 34.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
106.5	81.1 33.6	80.6 34.1	80.3 34.4	79.8 34.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107.0	81.4 33.4	80.9 33.9	80.6 34.1	80.1 34.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
107.5	81.6 33.2	81.1 33.6	80.7 34.0	80.3 34.4	80.0 34.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
108.0	81.9 33.0	81.4 33.4	80.9 33.9	80.7 34.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
108.5	82.1 32.9	81.7 33.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
109.0	82.2 32.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
109.5 to 117.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 6: C Curve; Table C-5

	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
108.5 to 111.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
111.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	102.7 18.2	102.0 18.6
112.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	104.0 17.5	102.7 18.2	102.1 18.5
112.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	104.6 17.3	104.1 17.4	102.7 18.2	102.1 18.5
113.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	106.3 16.5	104.7 17.2	104.2 17.4	103.0 18.0	102.3 18.4
113.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	106.6 16.3	104.8 17.1	104.4 17.3	103.0 18.0	102.5 18.3
114.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	107.9 15.8	106.7 16.3	104.9 17.0	104.5 17.3	103.3 17.9	102.6 18.3
114.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	107.9 15.8	107.2 16.0	105.9 16.7	104.6 17.3	103.3 17.9	102.7 18.2
115.0	0.0 0.0	0.0 0.0	0.0 0.0	109.8 14.9	109.0 15.2	108.0 15.7	107.4 16.0	106.0 16.6	105.3 16.8	103.4 17.7	103.0 18.0
115.5	0.0 0.0	0.0 0.0	0.0 0.0	109.9 14.9	109.1 15.2	108.1 15.7	107.5 15.9	106.1 16.5	105.4 16.8	104.0 17.5	103.1 18.0
116.0	0.0 0.0	0.0 0.0	111.2 14.4	110.0 14.8	109.2 15.1	108.2 15.6	107.5 15.9	106.2 16.5	105.6 16.7	104.3 17.4	103.3 17.9
116.5	0.0 0.0	0.0 0.0	111.4 14.3	110.1 14.7	109.5 15.0	108.3 15.5	107.6 15.8	106.4 16.4	105.7 16.6	104.3 17.4	103.8 17.6
117.0	113.1 13.6	112.0 14.0	111.5 14.3	110.1 14.7	109.7 15.0	108.4 15.5	107.9 15.8	106.5 16.5	106.0 16.6	104.5 17.3	104.0 17.5

Table 7: C Curve; Table C-6

	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0
108.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	97.1 21.4	96.2 21.8	95.3 22.4	94.9 22.7	94.2 23.3	93.8 23.6	93.2 24.0
109.0	0.0 0.0	0.0 0.0	98.5 20.6	97.8 21.0	97.2 21.3	96.5 21.7	95.4 22.3	95.0 22.7	94.3 23.1	94.0 23.4	93.5 23.8
109.5	0.0 0.0	0.0 0.0	98.6 20.5	97.8 21.0	97.3 21.3	96.5 21.7	95.7 22.1	95.1 22.5	94.5 23.1	94.0 23.4	93.6 23.7
110.0	100.4 19.4	99.9 19.8	98.8 20.4	98.0 20.8	97.4 21.2	96.8 21.5	95.8 22.1	95.3 22.4	94.6 23.0	94.3 23.2	93.8 23.6
110.5	100.4 19.4	100.0 19.7	98.8 20.4	98.1 20.8	97.6 21.1	97.0 21.4	95.9 22.0	95.4 22.3	94.7 22.9	94.4 23.1	93.9 23.5
111.0	100.6 19.3	100.1 19.7	98.9 20.3	98.3 20.7	97.7 21.0	97.2 21.3	96.0 21.9	95.6 22.2	94.9 22.7	94.5 23.1	94.0 23.4
111.5	101.3 18.9	100.3 19.6	98.9 20.3	98.5 20.6	97.7 21.0	97.2 21.3	96.3 21.7	95.7 22.1	95.0 22.7	94.6 23.0	94.2 23.3
112.0	101.4 18.8	100.3 19.3	99.1 20.2	98.6 20.5	98.0 20.8	97.4 21.2	96.7 21.5	95.9 22.0	95.2 22.5	94.9 22.7	94.3 23.1
112.5	101.5 18.8	100.5 19.1	99.3 20.1	98.8 20.4	98.1 20.8	97.5 21.2	96.8 21.5	96.5 21.7	95.4 22.3	95.0 22.7	94.6 23.0
113.0	101.7 18.7	100.8 19.0	99.9 19.8	99.4 20.0	98.3 20.7	97.8 21.0	97.1 21.4	96.6 21.7	95.7 22.1	95.4 22.3	94.7 22.9
113.5	101.8 18.7	101.0 19.0	100.0 19.8	99.5 20.0	98.4 20.6	97.9 20.9	97.3 21.3	96.9 21.5	95.8 22.1	95.4 22.3	94.8 20.8
114.0	101.8 18.6	101.1 19.0	100.2 19.7	99.7 20.0	98.3 20.4	98.1 20.8	97.5 21.2	97.1 21.4	96.2 21.8	95.6 22.2	95.0 22.7
114.5	101.9 18.6	101.2 18.9	100.3 19.5	99.8 19.9	98.9 20.3	98.3 20.7	97.6 21.2	97.3 21.3	96.4 21.6	95.8 22.0	95.2 22.5
115.0	102.0 18.6	101.4 18.8	100.6 19.3	100.1 19.7	99.4 20.2	98.6 20.5	97.9 20.9	97.5 21.2	97.0 21.4	96.2 21.8	95.6 22.2
115.5	102.2 18.4	101.8 18.6	101.0 19.0	100.2 19.7	99.6 20.0	98.8 20.4	98.1 20.8	97.8 21.0	97.2 21.3	96.4 21.6	95.8 22.0
116.0	102.5 18.3	101.9 18.5	101.0 19.0	100.6 19.3	99.8 19.9	99.5 20.0	98.4 20.6	98.0 20.8	97.4 21.2	97.0 21.4	96.1 21.8
116.5	102.6 18.3	102.0 18.6	101.2 18.9	100.7 19.3	100.0 19.8	99.6 20.0	98.6 20.5	98.2 20.7	97.8 21.0	97.3 21.3	96.4 21.6
117.0	103.0 18.0	102.5 18.3	101.6 18.7	101.0 19.0	100.3 19.5	99.7 20.0	99.0 20.3	98.6 20.5	97.9 20.9	97.4 21.2	97.0 21.4

Table 8: C Curve; Table C-7

	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5
108.5	92.8 24.3	92.2 24.7	91.8 25.0	91.0 25.7	90.7 25.9	89.9 26.5	89.4 26.9	88.7 27.3	88.2 27.7	87.7 28.2	87.3 20.5
109.0	92.8 24.3	92.3 24.7	92.0 24.9	91.2 25.5	90.8 25.8	90.0 26.5	89.6 26.8	88.9 27.2	88.6 27.4	88.0 27.9	87.6 28.2
109.5	93.0 24.2	92.4 24.6	92.0 24.9	91.3 25.5	90.9 25.8	90.3 26.3	89.8 26.6	89.1 27.1	88.6 27.4	88.1 27.8	87.6 28.2
110.0	93.3 24.0	92.7 24.4	92.2 24.7	91.6 25.2	91.2 25.5	90.4 26.2	90.0 26.5	89.4 26.9	89.0 27.1	88.3 27.7	88.0 27.9
110.5	93.4 24.9	92.8 24.3	92.3 24.7	91.9 25.0	91.3 25.5	90.8 25.8	90.1 26.4	89.6 26.8	89.2 27.0	88.6 27.4	88.2 27.7
111.0	93.7 23.7	93.0 24.2	92.6 24.4	92.0 24.9	91.6 25.2	90.9 25.8	90.4 26.2	89.9 26.5	89.4 26.9	88.9 27.2	88.5 27.5
111.5	93.8 23.6	93.2 24.0	92.7 24.4	92.1 24.8	91.7 25.1	91.2 25.5	90.7 25.9	90.0 26.5	89.7 26.7	89.1 27.1	88.7 27.3
112.0	94.0 23.4	93.5 23.8	92.9 24.2	92.4 24.6	92.0 24.9	9 1.4 25.4	91.0 25.7	90.4 26.2	90.0 26.5	89.5 26.8	89.0 27.1
112.5	94.1 23.4	93.7 23.7	93.1 24.1	92.6 24.4	92.1 24.8	91.6 25.2	91.2 25.5	90.7 25.9	90.2 26.3	89.7 26.7	89.1 27.1
113.0	94.3 23.0	93.9 23.5	93.5 23.8	92.8 24.3	92.4 24.6	91.8 25.0	91.5 25.3	90.9 25.8	90.6 26.0	90.0 26.5	89.6 26.8
113.5	96.4 23.0	94.0 23.4	93.6 23.7	93.0 24.1	92.6 24.4	92.0 24.9	91.7 25.1	91.0 25.7	90.7 25.9	90.3 26.3	0.0 0.0
114.0	94.7 22.9	94.2 23.3	94.0 23.4	93.3 23.9	92.8 24.3	92.3 24.7	92.0 24.9	91.4 25.4	91.0 25.7	0.0 0.0	0.0 0.0
114.5	94.8 20.8	94.4 23.1	94.1 23.4	93.6 23.7	93.0 24.1	92.4 24.6	92.1 24.8	91.6 25.2	0.0 0.0	0.0 0.0	0.0 0.0
115.0	95.1 22.6	94.7 22.9	94.4 23.1	93.8 23.6	93.5 23.8	92.8 24.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
115.5	95.4 22.3	94.8 20.8	94.5 23.1	94.0 23.4	93.7 23.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
116.0	95.7 22.1	95.0 22.7	94.7 22.9	94.3 23.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
116.5	95.8 22.0	95.3 22.5	94.8 20.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
117.0	96.2 21.8	95.7 22.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
117.5	96.6 21.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
118.0 to 126.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9: C Curve; Table C-8

	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0
108.5	86.8 28.8	86.4 29.2	85.8 29.8	85.5 30.0	85.0 30.4	84.7 30.7	84.2 31.0	83.7 31.4	83.2 31.8	82.9 32.1	82.4 32.6
109.0	87.0 28.7	86.7 28.9	86.1 29.5	85.7 29.9	85.3 30.2	85.0 30.4	84.5 30.8	84.0 31.2	83.5 31.6	83.1 31.9	82.7 32.2
109.5	87.1 28.6	86.8 28.8	86.3 29.3	85.8 29.8	85.5 30.0	85.1 30.3	84.7 30.7	84.2 31.0	83.8 31.1	83.3 31.7	0.0 0.0
110.0	87.5 28.3	87.1 28.6	86.6 29.0	86.2 29.4	85.7 29.9	85.4 30.1	84.9 30.5	84.6 30.8	84.2 31.0	0.0 0.0	0.0 0.0
110.5	87.7 28.2	87.2 28.6	86.8 28.8	86.4 29.2	85.9 29.7	85.6 30.0	85.2 30.2	84.8 30.7	0.0 0.0	0.0 0.0	0.0 0.0
111.0	88.0 27.9	87.5 28.3	87.0 28.7	86.7 28.9	86.2 29.4	85.8 29.8	85.5 30.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
111.5	88.2 27.7	87.8 28.0	87.4 28.4	86.9 28.8	86.6 29.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
112.0	88.4 27.5	88.1 27.8	87.7 28.2	87.2 28.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
112.5	88.7 27.3	88.3 27.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
113.0	89.1 27.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
113.5 to 126.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 10: C Curve; Table C-9

	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
117.5 to 118.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
119.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	115.2 12.8	114.4 13.1
119.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	115.4 12.7	114.6 13.0
120.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.5 12.5	115.7 12.6	114.9 12.9
120.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	116.6 12.2	115.9 12.5	115.0 12.9
121.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	117.6 11.8	116.7 12.2	116.0 12.4	115.2 12.8
121.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	117.8 11.7	117.1 12.0	116.2 12.3	115.2 12.8
122.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.4 11.0	118.8 11.4	117.9 11.7	117.3 11.9	116.4 12.3	115.3 12.8
122.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.6 11.0	118.9 11.3	118.1 11.5	117.3 11.9	116.5 12.2	115.7 12.6
123.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	119.7 10.9	119.1 11.2	118.5 11.9	117.5 11.8	117.0 12.1	115.9 12.5
123.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	120.3 10.6	119.8 10.8	119.2 11.1	118.5 11.4	117.6 11.8	117.2 12.0	116.0 12.4
124.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	120.5 10.5	119.9 10.8	119.4 11.0	118.8 11.4	117.7 11.7	117.3 11.9	116.1 12.4
124.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	120.6 10.5	120.0 10.7	119.4 11.0	118.9 11.3	117.8 11.7	117.4 11.8	116.2 12.3
125.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	122.5 9.9	121.7 10.3	120.2 10.6	119.6 11.0	119.2 11.1	118.4 11.5	117.6 11.8	116.5 12.2
125.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	122.6 9.9	121.8 10.1	120.4 10.6	119.6 11.0	119.2 11.1	118.6 11.4	117.6 11.8	116.7 12.2
126.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	122.8 9.8	121.9 10.1	120.6 10.5	119.8 10.8	119.4 11.0	118.8 11.4	117.7 11.7	117.0 12.1

Table 11: C Curve; Table C-10

	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
117.5	113.2 13.6	112.3 13.8	111.6 14.2	110.7 14.5	109.8 14.9	108.8 15.3	107.9 15.8	106.6 16.6	106.0 16.6	104.7 17.2	104.2 17.4
118.0	113.4 13.5	112.6 13.8	111.7 14.2	111.0 14.4	109.9 14.9	109.0 15.2	108.0 15.7	106.2 16.5	106.2 16.5	104.8 17.1	104.5 17.3
118.5	113.6 13.4	112.7 13.7	112.0 14.0	111.0 14.4	110.0 14.8	109.1 15.2	108.1 16.0	106.3 16.5	106.3 16.5	105.3 16.8	104.5 17.3
119.0	113.7 13.3	113.0 13.7	112.2 13.9	111.1 14.4	110.5 14.6	109.3 15.1	108.6 15.4	107.5 15.9	107.2 16.2	105.5 16.7	105.0 17.0
119.5	114.0 13.2	113.1 13.6	112.4 13.8	111.4 14.3	110.7 14.5	109.4 15.0	108.8 15.3	107.7 15.8	107.1 16.1	105.8 16.1	105.3 16.8
120.0	114.4 13.1	113.2 13.6	112.4 13.8	111.4 14.3	110.8 14.4	109.6 15.0	108.9 15.2	107.9 15.8	107.4 16.0	106.0 16.6	105.5 16.7
120.5	114.4 13.1	113.3 13.5	112.6 13.8	111.6 14.2	111.0 14.4	109.7 15.0	109.0 15.2	108.0 15.7	107.5 15.9	106.2 16.5	105.7 16.6
121.0	114.6 13.0	113.5 13.5	112.8 13.7	111.9 14.1	111.2 14.4	109.7 15.0	109.2 15.1	108.1 15.7	107.6 15.8	106.4 16.4	106.0 16.6
121.5	114.7 12.9	113.7 13.3	113.0 13.7	112.0 14.0	111.4 14.3	110.0 14.4	109.5 15.0	108.3 15.5	107.8 15.7	107.0 16.2	106.2 16.5
122.0	114.9 12.9	113.8 13.3	113.1 13.6	112.2 13.9	111.5 14.3	110.6 14.2	109.7 15.0	108.7 15.3	108.1 15.7	107.2 16.0	106.6 16.3
122.5	115.0 12.8	114.2 13.2	113.2 13.6	112.3 13.8	111.6 14.2	110.8 14.4	109.9 14.9	109.0 15.2	108.2 15.6	107.4 16.0	107.0 16.2
123.0	115.2 12.8	114.5 13.1	113.3 13.5	112.5 13.8	110.9 14.0	111.0 14.4	110.5 14.6	109.2 15.1	108.7 15.3	107.7 15.8	107.2 16.0
123.5	115.2 12.8	114.6 13.0	113.5 13.5	112.7 12.7	112.0 14.0	111.1 14.4	110.6 14.6	109.4 15.0	109.0 15.2	108.0 15.7	107.5 15.9
124.0	115.6 12.3	114.8 13.0	114.2 13.2	113.0 13.7	112.3 13.8	111.4 14.3	110.8 14.4	109.8 14.9	109.2 15.1	108.3 15.5	107.7 15.8
124.5	115.8 12.5	114.8 13.0	114.4 13.1	113.0 13.7	112.5 13.8	111.6 14.2	111.0 14.4	110.1 14.7	109.4 15.0	108.6 15.4	108.0 15.7
125.0	115.9 12.5	115.0 12.8	114.5 13.1	113.5 13.5	112.7 13.7	112.0 14.0	111.2 14.4	110.4 14.6	109.8 14.9	109.0 15.2	0.0 0.0
125.5	116.0 12.4	115.3 12.8	114.7 13.0	113.6 13.4	113.0 13.7	112.1 14.0	111.5 14.3	110.7 14.5	110.0 14.8	109.4 15.0	0.0 0.0
126.0	116.2 12.3	115.5 12.7	114.9 12.9	114.1 13.3	113.2 13.6	112.6 13.8	111.9 14.1	111.0 14.4	110.3 14.7	0.0 0.0	0.0 0.0

Table 12: C Curve; Table C-11

	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0
117.5	103.2 17.9	102.6 18.3	101.8 18.6	101.2 18.9	100.4 19.4	100.0 19.8	99.1 20.2	98.8 20.4	98.1 20.8	97.7 21.0	97.2 21.3
118.0	103.3 17.9	102.8 18.2	102.0 18.6	101.4 18.8	100.9 19.2	100.3 19.5	99.6 20.0	99.2 20.2	98.5 20.6	98.0 20.8	97.6 21.1
118.5	103.8 17.6	103.2 17.9	102.3 18.4	101.8 18.6	101.0 19.0	100.6 19.3	100.0 19.8	99.6 20.0	98.9 20.3	98.4 20.6	0.0 0.0
119.0	104.1 17.4	103.6 17.7	102.6 18.3	102.1 18.5	101.3 18.9	101.0 19.0	100.3 19.5	99.9 19.8	99.2 20.2	0.0 0.0	0.0 0.0
119.5	104.3 17.4	103.9 17.5	102.9 18.1	102.4 18.4	101.6 18.7	101.1 19.0	100.6 19.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
120.0	104.6 17.3	104.1 17.4	103.3 17.9	102.7 18.2	102.1 18.5	101.6 18.7	101.2 18.9	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
120.5	104.8 17.1	104.3 17.4	103.5 17.7	103.0 18.0	102.3 18.4	101.9 18.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
121.0	105.1 16.8	104.5 17.3	104.0 17.5	103.5 17.7	102.8 18.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
121.5	105.3 16.8	104.8 17.1	104.3 17.4	103.7 17.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
122.0	105.8 16.6	105.0 17.0	104.5 17.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
122.5	106.0 16.6	105.3 16.8	104.8 17.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
123.0	106.3 16.5	105.7 16.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
123.5	106.8 16.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
124.0	107.0 16.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
124.5 to 126.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 13: C Curve; Table C-12

	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
126.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	123.0 9.8	122.0 10.0	121.0 10.4	120.0 10.7	119.5 11.0	118.9 11.3	118.0 11.6	117.3 11.9
127.0	0.0 0.0	0.0 0.0	0.0 0.0	124.4 9.2	123.7 9.5	123.0 9.8	122.2 10.0	121.7 10.3	120.1 10.7	119.7 10.9	119.1 11.2	118.5 11.4	117.4 11.8
127.5	0.0 0.0	0.0 0.0	125.1 9.0	124.6 9.2	124.0 9.4	123.2 9.7	122.2 10.0	121.7 10.3	120.3 10.6	119.7 10.9	119.3 11.0	118.8 11.3	117.9 11.7
128.0	0.0 0.0	0.0 0.0	125.5 8.8	124.8 9.1	124.2 9.3	123.6 9.6	122.7 9.8	121.8 10.1	120.6 10.5	120.0 10.7	119.4 11.0	119.0 11.2	117.7 11.7
128.5	0.0 0.0	0.0 0.0	125.7 8.7	125.0 9.0	124.4 9.2	123.8 9.6	122.7 9.8	122.0 10.0	120.9 10.4	120.3 10.6	119.5 11.0	119.2 11.1	118.0 11.6
129.0	0.0 0.0	0.0 0.0	125.8 8.8	125.1 9.0	124.5 9.2	124.1 9.4	123.0 9.8	122.4 10.0	121.5 10.2	120.5 10.6	119.7 10.9	119.4 11.0	118.6 11.4
129.5	0.0 0.0	0.0 0.0	126.0 8.7	125.3 8.9	124.6 9.2	124.2 9.3	123.5 9.6	122.7 9.8	121.8 10.1	120.8 10.5	120.0 10.7	119.6 11.0	118.8 11.3
130.0	0.0 0.0	126.8 8.5	126.0 8.7	125.7 8.7	124.9 9.0	124.4 9.2	123.7 9.5	122.8 9.8	122.1 10.0	121.5 10.2	120.4 10.6	119.7 10.9	119.1 11.2
130.5	0.0 0.0	127.1 8.4	126.2 8.6	125.8 8.8	125.0 9.0	124.5 9.2	123.9 9.4	123.3 19.7	122.3 9.9	121.9 10.1	120.6 10.5	120.0 10.7	119.4 11.0
131.0	128.3 7.9	127.8 8.1	126.5 8.6	126.0 8.7	125.3 8.9	124.8 9.1	124.3 9.3	123.6 9.6	122.7 9.8	122.0 10.0	121.2 10.3	120.3 10.6	119.7 10.9
131.5	128.5 7.8	128.0 8.0	126.8 8.5	126.1 8.7	125.6 8.8	124.9 9.0	124.4 9.2	123.8 9.6	123.0 9.8	122.3 9.9	121.6 10.2	120.6 10.5	119.8 10.8
132.0	129.0 7.7	128.1 8.0	127.5 8.3	126.5 8.6	125.9 8.7	125.3 8.9	124.7 9.2	124.1 9.4	123.5 9.6	122.6 9.9	121.9 10.1	121.9 10.1	121.3 10.3
132.5	129.17 .7	128.6 7.8	127.8 8.2	126.6 8.5	126.0 8.7	125.5 8.8	124.8 8.8	124.4 9.2	123.8 9.6	123.2 9.7	122.1 10.0	121.8 10.1	120.6 10.5
133.0	129.4 7.6	129.0 7.7	128.0 8.0	127.5 8.3	126.4 8.6	125.9 8.7	125.1 9.0	124.7 9.2	124.1 9.4	123.5 9.6	122.6 9.9	122.0 10.0	121.2 10.3
133.5	130.4 7.2	129.1 7.7	128.2 8.0	127.7 8.2	126.7 8.5	126.1 8.7	125.4 8.9	124.9 9.0	124.4 9.2	123.8 9.6	122.9 9.8	122.4 10.0	121.6 10.2
134.0	130.7 7.1	130.1 7.2	128.7 7.8	128.0 8.0	127.5 8.3	126.5 8.6	125.9 8.7	125.3 8.9	124.7 9.2	124.2 9.3	123.6 9.6	122.9 9.8	0.0 0.0
134.5	131.0 7.0	130.2 7.2	129.0 7.7	128. 7.9	127.6 8.2	126.8 8.5	126.1 8.7	125.8 8.8	124.9 9.0	124.6 9.2	123.9 9.4	123.2 9.7	0.0 0.0
135.0	131.6 6.8	130.6 7.3	129.2 7.7	128.7 7.8	128.0 8.0	127.5 8.3	126.6 8.5	126.0 8.7	125.5 8.8	124.8 9.1	124.2 9.3	0.0 0.0	0.0 0.0

Table 14: C Curve; Table C-13

	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0
126.5	116.5 12.2	115.8 12.6	115.0 12.9	114.4 13.1	113.5 13.5	112.9 13.7	112.1 14.0	111.2 14.3	0.0 0.0	0.0 0.0
127.0	117.0 12.1	116.0 12.4	115.4 12.7	114.7 13.0	114.0 13.2	113.1 13.6	112.4 13.8	111.7 14.2	0.0 0.0	0.0 0.0
127.5	117.1 12.0	116.2 12.3	115.7 12.6	114.8 13.0	114.4 13.1	113.3 13.5	112.7 13.7	0.0 0.0	0.0 0.0	0.0 0.0
128.0	117.3 11.9	116.7 12.2	116.0 12.4	115.2 12.8	114.7 13.0	114.0 13.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
128.5	117.6 11.8	116.7 12.2	116.3 12.3	115.5 12.7	115.0 12.9	114.4 13.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
129.0	117.7 11.7	117.2 12.0	116.7 12.2	115.8 12.6	115.3 12.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
129.5	118.0 11.6	117.4 11.8	117.0 12.1	116.0 12.4	115.5 12.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
130.0	118.5 11.4	117.7 11.7	117.3 11.9	116.6 12.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
130.5	118.9 11.3	118.0 11.6	117.5 11.8	117.0 12.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
131.0	119.1 11.2	118.6 11.4	117.9 11.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
131.5	119.4 11.0	118.8 11.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
132.0	119.9 10.7	119.2 11.1	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
132.5	120.0 10.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
133.0 to 135.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 15: C Curve; Table C-14

	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
135.5	131.7 6.8	130.7 7.1	129.3 7.7	128.9 7.8	128.3 7.9	127.7 8.2	126.9 8.4	126.4 8.6	125.8 8.8	125.1 9.0	0.0 0.0	0.0 0.0	0.0 0.0
136.0	131.9 6.7	131.2 7.0	130.1 7.2	129.3 7.6	128.6 7.8	128.1 8.0	127.6 8.2	126.9 8.4	126.3 8.7	125.8 8.8	0.0 0.0	0.0 0.0	0.0 0.0
136.5	132.8 6.5	131.5 6.8	130.4 7.4	130.0 7.3	128.9 7.8	128.5 7.8	127.9 8.1	127.4 8.3	126.6 8.5	126.1 8.7	0.0 0.0	0.0 0.0	0.0 0.0
137.0	133.0 6.4	132.3 6.6	130.8 7.0	130.2 7.2	129.3 7.6	128.7 7.8	128.3 7.9	127.8 8.2	127.2 8.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
137.5	133.1 6.3	132.5 6.6	131.2 6.9	130.6 7.3	129.5 7.5	129.1 7.7	128.4 7.9	127.9 8.1	127.5 8.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
138.0	133.9 6.1	132.9 6.5	131.6 6.8	131.0 7.0	130.2 7.2	129.8 7.4	129.0 7.7	128.5 7.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
138.5	134.0 6.0	133.0 6.4	131.9 6.7	131.2 7.0	130.6 7.1	130.0 7.4	129.3 7.7	128.9 7.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
139.0	134.2 6.0	133.7 6.2	132.5 6.6	131.7 6.8	131.1 7.0	130.6 7.1	130.0 7.3	0.0	0.0	0.0	0.0	0.0	0.0
139.5	134.7 5.8	133.8 6.1	132.9 6.5	132.3 6.6	131.4 6.9	131.0 7.0	130.4 7.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
140.0	134.9 5.7	134.2 6.0	133.5 6.2	132.7 6.5	132.0 6.6	131.5 6.8	131.0 7.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
140.5	135.1 5.6	134.6 5.8	134.0 6.0	133.1 6.4	132.4 6.5	132.0 6.6	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
141.0	136.0 5.3	135.0 5.7	134.1 6.0	133.8 6.1	133.0 6.4	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
141.5	136.2 5.3	135.1 5.6	134.7 5.8	134.0 6.0	133.5 6.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
142.0	136.8 5.2	136.0 5.3	135.0 5.7	134.6 5.8	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
142.5	137.2 5.0	136.2 5.3	135.3 5.6	135.0 5.7	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
143.0	137.6 4.9	137.0 5.1	136.0 5.3	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
143.5	138.0 4.8	137.5 4.9	136.7 5.2	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0
144.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

Table 67-4

Table 1: Table 67-4; Conversion for Proctor Soil Density Tests

	Table		
	67-1a	67-1b	67-1c
Weight in grams	1000-1495	1500-1995	2000-2495

The tables convert proctor soil specimen wet weight in grams to soil wet weight per cubic foot in pounds.

NOTE: Table computed for proctor molds having capacity of 1/30 cubic foot.

Table 2: Table 67-1a

Wt in grams	Wt. Cu. Ft.		Wt. In grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.
1000	66.0		1100	72.6		1200	79.2		1300	85.8		1400	92.4
1005	66.3		1105	72.9		1205	79.5		1305	86.1		1405	92.7
1010	66.7		1110	73.3		1210	79.9		1310	86.5		1410	93.1
1015	67.0		1115	73.6		1215	80.2		1315	86.8		1415	93.4
1020	67.3		1120	73.9		1220	80.5		1320	87.1		1420	93.7
1025	67.7		1125	74.3		1225	80.9		1325	87.5		1425	94.1
1030	68.0		1130	74.6		1230	81.2		1330	87.8		1430	94.4
1035	68.3		1135	74.9		1235	81.5		1335	88.1		1435	94.7
1040	68.6		1140	75.2		1240	81.8		1340	88.4		1440	95.0
1045	69.0		1145	75.6		1245	82.2		1345	88.8		1445	95.4
1050	69.3		1150	75.9		1250	82.5		1350	89.1		1450	95.7
1055	69.6		1155	76.2		1255	82.8		1355	89.4		1455	96.0
1060	70.0		1160	76.6		1260	83.2		1360	89.8		1460	96.4
1065	70.3		1165	76.9		1265	83.5		1365	90.1		1465	96.7
1070	70.6		1170	77.2		1270	83.8		1370	90.4		1470	97.0
1075	71.0		1175	77.6		1275	84.2		1375	90.8		1475	97.4
1080	71.3		1180	77.9		1280	84.5		1380	91.1		1480	97.7
1085	71.6		1185	78.2		1285	84.8		1385	91.4		1485	98.0
1090	71.9		1190	78.5		1290	85.1		1390	91.7		1490	98.3
1095	72.3		1195	78.9		1295	85.5		1395	92.1		1495	98.7

Table 3: Table 67-1b

Wt in grams	Wt. Cu. Ft.		Wt. In grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.
1500	99.0		1600	105.6		1700	112.2		1800	118.8		1900	25.4
1505	99.3		1605	105.9		1705	112.5		1805	119.1		1905	125.7
1510	99.7		1610	106.3		1710	112.9		1810	119.5		1910	126.1
1515	100.0		1615	106.6		1715	113.2		1815	119.8		1915	126.4
1520	100.3		1620	106.9		1720	113.5		1820	120.1		1920	126.7
1525	100.7		1525	107.3		1725	113.9		1825	120.5		1925	127.1
1530	101.0		1630	107.6		1730	114.2		1830	120.8		1930	127.4
1535	101.3		1635	107.9		1735	114.5		1835	121.1		1935	127.7
1540	101.6		1640	108.3		1740	114.8		1840	121.4		1940	128.0
1545	102.0		1645	108.6		1745	115.2		1845	121.8		1945	128.4
1550	102.3		1650	108.9		1750	115.5		1850	122.1		1950	128.7
1555	102.6		1655	109.2		1755	115.8		1855	112.4		1955	129.0
1560	103.0		1660	109.6		1760	116.2		1860	122.8		1960	129.4
1565	103.3		1665	109.9		1765	116.5		1865	123.1		1965	129.7
1570	103.6		1670	110.2		1770	116.8		1870	123.4		1970	130.0
1575	104.0		1675	110.6		1775	117.2		1875	123.8		1975	130.4
1580	104.3		1680	110.9		1780	117.5		1880	124.1		1980	130.7
1585	104.6		1685	111.2		1785	117.8		1885	124.4		1985	131.0
1590	104.9		1690	111.5		1790	118.1		1890	124.7		1990	131.4
1595	105.3		1695	111.9		1795	118.5		1895	125.1		1995	131.7

Table 4: Table 67-1c

Wt in grams	Wt. Cu. Ft.		Wt. In grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.		Wt in grams	Wt. Cu. Ft.
2000	132.0		2100	13806		2200	145.2		2300	151.8		2400	158.4
2005	132.3		2105	139.0		2205	145.5		2305	152.1		2405	158.7
2010	132.7		2110	139.3		2210	145.9		2310	152.5		2410	159.1
2015	133.0		2115	139.6		2215	1465.2		2315	152.8		2415	159.4
2020	133.3		2120	139.9		2220	146.5		2320	153.2		2420	159.7
2025	133.7		2125	140.3		2225	146.9		2325	153.5		2425	160.0
2030	134.0		2130	140.6		2230	147.2		2330	153.8		2430	160.4
2035	134.3		2135	140.9		2235	147.5		2335	154.1		2435	160.7
2040	134.6		2140	141.2		2240	147.8		2340	154.4		2440	161.0
2045	135.0		2145	141.6		2245	148.2		2345	154.8		2445	161.4
2050	135.3		2150	141.9		2250	148.5		2350	155.1		2450	161.7
2055	135.6		2155	142.2		2255	148.8		2355	155.4		2455	162.0
2060	136.0		2160	142.6		2260	149.2		2360	155.8		2460	162.4
2065	136.3		2165	142.9		2265	149.5		2365	156.1		2465	162.7
2070	136.6		2170	143.2		2270	149.8		2370	156.4		2470	163.0
2075	137.0		2175	143.6		2275	150.2		2375	156.8		2475	163.4
2080	137.3		2180	143.9		2280	150.5		2380	157.1		2480	163.7
2085	137.6		2185	144.2		2285	150.8		2385	157.4		2485	164.0
2090	137.9		2190	144.5		2290	151.1		2390	157.7		2490	164.3
2095	138.3		2195	144.9		2295	151.5		2395	158.1		2495	164.7

SECTION 16

GDT 73A

RANDOM SELECTION OF ASPHALT PLANT SAMPLES

GDT 73
Method A
Random Selection of Asphalt Plant Samples

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to randomly select and test asphaltic concrete mixes for mixture acceptance on a lot basis.

B. Sample Size and Preparation

1. Lot Boundaries

   An Acceptance Lot normally consists of the amount of asphaltic concrete produced and placed in one construction day, or at least 500 tons (500 Mg).
2. Evaluate each Lot with the sampling procedures and the specified acceptance criteria for mixture composition.
3. When evaluating this feature, always use the same Lot boundaries. If the Job Mix Formula changes significantly, the Contractor QCT may end one Lot and begin a new Lot with the permission from the TMOS and TSS.

C. Procedures

1. Selecting Loads to be Sampled
   a. Randomly sample the designated Lot based on the load number.
   b. Randomly sample the mix for the Lot from sub lots consisting of approximately 500 tons (500 Mg).

2. Testing for Asphalt Cement Content and Gradation
   a. Use GDT 83 or GDT 125 to test for asphalt cement content.
      1) When the plant that produces the mix is operating and the mix is tested according to GDT 125, use the asphalt cement content calculated from the ticket. Calculate the content from the appropriate ticket that corresponds to the load from which the sample was taken. The ticket and gradation worksheet should be attached to the TM159-5 report and retained in the project files. In all cases, test the mixture gradation with GDT 38.
   b. Project personnel may submit to the Central Laboratory for approval any other method for random sampling when existing conditions make load sampling impractical.

Note: Test according to GDT 83 or GDT 125 and GDT 38. Accept according to Specification Section 400.

Updated 10-13-2020
Larry Warren, TM Branch Chief

GDT 73 Table 1

1		2		3		4		5		6		7	
.576	.730	.430	.754	.271	.870	.732	.721	.998	.239	.053	.899	.554	.627
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291	.810	.159	.225	.163
.669	.726	.501	.402	.231	.505	.009	.420	.517	.858	.081	.277	.035	.039
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761	.982	.468	.334	.921
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463	.095	.801	.576	.417
8		**9**		**10**		**11**		**12**		**13**		**14**	
.427	.760	.470	.040	.904	.993	.509	.025	.794	.850	.917	.887	.751	.608
.549	.405	.285	.542	.231	.919	.371	.059	.164	.838	.289	.169	.569	.977
.860	.507	.081	.538	.986	.501	.165	.996	.356	.375	.654	.979	.815	.592
.690	.806	.879	.414	.106	.031	.477	.535	.137	.155	.767	.187	.579	.787
.251	.884	.522	.235	.398	.222	.788	.101	.434	.638	.021	.894	.324	.871
15		**16**		**17**		**18**		**19**		**20**		**21**	
.698	.683	.566	.815	.622	.548	.947	.169	.817	.472	.864	.466	.897	.877
.796	.996	.901	.342	.873	.964	.942	.985	.123	.086	.335	.212	.875	.969
.348	.743	.470	.682	.412	.064	.150	.962	.925	.355	.909	.019	.190	.696
.358	.595	.068	.242	.667	.356	.195	.313	.396	.460	.740	.247	.341	.688
.698	.539	.874	.420	.127	.284	.448	.215	.833	.652	.601	.326	.846	.355
22		**23**		**24**		**25**		**26**		**27**		**28**	
.209	.862	.428	.117	.100	.259	.425	.284	.882	.227	.552	.077	.454	.731
.109	.843	.759	.239	.890	.317	.428	.802	.464	.658	.629	.269	.069	.998
.757	.283	.666	.491	.523	.665	.919	.146	.123	.791	.503	.447	.659	.463
.587	.908	.865	.333	.928	.404	.892	.696	.116	.120	.721	.137	.263	.176
.831	.218	.945	.364	.673	.305	.195	.887	.836	.206	.914	.574	.870	.390
29		**30**		**31**		**32**		**33**		**34**		**35**	
.716	.265	.058	.075	.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.917	.217	.220	.659	.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.994	.307	.631	.422	.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.798	.879	.432	.391	.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.104	.755	.082	.939	.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

D. Calculations

1. Method A

a. Method A Calculations

This example uses Table 1 to calculate the sub lot tests. You are given the following:

Expected plant production: 1,600 to 1,800 tons (1,600 to 1,800 Mg) (3 to 4 samples)

Average load of haul vehicles: 20 tons (20 Mg)

1) Therefore, use 25 loads [(500 tons (500 Mg) sublot size) / ((20 tons (20 Mg)/load) per truck load) = 25 loads per lot] for the sub lots.
2) By an unbiased method, select the table and random number to start with. (For this example, we selected table 18 and number 10) Therefore use the last random number in Block 18 of Table 1 in the right column and the four successive numbers (.215, .284, .802, .146 and .696).
3) Calculate the loads to sample as follows:

Sample	Calculation	Load
1	25 loads x .215 = 5.4 therefore 5 +0	= 5th Load
2	25 loads x .284 = 7.1 therefore 7 + 25	= 32nd Load
3	25 loads x .802 = 20.1 therefore 20 + 50	= 70th Load
4	25 loads x .146 = 3.7 therefore 4 + 75	= 79th Load

4) If the plant produced 92 loads for that day, take samples of the mix from loads 5, 32, 70, and 79 to represent that Lot.

b. This example uses pill can and tokens to calculate the sub lot tests. Given the following:

Plant production: 2,600 to 3,000 tons (2,600 to 3,000 Mg) (4 to 5 samples)

Average load of haul vehicles: 18 tons (18 Mg)

1) Therefore, use 27 loads [(500 tons (500Mg) sublot size) / (18 tons (18 Mg)/ per truck load) = 27 loads per sublot] for the sub lots.
2) Place 27 tokens numbered 1 through 27 in a container.
3) Draw a token from the container.
4) Record the number and return it to the container.
5) Calculate the sub lots to be tested as follows:

Sample	Calculation	Load
1	Token #1 drawn = 1	= 1st Load
2	Token #16 drawn = 16 + 27	= 43rd Load
3	Token #25 drawn = 25 + 27+27	= 79th Load
4	Token #16 drawn = 16 + 27+27+27	= 97th Load
5	Token #11 drawn = 11 +27+27+27+27	= 119th Load

6) If the plant produced 130 loads for that day, take samples of the mix from loads 1, 43, 79, 97, and 119 to represent that Lot

2. Method B (Computer Generated Method)
   a. This example uses GDOT approved computer program to calculate the sub lot tests.
      1) Using a computer-based program, enter the requested pertinent data about expected production and the haul load sizes. The program will randomly select the loads per sub lot for the entire Lot.
      2) Maintain computer generated random sampling data as part of the project records.

E. Re-Evaluation

The contractor shall submit a request for re-evaluation to the Area Manager for approval. The request for re-evaluation shall be made within 5 working days of notification of the lot results. Re-evaluation of lots and acceptance will be based on evaluations performed by the Department.

1) Mixture acceptance
For all mix types other than PEM, OGFC, and Mixture paid as patching and thin lift courses < 110 lbs. /yd^2, the Department will take the same number of new tests using cores taken at randomly selected locations and will only use these cores for acceptance. The pill can, total length of lot, and table 18 above shall be used to determine locations to be cored for each sublot. For PEM, OGFC and Mixture paid as patching and thin lift courses < 110 lbs. /yd^2, the retained opposite quarter shall be used for revaluation when a re-evaluation is requested by the Contractor as described above.

Note: Traffic control will be the responsibility of the contractor. The TMOS, ATMOS, or TSS must be present during re-evaluation.

a. **Determine Coring Locations**

This example uses Table 1 to calculate the sub lot tests. You are given the following:

Total number of acceptance test: 2

Total length of lot: 8,000 ft.

Total length of a sublot: Total Length of lot divided by number of QCT Tests to be re-evaluated = Total length of sublot. Example, 8000 ft. lot / 2 samples = 4,000 ft. sublots

1) Therefore, use sublot length to determine random sample location.
2) By an unbiased method, select the table and random number to start with. (For this example, we selected table 18 and number 10) Therefore use the last random number in Block 18 of Table 1 in the right column and the successive numbers (.215, .284, .802, .146 and .696).
3) Calculate the sample location as follows:

Station Within Each Sub lot	
Sub lot 1	4000 feet x 0.215= 860 feet from start of sub lot
Sub lot 2	4000t x 0.284= 1136 feet from start of sub lot

4) To determine transverse coordinates, divide the lane into equal transverse zones.
5) If the width of lane is 12 feet you will use 1 foot per zone (12 ft./12 zones = 1 ft. per zone
6) For this example, place 12 tokens, numbered 1 through 12, in a container.
7) By an unbiased method, you select 2 numbers from the pill can to determine the transverse locations of the test sites. The numbers are 2, and 9.
8) Since the left edge of the lane looking ahead is the axis, take the readings at the following transverse locations:

Sublot	Calculation	Location	Distance from Left Edge (Longitudinal Joint)
1	Pill 2	2 ft.	#2 (pill drawn) = 2 ft. from left edge
2	Pill 9	9 ft.	#9 (pill drawn) = 9 ft. from left edge

Note: Avoid testing sites that fall on the edge of a paving lane. Testing location must be a minimum of 1 foot off pavement edge.

9) Take the core for sub lot # 1 starting at 860 ft. from the beginning of the sub lot at 2 ft. from the left edge of the lane.
10) Determine the test locations for the remaining sub lots using the same process.

F. Report

Report all results on the 159.5 report.

SECTION 17

GDT 73B

RANDOM SELECTION OF ROADWAY ASPHALT SAMPLES FOR VOIDS

GDT 73
Method B
Random Selection of Roadway Asphalt Samples for Voids

A. Scope

Use this test method to randomly select and test roadway asphalt samples for voids on a lot basis.

B. Sample Size and Preparation

1. **Lot Boundaries**

   A lot consists of the amount of asphaltic concrete produced and placed in one construction day, or at least 500 tons (500 Mg). A lot can be less than 500 tons under certain circumstances.
2. Determine mixture compaction using either GDT 39, GDT 59, or AASHTO T331. The method of GDT 39 for "Uncoated Specimens, Dense Graded Mixtures Only" shall not apply when the water absorption of a sample exceeds 2.0 percent, as measured according to AASHTO T 166. In this case, either AASHTO 331 or the paraffin method of GDT 39 shall apply.
3. When evaluating this feature, always use the same Lot boundaries. If the Job Mix Formula changes significantly, the Contractor QCT may end one Lot and begin a new Lot with the permission from the TMOS and TSS.

C. Procedures.

1. **Determining Core locations for Void Acceptance**
   a. Determine core locations as follows:
      1) Divide the Lot into 5 sub-lots for lots containing greater than 500 tons (500 Mg) or 1 sub-lot per 100 tons (100 Mg) if 500 tons (500 Mg) or less (Example)

         Lots ≥ 500 tons (500Mg) of mix should be divided into 5 sub-lots of equal distance.

         Lots <500 tons (500Mg) of mix should be comprised of a sub-lot or sub-lots consisting of up to 100 tons (100 Mg) of mix each. There may be less than 5 sub-lots.

Note: Round up for any fraction tonnage to the next 100 tons (100 Mg). Example: 301 tons = 4 cores

GDT 73 Table 1

1		2		3		4		5		6		7	
.576	.730	.430	.754	.271	.870	.732	.721	.998	.239	.053	.899	.554	.627
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291	.810	.159	.225	.163
.669	.726	.501	.402	.231	.505	.009	.420	.517	.858	.081	.277	.035	.039
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761	.982	.468	.334	.921
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463	.095	.801	.576	.417
8		**9**		**10**		**11**		**12**		**13**		**14**	
.427	.760	.470	.040	.904	.993	.509	.025	.794	.850	.917	.887	.751	.608
.549	.405	.285	.542	.231	.919	.371	.059	.164	.838	.289	.169	.569	.977
.860	.507	.081	.538	.986	.501	.165	.996	.356	.375	.654	.979	.815	.592
.690	.806	.879	.414	.106	.031	.477	.535	.137	.155	.767	.187	.579	.787
.251	.884	.522	.235	.398	.222	.788	.101	.434	.638	.021	.894	.324	.871
15		**16**		**17**		**18**		**19**		**20**		**21**	
.698	.683	.566	.815	.622	.548	.947	.169	.817	.472	.864	.466	.897	.877
.796	.996	.901	.342	.873	.964	.942	.985	.123	.086	.335	.212	.875	.969
.348	.743	.470	.682	.412	.064	.150	.962	.925	.355	.909	.019	.190	.696
.358	.595	.068	.242	.667	.356	.195	.313	.396	.460	.740	.247	.341	.688
.698	.539	.874	.420	.127	.284	.448	.215	.833	.652	.601	.326	.846	.355
22		**23**		**24**		**25**		**26**		**27**		**28**	
.209	.862	.428	.117	.100	.259	.425	.284	.882	.227	.552	.077	.454	.731
.109	.843	.759	.239	.890	.317	.428	.802	.464	.658	.629	.269	.069	.998
.757	.283	.666	.491	.523	.665	.919	.146	.123	.791	.503	.447	.659	.463
.587	.908	.865	.333	.928	.404	.892	.696	.116	.120	.721	.137	.263	.176
.831	.218	.945	.364	.673	.305	.195	.887	.836	.206	.914	.574	.870	.390
29		**30**		**31**		**32**		**33**		**34**		**35**	
.716	.265	.058	.075	.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.917	.217	.220	.659	.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.994	.307	.631	.422	.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.798	.879	.432	.391	.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.104	.755	.082	.939	.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

2. **Determining locations with Nuclear Gauge or Cores**

a. The length of the Lot is 5,000 ft. (1,524 m). Use 1,000 ft. (1,524 m) per sub lot (5000 ft./5 sub-lots (unless less than 500 tons) = 1000

b. To determine stations, by some unbiased method, select the block in Table 1 and starting number. For this example, we selected random number 18 for block 18 and number 1 (.947, 0.942, 0.150, 0.195, and 0.448) to determine the stations.

Station Within Each Sub lot	
Sub lot 1	1000 feet x 0.947 = 947 feet from start of sub lot
Sub lot 2	1000 feet x 0.942 = 942 feet from start of sub lot
Sub lot 3	1000 feet x 0.150 = 150 feet from start of sub lot
Sub lot 4	1000 feet x.195 = 195 feet from start of sub lot
Sub lot 5	1000 feet x 0.448 = 448 feet from start of sub lot

c. To determine transverse coordinates, divide the lane into three equal transverse zones.

d. If the width of lane is 12 feet you will use 4 feet per zone (12 ft./3 zones = 4 ft. per zone)

e. For this example, place 4 tokens, numbered 1 through 4, in a container.

f. By an unbiased method, you select three numbers from the pill can to determine the transverse locations of the test sites. The numbers are 2, 3, and 1.

g. Since the left edge of the lane looking ahead is the axis, take the readings at the following transverse locations:

Zone	Calculation	Location	Distance from Left Edge (Longitudinal Joint)
1	Pill 2	2ft	2 (pill drawn) + 0 ft= 2 ft. from left edge
2	Pill 3	3 ft.	3 (pill drawn) + 4 ft. (zone 1) = 7 ft. from left edge
3	Pill 1	1 ft.	1 (pill drawn) + 4 ft. (zone 1) + 4 ft. (zone 2) = 9 ft. from left edge

Note: Do not test any section within 25 ft. of a transverse joint. Do not test any turning lanes, turnouts, and driveways less than 200 ft. in length or tapered sections less than 10 ft. wide.

Note: Avoid testing sites that fall on the edge of a paving lane. Testing location must be a minimum of 1 foot off pavement edge.

h. Take the 3-gauge readings for sub lot #1 starting 947 ft. from the beginning of the sub lot at 2 ft., 7 ft., and 9 ft. from the left edge of the lane.

i. Use the average of the three readings as the test for that sub lot.

j. Determine the test locations for the remaining sub lots using the same process.

k. For cores you would use pills 1 through 12 for a 12-foot lane and cut the core at the foot mark determined by the pill.

Note: Before reporting test results for payment, automatically retest non-conforming lots of asphaltic concrete density. Test at the same longitudinal location as the previous tests and at a randomly selected transverse site. Base official values for non-conforming average Lot density on the core average from step 5 below

Note: It is the intention of this procedure to sample materials from the population in a random manner. The use of a Random Number Generator such as those found as a function on some Scientific Calculators and as found within the approved computer-based system is allowed. If a Random Number Generator is used, determine the test location by substituting the randomly generated number for the random numbers from Table 1 in the examples of Method A

Note: In some individual cases due to safety reasons, material must be tested within a lane closure. This will make equal sub lots impossible; however, you must include the full length of each day's production in the Lot. There are also safety issues to be considered. In the event that a test site falls in an unsafe area (i.e. in blind curves or just over the crest of a hill) the test location should be moved to just beyond the unsafe area but within the boundaries of the sub lot being tested. In the event that either of these is the case, an explanation should be included in the remarks section of TM 150 test report.

D. Re-Evaluation

The contractor shall submit a request for reevaluation to the Area Manager for approval. The request for re-evaluation shall be made within 5 working days of notification of the lot results. Re-evaluation of lots and acceptance will be based on evaluations performed by the Department.

1. Compaction Acceptance

   The Department will reevaluate the lot by randomly taking the same number of cores originally obtained and averaging these results with the results from the original density tests. The Department will use the average to determine acceptance according to the Compaction Acceptance Schedule.

2. Range Reevaluation

   The Department will reevaluate the lot through additional testing, by randomly cutting 3 cores in each of the sub lots that represent the high and low in-place air voids. The 6 cores will replace the original five for range specified requirements only. The original 5 core results will be reported for Pavement Mean Air Voids for the lot. This will be the final evaluation for void range for the lot.

Note: Traffic control will be the responsibility of the contractor. The TMOS, ATMOS, or TSS must be present during re-evaluation.

E. Report

Keep track of the loads sampled and locations sampled and report actual tests on the respective forms:

1. From TM150 for Nuclear Gauge Compaction.

SECTION 18

GDT 73C

RANDOM SELECTION OF ROADWAY CONCRETE SAMPLES

GDT 73
Method C

Random Selection of Roadway Concrete Samples

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use these test methods to randomly select and test for acceptance and depth checks on concrete mixes and pavement construction. The characteristics to be tested are mixture composition and depth.

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B. Determining Sample Locations for Mixture Acceptance

1. **Lot Boundaries**

A lot of concrete consist of approximately 5,334 yd^2 (4400 m^2) placed continuously, except for required work stoppages. Include acceleration or deceleration lanes, wedges, or other varied width sections in other lots if the total paving quantity is not greater than 7,500 yd^2 (6300 m^2). The Engineer will randomly select three production sub-lots from each lot for compressive strength, air content, slump and temperature determination tests. Ramps may be set apart as individual lots

Example for sampling lots for Acceptance

You are given the following: The lot is 5334 yd2 and the lane is 12 ft. wide.

First convert square yards (yd2) to square feet (ft2)   (1 yd2 = 9 ft2)

Take   5334 yd2 x 9 = 48006 ft2

48006 ft2 / 12 ft lane width = 4000.5 ft Lot

4000.5 ft Lot / 3 sublots = 1333.5 ft sublot

You are dividing the lot into 3 sub-lots, each sub-lot is 1333.5 long. By an unbiased method, determine the block and starting number in Table 1. For this example we are using Block 18 of Table 1 and number 1 for the starting number and the two successive numbers (0.947, 0.942, and 0.150) to determine longitudinal values.

Location of Sample from Beginning of Each Sub-lot		
Sample No.	**Longitudinal Coordinate**	Longitudinal Coordinate from the Beginning of the lot
Sub-lot 1	1333.5ft x 0.947 = 1262.8ft	1262.8 + 0 = 1262.8 or 1263ft from the beginning of the lot
Sub-lot 2	1333.5ft x 0.942 = 1256.2ft	1256.2 + 1333.5(sublot 1) = 2589.7 or 2590ft from beginning of lot
Sub-lot 3	1333.5ft x 0.150 = 200.0ft	200.0 + 1333.5(sublot 1) + 1333.5(sublot 2) = 2867ft from the beginning of the lot

Locations can also be determined by using loads instead of ft. by dividing 5334 by 9 to get the cubic yards and then by amount truck is hauling.

Example:

5334 / 9 = 592.6 cubic yards Truck is hauling 8 yds

592.6 / 8 = 74 loads per lot / 3 = 25 loads per sub-lot

1-25 pills are placed in a can and drawn 3 times (pills drawn are 1, 7, 15)

Load 1 is sampled

25+7= 32 32nd load is sampled

25+25+15= 65 65th load is sampled.

GDT 73 Table 1

1		2		3		4		5		6		7	
.576	.730	.430	.754	.271	.870	.732	.721	.998	.239	.053	.899	.554	.627
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291	.810	.159	.225	.163
.669	.726	.501	.402	.231	.505	.009	.420	.517	.858	.081	.277	.035	.039
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761	.982	.468	.334	.921
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463	.095	.801	.576	.417
8		**9**		**10**		**11**		**12**		**13**		**14**	
.427	.760	.470	.040	.904	.993	.509	.025	.794	.850	.917	.887	.751	.608
.549	.405	.285	.542	.231	.919	.371	.059	.164	.838	.289	.169	.569	.977
.860	.507	.081	.538	.986	.501	.165	.996	.356	.375	.654	.979	.815	.592
.690	.806	.879	.414	.106	.031	.477	.535	.137	.155	.767	.187	.579	.787
.251	.884	.522	.235	.398	.222	.788	.101	.434	.638	.021	.894	.324	.871
15		**16**		**17**		**18**		**19**		**20**		**21**	
.698	.683	.566	.815	.622	.548	.947	.169	.817	.472	.864	.466	.897	.877
.796	.996	.901	.342	.873	.964	.942	.985	.123	.086	.335	.212	.875	.969
.348	.743	.470	.682	.412	.064	.150	.962	.925	.355	.909	.019	.190	.696
.358	.595	.068	.242	.667	.356	.195	.313	.396	.460	.740	.247	.341	.688
.698	.539	.874	.420	.127	.284	.448	.215	.833	.652	.601	.326	.846	.355
22		**23**		**24**		**25**		**26**		**27**		**28**	
.209	.862	.428	.117	.100	.259	.425	.284	.882	.227	.552	.077	.454	.731
.109	.843	.759	.239	.890	.317	.428	.802	.464	.658	.629	.269	.069	.998
.757	.283	.666	.491	.523	.665	.919	.146	.123	.791	.503	.447	.659	.463
.587	.908	.865	.333	.928	.404	.892	.696	.116	.120	.721	.137	.263	.176
.831	.218	.945	.364	.673	.305	.195	.887	.836	.206	.914	.574	.870	.390
29		**30**		**31**		**32**		**33**		**34**		**35**	
.716	.265	.058	.075	.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.917	.217	.220	.659	.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.994	.307	.631	.422	.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.798	.879	.432	.391	.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.104	.755	.082	.939	.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

C. For Depth Determination

1. Take one core or 3 reading using the Echo Meter for each 2,000 yd^2 (1675 m^2) of pavement, or fraction of pavement, in each unit for depth determination where the Engineer selects. 2. The Department will take one core or 3 reading at random in each unit.

NOTE: The Echo Meter may be used as acceptance but any area that exceeds the allowable tolerance for depth must be cored to determine final measurement for payment

a. When the core measurement is deficient 0.2 in (5 mm) or less from the Plan thickness, full payment is made.
b. When the measurement is deficient more than 0.2 in (5 mm) and not more than 1 in (25 mm) from the plan thickness, two additional cores are secured from the unit and used to determine the average thickness.

c. A random selection process determines where to secure additional cores. However, do not secure cores within 50 ft. (15 m) of other thickness measurement cores. The adjusted Unit Price in Subsection 430.5.01.A, "Concrete Pavement Thickness Deficiency" is used to determine payment for the unit.

3. Determining locations For Depth check with cores and with Echo Meter every 2000 yd2. When using Echo Meter you must get the average of 3 readings for depth check. Take 2000 yd2 x 9 to convert to ft2 = 18000 ft2. Take 18000 ft2 / 12 ft lane width = 1500 ft lot length for depth measurements. Take a depth check in every 1500 ft lot for a 12 ft lane. To determine stations, use an unbiased method. The first random number in block 18 in Table 1 in the right column (.947) determine the stations.

Station Within Each Sub lot	
Lot 1	1500 feet x 0.947 =1420.5 feet from the start of the lot

4. **Determining transverse coordinate**

a. To determine transverse coordinates when using the Echo Meter, divide the lane into three equal transverse zones. When coring for depth checks Transverse coordinates are not required.
b. Record on the work sheet one reading within each zone at the random selected site.
c. Determine the average and record it as a test.
d. If the width of lane is 12 feet you will use 4 feet per zone (12 ft./3 zones = 4 ft. per zone
e. For this example, place 4 tokens, numbered 1 through 4, in a container.
f. By an unbiased method, you select three numbers from the pill can to determine the transverse locations of the test sites. The numbers are 2, 3, and 1.
g. Since the left edge of the lane looking ahead is the axis, take the readings at the following transverse locations:

Zone	Calculation	Location	Distance from Left Edge (Longitudinal Joint)
1	Pill 2	2ft	2 (pill drawn) + 0 ft= 2 ft. from left edge
2	Pill 3	3 ft.	3 (pill drawn) + 4 ft.(zone 1) = 7 ft. from left edge

3	Pill 1	1 ft.	1 (pill drawn) + 4 ft.(zone 1) + 4 ft.(zone 2) = 9 ft. from left edge

Note: When using the echo meter for determining the depth on concrete paving, a 6" core must be cut and used to calibrate the meter and then one out of every 5 locations checked with the meter must be cored to ensure the accuracy.

With the limitations of the meter's accuracy, the (5mm) tolerance listed in section 430 of the standard specifications will be increased to ½ tolerance for acceptance. However, should more than 2 sections in a row show ½ deficiencies in depth, then a core must be cut to determine the exact measurement and will continue until the meter is back in tolerance. Should cores have to be taken due to deficiencies, then section 430 H. Thickness 1-3 should be followed.

D. Report

Keep track of the loads sampled and locations sampled and report actual tests on the respective forms:

SECTION 19

AASHTO R 90

STANDARD PRACTICE FOR SAMPLING AGGREGATE PRODUCTS

AASHTO R 90

AASHTO R 90 is the Standard Practice for Sampling Aggregate Products. Knowledge of the R-90 procedures will be required during the certification process.

Note: *Due to copyright laws, AASHTO Test Procedures are not provided. AASHTO Procedures may be obtained at* https://compass.astm.org

SECTION 20

SAMPLING, TESTING, AND INSPECTION REQUIREMENTS

SAMPLING, TESTING

AND

INSPECTION COMPACTION REQUIREMENTS

COMPACTION REQUIREMENTS

Backfill Structures	95% up to one foot of grade
Sub-grade	100%
GAB Group II	100%
GAB Group I	98%
GAB	96% shoulders 6’ or less
Asphalt 2ft widening	9.0% Voids
Asphalt (End Result / On System)	7.0 % Voids
Asphalt (Non-End Result / Off System)	7.8% Voids
MSE wall backfill (Section 626)	100%
MSE wall backfill (Section 627)	See Plans for compaction
Earth wall Leveling Pad	100% 100’ of bridge
Earth wall Leveling Pad	95% other
Embankment	100% total fill within 100’ of bridge
Embankment	95% all other to one foot of grade

SECTION 21

GENERAL INFORMATION FOR ROADWAY SAMPLING AND TESTING

GENERAL INFORMATION

For

Roadway

Sampling and Testing

(General Information)

GAUGE CALIBRATION
(Asphaltic Concrete)

1. Ensure that the mixture is within the allowable tolerance of Section 828 (Standard Specification).

2. Move to another section from where rolling densification was established.

3. Minimum of 100 feet.

4. Observe rollers to make sure rolling densification is being followed.

5. After completion of the rolling operation, divide the selected area into three or five equal longitudinal sub-lots and select one transverse sector at each sub-lot. Obtain a minimum of one nuclear density reading within each longitudinal sub-lot. Mark selected areas where gauge readings was taken and core the areas to determine the (GDT-39) Bulk Specific Gravity.

6. Correlation of the nuclear gauge to cores. N/G calibration – asphaltic concrete
   - Cores (Bulk Specific Gravity GDT-39)
   - Prepare Proper Gauge Calibration Worksheet and OMR-TM-150 Compaction Report.
   - Inform Project Engineer, Contractor Representative and Technical Service of final results.
   - Place all test reports in project file for future references.

(General Information)

FREQUENCIES FOR ROADWAY TESTING
(ASPHALT)

ROLLING DENSIFICATION

The Department is responsible for pavement mean air void acceptance testing. The Contractor is responsible for establishing all roller patterns and any quality control testing. Upon written request by the Contractor, the Office of Materials and Testing will provide nuclear gauge testing assistance for compaction related issues.

DETERMINATION OF MEAN AIR VOID CONTENT
(determined through compaction test)

1. Five Air Void Contents should be recorded and filed for each lot.
2. Lots containing less than 500 tons require one Void Contents per 100 tons of mix.
3. If Void Contents are to be obtained with a nuclear gauge, gauge calibration is required.
4. If voids fail with nuclear gauge (backscatter mode), Cores should be taken at the same random stations used for void determination
5. E-mail Branch Lab and Asphalt Plant to report Void Contents on each lot.
6. Void Contents are to be taken reported as soon as possible.

ROADWAY ADJUSTMENT PERIOD FOR MEAN AIR VOID CONTENT

"On-System"

1. Density: Contractors are allowed 4 Lots or "Production" days to correct mix exceeding 7.0% maximum Pavement Mean Air Void for compaction per contract.
2. Pavement Mean Air Voids for density must meet a 0.90 Pay Factor during Adj. Period to receive 100% pay.
3. Extraction Acceptance: Contractors are allowed 1 Lot or "Production day to correct mix out of tolerance on AC and gradation per contract.
4. Asphalt cement content must meet a minimum 1.00 Pay Factor and a 0.90 pay factor for gradation during Adj. Period to receive 100% pay.
5. If Voids are below 0.90 pay factor, then a penalty is applied.
6. "Range" penalties do not apply during an Adjustment period.

"Off-System"

1. Contractors are allowed 3 "Production" days to correct mix exceeding 7.8% Pavement Mean Air Void
2. After Adjustment period if Mean Air Voids exceed 8.3%, BCE shall stop production And allow up to a 1000' test strip until problem is corrected.
3. Range Penalties do not apply on "Off-System" Project

ROADWAY TESTING
(ASPHALT continued)

DEPTH CHECKS

1. Depth checks must be obtained on all projects where depth is specified on the plans.
2. Depth checks not required on projects where a "Spread-Rate" is specified in the plans.
2. If 25MMSP and 19MMSP mix depth is specified on plans but surface mix is paid for by the spread rate, then depth check cores should be cut prior to surface mix placement.
3. Depth check frequency is 1 per 1000 feet per 2 lanes (12-feet lane width).

NOTE: If lane width is other than 12-feet wide, pro-rate accordingly. For example, 4 foot shoulder frequency is 1 per 6,000 feet per two lanes.

ROADWAY SAMPLING AND TESTING

207 NORMAL BACKFILL	
Compaction frequency	1 per 2800 cubic feet
Compaction requirements	95% up to top foot 100% on top foot
Sampling requirements	1 per major soil type 30 lbs. sample
Examined for 810.01	
208 EMBANKMENT	
Compaction frequency	1 per 5,000 cubic yards
Compaction requirements	95% up to top foot 100% on top foot or within 100 feet of any bridge structure
Sampling requirements	1 per major soil type 30 lbs. sample
Examined for 810.01	
209 SUB-GRADE	
Compaction frequency	1 per 1500 feet per 2 lanes
Compaction requirements	100%
Sampling requirements	1 per 1500 feet per 2 lanes
Examined for 810.01	
310 GRADED AGGREGATE BASE	
Compaction frequency	1 per 1500 feet per 2 lanes
Compaction requirements	98% for Group I Aggregates 100% for Group II Aggregates 96% for GAB no more than 6 feet in width
Thickness measurements	1/2" tolerance
Sampling frequency	1 per 20,000 tons (no less than 1 per project) 45 lbs. sample

Compaction Range

1. **RANGE**

If there is a range penalty with the nuclear gauge, the highest and lowest void should be re-read with the nuclear gauge if there is still a range penalty the lot should be cored

For a lot to receive a pay factor of 1.00 for compaction acceptance, the air void range cannot exceed 5 percent for new construction or resurfacing projects. The range is the difference between the highest and lowest acceptance test results within the affected lot. If the air void range exceeds these tolerances, apply a Pay Factor of 95%.

The 5% reduced pay factor for the compaction range does not apply in these instances:

- The mixture is placed during the adjustment period as defined in

Subsection 400.5.01.A, "Materials Produced and Placed During the Adjustment Period."

A. All air void results within a given lot are less than 7.0%.

B. A lot containing two sublot or less.

C. On two foot trench widening

D. For sub-surfaces mixes including 19 mm and 25 mm Superpave mixes if all air void results within a given lot are >2.5 % <8 %.

When lots are reevaluated for range penalty, as shown in Subsection 106.03, "Samples, Tests, Cited Specifications," sampling and testing is according to GDT 73. Request for reevaluation must be made within 5 working days of notification of the lot results. The following procedures apply:
The Department will reevaluate the lot through additional testing by obtaining and testing three additional cores acquired in representative sites selected randomly throughout each sub-lot representing the high and low in-place air voids as detailed in GDT 73. The additional six cores (three cores from each sub-lot will be averaged) will replace the original five core results for range specified requirements only. The original five cores results will be reported for Pavement Mean Air Voids for the lot. This will be the final evaluation for compaction range for the lot. Lots will not be re-evaluated for range when the Pavement Mean Air Voids result in a lower than 95% pay factor. Ensure requests for reevaluation are made within 5 working days of notification of the lot results.
The Department will determine the payment for each lot by multiplying the Contract Unit Price by the adjusted pay factor shown in the Table 7 Average Air Voids Range Acceptance Schedule:
Table 7—Average Air Voids Range For Acceptance Schedule
Pay Factor Range between High and Low Air Void
Original 5 cores Re-evaluated Range between High and Low Air Void Cores
6 New Cores obtained from High (3 cores) and Low location (3 cores)
Pay is as follows:

100 ≤ 5 % < 4.50 %
0.95 > 5 % > 4.50%

****NEVER APPLY PENALTY BASED ON NUCLEAR GAUGE****

4. Anytime roadway compaction is extremely hard to obtain or extreme changes in roadway results are obtained, notify the Area TSE. The Area TSE may then request that a sample be submitted for T-209 results.

(GENERAL INFORMATION ON ROLLER TYPES)

1. BREAKDOWN ROLLING

   Usually roll breakdown until break point. Then back off 1 pass. (Usually 3-4 passes.)

   NOTE: a. Vibratory is much more effective at slow ground speed than fast. Therefore 3 slow passes is usually more effective than 5 fast passes. (Good speed is fast walking pace.)
   b. Do not set up more passes than can be done and keep roller close behind paver. (May in extreme cases need 2 breakdown rollers. Talk to Area TSE. & Project Engineer)
   c. Do not damage mat by over-rolling, cracking, skipping, knots.
   d. Breakdown roller should make a complete coverage of the mat before proceeding to remaining required passes.
   e. Generally but not always vibratory roller on asphalt should be run on high frequency (How fast it vibrates) and on low amplitude (How hard it hits.)

2. PNEUMATIC ROLLING (Intermediate Rolling)

   NOTE: a. Pneumatic roller is required not optional on conventional mixes – may not be able to be used on Superpave or Modified A-C mixes.
   b. CANNOT use on Open Graded Friction (D) or SMA's.
   c. Check roller for uniform air pressure (Should be within 5 lbs.)
   d. Tires should be same size and ply.
   e. Water system and mats can be required if needed.
   f. No readings are required behind the rubber tire roller.

   It's very important for this roller to roll as continuous as possible to minimize "picking-up" mixes on tires and marring newly placed mat.

   Need minimum of 8-12 passes over each area.

   SPEED – adjust as needed to begin rolling as soon as possible behind breakdown roller without causing excessive "picking-up" or mat marring to obtain continuous operation.

3. FINISH ROLLING

   NOTE: a. Finish rolling is accomplished using a steel wheeled tandem or vibratory roller (in static mode).
   b. <u>DO NOT VIBRATE FINISH ROLLING</u>.
   c. Begin finish rolling as soon as possible behind pneumatic rolling without causing cracking, slipping, or displacement of the newly placed mat.
   d. Generally, rolling 1-3 passes at a slow ground speed (walking pace) is satisfactory to remove visible blemishes.

**Any technician not satisfied with results of rolling pattern, target density, or surface texture should notify the T.M.O.S. and/or Area TSE.

(General Information)

SOIL COMPACTION (207, 208, 209)

A. FREQUENCY

1. Subgrade compactions: one per 1500' per two lanes or fraction thereof.
2. Embankment: one per 5000 cubic yards of fill material or fraction thereof.
3. Small structure backfill: 1 per 2800 cubic feet of pipe or 500 cubic yards whichever comes first.
4. Miscellaneous items.

a. Culverts – 500 cubic yards whicheve
b. Median barrier walls – two tests per mile.
c. Two foot widening – one compaction per mile per two lanes.
d. Bridge column footing – one per footing if requested by engineer.
e. Utilities – as requested by engineer.

B. PREPARATION OF SITE

1. With shovel or help of motor grader, prepare a level surface. If gauge rocks to the touch, make adjustment to level.
2. Drive metal pin through plate deeper than the depth to be tested.

C. STANDARD COUNTS

1. Standard counts of both moisture and density shall be taken twice daily – once in the morning and once in afternoon.
2. Place back of gauge against block lip.
3. Obtain standard count readings using the four minute setting and record counts. Gauge is kept in safe position.
4. Gauge shall be at least 30' away from any vehicle.

D. TAKING READINGS

1. Push probe to depth to be tested.
2. Set gauge to one minute reading and record counts.

E. SELECTION OF MATERIAL FOR MOLD

1. Shovel material from test site where gauge rested.
2. Use a cross section of all materials, i.e. rock, decayed rock, soil, etc.
3. Break-up big clumps and thoroughly mix.

F. COMPACTING MATERIAL IN MOLD

1. Place mold on mold block.
2. Check wing nuts and extension for tightness.
3. Using rammer, compact material in three layers, 25 blows per layer. (Clean rammer face after each layer.)
4. Scrape excess material off both ends of mold using a straightedge free of dings and nicks.

5. Weigh material plus mold and record.

G. CALCULATIONS ON GAUGE
1. Take Wet Density and Moisture PCF from Gauge
2. Subtract pcf moisture from wet density. Answer is dry density. Record
3. Divide pcf moisture by dry density. Answer is percent moisture. Record

H. CALCUALTIONS OF MOLD WEIGHT
1. Subtract weight of mold from total weight. Result is weight of material. Record.
2. Multiply material weight by mold correction factor or multiply weight by 30 and divide by 454. Answer is pcf. Record.

I. DETERMINING MAXIMUM DRY DENSITY

1. Use percent moisture and pcf material from mold.
2. Determine optimum moisture by looking straight down chart from MDD.
3. Use percent moisture and density pcf from proctor to plot in appropriate Family of Curves and determine MDD. Record.

J. COMPACTION
Divide In-Place dry density by MDD. Answer is % compaction. Record.

K. FLAME DRIED MOISTURE
1. There are times when soil is excessively dry or wet and the gauge does not give a representative moisture percent. In this case disregard gauge moisture and flame dry one. (1% over, 3% under.)
2. Tare a container and weigh at least 500 grams of material from roadway site. Record.
3. Dry to a constant weight. Record.

4. Divide the difference between wet and dry by the dry weight. Answer is percent moisture. Record.

   Example: $\frac{A - B}{B}$ A – wet weight B – dry weight

5. On compaction worksheet, divide the wet density by percent moisture plus 100. Answer is dry density. Record.

L. PLUS 10 CORRECTION

1. As a general rule, the family of curves book or chart will accurately give a MDD on ten percent plus ten or less. If more than ten percent, you have to correct the total sample to a chart found in GDT-7.
2. Dry sample to a low moisture content. Let cool and record weight.
3. Screen material through a number ten sieve and capture plus ten material.

4. Weigh plus ten material. Record and divide initial weight into plus ten weight. Answer is percent plus ten. Record.
5. Wet minus ten material and determine pcf material in mold and MDD as previously stated.
6. Use MDD on minus ten material and percent plus ten and determine total sample MDD on chart.
7. Optimum moisture is also to be adjusted by using optimum moisture on minus ten material and percent plus ten material.
8. Use moisture chart with two percent absorption and determine optimum moisture.

M. MOISTURE ADJUSTMENT FOR CHART OR BOOK

1. When soil is too dry, add water, mix thoroughly, compact in mold and flame dry a moisture.
2. When soil is too wet, dry back below curve line and add water back, mix thoroughly, compact in mold and flame dry a moisture.
3. After pcf mold weight and percentage moisture are determined, look up MDD as previously stated

GDOT 553 - Roadway Compaction Report (English)

Tech ID: RTT07452 **Sample Number: 446** **Sample Year: 2012**

Contract ID No.: B13846-10-000-1 Contractor Code: 2MA850 CountyNo: 093
Project No.: M004205 District No: 3 Date: 4/25/2012
Item No.: 209 Item Desc: Subgrade Area Engineer No: 313 Station No.(l.ft.): 1288+50

Gauge No: 36388 Mode: 6 Density Standard Count: 2488
Moisture Standard Count: 631

In Place Data **Gauge Offset**

Total

Location: SBOL Wet Density (lb/ft³): 122.4 0.00 122.40
Depth - BG (feet):
Plan Thickness (inches):
Actual Thickness (inches): Moisture PCF (lb/ft³): 15.60 0.00 15.60
Dry Density (lb/ft³): 106.8
% Moisture: 14.61

Moisture Data Wet Mass (grams): % Moisture:
Dry Mass (grams): Dry Density(lb/ft³):

Proc-tor Soil #	Wet Mass grams	Dry Mass grams	% Moisture	% Moist. Used	MassMix+Mold (grams)	Mold (grams)	Mix (grams)	Mass of Fctr (lb/ft³/g)	WetMassof PCF (lb/ft³)	chart	MoldCorr. curve Ff. Curve	Wet Mass Den(lb/ft³) Max. Dry	Optimum % Moisture
Final:				**14.61**	**3761**	**2039**	**1722**	**0.06638**	**114.3**	**C**		**104.6**	**17.3**

Dry Density Used (lb/ft³): 106.8
Max. Dry Density (lb/ft³): 104.6
Optimum % Moisture: 17.3
% Compaction Required: 100
% Compaction Obtained: 102.1
Remarks:

Passed Test: Passed
Recheck: N
Testing Group: Testing Management
IA Quality:
Verified By: BLJ

GDOT 553 - Roadway Compaction Report (English)

Tech ID: RTT07452 **Sample Number: 374** **Sample Year: 2012**

Contract ID No.: B13846-10-000-1 Contractor Code: 2MA850 CountyNo: 093
Project No.: M004205 District No: 3 Date: 4/13/2012
Item No.: 310 Item Desc: GAB Top Lift Area Engineer No: 313 Station No.(l.ft.): 1201+50

Gauge No: 35284 Mode: 6 Density Standard Count: 2487
Moisture Standard Count: 637

In Place Data **Gauge Offset**

Total

Location: SBOS Wet Density (lb/ft³): 131.9 4.20
136.10
Depth - BG (feet):
Plan Thickness (inches): 6
Actual Thickness (inches): 6.5 Moisture PCF (lb/ft³): 9.20 -1.20 8 .00
Dry Density (lb/ft³): 128.1
% Moisture: 6.25

Moisture Data Wet Mass (grams): % Moisture:

Dry Mass (grams): Dry Density(lb/ft³):

Proc-tor Soil #	Wet Mass grams	Dry Mass grams	% Max. Dry Moisture	% Optimum % Used	% Moist. old	MassMix+M Mold (grams)	Mix (grams)	Mass of Fctr (lb/ft³/g)	WetMassof (lb/ft³)	PCF chart	MoldCorr. curve Ff. Curve	Wet Mass Den(lb/ft³) Moisture
Final:					**6.25**			**0.06638**				

Dry Density Used (lb/ft³): 128.1
Max. Dry Density (lb/ft³): 127.3
Optimum % Moisture: 8.7
% Compaction Required: 100
% Compaction Obtained: 100.6
Remarks:
CRUSHED CONCRETE

Passed Test: Passed
Recheck: N
Testing Group: Testing Management
IA Quality:
Verified By: BLJ

Pipe Test Calculation

$$\left(\frac{3.14 \times \text{radius}^2}{144}\right) \times \left(\frac{\text{Linear Ft}}{2800}\right) = \text{Number of Pipe Test}$$

Radius = Diameter/2

Example:

Project has 15,000 linear feet of 18 inch pipe (18 is the diameter)

18/2 = 9

$$\left(\frac{3.14 \times 9^2}{144}\right) \times \left(\frac{15000}{2800}\right) = \text{Number of Pipe Test}$$

$$\left(\frac{3.14 \times 81}{144}\right) \times \left(\frac{15000}{2800}\right) = \text{Number of Pipe Test}$$

$$\left(\frac{254.34}{144}\right) \times \left(\frac{15000}{2800}\right) = \text{Number of Pipe Test}$$

1.77 X 5.36 = 10 pipe tests

(General Information)

GAB COMPACTION (310)

A. FREQUENCY

One test per 1500’ per two lanes per lift is minimum requirements.

B. PREPARATION OF SITE

1. Select a representative test site of area to be tested.
2. Drive pin to depth to be tested plus one inch.

C. GAUGE READINGS

1. Set probe at desired depth.
2. Set gauge to one minute reading and record moisture and density counts.

D. CALCULATIONS

1. Take Wet Density and Moisture PCF from Gauge. Record
2. Add or subtract calibration factors (offsets)
3. Subtract pcf moisture from wet density. Result is dry density. Record.
4. Divide pcf moisture by dry density. Result is percent moisture. Record.
5. Divide pcf dry density from MDD. Result is percent compaction. Record.

AASHTO T-180 Method D establishes Theoretical Maximum Dry Density for GAB used as pay item 310

DOT 553

Rev. 7/26/11

GEORGIA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS AND RESEARCH
ROADWAY COMPACTION REPORT

PROJECT	PR-491-2(63)C1	CONTRACT ID	C30461-99-000-0	PI	
ITEM	310	COUNTY	HENRY	DISTRICT	3
PRIME CONTRACTOR	ER SNELL	AREA ENGINEER	315	TESTED BY	BRENT JOHNSON
TITLE	TMFT 2				

IN-PLACE DATA

	BASE, SUBGRADE, EMB., ETC	GAB		
GAUGE NO.	DATE	09 / 05 /12		/ /
20935	SAMPLE NO	RTT07452		
MODE" 6	STATION	31+00		
DENSITY STANDARD COUNT	LOCATION	NBL		
2437	DEPTH THICKNESS	6		
MOISTURE STANDARD COUNT	PLAN THICKNESS	6		
643	WET DENSITY	149.3		
DENSITY OFFSET (BASE, GAB)	CORRECTED DENSITY (+/-)	151.3		
2	MOISTURE (PCF)	8.3		
MOISTURE OFFSET (BASE, GAB)	CORRECTED M. PCF (+/-)	7.3		
-1	DRY DENSITY	144		
	CORRECTED DRY DENSITY - WHEN NEEDED			
	% MOISTURE	5.06		

*IN-PLACE	WET WEIGHT		
MOISTURE BY	DRIED WEIGHT		
DRYING A SAMPLE	PERCENT (%)		

FAMILY OF CURVES DATA

*MOISTURE IN	WET WEIGHT		
ONE POINT BY	DRIED WEIGHT		
DRYING A SAMPLE	PERCENT (%)		
	% MOISTURE (FROM IN-PLACE DATA)		
	WT. OF MIXTURE + MOLD		
	WT. OF MOLD		
	WET WT. OF MIXTURE		
	WET WT. PER CU. FT.		
	MAX DRY DENSITY / FROM CURVE NO.		

COMPACTION DATA

MAX DRY DENSITY	141	
% COMPACTION REQUIRED	100	
% COMPACTION OBTAINED	102.1	
OPTIMUM MOISTURE	5.3	
PASSED/FAILED/RECHECK	P	

* FOR USE WHEN GAUGE WAS NOT USED TO TEST MOISTUR

(General Information)

TESTING MANAGEMENTGUIDELINES

FOR

ESTABLISHING ROLLING DENSIFICATION AND GAUGE CALIBRATION FOR ASPHALTIC CONCRETE

(Voids Specification)

A. ROLLING DENSIFICATION

The Department is responsible for pavement mean air void acceptance testing. The Contractor is responsible for establishing all roller patterns and any quality control testing. Upon written request by the Contractor, the Office of Materials and Testing will provide nuclear gauge testing assistance for compaction related issues.

CORRELATION WORKSHEET

CALIBRATION OF NUCLEAR GAUGE TO ASPHALT CORES

Project #	TSAP-120(85)01	PI#	
Contract ID	B14775-11-000-0	Date	9-5-12
County	BIBB	Gauge #	30165
Plant/Contractor	GA ASPHALT	Type Mix	25MM
% AC	4.30	Theoretical	159.4
Mix I.D. #	171XR25	Lot #	1
Density Standard Count	2748	Tested By	BRENT JOHNSON

OBTAIN CORE DENSITIES

Sample Numbers					
Site	1	2	3	4	5
Air Weight	1078	1495	1383	1291	1252
SSD Weight or Wax Weight	1079	1496	1384	1293	1254
Water Weight	630	875	819	753	731
Difference (SSD – Water Weight)	449	621	565	540	523
Specific Gravity (Air Weight ÷ Difference)	2.4009	2.4074	2.4478	2.3907	2.3939
Density (Specific Gravity x 62.4)	149.8	150.2	152.7	149.2	149.4

1. **Average Core Density** 150.3
2. **Average Gauge Density**** 148.1
3. **Density Offset (1-2)** +2.2

Note: If 1 is higher than 2, offset will be a plus (+)
If 2 is higher than 1, offset will be a minus (-)

CALCULATE GAUGE DENSITIES

Site	1	2	3	4	5	Average
Gauge Density ** (Nuclear Gauge Readings)	148	149.2	147.6	148.6	147.2	**148.1
Core Density	149.8	150.2	152.7	149.2	149.4	150.3
Gauge Density (From 5 gauge readings, after offset is applied)	150.2	151.4	149.8	150.8	149.4	150.3
Difference (Core Density – Gauge Density with offset)						

1. **If the average difference is greater than .5 lbs/ft³ (8.0095 Kg/m³), contact Area Coordinator or Field Supervisor for further instruction.**

OMR-TM-158 Rev. 07/25/11 Department of Transportation State of Georgia **Nuclear Gauge Calibration** **(12" Ring)**	**Nuclear Gauge Calibration to Graded Aggregate Base** Project:_______STP-00-004(90)01________County: UPSON_______ Contract ID:____B11754-10-000-1________PI # ____________________ Prime Contractor: ____REEVES____________________ Quarry:______FLORIDA ROCK GRIFFIN____________ Material:_______GAB______._______________Item: _____310______________ Tested By:____MIKE ELLINGTON_________Title: _______ET______________	Date __9___/_5____/ 12_____ N/G # _23015_____________ Mode____6____________ **Density Standard** **Count**______3001__________

Maximum Dry Density:__132.5_______

Optimum Moisture_____6.4_________

Moisture Standard
Count_____650_____________

IN PLACE DATA (NUCLEAR GAUGE)	**(1)**	**(2)**	**(3)**
Sample No	1	2	3
Station #	1+00	2+00	3+00
Depth - Thickness	6	6	6
Gauge Wet Density (PCF)**	135.2	133.7	135.5
Density Offset	+2.4	+2.4	+2.4
Wet Density (Gauge Wet Density +/- Offset)	137.6	136.1	137.9
Gauge Moisture Density (PCF)**	2.45	3.60	3.25
Moisture Offset	2.5	2.5	2.5
Moisture (PCF) (Gauge Moisture Density +/- Offset)	4.95	6.1	5.75
Dry Density (Wet Density – Moisture PCF)	132.7	130.0	132.2
% Moisture (Moisture PCF ÷ Dry Density)			
IN PLACE WET DENSITY (12" RING)	**(1)**	**(2)**	**(3)**
Sand Density________95.5			
Gross Wt. (Container and Sand)	22294 _gms./lbs.	17799 gms./lbs.	19449 gms./lbs.
Final Wt. (Container / Bag)	5398 _gms./lbs.	3466_ gms./lbs.	8854_ gms./lbs.
Wt. of Sand Used (Gross Wt – Final Wt.)	____16896_____gms./lbs.	___14333_____gms./lbs.	_____10595_____gms./lbs.
Wt. of Wet Material from Hole (Include. Container)	25534 _gms./lbs.	21215 _gms./lbs.	15900 gms./lbs.
Wt. of Container / Bag	___823____gms./lbs.	826_ _ gms./lbs.	826 gms./lbs.
Wt. of Wet Material from Hole (Wet Wt Fr. Hole -- Container Wt)	__24711 ____gms./lbs.	__20389_______gms./lbs.	_____15074____gms./lbs.
In-Place Wet Density (Wet Wt Fr. Hole x Sand Density ÷ Sand Used)	___139.7_____PCF	___135.9________PCF	_____135.9_______PCF
In-Place Dry Density (Wt. Density ÷ % Moist. Content +100 x 100)	134.1 PCF	129.8 _PCF	130.8 PCF
IN-PLACE MOISTURE (FLAME DRY)	**(1)**	**(2)**	**(3)**
Wt. of Wet Sample	2000 _gms./lbs.	_2000 _ _gms./lbs.	
Wt. of Dry Sample	_1920.4 gms./lbs.	1910.1 gms./lbs.	
Wt. of Water (Wt. Wet Sample – Wt. Dry Sample)	_79.6_______gms./lbs	___89.9_________gms./lbs.	__74.3________gms./lbs.
Moisture Content % (Wt. of Water ÷ Dry Sample x 100)	___4.14___________%	____4.71___________%	___3.86___________%
Moisture Content PCF (Wet density – Dry density)	5.6 PCF	6.1 PCF	5.1 PCF

CALCULATION FOR DENSITY OFFSET	**CALCULATION FOR MOISTURE OFFSET**
Avg. In-Place Wet Density (12" Ring)______137.2__________**(A)**	**Avg. PCF (Flame Dry Moisture)**______5.6_________**(A)**
Avg. Nuclear Gauge Wet Density **_________134.8__________(B)	**Avg. N/G Moisture Density ****________3.1__________**(B)**
A – B = Density Offset __________+2.4__________	**A – B = Moisture Offset** _________+2.5__________

OMR-TM-150 (Rev. 7/26/11)

GEORGIA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS AND RESEARCH
ASPHALTIC CONCRETE COMPACTION REPORT

PROJECT BRF00-0153-01(024) LOT 03 ITEM 400
COUNTY MACON (189) DISTRICT 3 DATE 09/22/2017
PRIME CONTRACTOR 2GS050 TESTED BY: TORREY WALL
CONTRACT ID B14653-13-000-1 PI #

BEG. STA	END STA.	LENGTH	LANE LOCATION
55+00	71+50	16+50	EBL
55+00	71+50	16+50	WBL

RES. ENG 313 TITLE TMBS
PLANT LOCATION MACON (098)
TYPE MIX 12.5MM SP % A.C. 5.10

Total Length of Lot=	Length of Sublot=	NOTES:
33+00	6+60	

TABLE #	BEG STA	END STA	LENGTH	LN	RANDOM #	RANDOM STATION	MEAS	REMARKS
1.) 204	55+00	61+60	3+97	EBL	.602	58+97		
SAMPLE #								
2.) 205	61+60	68+20	6+07	EBL	.919	67+67		
SAMPLE #								
3.) 206	68+20	71+50	4+28	EBL	.648			
SAMPLE #	55+00	58+30		WBL		55+98		
4.) 207	58+30	64+90	3+01	WBL	.456	61+31		
SAMPLE #								
5.) 208	64+90	71+50	4+04	WBL	.612	68+94		
SAMPLE #								

GAUGE # 31646

THEO. DENSITY = 153.8
DENSITY OFFSET (+/-) = + 1.9
MAX % VOIDS = 7.0%
AVG. VOIDS = 5.2
RANGE = 2.1
DENSITY STD. COUNT= 2379

NUCLEAR RESULTS

DEN.		0	CORRECTED	
LEFT	144.0		(+/-) Offse	
CENTER	141.1		DENSITY	144.0
RIGHT	141.1			
AVG.	142.1		% VOIDS	6.4
DEN.			CORRECTED	
LEFT	148.0		(+/-) Offse	
CENTER	145.1		DENSITY	147.2
RIGHT	142.8			
AVG.	145.3		% VOIDS	4.3
DEN.			CORRECTED	
LEFT	143.4		(+/-) Offse	
CENTER	144.8		DENSITY	145.7
RIGHT	143.2			
AVG.	143.8		% VOIDS	5.3
DEN.			CORRECTED	
LEFT	144.5		(+/-) Offse	
CENTER	140.7		DENSITY	145.1
RIGHT	144.4			
AVG.	143.2		% VOIDS	5.7
DEN.			CORRECTED	
LEFT	144.9		(+/-) Offse	
CENTER	144.5		DENSITY	146.9
RIGHT	145.6			
AVG.	145.0		% VOIDS	4.5

CORE RESULTS

AIR		SPEC. GR.	
SURF. AIR		PCF	
WATER			
DIFFERENCE		% VOIDS	
AIR		SPEC. GR.	
SURF. AIR		PCF	
WATER			
DIFFERENCE		% VOIDS	
AIR		SPEC. GR.	
SURF. AIR		PCF	
WATER			
DIFFERENCE		% VOIDS	
AIR		SPEC. GR.	
SURF. AIR		PCF	
WATER			
DIFFERENCE		% VOIDS	
AIR		SPEC. GR.	
SURF. AIR		PCF	
WATER			
DIFFERENCE		% VOIDS	

0 = RANDOM LATITUDE

(General Information)

CALIBRATING NUCLEAR GAUGE TO 12" RING USING FORM OMR-IM-158

1. First, determine the Density of Sand according to GDOT-21.
2. Next, obtain Standard Counts for both density and moisture.
3. Then get wet density and moisture pcf on the three areas.
   a. Average the 3 wet density's from the 3 areas.
   b. Average the 3 moisture pcf from the 3 areas.

4. At this point perform the Conventional Tests. (12" ring calibration)
   a. Get the gross wt. of bag (container) and enough sand.
   b. Weigh the bag (container) to be used for material from hole.
   c. Place 12" Ring on test site to use as guide to dig holes.
   d. Dig hole as specified and place material into bag (container).
   e. Immediately determine the weight of material from the hole.
   f. Carefully fill the hole with calibrated sand as specified.
   g. Calculate how much sand was used to fill hole.

5. Determine "in-place" wet density for the 3 areas. Use this formula.

$$\frac{W_w \times D_s}{W_s}$$

Where,

W_w = Wet weight of material from hole
D_s = Density of Sand
W_s = Weight of sand used

Example:

$$\frac{13{,}594 \times 81.5}{7644} = \frac{1{,}107{,}911}{7644} = 144.93864 = 144.9$$

6. Next, determine the Offset for density.
   a. Average the 3 "in place" wet densities – (example – Avg. = 145.2)
   b. Average the 3 Nuclear Gauge Wet Densities.
   c. To determine the Offset for Density, we take the difference from our "In-place" wet density and the Nuclear gauge wet density.

Example: Avg. In-place wet density- Avg. Nuclear gauge wet density = Offset

145.2 - 143.7 = +1.5

Correlate each gauge density to each 12" ring test wet density. Results should be within 0.5 pcf.

7. Next we perform Moisture Determinations for each area.
   a. Obtain specimen of no more than 2000 gms taken from the material removed from one of the holes. Weigh and record.
   b. Flame dry the specimen. Once dry, subtract the weight of the drying pan, and record.
   c. Calculate the weight of the water by subtracting the weight of the dry sample from the weight of the wet sample. Record.
   d. Next, we determine the Moisture Content in Percent using this formula.

$$\frac{A - B}{B} \times 100$$

Where,

A = Wt. of wet sample

B = Wt. of dry sample

Example

$$\frac{2000 - 1937}{1937} x100 \qquad = 3.25245 \text{ or } 3.3$$

e. Now, we change the Moisture Content in percent to Moisture pcf.

1) First, determine the "in-place" dry density using this formula

$$\frac{\text{"in - place" wet density}}{\text{Moisture(\%)} + 100} \text{ x } 100$$

Example

$$\frac{144.9}{3.3 = 100} \text{ x } 100 \qquad = 140.27105 \text{ or } 140.3$$

2) Now, we calculate the Moisture pcf by subtracting the "in-place dry density from the "in-place" wet density.

"in-place" wet density	144.9
- "in-place" dry density	- 140.3
Moisture PCF	4.6

8. Now, we find the Offset for moisture.
   a. Average the 3 Moisture pcf's. (Example Avg. = 4.2)
   b. Average the three Nuclear gauge moisture pcf's.

   c. We now determine an Offset for Moisture. To do this, we take the difference from our Avg. "in-place" moisture pcf's and our Avg. Nuclear gauge moisture
   Example:
   Avg. "in-place" moisture – Avg. nuclear gauge moisture.
   5.52 – 4.63 = +.89

9. To check the results and the gauge, correlate each gauge moisture pcf to each flame dry moisture pcf. Results should be within 0.5 pcf.
   calculate the average of the 3 moisture pcf's from our Moisture Determinations.

SECTION 22

REFERENCES

References

NUMBER	TITLE
	Specifications
Section 207	Excavation and Backfill for Minor Structures
Section 208	Embankment
Section 209	Subgrade Construction
Section 210	Grading Complete
Section 211	Bridge Excavation and Backfill
Section 310	Graded Aggregate Construction
Section 400	Asphaltic Concrete
	Sampling and Testing Procedures
GDT 7	Determining Maximum Density of Soil
GDT 21	Determining Field Density of Soils containing>45% retained on 2mm sieve (or >10% retained on 25mm sieve)
GDT 39	Specific Gravity of Compressed Bituminous Mixtures
GDT 59	Testing Density of Roadway Materials with Nuclear Gauge
GDT 67	Family of Curves Method for Determining Maximum Density of Soils
GDT 73A	Random Selection of Asphalt Plant Samples
GDT 73B	Random Selection of Roadway Asphalt Samples for Voids
GDT 73C	Random Selection of Roadway Concrete Samples
AASHTO R 90	Standard Practice for Sampling Aggregate Products

SECTION 23

RTT EQUIPMENT CHECKLIST

DOT FIELD TECHNICIANS AND CONTRACTORS QCT'S AND RTT'S EQUIPMENT LIST

PLANT EQUIPMENT NOTED WITH *

WORK GLOVES *	HEAT GLOVES *
SAFETY EQUIPMENT FOR IGNITION OVEN	LONG STRAIGHT EDGE
FIRST AID KIT*	1/30 CF MOLD
FIRE EXTINGUISHER*	MOLD BLOCK
LIGHTER, MATCHES*	MOLD RAMMER
CALCULATOR*	WIRE BRUSH*
SPECIFICATIONS BOOK	SPATULA *
QUICK GUIDE	SPOONS*
SAMPLE TESTING INSPECTION MANUAL	CHISEL
TESTING & MGMT PROCEDURES	THREE POUND HAMMER
PROPOSAL OR CONTRACT*	TWELVE INCH RING
CLIPBOARD*	PIE PANS
STAPLER*	MIXING BOWLS*
FILE FOLDERS*	GAS STOVE'GAS BOTTLE*
ACCORDIAN FOLDERS	GAS REGULATOR*
STROBE LIGHTS	6000 GRAM SCALES*
TWO WAY RADIO	SCALE LEVELING DEVICE*
MARKING CRAYON	PAINT BRUSH 3 INCH*
MARKING PAINT	SQUARE SHOVEL
NUCLEAR GAUGE	ROUND SHOVEL
APPROVED TRANSPORT CASE	POSTHOLE DIGGERS
BILL OF LADING	PICK
STANDARD BLOCK	6 FOOT FOLDING RULER
GAUGE BOOK	PIN
GAUGE CHARGER	PLATE
SAMPLE BAGS (Cloth & Plastic)*	T-HANDLE
SOIL FERTILITY BAGS	LAPTOP / DESK TOP COMPUTER*
SAMPLE CARD BAGS	POWER CONVERTER
HARD HAT	TOKENS*
SAFETY VEST SAFETY FLAGS	THERMOMETER*
FLASH LIGHT	IGNITION OR CONVECTION OVENS*
RAIN SUIT	HOT MELT BOXES*
RUBBER BOOTS	QUARTERING TOOL*
	12" TO 16" DIAMETER ROUND PAN*