# TECHNICAL SPECIFICATIONS BID SET

PROJECT:	PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT (19-1741.0 Job 162)
LOCATION:	Roosevelt Roads Base Ceiba, P.R.
OWNER:	Local Redevelopment Authority for Roosevelt Roads
A/E:	<b>Integra Design Group,PSC</b> PO Box 195488 San Juan, PR 00919-5488 Tel. (787) 767-2111
DATE:	April 12, 2022

# **TABLE OF CONTENTS**

# **DIVISION 00- PROCUREMENT AND CONTRACTING REQUIREMENTS**

00 72 00 GENERAL CONDITIONS

# **DIVISION 01- GENERAL REQUITEMENTS**

- 01 11 00 SUMMARY OF WORK
- 01 25 00 SUSBSTITUTION PROCEDURES
- 01 25 19 SUBSTITUTION REQUEST FORM
- 01 31 00 PROJECT MANAGEMENT AND COORDINATION
- 01 32 16 CONSTRUCTION PROGRESS SCHEDULE
- 01 33 00 SUBMITTAL PROCEDURES
- 01 40 00 QUALITY REQUIREMENTS
- 01 50 00 TEMPORARY FACILITIES AND CONTROLS
- 01 58 00 PROJECT IDENTIFICATION
- 01 74 19 CONSTRUCTION WASTE MANAGEMENT
- 01 77 00 CLOSEOUT PROCEDURES

# **DIVISION 02- EXISTING CONDITIONS**

02 4116 STRUCTURE DEMOLITION

# **DIVISION 03- CONCRETE**

- 03 10 00 CONCRETE FORMING
- 03 20 00 CONCRETE REINFORCING
- 03 30 00 CAST-IN-PLACE CONCRETE
- 03 35 00 CONCRETE FINISHING

# **DIVISION 31- EARTHWORKS**

- 31 11 00 CLEARING AND GRUBBING
- 31 13 00 SELECTED TREE AND SHRUB REMOVAL
- 31 22 00 GRADING

- 31 23 00 EXCAVATION AND FILL
- 31 23 16 TRENCHING FOR SITE UTILITIES
- 31 25 00 EROSION AND SEDIMENTATIONS

# PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY (PRHTA) SPECIFICATIONS

The following Standard Technical Specifications and Supplemental Specifications from the PRHTA "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION 2005" are applicable to this project.

# EARTHWORK SERIES

212 RECONDITIONING OF SHOULDERS AND DITCHES

# **BASE COURSES**

304 AGGREGATE BASE COURSE

# **BITUMINOUS PAVEMENTS**

401	HOT PLANT-MIX BITUMINOUS PAVEMENT
402	REHABILITATION OF BITUMINOUS CONCRETE PAVEMENT

403 COLD MILLING OF BITUMINOUS CONCRETE PAVEMENT

# **MISCELLANEOUS CONSTRUCTION**

609	CURB AND	GUTTER

- 618 THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS
- 638 MAINTENANCE AND PROTECTION OF TRAFFIC
- 640 RAISED PAVEMENT MARKINGS

# MATERIALS

- 702 BITUMINOUS MATERIALS
- 703 AGGREGATES
- 716 PAVEMENT MARKING MATERIALS
- 719 BITUMINOUS PAVEMENTS, MEASUREMENT OF REDUCTION IN MARSHALL STABILITY CAUSED BY IMMERSION IN WATER

# SUPPLEMENTAL SPECIFICATIONS

- 401 HOT PLANT-MIX BITUMINOUS PAVEMENT
- 403 COLD MILLING OF BITUMINOUS CONCRETE PAVEMENT
- 638 MAINTENANCE AND PROTECTION OF TRAFFIC
- 640 RAISED PAVEMENT MARKINGS

End of Table of Contents

**DIVISION 00** 

# DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

Local Redevelopment Authority for Roosevelt Roads PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

# **DOCUMENT 00 72 00**

# **GENERAL CONDITIONS**

# 1.1SUMMARY

- Related Documents: Α.
  - Document 00 7300 Supplementary Conditions. 1.
  - Division 01 General Requirements. 2.

#### DOCUMENT 1.2

Α. American Institute of Architects (AIA) Document A201-2007, General Conditions of the Contract for Construction, forms a part of this Contract and by reference is incorporated herein as fully as if repeated at length.

# END OF DOCUMENT

# **DIVISION 01 GENERAL REQUIREMENTS**

Local Redevelopment Authority for Roosevelt PAVEMENT REHABILITATION AT ROOSEVELT Roads

ROADS RE-DEVELOPMENT Ceiba, PR

### **SECTION 01 11 00**

### SUMMARY OF WORK

### PART 1GENERAL

#### 1.1 SUMMARY

- Α. Section Includes:
  - 1. Project description.
  - 2. Work by Others.
  - Work sequence. 3.
  - 4. Owner occupancy.
  - 5. Future work.
  - Contractor's use of site and premises. 6.
  - 7. Owner furnished Products.

#### PROJECT DESCRIPTION 1.2

Β. Work includes:

1. Construction of site improvements (two parking areas, grading, electric, storm sewer, fences, walks, retaining walls, landscaping).

#### 1.3 WORK SEQUENCE

Α. Coordinate construction schedule and operations with the Owner and Architect.

#### CONTRACTOR'S USE OF SITE AND PREMISES 1.4

- Α. Contractor shall have complete use of site and premises for execution of the Work.
- Assume full responsibility for protection and safekeeping of products under this Contract stored on Β. site.
- C. Obtain and pay for use of any additional storage or work areas needed for operations.
- Coordinate use of site and premises with the Owner: D.
  - 1. Employee parking: In designated areas.
  - 2. Access to site and premises: In designated areas.
  - Storage and staging areas: In designated areas. 3.
  - Transport materials and equipment to and from construction area along routes approved by 4. Owner.
- Ε. Conform to PR Laws, Codes, Rules and Regulations.
- F. Confine operations to construction area unless otherwise approved by Owner.
- G. Prohibit smoking within interior spaces.

#### PART 2 PRODUCTS

Not used

#### PART 3 **EXECUTION**

Not used

END OF SECTION

Local Redevelopment Authority for Roosevelt Roads

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

### **SECTION 01 25 00**

### SUBSTITUTION PROCEDURES

### PART 1 GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Product Substitution Procedures.

### 1.2 GENERAL

- A. Definition: Proposal by Contractor Construction Manager to use manufacturer, product, material, or system different from one required in Contract Documents.
- B. Do not substitute Products unless a substitution request has been approved by Architect.
- C. In case of non-availability of a specified Product notify Architect in writing as soon as non-availability becomes apparent.

### 1.3 SUBSTITUTION REQUESTS

- A. Submit substitution requests on copy of form bound into Project Manual.
- B. Document specified product and proposed substitution with complete data, including:
  - 1. Product identification, including name and address of manufacturer.
  - 2. Product description, performance and test data, and reference standards.
  - 3. Sample, if requested.
  - 4. Description of any anticipated effect that acceptance of proposed substitution will have on Progress Schedule, construction methods, or other items of Work.
  - 5. Description of any differences between specified product and proposed substitution.
  - 6. Difference in cost between specified product and proposed substitution.
- C. A request constitutes a representation that the Contractor:
  - 1. Has investigated the proposed Product and determined that it meets or exceeds the quality level of the specified Product.
  - 2. Will provide the same warranty for the substitution as for the specified Product.
  - 3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
- D. Substitutions will not be considered if:
  - 1. They are indicated or implied on Shop Drawings or other submittals without submittal of a substitution request.
  - 2. Approval will require substantial revision of Contract Documents without additional compensation to Architect.
- E. Architect will notify Contractor of approval or rejection of each Substitution Request.

### PART 2 PRODUCTS

Not used

### PART 3 EXECUTION

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR April 12, 2022

Not used

END OF SECTION

Local Redevelopment Authority for Roosevelt Roads PAVEMENT REHABILITATION AT ROOSEVELT Integra Design Group Project: 19-1741.0 (Job Ceiba, PR

162)

### **DOCUMENT 01 25 19**

### SUBSTITUTION REQUEST FORM

DATI	≣: _		
TO:	-		
ATTE	ENTION:		
PRO	JECT:		
We s	ubmit for your	consideration the follo	owing product as a substitution for the specified product:
	Section No.	Paragraph	Specified Product
	Proposed Sul	ostitution:	
	Reason for S	ubstitution:	
Prod	uct Data:		
	Attach comple information of installation.	ete technical data for n changes to Contrac	both the specified product and the proposed substitution. Include t Documents that the proposed substitution will require for its proper
Sam	oles:		
Attached Will be furnished upon request			
Does the substitution affect dimensions shown on Drawings?			
	No	Yes (explain	ר)
Effects of proposed substitution on other Work:			

Local Redevelopment Authority for Roosevelt<br/>RoadsPAVEMENT REHABILITATION AT ROOSEVELT<br/>ROADS RE-DEVELOPMENTIntegra Design Group<br/>Project: 19-1741.0 (Job Ceiba, PR

Differences between proposed substitution and specified Product:			
Manufacturer's warranties of the proposed substitution are:			
Same Different (explain)			
Maintenance service and spare parts are available for prop	osed substitution from:		
Previous installations where proposed substitution may be	seen:		
Project:	Project:		
Owner:	Owner:		
Architect:	Architect:		
Date Installed:	Date Installed:		
Cost savings to be realized by Owner, if proposed substitut	on is approved:		
Change to Contract Time, if proposed substitution is approv	ved:		
No Change Add days	Deduct days		
Submittal constitutes a representation that Contractor has r	ead and agrees to the provisions of Section 01 2500.		
Submitted by Contractor:			
Signaturo			
Signature			
Firm			
Local Redevelopment Authority for Roosevelt PAVEMENT RE Roads ROAD	HABILITATION AT ROOSEVELTIntegra Design GroupDS RE-DEVELOPMENTProject: 19-1741.0 (JobCeiba, PR162)		

# For Use by Architect:

Based on the information supplied by the Contractor, the Architect has reviewed the proposed substitution on the basis of design concept of the Work and conformance with information given in Contract Documents.

\_\_\_\_ Approved as Noted \_\_\_\_ Rejected \_\_\_\_ Approved

Submit Additional Information:	
-	

By: \_\_\_\_\_ Date: \_\_\_\_\_

### **SECTION 01 31 00**

### **PROJECT MANAGEMENT AND COORDINATION**

#### PART 1 **GENERAL**

#### SUMMARY 1.1

- Α. Section Includes:
  - Project coordination. 1.
  - 2. Coordination drawings.
  - 3. Project meetings.
- Β. **Related Sections:** 
  - Section 01 7700 Contract Closeout. 1.

#### 1.2 **PROJECT COORDINATION**

- Α. Submit required project submittals electronically in Abode PDF format.
- Β. Coordinate scheduling, submittals, and work of various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
- C. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service such equipment.
- D. Coordinate space requirements and installation of mechanical and electrical items that are indicated diagrammatically on Drawings.
  - 1. Follow routing shown as closely as practical: place runs parallel with building lines.
  - 2. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- Ε. In finished areas, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean up of work of separate Sections in preparation for Substantial Completion.
- After Owner occupancy, coordinate access to site for correction of defective Work and Work not in G. accordance with Contract Documents to minimize disruption of Owner's activities.

#### 1.3 COORDINATION DRAWINGS

Α. **Coordination Drawings:** 

- Prior to commencement of Work, prepare coordination drawings to define relationship of 1. mechanical, plumbing, fire protection, and electrical components with beams, columns, ceilings and walls.
- 2. Include plans, elevations, sections, and details required to define relationships between components.
- 3. Prepare drawings at 1/4 inch = 1'-0" scale for general layout and 3/8 inch = 1'-0" for plans and sections in congested areas including equipment spaces.
- Β. Hold coordination meetings with trades providing mechanical, plumbing, fire protection, and electrical work.
- C. Resolve conflicts between trades, prepare composite coordination drawings and obtain signatures on original composite coordination Drawings.
- D. When conflicts cannot be resolved:
  - 1. Cease work in areas of conflict and request clarification prior to proceeding.
  - 2. Prepare drawings to define and to indicate proposed solution.
  - 3. Submit drawings for approval when actual measurements and analysis of Drawings and Project Manual indicate that various systems cannot be installed without significant deviation from intent of Contract Documents.
- E. Submit original composite coordination drawings as part of Project Record Documents specified in Section 01 7700.

#### **PROJECT MEETINGS** 1.4

- Α. Schedule and administer progress meetings and pre-installation conferences.
- Β. Make physical arrangements for meetings; notify involved parties.
- Record significant proceedings and decisions at each meeting; reproduce and distribute copies to C. parties in attendance and others affected by proceedings and decisions made.

#### 1.5 **PROGRESS MEETINGS**

- Α. Schedule weekly progress meetings.
- Β. Location: Contractor's project field office.
- C. Attendance:
  - Contractor. 1.
  - 2. Owner.
  - 3. Architect and consultants as appropriate to agenda.
  - Subcontractors and suppliers as appropriate to agenda. 4.
  - Others as appropriate to agenda. 5.
- D. Review and Discuss:
  - 1. Work progress since previous meeting, including:
    - Field observations, deficiencies, conflicts, and problems. a.
    - b. Progress and completion date.

ROADS RE-DEVELOPMENT Ceiba, PR

- Corrective measures needed to maintain quality standards, progress, and completion c. date.
- 2. Status of:
  - a. Requests for information.
  - b. Submittals.
  - c. Contract modifications.
- 3. Coordination between various elements of Work.
- 4. Maintenance of Project Record Documents.

#### PRE-INSTALLATION CONFERENCES 1.6

- Where required in individual specification Section, convene a pre-installation conference at project Α. site or other designated location.
- Β. Require attendance of parties directly affecting or affected by work of the specific Section.
- C. Review conditions of installation, preparation and installation procedures, and coordination with related work.

#### PART 2 PRODUCTS

Not used

#### PART 3 **EXECUTION**

Not used

END OF SECTION

### **SECTION 01 32 16**

### **CONSTRUCTION PROGRESS SCHEDULES**

#### PART 1 **GENERAL**

#### 1.1 SUMMARY

- Α. Section Includes:
  - Construction progress schedule. 1.

#### Β. **Related Sections:**

- Section 01 1100 Summary of Work: Work sequence. 1.
- 2. Section 01 2900 - Payment Procedures.

#### FORMAT 1.2

- Α. Prepare Progress Schedule.
- Β. Sequence of Listings: The chronological order of the start of each item of Work.
- C. Scale and Spacing: To provide space for notations and revisions.
- Sheet Size: Multiples of 8-1/2 x 14 inches, or 11 x 17 inches. D.

#### CONTENT 1.3

- Show complete sequence of construction by activity, with dates for beginning and completion of each Α. element of construction.
- Β. Identify each item by specification Section number.
- C. Identify work of separate floors and other logically grouped activities.
- D. Provide subschedules for each phase of Work identified in Section 01 1100.
- E. Provide subschedules to define critical portions of the entire Progress Schedule.
- F. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- G. Provide separate schedule of submittal dates for Shop Drawings, Product Data, and Samples, including:
  - Dates reviewed submittals will be required from Architect. 1.
  - Decision dates for selection of finishes. 2.
  - 3. Delivery dates for Owner furnished products and Products identified under Allowance.
- H. Coordinate content with Schedule of Values specified in Section 01 2900.
- Ι. **Revisions:**

Local Redevelopment Authority for Roosevelt PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

- 1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
- Identify activities modified since previous submittal, major changes in scope, and other 2. identifiable changes.
- J. Provide narrative report to define problem areas, anticipated delays, and impact on Progress Schedule. Report corrective action taken, or proposed, and its effect.

#### SUBMITTAL 1.4

Submit revised Progress Schedule with each Application for Payment. Α.

#### DISTRIBUTION 1.5

- Α. Distribute copies of approved Progress Schedule to project site file, Subcontractors, suppliers, and other concerned parties.
- Β. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in Progress Schedule.

#### PART 2 PRODUCTS

Not used

#### PART 3 **EXECUTION**

Not used

END OF SECTION

### **SECTION 01 33 00**

### SUBMITTAL PROCEDURES

### **PART 1GENERAL**

#### 1.1 SUMMARY

- Α. Section Includes:
  - Submittal procedures. 1.
  - 2. Proposed Products list.
  - Submittal schedule. 3.
  - Shop Drawings. 4.
  - 5. Product Data.
  - 6. Samples.
  - Quality control submittals. 7.
- Β. **Related Sections:** 
  - Section 01 4000 Quality Requirements. 1.

#### 1.2 SUBMITTAL PROCEDURES

- Number each submittal with Project Manual section number and a sequential number within each Α. section. Number resubmittals with original number and an alphabetic suffix.
- Identify Project, Contractor, Subcontractor or supplier, pertinent Drawing sheet and detail numbers, Β. and specification Section number, as appropriate.
- C. Submit all submittals listed under "Submittals for Review" simultaneously for each Product or Specification Section.
- D. Where multiple Products function as an assembly, group submittals for all related Products into single submittal.
- E. Architect will not review incomplete submittals.
- F. Apply Contractor's stamp, signed or initialed certifying that:
  - Submittal was reviewed. 1.
  - 2. Products, field dimensions, and adjacent construction have been verified.
  - Information has been coordinated with requirements of Work and Contract Documents. 3.
- G. Schedule submittals to expedite the Project, and deliver to Architect. Coordinate submittal of related items.
- For each submittal, allow 7 days for Architect's review, excluding delivery time to and from H. Contractor.
- I. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of completed Work.

Local Redevelopment Authority for Roosevelt PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

- J. Revise and resubmit submittals when required; identify all changes made since previous submittal.
- K. Distribute copies of reviewed submittals to concerned parties and to Project Record Documents file. Instruct parties to promptly report any inability to comply with provisions.

### 1.3 PROPOSED PRODUCTS LIST

- A. Within 7 days after date of Notice to Proceed, submit a complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

### 1.4 SUBMITTAL SCHEDULE

- A. Within 7 days after date of Notice to Proceed, submit a submittal schedule showing all submittals proposed for project, including submittals listed as:
  - 1. Submittals for Review.
  - 2. Quality Control Submittals.
  - 3. Closeout Submittals.
- B. Include for each submittal:
  - 1. Specification section number.
  - 2. Description of submittal.
  - 3. Type of submittal.
  - 4. Anticipated submittal date.
  - 5. For submittals requiring Architect's review, date reviewed submittal will be required from Architect.

### 1.5 SHOP DRAWINGS

- A. Present information in clear and thorough manner.
- B. Identify details by reference to sheet and detail numbers or room number shown on Drawings.
- C. Reproductions of details contained in Contract Documents are not acceptable.

### 1.6 PRODUCT DATA

- A. Mark each copy to identify applicable products, models, options, and other data.
- B. Supplement manufacturers' standard data to provide information unique to this Project.

### 1.7 SAMPLES

A. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

- Β. Where so indicated, submit samples of finishes from the full range of manufacturers' standard colors, textures, and patterns for Architect's selection.
- C. Include identification on each sample, with full Project information.
- D. Unless otherwise specified in individual specifications, submit two of each sample.
- E. Architect will notify Contractor of approval or rejection of samples, or of selection of color, texture, or pattern if full range is submitted.

#### QUALITY CONTROL SUBMITTALS 1.8

Quality control submittals specified in Section 01 4000 are for information and do not require Α. Architect's responsive action except to require resubmission of incomplete or incorrect information.

#### PART 2 PRODUCTS

Not used

#### EXECUTION PART 3

Not used

END OF SECTION

### **SECTION 01 40 00**

### QUALITY REQUIREMENTS

#### PART 1 **GENERAL**

#### 1.1 SUMMARY

- Section Includes: A.
  - References. 1.
  - 2. Quality assurance and control of installation.
  - 3. Mockups.
  - 4. Manufacturer's field services and reports.
  - 5. Design data and calculations.
  - Test reports and certifications. 6.
  - 7. Manufacturer's installation instructions.

#### 1.2 REFERENCES

- Α. For products or workmanship specified by reference to association, trade, or industry standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- Β. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

#### QUALITY ASSURANCE AND CONTROL OF INSTALLATION 1.3

- Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and Α. workmanship, to produce Work of specified quality.
- Β. Comply fully with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- Ε. Perform work by persons qualified to produce workmanship of specified quality.
- F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

#### 1.4 MOCKUPS

ROADS RE-DEVELOPMENT Ceiba, PR

- Α. Definition:
  - 1. Mockups are field samples constructed, applied, or assembled at the project site for review by the Owner and Architect that illustrate materials, equipment, or workmanship.
  - 2. Approved mockups establish the standard of quality by which the Work will be judged.
- Β. Construct, apply, or assemble specified items, with related attachment and anchorage devices, flashings, seals, and finishes.
- C. Perform work in accordance with applicable specifications sections.
- D. Erect at project site at location acceptable to Architect. Protect from damage.

#### Removal: E.

- Mockups may remain as part of the Work only when so designated in individual specification 1. sections.
- 2. Do not remove mockups until removal is approved by Architect or upon Final Completion.
- 3. Where mockup is not permitted to remain as part of the Work, clear area after removal of mockup has been approved by Architect.

#### 1.5 MANUFACTURERS' FIELD SERVICES AND REPORTS

- Α. When specified in individual specification Sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, guality of workmanship, or startup of equipment, as applicable, and to initiate instructions when necessary.
- Β. Individuals to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- C. Submit report to Architect within 10 days of observation.

#### 1.6 DESIGN DATA AND CALCULATIONS

- Α. When specified in individual specification Sections, require material or Product suppliers or manufacturers to provide design data and calculations.
- Β. Accuracy of design data and calculations is the responsibility of the Contractor.
- C. When so specified, prepare design data and calculations under the direction of a professional engineer licensed in the state in which the Project is located. Affix engineer's seal to submittals.

#### TEST REPORTS AND CERTIFICATIONS 1.7

Α. When specified in individual specification Sections, require material or Product suppliers or manufacturers to provide test reports and manufacturers' certifications.

ROADS RE-DEVELOPMENT Ceiba, PR

### April 12, 2022

- B. Indicate that material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Submittals may be recent or previous test results on material or Product, but must be acceptable to Architect.

#### MANUFACTURER'S INSTALLATION INSTRUCTIONS 1.8

- Α. When Contract Documents require that Products be installed in accordance with manufacturer's instructions:
  - Submit manufacturer's most recent printed instructions for delivery, storage, assembly, 1. installation, start-up, adjusting, and finishing, as applicable.
    - Submit in quantities specified for Product Data. a.
    - b. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
    - Identify conflicts between manufacturers' instructions and requirements of Contract C. Documents.
  - Perform installation of Products to comply with requirements of manufacturer's instructions. 2.
  - If installation cannot be performed in accordance with manufacturer's instructions, notify 3. Architect and await instructions.

#### PART 2 PRODUCTS

Not used

#### PART 3 **EXECUTION**

Not used

END OF SECTION

Roads

Local Redevelopment Authority for Roosevelt PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

### **SECTION 01 50 00**

### **TEMPORARY FACILITIES AND CONTROLS**

#### PART 1 **GENERAL**

#### 1.1 SUMMARY

- Α. Section Includes:
  - 1. Temporary utilities.
  - 2. Field offices and sheds.
  - 3. Temporary controls.
  - Protection of installed Work. 4.
  - 5. Security.
  - 6. Progress cleaning.
  - Water, erosion, sediment, dust, and mold and mildew control. 7.
  - 8. Access roads and parking areas.
  - 9. Removal.

#### 1.2 REFERENCES

Green Seal, Inc. (GS) 37 - Environmental Standard for Industrial and Institutional Cleaners. Α.

#### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Cleaning Materials: Use only materials that:
  - Comply with GS 37. 1.
  - 2. Are not potentially hazardous to health or property.
  - 3. Do not contain hazardous ingredients.
  - 4. Are non-carcinogenic.
  - 5. Are non or mildly irritating to skin, eyes, and mucous membranes.
  - Have an LD50 rating above 5 grams per kilogram. 6.
  - 7. Are non-reactive.
  - 8. Contain minimum fragrance and dye.
  - 9. Do not require respiratory protection.

#### PART 3 **EXECUTION**

- **TEMPORARY ELECTRICITY** 3.1
  - Α. Owner will provide temporary electricity required for construction and will charge according to meter readings and PREPA billing rate. Contractor shall install sub-metering if required.

Roads

Local Redevelopment Authority for Roosevelt PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

- B. Provide temporary electrical service of capacity and characteristics required for construction.
- C. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.
- D. Maintain distribution system and provide routine repairs.

### 3.2 TEMPORARY LIGHTING

- A. Provide temporary lighting for construction and security purposes.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lamps and provide routine repairs.
- D. Provide portable lights when required to provide minimum lighting levels necessary for specific work.

### 3.3 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to facilitate curing of materials, disperse humidity, and prevent accumulations of dust, fumes, vapors, or gases.
- B. Provide temporary fan units as required to maintain clean air for construction.

### 3.4 TEMPORARY TELEPHONE, FACSIMILE, AND COMPUTER SERVICES

- A. Contractor shall be accessible during normal business hours via mobile telephone with voice mail or an answering service.
- B. Provide Internet access and email service in Contractor's field office.

### 3.5 TEMPORARY WATER

- A. Owner will provide temporary water required for construction and will charge according to meter readings and PRASA billing rate. Contractor shall install sub-metering if required.
- B. Extend branch piping and provide temporary hoses so that water is available at locations needed for work.
- C. Maintain distribution system and provide routine repairs.

# 3.6 TEMPORARY SANITARY FACILITIES

A. Provide chemical toilets for use during construction.

Local Redevelopment Authority for Roosevelt	PAVEMENT REHABILITATION AT ROOSEVELT
Roads	ROADS RE-DEVELOPMENT
	Ceiba, PR

- B. Permanent toilets may not be used during construction.
- C. Maintain facilities in clean and sanitary condition.

#### 3.7 FIELD OFFICES AND SHEDS

- Α. Provide temporary field offices and storage sheds required for construction.
- Β. Provide temporary field offices for owner resident inspection.
- C. Do not unreasonably encumber site or premises with excess materials or equipment.
- D. **Temporary Structures:** 
  - Portable or mobile buildings, structurally sound, weathertight, with floors raised above ground. 1.
  - 2. Temperature transmission resistance: Compatible with occupancy and storage requirements.
  - Provide connections for utility services when required. 3.
  - Provide steps and landings at entrances. 4.

#### E. Field Office:

- Size required for Contractor's use and to provide space for project meetings. 1.
- Adequate electrical power, lighting, heating, and cooling to maintain human comfort. 2.
- Provide facilities for storage of Project Record Documents. 3.
- 4. Provide thermometer and rain gage mounted at convenient outside location, not in direct sunlight.
- 5. Provide separate office for Owner Resident Inspection equip with:
  - Drawing layout table. a.
  - Desk and chair. b.
  - 2-drawer filing cabinet. C.
  - d. Drawing hanging rack.
  - Air conditioning. е

#### BARRIERS 3.8

- Provide barriers to prevent unauthorized entry to construction areas and to protect adjacent Α. properties from construction operations.
- B. Provide barricades and covered walkways required by governing authorities for public right-of-ways and for public access to existing facilities.
- C. Fencina:
  - 1. Provide temporary fencing for construction operations.
  - Construction: Contractor's option. 2.
  - 3. Height: 6 feet.
  - Locate to protect construction operations, materials, and equipment. 4.
  - Provide vehicular gates. 5.
- D. Tree and Plant Protection:
  - Protect existing trees and plants at site that are designated to remain. 1.

ROADS RE-DEVELOPMENT Ceiba, PR

- 2. Employ qualified tree surgeon to Remove roots and branches that interfere with construction.
- 3. Do not permit vehicular traffic, parking, storage of materials, dumping of harmful chemicals or liquids, or standing or continuously running water within root zones.
- 4. Supervise earthwork operations to prevent damage to root zones.
- 5. Replace trees and plants that are damaged or destroyed due to construction operations.

### 3.9 EXTERIOR CLOSURES

- A. Provide temporary weathertight closures for exterior openings to provide acceptable interior working conditions, to allow for temporary heating and maintenance of ambient temperatures required in individual specification sections, to protect the Work, and to prevent entry of unauthorized persons.
- B. Provide access doors with locking hardware.

### 3.10 PROTECTION OF INSTALLED WORK

- A. Protect installed work from construction operations; provide special protection when required in individual specification sections.
- B. Minimize traffic, storage, and construction activities on roof surfaces. If traffic, storage, or activity is necessary, obtain recommendations for protection from roofing manufacturer.
- C. Prohibit traffic from landscaped areas.

### 3.11 SECURITY

- A. Provide a project security program, to:
  - 1. Protect the Work, stored products, and construction equipment from theft and vandalism.
  - 2. Prevent entry by unauthorized persons.

### 3.12 PROGRESS CLEANING

- A. Maintain areas free from waste materials, debris, and rubbish. Maintain site in clean and orderly condition.
- B. Provide containers for collection of waste materials, debris, and rubbish; remove and dispose of off site as required by construction activities.
- C. Periodically clean interior areas to provide suitable conditions for finish work.

### 3.13 TEMPORARY CONTROLS

- A. Water Control:
  - 1. Grade site to drain. Prevent puddling water.
  - 2. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
  - 3. Provide water barriers to protect site from soil erosion.

Local Redevelopm	nent Authority for Roosevelt	
	Roads	

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

- B. Erosion and Sediment Control:
  - 1. Plan and execute methods to control surface drainage from cuts, fills, borrow areas, and waste disposal areas. Prevent erosion and sedimentation.
  - 2. Minimize amount of bare soil exposed at any one time.
  - 3. Provide temporary measures such as silt fences, dikes, berms, settlement basins, and drainage systems to prevent water flow and sedimentation.
  - 4. Periodically inspect earthwork to detect erosion and sedimentation; promptly employ corrective measures.
- C. Dust Control:
  - 1. Provide dust control materials and methods to minimize dust from construction operations.
  - 2. Prevent dust from dispersing into atmosphere.
- D. Mold and Mildew Control:
  - 1. Provide continuous measures to prevent formation of mold and mildew in construction.
  - 2. Do not install materials sensitive to mold and mildew growth until protection can be provided.
  - 3. Promptly remove and replace materials exhibiting mold and mildew growth.

### 3.14 ACCESS ROADS AND PARKING AREAS

- A. Construct and maintain temporary roads accessing public thoroughfares to serve construction needs.
- B. Existing roads designated by Owner may be used for construction purposes. Do not allow heavy vehicles or construction equipment in parking areas.
- C. Provide for access by emergency vehicles.
- D. Keep fire hydrants and water control valves free from obstruction and accessible for use.
- E. Provide parking facilities for construction personnel. When parking needs exceed on site capacity, provide additional off site facilities.
- F. Maintain existing construction, and restore to original or specified condition at completion of Work.

### 3.15 REMOVAL

- A. Remove temporary utilities, equipment, facilities, and services when construction needs can be met by use of permanent construction or upon completion of Project.
- B. Remove foundations and underground installations; grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore permanent facilities used during construction to original or to specified condition.

# END OF SECTION

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

### **SECTION 01 58 00**

### **PROJECT IDENTIFICATION**

#### PART 1 **GENERAL**

#### 1.1 SUMMARY

- A. Section Includes:
  - Project identification sign. 1.
  - 2. Maintenance and removal.

#### QUALITY ASSURANCE 1.2

- Α. Project Sign:
  - Finishes, Printing or Painting: Adequate to withstand weathering, fading, and chipping for 1. duration of construction.
- Β. Do not erect other signs at site without Owner's approval, except those required by governing authorities.

#### PART 2 PRODUCTS

#### 2.1 MATERIALS

- Α. Structure and Framing: New lumber or galvanized steel, structurally adequate.
- Β. Sign Surfaces: Exterior grade plywood with medium density overlay, nominally 3/4 inch thick, standard large sizes to minimize joints.
- C. Rough Hardware: Galvanized steel or aluminum.
- D. Paints: Alkyd or Latex type, printing tint, exterior guality, gloss, semigloss or satin sheen.

#### 2.2 FABRICATION

- Α. Provide one sign.
  - 1. Bottom edge of sign: 6 feet above ground.
  - Content: 2.
    - a. Project title and logos.
    - Owner's name. b.
    - Names and titles of Architect and Consultants. c.
    - d. Name of Contractor.
    - Permits Numbers (Demolition, Construction, Consolidado) e.
  - 3. Graphic design, colors, and lettering style: As designated by Owner.

ROADS RE-DEVELOPMENT Ceiba, PR

#### PART 3 **EXECUTION**

### 3.1 INSTALLATION

- Α. Erect at designated location.
- Β. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
- C. Install sign surface plumb and level, with butt joints. Anchor securely.
- D. Paint exposed surfaces of sign, supports, and framing.

#### MAINTENANCE 3.2

Α. Maintain signs and supports clean. Repair deterioration and damage.

#### REMOVAL 3.3

Remove signs, framing, supports, and foundations at completion of Project and restore the area. Α.

# END OF SECTION

### **SECTION 01 74 19**

### **CONSTRUCTION WASTE MANAGEMENT**

#### PART 1 **GENERAL**

#### SUMMARY 1.1

- Section Includes: Α.
  - Construction waste management goals, plan, and records. 1.

#### WASTE MANAGEMENT GOALS 1.2

- A. Reuse, salvage, or recycle non-hazardous waste materials.
- Β. Minimize waste sent to landfills.
- C. Prioritize non-hazardous construction waste management in following order:
  - Reduce amount of waste generated. 1.
  - Reuse material through on-site reuse or off-site salvaging, including sale or donation. 2.
  - 3. Recycle material including diverting materials for secondary uses whenever economically feasible.
  - 4. Dispose of materials with no practical use or economic benefit at landfill.
- D. Divert minimum 75 percent of construction waste by weight (in tons) or volume (in cubic yards) from landfills and incinerators.
- Ε. Calculations may be performed using weight or volume but must be consistent throughout Project.

#### 1.3 WASTE MANAGEMENT

- Pro-actively manage construction and demolition waste: Α.
  - Practice efficient waste management when sizing, cutting, and installing products. 1.
  - 2. Use all reasonable means to divert construction and demolition waste from landfills, and to facilitate recycling and reuse.
  - 3. Return unused products and overages to supplier, or donate to non-profit group.
  - Carefully install products; avoid removal of ill-timed and poorly installed products. 4.
  - Use centralized cutting areas to facilitate waste collection. 5.
  - Deliver, store, and handle products to prevent damage. 6.
- Β. Require subcontractors and suppliers to participate in waste management efforts.
- C. Construction waste includes:
  - 1. Products from demolition and removal, excluding excavated soil and land-clearing debris.
  - 2. Excess and unusable construction products.
  - 3. Packaging materials for construction products.
  - 4. Other materials generated during construction process but not incorporated into the Work.
- D. Give consideration to:
  - Availability of viable recycling markets. 1.
  - 2. Condition of materials.

ROADS RE-DEVELOPMENT Ceiba, PR

- 3. Ability to provide material in suitable condition and in quantities acceptable to available markets.
- 4. Time constraints imposed by internal project completion mandates.
- Ε. Be responsible for implementation of special programs involving rebates and similar incentives related to recycling of waste.
- F. Revenues and other savings obtained for salvage and recycling accrue to Contractor.
- G. Ensure that firms and facilities used for recycling, reuse, and disposal have legal permits for intended uses.

#### SUBMITTALS 1.4

- A. Waste Management Plan:
  - 1. Submit waste management plan.
  - 2. Include:
    - Name of individual on Contractor's staff responsible for waste prevention and a. management.
    - Actions proposed to reduce solid waste generation and achieve waste management goal. b.
    - Description of proposed methods for recycling and reuse of materials generated, c. including areas and equipment for processing, sorting, and temporary storage.
    - Estimated types and guantities of waste to be generated. d.
    - Name of landfills and incinerators to be used. e.
    - Identification of local and regional reuse programs that will accept waste materials. f.
    - List of waste materials to be salvaged for resale, salvaged and reused, or recycled. g. Identify recycling facilities to be used.
    - Identification of materials that cannot be recycled or reused, with justification. h.
  - If required, revise and resubmit plan within ten days after receipt of comments. 3.
  - Distribute copies of approved Waste Management Plan to concerned parties. 4.
  - Update Waste Management Plan periodically through duration of Project to reflect changed 5. conditions.

#### QUALITY ASSURANCE 1.5

- Review and discuss waste management plan implementation and progress at Preconstruction Α. Conference and Progress Meetings.
- DELIVERY, STORAGE AND HANDLING 1.6
  - A. Designate separate areas to facilitate separation of materials for potential recycling, salvage, reuse and return.
  - Β. Clearly identify areas and receptacles.
  - C. Keep storage areas and receptacles clean and orderly; prevent contamination of materials.
  - D. Monitor storage areas; correct problems and implement preventative measures.

#### 1.7 TRAINING

Α. Provide training of waste management methods to be used at appropriate stages of Project.

Local Redevelopment Authority for Roosevelt PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

Β. Require participation of all subcontractors.

#### PART 2 PRODUCTS

Not used

#### PART 3 **EXECUTION**

- 3.1 WASTE COLLECTION
  - Α. Provide containers and storage areas to facilitate waste management, clearly identified.
  - Β. Handle recyclable materials to prevent contamination by incompatible products and materials.
  - C. Separate materials by:
    - Placing into marked separate containers, then transporting to recycling facility. 1.
    - 2. Placing into single container, then transporting to recycling facility for separation.

#### DISPOSAL 3.2

- Α. Dispose of nonhazardous waste materials that cannot be reused, recycled, or salvaged at licensed landfill or incinerator.
- Β. Handle, store, and dispose of hazardous wastes in accordance with applicable codes, ordinances, rules, and regulations.

# END OF SECTION

### SECTION 01 77 00

### **CLOSEOUT PROCEDURES**

### PART 1 GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Closeout procedures.
  - 2. Final cleaning.
  - 3. Adjusting.
  - 4. Project record documents.
  - 5. Operation and maintenance data.
  - 6. Warranties.
  - 7. Spare parts and maintenance materials.
  - 8. Starting of systems.
  - 9. Demonstration and instructions.
- B. Related Sections:
  - 1. Section 01 1100 Summary of Work.

### 1.2 CLOSEOUT PROCEDURES

- A. Final Inspection:
  - 1. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with the Contract Documents and ready for Architect's inspection.
- B. Closeout Submittals:
  - 1. Evidence of compliance with requirements of governing authorities.
  - 2. Certificate of Occupancy ("Permiso de Uso" of each structure to be obtained by Contractor).
  - 3. Contractor shall provide acceptance by PRASA and PREPA of service facilities
  - 4. Project Record Documents.
  - 5. Operation and Maintenance Data.
  - 6. Warranties.
  - 7. Keys and keying schedule.
  - 8. Spare parts and maintenance materials.
  - 9. Evidence of payment of Subcontractors and suppliers.
  - 10. Final lien waiver.
  - 11. Certificate of insurance for products and completed operations.
  - 12. Consent of Surety to final payment.

### 1.3 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR
#### April 12, 2022

- B. Clean surfaces exposed to view:
  - 1. Clean glass.
  - 2. Remove temporary labels, stains and foreign substances.
  - 3. Polish transparent and glossy surfaces.
  - 4. Vacuum carpeted surfaces; damp mop hard surface flooring.
- C. Clean equipment and fixtures to a sanitary condition.
- D. Clean or replace filters of operating equipment.
- E. Clean debris from roofs and drainage systems.
- F. Clean site; sweep paved areas, rake clean landscaped surfaces.
- G. Remove waste and surplus materials, rubbish, and construction facilities from the site.

#### 1.4 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Maintain following record documents on site; record actual revisions to the Work:
  - 1. Drawings.
  - 2. Specifications.
  - 3. Addenda.
  - 4. Change Orders and other Modifications to the Contract.
  - 5. Reviewed Shop Drawings, Product Data, and Samples.
  - 6. Material Safety Data Sheets.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Make entries neatly and accurately.
- E. Label each set or volume with title "PROJECT RECORD DOCUMENTS", project title, and description of contents.
  - 1. Organize contents according to Project Manual table of contents.
  - 2. Provide table of contents for each volume.
- F. Drawings: Mark each item to record actual construction including, and prepare as-built cad drawings:
  - 1. Measured depths of foundations in relation to finish floor datum.
  - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
  - 4. Field changes of dimension and detail.
  - 5. Details not on original Drawings.

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR April 12, 2022

- G. Specifications: Mark each Product section description of actual Products installed, including the following:
  - Manufacturer's name and product model and number. 1.
  - Product substitutions or alternates utilized. 2.
  - 3. Changes made by Addenda and Modifications.
- Η. Shop Drawings: Mark each item to record actual construction including:
  - 1. Field changes of dimension and detail.
  - 2. Details not on original Shop Drawings.

#### **OPERATION AND MAINTENANCE DATA** 1.6

- Identify as "OPERATION AND MAINTENANCE INSTRUCTIONS" and title of project. Α.
- Β. Contents:
  - Directory: List names, addresses, and telephone numbers of Architect, Contractor, 1. Subcontractors, and major equipment suppliers.
  - 2. Operation and maintenance instructions: Arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
    - Significant design criteria. a.
    - List of equipment. b.
    - Parts list for each component. c.
    - Operating instructions. d.
    - Maintenance instructions for equipment and systems. e.
    - Maintenance instructions for special finishes, including recommended cleaning methods f. and materials and special precautions identifying detrimental agents.
  - 3. Project documents and certificates including:
    - Shop drawings and product data. a.
    - Air and water balance reports. b.
    - Certificates. c.
    - d. Copies of warranties and bonds.
- C. Submittal:
  - Submit 2 copies. Submit electronically in Adobe PDF format at least 15 days prior to final 1. inspection.
  - 2. Architect will notify Contractor of any required revisions after final inspection.
  - Revise content of documents as required prior to final submittal. 3.

#### WARRANTIES 1.7

- Α. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.
- Β. Include Table of Contents.

#### SPARE PARTS AND MAINTENANCE MATERIALS 1.8

April 12, 2022

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.
- B. Deliver to Project site in location as directed; obtain receipt prior to final payment.

#### 1.9 STARTING OF SYSTEMS

- A. Notify Owner and Architect at least seven days prior to startup of each system or piece of equipment.
- B. Prior to beginning startup verify that:
  - 1. Lubrication has been performed.
  - 2. Drive rotation, belt tension, control sequences, tests, meter readings, and electrical characteristics are within manufacturer's requirements.
  - 3. Utility connections and support components are complete and tested.
- C. Execute start-up under supervision of applicable manufacturer's representative or Contractor's personnel in accordance with manufacturers' instructions, Owner Resident Inspector.
- D. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to startup, and to supervise placing equipment or system in operation.
- E. Submit written report that equipment or system has been properly installed and is functioning correctly.

#### 1.10 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Utilize Operation and Maintenance Manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed upon times, at equipment location.
- E. Prepare and insert additional data in Operation and Maintenance Manuals when need for additional data becomes apparent during instruction.

#### PART 2 PRODUCTS

Not used

#### PART 3 EXECUTION

#### Not used

01 77 00 - 5

# END OF SECTION

Local Redevelopment Authority for Roosevelt ROADS RE-DEVELOPMENT REHABILITATION AT ROOSEVELT Integra Design Group Project: 19-1741.0 (Job Ceiba, PR 162)

# DIVISION 02 EXISTING CONDITIONS

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR Integra Design Group Project: 19-1741.0 (Job 162)

#### SECTION 02 41 16

#### STRUCTURE DEMOLITION

#### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Demolition of designated structures.
  - 2. Demolition of foundations and slabs on grade.
  - 3. Disconnection, capping and removal of utilities.
  - 4. Demolition of walks, paving, curbs, gutters, and site improvements.
  - 5. Removal of materials from site.
- B. Related Sections:
  - 1. Division 01: Administrative, procedural, and temporary work requirements.
  - 2. Section 31 2300- Excavation and Fill.

#### 1.2 SUBMITTALS

- A. Submittals for Review:
  - 1. Demolition procedures and operational sequence.
- B. Quality Control Submittals: Submit prior to beginning demolition:
  - 1. Permits authorizing building demolition.
  - 2. Certificates of severance of utility services.
  - 3. Permit for transportation and disposal of debris.
- C. Closeout Submittals:
  - 1. Indicate location and sizes of existing pier or pile foundations.

#### 1.3 QUALITY ASSURANCE

- A. Comply with applicable codes, ordinances, rules, and regulations, including those for demolition, transportation, and disposal of debris.
- B. Arrange for, obtain permits and certificates for, and pay fees required for:
  - 1. Transportation and disposal of debris.
  - 2. Demolition.
  - 3. Utility severance or relocation, including removing meters and capping lines.
  - 4. Use or closing of streets, sidewalks, or other public places.

#### PART 2 PRODUCTS

Not used

#### PART 3 EXECUTION

#### 3.1 PREPARATION

#### A. Prior to beginning demolition, verify that:

Local Redevelopment Authority for Roosevelt Roads

- 1. Structures are unoccupied and removed from service.
- 2. Temporary controls and devices are in place and operational.
- 3. Utilities are temporarily or permanently disconnected or relocated as required.
- 4. Items salvaged for Owner are removed and stored in designated area.

#### 3.2 DEMOLITION

- A. Demolish structures in accordance with demolition procedures approved by Architect.
- B. Sprinkle debris, and use temporary closures as necessary to limit dust to lowest practical level.
- C. Do not use water to extent causing flooding, contaminated runoff.
- D. Begin demolition at top of building and proceed to lowest level, not using explosives.
- E. Demolish structure above each floor level before damaging supporting members on lower levels.
- F. Break concrete and masonry into sections less than 3 feet in any dimension.
- G. Remove slabs and foundations to full depth.
- H. Remove tops of pier, pile foundations to depth indicated on drawings. Document remaining foundation locations and sizes for future use.
- I. Remove below grade wood and metal.
- J. Remove walks, paving, curbs, gutters, and site improvements.
- K. Remove underground utilities back to locations indicated. Flag and identify underground utilities to remain.
- L. Backfill excavations to depth indicated, loose, even, horizontal lifts, using clean soil. Uniformly compact each lift to requirements of Section 31 2300.
- M. Uniformly grade areas to smooth surface. Adjust contours to eliminate water ponding and provide positive drainage. Make grade changes gradually. Blend slopes into level areas.

#### 3.3 MATERIAL DISPOSAL

- A. Salvage: Remove, protect, and relocate materials designated to remain property of Owner.
- B. Disposal:
  - 1. Materials, equipment, and debris resulting from demolition operations becomes property of Contractor. Remove debris as soon as practical.
  - 2. Cover debris in trucks to prevent spillage during transportation.
  - 3. Do not store or burn materials on site.
  - 4. Transport debris to off site disposal area and legally dispose of.

# DIVISION 03 CONCRETE

Local Redevelopment Authority for Roosevelt Roads PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR Integra Design Group Project: 19-1741.0 (Job 162)

#### SECTION 03 10 00

#### **CONCRETE FORMING**

# PART 1 GENERAL

- 1.1 SUMMARY
  - A. Section Includes:
    - 1. Forms for cast-in-place concrete, with shoring, bracing, and anchorage.
    - 2. Form accessories.
    - 3. Stripping of forms.

#### 1.2 REFERENCES

- A. American Concrete Institute (ACI):
  - 1. 301 Specifications for Structural Concrete for Buildings.
  - 2. 347 Recommended Practice for Concrete Formwork.
- B. American Society of Mechanical Engineers (ASME) A17.1 Safety Code for Elevators and Escalators.

#### 1.3 SUBMITTALS

- A. Submittals for Review:
  - 1. Shop Drawings: Diagram of proposed construction joints not indicated on Drawings.
- B. Sustainable Design Submittals:
  - 1. Materials Reuse.
  - 2. Recycled Content.
  - 3. Regional Materials.

#### 1.4 QUALITY ASSURANCE

A. Design formwork in accordance with ACI 301 and 347

### PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Forms:
  - 1. Recycled Wood, reusable metal, reusable glass fiber, or other approved material that will not adversely affect surface of concrete and will provide or facilitate obtaining specified surface finish.
  - 2. Wood:
    - a. Concealed surfaces:
      - 1) Lumber, No. 2 Common or better, dressed to smooth contact surfaces, or:
      - 2) APA Rated Plyform Class I
    - b. Exposed surfaces: Non absorptive medium density overlay plywood.
  - 3. Metal: Minimum 16 gage steel, tight fitting, stiffened to support concrete.
- B. Architectural Form Liners:
  - 1. Type: to be selected from manufacturer's full range of patterns.

### C. Void Forms:

Local Redevelopment Authority for Roosevelt Roads PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR Integra Design Group Project: 19-1741.0 (Job 162)

- 1. Corrugated paper with wax-coated exterior and uniform cellular configuration.
- 2. Capable of supporting live and dead loads while maintaining full void depth indicated.
- 3. Designed to lose strength upon contact with soil moisture.
- 4. Soil retainers: [1/4 inch thick tempered hardboard] [or] [1-1/2 inch thick, minimum 40 PSI compressive strength extruded polystyrene insulation].
- D. Tubular Forms:
  - 1. Round, spirally wound laminated fiberboard, surface treated with release agent, non reusable.

#### 2.2 ACCESSORIES

- A. Form Ties: Snap off type, adjustable length, [1] inch back break dimension, free of defects that could leave holes larger than [1] inch in concrete.
- B. Form Release Agent: Nonstaining, colorless mineral oil that will not absorb moisture, stain concrete, or impair adhesion of coatings to be applied to concrete.
- C. Construction Joints Forms: Formed galvanized steel, minimum [18] gage, with keyway.
- D. Anchors and Fasteners: Size as required, sufficient strength to maintain forms in place while concrete is placed.

#### PART 3 EXECUTION

#### 3.1 CONSTRUCTION

- A. Construct formwork, shoring, and bracing to produce concrete of required shape, line, and dimension.
- B. Arrange and assemble formwork with minimum joints, located to allow dismantling without damage to concrete.
- C. Make joints watertight.
- D. Provide chamfer strips in corners of forms to produce beveled external corners.
- E. Camber formwork to compensate for deflection during concrete placement.
- F. Adjust supports to take up settlement caused by concrete placement.
- G. Provide temporary openings in formwork to allow cleaning and observation; locate at bottom of forms. Close with tight fitting panels flush with face of forms.
- H. Construct forms for beams and girders so that sides may be removed without disturbing bottom of form or its support.
- I. Clean contact and screed surfaces prior to concrete placement.
- J. Install architectural form liners [at locations indicated on Drawings.]
  - 1. Attach liner to forms before installing form ties.
  - 2. Install liners square in form, with pattern aligned.
  - 3. Seal joints to prevent grout leaks.
  - 4. Dress joints and edges to match liner pattern.
- K. Construction Joints:

- 1. Unless otherwise indicated on drawings, each unit of construction is a single unit; place concrete continuously to provide monolithic construction.
- 2. Obtain Architect's approval of construction joint locations not indicated on Drawings.
- 3. Provide keys and dowels in joints.
- 4. Use construction joint form for joints in floor slabs. Set screed edge at required elevation. Secure to prevent movement.
- L. Form Release Agent:
  - 1. Apply form release agent to formwork prior to placing reinforcing, anchoring devices, and embedded items; follow manufacturer's instructions.
  - 2. Do not allow agent to puddle in forms or to contact hardened concrete against which fresh concrete is to be placed.
- M. Waterstops:
  - 1. Install waterstops at [below-grade joints in concrete.]
  - 2. Install continuously without displacing reinforcement.
- N. Inserts and Embedded Parts:
  - 1. Before concrete is placed, install inserts, anchor slots, anchor bolts, and embedded parts required for attachment of work.
  - 2. Provide formed openings where required for pipes, conduits, sleeves, and other work passing through concrete members.
  - 3. Maintain in position during concrete placement.
- O. Form Removal:
  - 1. Do not remove formwork until concrete has attained sufficient strength to resist dead loads plus applied live loads.
  - 2. Remove formwork in manner that will not damage surfaces of concrete; patch work damaged during form removal operations.
  - 3. Provide shoring, reshoring, and bracing as required.
- P. Installation Tolerances:
  - 1. Construct formwork to maintain tolerances required by ACI 301.
  - 2. Construct formwork for elevator hoistways in accordance with ASME A17.1.

#### SECTION 03 20 00

#### **CONCRETE REINFORCING**

### PART 1 GENERAL

#### 1.1 SUMMARY A. Section

- Section Includes:
  - 1. Reinforcing bars, wire fabric, and accessories for cast-in-place concrete.

#### 1.2 REFERENCES

- A. American Concrete Institute (ACI) 301 Specifications for Structural Concrete for Buildings.
- B. ASTM International (ASTM):
  - 1. A185/A185M Standard Specification for Welded Steel Wire Reinforcement, Plain, for Concrete.
  - 2. A615/A 615M Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 3. A767 Standard Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement.
  - 4. D3963 Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel.
- C. American Welding Society (AWS) D1.4 Structural Welding Code Reinforcing Steel.
- D. Concrete Reinforcing Steel Institute (CRSI):
  - 1. Manual of Practice.
  - 2. Publication 63 Recommended Practice for Placing Reinforcing Bars.
  - 3. Publication 65 Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.

#### 1.3 SUBMITTALS

- A. Submittals for Review:
  - 1. Shop Drawings:
    - a. Include bar sizes, spacings, laps, locations, and quantities of reinforcing bars, wire fabric, and accessories.
    - b. Provide bending and cutting schedules.
    - c. Show complete layout plan for each layer of reinforcing.
- B. Sustainable Design Submittals:
  - 1. Recycled Content.
  - 2. Regional Materials.

### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcing to project site in bundles marked with tags indicating bar size, length, and mark.
- B. Store reinforcing above ground in dry, well drained area; protect from corrosion.

### PART 2 PRODUCTS

2.1 MATERIALS A. Reinford

B.

- Reinforcing Bars:
  - 1. ASTM A615/A615M, deformed billet steel, Grade 60.
- 2. Finish: Plain
- Welded Wire Fabric:
  - 1. ASTM A185/A185M.
  - 2. Finish: Plain.

Local Redevelopment Authority for Roosevelt Roads PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR Integra Design Group Project: 19-1741.0 (Job 162)

#### 2.2 ACCESSORIES

- A. Spacers, Chairs, Bolsters, and Bar Supports:
  - 1. Sized and shaped for strength and support of reinforcement during concrete placement.
  - 2. Galvanized or plastic coated steel for surfaces exposed to weather.
- B. Tie Wire: Annealed steel, minimum 16 gage.

#### 2.3 FABRICATION

- A. Fabricate in accordance with ACI 301 and CRSI Manual.
- B. Bend bars cold; do not heat or bend by makeshift methods. Discard damaged bars.
- C. Welding: AWS D1.4.
- D. Fabrication Tolerances:
  - 1. Sheared length: Plus or minus 1 inch.
  - 2. Bends in stirrups and ties: Plus or minus 1/2 inch.
  - 3. All other bends: Plus or minus 1 inch.

#### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Before placing in work, thoroughly clean reinforcing of loose rust, mill scale, dirt, oil, and other materials that could reduce bonding.
- B. Inspect reinforcing left protruding for future bonding or following delay in work, and clean if necessary.

#### 3.2 INSTALLATION

- A. Install reinforcing in accordance with ACI 301, and CRSI Manual and Publications 63 and 65.
- B. Accurately position reinforcing; securely tie at intersections.
- C. Welding: AWS D1.4.
- D. Install wire fabric reinforcing in longest practical lengths. Offset end laps in adjacent widths to prevent continuous lap.
- E. Do not displace or damage vapor retarder.
- F. Locate splices not indicated on Drawings at points of minimum stress.
- G. Clean and protect surfaces cut or damaged during installation.

### SECTION 03 30 00

# CAST-IN-PLACE CONCRETE

#### PART 1 GENERAL

# **1.01 SECTION INCLUDES**

- A. Concrete building frame members.
- B. Concrete for composite floor construction.
- C. Elevated concrete slabs.
- D. Floors and slabs on grade.
- E. Concrete shear walls, elevator shaft walls, and foundation walls.
- F. Concrete foundations for water storage tank(s).
- G. Joint devices associated with concrete work.
- H. Miscellaneous concrete elements, including equipment pads, light pole bases, flagpole bases, thrust blocks, and manholes.

# **1.02 RELATED REQUIREMENTS**

- A. Section 32 1313 Concrete Paving: Sidewalks, curbs and gutters.
- B. Section 03 1000 Concrete Forming and Accessories: Forms and accessories for formwork.
- C. Section 03 2000 Concrete Reinforcing.
- D. Section 07 9005 Joint Sealers.

### 1.03 REFERENCE STANDARDS

- A. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International; 2006.
- B. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- C. ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete; American Concrete Institute International; 1998 (Reapproved 2004).
- D. ACI 301 Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
- E. ACI 302.1R Guide for Concrete Floor and Slab Construction; American Concrete Institute International; 2004 (Errata 2007).
- F. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- G. ACI 305R Hot Weather Concreting; American Concrete Institute International; 1999.
- H. ACI 308R Guide to Curing Concrete; American Concrete Institute International; 2001.
- I. ACI 318 Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2008.

- J. ACI 347 Guide to Formwork for Concrete; American Concrete Institute International; 2004.
- K. ASTM A 185/A 185M Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- L. ASTM A 497/A 497M Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.
- M. ASTM C 33 Standard Specification for Concrete Aggregates; 2007.
- N. ASTM C 39/C 39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2005.
- O. ASTM C 94/C 94M Standard Specification for Ready-Mixed Concrete; 2007.
- P. ASTM C 143/C 143M Standard Test Method for Slump of Hydraulic-Cement Concrete; 2005a.
- Q. ASTM C 150 Standard Specification for Portland Cement; 2007.
- R. ASTM C 171 Standard Specification for Sheet Materials for Curing Concrete; 2007.
- S. ASTM C 173/C 173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2007.
- T. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete; 2006.
- U. ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2007.
- V. ASTM C 330 Standard Specification for Lightweight Aggregates for Structural Concrete; 2005.
- W. ASTM C 494/C 494M Standard Specification for Chemical Admixtures for Concrete; 2008.
- X. ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2005.
- Y. ASTM C 685/C 685M Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2007.
- Z. ASTM C 881/C 881M Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2002.
- AA. ASTM C 979 Standard Specification for Pigments for Integrally Colored Concrete; 2005.
- BB. ASTM C 1059 Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 1999.
- CC.ASTM C 1107/C 1107M Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2007a.
- DD.ASTM D 994 Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type); 1998 (Reapproved 2003).
- EE. ASTM D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004.

- FF. ASTM E 1155M Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers [Metric]; 1996 (Reapproved 2008).
- GG. ASTM E 1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 1997 (Reapproved 2004).
- HH.COE CRD-C 48 Method of Test for Water Permeability of Concrete; 1992.
- II. COE CRD-C 513 COE Specifications for Rubber Waterstops; Corps of Engineers; 1974.
- JJ. NSF 61 Drinking Water System Components Health Effects; 2007a.

# 1.04 SUBMITTALS

- A. See Section 01 3000 Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.
- C. Samples for Pigment Color Selection: Submit manufacturer's complete sample chip set, including pigment number and required dosage rate for each color.
- D. Verification Samples: Submit sample chips of specified colors indicating pigment numbers and required dosage rates, for subsequent comparison to installed concrete.
- E. Samples: Submit samples of underslab vapor retarder to be used.
- F. Samples: Submit two samples of waterstops and construction joint devices.
- G. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction for concrete accessories.
- H. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

### **1.05 QUALITY ASSURANCE**

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.

# PART 2 PRODUCTS

# 2.01 FORMWORK

A. Comply with requirements of Section 03 1000.

# 2.02 REINFORCEMENT

A. Comply with requirements of Section 03 2000.

# 2.03 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Type I Normal portland type.
  - 1. Acquire all cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.
  - 1. Acquire all aggregates for entire project from same source.
- C. Lightweight Aggregate: ASTM C 330.

- D. Color Additives: Pure, concentrated mineral pigments specifically intended for mixing into concrete and complying with ASTM C 979.
- E. Waterproofing Additive: Crystalline waterproofing intended for mixing into concrete to close concrete pores by growth of crystals, with no decrease in concrete strength or chemical resistance.
  - 1. Permeability of Cured Concrete: No measurable leakage when tested in accordance with COE CRD-C 48 at 350 feet of head; provide test reports.
  - 2. Potable Water Contact Approval: NSF certification for use on structures holding potable water, based on testing in accordance with NSF 61.
  - 3. Manufacturers:
    - a. Aquafin, Inc: www.aquafin.net.
    - b. Xypex Chemical Corporation: www.xypex.com.
    - c. Substitutions: See Section 01 6000 Product Requirements.
    - F. Water: Clean and not detrimental to concrete.

# 2.04 CHEMICAL ADMIXTURES

- A. Air Entrainment Admixture: ASTM C 260.
- B. High Range Water Reducing and Retarding Admixture: ASTM C 494/C 494M Type G.
- C. High Range Water Reducing Admixture: ASTM C 494/C 494M Type F.
- D. Water Reducing and Accelerating Admixture: ASTM C 494/C 494M Type E.
- E. Water Reducing and Retarding Admixture: ASTM C 494/C 494M Type D.
- F. Accelerating Admixture: ASTM C 494/C 494M Type C.
- G. Retarding Admixture: ASTM C 494/C 494M Type B.
- H. Water Reducing Admixture: ASTM C 494/C 494M Type A.

# 2.05 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E 1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single ply polyethylene is prohibited.
- B. Non-Shrink Grout: ASTM C 1107/C 1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
  - 1. Minimum Compressive Strength at 48 Hours: 2,400 psi.
  - 2. Minimum Compressive Strength at 28 Days: 7,000 psi.
- C. Moisture-Retaining Cover: ASTM C 171; regular curing paper, white curing paper, clear polyethylene, white polyethylene, or white burlap-polyethylene sheet.
- D. Liquid Curing Compound: ASTM C 309, Type 1, clear or translucent.

# 2.06 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-dispersible acrylic latex, complying with ASTM C 1059 Type II.
- B. Epoxy Bonding System: Complying with ASTM C 881/C 881M and of Type required for specific application.
- C. Waterproofing Admixture Slurry: Slurry coat of portland cement, sand, and crystalline waterproofing additive, mixed with water in proportions recommended by manufacturer to achieve waterproofing at cold joints in concrete.
  - 1. Manufacturers:
    - a. Xypex Chemical Corporation: www.xypex.com.
    - b. Substitutions: See Section 01 6000 Product Requirements.
- D. Waterstops: Rubber, complying with COE CRD-C 513.
  - 1. Configuration: As indicated on the drawings.
  - 2. Size: As indicated on the drawings.
- E. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement.
  - 1. Size: As indicated on drawings.
- F. Joint Filler: Nonextruding, resilient asphalt impregnated fiberboard or felt, complying with ASTM D 1751, 1/4 inch thick and 4 inches deep; tongue and groove profile.
- G. Joint Filler: Compressible asphalt mastic with felt facers, complying with ASTM D 994, 1/4 inch thick and 4 inches deep.
- H. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with minimum 1 inch diameter holes for conduit or rebars to pass through at 6 inches on center; ribbed steel stakes for setting.
  - 1. Provide removable plastic cap strip that forms wedge-shaped joint for sealant installation.
  - 2. Height: To suit slab thickness.
- I. Sealant and Primer: As specified in Section 07 9005.

### 2.07 CONCRETE MIX DESIGN

- A. Concrete Mix Design shall be as specified in Construction Drawings and the following recommendations.
- B. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- C. Proportioning Structural Lightweight Concrete: Comply with ACI 211.2 recommendations.
- D. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
  - 1. For trial mixtures method, employ independent testing agency acceptable to Integra Architects & Engineers, PSC for preparing and reporting proposed mix designs.
- E. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

#### 2.08 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C 685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
  - 1. Colored Concrete: Add pigments in strict accordance with manufacturer's instructions to achieve consistent color from batch to batch.
- B. Transit Mixers: Comply with ASTM C 94/C 94M.

#### **PART 3 EXECUTION**

#### 3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

#### 3.02 PREPARATION

- A. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
  - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
  - 2. Use latex bonding agent only for non-load-bearing applications.
- B. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
- C. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- D. Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches and seal watertight by taping edges and ends. Cover with sand to depth shown on drawings; repair damaged vapor retarder before covering.

#### 3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Integra Architects & Engineers, PSC not less than 24 hours prior to commencement of placement operations.
- D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

- E. Repair underslab vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.
- F. Separate slabs on grade from vertical surfaces with joint filler.
- G. Place joint filler in floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- H. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface. Conform to Section 07 9005 for finish joint sealer requirements.
- Install joint devices in accordance with manufacturer's instructions. I.
- Install construction joint devices in coordination with floor slab pattern placement sequence. J. Set top to required elevations. Secure to resist movement by wet concrete.
- K. Install joint device anchors for expansion joint assemblies specified in Section 07 9513. Maintain correct position to allow joint cover to be flush with floor and wall finish.
- L. Apply sealants in joint devices in accordance with Section 07 9005.
- M. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- N. Place concrete continuously between predetermined expansion, control, and construction joints.
- Do not interrupt successive placement; do not permit cold joints to occur.
- P. Place floor slabs in checkerboard or saw cut pattern indicated.
- Q. Saw cut joints within 24 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.
- R. Screed floors level, maintaining surface flatness of maximum 1/4 inch in 10 ft.

# 3.04 SEPARATE FLOOR TOPPINGS

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
- B. Place required dividers, edge strips, reinforcing, and other items to be cast in.
- C. Apply bonding agent to substrate in accordance with manufacturer's instructions.
- D. Place concrete floor toppings to required lines and levels.
  - 1. Place topping in checkerboard panels not to exceed 20 ft in either direction.
- E. Screed toppings level, maintaining surface flatness of maximum 1:1000.

# **3.05 CONCRETE FINISHING**

- Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:

- 1. Wood float surfaces that will receive quarry tile, ceramic tile, and terrazzo with full bed setting system.
- 2. Steel trowel surfaces that will receive carpeting, resilient flooring, seamless flooring, thin set quarry tile, and thin set ceramic tile.
- 3. Steel trowel surfaces that will be left exposed.
- D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

# **3.06 CURING AND PROTECTION**

- A. Comply with requirements of ACI 308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
  - 1. Normal concrete: Not less than 7 days.
- C. Surfaces Not in Contact with Forms:
  - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
  - 2. Final Curing: Begin after initial curing but before surface is dry.
    - a. Moisture-Retaining Cover: Seal in place with waterproof tape or adhesive.
    - b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

# 3.07 FIELD QUALITY CONTROL

- A. An independent testing agency provided and paid by the Contractor will perform field quality control tests, as specified in Section 01 4000.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- E. Compressive Strength Tests: ASTM C 39/C 39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
- F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C 143/C 143M.

# **3.08 DEFECTIVE CONCRETE**

- A. Test Results: The testing agency shall report test results in writing to Integra Architects & Engineers, PSC and within 24 hours of test.
- B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Integra Architects & Engineers, PSC. The cost of additional testing shall be borne by when defective concrete is identified.

#### SECTION 03 35 00

#### **CONCRETE FINISHING**

#### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Finishing concrete slabs and formed surfaces.
  - 2. Floor sealer.
  - 3. Colored, Patterned and Sandblasted concrete finish.
- B. Related Sections:
  - 1. Section 03 3000 Cast-In-Place Concrete.

### 1.2 REFERENCES

- A. American Concrete Institute (ACI):
  - 1. 301 Structural Concrete for Buildings.
  - 2. 302.1 Guide for Concrete Floor and Slab Construction.
- B. ASTM International (ASTM):
  - 1. C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
  - 2. E1155 Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound Units).

#### 1.3 DEFINITIONS

- A. Specified Overall Value (SOV): Describes the flatness or levelness value which must be achieved when all measured values of that type on a given Test Surface are combined.
- B. Minimum Local Value (MLV): Describes the flatness or levelness value below which repair or replacement is required and applies to Minimum Local Area.
- C. Minimum Local Area (MLA): An area bounded by construction or contraction joints or by column lines or half-column lines, whichever is smaller; no boundary crosses a construction joint or expansion joint.
- D. Level: Horizontal, normal to the direction of gravity. An envelope is defined by 2 level lines which are separated by stated distances.

### 1.4 SUBMITTALS

A. Submittals for Review:1. Product Data: Descriptive data for sealer.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum 2 years experience in work of this Section.
- B. Concrete Mix Design: Free from admixtures and additives not specifically approved by colorant manufacturer.

- C. Mockup:
  - 1. Size: 4 x 8 feet.
  - 2. Show: Exposed aggregate, Colored, Patterned and Sandblasted concrete joint profile.
  - 3. Locate where directed.
  - 4. Approved mockup may remain as part of the Work.

# PART 2 PRODUCTS

- 2.1 MATERIALS
  - A. Concrete Materials: Specified in Section 03 3000.
  - B. Dry-Shake Colorant: to be selected from manufacturer's standards.
  - C. Concrete Stain:
    - 1. Source: to be selected from manufacturer's standards.
  - D. Colored Curing Compound:
    - 1. Type recommended by colorant manufacturer, colored to match.
  - E. Floor Sealer:
    - 1. Type: ASTM C309, water based, acrylic copolymer resin.
    - 2. Source: or approved substitute.

\*\*\*\* OR \*\*\*\*

- F. Floor Sealer/Hardener:
  - 1. Type: Water soluble, magnesium-flurosilicate based, reactive with free lime in concrete, nonfilm forming.] [Water soluble, sodium-silicate based, free from residues.] [Water soluble, inorganic silicate based.
  - 2. Source: to be selected from manufacturer's standards.

### 2.2 MIXES

- A. Patching Mortar:
  - 1. Use same proportions as concrete except omit coarse aggregate.
  - 2. Add minimum water required for handling and placing.
- B. Mortar Slurry: 1 part Portland cement and 1-1/2 part damp, loose sand, by volume.

### PART 3 EXECUTION

- 3.1 FINISHING FORMED SURFACES
  - A. Concealed Surfaces: Leave texture imparted by forms.
  - B. Exposed Surfaces:
    - 1. While concrete is still green, patch voids over 1/2 inch in diameter or depth.
    - 2. Chip away defective concrete; form edges perpendicular to surface. Wet area to be patched with clean water.
    - 3. Apply bonding agent in accordance with manufacturer's instructions.

Local Redevelopment Authority for Roosevelt	PAVEMENT REHABILITATION AT ROOSEVELT	Integra Design Group
Roads	ROADS RE-DEVELOPMENT	Project: 19-1741.0 (Job
	Ceiba, PR	162)

- 4. Press mortar into place; strike off slightly higher than surrounding surface. Allow initial shrinkage to occur before finishing.
- 5. Finish to match texture and color of adjacent surfaces.
- 6. Remove fins and other protrusions by rubbing with carborundum stone while concrete is still green.

#### \*\*\*\* OR \*\*\*\*

- C. Exposed Surfaces:
  - 1. While concrete is still green, patch voids over ½ inch in diameter or depth.
  - 2. Chip away defective concrete; form edges perpendicular to surface. Wet area to be patched with clean water.
  - 3. Apply bonding agent in accordance with manufacturer's instructions.
  - 4. Press mortar into place; strike off slightly higher than surrounding surface. Allow initial shrinkage to occur before finishing.
  - 5. Finish to match texture and color of adjacent surfaces.
  - 6. Remove fins and other protrusions by rubbing with carborundum stone while concrete is still green.
  - 7. After patching and while concrete is still green, spread mortar slurry over dampened surface.
  - 8. Apply using burlap pads or sponge rubber floats. Remove surplus material, then rub with clean burlap.
  - 9. Keep surfaces damp for 7 days minimum.

#### 3.2 FINISHING INTERIOR FLOOR SURFACES

A. Finish concrete floor surfaces in accordance with ACI 301 and ACI 302.1.

# DIVISION 31 EARTHWORKS

Local Redevelopment Authority for Roosevelt Roads PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR Integra Design Group Project: 19-1741.0 (Job 162)

#### SECTION 31 11 00

#### **CLEARING AND GRUBBING**

#### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Removal of surface debris, paving and curbs.
  - 2. Removal of plant life and grass.
  - 3. Grubbing roots.
  - 4. Topsoil excavation.
- B. Related Sections:
  - 1. Division 01: Administrative, procedural, and temporary work requirements.
  - 2. Section 31 2200 Grading.

#### PART 2 PRODUCTS

Not used

#### PART 3 EXECUTION

- 3.1 SITE CLEARING
  - A. Remove vegetation, debris, and obstructions from areas of structures, walks, paving and planting beds.
  - B. Apply herbicide to remaining stumps and plant life to inhibit growth.
  - C. Strip existing topsoil from areas of structures, walks, and paving. Stockpile on site for reuse as needed as specified in Section 31 2200 or remove from site.
  - D. Grub out roots and underground obstructions to minimum depth of 12 inches.
  - E. Remove waste material from site as it accumulates. Comply with applicable codes and ordinances regarding waste transportation and disposal.

#### SECTION 31 13 00

#### SELECTED TREE AND SHRUB REMOVAL AND TRIMMING

#### PART 1 - GENERAL

- 1.1 SCOPE
  - A. Work includes the felling or removal by tree spade of trees or larger shrubs designated in the contract to be removed from the project site, and related work as indicated in the drawings.

#### 1.2 RELATED WORK

- A. Applicable provisions of Division 1 shall govern all work under this section.
- B. Dimensions: Tree caliper measurements shall be taken 54" (1.4 m) above ground level.
- C. Related Work Specified Elsewhere:
  - 1. Section 32 96 00 Transplanting
  - 2. Section 32 93 00 Plants

#### 1.3 REFERENCES

A. Tree limbs shall be pruned according to current American National Standards for Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance-Standard Practices.

### PART 2 - PRODUCTS

### 2.1 MATERIALS

A. As specified on drawings.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Mechanical diggers shall be in good operating condition, with properly aligned, sharpened and damage-free blades. Hydraulic systems shall be free of leaks.
- B. For trees up to 10" (25.4 cm) caliper, the tree spade size used should allow a minimum root area equivalent of 9-10" (22.9-25.4 cm) of soil per inch of trunk diameter. (Example: A 4" caliper tree should be dug with a 40" tree spade.)

### 3.2 FELLING

A. Fell trees to prevent damage to adjacent structures and to those trees and shrubs designated to remain. Remove stumps and roots to a clear depth of 36" (0.9 m) below existing grades in areas of lawn, and to full depth in areas of paving, building footings, or utility structures.

### 3.3 PRUNING

- A. Only those branches of existing trees that interfere in some way with the Contractor's operations, or with the spading operation are to be pruned.
- B. Pruning shall be performed by a certified arborist or tree surgeon.
- C. Where necessary, repairs to damaged wood shall be performed under the direction of the Owner, or a certified arborist.
- D. Evergreens shall only be pruned to remove dead, broken or damaged branches.
- E. Perform pruning using scissors-style cutting devices, and not anvil-style handpruners, pole pruners or loppers.

#### 3.4 DIGGING

- A. To minimize soil compaction, damage from tires, etc., the Contractor shall lay down wood planking as surface protection during tree spade operations.
- B. In preparing a tree for removal by tree spade, branches are to be tied up or down to allow access by spade. Presoaking the area around the tree for 24-48 hours prior to removal is advisable. Two to three hours prior to transplanting spray tree to run-off with an approved anti-transpirant at a 1:10 dilution rate.
- C. Remove weeds and excess topsoil from the rootball prior to removal. Match the size of the rootball with the hole dug for transplanting.
- D. Spade blades are to be dropped one at a time, alternating one side with the other to ensure even penetration. After lifting tree, cut any roots protruding from spades with sharp hand tools.

#### 3.5 TRANSPORT

A. Prior to transporting, wrap tarp around both the upper portion of tree to prevent moisture loss from leaves and stems and around the bottom of the rootball.

### 3.6 CLEANING

A. All trimmed branches and other debris shall be removed from the site by the Contractor at the end of each work day.

### **SECTION 31 22 00**

#### GRADING

#### PART 1 **GENERAL**

#### 1.1 SUMMARY

- A. Section Includes:
  - Cutting and grading of site. 1.
  - 2. Topsoil placement.
- B. Related Sections:
  - 1. Division 01: Administrative, procedural, and temporary work requirements.
  - 2. Section 31 1100 - Clearing and Grubbing.

#### SUBMITTALS 1.2

- A. Submittals:
  - Fill Material classification and origin. 1.

#### PART 2 PRODUCTS

#### MATERIALS 2.1

- Α. Topsoil:
  - Stockpiled on site material, specified in Section 31 1100 [supplemented by off site material if 1. required].
  - 2. Off site materials: Natural friable loam of region, free of clay, toxic substances, large or matted roots, debris, excess weeds, and rocks over 1 inch in any dimension.

#### PART 3 EXECUTION

- CUTTING AND GRADING 3.1
  - Α. Excavate subsoil to permit placement of structures, paving, and site improvements, and from areas to be regraded.
  - В. Uniformly grade areas to smooth surface at required grades and elevations. Adjust contours to eliminate water ponding and provide positive drainage. Make grade changes gradually. Blend slopes into level areas.
  - C. Leave areas to receive topsoil 4 inches below final required grade.
  - D. Tolerances: Within plus or minus 1 inch of required subgrade elevation.

#### 3.2 TOPSOIL PLACEMENT

- Place topsoil to 4 inch depth over areas modified by work of this Contract that are not covered by Α. planting beds, structures or paving.
- Β. Uniformly distribute to required grades; feather back to where grades remain unchanged.

- C. Uniformly grade areas to smooth surface at required grades and elevations. Adjust contours to eliminate water ponding and provide positive drainage. Make grade changes gradually. Blend slopes into level areas.
- D. Remove rubbish, debris, vegetation, and concentrations of rocks. Rake areas smooth; leave suitable for seeding or sodding.
- 3.3 CLEANING
  - A. Remove surplus materials and those not suitable for reuse from site.

#### 3.4 PROTECTION

- A. Protect graded areas from traffic and erosion; keep free of trash and debris.
- B. Repair settled, eroded, or rutted areas.

#### SECTION 31 23 00

#### **EXCAVATION AND FILL**

#### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Excavating for structures and site components.
  - 2. Filling.
  - 3. Trenching.
  - 4. Backfilling.
- B. Related Sections:
  - 1. Division 01: Administrative, procedural, and temporary work requirements.

#### 1.2 REFERENCES

- A. ASTM International (ASTM):
  - 1. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>) (600 kN-m/m<sup>3</sup>).
  - 3. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>).
  - 4. D2487 Standard Classification of Soils for Engineering Purposes.
  - 5. D2922 Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 6. D4254 Standard Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.
  - 7. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

#### 1.3 SYSTEM DESCRIPTION

- A. Limits of Work: Do not extend earthwork beyond areas of excavation or construction shown on Drawings or reasonably necessary for performance of Work.
- B. Contractor is responsible for design of temporary earth retention systems.

### 1.4 SUBMITTALS

- A. Submittals:
  - 1. Fill Material classification and origin.

#### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Engineered Fill:
  - 1. Type: Granular Material
  - 2. Tested to ASTM D4318, classified as Type GC in accordance with ASTM D2487 and Type A-2-4 in accordance with AASHTO.
  - 3. Free from trash, debris, roots over 1 inch in diameter, matted roots, rocks over 3 inches in diameter, topsoil, and other deleterious matter.

#### 2.2 SOURCE QUALITY CONTROL

- Α. Testing and Inspection Services: Test Engineered Fill prior to placement:
  - Liquid limit, plastic limit, and plasticity index: Test to ASTM D4318. 1.
  - 2. Moisture/density relationship: Test to ASTM D698.
  - 3. Provide soil description; determine compliance with gradation and quality requirements.

#### PART 3 **EXECUTION**

#### 3.1 **EXCAVATING**

- Α. Excavate to grades and subgrades indicated. Make excavations large enough to permit placing and inspection of work.
- Β. Stockpile excavated materials that are suitable for reuse separately from subgrade material.
- C. Remove and dispose of excavated material that is unsuitable or not required for backfilling. Remove underground obstructions.
- D. Brace sides of excavations where necessary; maintain until permanent construction is in place. Remove temporary shoring and bracing as backfill is placed.
- E. Excavation for Structures:
  - 1. Form bottoms of excavations reasonably level.
  - 2. Maintain moisture level in excavations as near their natural level as possible.
- F. Correct over-excavation under footings by use of lean concrete. Correct other over-excavation by use of Engineered Fill, compacted to density of existing subgrade.
- G. Keep excavations free of water.

#### 3.2 FILLING

- A. Prior to placing fill on existing subsoils:
  - Proof roll to detect soft and weak zones. Remove soft and spongy soils down to firm subsoil. 1.
  - 2. Replace undercut areas with Engineered Fill placed in maximum 12 inch deep loose, even, horizontal lifts. Compact each lift to 95 percent of ASTM D1557 modified Proctor maximum dry density.
- Β. Fill low areas outside of structures and under paving with Engineered Fill to achieve required grades and elevations.
  - 1. Place fill in maximum 12 inch deep loose, even, horizontal lifts.
  - 2. Compact each lift to 95 percent of ASTM D1557 modified Proctor maximum dry density.
- C. Fill under structures with Engineered Fill.
  - Place fill in maximum 12 inch deep loose, even, horizontal lifts. 1.
  - 2. Compact each lift to 95 percent of ASTM D1557 modified Proctor maximum dry density.
- D. Do not fill over porous, wet, frozen, or soft subgrades.
- Ε. Bench fill into slopes.
- F. When moisture must be added to aid in compaction, uniformly apply water to surface, but do not flood. Free water shall not appear on surface during or after compaction operations.

- G. Scarify soil too wet for proper compaction and allow to dry. Replace and recompact.
- H. Uniformly grade areas to smooth surface at required grades and elevations. Adjust contours to eliminate water ponding and provide positive drainage. Make grade changes gradually. Blend slopes into level grades.
- I. Tolerances: Within plus or minus 1 inch of required subgrade elevation.

#### 3.3 TRENCHING

- A. Cut trenches sufficiently wide to allow for installation of utilities and for inspection of work.
- B. Hand trim excavations; remove loose matter.
- C. Remove rocks and obstructions.
- D. Correct over-excavation by use of lean concrete or pipe bedding material.
- E. Keep trenches free of water.

#### 3.4 BACKFILLING

- A. Backfill under structures with Fill material AASHTO A-2-4.
  - 1. Place backfill in loose, even, horizontal lifts maximum 12 inches deep.
  - 2. Compact each lift to 95 percent of ASTM D1557 modified Proctor maximum dry density.
- B. Backfill outside of structures and under paving with Fill material AASHTO A-2-4.
  - 1. Place backfill in loose, even, horizontal lifts maximum 12 inches deep.
  - 2. Compact each lift to 95 percent of ASTM D1557 modified Proctor maximum dry density. .

#### 3.5 FIELD QUALITY CONTROL

- A. Testing and Inspection Services: Perform field in place density tests, ASTM D2922, at following rates; minimum of three tests for each lift or area:
  - 1. Under structures: One test for each 270 square feet, per lift.
  - 2. Under paving: Minimum two tests for each paved area, or every 10,000 square feet.
  - 3. Trenches, below grade walls, retaining walls, grade beam backfill: One test for the first 100 linear feet, per lift, then one test every 250 linear feet, per lift.

# 3.6 CLEANING

A. Remove surplus materials and those not suitable for reuse from site.

### 3.7 PROTECTION

A. Protect graded areas from traffic and erosion; keep free of trash and debris.

#### **SECTION 31 23 16**

#### TRENCHING FOR SITE UTILITIES

#### PART 1 GENERAL

#### 1.01 SECTION INCLUDES:

A. Backfilling and compacting for utilities outside the building to utility main connections.

#### 1.02 RELATED SECTIONS

A. Section 31 22 00 - Grading: Site grading.

B. Section 31 23 00 - Excavation: Building and foundation excavating and backfilling at building and foundations

#### 1.03 REFERENCES

- A. AASHTO T 180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2001 (2004).
- B. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates;

2006. C. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of

Soil Usina

Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2000a.

D. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2000.

E. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using

Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2002.

F. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994(R 2001).

G. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified

Soil Classification System); 2000.

H. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by I. Nuclear

Methods (Shallow Depth); 2005.

J. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils: 2005.

#### 1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

### 1.05 SUBMITTALS

- A. Materials Sources: Submit name of imported materials source.
- B. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- C. Compaction Density Test Reports.

#### 1.06 PROJECT CONDITIONS

- A. Provide sufficient quantities of fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where indicated.
  - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
  - 2. Prevent contamination.
  - 3. Protect stockpiles from erosion and deterioration of materials.
- C. Verify that survey bench marks and intended elevations for the Work are as

indicated.

- D. Protect plants, lawns, rock outcroppings, and other features to remain.
- E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

# PART 2 PRODUCTS

#### 2.01 FILL MATERIALS

- A. General Fill Fill Type A-2-4: Imported borrow.
  - 1. Graded.

2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.

- B. Granular Fill Gravel Fill Type A-1: Pit run washed stone; free of shale, clay, friable material and debris.
- C. Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
- D. Topsoil: See Section 32 91 13.
- E. Topsoil: Topsoil excavated on-site.
1. Free of roots, rocks larger than 1/2 inch (12 mm), subsoil, debris, large weeds and foreign matter.

#### 2.02 SOURCE QUALITY CONTROL

- A. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided before delivery to site.
- B. If tests indicate materials do not meet specified requirements, change material and

retest.

C. Provide materials of each type from same source throughout the Work.

#### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.

#### 3.02 TRENCHING

- A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet (1.2 meters) to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.
- G. Remove excavated material that is unsuitable for re-use from site.
- H. Stockpile excavated material to be re-used in area designated on site.
- I. Remove excess excavated material from site.

#### 3.03 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill

material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

#### 3.04 BACKFILLING

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- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 12 inches compacted depth.

- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 12 inches compacted depth.
- Η. Slope grade away from building minimum 2 inches in 10 ft (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- Ι. Correct areas that are over-excavated.
  - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- Compaction Density Unless Otherwise Specified or Indicated: J.
  - Under paving, slabs-on-grade, and similar construction: 95 percent of maximum 1. dry density.
  - 2. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.

#### 3.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Utility Piping, Conduits, Duct Bank:
  - 1. Bedding: Use sand.
  - 2. Cover with general fill.
  - 3. Fill up to subgrade elevation.
  - 4. Compact in maximum 8 inch (200 mm) lifts to 95 percent of maximum dry density.
- C. At Pipe Culverts:
  - 1. Bedding: Use sand.
  - 2. Place filter fabric if specified over compacted bedding.
  - 3. Cover with general fill.
  - 4. Fill up to subgrade elevation.
  - Compact in maximum 8 inch (200 mm) lifts to 95 percent of maximum dry 5. density.

#### 3.06 TOLERANCES

#### A. Top Surface of General Backfilling: Plus or minus 1 inch (25 mm) from required

elevations.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.

#### 3.07 FIELD QUALITY CONTROL

- A. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D2922, or ASTM D3017.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.08 CLEAN-UP

- A. Leave unused materials in a neat, compact stockpile.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

#### **SECTION 31 25 00**

#### **EROSION AND SEDIMENTATION CONTROLS**

#### **PART 1 GENERAL**

#### **1.1 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Society for Testing and Materials (ASTM):
    - a. D1682, Breaking Load and Elongation of Textile Fabrics.
    - b. D3776, Mass Per Unit Area (Weight) of Woven Fabric.
    - c. D3786, Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics-Diaphragm Bursting Strength Tester Method.
    - d. D4355, Deterioration of Geotextiles from Exposure to Ultraviolet LightC and Water (Xenon-Arc Type Apparatus).
    - e. D4632, Grab Breaking Load and Elongation of Geotextiles.

#### **1.2 DEFINITIONS**

A. N/A

#### **1.3 SUBMITTALS**

- A. Administrative Submittal: Sub-schedule of drainage, erosion, and sedimentation control.
- B. Shop Drawings:
  - 1. Product Data: Commercial products.
- C. Quality Control Submittals:
  - 1. Construction Period Drainage and Erosion/Sedimentation Control Plan and Procedures.
  - 2. Manufacturer's Installation Instructions: Commercial products.

#### **1.4 DELIVERY, STORAGE, AND PROTECTION**

#### **1.5 SEQUENCING AND SCHEDULING**

- A. ENGINEER's acceptance of Construction Period Erosion/Sedimentation Control Plan required prior to starting earth disturbing activities.
- B. Notify ENGINEER at least 3 days in advance of:
  - 1. Materials delivery.
  - 2. Start of control activities.

#### **1.6 MAINTENANCE**

- A. Operations:
  - 1. Inspect, repair, and replace as necessary all erosion control measures during the time period from start of construction to completion of construction.

#### PART 2 PRODUCTS

#### 2.1 EROSION CONTROL MATTING

#### 2.2 REINFORCED PLASTIC COVERING

- A. Co-extruded, copolymer laminate reinforced with a nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.
- B. Black in color and ultraviolet stabilized.
- C. Physical Requirement (Minimum Average Roll Values):
  - 1. Tear Strength: 130 pounds.
  - 2. Elongation: 620 percent.
- D. Manufacturers:
  - 1. Reef Industries, Inc., Houston, TX.
  - 2. Griffolyn Co., Houston, TX.

#### 2.3 CLEARING LIMIT FENCE

- A. Ultraviolet stabilized polyethylene or polypropylene safety fence, 3 feet in height, and yellow or orange in color.
- B. Pervious Sheet: Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
  - 1. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
  - 2. Material Edges: Finish so that filaments retain their relative positions under stress.
- C. In accordance with requirements of Table No. 1:

Table No. 1 - Filter Fence				
	Required			
Physical Property	Value	Test Method		
Weight, pz/sq yd, min.	4	ASTM D3776		
Equivalent Opening Size, max.	50-70	U.S. Standard Sieve		
Grab Tensile Strength, lb, min.	160	ASTM D4632		
Elongation, % max.	25	ASTM D1682		
Mullen Burst Strength, psi, min.	350	ASTM D3786		
Ultraviolet Radiation Resistance, %	70	ASTM D4355		
Strength Retention				

- D. Manufacturers:
  - 1. Polyfelt, Evergreen, AL.
  - 2. Dupont Co., Wilmington, DE.

ROADS RE-DEVELOPMENT Ceiba, PR

3. Mirafi, Inc., Charlotte, NC.

#### 2.4 SUPPORT FENCE

- A. Wire Mesh Material: As recommended by manufacturer of geotextile; strong enough to support applied loads.
- B. Support Posts: As recommended by manufacturer of geotextile.
- C. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

#### 2.5 STRAW BALES

A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

#### 2.6 POSTS FOR STRAW BALES

A. 2-inch by 2-inch untreated wood or commercially manufactured metal posts.

#### PART 3 EXECUTION

#### 3.1 CLEARING LIMIT FENCE

A. Install in accordance with manufacturer's standard instructions and before beginning clearing and grubbing operations.

#### 3.2 SUPPORT FENCE AND GEOTEXTILE

- A. Install prior to starting earth disturbing activities upslope of fence.
- B. One-piece geotextile or continuously sewn to make one-piece geotextile for full height of the fence, including portion buried in the toe trench.
- C. When joints are necessary, splice geotextile together only at a support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.
- D. Geotextile shall not extend more than 24 inches above the ground surface. Securely fasten to upslope side of each support post using ties. Geotextile shall not be stapled to existing trees.
- E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 inches, and not more than 36 inches above the ground surface.
- F. Take precaution not to puncture geotextile during installation. Repair or replace damaged area.
- G. Remove support fence for geotextile after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the geotextile fence has been removed to conform to existing grade. Prepare and seed graded area.

#### **3.3 SOIL STOCKPILES**

A. Protect from erosion with geotextile and support fence.

#### 3.4 STRAW BALES

- A. Embed minimum of 4 inches in flat-bottomed trench.
- B. Place with ends tightly abutting or overlapped. Corner abutment is not acceptable.
- C. Install so that bale bindings are oriented around the sides and not over the top and bottom of the bale.
- D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.
- E. Wedge loose straws in any gaps between bales.

#### 3.5 FIELD QUALITY CONTROL

A. Upon completion of maintenance period and on written notice from CONTRACTOR, ENGINEER will, within 15 days of receipt, determine if a satisfactory stand has been established.

#### **END OF SECTION**

# **PRHTA SPECIFICATIONS**

PAVEMENT REHABILITATION AT ROOSEVELT ROADS RE-DEVELOPMENT Ceiba, PR

# SPECIFICATION 212–RECONDITIONING OF SHOULDERS AND DITCHES

# 212-1 DESCRIPTION

#### 212-1.01 Scope

a. This work shall consist of the reconditioning and reshaping of existing earth shoulders, ditch slopes and ditches in accordance with these specifications and in conformity with the locations, lines, grades, dimensions and sections shown in the contract documents or established by the Engineer.

b. The work includes performing any clearing and grubbing, excavation work, and removal and disposal of excess material and debris necessary to carry out the reconditioning and reshaping work within the designated shoulder, ditch slope and ditch area.

c. The work also includes the furnishing, placing and compacting of any material necessary to complete the reconditioning and reshaping work to the lines, grades and sections indicated in the contract documents or established by the Engineer.

# 212-2 MATERIALS

**212-2.01** Material required to bring the shoulders to the specified dimensions, grade and shape shall be a granular soil classifiable as A-1, A-3, A-2-4, or A-2-5 under AASHTO M 145 but which shall be free of stones or rock fragments larger than 5 centimeters in their greatest dimension.

**212-2.02** Any backfill material needed for the reconditioning and reshaping of the ditch slopes and ditches may be excess non-organic soil resulting from the excavation work which is acceptable to the Engineer or a borrow similar to the in-place material.

# SPECIFICATION 212–RECONDITIONING OF SHOULDERS AND DITCHES

# 212-3 CONSTRUCTION REQUIREMENTS

**212-3.01** Clearing and grubbing of the existing shoulders, ditch slopes and ditches shall be performed in accordance with the requirements of Specification 201 - Clearing and Grubbing.

**212-3.02** After clearing and grubbing, the shoulders, ditch slopes and ditches shall be finished by means of suitable grading equipment and, where necessary, by hand tools, to the required shape and cross section.

**212-3.03** All debris and excess excavation material shall be disposed of by the Contractor, at his expense, at acceptable locations outside the project limits in accordance with all applicable local, Commonwealth and Federal regulations.

**212-3.04** Shoulders shall be brought to the required dimensions, grade and shape placing, as necessary, the specified shoulder material, and compacted with suitable power rollers to a firm and dense condition. Water shall be applied as needed during the compaction operations.

**212-3.05** The completed work shall be uniform in appearance and in substantial conformance with the specified cross sections and grades.

# 212-4 METHOD OF MEASUREMENT

**212-4.01** The quantity of reconditioning of shoulders and ditches to be paid for shall be the actual length in kilometers, measured horizontally to the nearest meter, completed and accepted by the Engineer.

a. The pay unit includes the complete section of shoulder, ditch slope and ditch on one side of the road. Each side of the road will be measured independently. Measurement shall be along the project centerline.

# SPECIFICATION 212–RECONDITIONING OF SHOULDERS AND DITCHES

b. Sections where no work on reconditioning of shoulder and ditches is performed such as where there are existing curbs and sidewalks, will be considered exceptions and will not be included in the measurement; however, intersecting roads and driveways will not be considered exceptions.

c. Additional length of shoulder and ditch reconditioning due to intersection returns, tapers, driveways and irregular areas will not be separately measured for payment but shall be considered subsidiary to the centerline measurement provided herein.

d. When the placement, shaping and compacting of earth behind newly constructed curbs is required, such earthwork will be included in the measured length of shoulder and ditch reconditioning.

**212-4.02** No separate measurement and payment will be made for clearing and grubbing, excavation work, disposal of debris and excess material, the furnishing and placing of any required borrow material, watering and compaction as all this work is subsidiary to the pay items for reconditioning of shoulders and ditches.

# 212-5 BASIS OF PAYMENT

**212-5.01** The length of reconditioned shoulders and ditches, determined as provided above, will be paid for at the contract unit price. Such price and payment shall be full compensation for furnishing all the materials, equipment, tools, labor and incidentals necessary to complete all the work as required by the contract documents.

**212-5.02** Payment will be made under:

Pay Item

<u>Pay Unit</u>

Reconditioning of Shoulders and Ditches..... Kilometer

#### **304-1 DESCRIPTION**

**304-1.01** Scope - The work shall consist of furnishing, placing and compacting one or more courses of aggregate base and filler, if required, on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

#### 304-2 MATERIALS

#### 304-2.01 Aggregate

a. The aggregate for base course shall consist of hard, durable particles of crushed or natural gravel or crushed stone meeting the requirements of Section 703-4 of Specification 703 - Aggregates.

b. The aggregate shall meet any of the gradings given in Table 703-4 under Section 703-4 of Specification 703 – Aggregates, unless a specific grading is called for in the contract documents.

c. If filler material in addition to that present in the aggregate is necessary for meeting the grading requirement or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the screening and crushing plant or on the road.

#### **304-2.02** Sampling and Testing

a. The Contractor shall advice the Engineer as to the exact location of the source of aggregates which he proposed to use. It shall be the Contractor's responsibility to ascertain that the materials from such source meet the specification requirements. The Engineer will take random samples of materials incorporated into the project in its final position after the material has been compacted to specification

requirements for testing for conformance with the specified quality and grading requirements. The sampling frequency for the aggregate base course will be as follows:

> 1. A sample shall be obtained at random for every 200 cubic meters of the in-place aggregate base course material incorporated into the project so as to verify its compliance with the grading requirements included in this specification.

> 2. Additionally, a sample shall be obtained at random for every 5,000 cubic meters of the in-place aggregate base course material incorporated into the project so as to verify its compliance with the quality requirements included in this specification.

b. The Authority reserves the right to further sample and test all aggregate base course materials incorporated in the project so as to verify its compliance with contract requirements.

c. When an aggregate base course material fails to conform to the requirements indicated in this specification, the Contractor will have the option to request retesting of said material. Said retesting will be conducted as follows:

1. Two additional samples will be taken at random by the Authority in the lot represented by the failing sample. The average of the original and the two new test results will be used for acceptance purposes. If the average of the three (3) samples fails, the reduction in unit price determined in article 304-5 will be applied using the average of the three (3) results.

2. The Contractor may request further resampling and retesting at his expense in which case the samples will be increased to four (4). The price reduction

formula will be applied using the average test value of all samples taken (4 samples).

d. Aggregate base course materials that fail to meet specification requirements following placement shall be removed at the Contractor's expense and shall be replaced by acceptable material. When the plasticity index (PI) of the inplace aggregate base course material exceeds 6 but is not greater than 10, the material may be accepted at the discretion of the Authority but subject to a reduction in unit price as described in article 304-5.

e. Aggregate base course materials that fail to meet specification requirements following placement shall be removed at the Contractor's expense and shall be replaced by acceptable material. When the liquid limit (LL) of the inplace aggregate base course material exceeds 25 but is not greater than 30, the material may be accepted at the discretion of the Authority but subject to a reduction in unit price as described in article 304-5.

f. Aggregate base course materials that fail to meet specification requirements following placement shall be removed at the Contractor's expense and shall be replaced by acceptable material. When the grading of the in-place aggregate base course material fails to conform to the requirements of Table 703-4, section 703-4 of specification 703 - Aggregates by not more than +/- 2.0 percent, the material may be accepted at the discretion of the Authority but subject to a reduction in unit price as described in article 304-5.

# **304-3 CONSTRUCTION REQUIREMENTS**

#### **304-3.01 Preparation of Surface**

a. The subgrade or subbase on which the base course is to be placed shall have been completed and the surface finished in accordance with the requirements of Specification 203, 204 or

301 as applicable. Immediately before placing base course material, the subgrade or subbase shall be checked as to conformity with grade and cross section.

b. No base course shall be placed on the subgrade or subbase unless it is reasonably dry and free from impounded water, and the surface finish accepted by the Engineer.

#### 304-3.02 Placing

a. The base course material shall be spread on the prepared surface and compacted in layers not exceeding 15 centimeters in thickness. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.

b. Placing shall be from spreader boxes or from vehicles equipped to distribute the material in a uniform layer or windrow without segregation of size. The layer or windrow shall be of such size that when spread and compacted, the layer shall have the required thickness. Spreading may be by motor grader.

#### 304-3.03 Mixing and Spreading

a. If after the layer of base course material has been placed and spread as indicated above, it is found that it is not uniform, it shall be thoroughly mixed to its full depth by means of power graders, traveling mixers or other mixing equipment approved by the Engineer. During the mixing, water shall be added in the amount necessary to provide the optimum moisture content for compaction.

b. When mixed, the material shall be spread smoothly to a uniform thickness and in the case of the top course, to the cross section shown on the plans. Spreading and compaction shall be completed within 24 hours after mixing.

c. Filler material, when added on the roadbed, shall be thoroughly mixed into the aggregate layer as in paragraph a. above.

# 304-3.04 Compaction

a. Immediately following spreading and smoothing, each layer shall be compacted to its full width. Compaction effort shall continue until the base aggregate material reaches a density of at least 83 percent of its solid volume density. The solid volume density of the aggregate shall be computed on the basis of its bulk specific gravity as determined by AASHTO T 84 and T 85, and the dry weight of the aggregate. The in-place density of the compacted aggregate base shall be determined by the use of AASHTO T 191, T 205 or T 238.

b. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture is produced and the aggregate firmly keyed. If required, water shall be uniformly sprinkled over the base materials during compaction in the amount necessary for proper consolidation.

c. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

d. Along curbs, headers, and walls, and at all places not accessible to the roller, the base course material shall be thoroughly compacted with mechanical tampers.

#### **304-3.05** Thickness Requirements

a. The thickness of the completed base course shall not vary by more than 1.25 centimeters from that called for in the plans. Test holes shall be dug, at the discretion of the Engineer, at the center and sides of the base course to determine if its compacted thickness is within the allowed tolerance. Any areas

not within the allowable tolerance shall be corrected by removing or adding material as necessary and shaping and compacting it as specified.

b. The Contractor shall refill the test holes in such manner as to leave the finished surface compacted, smooth and uniform, to the satisfaction of the Engineer.

# **304-3.06** Surface Finish Requirements

a. The finished surface of the base course shall conform so nearly to that required by the plans that it will nowhere vary by more than 1.25 cm. when tested with a 3-meter straightedge. Straightedges shall be furnished by the Contractor at no extra cost and shall remain the property of the Contractor.

b. Any areas where the surface variation exceeds the 1.25 centimeter tolerance shall be reworked by the Contractor until the variation falls within this limit.

c. The finished surface shall be rolled as necessary to maintain a smooth, even, uniformly compacted base until any surface or treatment that may be provided for in the same contract is placed thereon.

#### **304-4 METHOD OF MEASUREMENT**

**304-4.01** Aggregate base course, including filler, will be measured by the cubic meter of material in place in the completed course, computed on the basis of the thickness shown on the plans. No additional thickness over that shown on the plans will be considered for measurement.

# **304-5 BASIS OF PAYMENT**

**304-5.01** The volume of compacted base course material, determined as provided above, placed, compacted and accepted will be paid for at the contract unit price per cubic meter of the class and

grading called for in the contract documents. Such price and payment will be full compensation for furnishing and placing all materials, including any necessary filler and water, and for all labor, equipment, tools and incidentals necessary to complete the work as specified.

**304-5.02** If the in-place aggregate base course material is subjected to a reduction in unit price as per article 304-2.02 of this specification, the following formula will apply to compute the price reduction:

- PR = (PI-6)\*10 + (LL-25)\*10 + G PR = Parameters reduction in unit price
- PR = Percentage reduction in unit price.
- PI = Plasticity Index of deficient in-place material.
- LL = Liquid Limit of deficient in-place material.

G = 10 percent reduction in unit price when grading in any of the sieves exceeds the limits stated in Table 703-4, but is within the tolerances indicate in article 304.202 f. The 10 percent reduction in unit price will only be applied once per each sample.

The "PI" portion of the above formula will be omitted when the plasticity index of the in-place aggregate base course material is 6 or less. The "LL" portion of the above formula will be omitted when the liquid limit of the in-place aggregate base material is 25 or less. The "G" portion of the above formula will be omitted when the grading of the in-place aggregate base course material meets the requirements of table 703-4. Also, in no case the total percentage deduction, PR, exceed 90 percent of the contract unit price for aggregate base course.

**304-5.02** Payment will be made under:

Pay Item	<u>Pay Unit</u>
Aggregate Base Course	Cubic Meter

#### 401-1 **DESCRIPTION**

#### 401-1.01 Scope

a. This work shall consist of constructing one or more courses of hot plant-mix bituminous pavement on a prepared foundation in accordance with these specifications, and in conformance with the lines, grades, thickness and typical cross sections shown on the plans or established by the Engineer. Courses will be identified as base, leveling and surface.

b. The work shall also include the application of any required tack and prime coats as specified in Specifications 407 and 408 respectively.

# 401-2 MATERIALS

**401-2.01 Bituminous Materials** - The bituminous material shall be an asphalt performance graded binder PG 64-22, PG 70-16 or PG 70-22 as per AASHTO MP-1, unless otherwise specified in the contract documents. The Contractor shall submit all the physical properties data certified by an AASHTO Accredited LAB (AAP R18) on the asphalt performance graded binders indicated above. The Authority's Materials Testing Office reserve the right to take samples of the asphalt binder in any location deemed necessary to verify the quality of the product being served.

**401-2.02 Aggregates** - Aggregates, including mineral filler, shall meet the requirements of Section 703-3 of Specification 703 - Aggregates. The job-mix formula plus and minus the gradation tolerances must remain within the overall gradation requirements of section 703-3. If the job mix plus or minus the gradation tolerances exceed the Section 703-3 limits, then the Section 703-3 limit shall constitute the absolute permitted limit and, therefore, the material represented by that lot will be rejected.

a. Reclaimed Asphalt Pavement (RAP) – The use of Reclaimed Asphalt Pavement (RAP) in the construction of hot plant-mix bituminous pavement courses (S-1, S-2, B-1, B-2, L-1 and L-2) will be allowed as a replacement material of aggregates subject to the following conditions and restrictions:

1. The contractor shall submit a new mix design for mixes containing RAP following the regular procedures established by the Materials Testing Office. The percent (%) of RAP used shall be clearly stated in the mix design and it shall contain all of the data as a regular source of aggregates.

2. All of the requirements and conditions established and all of the reference documents stated herein shall be met regardless of the use of RAP. All of the deductions and/or penalties called for in the contract documents will be applied to deficient materials or lots.

3. It shall be the contractor's responsibility to design the new mix containing RAP in accordance with the Asphalt Institute's Manual MS-2 so that it meets all of the requirements of hot-plant bituminous pavement mix indicated in the contract documents.

4. The contractor shall submit for approval of the Materials Testing Office, prior to the production of RAP, the proposed method in which he intends to incorporate it into the mix.

5. All of the sampling, testing and acceptance will be performed following the requirements indicated herein and in other contract documents.

6. The maximum percentage of RAP allowed to be incorporated in surface courses (S-1 and S-2) shall be 5% by weight of total mix.

7. The maximum percentage of RAP allowed to be incorporated in base and leveling courses (B-1, B-2, L-1 and L-2) shall be 10% by weight of total mix.

8. The Highway Authority's personnel shall have access at all times to the plant's control tower to verify the actual percentages of RAP being produced at the time. At the end of each day, the contractor shall submit a copy of the computer printouts containing the percentages of each of the materials being used or a notarized certification indicating the percentage of RAP used during that day.

9. The Highway and Transportation Authority reserves the right to prohibit immediately the use of RAP in this contract if contractor does not comply with any of the above conditions and restrictions and if the hot-plant bituminous mix with RAP does not exhibit appropriate behavior or performance in the field, as determined by the Authority. The removal and replacement of any tonnage of hot plant bituminous mix in non-compliance with all of the above shall be the contractor's responsibility and at no cost to the Authority.

**401-2.03 Hydrated Lime** - Hydrated lime shall meet the requirements of Section 712-3 of Specification 712 – Miscellaneous Materials. The Contractor shall submit certified laboratory reports on tests of the hydrated lime to be used showing its compliance with the specifications.

401-2.04 Other Additives – Anti-stripping agents, when required, may be liquid additives to the asphalt performed graded

binder or pulverent solids such as fly ash, hydrated lime or Portland cement added to the aggregates. The proposed additives shall be submitted to the Authority for approval prior to use.

#### 401-2.05 Composition of Mixtures

a. General - The bituminous plant mix shall consist of a mixture of aggregates, asphalt performed graded binder, and anti-stripping additives, if required. The various mixes are as indicated below. The number in parenthesis refers to the applicable number of hammer blows to be used in the Marshall Test (AASHTO T 245) for each mix as called for in the contract documents. If the number of hammer blows is not specified, a value of 75 shall be used for all mixes on primary and secondary roads, and a value of 50 for municipal and tertiary roads as determined by the Authority.

- 1. Base Courses B-1 (50 or 75), B-2 (50 or 75)
- 2. Leveling Courses L-1 (50 or 75), L-2 (50 or
- 75)
- 3. Surface Course S-1 (50 or 75), S-2 (50 or 75)

Job-Mix Formula - The Contractor shall submit in b. writing for the Engineer's approval, at least three weeks in advance of the date he intends to start paving operations, a job-mix formula for each type of mixture to be used in the project. Each job-mix formula shall be supported by certified laboratory test data and the design charts used. The submission shall also identify the proposed sources of the asphalt cement, aggregates and the specific additives, if any, to be used. When requested by the authority, the Contractor shall submit samples of any of the materials proposed for use in the mix for checking the mix design. The three-week lead requirement may be waived where the Contractor proposes to use a job-mix and mix components which have been previously approved by the Authority. The submittal shall show the compliance of the proposed job-mix formula with the requirements specified below.

c. Mix Requirements - Each mix shall be designed according to the Marshall Mix Design Method as described in the Asphalt Institute Manual MS-2 and shall meet the following requirements:

1. Stability as determined by AASHTO T 245 -1200 lbs. minimum for 50 blows, 1500 lbs. minimum for 75 blows, and 3500 lbs. maximum for all mixes except that for the B-1 and L-1 mixes the maximum shall be 4500 lbs. For the purposes of this specification, the last sentence of Section 1.1 of AASHTO T 245 shall be disregarded and the Marshall Test will be applicable to all mixes (B-1, B-2, L-1, L-2, S-1, S-2) regardless of maximum aggregate size specified.

2. Flow, 0.01 inch (25 mm) as per AASHTO T 245 – 8 minimum to 16 maximum.

3. Residual stability as determined by Specification 719 - 75% minimum. If the mix fails to meet this residual stability requirement, the aggregate source shall be changed or hydrated lime, or other anti-stripping agent, shall be added to attain the 75% requirement.

4. Percent air voids in the mix as determined by AASHTO T 166, T 209 and T 269 - 3% minimum to 8% maximum for B-1 and L-1 mixes, and 3% minimum to 5% maximum for other mixes.

5. Voids in the mineral aggregate (VMA) as determined by the Asphalt Institute Method shall be as follows:

Nominal Maximum Size Of Aggregate in Mix (inches)	Minimum Voids in Percent	
1/2	15	
3/4	14	
1	13	
1 1/2	12	

6. Dust-asphalt ratio, computed by dividing the percentage of material passing the 200 sieve by the percent of asphalt performed graded binder in the mix, both determined from extraction tests made on mix samples - 1.2 maximum.

7. Mixing temperature - The temperature at which the asphalt will have a viscosity of 170 +/- 20 Cs as determined from the temperature/viscosity chart for the asphalt to be used. This mixing temperature will be for laboratory use only.

8. Compacting Temperature - The temperature at which asphalt will have attained a viscosity of 280 +/-30 Cs. This compacting temperature will be for laboratory use only.

The Authority will take, at its discretion, random samples of the mix being produced to test for compliance with the above mix requirements to assure the quality of the mix. If at any time, the results of these random tests show a failure or non-compliance to meet any requirements of the specification, the Authority reserves the right to refuse further deliveries of mixes from the plant until the deficiencies have been corrected including the submission of a new job mix formula, if required.

d. Mix Values - Each job-mix formula submitted shall propose definite values for:

1. Single percentage of aggregates passing each required sieve size.

2. Single percentage of asphalt performed graded binder to be added based on total weight of the mixture.

3. The kind and percentage of additives to be used, if any

4. The kind and percentage of mineral filler to be used, if any

5. The plant mixing temperature and the temperature at which the mixture is to be delivered at the point of placement.

6. The laboratory density of the bituminous mixture.

e. Mix Tolerances - After the job-mix formula is approved, all mixtures furnished for the project shall conform to the following ranges of allowable deviations from target values:

1.	Aggregate passing the 3/4", 1/2" or 3/8"	<u>+</u> 5%
2.	Aggregate passing the No. 4 sieve	<u>+</u> 5%
3.	Aggregate passing the No. 30 sieve	<u>+</u> 4%
4.	Aggregate passing the No. 100 sieve	<u>+</u> 3%
5.	Aggregate passing the No. 200 sieve	<u>+</u> 2%

6. Amount of performance graded binder.....  $\pm 0.4\%$ 

7. Mixing Temperature.....  $\pm 20^{\circ}$  F

f. Mix Changes - Should a change in sources of materials occur or be proposed, or should a job-mix formula prove unsatisfactory as determined by the Engineer, a new job-mix formula shall be developed and submitted by the Contractor for approval prior to production and use. Acceptance of any tonnage of bituminous mix produced under an approved job mix is subject to appropriate behavior of the mix in the field as determined by the Authority. Failure of the approved mix to exhibit appropriate behavior in the field will be cause for its rejection.

#### 401-2.06 Sampling and Testing

a. All sampling and testing will be performed by the Authority, except as noted below. Samples will remain in the custody of the Authority at all times. The Contractor or his authorized representative may be present, if so desired, when these sampling and testing operations are being performed. All testing will be done at a laboratory of the Authority. However, the Authority may, at its discretion, perform the testing at the producer's plant laboratory provided it meets the requirements specified in paragraph 401-2.06c below to the satisfaction of the Authority's Materials Testing Office.

b. The Contractor shall provide the following sampling and testing equipment and their operators:

1. Coring machine and personnel at the project site to take full depth 4" diameter cores from the inplace bituminous pavement as required for testing and acceptance.

2. Scoops, insulated working gloves, plain kraft paper, string or tape for the taking, packaging and transporting of samples of the mix taken at the plant for testing by the Authority at its laboratory.

A nuclear density meter, capable of measuring 3. the density of compacted bituminous mixes and of limiting the depth of reading to the required layer thickness, an operator to use it, included in the Authority's Materials Testing Office certified list by the type of meter to be used. The meter shall be calibrated at least once a year by a licensed firm and copies of these calibration certificates shall be submitted to the Engineer and to the Materials Testing This nuclear density meter will be used to Office. check the density of the in-place compacted bituminous concrete when paving operations are in progress, to guide the Contractor on the adequacy of his compaction efforts. In accordance with the calibration certificate, the nuclear density reading time shall be at least 1.00 minute. The Authority reserves the right to verify the calibration of any of the nuclear gages used by the Contractor using the calibration blocks property of the Authority. Nuclear gages which fail such calibration and are not in compliance with ASTM D-2922 and ASTM D-2905 shall not be used in the project. All of the above shall be considered subsidiary obligation.

c. The Contractor shall provide at the mixing plant, for quality control, a laboratory and all the equipment, tools, supplies and other apparatus required for sampling the mix, preparing specimens and testing for compliance of the mix being produced and its components with all the requirements specified in Article 401-2.05.

1. The equipment listed below shall be provided as a minimum at the plant laboratory. This equipment

shall comply with the requirements of the AASHTO or ASTM specification indicated, or be equal or similar to the specific equipment indicated.

(a) Automatic Bituminous Compactor - ASTM D 1559

(b) Specimen Ejector – ASTM D 1559

(c) Asphalt Centrifuge Extractor with Filter Disks- AASHTO T 164, modified for the use of biodegradable solvents (terpene)

(d) Oven (392 degrees F) - Soiltest L-5B

(e) Compaction Molds (4 inches) - ASTM D 1559

(f) Paper Disks for Compaction Molds - ASTM D 1559

(g) Water Bath - ASTM D-1559, at its discretion the Authority may require the bath to be enclosed in an approved cage with padlock.

(h) Marshall Test Set - AASHTO T 245

(i) Asphalt Flow Indicator - ASTM D 1559

(j) Triple Beam Scale (with clamp and rod support for specific gravity weighing) - AASHTO M 231

(k) 12 inch Standard Sieve Set (2 inch to #200) - ASTM E 11

(l) Wet Sieve Set - ASTM E 11

(m) Six Stainless Steel Pans – 20" X 12" X4" deep

(n) Six Stainless Steel Mixing Bowls -5 qts.

- (o) Round Mouth Scoop
- (p) Laboratory Tongs
- (q) Heat Resistant Gloves
- (r) Trowel
- (s) Spatulas (10" L X 1 1/4" W)
- (t) Calipers

(u) Laboratory Thermometers (temp. range 0 - 200 degrees F) - Soiltest G-171.or G-178
(v) Armored Thermometer (temp. range 0-500 degrees F) - Soiltest G-185 or G-191
(w) Aprons
(x) Biodegradable solvents for asphalt (terpene) - AASHTO T 164

2. The plant laboratory testing equipment shall be calibrated and certified at least once a year by an independent laboratory qualified to perform such calibration.

3. The plant laboratory shall be available to the Authority, upon request, to perform such tests on the mix being prepared, or being delivered to the project, as may be considered necessary by the Engineer.

d. The Authority will take, at its discretion, random samples of the asphalt performed graded binder and the aggregates at the plant, prior to and during mix production, to test for the compliance of these materials with their specifications requirements. If at any time the results of these random tests show a failure of the asphalt performed graded binder or the aggregates to meet the requirements of the specification, the Authority reserves the right to refuse further deliveries of mixes from the plant until the deficiencies have been corrected including the submission of a new job-mix formula, if required.

e. Samples of the mix material being produced for delivery to the project will be taken by the Engineer at the plant for testing by the Authority for compliance with the aggregates grading and asphalt content and, at its discretion other specification requirements. The control unit for sampling, testing and acceptance purposes will be a lot which is defined as 300 tons of bituminous mix or fraction thereof. At the discretion of the Materials Testing Office, if at the end

of the production there are still 90 tons or less not included in any lot, said material could be added to the last lot. Samples will consist of 3 specimens of at least 2000 grams each taken at random from each lot. The Authority may, at its discretion, take samples of the mix being delivered to the project site for testing.

1. The specimens will be taken from the delivery trucks and wrapped in kraft paper for delivery to the Authority's laboratory, as soon as possible, for testing by Authority personnel.

2. Extraction tests will be performed on one of these specimens, selected at random, to determine aggregate sizes, percentage of asphalt in the mix and at the discretion of the Authority, the viscosity of the recovered asphalt. Testing for percentage of aggregate passing the No. 200 sieve will be at the discretion of the Authority.

3. If the tested specimen meets all requirements of the specification, the other two specimens will be disposed of without testing.

4. If the tested specimen fails in any of the specification requirements, the other two samples will be tested and the average results of all three specimens of the lot will be used for comparing with the specification requirements for acceptance purposes.

f. Ten (10) nuclear density readings will be taken at random locations for each 300-ton lot, or fraction thereof, of bituminous mix placed and compacted for testing for compliance with the density requirements. The Contractor's nuclear gage operator and the inspector will witness the nuclear gage readings and report and certify their veracity by

signing the appropriate forms provided by the Authority for such purposes. This lot will not necessarily coincide with the 300-ton specified in paragraph "e" above. In addition, a core will be taken by the contractor under Authority's supervision at one of the nuclear density reading location selected at random. The Materials Testing Office, at its discretion, will inspect the density readings taken at the field.

> 1. The core shall be 4" in diameter and extend for the full depth of the pavement layer being tested. It shall not be taken until at least 72 hours have elapsed since placing the mix but not later than 144 hours after placing. At his risk, the Contractor may elect to take cores prior to the minimum 72 hours period established. The Authority will not accept extracted core samples that do not meet the above requirements.

> 2. The computed density of the core will be compared with the nuclear density meter reading for verification purposes.

3. The other nuclear readings will be corrected as required and an average of all the corrected readings will be computed. This average will be used to compare the density of the lot being tested with the laboratory density. At its discretion and after a statistical analysis of the veracity of the nuclear meter and operator the Authority may wave the testing of the core and base acceptance of the lot solely upon nuclear readings.

g. Leveling courses of less than 3.8 centimeters thickness will be exempt from coring and nuclear density testing.

#### 401-2.07 Basis of Acceptance

a. The acceptability of the quality of the hot plant-mix bituminous pavement will be based on the results of the sampling and testing performed as called for in Article 401-2.06 above as compared to the mix requirements for aggregates, asphalt content and compacted density specified in Article 401-2.05 and the tolerances and conditions provided in subsequent paragraphs herein.

b. Asphalt Content - Mixes with asphalt performance graded binder content exceeding the specified tolerance of +/-0.4% will be rejected. However, at the discretion of the Authority, mixes within +/- 0.52% of the approved job-mix formula asphalt performance graded binder content may be accepted but subject to payment at a reduced unit price as specified in Articles 401-5.01 and 401-5.02. Mixes with asphalt content deviating in excess of +/- 0.52% of the specified asphalt will be rejected and shall be removed from the project at the Contractor's expense and replaced with a suitable mix. However, the Contractor may propose corrective measures to be made at his expense for consideration by the Authority. If these are accepted by the Authority the mix may remain in place subject to such price reductions as may be determined by the Authority but not to exceed 90%. If the corrective measures are not accepted, the deficient mix shall be removed at the Contractor's expense and replaced with acceptable mix.

c. Aggregate Grading - Mixes with aggregates grading exceeding the range of allowable deviations from the job-mix formula specified in paragraph "e" of Article 401-2.05 will be rejected. However, at the discretion of the Authority, mixes with aggregate within the ranges of deviation indicated below may be accepted but subject to payment at a reduced unit price as specified in Articles 401-5.01 and 401-5.02. Mixes exceeding these deviations will be rejected and shall be removed from the project at the Contractor's expense and

replaced with suitable mix. The job-mix formula plus or minus the gradation tolerances must remain within the overall gradation requirements of section 703-3. If the job mix plus or minus the gradation tolerances exceed the Section 703-3 limits, then the Section 703-3 limits shall constitute the absolute permitted limit and, therefore, the material represented by that lot will be rejected (see exception to the above in note 1 below). However, the Contractor may propose corrective measures to be made at his expense for consideration by the Authority. If these are accepted by the Authority, the mix may remain in place but subject to such price reductions as may be determined by the Authority but not to exceed the maximum values specified in paragraph 401-5.02b. If the corrective measures are not accepted, the deficient mix shall be removed at the Contractor's expense and replaced with acceptable mix.

Aggregate Passing	Deviation from Target Value
3/4" Sieve	+/- 7.0% (B-1 7 L-1)
1/2" Sieve	+/- 7.0% (S-2)
3/8" Sieve	+/- 7.0% (B-2, L-2 & S-1)
No. 4 Sieve	+/- 7.0 % (All mixes)
No. 30 Sieve	+/- 6.0 % (All mixes)
No. 100 Sieve	+/- 3.8 % (All mixes)

Note 1:Exception is made with the No. 100 sieve in which an additional 2.5% below the overall limit indicated in table 703-3 will be considered acceptable.

d. When it is determined from the test results that the in place mix has such deficiencies in asphalt content and/or aggregate grading that it should be removed, the Authority may at its discretion, when so requested by the Contractor, evaluate the mix to determine whether it may allow it to remain in place but at reduced payment to be established by the Authority, which deduction will be at least 50 percent of the contract unit price.

e. Mix Density - The compacted bituminous mix shall have a density of at least 97% of the laboratory density for the specified job-mix. Compacted mixes that fail to attain this 97% value but have at least 92% of the density will be accepted, if otherwise acceptable, but subject to a reduced payment as specified in Article 401-5.02. Compacted mixes with less than 92% of the laboratory density will be rejected and shall be removed from the project at the Contractor's expense and replaced. However, the Authority may, at its discretion, allow such failing mixes to remain in place but at a payment of only 50 percent of the contract unit price.

f. Intentionally omitted

g. Thickness - Acceptance for thickness will be as provided in Article 401-3.14.

h. Retesting - When an in-place mix is accepted subject to reduced payment or is rejected and ordered removed under the above provisions, the Contractor may request retesting of the rejected lot. Such request must be made in writing within 30 days of notification by the Authority of the mix deficiencies. All of the retesting described above will be performed by the Materials Testing Office. Such retesting will be conducted as follows:

1. Three squares of the full depth of the pavement layer and weighing approximately 4,000 grams will be saw cut or core out by the Contractor, at his expense, under the supervision of the Engineer for each 300 ton lot being retested.

2. Extraction tests will be performed by the Authority on each specimen to determine the asphalt content and the aggregate grading. These values will supersede and replace the values previously obtained

for the initial specimens taken under the provisions of paragraph d of Article 401-2.06.

3. The average of the results of the three new specimens will be compared with approved job-mix values for acceptance purposes under the requirements of paragraphs b and c of this Article 401-2.07.

Retesting for compliance with the density 4 requirements will be performed by repeating the nuclear testing and core extraction, at the Contractor's expense, described in Article 401-2.06f at ten new locations selected at random. These values will supersede and replace the initial readings. The average of the new readings, corrected as may be necessary, will be compared with the laboratory density for acceptance purposes under the provisions of Article 401-2.07e. At the discretion of the Authority, if a retesting layer of an approved mix is already below the final surface course, the contractor shall drill a core through both surfaces and remove the material from the surface course. In said case the original 10 nuclear readings will be used for acceptance purposes. The retesting will be performed by personnel from the Materials Testing Office. The Authority reserves the rights of taking the core extraction. If no core extraction is taken, the average of the 10 nuclear readings will be the retesting density.

i. The results of the retesting made under paragraph "h" above will be considered final for acceptance purposes and no further retesting will be performed.

**401-2.08 Sampling Repairs** - The Contractor shall, at his expense, refill all core holes and other sampling cuts in the pavement courses which are accepted with mix of the appropriate type, placed and compacted to the satisfaction of the Engineer. On roadways

open to traffic, the repairs shall be made on the same day the cuts and cores are taken.

# 401-3 CONSTRUCTION REQUIREMENTS

**401-3.01 Bituminous Mixing Plant** - Plants used for the preparation of bituminous mixes shall conform to AASHTO M 156 modified and supplemented as follows:

a. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mix, the Engineer, or his authorized representative, shall have access, at all times, to all portions of the mixing plant, aggregates plant, storage yards, and other facilities for producing and processing the mix materials.

b. Scales shall be inspected and sealed as often as the Engineer may deem necessary, but not less than once a year, to assure their continued accuracy, by the Division of Weights and Measures of the Commonwealth Department of Commerce. Any cost involved in the inspection and sealing of the scales shall be at the Contractor's expense.

c. All projects involving 2,000 Tons or more of bituminous mixture shall be served by a plant having automatic controls which coordinate the proportioning, timing and discharge of the mixture.

d. All plants shall have silos and shall be equipped with air pollution control devices which meet the requirements of the Environmental Quality Board.

e. The completed bituminous mixture may be weighed on approved scales furnished by the Contractor at his expense. The scales shall be inspected and calibrated at least once a year by an independent entity.
f. As specified in Article 401-2.06c, the plant shall have a laboratory adequately equipped and staffed to perform AASHTO T 245 and all other testing required for quality control. The producer's laboratory technician shall be present during periods of mix production. The producer's technician may participate in the testing under the supervision of Authority's personnel. If he participates, the producer's technician will sign the appropriate test reports along side the Authority's representative. Refusal to sign on part of the producer's technician will disqualify him from participating in the testing and sampling procedures and may only be present as an observer.

**401-3.02 Hauling Equipment** - Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution or other approved material to prevent the mixture from adhering to the beds. No gas oil or diesel fuel will be allowed for preventing the mixture adhering to the truck bed. Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture and for use during hauling operations. No truck will be allowed to leave the plant without covering the mix with the cover of canvas.

**401-3.03 Delivery Trucks** - Before unloading at the site of the work the bituminous mix supplier shall furnish to the Engineer a delivery tickets containing the following information concerning the bituminous mix in the truck:

- a. Name of bituminous mixing plant
- b. Serial number of ticket
- c. Date, time and truck number
- d. Name of Contractor

e. Specific designation of job (name, number and location)

- f. Type of mix
- g. Weight of mix in the truck

h. Space for signature of Authority's inspector at the paving site and at the scales

- i. Temperature of the asphalt mix measured at the plant.
- j. Temperature of the asphalt mix measured at the site

### 401-3.04 Bituminous Pavers

a. Bituminous pavers shall be self-contained, powerpropelled units with a vibrating or tamper screed and strikeoff assembly covering the full laydown width, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material which will meet the specified typical section, thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in the widths shown on the plans.

b. The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed and strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

c. The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

d. The paver shall be equipped with a grade and slope control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensordirected mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made

inoperative and the screed shall be controlled by sensor directed automatic mechanisms which will independently control the elevation of each end of the screed from the reference lines or surfaces. The controls shall work in conjunction with any of the following attachments:

1. Ski-type device, floating beam of not less than 30 feet (9.14 m) in length or as directed by the Engineer.

2. Short ski or shoe to match adjoining lanes either fresh or old.

3. Taut string line wire set by the Contractor to the specified grade.

e. The Contractor shall furnish the long ski and the short ski or shoe, or furnish and install all required stakes and wire for a taut string line. Should the automatic control system become inoperative during the days work, the Contractor will be permitted to finish the day's paving work using manual controls. However, work shall not be resumed thereafter until the automatic control system has been made operative.

f. The Contractor may be exempt from the use of the automatic control system at locations where the Engineer determines that pavement geometry or widths makes its use impracticable.

**401-3.05 Rollers** - Rollers may be of the vibratory or tandem steel wheel type. Pneumatic-tired rollers may be used in conjunction with either of the steel wheel types. Rollers shall be in good condition, be capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without

detrimentally affecting the compacted material. For leveling courses, at least one pneumatic tire roller shall be used.

**401-3.06** Weather Limitations - Bituminous plant mix shall not be placed on any wet surface or when weather conditions prevent the proper handling or finishing of the bituminous mixture.

### 401-3.07 Preparation of Surface to be Paved

a. The surface to be paved shall be true to line and grade, dry and free from loose or deleterious material immediately before the placing of bituminous mixture. If necessary, the surface shall be cleaned by brooming or other approved means.

b. When the surface of an existing pavement or old base to be paved is irregular, it shall be brought to uniform grade and cross section by a leveling course as directed, which shall be compacted to the satisfaction of the Engineer before placing subsequent paving courses.

c. When a leveling course is not required, all depressions and other irregularities shall be patched or corrected in a manner satisfactory to the Engineer. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material, shall be removed from the area to be paved. Blotting of excessive deposits of asphalt with sand or stone will not be permitted.

d. Where the area to be paved is an untreated soil or aggregate, it shall be compacted to the required density and then primed in accordance with the provisions of Specification 408 - Bituminous Prime Coat. The prime coat shall be allowed to cure properly in accordance with the provisions of Specification 408 before any further operations are permitted on the primed area. No prime coat will be

required for single bituminous mix course 7.5 cm. or more in compacted thickness.

e. Before spreading the mixture upon a portland cement concrete surface or a bituminous surface older than 3 months or excessively dirty, a tack coat in accordance with the provisions of Specification 407 - Bituminous Tack Coat shall be applied. No tack is required on bituminous surfaces which are less than 3 months old if they can be cleaned to the satisfaction of the Engineer.

f. Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of bituminous material as specified for the tack coat prior to the bituminous mixture being placed against them.

**401-3.08 Preparation of Bituminous Material** - The bituminous material shall be heated to the temperature specified in Table 702-1 of Specification 702 - Bituminous Materials. The bituminous material shall be heated in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. Asphalt cement shall not be used while it is foaming nor shall it be heated above 350 degrees F at any time after delivery to the plant.

### 401-3.09 Mixing

a. The aggregates shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula. The materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured.

b. No mix will be allowed to leave the plant with a temperature lower or higher than the +/-20 degrees F of the production temperature indicated in the job mix. Failure to comply with the above requirement will be cause for rejection of the mix contained in the truck.

c. All mixes shall be delivered at the paving site at a temperature of no less than 225 degrees F.

### 401-3.10 Transporting, Spreading and Finishing

a. The mixture shall be transported from the mixing plant to the paving site in vehicles conforming to the requirements of Article 401-3.02. The required protective cover shall be placed over the mix prior to departing the plant and retained in place until the mix is delivered. Failure to comply with the above requirement will be cause for rejection of the mix contained in the truck.

b. The bituminous mixture shall be laid upon an approved clean surface, spread and struck off to the established grade and elevation. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

c. The longitudinal joint in one layer shall be offset from that in the layer immediately below by approximately 15 centimeters; however, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises two lanes of width, or at lane lines if the roadway is more than two lanes in width, unless otherwise directed. Failure of the Contractor to observe the above dispositions and the placement of the longitudinal joint at the wheel path will allow the Authority to reject the mix or to accept the same at a 50% reduction in price.

d. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread and finished by hand tools. For such areas the mixture shall be dumped, spread and screeded to provide the required section and compacted thickness. The Contractor shall provide suitable heating equipment for keeping hand tools free from asphalt. The temperature of the tools when used shall not be greater than the temperature of the mix placed. Only heat shall be used for cleaning hand tools. The use of petroleum oils, diesel fuels or volatiles will not be permitted.

e. The mixtures shall be placed in layers as indicated on the plans. No single layer shall exceed 10 cm. (4") in compacted thickness.

#### 401-3.11 Compaction

a. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in workable condition. The sequence of rolling operations and the selection of roller types shall be such as to provide the required pavement density of at least 97% of the laboratory density. However, the use of pneumatic tire rollers is mandatory for compacting L-1 and L-2 leveling courses.

b. Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, gradually progressing to the crown of the road. Trip overlaps of the roller shall not exceed 6 inches (15 cm.). When paving in echelon or abutting a previously placed lane, the longitudinal joint shall be rolled first followed by the

regular rolling procedure. On super-elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline.

c. Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver except when rolling an incline, then the procedure is reversed.

d. Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material.

e. Along forms, curbs, headers, walls and other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers. On depressed areas, a trench or small vibratory roller may be used, or cleated compression strips may be used under the roller to transmit compression to the depressed area.

f. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous mix material shall be corrected to the satisfaction of the Engineer.

### 401-3.12 Joints, Trimming Edges and Cleanup

a. Placing of the bituminous mix shall be as continuous as possible. Rollers shall not pass over the unprotected end of

a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. When directed by the Engineer, a brush coat of bituminous material of the type being used in the mix shall be used on the contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

b. At the beginning or end of a project connecting to an existing pavement the feathering of the new surface course to match the existing grade of the old pavement will not be permitted. To transition and match the grades, the old pavement shall be undercut to a depth equal to the compacted depth of the new surface course being connected to it. This work shall be a subsidiary obligation of the Contractor under the new pavement pay items.

c. Material trimmed from the edges and any other discarded bituminous mixture shall be removed from the roadway and disposed of by the Contractor outside the project limits or in an approved area out of sight from the road.

### 401-3.13 Surface Requirements

a. The Contractor shall provide a 3-meter (10-foot) rolling straight edge, to be operated by the Engineer, that automatically marks, in colored dye, the length of surface variations which exceed a tolerance of 0.5 centimeter (3/16 inch) in 3 meters (10 feet) for testing the top surface of mainline pavements in a longitudinal direction, or a similar instrument, acceptable to the Authority, that will identify surface variations. In addition, the Contractor shall provide a 3-meter portable aluminum straightedge for testing mainline surfaces transversely and for testing base course surfaces, ramps, frontage roads and other miscellaneous surfaces.

b. The surfaces of new aggregate and bituminous base courses will be tested with a 3-meter straightedge. Any depressions in excess of 1.25 cm. (1/2") shall be corrected with leveling or surface course material.

c. Each lane of new surface course placed on mainline pavement and over a base course of uniform thickness will be tested longitudinally, approximately along the lane wheel path, with the rolling straightedge to determine the length of surface variations which exceeds the permissible tolerance of 0.5 centimeter in 3 meters. The percent of defective length in the total lane measured length will be computed.

d. The top surface course of mainline pavement will be accepted as is when the percentage of defective length does not exceed 4.0% in any 300-meter sections selected by the Engineer. When the percentage of deficient surface length in a lane in such sections exceeds 4.0%, the deficient sections shall be removed or shall be corrected to the satisfaction of the Engineer at the Contractor's expense.

e. The top surface of ramps, frontage roads, and miscellaneous travel ways other than the main line lanes may be tested by the Engineer at random locations using the rolling straightedge or the portable 3-meter straightedge to check for conformance with the 0.5 centimeters surface variation tolerance.

f. During placement of the surface course, random control testing will be performed with the 3-meter straightedge to ascertain the capability of the paving equipment and operations to meet the surface requirements.

### 401-3.14 Testing Pavement Thickness

a. The cores taken to determine the in-place density shall be used to determine the pavement thickness.

b. For surface courses no core shall be deficient by more than 0.6 cm. and the average of all cores must be not less than the thickness specified in the plans.

c. Base courses shall be checked in the same manner as for surface course in paragraph "a" above, except that the tolerance shall be 1.2 cm. for thicknesses in excess of 10 cm.

d. In addition, if the average total thickness for each course exceeds the plan thickness by more than 15%, the excess tonnage equivalent to the excess in average thickness over 115% of plan thickness will not be compensated.

e. Material which is used for a leveling course will not be considered in pavement thickness determinations.

**401-3.15 Protection of Pavement** - Sections of newly finished work shall be protected from traffic of any kind until the mixture has become properly hardened by cooling. In no case will traffic be permitted less than 6 hours after completion of the pavement unless a shorter period is authorized or directed by the Engineer in emergencies or in reconstruction work.

### 401-4 METHOD OF MEASUREMENT

**401-4.01** Plant-mix bituminous pavement courses will be measured by the ton of compacted mixture placed in the accepted work, as called for in the contract documents. Measurement will be by weighing the delivery trucks at approved scales. Batch weights will not be accepted as a method of measurement.

**401-4.02** Any excess tonnage due to excess thickness, determined as provided in Article 401-3.14d, will be deducted from the measurement for payment.

401-4.03 Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the contract

quantities and no adjustment in the contract unit price will be made because of such variation.

**401-4.04** Work prescribed under Article 401-3.07, Preparation of Surface to be Paved, except for the leveling course and mix material used for patching and correcting irregularities in old surfaces, will not be measured directly for payment, but will be considered as a subsidiary obligation of the Contractor under the various items of hot plant-mix bituminous pavement. Hot plant-mix material used for patching and leveling in this work will be measured for payment under the respective unit prices.

## 401-5 BASIS OF PAYMENT

**401-5.01** The completed and accepted quantities of each class of hot plant mix pavement, measured as provided above, will be paid for at the contract unit price per unit of measurement except as specified in Article 401-5.02 below. Such prices and payment shall constitute full compensation for the cost of preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting and finishing of all required materials for the pavement; and for all labor, equipment, tools and incidentals necessary to complete each item of work as required by the plans and specifications.

**401-5.02** Pavement found to be deficient as to asphalt content, aggregate gradation or compacted density but allowed to remain in place under the provisions of Article 401-2.07 will be paid for at a reduced unit price as follows:

a. For asphalt content:

Deviation in Asphalt	Percent Reduction in
Content From Design Value	Unit Price
+/- 0.4 %	0
+/- 0.41 % to 0.44 %	3
+/- 0.45 % to 0.48 %	6

+/- 0.48 % to 0.52 %	10
Over +/- 0.52 %	See Arts. 2.07b and d

## b. For aggregate grading:

Sieve Size	Deviation in % Passing	Percent Reduction In
	From Design Value	Unit Price
3/4" (B-1, L-1)	+/- 5.0	0
Or	+/- 5.1 to 5.5	2
3/8" (B-2, L-2,	+/- 5.6 to 6.0	4
& S-1)	+/- 6.1 to 6.5	7
Or	+/- 6.6 to 7.0	10
1/2" (S-2)	Over 7.0	See Arts. 2.07 c and d
No 4	+/- <b>5</b> 0	0
110. 4	+/-5.0	0
	+/-56to60	2 1
	+/-61 to 65	7
	+/-66 to 7.0	10
	Over 7.0	See Arts. 2.07 c and d
No. 30	+/- 4.0	0
	+/- 4.1 to 4.5	2
	+/- 4.6 to 5.0	4
	+/- 5.1 to 5.5	7
	+/- 5.6 to 6.0	10
	Over 6.0	See Arts. 2.07 c and d
No. 100	1/ 30	0
NO. 100	+/-3.0	0
	$\pm 1 - 3.1 \text{ to } 3.6$	5
	$\pm /-3.4$ to 3.8	10
	Over 3.8	See Arts 207 c and d
	Over 5.8	See Arts. 2.07 c and d

Where the aggregate is deficient in more than one sieve, the reductions in unit price for aggregate failure

will be applied on the basis of the largest deduction only.

c. For in place density:

Percent of Laboratory	Percent Reduction In
Density Attained	Unit Price
97 and over	0
96.0 to 96.9	3
95.0 to 95.9	6
94.0 to 94.9	9
93.0 to 93.9	12
92.0 to 92.9	15
Less than 92	See Art. 2.07 e

d. The total percentage deduction in unit price for deficiencies will be determined by adding the percentage reduction due to deficiency in asphalt content, if any, to the highest percentage reduction due to deficiencies in aggregate grading in any of the sieve sizes, and to the percentage reduction due to density deficiencies. However, the total percentage deduction to be applied for these three combined causes shall not exceed 25%. Such reduction will be in addition to any reduction in payment for excess tonnage in pavement thickness provided under Article 401-3.14.

401-5.03 Payment will be made under:

Pay Item	<u>Pay Unit</u>
Hot Plant-Mix Bituminous Pavement Mix S-1 (50 or 75)*	Ton
Hot Plant-Mix Bituminous Pavement Mix S-2 (50 or 75)*	Ton
Hot Plant-Mix Bituminous Pavement Mix L-1 (50 or 75)*	Ton
Hot Plant-Mix Bituminous Pavement Mix L-2 (50 or 75)*	Ton

Pay Item	<u>Pay Unit</u>
Hot Plant-Mix Bituminous Pavement Mix B-1 (50 or 75)*	Ton
Hot Plant-Mix Bituminous Pavement Mix B-2 (50 or 75)*	Ton
* Indicate the number of applicable hammer blows (AASHTO	T 245)

## 402-1 **DESCRIPTION**

**402-1.01 Scope** - This work shall consist of the rehabilitation of existing bituminous concrete pavement to correct undesirable conditions such as rutting, bleeding, cracking, rough surfaces and lack of stability. The work shall be performed at the locations shown on the plans or indicated by the Engineer, in accordance with these specifications, and in conformity with the lines, grades, cross sections and details shown on the plans or established by the Engineer.

## 402-2 MATERIALS

**402-2.01** Replacement material for subgrade or subbase shall meet the requirements of Specification 301 - Subbase Course.

**402-2.02** Replacement material for aggregate base course shall meet the requirements of Specification 304 - Aggregate Base Course.

**402-2.03** Bituminous plant mix material shall meet the applicable requirements of Specification 401 - Hot Plant-Mix Bituminous Pavement for the specific mixes called for in the plans or ordered by the Engineer.

**402-2.04** The bituminous material for prime and tack coats shall meet the requirements of Specifications 407 and 408 respectively.

### 402-3 CONSTRUCTION REQUIREMENTS

### 402-3.01 General

a. The construction work will include any one or more of the rehabilitation operations described herein at the locations shown on the plans or indicated by the Engineer.

b. Test cores, 4 inches in diameter, will be drilled by the Contractor at the locations selected by and under the

supervision of the Engineer to ascertain the depth and condition of the existing bituminous concrete pavement. The cores shall be identified as to location and date taken, and delivered to the Engineer for evaluation. When so ordered by the Engineer, the test core shall be extended through the existing aggregate base and subbase courses, and the subgrade material, to an additional depth not exceeding 60 centimeters, to ascertain the condition of these materials. If feasible, these core extensions may be drilled using a hand auger.

c. Test pits into the aggregate base, subbase and subgrade will be excavated at the locations selected by and under the supervision of the Engineer to ascertain the condition of the in place materials. The test pits shall be approximately 45 centimeters by 45 centimeters in area and extend to a depth not exceeding 60 centimeters below the bottom of the bituminous concrete pavement courses.

d. Rollers

1. Pneumatic and steel wheeled rollers shall have a minimum operating weight of 8 tons.

2. Vibrating rollers shall have a minimum operating weight of 2.25 tons, a frequency of 3300 vibrations per minute, an amplitude of 0.022 inches, and a centrifugal force per drum of 4600 pounds.

e. The work shall be performed in a manner that causes a minimum of inconvenience to public traffic and in conformance with all maintenance and protection of traffic requirements as provided in the General Provisions, in Specification 638 and on the plans.

**402-3.02 Construction Sequence** - The rehabilitation operations shall be conducted one lane at a time. Unless otherwise

specified or ordered by the Engineer, the operations shall be performed in the following sequence:

a. Measurement as required of the existing cross sections and cross slopes under the provisions of Specification 150 -Survey and Stakeout.

b. Drilling of test cores in the existing pavement when required.

c. Repair of pavement areas where full depth removal of the existing pavement and possible removal and replacement of base, subbase and subgrade material is required. This includes the removal of the existing pavement within the limits specified or ordered by the Engineer, the investigation of the condition of the existing base, subbase and subgrade including the excavation of such test pits as may be ordered by the Engineer, and the removal and replacement of such base, subbase and subgrade material as may be specified or ordered by the Engineer.

d. Initial adjustment of existing manholes, inlets, valve boxes, junction boxes, pull boxes and miscellaneous structures as required to perform cold milling operations.

e. Partial depth removal of existing bituminous concrete pavement by the cold milling process, under the provisions of Specification 403, when required in the rehabilitation process of rutted, bleeding, unstable and other deficient pavement sections.

f. The following construction items, when included, shall be performed after milling operations and the placing of the leveling course have been completed:

1. Longitudinal slotted pipe drains.

2. Concrete barriers abutting on the pavement being milled.

3. Placing of frames and covers on grates of any manholes, inlets or similar structures which will abut or be located within the pavement.

#### 402-3.03 Removal of Existing Pavement

a. All required partial depth removal of existing bituminous concrete pavement shall be performed and paid for by the cold milling process under Specification 403 except where otherwise specifically authorized in the contract documents, or by the Engineer, because of physical or geometric restraints that preclude the use of the milling equipment.

b. Where either full depth removal of bituminous pavement is required or partial depth removal by other than cold milling is authorized, the edges of each area to be removed shall be saw cut to a depth of at least 5 centimeters. The bituminous material may then be removed by any method selected by the Contractor provided that the adjacent and underlying materials to remain are not disturbed or damaged in any way by the removal procedure. Any such damage shall be repaired by the Contractor, at his expense, in a manner approved by the Engineer.

### 402-3.04 Rehabilitation of Rutted Pavements

a. The rehabilitation of rutted pavements shall be performed at the locations and by the procedure indicated on the plans which may be either one of the following:

1. Partial removal of the surface layers of the existing pavement by cold milling to the width and depth indicated on the plans or established by the

Engineer and then resurfacing with one or more courses of bituminous plant-mix of the classes and thicknesses shown on the plans. The partial removal and resurfacing of any rutted area shall be completed the same day.

2. Filling the ruts with a bituminous leveling mix of the class indicated in the contract documents and then placing an overlay of one or more courses of bituminous plant-mix of the classes and thicknesses shown on the plans.

b. The use of pneumatic tired rollers to compact each bituminous plant-mix course placed is mandatory in all of the above cases.

c. All patch areas which are to be overlaid by a final surface course, shall be finished to a compacted elevation 0.25 to 0.35 centimeters above the adjacent existing pavement surfaces to remain.

### 402-3.05 Rehabilitation of Bleeding and Unstable Pavement Surfaces

a. The areas to be repaired by partial or full depth pavement removal under these procedures are identified on the plans. Additional areas may be selected by the Engineer at his discretion.

b. The depth of existing bituminous plant mix pavement surface courses to be removed will be as indicated on the plans but may be revised by the Engineer, at his discretion, on the basis of core data and inspection of areas where pavement has been removed.

c. The partial depth removal of bleeding and unstable pavement surfaces shall be by cold milling under

Specification 403 except that small isolated areas may be removed as specified in paragraph 402-3.03b.

d. Pavement patch areas where plant mix has been partially removed shall be back filled the same day with bituminous plant mix of the class specified in the contract documents, to the depth indicated on the plans, and compacted as required in Specification 401. The use of pneumatic tired rollers for this compaction is mandatory. When the bituminous plant mix for backfilling is not specified, mix type B-1 shall be used for depths in excess of 7.5 centimeters and mix type B-2 for depths of up to 7.5 centimeters.

e. When called for in the contract documents, the total pavement section shall be overlaid with one or more courses of bituminous plant mix of the classes indicated on the plans.

f. When the Engineer determines that the full depth of the existing bituminous plant mix pavement originally scheduled for partial depth removal has to be removed down to the aggregate base or subbase or subgrade, the rehabilitation work shall follow the procedures specified under Article 402-3.06 for full depth removal.

### 402-3.06 Rehabilitation of Cracked Pavements

a. Cracked bituminous plant mix surfaces normally reflect deficient base and/or subgrade conditions. In the areas of cracked pavement indicated on the plans or selected by the Engineer, the full depth bituminous concrete pavement structure shall be removed down to the untreated aggregate base course, if one is present, or to subgrade elevation if there is no aggregate base course.

b. Each repair area will be inspected by the Engineer after the existing pavement has been removed to determine

the condition and adequacy of the base, subbase, and subgrade material. The contractor shall excavate test pits at the locations and to the depth, not to exceed 60 centimeters, ordered by the Engineer. If the existing material under the pavement is determined to be suitable to remain, the Contractor shall backfill the test pit with replacement subbase and aggregate base course material to the satisfaction of the Engineer.

c. Where the Engineer determines that the existing material under the pavement is unsuitable, the Contractor shall excavate and remove such unsuitable material within the area and to the depth established by the Engineer.

d. The removed unsuitable material shall be replaced by the Contractor with approved subbase and base materials to the depths shown on the plans or ordered by the Engineer. This backfill material shall be placed in layers not exceeding 15 centimeters in thickness and each layer compacted with vibratory rollers to the requirements of Specification 301 for subbase materials and Specification 304 for aggregate base course materials.

e. Any exposed aggregate base or subbase courses which are to remain in place under full depth pavement removal shall be thoroughly recompacted with vibratory rollers prior to placing any new bituminous plant mix material over them.

f. The removal of existing pavement and underlying materials and the placement of all required replacement materials, including the various bituminous plant mix pavement courses in any individual repair area, shall be completed on the same day. The Contractor shall maintain stockpiles of aggregate base course material and subbase material at the project site to insure their ready availability when needed.

g. Where, in addition to correcting cracked pavement areas as indicated above, the complete pavement section is to be partially removed by cold milling under Specification 403, all the partial and full depth repair work shall be completed prior to the cold milling removal operations.

**402-3.07 Adjustment of Structures** - The initial and/or final adjustment of existing manholes, inlets, valve boxes and other structures within or abutting the pavement that may be required by the rehabilitation operations and to meet final grade requirements, shall be performed and paid for under the provisions of Specification 604 - Manholes, Inlets and Catch Basins.

**402-3.08 Disposal of Removed Material** - The bituminous pavement material and the base and subgrade materials removed from the repair areas shall be disposed of by the Contractor at his expense. To the extent shown on the plans or approved by the Engineer, the removed material may be used to flatten existing road section slopes. Removed material which is not allowed to be used within the project limits shall be disposed of outside the project rightof-way in areas selected by the Contractor. Copies of all permits authorizing the use of the selected disposal areas shall be furnished by the Contractor to the Engineer.

### 402-3.09 Protection of Patch Areas

a. The Contractor shall protect from rainfall with sheet plastic material the areas being worked on to minimize the penetration of water into the aggregate base and subgrade prior to placing the new pavement. Any damages to open patch areas left uncovered shall be repaired at the Contractor's expense.

b. Temporary drainage trenches to dispose of any water accumulated in the work areas shall be constructed by the Contractor as shown on the plans or ordered by the Engineer.

This work shall be a subsidiary obligation of the Contractor under the pavement removal pay item.

### 402-3.10 Bituminous Plant-Mix Overlays

a. The construction of bituminous plant-mix overlays shall be performed in accordance with all the requirements of Specification 401 - Hot Plant-Mix Bituminous Pavement except as specifically modified by this specification.

b. Bituminous plant mix shall be placed in courses of the thicknesses and widths shown on the plans or as directed by the Engineer.

c. In non-contiguous patch areas of less than 10 square meters, the bituminous mixes may be laid and spread with graders and shall be compacted with pneumatic wheel rollers.

### 402-4 METHOD OF MEASUREMENT

**402-4.01** Test cores of the bituminous concrete pavement included in the contract documents or ordered by the Engineer will be measured by the number of cores acceptably drilled and delivered to the Engineer. When the Engineer orders that a core be extended through the aggregate base and subbase, and the subgrade, to an additional depth of up to 60 centimeters as per paragraph 402-3.01b, such core shall be counted as two cores for measurement and payment purposes.

**402-4.02** The partial depth removal and disposal of bituminous concrete pavement by cold milling will be measured and paid for by the square meter of pavement acceptably removed and disposed of under Specification 403.

**402-4.03** The full depth removal and disposal of bituminous concrete pavement will be measured by the cubic meter of pavement acceptably removed and disposed of. Any pavement area in which

both partial depth removal by cold milling and full depth removal is performed will be included for payment under both pay items.

**402-4.04** Test pits ordered by the Engineer to be excavated into the aggregate base, subbase and subgrade, will be measured by the number of such pits excavated.

**402-4.05** The removal and disposal of unsuitable aggregate base course, subbase and subgrade material ordered by the Engineer will not be measured for direct payment. This work shall be a subsidiary obligation of the Contractor under the pay items of subbase and aggregate base course materials used to replace the removed materials.

**402-4.06** The subbase and aggregate base course materials used to replace removed subgrade, subbase and aggregate base materials will be measured by the cubic meter of each class of compacted material accepted in final position.

**402-4.07** Bituminous hot-plant mix for filling ruts, replacing removed bituminous concrete, and placed in overlays will be measured and paid for as provided in Specification 401 - Hot Plant-Mix Bituminous Pavement.

**402-4.08** The adjustment of existing manholes, inlets, valve boxes and other structures within or abutting the pavement will be measured and paid for under the respective pay items under Specification 604 - Manholes, Inlets and Catch Basins.

### 402-5 BASIS OF PAYMENT

**402-5.01** The accepted quantity of test cores, determined as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for drilling the cores, including any extensions ordered, disposing of the removed material, and backfilling the hole where required.

**402-5.02** The accepted quantity of full depth removal of bituminous concrete pavement, determined as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for excavating the pavement and disposing of the excavated material.

**404-5.03** The accepted quantity of test pits, determined as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for excavating the test pits, disposing of the excavated materials and backfilling the pits when no further removal and replacement of the material underlying the pavement is performed.

**402-5.04** The accepted quantities of replacement of subbase and aggregate base course material, determined as provided above, will be paid for at the respective contract unit prices. Such prices and payment shall constitute full compensation for the excavation and disposal of unsuitable base, subbase and subgrade material and the furnishing, placing, compacting and finishing of the specified replacement materials.

**402-5.05** In addition to the above, payment under the unit prices listed below shall constitute full compensation for all materials, equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

402-5.06	Payment will be made under:
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Pay Item

Pay Unit

Test Cores	Each
Test Pits	Each
Replacement Subbase Material	Cubic Meter
Replacement Aggregate Base Course	Cubic Meter
Full Depth Removal of Bituminous Concrete	
Pavement	Cubic Meter

## 403-1 DESCRIPTION

**403-1.01 Scope** - This work shall consist of the partial-depth removal of existing bituminous concrete pavement by cold milling in accordance with these specifications and in conformity with the lines, grades, dimensions and cross sections shown on the plans or established by the Engineer. This work is normally performed to remove excess or deteriorated pavement and to provide the desired road profile and cross section prior to laying a new bituminous concrete surface.

### 403-2 MATERIALS

403-2.01 No materials are specified.

## 403-3 CONSTRUCTION REQUIREMENTS

### 403-3.01 Milling Equipment

a. The cold milling shall be accomplished by a power driven, self-propelled machine which is specifically designed for automatically controlled removal to a specified depth of bituminous concrete pavement or removed to a specified grade line. The equipment shall be of such size, shape and dimensions as will allow it to operate on a full traffic lane 3.65 M (12 ft) wide without restricting the safe passage of traffic in adjacent lanes.

b. The milling machine shall be equipped with automatic grade and slope controls operating from a string line or a ski not less than 20 feet long and shall be capable of removing pavement to an accuracy of  $\pm 1/8$  inch from the control depth or grade line. The automatic controls shall provide for accurately establishing profile grades at each edge of the machine by referencing from an independent grade reference.

c. There shall also be available a small milling machine with a short turning radius for use in milling around manholes and at other irregular or confined areas.

d. Power driven conveyors capable of side, rear or front loading shall be provided together with the necessary equipment to transfer the milled material from the roadway to a truck.

e. The machine shall be equipped with a system to effectively control the dust generated by the cutting operations so as to minimize the dust emissions and air contamination.

f. The equipment shall be furnished with a lighting system adequate for night work.

### 403-3.02 Construction Sequence

a. Partial depth removal of bituminous concrete pavement by the cold milling procedure shall be performed within the appropriate place in the sequence of pavement rehabilitation operations provided in Article 402-3.02 of Specification 402 - Rehabilitation of Bituminous Concrete Pavement.

b. No cold milling operations shall be performed on a cracked pavement until any required full depth repairs in marked areas have been completed.

### 403-3.03 Milling and Disposal Operations

a. The bituminous concrete pavement shall be removed by cold milling to the depth, width, grade and cross section shown on the plans or ordered by the Engineer. The number of equipment passes required to achieve the specified width

and depth of cut, profile grade and cross slope shall be determined by the Contractor.

b. The milling operations shall be so scheduled as to proceed in a manner that will produce a uniform finished surface, maintaining a constant cross slope between lane edges.

c. In the event the entire width of a pavement along a section has not been milled by the end of a work period, resulting in a vertical longitudinal face to be exposed to traffic, the maximum deviation between the two adjacent surfaces shall not exceed 3.8 centimeters  $(1 \ 1/2 \ in.)$ .

d. Vertical cuts along a gutter line will be allowed at the end of a work period. However, should the depth of the cut exceed 7.5 centimeters (3 in.) the Contractor shall erect, at his expense, signing and warning devices in accordance with the requirements of Part VI of the DTPW's "Manual de Dispositivos Uniformes para el Control de Tránsito en las Vías Públicas de Puerto Rico".

e. When the leveling and final surface courses are not to be placed on the same day that the milling operation is performed, the Contractor shall construct temporary openings to existing drainage structures to facilitate the removal of runoff from the pavement. This work shall be a subsidiary obligation of the Contractor under the cold milling pay item.

f. Transverse vertical edges in the pavement produced by the removal operations shall be tapered at the end of the work period prior to opening to traffic. The taper shall extend at least one meter per each 2.5 centimeters of vertical difference.

g. Adequate loading, sweeping, dust control and hauling equipment shall be provided by the Contractor to remove all

milled pavement material on a daily basis. Unless otherwise provided in the contract documents, the pavement materials removed shall become the property of the Contractor.

h. At locations where the bituminous concrete pavement cannot be removed by the power driven milling machines because of physical or geometrical restraints that preclude the use of the equipment, the pavement may be removed by other methods acceptable to the Engineer. However, in such cases, the edges of the areas to be removed shall be saw cut to a depth of at least 5 centimeters.

i. Patch areas where the existing bituminous pavement has been only partially removed shall be resurfaced on the same day as required under Specification 402.

j. Where same day resurfacing is not mandatory, such as in full width partial depth pavement removal, the placing of leveling and final surfaces courses shall be completed as soon as possible, but not later than five days, after the milling operations have been completed.

### 403-3.04 Surface Tolerances

a. The cold milling operations shall produce a pavement surface that is true to line, grade and cross-section, and of uniform texture.

b. The milled pavement surface will be subject to visual and straight edge inspection. The Contractor shall provide a 3-meter aluminum straightedge for testing. The milled surface shall not deviate more than 0.6 centimeter (1/4 in.) when tested longitudinally and transversely with the 3-meter straightedge.

c. The transverse slope of the milled surface shall conform to the specified slope within 0.25 percent.

d. All irregularities in excess of the specified tolerance shall be corrected at the Contractor's expense.

### 403-4 METHOD OF MEASUREMENT

**403-4.01** Cold milling of bituminous concrete pavement will be measured by the square meter of pavement acceptably milled to the grades and areas specified on the contract documents or established by the Engineer.

a. For each strip of existing pavement removed by the cold milling process, the volume removed will be determined by multiplying the average depth removed, measured to the nearest millimeter, by the length and width of the strip measured to the nearest centimeter.

b. The average depth of each strip will be determined by measuring the depth removed at the lip along the longitudinal edge of the strip, every 6.0 meters or fraction thereof, and averaging these measurements.

c. Pavement removed in excess of the depth, cross section or profile grade specified in the plans, or ordered by the Engineer, will not be included in the measurement for payment.

**403-4.02** Dust control and the loading, hauling and disposal of the milled pavement material will not be measured for direct payment but shall be a subsidiary obligation of the Contractor under the cold milling pay item.

### 403-5 BASIS OF PAYMENT

**403-5.01** The accepted volume of bituminous concrete pavement milled, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for all materials, equipment, tools, labor and

incidentals necessary to complete the work as required by the plans and specifications.

403-5.02 Payment will be made under:

Pay Item

Pay Unit

Cold Milling Bituminous Concrete Pavement... Square Meter

## 609-1 DESCRIPTION

### 609-1.01 Scope

a. This work shall consist of the construction of curb, gutter or combination curb and gutter in accordance with these specifications and in reasonably close conformity with the lines, details, and grades shown on the plans or established by the Engineer.

b. The types of curbs and gutters covered by these specifications are as follows:

- 1. Cast in place concrete curb.
- 2. Cast in place concrete gutter.

3. Cast in place combination concrete curb and gutter.

- 4. Precast concrete curb.
- 5. Precast combination concrete curb and gutter.

c. Unless otherwise specified in the contract documents, the Contractor may, at his option, furnish either cast in place or precast curb or curb and gutter.

## 609-2 MATERIALS

**609-2.01** Portland cement concrete for cast in place concrete curb, gutter and combination concrete curb and gutter shall meet the requirements of Specification 601 - Structural Concrete for the class of concrete indicated on the plans. If no class is specified in the plans, Class B concrete shall be provided.

**609-2.02** Precast concrete curb and curb and gutter shall meet the requirement specified in Section 712-4 of Specification 712 -

Miscellaneous Materials. Precast sections shall be reinforced as required to permit lifting, hauling and placing without damage.

**609-2.03** Other materials shall meet the requirements of the following specifications:

#### Material

Specification

Bed Course Material	703-5
Joint Filler	705-1
Joint Mortar	705-2
Curb Paint	716-1
Glass Beads for Reflectorized Paint	716-2
Reflectorized Paint	716-3

**609-2.04** Concrete and manufactured curbing materials will be subject to inspection and tests at the plants for compliance with quality requirements.

### 609-3 CONSTRUCTION REQUIREMENTS

### 609-3.01 Cast in Place Concrete Curb and Curb and Gutter

a. Excavation and Bedding - Excavation shall be made to the required depth, and the base upon which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with bed course material which shall be thoroughly compacted.

b. Forms - Forms shall be of metal and shall extend for the full depth of the concrete. Wooden forms may be used, when authorized by the Engineer, on short radius curves such as at street intersections and at such other locations for which curved metal forms may not be available. All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with an approved form release agent or

form oil before concrete is placed. Divider plates shall be of metal. Forms shall conform to the specified radius when placed on curves.

c. Mixing and Placing - Concrete shall be proportioned, mixed and placed in accordance with the requirements for the class of concrete specified. Consolidation of concrete placed in the forms shall be by mechanical vibration or other methods acceptable to the Engineer. Forms shall be left in place for 24 hours or until the concrete has set sufficiently so that they can be removed without injury to the curbing.

d. Finishing - Immediately upon removal of the forms the exposed surfaces of the curbing shall be given a Class 2 -Rubbed Finish with a carborundum stone in accordance with Specification 601 - Structural Concrete. For the purpose of matching adjacent concrete finishes or for other reasons, the Engineer may permit other methods of finishing. Plastering will not be permitted.

e. Sections - Curbing shall be constructed in sections having a uniform length of 3 meters, unless otherwise ordered. Sections shall be separated by open joints 3mm wide except at expansion joints. Where the curbing is constructed adjacent to concrete pavement, these open joints in the curbing shall match the contraction joints in the pavement.

f. Expansion Joints - Expansion joints shall be formed at the intervals shown on the plans using a preformed expansion joint filler having a thickness of 19mm. When the curb is constructed adjacent to or on concrete pavement, expansion joints shall be located opposite to or at expansion joints in the pavement.

g. Curing - Immediately upon completion of the finishing, the curbing shall be moistened and kept moist for three days, or the curbing shall be cured by the use of membrane forming material meeting the requirements of Section 711-1 of Specification 711. If after removal of the

forms back-filling is not done immediately, the surfaces thus exposed shall also be cured by the use of an approved membrane curing compound. The method and details of curing shall be subject to the approval of the Engineer.

h. Backfilling - After the concrete has set sufficiently, the spaces in front and back of the curb shall be refilled to the required elevation with suitable material, which shall be thoroughly tamped in layers of not more than 15 centimeters in depth. Backfilling at both front and back of new curb or curb and gutter constructed on projects open to traffic shall be completed within 48 hours after removal of the forms.

i. Curb Machine - The curb or curb and gutter may be constructed by the use of an automatic curb forming machine meeting the following requirements:

1. The weight of the machine shall be such that required compaction is obtained without the machine riding above the bed on which curbing is constructed.

2. The machine shall form curbing that is uniform in texture, shape and density.

3. The Engineer may permit the construction of curbing by means other than the automatic curber or machine, when short sections or sections with short radii are required, or for such other reasons as may seem to him to be warranted. The resulting curbing shall conform in all respects to the curbing produced by the use of the machine.

### 609-3.02 Precast Concrete Curb and Curb Gutter

a. Excavation and Bedding - Excavation and bedding shall conform to the requirements of paragraph 609-3.01a. above.
## **SPECIFICATION 609 – CURB AND GUTTER**

b. Installation - The curb shall be set so that the top lines conform to the line and grade required. All spaces under the curbing shall be filled with material conforming to the requirements of the material for bed course. This material shall be thoroughly tamped.

c. Joints - All joints, except expansion joints, shall be filled with mortar. In those cases where a portland cement concrete pavement is to be constructed contiguous to a curbing, joints shall be constructed in the curbing directly in line with the pavement expansion joints. These joints in the curb shall be 19mm in width and shall be filled with an expansion joint filler of the same nominal thickness as the pavement joint. Any voids between the filler and the precast curb shall be filled with mortar.

d. Backfilling - After the curb has been set, excavated areas shall be filled with approved material. This material shall be placed and thoroughly tamped in layers not exceeding 15 centimeters in depth.

**609-3.03 Reconstruction of Concrete Curb and Gutters** - The reconstruction of existing concrete curbs, gutters and combination curbs and gutters will be performed in accordance with the requirements included in Articles 609-3.01 and 609-3.02 above, as applicable.

#### 609-3.04 Painting Concrete Curbs

a. When called for on the plans, the exposed faces of concrete curbs shall be painted within the longitudinal limits indicated. Paint shall be reflectorized yellow paint unless otherwise shown on the plans.

b. Painting shall be performed in accordance with the applicable construction requirements specified under Section 639-3 of Specification 639-Painted Pavement Markings.

## **SPECIFICATION 609 – CURB AND GUTTER**

## 609-4 METHOD OF MEASUREMENT

**609-4.01** For both new construction and reconstruction, curb will be measured by the linear meter, to the nearest tenth, along the front face of the section at the finished grade elevation. Combination curb and gutter will be measured along the face of the curb. Concrete gutter will be measured along the centerline of the gutter.

a. No deduction in length will be made for drainage structures, such as grate inlets, installed adjacent to the curbing when the curb is constructed independent of the drainage structure.

b. When the drainage structure, such as curb type inlets, include their own section of curb, the length of such structure curbing will be omitted from the measurement of curb and curb and gutter.

c. No deduction in length will be made for driveway ramps or for wheel chair ramps where the gutter is carried across the ramp.

**609-4.02** Excavation, bed course, backfill, disposal of excess material and other miscellaneous items will not be measured directly for payment. These items and work shall be a subsidiary obligation of the Contractor with their cost included in the curb and curb and gutter pay items.

**609-4.03** The demolition and disposal of existing curbs, gutters, and combination curb and gutters to be reconstructed shall be a subsidiary obligation of the contractor under the pay items of curb, gutter, and curb and gutter reconstruction.

**609-4.04** The painting of concrete curb will be measured by the linear meter, to the nearest tenth, along the front face of the painted curbs.

## **SPECIFICATION 609 – CURB AND GUTTER**

#### 609-5 BASIS OF PAYMENT

**609-5.01** The accepted quantities, determined as provided above for the pay items listed below which are included in the contract, will be paid for at the contract price per unit of measurement. Such price and payment shall constitute full compensation for furnishing and placing all required materials and for all labor, equipment, tools and incidentals necessary to complete each item as required by the plans and specifications.

609-5.02 Payment will be made under:

#### Pay Item

#### Pay Unit

Concrete Curb, Type	Linear Meter
Concrete Gutter, Type	Linear Meter
Combination Concrete Curb and Gutter, Type	Linear Meter
Reconstruction of Existing Curb, Type	Linear Meter
Reconstruction of Existing Gutter, Type	Linear Meter
Reconstruction of Existing Curb and Gutter, Type	Linear Meter
Painting Concrete Curb	Linear Meter

# SPECIFICATION618–THERMOPLASTICANDPREFORMED PLASTIC PAVEMENT MARKINGS

## 618-1 DESCRIPTION

#### 618-1.01 Scope

a. This work shall consist of furnishing and applying pavement markings on the finished pavement surfaces at the locations shown on the plans, or ordered by the Engineer, and of the types, colors, patterns and dimensions called for in the contract documents, using thermoplastic compound or preformed plastic in conformance with these specifications.

b. These markings shall be of the following types:

1. Hot applied thermoplastic compounds which soften when heated and harden when cooled without changing the inherent properties of the material. These include any of the following:

(a) Reflectorized thermoplastic material that is extruded by mechanical means in a molten state onto a primed pavement surface with a surface application of glass beads.

(b) Reflectorized thermoplastic pavement marking material which is applied to the surface in a hot-spray powder form with a surface application of glass beads.

2. Reflective preformed plastic pavement marking material consisting of a polymer film with embedded glass beads, for direct application to the pavement.

## SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS

## 618-2 MATERIALS

#### 618-2.01 General

a. The materials shall be of the best quality available for the purpose in good commercial practice, and shall be free from all defects and imperfections that might affect the visibility and serviceability of the finished product.

b. Each container shall be clearly and adequately marked to indicate the color of the material, the process batch number or similar manufacturer's identification, the manufacturer's name and location of plant, and the date of manufacture.

c. The Contractor shall furnish manufacturer's certificates of the proposed materials showing that they meet the requirements of these specifications.

**618-2.02 Glass Beads** - The glass beads to be used to reflectorize pavement markings shall conform to Article 716-2, Glass Beads, of Specification 716.

**618-2.03** Thermoplastic Pavement Markings - Shall conform to the requirements of Article 716-4, Reflectorized Thermoplastic Pavement Marking Materials, of Specification 716. Any one of the two types covered in Article 716-4 may be used by the Contractor unless otherwise specified in the contract documents.

**618-2.04 Preformed Plastic Pavement Markings** - Shall conform to the requirements of Article 716-5, Reflectorized Preformed Plastic Film, of Specification 716. This material may be used for pavement markings on asphaltic concrete pavements in lieu of Thermoplastic Pavement Markings, unless specifically prohibited in the contract documents.

**618-2.05 Warranties** - All warranties on materials that are offered by manufacturers as normal trade practices shall be turned over by the Contractor to the Highway Authority.

# SPECIFICATION618–THERMOPLASTICANDPREFORMED PLASTIC PAVEMENT MARKINGS

#### 618-3 CONSTRUCTION REQUIREMENTS

#### 618-3.01 General

a. The surface to be marked shall be completely dry and free of dirt, curing compound, grease, oil, moisture, loose particles and any other material which would adversely affect the bonding of the markings to the surface. For portland cement concrete pavements, the Contractor shall clean the surface using water blasting at 3,000 psi. For hot plantmix bituminous pavements, surface shall be cleaned using compressed air or other effective means to the satisfaction of the Engineer.

b. The Contractor shall submit satisfactory evidence of having previously performed successful applications of the paving marking materials being used, or shall provide such evidence for his subcontractor, if one is used. He shall employ experienced technicians thoroughly familiar with the equipment to be used and the application of the pavement marking materials.

c. All markings shall be as shown on the plans or as ordered by the Engineer. Details not shown on the plans shall be in accordance with the "Manual de Dispositivos Uniformes para el Control de Tránsito en las Vías Públicas de Puerto Rico" (MDUCT) of the P. R. Department of Transportation and Public Works. All markings shall present a clear cut, uniform and workmanlike appearance. Any markings which fail to have a uniform, satisfactory appearance, either day or night, shall be corrected at the Contractor's expense.

d. Tack points shall be painted on the pavement at appropriate intervals for use in aligning the equipment that will apply the traffic stripes and, if necessary to achieve the required accuracy, a string line will be set from such points. The tack points shall be painted prior to opening any

## **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

pavement to traffic to provide for traffic guidance until the permanent markings are applied.

e. Before any final pavement marking work is begun, a schedule of operations shall be submitted for the approval of the Engineer.

f. When pavement markings are to be applied under traffic, the Contractor shall provide all necessary flags, markers, signs, cones, etc. to protect the markings until they are thoroughly set and can be crossed without tracking. The Contractor shall take all the necessary measures to control and protect the traffic while the marking operations are in progress and shall comply with the applicable provisions of Specification 638. The application of pavement markings shall be done in the general direction of traffic; striping against traffic shall not be allowed except when marking the centerline of a two-way, two-lane road.

g. The application of thermoplastic markings shall not be initiated until at least ten (10) days after the pavement is completed but shall be started no later than 5 days thereafter. However, the application of preformed plastic marking film which is to be inlaid on a fresh asphaltic concrete surface shall be made before the final rolling of the pavement.

#### 618-3.02 Reflectorized Thermoplastic Markings

a. Equipment - The thermoplastic material shall be applied to the surface utilizing either extrusion or spray application equipment appropriate for the type of material used and approved by the Engineer. It shall meet the following requirements:

1. The equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the shaping die shall prevent accumulation and

## **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

clogging. All parts of the equipment which come in contact with the material shall be easily accessible and exposable for cleaning and maintenance.

2. All mixing and conveying parts up to and including the shaping die, shall maintain the material at the plastic temperature with heat transfer oil or electrical element controlled heat.

3. The equipment shall assure continuous uniformity in the dimensions of the stripe and shall provide for varying die width to produce varying widths of traffic markings.

4. The applicator shall produce straight lines and true arcs and shall provide a means for cleanly cutting off square stripe ends and a method of applying "skip" lines. The use of pans, aprons or similar appliances which the die overruns will not be permitted.

5. The equipment shall include an automatic bead dispenser attached to the liner in such manner that the glass spheres are uniformly dispensed almost instantly upon the complete line. The bead dispenser shall be equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

6. A special kettle shall be provided for melting and heating the material. The kettle shall be equipped with an automatic thermostatic control device and temperature gage in order to provide uniform and positive temperature control to prevent overheating of the composition. The applicator and kettle must be so equipped and arranged as to satisfy the requirements of the National Board of Fire Underwriters.

#### **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

7. All of the equipment necessary to the preheating and application of the material shall be so designed that the temperature of the material can be controlled within the limits specified by the manufacturer and necessary to its pourability for good application. It shall permit agitation of the material to prevent scorching, discoloration or excessive high temperatures of any part of the material.

8. Applicator shall consist of either hand operated portable equipment for use in marking crosswalks, stop bars, arrows, legends, and short lengths of lane, edge, and centerlines; or truck mounted, self-contained equipment machines for marking lane, edge, and centerlines.

b. Sealing Primer - Prior to the application of the thermoplastic marking, a sealing primer if required, of the type and amount recommended by the manufacturer of the thermoplastic compound shall be sprayed on the clean and dry surface using mobile spray equipment. If necessary, as determined by the Engineer, the surface of new and existing bituminous pavements shall be washed with a detergent solution followed by a water rinse to remove any clay coating or other foreign material prior to priming or to applying the markings. On new or existing PCC pavement, the surface shall be abrasive blast cleaned to remove laitance, curing seal or other foreign material prior to priming.

c. The thermoplastic material shall be applied to the pavement at a temperature within the range specified by the manufacturer, normally between  $380^{\circ}$  and  $420^{\circ}$ F.

d. Application Rates - The various materials used to complete the reflectorized thermoplastic markings shall be applied at the following rates:

## **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

1. Primer - Unless otherwise recommended by the manufacturer, the primer shall be applied at a wet film thickness of  $5 \pm 1$  mils on asphaltic pavements and between 4 and 5 mils on PCC pavements.

2. Thermoplastic Material - Shall be applied to provide thickness ranging from a minimum of 110 mils to a maximum of 130 mils but with a minimum average of 120 mils. The Authority will measure at the edge of the pavement markings the thickness of the thermoplastic pavement marking above the pavement area and compute the average thickness. The Authority, in its judgment, may reject and require the removal and replacement, at the Contractor's expense, of pavement markings with excessive thickness or thickness variability in excess of the permissible range.

3. Glass Beads - Glass beads shall be automatically applied immediately behind the striping mechanism at a rate of one pound per 3 square meters of thermoplastic surface area.

e. The pigment shall be evenly dispersed throughout the marking and the density and character of the material shall be uniform throughout its thickness.

f. The completed marking shall maintain under traffic its original dimensions and placement. The ductility of the material shall be such as to permit normal movement with the road surface without chipping or cracking.

g. When the material is applied over an existing marking, the total thickness shall meet the requirements specified for new markings. New material applied over an old marking of compatible material shall bond itself to the old material in such a manner that no splitting or separation takes place during its useful life.

## **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

#### 618-3.03 Reflective Preformed Plastic Pavement Markings

a. Reflective preformed plastic pavement marking film shall be applied using the proper mechanical applicator and procedures recommended by the manufacturer that will assure an effective performance life.

b. This material is intended for inlay markings on fresh asphaltic concrete pavements. The marking film shall be inlaid in the fresh surface during final rolling of the mat before the pavement is opened to traffic.

#### 618-3.04 Tolerances

a. Dimensions - No marking shall be less than the specified width nor exceed it by more than 1.25 centimeters. The length of the marked segment for skip stripes and the open gap between segments may each vary plus or minus 30 centimeters, except that the over and under tolerance lengths shall approximately compensate.

b. Alignment - On tangents, and on curves of 1800 meter radius or larger, the alignment of the traffic stripes shall not deviate from the stringline line by more than 2.5 centimeters. On curves of less than 1800 meter radius, the maximum permissible variation will be 5.0 centimeters. The outer edge of pavement edge stripes shall fall uniformly at no less than 5.0 nor more than 10.0 centimeters from the edge of pavement and shall have no noticeable breaks or deviations in alignment.

c. Correction Rates - Any corrections in variations in the width or alignment of stripes shall not be made abruptly but the stripes shall be returned to the design width at the rate of at least 3.0 meters for each 1.25 centimeters of correction, and returned to the stringline alignment at the rate of at least 8 meters per 2.5 centimeters of correction.

# SPECIFICATION618–THERMOPLASTICANDPREFORMED PLASTIC PAVEMENT MARKINGS

#### 618-3.05 Corrective Measures

a. All markings which fail to meet the specifications, including the tolerance and appearance requirements, or are damaged by the Contractor's equipment and operations, shall be corrected at the contractor's expense. When necessary to correct a deviation which exceeds the permissible tolerance in alignment, that portion of the marking shall be removed and replaced in accordance with these specifications at the Contractor's expense.

b. All drip and spattered markings shall be removed to the satisfaction of the Engineer. Removal of markings shall be done by means approved by the Engineer, which will not damage the underlying surface of the pavement.

#### 618-3.06 Acceptance

a. When the work under this specification has been completed to the satisfaction of the Engineer, including any required corrective work, and the pavement is to be opened to traffic, acceptance will be made by the Engineer, independently of other remaining work under the contract, and the Contractor will be relieved of all maintenance of the markings except as covered by warranties or for damage caused by his operations.

#### 618-4 METHOD OF MEASUREMENT

**618-4.01** The accepted quantities of pavement markings will be measured as follows:

a. Stripes - Center, lane, pavement edge and other stripes or lines will be measured in lineal meters, to the nearest tenth of a meter, along their centerline as outlined below, completed and accepted.

## **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

1. Solid stripes will be measured from end to end of each continuous stripe.

2. Dashed or broken stripes will be measured end to end of each segment. No measurement will be made of the skip or open space.

3. The contract unit price of each type and color of stripe will be based on a width of 15 centimeters (6 inches). The measured length of lines or stripes wider or thinner than 15 centimeters (6 inches) will be adjusted in the ratio of their specified width to 15 centimeters (6 inches).

b. Symbols and letter markings will be measured by each unit applied and accepted. A unit will consist of one letter or one symbol.

## 618-5 BASIS OF PAYMENT

**618-5.01** The quantities determined as provided above for the pay items listed below which are included in the contract, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for furnishing and placing all materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

**618-5.02** Thermoplastic pavement markings found deficient in thickness but which are accepted by the Authority according to Article 618-3.02 d. (2) of this specification will be paid for at a reduced unit price.

## **SPECIFICATION 618 – THERMOPLASTIC AND PREFORMED PLASTIC PAVEMENT MARKINGS**

a. The reduced unit price will be computed in accordance with the following formula:

	RUP =	(1-R)*UP
Where	RUP =	Reduction in unit price
	R =	(120 – AMT) / 120
	R = price	Percentage reduction in unit
	UP =	Contract unit price
	AMT =	Average measured thickness of thermoplastic pavement markings measured in mils.

b. No additional payment will be made for thermoplastic pavement markings with excess thickness or thickness variability in excess of the permissible range which are accepted to remain.

618-5.03 Payments will be made under:

Pay Item	Pay Unit
Thermoplastic Pavement Markings Stripes, white or yellow	Linear Meter
Thermoplastic Pavement Marking Symbols and Letters, white	Each
Preformed Plastic Pavement Markings Stripes, white or yellow	Linear Meter
Preformed Plastic Pavement Markings Symbols and Letters, white	Each

#### 638-1 DESCRIPTION

#### 638-1.01 Scope

a. This work shall consist of maintaining traffic and protecting the public from damage to persons and property throughout the project construction area for the duration of the contract. The contractor shall be required to maintain and protect through and local traffic within the limits of the project, including traffic on all existing roads and streets which intersect the project within the project limits, and access driveways, except as otherwise provided on the plans or other contract documents. Traffic shall be maintained from the time the contractor begins work at the project site until final acceptance of the project.

b. All work to be performed shall be as shown on the plans and contract documents, as specified herein and as directed by the Engineer.

c. The work includes furnishing, installing, moving, removing, and maintaining temporary construction signs, barricades, cone, drums, pavement marking, guard rails, concrete barriers, impact attenuators, traffic signals, highway lighting and other traffic control devices as may be required for the maintenance and protection of traffic. It includes providing the necessary flag persons with appropriate equipment for adequate traffic control on the traveled way during construction operations. It also includes making any necessary repairs and maintaining the existing and temporary roadways within the project limits as required providing a reasonably safe and smooth traveled way.

d. All traffic control devices and traffic control operations shall be in accordance with the "Manual de Dispositivos Uniformes para el Control del Tránsito en las Vías Públicas de Puerto Rico" adopted by the Puerto Rico Department of Transportation and Public Works (DTPW) and

in particular with Part VI- "Controles de Tránsito para Operaciones de Construcción y Conservación en Calles y Carreteras" of this manual and/or with the Manual on Uniform Traffic Control Devices (MUTCD- FHWA) – Edition 2000.

e. The contractor is placed in notice that maintenance and protection of traffic over a highway during construction is considered as important as the construction itself. The contractor shall at all times conduct his operations in a manner to insure the convenience and safety of all travelers and abutting property owners as well as the safety of his own employees.

f. The contractor is also put in notice that he has the primary responsibility for providing the necessary traffic control devices and taking other appropriate measures for the protection of the public and his personnel. The fact that provisions may be included in the plans and other contract documents, or may be ordered by the Engineer, for the maintenance and protection of traffic during construction, including the payment for certain items under this relieve his specification, does not the contractor of responsibility under Articles 104.07, 107.08, 107.11 and 107.15 of the General Provisions. In the absence of specific provisions in the contract plans and specification, or instructions from the Engineer, the Contractor shall provide at his expense such additional devices and operational measures as may be necessary for the protection of the public and his employees.

#### 638-2 MATERIALS

#### 638-2.01 General

a. All traffic control devices shall conform to the design, dimensions, materials, color, fabrication and installation requirements specified on the plans, the "Manual de Dispositivos Uniformes para el Control del

Tránsito"(MUTCD), the Manual de Señales de Tránsito (MST) of the DTPW, the standard drawings of the Authority, and the applicable standard specifications as may be modified by the specification and/or with the Manual on Uniform Traffic Control Devices (MUTCD- FHWA) – Edition 2000.

b. All traffic control devices, whether new or used, shall be in good working condition and shall be subject to approval by the Engineer.

c. Reflecting sheeting of the high intensity type, meeting the requirements of Article 613-2.02 of Specification 613 shall be used on all devices requiring reflectorization.

d. All other materials whether paid under this specification or under other contract items, shall meet the requirements of their respective specifications.

#### 638-2.02 Construction Signs

Sign panels may be made of aluminum, galvanized steel or marine plywood. Sign posts shall be metallic as shown on the standard drawings but wood supports may be used when so designed as to yield if impacted by moving vehicle. Nothing larger than 2"x 2" nominal size timber shall be used, except that 2"x 4" may be used with a 2" bored drilled 4"above level on the 4"side.

#### 638-2.03 Barricades, Drums and Cones (limited use)

Barricades shall be constructed of wood or plastic. Drums shall be plastic with conic, round or square section, approximately 36 inches high and a minimum of 18 inches in diameter. Cones shall be used on low-volume, low-speed (40MPH or less) roadways only. Never shall be used on expressway, freeway or toll roads. They shall be a minimum of 28 inches in height with a broadened base, orange colored and shall be made of a material that can be struck without causing damage to the impacting vehicle. Barricades, drums and cones shall be marked and reflectorized in accordance with the

requirements of Part VI of the MDUCT. The name and the telephone number of the Contractor shall be shown on the non-retro reflective surface of all types of channelizing devices. Both, the letters and numbers shall be non-retro reflective and not over 50 mm (2 in.) in height.

## 638-2.04 Temporary Pavement Markings

Temporary pavement markings shall comply with the following requirements:

a. When placed on temporary pavement surfaces or on a layer of the pavement, which is to be subsequently covered, by another layer, reflectorized traffic paint or removable reflectorized traffic tape shall be used at the option of the Contractor.

b. When placed on the final finished pavement surface, only removable reflectorized traffic tape shall be used.

c. Reflectorized traffic paint shall be conforms to the appropriate requirements of Specification 639 - Painted Pavement Markings.

d. Removable reflectorized traffic tape shall be consist of glass spheres of a high optical quality imbedded into a polymeric bonder film on a suitable backing that is precoated with a pressure sensitive adhesive and conforming to the following requirements:

> 1. The glass spheres shall be uniform graduation and distributed evenly over the surface of the tape. The spheres adhesion shall be such that the spheres are not easily removed when the tape surface is scratched with the thumbnail.

2. The color of the tape shall conform to the standard colors for pavement markings and shall be readily visible when viewed under vehicular headlights a night.

3. The tape shall be precoated with a pressure sensitive adhesive and shall be capable of being adhered to bituminous concrete or Portland cement concrete pavement surfaces without the use of heat, solvents or other additional adhesive means. It shall be immediately ready for traffic after application and shall be capable of being removed intact or in large strips either manually or with a recommended roll-up device upon completion of service. A non-metallic medium shall be incorporated to facilitate removal.

4. The tape, when applied in accordance with the manufacturer's recommended procedure, shall be o good appearance, free of cracks, and its edges shall be true, straight and unbroken. The tape shall be weather resistant, and shall show no appreciated fading, lifting or shrinkage during its useful life.

#### 638-2.05 Temporary Post Mounted Guard Rail

Temporary post-mounted guard rail shall be of the corrugated steel beam type conforming to the requirements shown on the plans and Specification 606.

#### 638-2.06 Temporary Concrete Barrier

Temporary concrete barrier sections shall be portable, shall be not less than 3 meters in length, and shall conform to the shape and dimensions shown on the plans, he Standard Drawings, MPT 3 to MPT 8 and to the applicable requirements of the Specification 610 - Concrete Barrier. Lifting devices shall no protrude from the sides of the barrier.

## 638-2.07 Temporary Impact Attenuators

Temporary impact attenuators shall be the sand-filled plastic drum type conforming to Specification 620. They shall be installed as indicated on the plans or as ordered by the Engineer.

## 638-2.08 Temporary Traffic Signals

Temporary traffic signals shall conform to the requirements shown on the plans and to the appropriate sections of Specification 654 and 723. Used equipment such as signal heads controllers, poles and mast arms may be furnished, subject to approval by the Engineer, provided it is in good operating condition.

## 638-2.09 Temporary Highway Lighting

Temporary highway lighting shall conform to the requirements specified in the contract documents and to the appropriate sections of Specification 612 and 714.

#### 638-2.10 Flashing Arrow Signs

Flashing arrow signs shall conform to the details shown on the plan and shall comply with the following requirements:

a. Sign boards shall be rectangular in shape and finished in flat black enamel. They shall be either 4 feet high by 8 feet wide or 3 feet high by 6 feet wide as indicated in the contract documents. When no size is specified, the 4'x 8'size shall be approved.

b. Lamps shall be mounted on the sign board in such a way as to be capable of forming each of the following patterns:

Pattern 1 – Flashing arrow left Pattern 2 – Flashing arrow right Pattern 3 - Sequential arrow left

Pattern 4 – Sequential arrow right Pattern 5 – Simultaneous mode Pattern 6 – Caution mode

c. In the flashing arrow patterns all lamps forming the arrowhead and shaft shall flash on and off simultaneously. In the sequential arrow patterns, either arrowheads or arrow shall flash sequentially in the direction indicated or the arrow shall be formed sequentially from the shaft to the head in three steps. In the simultaneous mode, the lamps forming both left and right arrowheads and the lamps of the arrow shaft shall flash on and off simultaneously. The first light on the shaft next to the light on the arrowhead point shall remain unlit when that arrow head lights up. In the caution mode, a combination of four or more lamps shall flash on and off in a pattern that will not indicate direction.

d. There shall be no less than fifteen (15) lamps on the sign. These shall be either recess-mounted or each lamp provided with a hood or visor surrounding the upper half.

e. Lamps shall be 12 volt, sealed-beam units, yellow or amber color. Lamps shall be type PAR 46 but on the 3' x 6' size signs PAR 36 may be used. The lamps shall provide a minimum candlepower at design voltage of 8,800 on the 4'x 8' sign and 7,000 on the 3'x 6' signs.

f. Lamps shall be controlled by an electronic o electromechanical circuit that will provide between 30 and 45 complete operating cycles per minutes in each of the patterns specified. A dimmer control capable of varying the lamps voltage from 6 to 12 volts shall also be provided. The dimmer shall automatically dim the arrow board at night. The control switch box shall be lockable.

## 638-2.11 Warning Lights

Warnings lights shall be of the steady burning type meeting the requirements of Part VI of the MUTCD.

#### 638-2.12 Roadway Maintenance

Existing and temporary pavements shall be kept free of trash and debris and in good repair using materials compatible with the pavement.

## 638-3 CONSTRUCTION REQUIREMENTS

#### 638-3.01 General

a. The Contractor shall notify the Engineer before starting any work that might inconvenience or endanger traffic. Arrangements shall be made by the Contractor for closing the road, if required, and providing detours, signs barricades and other necessary appurtenances for the maintenance and protection of traffic prior to beginning the work.

b. The Contractor shall follow the provisions for traffic maintenance indicated on the plans or ordered by the Engineer. The Contractor may submit alternative traffic maintenance plans for approval by the Engineer.

c. The Contractor shall provide a traveled way suitable for two lanes of moving traffic, or more lanes when specified in the contract documents. The traveled way shall be kept reasonably smooth and hard at all times, and shall be well drained and free of potholes, bumps, irregularities and depressions that hold or retain water. The Contractor shall devote particular attention to all drainage facilities, keeping them fully operative at all times. This work will be paid for as maintenance as per paragraph 638-5.01g. except for damage caused by the Contractor.

d. Construction operations shall be conducted in such way as to insure a minimum of delay to traffic. Construction operations on high volume highways may be restricted to off-peak periods of the day. Stopping traffic for more than five minutes shall not be permitted unless specifically authorized by the Engineer.

e. The Contractor shall keep the traveled way free of foreign objects such as spilled earth, rocks, timber, and other items that may fall from transporting vehicles.

f. Dusty conditions resulting from the Contractor's operations shall be corrected by the used of calcium chloride, water, or other mans acceptable to the Engineer, at the Contractor's expense.

g. The Contractor shall provide and maintain at all times, safe and adequate pedestrian and vehicular ingress and egress to and from intersecting highways, houses, businesses, and other establishment at existing or new access points, consistent with the work, unless otherwise shown on the plans or authorized by the Engineer. This work shall be at the Contractor's expense.

h. Existing traffic signs and other traffic control devices within the project limits that are to remain shall be protected from damage by construction operations. Any such items lost or damaged because of negligence on the part of the Contractor shall be replaced at the Contractor's expense. Should temporary relocation of any such items be required because of construction operations, they shall be placed as directed by the Engineer at the Contractors expense.

i. In the event of an unauthorized suspension of work by the Contractor or when a temporary suspension of work is ordered by the Engineer because of failure of the Contractor to comply with any of the contract provisions or to carry out any legitimate order of the Engineer, it shall be the

Contractor's responsibility to maintain the traffic in accordance with the requirements of this specification. During the days on which such suspension is in effect, the cost of maintenance of traffic will be borne by the Contractor at no extra cost to the Highway Authority. Maintenance of traffic during any authorized suspension of work for reasons not attributable to the Contractor's fault or negligence will be paid for in accordance with this specification.

j. The Contractor shall not permit his employees to park their vehicles nor shall he store equipment or materials adjacent to the traveled way where it may be a hazard to traffic. A clear distance from the edge of the pavement consistent with the type of highway and space available shall be kept free of any such obstacles.

k. Whenever construction operations near the traveled way result in a hazardous condition to the traveling public, such as excavation and replacement or shoulders, the extent of such operations should be limited to work that can be replaced within a reasonable period of time. Once started, such work should progress continuously to completion within a reasonable extent of time.

1. Temporary traffic control devices shall remain in operation only as long as they are needed for traffic guidance and safety. Only those devices shall be in place as apply to conditions and operations in existence at a particular time.

m. All traffic control devices shall be cleaned, repainted, reflectorized or replaced as necessary to provide adequate visibility and legibility at all times. This work shall be at the Contractor's expense.

n. Any materials in good condition recovered from existing or temporary installations of guard rail, impact attenuators, traffic signals and highway lighting within the project limits may be incorporated into the final project

location by the Contractor as called for in the plans and the Contractor will be compensated under the corresponding pay item. The use of the such materials shall be subject to approval by the Engineer.

o. The items for the maintenance and protection of traffic furnished by the Contractor under this specification are his property. The items shall be promptly removed from the project after they are no longer required except those items specifically indicated in the contract to remain after completion of construction.

#### 638-3.02 Construction Signs

a. The Contractor shall furnish, erect, maintain, move and remove construction signs as required and as directed by the Engineer to adequately and safely inform and direct the traveling public.

b. The number of signs indicated in the MDUCT and the plans area a minimum and the Engineer may require additional signs. The Contractor shall have an adequate quantity of these signs on hand prior to starting construction operations for use as required.

c. All signs and markers shall be appropriate for actual existing conditions and shall be covered, moved removed, relocated or changed as required by changed conditions or as directed by the Engineer.

d. All signs shall be kept clean and in good condition for the duration of the contract. They shall be mounted at the required height on adequate supports and placed in proper position and alignment so as to give maximum visibility both day and night.

e. During non-working hours and following the completion of a particular construction operation, all warning signs, except those required to remain for the safety of the public, shall be removed or covered as indicated in the standard drawings.

#### 638-3.03 Barricades, Drums and Cones

a. The Contractor shall furnish, erect, maintain, move, replace and remove construction barricades, drums and cones where and as indicated on the plans, in the MDUCT, Part VI, or as directed by the Engineer.

b. Where indicated on the plans or proposal, or directed by the Engineer, construction barricades shall be supplemented by approved steady burning lights as appropriate. The operation and maintenance of such lights shall be at the Contractor's expense.

c. Whenever construction work results in a long-term stationary operation, temporary concrete barriers shall be used instead of plastic drums.

#### 638-3.04 Temporary Pavement Markings

a. The Contractor shall furnish, apply and, when so ordered, remove temporary payment markings when shown on the plans or as ordered by the Engineer. Unless otherwise indicated in the contract documents, or ordered by the Engineer, any course of asphaltic concrete, including base courses, upon which traffic will be maintained shall be properly delineated as soon as completed. Concrete surfaces shall be marked prior to opening to traffic.

b. Paint used for pavement delineation shall be applied in accordance with Specification 639. Traffic tape shall be applied in accordance with the manufacturer's recommendations. Any tape that fails to adhere to the

pavement surface during the period of shall be replaced by the Contractor at no additional cost to the Highway Authority.

## 638-3.05 Removal of Pavement Markings

The Contractor shall remove existing and temporary pavement markings as shown on the plans or ordered by the Engineer. The existing pavement markings may be removed by grinding, sandblasting, scraping or any other method approved by the Engineer provided that it is conducted in such a manner that the pavement surface is not damaged or left in a pattern that will mislead or misdirect the motorist. Painting out pavement markings is not an acceptable method.

## 638-3.06 Temporary Guard Rail and Temporary Concrete Barrier

a. The Contractor shall furnish, install and maintain temporary guard rails or concrete barriers of the types indicated and at the locations shown on the plans, the Standard Drawings, volumen I (sheets MPT 3-8) or ordered by the Engineer prior to diverting traffic or prior to beginning the construction work necessitating the use of such barriers.

b. Temporary strong post type guard rail or concrete barrier shall be used when it is necessary to provide a barrier that will deflect or stop an impacting vehicle. They shall be moved and relocated as required by the construction operations and shall be removed when ordered by the Engineer. The sequence of removal shall be in the direction opposite to the traffic flow.

#### 638-3.07 Temporary Impact Attenuator

a. The contractor shall furnish, install and maintain temporary traffic impact attenuators of the inertial barrier type at the location shown on the plans or as ordered by the Engineer.

The impact attenuator for each particular location shall be designed and erected in accordance with the manufacturer's recommendations. It shall not be removed until ordered by the Engineer.

b. Any impact attenuator modules damaged by impacting vehicles shall be promptly replaced. If the damage is caused by the Contractor's forces, the replacement shall be at the Contractor's expense.

## 638-3.08 Temporary Traffic Signals

a. The Contractor shall furnish and install temporary traffic signals as shown on the plans or as directed by the Engineer and shall maintain them in proper operation until their removal is approved. He shall be responsible for their continuous operation except for reasonable shut down during relocation and transfer operations if such are required.

b. The Contractor shall paint on each signal controller cabinet a sign indicating the telephone to be called for repairs in case of malfunctioning of the signal system.

c. If for any reason a signal is not functioning as required, the Contractor shall commerce repair work on this signal within 4 hours after he has been notified of a malfunction. The Contractor shall provide adequate traffic control acceptable to the Engineer, at his own expense, during repair work and until the temporary traffic signal is restored to proper operation. If the Contractor fails complete the repair of a malfunctioning signal within a reasonable time, normally considered to be 24 hours, the Authority may opt to complete the necessary repairs and deduct the expenses incurred in such repairs from any monies due the Contractor.

d. The electric power consumption and the maintenance of the temporary traffic signals shall be at the Contractor's expense.

e. Any installed temporary traffic signal that is not in operation shall be bagged and have the power turned off.

#### 638-3.09 Temporary Highway Lighting

a. The Contractor shall furnish, install, operate and maintain temporary highway lighting as shown on the plans or as ordered by the Engineer and it shall remain in place and operation until its removal is ordered by the Engineer.

b. The electric power consumption and the maintenance of the temporary highway lighting shall be a subsidiary obligation of the Contractor under the temporary highway lighting pay items.

#### 638-3.10 Flashing Arrow Signs

a. Each flashing arrow sign shall be mounted on a truck or on a trailer and shall be capable of operating while the vehicle is moving. It shall also be capable of being placed and maintained in operation at stationary locations as shown on the plans or as directed by the Engineer.

b. Signs shall be mounted to provide a minimum of 7 feet between the bottom of the sign and the roadway.

c. The electrical power to operate the sign shall be obtained from the vehicle on which the sign is mounted, from a generating plant mounted on the vehicle, or from selfcontained batteries. Regardless of the source, the supply of electrical energy shall be capable of operating the sign in the manner specified.

d. Where batteries are used as the primary source of power they shall be of sufficient capacity to provide, between chargings, 11 volts or more to each of the lamps for a period of at least 72 continuous hours of operation at full daylight intensity. Units that operate on battery power shall have a

permanently mounted voltmeter which shall be wired so as to measure the voltage available to the lamps.

e. Trailer mounted units utilizing generators shall be equipped with storage batteries wired so that the units shall automatically switch to battery operation in the event of a generator failure. The standby batteries shall be of sufficient capacity to operate the units for a minimum of three hours in any pattern at 11 volts or greater.

## **638-3.11** Flag persons

a. The Contractor shall provide a sufficient number of competent flaggers in areas where construction equipment is operating in potential conflict with public traffic, regardless of the volume of traffic and the sight distances.

b. Whenever it becomes necessary to maintain traffic in two directions alternating in only one lane, the Contractor shall provide a sufficient number of flaggers of continuously control the alternating traffic and, if possible, provide twoway radio communication between the flaggers.

c. For daytime work, the flagger's vest, shirt, or jacket shall be orange, yellow, yellow-green, or a fluorescent version of these colors. For nighttime work, similar outside garments shall be retro reflective. The flagmen operate in conformance with the procedures and requirements of Part VI of the MUTCD.

#### 638-4 METHOD OF MEASUREMENT

**638-4.01 Individual Basis** –The various devices required for the maintenance and protection of traffic will be measured as follows:

a. Construction signs will be measured by the square meter of area, computed to the nearest hundredth, for signs

furnished, installed and accepted by the Engineer. Both fixed and portable signs will be measured for payment one time only, at the time of initial installation, except as provided under basis of payment. The relocation, removal, reinstallation and maintenance of temporary signs required for the maintenance of traffic during construction shall be a subsidiary obligation of the Contractor included in the contract unit price for this item.

b. Barricades (all types), cones drums and warning lights will be measured by the individual unit for the actual quantity of each furnished, installed and accepted by the Engineer. They will be measured one time only except as provided under the basis of payment. Their relocation, removal, reinstallation and maintenance as required for the maintenance of traffic should be a subsidiary obligation of the Contractor included in the contract unit price for this item.

c. Each construction sign, barricade, drum and cone accepted and certified for payment by the Engineer shall be identified as directed by the Engineer for inventory and control purposes.

d. The quantity of temporary pavement markings to be paid for will be the actual marking s placed as shown on the plans or ordered by the Engineer, measured as follows:

1. Pavement lines or stripes will be measured in linear meters, to the nearest tenth of a meter, along their centerline and shall be based on a 4-inch width. The linear measurement of lines or stripes specified to be wider than 4 inches shall be adjusted in the ratio of the specified width to 4 inches.

2. For dashed lines, the skip or open space between dashes will not be measured for payment.

3. Double lines will be measured separately as for single lines.

4. Symbols and letters will be measured by each unit applied. A unit will consist of one letter or one symbol.

5. The maintenance of temporary pavement markings throughout their period of need and use shall be an obligation of the contractor included in the contract unit price for this item.

6. The removal of temporary pavement markings will be an obligation of the Contractor under this pay item and no separate measurement and payment will be made.

e. The pay item for removal of pavement markings applies only on the removal of permanent markings existing prior to construction. The quantity to be paid for will be measured in liner meters to the nearest tenth of a meter. Measurement will be made as provided for temporary pavement markings in paragraph "d" above except that symbols and letters will also be measured linearly along their longest dimensions and not as units.

f. The quantity of temporary guard rail to be paid for will be the linear meters, measured to the nearest tenth of a meter, of guard rail of each type installed as shown on the plans or ordered by the Engineer. Required end anchorages, including connections at structures, will not be measured separately, but shall be a subsidiary obligation included in the contract unit price for this item. Terminal sections will be measured as for regular rail sections.

g. The quantity of temporary concrete barrier to be paid for will be the linear meters, measured to the nearest tenth of a meter, of barrier installed as shown on the plans or ordered

by the Engineer. Required temporary end sections will be included in the linear measurement. Temporary concrete barrier will be measured for payment only once, at the time of initial installation, except as provided under basis of payment. The relocation, removal and reinstallation of temporary concrete barriers as may be required during construction shall be a subsidiary obligation of the Contractor included in the contract unit price for this item.

h. Temporary impact attenuators installed as shown on the plans or ordered by the Engineer, other than those which are a subsidiary obligation of concrete barrier under Specification 610, will be measured by each inertial barrier module required. Each module will be measured for payment only once, at the time of initial installation, except as provided under basis of payment. The relocation, removal and reinstallation of modules as may be required shall be a subsidiary obligation of the Contractor included in the contract unit price for this item.

i. Each temporary traffic signal installation shown on the plans will be measured as a unit. Each unit will include all the necessary components to provide a complete operating installation including the signal heads, controller, standards, wiring, hardware, detectors, other appurtenances and power consumption.

j. Temporary highway lighting will be measured and paid for as provided in Specification 612-Highway Lighting System.

k. Flashing arrow signs will be measured by full days (24 hours) of actual operation of each unit required by the Engineer and furnished by the Contractor, and accepted by the Engineer.

1. Flagpersons will not be measured for direct payment but shall be a subsidiary obligation of the Contractor covered under other contract items.

m. Roadway maintenance items not covered by contract unit prices will be measured as required for force account work under Article 109.04 of the General Provisions.

#### 638-5 BASIS OF PAYMENT

#### 638-5.01 Payment

a. The quantities determined as provided above for construction signs, barricades (all types), cones, drums, warning lights, flashing arrow signs, temporary pavement markings, removal of pavement markings, temporary guard rail, temporary concrete barrier, temporary impact attenuators and temporary traffic signals will be paid for at the contract price per unit of measurement, respectively, for each of the particular pay items included in the bid schedule. The unit price shall be full compensation for all material, tools, equipment and labor necessary to complete each item as required by the plans and specifications, including erection, relocation, maintenance, operating costs, electric power costs, storage and removal.

b. Traffic control devices required for the maintenance of traffic that are removed from the project without the prior approval of the Engineer will not be considered for payment.

c. Any traffic control device that is damaged by traffic, vandalism or other cause attributable to negligence on the part of the Contractor will be repaired by force account or by agreed unit price, or will be replaced at the contract unit price when so ordered by the Engineer. However, no payment will be made for required repair or replacement of traffic control devices damaged by the Contractor's personnel or equipment,

or as a result of negligence on his part, or for normal maintenance.

d. No payment will be made for the repair and maintenance of temporary traffic signals and highway lighting required because of malfunctioning, normal wear and tear, or damage caused by the Contractor's personnel or equipment. However, repairs to these items required by damage due to traffic accidents or other cause not attributable to the Contractor will be paid for on a force account or agreed price basis as may be agreed upon with the Engineer.

e. Items necessary for the construction of temporary detours shown on the plans or ordered by the Engineer will be paid for on the basis of the contract unit prices of the appropriate items included in the contract.

f. Roadway maintenance items ordered and accepted by the Engineer as per paragraph 638-3.01c will be paid for in accordance with the provisions of Article 109.04 of the General Provisions. However, roadway maintenance required because of construction deficiencies, or because of damage caused by the Contractor's operations or equipment, shall be undertaken by the Contractor at this expense.

g. When the contract does not include any maintenance of traffic pay items, any construction signs, barricades, cones, drums, temporary pavement markings, temporary guard rail, temporary concrete barrier, temporary impact attenuators, temporary traffic signals and any other traffic protection devices required to comply with Article 107.11 of the General Provisions shall be furnished, installed and maintained by the Contractor and will not be paid for directly but this work shall be a subsidiary obligation of the Contractor covered under other contract items.

h. In the event that the Contractor fails to maintain traffic in a satisfactory manner in accordance with the requirements of Articles 104.7, 104.8 and 107.11 of the General Provisions and of this specification, and with the Violation Citation emitted by the Safety Office of the Authority, he will be assessed liquidated damages at the rate specified in the Article 108.09 of the General Provisions for each day for the violations indicated in the citation. The Engineer will notify the Contractor in writing of the effective date of the application of the penalty.

These fines or penalties are not reimbursable and are in addition to non-payment for items that the Contractor failed to provide and maintain under the requirements of this specification.

i. If the Contractor fails to maintain and project traffic adequately and safely for a period of 24 hours or more, the Engineer will correct the adverse conditions by any means he deems appropriate and will deduct the cost of such corrective work from any monies due the Contractor. The cost of this work shall be in addition to the liquidated damages and nonpayment for items specified above.

#### 638-5.02 Pay Items

Payment will be made under:

#### Pay Item

Pay Unit

Construction Signs	Square Meter
Barricades (All Types)	Each
Cones	Each
Drums	Each
Temporary Pavement Markings – Stripes	Linear Meter
Temporary Pavement Markings – Symbols and	
Letters	Each
Removal of Pavement Marking	Linear Meter
## **SPECIFICATION 638 – MAINTENANCE AND PROTECTION OF TRAFFIC**

Temporary Guard Rail	Linear Meter
Temporary Concrete Barrier	Linear Meter
Temporary Impact Attenuators	Each Module
Temporary Traffic Signals	Each
Flashing Arrow Signs	Full Days
	(24 hours)
Warning Lights	Each

### 640-1 DESCRIPTION

#### 640-1.01 Scope

a. This work shall consist of furnishing and installing raised pavement markings on the finished pavement surfaces at the locations shown on the plans, or ordered by the Engineer, and of the types, materials, colors, patterns and dimensions called for in the contract documents, and in accordance with these specifications.

b. Raised pavement markings shall be of the following types:

1. Non-reflective raised pavement markers consisting of a heatfired, vitreous, ceramic base with a heat-fired, opaque, white or yellow glazed surface.

2. Reflective raised pavement markers consisting of an acrylic plastic shell filled with a tightly adherent potting compound.

#### 640-2 MATERIALS

#### 640-2.01 General

a. The materials shall be of the best quality available for the purpose in good commercial practice, and shall be free from all defects and imperfections that might affect the visibility and serviceability of the finished product.

b. The Contractor shall furnish manufacturer's certificates of the proposed materials showing that they meet the requirements of these specifications.

**640-2.02** Non-Reflective Raised Pavement Markers - Shall conform to the requirements of Article 716-6 of Specification 716.

**640-2.03 Reflectorized Raised Pavement Markers** - Shall conform to the requirements of Article 716-7 of Specification 716.

**640-2.04 Warranties** - All warranties on materials that are offered by manufacturers as normal trade practices shall be turned over by the Contractor to the Highway Authority.

#### 640-3 CONSTRUCTION REQUIREMENTS

#### 640-3.01 Application of Markings

a. The surface to be marked shall be free of dirt, curing compound, grease, oil, moisture, loose particles and any other material which would adversely affect the bonding of the markings to the surface. The Contractor shall clean the surface using compressed air or other effective means to the satisfaction of the Engineer.

b. All markings shall be as shown on the plans or ordered by the Engineer. Details not shown on the plans shall be in accordance with the "Manual de Dispositivos Uniformes para el Control de Tránsito en las Vías Públicas de Puerto Rico" (MDUCT) of the P.R. Department of Transportation and Public Works. All markings shall present a clear cut, uniform and workmanlike appearance. Any markings which fail to have a uniform, satisfactory appearance, either day or night, shall be corrected at the Contractor's expense.

c. Tack points shall be painted on the pavement at appropriate intervals for use in aligning the markers when delineating traffic stripes and, if necessary to achieve the required accuracy, a string line will be set from such points. The tack points shall be painted prior to opening any pavement to traffic to provide for traffic guidance until the final markings are applied.

d. Before any final pavement marking work is begun, a schedule of operations shall be submitted for the approval of the Engineer.

e. When pavement markers are to be applied under traffic, the Contractor shall provide all necessary flags, markers, signs, cones, etc. to protect the markers until they are thoroughly set and can be crossed without damaging them. The Contractor shall take all the necessary measures to control and protect the traffic while the marking operations are in progress and shall comply with the applicable provisions of Specification 638. The application of pavement markers shall be done in the general direction of traffic; marking against traffic shall not be allowed except when marking the center line of a two-way, two-lane road.

f. The application of raised pavement markings shall not be initiated until at least ten (10) days after the pavement is completed but shall be started no later than 5 days thereafter.

g. Markers shall be bonded to the pavement using the adhesive specified in paragraph 716-6.03 of Specification 716. However, standard set type adhesive shall only be used when the installation will not be exposed to traffic for at least six hours.

h. No marker shall be placed over longitudinal or transverse joints of the pavement surface.

i. The adhesive shall be placed uniformly on the pavement surface or on the bottom of the marker in sufficient quantity to completely cover the base of the marker with no voids present and with a slight excess after the marker has been pressed in place. The marker shall be placed in position and pressure applied until firm contact is made with the pavement. Excess adhesive around the edge of the marker, excess adhesive on the pavement, and any adhesive on the surface of the marker shall be immediately removed. Soft rags moistened with mineral spirits conforming to Federal

Specification TT-T 291, or kerosene, may be used to remove adhesive from the exposed surface of the marker. The marker shall be protected against impact until the adhesive has hardened to the degree designated by the Engineer.

#### 640-3.02 Tolerances

a. Dimensions - The length of the segment for skip stripes delineated by raised markers and the open gap between segments may each vary plus or minus 30 centimeters, except that the over and under tolerance length shall approximately compensate.

b. Alignment - On tangents, and on curves of 1800 meter radius or larger, the alignment of the traffic stripes delineated by markers shall not deviate from the stringline line by more than 2.5 centimeters. On curves of less than 1800 meter radius, the maximum permissible variation will be 5.0 centimeters. The outer edge of pavement edge markings shall fall uniformly at no less than 5.0 nor more than 10.0 centimeters from the edge of pavement and shall have no noticeable deviations in alignment.

c. Correction Rates - Any corrections in variations in the alignment of markers shall not be made abruptly but the markers shall be returned to the stringline alignment at the rate of at least 8 meters per 2.5 centimeters of correction.

#### 640-3.03 Corrective Measures

a. All markings which fail to meet the specifications, including the tolerance and appearance requirements, or are damaged by the Contractor's equipment and operations, shall be corrected at the Contractor's expense. When necessary to correct a deviation which exceeds the permissible tolerance in alignment, that portion of the marking shall be removed and replaced in accordance with these specifications at the Contractor's expense.

b. Removal of markers shall be done by means approved by the Engineer, which will not damage the underlying surface of the pavement.

### 640-3.04 Acceptance

When the work under this specification has been completed to the satisfaction of the Engineer, including any required corrective work, and the pavement is to be opened to traffic, acceptance will be made by the Engineer, independently of other remaining work under the contract, and the Contractor will be relieved of maintenance of the markings after 3 months of service under traffic, except as covered by warranties or for damage caused by his operations.

## 640-4 METHOD OF MEASUREMENT

**640-4.01** Reflective and non-reflective raised pavement markers will be measured as units of the types and colors specified, determined from actual count in place and accepted.

## 640-5 BASIS OF PAYMENT

**640-5.01** The quantities determined as provided above for the pay items listed below which are included in the contract, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for furnishing and placing all materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

640-5.02	Payment will be made under:	
	Pay Unit	
Non-reflec Yellow.	ctive Raised Pavement Markers White or	Each
Reflective One way	Raised Pavement Markers	Each

#### **SPECIFICATION 702 – BITUMINOUS MATERIALS**

## 702-1 ASPHALT CEMENT

**702-1.01** Asphalt cements shall conform to the requirements of AASHTO M 226 for the viscosity grade specified, modified and supplemented as follows:

a. The asphalt cements shall conform to the requirements of Table 1 of AASHTO M 226 to which another viscosity grade AC-30 meeting the following requirements, is added:

-	Viscosity, 60C (140F), poises	3,000 <u>+</u> 600
-	Viscosity, 135C (275F), Cs-minimum	250
-	Penetration, 25C (77F), 100 g., 5 sec	30
	Minimum	
-	Flash Point, COC, C (f), minimum	232 (450)
-	Solubility in trichloroethylene, % - minimum	99.0
-	Test on residue from Thin-Film Oven	
	Test:	
	Viscosity, 60C (140F), poises - maximum	12,000
	Ductility, 25C (77F), 5 cm. per minute,	14

cm-minimum.....

# 702-2 CUTBACK ASPHALTS

**702-2.01** Cut-back asphalts shall conform to the requirements of the following specifications:

Rapid-Curing Type	AASHTO M 81
Medium-Curing Type	AASHTO M 82

#### 702-3 EMULSIFIED ASPHALTS

**702-3.01** Emulsified asphalts shall conform to the requirements of the following specifications:

Anionic Emulsified Asphalts	AASHTO M 140
Cationic Emulsified Asphalts	AASHTO M 208

## **SPECIFICATION 702 – BITUMINOUS MATERIALS**

#### 702-4 APPLICATION TEMPERATURES

**702-4.01** Bituminous materials for the several applications indicated in the specifications shall be applied within the temperature ranges indicated in Table 702-1 unless otherwise specified.

#### **TABLE 702-1**

#### APPLICATION TEMPERATURE FOR BITUMINOUS MATERIALS

	Application Temperature Range (°F)					
Type and Grade of	SPRAY	MIX				
Material	(Min Max.)	(Min. – Max.)				
Cut-backs						
MC-30	70 - 145	60 - 105				
RC or MC-70	105 - 185	155 - 190				
RC or MC-250	140 - 225	125 - 200				
RC or MC-800	175 - 265	160 - 225				
RC or MC-3000	215 - 290	200 - 260				
Emulsions						
All grades	50 - 160	50 - 160				
Asphalt Cements						
All grades	275 - 325	See Note 1				
1. As determined from th	1. As determined from the applicable temperature/viscosity					
chart. See Specification 401.						

#### **SPECIFICATION 703 – AGGREGATES**

# 703-1 FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE

**703-1.01** Fine aggregate for Portland cement concrete shall conform to the requirements of AASHTO M 6 but subject to the following:

- a. The requirements for soundness do not apply.
- b. The gradings given in Table 703-1 are suggested and not mandatory.

**703-1.02** Manufactured sands shall not be used in Portland cement concrete mixes for pavements, bridge decks or any other concrete structure which will serve as the travel surface for vehicular traffic.

#### TABLE 703-1 SUGGESTED GRADING OF FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE (AASHTO T-27)

	Percentage by Weight Passing			
Sieve Designation	Grading A	Grading B		
3/8"	100	-		
No. 4	95 - 100	100		
No. 8	-	90 - 100		
No. 16	45 - 80	80 - 100		
No. 50	10 - 30	10 - 45		
No. 100	2 - 10	2 - 10		

# 703-2 COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE

**703-2.01** Coarse aggregate for Portland cement concrete shall consist of crushed stone or crushed gravel conforming to the requirements of AASHTO M 80 but subject to the following:

## **SPECIFICATION 703 – AGGREGATES**

a. The maximum percentage of wear when tested as per AASHTO T 96 shall not exceed 40.

b. Suggested gradings are shown in Table 703-2.

c. Deleterious substances shall not exceed the limits of Class Designation B (Table 1 in M 80) for all uses. The soundness requirements do not apply.

d. The coarse aggregate in Portland cement concrete mixes for pavements, bridge decks and any other concrete that will serve as a surface for vehicular traffic shall have a minimum polishing value of 48% as determined by ASTM D 3319.

#### **TABLE 703-2**

#### SUGGESTED GRADATION FOR COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE

Designated		Percentage by Weight Passing Square Mesh Sieves (AASHTO T-27)								
Size	3	2-1/2	2	1-1/2	1	3/4	1/2	3/8	No. 4	No. 8
	inch	inch	inch	inch	inch	inch	inch	inch		
1/2" to No.4	-	-	-	-	-	100	90-100	40-70	0-15	0-5
3/4" to No. 4	-	-	-	-	100	90-100	-	20-55	0-10	0-5
1" to No. 4	-	-	-	100	90-100	-	25-60	_	0-10	0-5
1-1/2" to No.	-	-	100	95-100	-	35-70	-	10-30	0-5	-
4										
2" to No. 4	-	100	95-100	-	35-70	-	10-30	-	0-5	-
2-1/2" to No.	100	95-100	-	35-70	-	10-30	-	-	0-5	-
4										
1-1/2"to 3/4"	_	_	100	90-100	20-55	0-15	_	0-5	_	_
2" to 1"	-	100	90-100	35-70	0-15	-	0-5	-	-	-

#### **SPECIFICATION 703 – AGGREGATES**

# 703-3 AGGREGATES FOR HOT PLANT-MIX BITUMINOUS PAVEMENT

**703-3.01** Aggregates for hot plant-mix bituminous pavements shall conform to the grading requirements shown in Table 703-3 for each specified mix.

**703-3.02** Coarse aggregate (not passing the No. 8 sieve) shall be crushed stone or crushed gravel meeting the following requirements:

a. It shall be free from soft and disintegrated pieces, clay, organic or other deleterious matter.

b. The maximum percentage of wear when tested as per AASHTO T 96 shall not exceed 40.

c. Aggregate for surface courses shall have a minimum polishing value of 48% as determined by ASTM D 3319.

d. The coarse aggregate shall have the following minimum percentages of fractured faces:

Fractured	<b>Course Designation</b>				
Faces	Surface Leveling	Base			
One Face	75 50	50			

e. Maximum number of pieces with elongated faces shall not exceed 15%. An elongated face is one where the ratio of the longest dimension to the shortest dimension exceeds 5.

f. The grading of the coarse aggregate shall be such that when it is combined with other required aggregate fractions in proper proportion, the resultant mixture will meet the gradation required by the composition of the particular mix specified in the contract.

## **TABLE 703-3**

## AGGREGATE GRADINGS FOR HOT PLANT-MIX BITUMINOUS PAVEMENTS

	Percentage by Weight Passing Square Mesh Sieves (AASHTO T-27)					
Sieve	Base Co	ourses	urses Leveling Courses		Surface Course	
Designation	B-1	B-2	L-1	L-2	S-1	S-2
1-1/2"	100	-	100	-	-	-
1"	80-100	-	80-100	-	-	-
3/4"	70-90	100	70-90	100	100	100
1/2"	-	80-100	-	80-100	85-100	85-100
3/8"	55-75	70-90	55-75	70-90	70-90	75-92
No. 4	45-62	50-70	45-62	50-70	50-70	45-75
No. 8	35-50	35-50	35-50	35-50	35-50	40-55
No. 30	19-30	18-29	19-30	18-29	18-29	18-29
No. 50	13-23	13-23	13-23	13-23	13-23	13-23
No. 100	7-15	8-16	7-15	8-16	8-16	8-16
No. 200	0-83	4-10	0-8	4-10	4-10	4-10
Recommended Range in Compacted Depth in Centimeters for each Individual Course						
	7.5 - 10.0	3.8 - 7.5	7.5 - 10.0	2.5 - 5.0	3.8 - 6.3	2.5 - 3.8

# **SPECIFICATION 703 - AGGREGATES**

**703-3.03** Fine aggregate (passing the No. 8 sieve) shall consist of natural sand, stone screenings, or a combination thereof and shall conform to the quality requirements of AASHTO M 29 except that the soundness test is not required. It shall be of such gradation that when combined with other required aggregate fractions in proper proportion, the resultant mixture will meet the gradation requirements of the particular mix specified in the contract.

**703-3.04** Mineral filler for bituminous paving mixtures shall conform to the requirements of AASHTO M 17.

# 703-4 AGGREGATE FOR BASE COURSE

**703-4.01** Aggregate for untreated aggregate base course shall consist of hard durable particles or fragments of crushed stone or crushed or natural gravel conforming to the grading requirements shown in Table 703-4 for the grading class specified in the contract and meeting the following requirements:

a. Material shall be free from lumps of clay, vegetable matter or other objectionable matter.

b. The coarse aggregate not passing the No. 8 sieve shall have a percentage of wear, when tested by AASHTO T 96, of not more than 45.

c. Maximum number of pieces with elongated faces shall not exceed 15%. Elongated faces are defined in paragraph 703-3.02e.

d. The fraction passing the No. 200 sieve shall not be greater than two-thirds (2/3) of the fraction passing the No. 40 sieve.

e. The fraction passing the No. 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6.

#### **SPECIFICATION 703 – AGGREGATES**

f. When crushed aggregate is specified, not less than 50 percent by weight of the particles retained in the No. 4 sieve shall have at lease one fractured face.

#### **TABLE 703-4**

#### **GRADINGS FOR AGGREGATE BASE COURSE** (Percentage by Weight Passing Square Mesh Sieve)

	Grading Class					
Sieve	А	В	С	D		
Designation						
2"	100	-	-	100		
1 1/2"	-	100	-	-		
1"	50 - 80	-	100	50 - 80		
1/2"	-	40 - 75	-	-		
No. 4	20 - 50	30 - 60	40 - 75	20 - 50		
No. 10	_	_	25 - 60	_		
No. 200	5 - 12	5 - 12	5 - 12	0 - 5		

## 703-5 BED COURSE MATERIAL

**703-5.01** Bed course material for sidewalks, curbing, and paved waterways shall consist of sand, gravel, crushed stone or other approved material of such gradation that all particles will pass through a sieve having 1/2 inch square openings and not more than 12 percent shall pass a No. 200 sieve.

**703-5.02** Bed course material for slope paving shall be a porous material consisting of sand, gravel, crushed stone or other approved free-draining material. This material shall be uniformly graded and of such size that 100 percent of the material will pass through a sieve having 1 1/2 inch square openings.

## **SPECIFICATION 703 - AGGREGATES**

# 703-6 AGGREGATES FOR BITUMINOUS SURFACE TREATMENTS

**703-6.01** Aggregates for bituminous surface treatments, including seal coats, shall consist of crushed stone on crushed gravel conforming to the grading requirements shown on Table 703-5 for each specified grading class.

**703-6.02** The coarse portion of the aggregate not passing the No. 8 sieve shall meet the following requirements:

a. It shall be free from soft and disintegrated pieces, clay, organic material and other deleterious material.

b. A minimum of 75 percent of the material shall have at least one fractured face.

c. The maximum number of pieces with elongated faces shall not exceed 15%. Elongated faces are defined in paragraph 703-3.02e.

d. The maximum percentage of wear when tested as per AASHTO T 96 shall not exceed 40.

e. Aggregate for seal coats and for the top layer of other bituminous surface treatments shall have a minimum polishing value of 48% as determined by ASTM D 3319.

f. The aggregate shall have a retained bituminous film cover of no less than 95 percent when tested for coating and stripping under AASHTO T 182. Subject to approval by the Authority, a chemical additive may be used to aid in meeting this requirement.

**703-6.03** Sand and fine screenings shall consist of natural sand, stone screenings, or a combination thereof and shall conform to the quality requirements of AASHTO M 29 except that the soundness test is not required. It shall be of such gradation that when combined with other required aggregate fractions in proper proportion, the

#### **SPECIFICATION 703 – AGGREGATES**

resultant mixture will meet the gradation requirements of the particular class specified in the contract.

### 703-7 BLOTTER MATERIAL

**703-7.01** Blotter material shall be non-plastic rock screening or sand conforming to the gradation requirements of Size No. 10 of AASHTO M 43, and free from organic matter, clay or other deleterious material.

#### **TABLE 703-5**

### AGGREGATE GRADINGS FOR BITUMINOUS SURFACE TREATMENTS

Sieve	Grading Class					
Designation	А	В	С	D		
1"	100	-	-	-		
3/4"	90-100	100	-	-		
1/2"	0-35	90-100	100	-		
3/8"	0-12	0-35	85-100	100		
No. 4	-	0-12	0-35	85-100		
No. 8	-	-	0-8	0-20		
No. 200	0-1	0-1	0-1	0-1		

(Percentage by Weight Passing Square Mesh Sieve)

#### 716-1 PAVEMENT MARKING PAINT

**716-1.01** Pavement marking paint, white or yellow, shall conform to the requirements of AASHTO M 248 as modified and supplemented herein.

**716-1.02** All paint shall be furnished in strong, substantial and properly sealed containers. Five-gallon steel or plastic pails shall have a full diameter hub cover, wire bail and handle. Large containers, of 50 to 55 gallon capacity, shall be open-end drums equipped with a ring and lock closure, multi-seal reusable sponge gasket and removable lid which can be readily resealed after partial use of its contents. All containers shall meet current specifications of the U. S. Department of Transportation for transporting flammable liquids.

**716-1.03 Drying Time** - Unless otherwise specified in the contract documents, Type "N" traffic paint shall be furnished. It shall set to touch in not more than 15 minutes and shall dry hard so that there is no tracking under traffic in 30 minutes. At the Contractors' option a Type "F" paint, with a drying time of 3 to 5 minutes when heated in the applicator, may be used.

**716-1.04 Hiding Power** - The traffic paint when applied at the rate of 10 mils wet film thickness, using a suitable doctor blade (Bird Film Applicator or equivalent) shall show complete hiding over Morest Black and White Hiding Power Chart, Form 03-B (supplied by the Morest Company, 211 Center Street, New York 13, New York). If there should be questions on the complete hiding as determined visually on this chart, then hiding may be measured by use of the Hunter Multi-Purpose Reflectometer. By use of this instrument, the reflectance over the white and black surfaces is determined. A minimum contrast ratio of 0.98 shall represent complete hiding. The contrast ratio is calculated by dividing the reflectance over black by reflectance over white.

**716-1.05** Flexibility - The paint, as evidence of its flexibility, shall show no cracking or flaking when submitted to the following

test conducted in accordance with the method of test of Federal Specification TT-P-115 a, with the exception that the film is to be applied with a doctor blade in lieu of a brush.

a. The tin panels used in this test shall be cut from bright tin plate weighing not more than 25 grams and not less than 19 grams per square decimeter (0.51 to 0.39 pounds per square foot). The panels shall be about 7.5 by 13.0 centimeters ( $3^{"} \times 5^{"}$ ) and shall be lightly buffed with steel wool and thoroughly cleaned with benzol immediately before using.

b. The paint shall be applied in a uniform manner on duplicate tin panels using a Bradley blade or similar doctor blade which will produce a wet film thickness of 0.0025".

c. The applied paint shall be let to dry in a horizontal position at room temperature  $(70^{\circ} - 90^{\circ}F)$  for 18 hours and then the panels shall be placed in an oven heated to  $105^{\circ} - 110^{\circ}C$  and baked for 5 hours after which, the panels shall be removed and let to cool for 15 minutes to  $25^{\circ}C$ .

d. The panels shall be placed with the painted side uppermost over a 1/2" diameter rod held firmly by suitable supports and bent double rapidly, then examined for cracks with the naked eye. No cracks shall appear on either panel or the paint shall be considered to have failed the test.

716-1.06 Water Resistance - The paint will be tested for water resistance in accordance with Federal Specification TT-P-115 a except that:

a. The paint shall be applied to 8" x 8" glass panels, which have been previously cleaned with benzol, with an 0.003" Bradley or similar doctor blade. Application shall be started within approximately one (1) inch from the top of the panel.

b. The coated glass panels shall be allowed to air dry at room temperature  $(70^{\circ} - 90^{\circ})$  for ninety hours. The top of the panel where application was started shall be immersed to a depth of four (4) inches in distilled water. After eighteen (18) hours, the panels shall be removed and allowed to dry for two (2) hours and examined. The immersed paint film shall show good adhesion to the glass panel and shall show no wrinkling, blistering, or other forms of deterioration.

**716-1.07 Dilution** - The paint shall be tested for dilution in accordance with Test 4203 of Federal Test Method, Standard No. 141. To about 120 milliliters of paint in a small beaker, there shall be added 15 milliliters of ordinary white gasoline (boiling range not less than 10% above 60°C and not more than 10% above 170°C) slowly, with constant stirring. The thinned paint shall be uniform, and shall show no separation, curdling or precipitation.

**716-1.08** Gasoline Resistance - The paint when subjected to the following test shall show no blistering or wrinkling immediately upon removal of the panel from the gasoline:

a. The paint shall be applied at a wet film thickness of six thousandths of an inch (.006") to tin panels of the same size and prepared in the same manner as described above under subparagraph 716-1.04, "Flexibility".

b. The coated panels shall be air dried for ninety (90) hours and subsequently immersed in gasoline conforming to Federal Specification VV-G-101a to a depth of approximately three (3") inches in a container covered with a watch glass and allowed to remain in the gasoline at room temperature  $(70^{\circ}F - 90^{\circ}F)$  for eighteen (18) hours. At the end of the 18 hours the coated panels shall be removed, allowed to dry, and examined.

c. Any softening effect that may remain two hours after removal from the gasoline shall have disappeared after air drying for twenty-four hours.

**716-1.09 Bleeding** - The paint shall show no perceptible bleeding over bituminous surfaces when tested in accordance with ASTM Standard D 969.

**716-1.10** Weight - The paint shall weigh no less than 11.0 pounds per gallon.

**716-1.11 Samples** - For testing purposes the Contractor shall submit three (3) gallons each of white and/or yellow traffic paint not later than 90 calendar days prior to the date for starting pavement marking operations. These samples shall be submitted in separate one-gallon cans.

# 716-2 GLASS BEADS FOR REFLECTORIZED PAVEMENT MARKINGS

**716-2.01** The glass beads for use in reflectorized pavement markings shall conform to the requirements of AASHTO M 247 as modified and supplemented herein. Type I, standard gradation shall be used unless other wise specified in the contract documents.

**716-2.02 Atmospheric Test** - The glass beads shall be subjected to either one of the following tests:

a. Accelerated Test - Place 100 milliliters of distilled water in a 300 ml beaker, cover beaker and place in a hot plate or oven previously warmed to 180°F. Allow the water to warm to 180°F, place a small glass dish floating in the beaker and place 10 grams of the glass beads on the dish. Again cover the beaker and place it in the oven or hot plate and allow it to stay at 180°F for 8 hours. At the end of the 8 hours remove the beaker from the oven or hot plate and examine the glass beads. If the beads are still clear they will be considered to have passed the test. If they are cloudy they will be rejected.

b. Standard Test - Place 5 centimeters of water in the bottom of a glass desiccator and keep at an ambient

temperature of  $72^{\circ}$ F. Place 10 grams of the glass beads in a glass dish in the desiccator and replace the desiccator cover. The glass beads shall stay in the desiccator for seven (7) days. Once every 24 hours the cover of the desiccator shall be removed for 30 minutes and then replaced. After the seventh day the glass beads shall be removed from the desiccator and examined. If the beads are still clear they shall be considered to have passed the test. If they are cloudy they will be rejected.

**716-2.03** Certification - Four copies of certified test results showing that the glass beads meet the above specifications shall be submitted to the Engineer by the Contractor.

# 716-3 REFLECTORIZED PAVEMENT MARKING PAINTS

**716-3.01** The reflectorized pavement marking paints shall comply with the weathering, abrasion and reflectance tests specified below. A sufficient number of sample panels shall be prepared to permit making these various tests.

**716-3.02 Panel Preparation** - The traffic paint shall be applied on suitably cured concrete panels at a wet film thickness of 0.015" using a Bradley or other suitable doctor blade. Glass beads of correct gradation shall be uniformly distributed into the wet film in the ratio of 6 pounds of glass beads to one gallon of paint. The beads shall be dropped immediately after the paint is applied.

**716-3.03** Accelerated Weathering Test - The prepared panels shall be subjected to an accelerated weathering test equivalent to 12 months of exterior exposure. The samples so exposed shall show no excessive discoloration and not more than 20% loss of reflecting power at the end of the test period. To accomplish this test, either one of the following methods may be used. Six hundred (600) hours of exposure in either one of the two tests shall be considered equivalent to 12 months of exterior exposure.

a. Exposure in National Carbon Apparatus - The test shall be conducted in accordance with Method 6151 of the Federal Test Method Standard No. 141. The samples shall be exposed for 600 hours in the National Carbon Arc Type DMC-R accelerated weathering machine using Sunshine Carbon Arcs enclosed in Corex D Filters, and sprayed with water every two (2) hours.

b. Exposure in Atlas Twin - Arc Apparatus. The test shall be conducted in accordance with Method 6152 of the Federal Test Method Standard No. 141. The samples shall be exposed for 600 hours in the Atlas Twin-Arc Type accelerated weathering machine. The Atlas cycle shall provide 3 minutes of water spray out of each 20 minute period. Ambient temperature at the specimen shall be 130°F plus or minus 5 degrees.

**716-3.04** Accelerated Abrasion Test - Upon completion of the accelerated weathering test, three panels of sample material shall be subjected to an accelerated abrasion test. The cured concrete panels shall be removed from the Weatherometer and conditioned at room temperature for 72 hours. After this conditioning period, the panels shall be placed on the periphery of a modified Hickson type, vertical abrasion machine, using a 10 pound brake load, 5° angle of shear and 80 pound loading. The panels shall withstand not less than 500,000 revolutions (impacts) before losing 75% of the paint film or 80% of the glass spheres. If at least two panels meet these requirements, the material shall be accepted as meeting abrasion tests satisfactorily.

**716-3.05 Directional Reflectance Test** - The directional reflectance of a surface for the given incidence and divergence angles is defined as the reflecting power of the test surface expressed in comparison with the reflecting power of a completely reflecting, perfectly diffusing surface for the same angles. For incidence and divergence angles specified herein a panel of white casein paint will closely duplicate the reflective properties of the ideal, completely reflecting, perfectly diffusing surface. The materials furnished under

these specifications shall have direction reflectance values at least equal to the following:

Incidence Angle	Divergence Angle	Minimum Directional Reflectance
75°	1°20'	3
88°	1°20'	10

**716-3.06 Laboratory Equipment** - The supplier of the materials for reflectorized pavement marking paints shall have available the laboratory equipment necessary to perform all the required tests.

**716-3.07** Certification - Four copies of certified test results showing that the reflectorized pavement marking paint meets the above specifications shall be submitted to the Engineer by the Contractor.

## 716-4 REFLECTORIZED THERMOPLASTIC PAVEMENT MARKING MATERIALS

**716-4.01** Reflectorized Extruded Thermoplastic Pavement Marking Material - This type shall conform to the requirements of AASHTO M 249.

**716-4.02 Reflectorized Thermoplastic Pavement Marking Material, Flame-Spray Powder** - This type shall conform to the requirements of AASHTO M 250.

## 716-5 REFLECTIVE PREFORMED PLASTIC PAVEMENT MARKING FILM

**716-5.01** Reflective preformed plastic pavement marking film shall consist of a mixture of high quality polymeric materials, pigments and glass beads uniformly distributed throughout its base cross-section area, with a reflective layer of protruding glass beads

bonded to the top surface. The film shall comply with the following requirements.

**716-5.02** The composition of the film shall be as follows:

Resins and Plasticizers, Minimum	20%
Pigments, Minimum	30%
Glass Beads, Minimum	33%

**716-5.03** The preformed markings shall consist of white or yellow films with pigments selected and blended to conform to standard FHWA highway colors through the expected life of the film. Glass beads shall be incorporated to provide immediate and continuing retroreflection. The markings shall be readily visible when viewed with automobile headlights at night.

**716-5.04** The glass beads shall conform to AASHTO M 247 and their size, quality and refractive index shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

**716-5.05** The film shall have glass bead retention qualities such that when a 2" x 6" sample is bent over a 1/2" diameter mandrel, with the 2" dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

**716-5.06** The preformed markings shall be capable of being adhered to asphalt concrete or portland cement by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface. The preformed marking film shall mold itself to pavement contours by the action of application on new, dense and open graded asphalt concrete wearing courses during the paving operation in accordance with the manufacturer's instructions. After application, the markings shall identify be immediately ready for traffic. The Contractor and his supplier shall identify proper solvents and/or primers (where necessary) to be applied at the time of

application, all equipment necessary for proper application, and recommendations for application that will assure the materials shall be suitable for use for one year after the date of receipt.

**716-5.07 Tensile Strength and Elongation** - The film shall have a minimum tensile strength of 150 pounds per square inch of cross section at maximum load, when tested according to ASTM D 638-76. A sample 6 inches by 1 inch by 0.06 inch shall be tested at a temperature between  $70^{\circ}$  and  $80^{\circ}$ F using a jaw speed of 10 to 12 inches per minute. The sample shall have a minimum elongation of 75% at break when tested by this method.

**716-5.08** Skid Resistance - The surface of the film shall provide an initial minimum skid resistance value of 45 BPN when tested according to ASTM E 303-74.

**716-5.09 Thickness** - The film, less adhesive, shall be a standard thickness of 0.06 inch (60 mils).

**716-5.10** The film shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking film of the same composition under normal conditions of use. It shall be capable of use for patching worn out areas of the same type film in accordance with manufacturer's instructions.

716-5.11 film, when applied The according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no fading, lifting or shrinkage which will significantly impair the intended usage of the marking throughout its useful life, and shall show no significant tearing, roll back or other signs of poor adhesion.

**716-5.12 Certification** - Four copies of certified test results showing that the marking film meets the above specification shall be submitted to the Engineer by the Contractor.

## 716-6 NON-REFLECTIVE RAISED PAVEMENT MARKERS – CERAMIC TYPE

**716-6.01** Non-reflective ceramic raised pavement markers shall consist of a heat-fired, white, vitreous, ceramic base and a heat-fired, opaque, white or yellow glazed surface, as indicated on the plans. The bottoms of the markers shall be free from gloss or glaze and shall have a number of integrally formed protrusions of approximately 0.05-inch projecting from the surface in a uniform pattern of parallel rows. The markers shall be free from defects which affect appearance or service-ability.

**716-6.02** The top surface of the marker shall be convex and the radius of curvature shall be between 3 1/2 inches and 6 inches except that the radius of the 1/2 inch nearest the edge may be less. Any change in curvature shall be gradual. Each marker shall be  $4" \pm 0.1"$  in diameter at the base. Height of the marker shall be  $11/16" \pm 1/16"$  or  $7/16" \pm 1/16"$  or as shown on plans. The base of the marker shall not deviate from a flat plane by more than 1/16". The glazed surface shall have a mean thickness not less than .005 inch when measured not closer than 1/4" from the edge of the marker to the nearest 0.001 inch by a calibrate scale microscope.

**716-6.03** Markers shall be bonded to the pavement surface by the use of an epoxy resin adhesive meeting the requirements of AASHTO Specifications M 234 and M 237. Class II, Type III or III-M adhesive (Standard Setting) shall be used on new construction where the markers will be protected from the traffic for at least six hours, unless otherwise provided in the contract documents. Where the pavement has to be quickly exposed to traffic, as on existing roads, a Rapid Setting Type I or I-M adhesive shall be used.

#### 716-7 REFLECTIVE RAISED PAVEMENT MARKERS

**716-7.01** Reflective raised pavement markers shall be of the prismatic reflector type consisting of an acrylic plastic shell filled with a mixture of an inert thermosetting compound and filler material. The shell shall be molded of methyl methacrylate conforming to Federal Specification L-P-380 a, Type I, Class 3. The exterior surface of the shell shall be smooth and contain one or two methyl methacrylate prismatic reflector faces of the color specified.

**716-7.02** Markers shall be monodirectional or bidirectional to incident light as specified on the plans. The reflective lens shall not contain any voids or air space and the back of the lens shall be metallized.

**716-7.03** The markers shall be in the shape of a shallow frustrum of a pyramid with the base 4" x 4" and a height of 0.75". The base of the marker shall be flat and the bottom rough textured and free from gloss or any substance that may reduce its bond to the adhesive.

**716-7.04** Markers shall be bonded to the pavement surface as provided in paragraph 716-6.03 of this specification.

## SPECIFICATION 719 – BITUMINOUS PAVEMENTS, MEASUREMENT OF REDUCTION IN MARSHALL STABILITY CAUSED BY IMMERSION IN WATER

# 719-1 SCOPE

**719-1.01** This test method is intended to measure the reduction in Marshall stability resulting from the action of water on compacted bituminous mixtures containing viscosity grade asphalt cement. A numerical index of reduced stability is obtained by comparing the stability of specimens determined in accordance with usual Marshall procedures with the stability of specimens that have been immersed in water for a prescribed period. This test procedure is also applicable to core specimens obtained from compacted hot plant mix bituminous pavement courses.

# 719-2 APPARATUS

**719-2.01** A water bath at least 6 inches deep provided with mechanical water agitator, heating elements, and thermostatic controls capable of maintaining the bath water at temperatures ranging from  $100^{\circ}$  to  $140^{\circ}$  F. The bath shall have a perforated false bottom or be equipped with a shelf of supporting specimens 2 inches above the bottom of the bath.

**719-2.02** Balance and water container with accessory equipment for weighing the test specimens in air and water.

**719-2.03** Transfer plates, flat, of glass or metal. One of these plates shall be kept under each test specimen during immersion and subsequent handling, except when weighing and testing, in order to prevent breakage or distortion of the specimens.

# 719-3 SPECIMENS

**719-3.01** A minimum of six standard Marshall test specimens, 4 in. in diameter and 2 1/2 inches  $\pm 1/8$  in. in thickness, shall be prepared for each test in accordance with the procedures described in AASHTO T 245. The compaction effort used shall be 50 or 75 blows on each end of the specimen as required by the specific mix being tested. When core specimens with thickness other than 2 1/2

### SPECIFICATION 719 – BITUMINOUS PAVEMENTS, MEASUREMENT OF REDUCTION IN MARSHALL STABILITY CAUSED BY IMMERSION IN WATER

inches are used, the measured stability of the specimens shall be corrected by using the correlation ratios included in Table 1 of AASHTO T 245.

#### 719-4 PROCEDURE

719-4.01 Weigh each test specimen in air and in water.

**719-4.02** Calculate the specific gravity of each test specimen as follows:

Specific Gravity = 
$$\underline{A}$$
  
A - B

Where A = weight of specimen in air B = weight of specimen in water

**719-4.03** Sort the test specimens into two groups so that the average specific gravity of the specimens in group 1 is essentially the same as that of group 2.

**719-4.04** Place the group 1 specimen in the water bath at  $140^{\circ} \pm 1^{\circ}$ F for 30 to 40 minutes. Immediately upon removal from the water, test the specimen for Marshall stability and flow as per AASHTO T 245.

**719-4.05** Place the group 2 specimens in the water both at 140  $\pm$  1°F for 24 hours. Immediately upon removal from the water, weigh the specimens and test for Marshall stability and flow as per AASHTO T 245.

## 719-5 CALCULATION

**719-5.01** Calculate the water absorption of each group 2 immersed-in-water specimens as follows:

#### SPECIFICATION 719 – BITUMINOUS PAVEMENTS, MEASUREMENT OF REDUCTION IN MARSHALL STABILITY CAUSED BY IMMERSION IN WATER

Water Absorption (Percent) =	<u>(B - A)100</u>
	А

Where A = Weight in grams of specimen before 24 hour immersion.

B = Weight in grams of specimen after 24 hour immersion.

**719-5.02** Calculate the numerical index of resistance of bituminous mixtures to the detrimental effect of water, expressed as a percentage of the original stability, as follows:

Index of Retained Stability (Percent) =	<u>S2x100</u>
	$\mathbf{S}_1$

Where	$S_1 =$	Marshall stability of group 1 (average)
	$S_2 =$	Marshall stability of group 2 (average)

#### **719-6 REPORT**

**719-6.01** The test report shall include the following values:

a. Specific gravity for group 1 and 2 specimens.

b. Average unit weights (lbs./cu. ft.) for group 1 and 2 specimens.

c. Average Marshall stability (lbs.) and flow value (0.01 in.) for group 1 and 2 specimens.

d. Average water absorption in percent.

e. Retained stability in percent.

#### **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

#### 401-1 **DESCRIPTION**

#### 401-1.01 Scope -

a. This work shall consist of constructing one or more courses of Marshall hot plant-mix bituminous pavement on a prepared foundation in accordance with these specifications, and in conformance with the lines, grades, thickness and typical cross sections and smoothness requirements shown on the plans or established by the Engineer. Courses will be identified as, leveling (L), base (B) and surface (S).

b. The work shall also include the application of any required tack and prime coats as specified in Specifications 407 and 408 respectively.

# 401-2 COMPACTIVE EFFORT LEVELS, CATEGORIES AND TYPES OF MIXES, AND THICKNESS REQUIREMENTS

**401-2.01** General - The bituminous plant mix shall consist of a mixture of aggregates, asphalt binder, hydrated lime and anti-stripping additives, if required.

**401-2.02 Compactive Effort Levels** - The contract documents will specify the number of hammer blows to be used in the Marshall Test (AASHTO T 245) for each mix. When the number of hammer blows is not specified, the requirements for mixes will be based on the road classification as indicated on **Table 401-1** below:

Road Classification	Compactive Effort Levels (Number of Marshall Hammer Blows- AASHTO T-245)
Primary and Secondary	75
Tertiary and Municipal	50

Table 401-1

**401-2.03** Categories of Mixes – The Combined aggregate gradation of Mixes designed and produced under this specification shall be categorized as coarse-graded when it passes below the Primary Control Sieve<sup>1</sup> (PCS) control points defined in Table 401-2. Other gradations shall be categorized as fine-graded.

 ${}^{1}PCS$  – The Primary Control Sieve is the aggregate size that determines what is coarse and what is fine for any aggregate combination. The weight or mass of coarse aggregate (passing the PCS) determines if a mix is a "coarse graded mix" or "fine graded mix".

SS-401/Page 1 of 30

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

1 abic 401-2				
PCS Control Point for Mixture Nominal Maximum Aggregate Size <sup>2</sup> (NMAS)				
Nominal Maximum Aggregate Size (NMAS)	1-inch	<sup>3</sup> / <sub>4</sub> -inch	<sup>1</sup> / <sub>2</sub> -inch	3/8-inch
Primary Control Sieve (PCS)	No.4	No.4	No.8	No.8
PCS Control Point (%Passing)	40	47	39	47

Table 401 2

**401-2.04** Types of Mixes – Mixes as designed and produced under this specification shall be of the following types in conformance with Article 401-3.02 of this specification.

a. Leveling mixes (L) - Leveling mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1-inch (25 mm),  $\frac{3}{4}$ -inch (19 mm),  $\frac{1}{2}$ -inch (12.5 mm) or 3/8-inch (9.5 mm).

b. Base mixes  $(\mathbf{B})$  – Base mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1-inch (25 mm), 3/4-inch (19 mm) or  $\frac{1}{2}$ -inch (12.5 mm).

c. Surface mixes (S) - Surface mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1/2-inch (12.5 mm) or 3/8-inch (9.5 mm).

The Contractor will select, for all types of mixes described herein, the category (fine-graded or coarse-graded) of the mix to be designed, produced and placed in the project. Also, in those cases in which the Authority does not require a specific NMAS of mix in the mix pay item, the Contractor will have the option of selecting, from the sizes specified above, the NMAS of the mix to be designed, produced and placed in the project. The selection by the Contractor of the above mix properties shall be based upon mix compliance with all specification requirements.

**401-2.05** Layer (course) Thickness – Compacted thickness for each course of mix shall be as indicated in Table 401-3 as follows:

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

<b>Table 401-3</b>		
NOMINAL MAXIMUM	COMPACTED THICKNESS	
AGGREGATE SIZE	FOR EACH COURSE (inches)	
(NMAS)	Min – Max	
NMAS = 3/8-inch	1.00 - 2.00	
$NMAS = \frac{1}{2}-inch$	1.50 - 2.50	
$NMAS = \frac{3}{4}-inch$	2.25 - 3.75	
NMAS = 1-inch	3.00 - 5.00	

<sup>2</sup>Nominal Maximum Aggregate Size (NMAS) is defined as being one sieve larger than the first sieve to have a percent passing less than 90 percent by weight.

# 401-3 MATERIALS

**401-3.01** Asphalt Binder - The asphalt binder shall conform to the requirements of Section 702-1 of Specification 702 – Bituminous Materials.

**401-3.02** Aggregates - Aggregates, including mineral filler, shall meet the requirements of Section 703-3 of Specification 703 - Aggregates.

**401-3.03 Reclaimed Asphalt Pavement (RAP)** – Reclaimed Asphalt Pavement materials shall meet the requirements of Section 703-3.02 of Specification 703-Aggregates.

**401-3.04 Hydrated Lime** - Hydrated lime shall meet the requirements of section 712-3 of specification 712 – Miscellaneous Materials. The Contractor shall submit certified laboratory reports on tests of the hydrated lime to be used showing its compliance with the specifications.

**401-3.05** Chemical Anti-Strip Agent - Furnish commercially produced, heat stable liquid products that when added to an asphalt have the chemical and physical properties to prevent separation of the asphalt from aggregates. The Contractor shall submit for approval the certified laboratory reports of the proposed chemical anti-strip agents. Contractor shall be responsible for verifying the affinity/compatibility of the proposed quantity and source of anti-strip agent with all mix components.

# 401-3.06 Composition of Mixtures -

a. **Job-Mix Formula<sup>3</sup>** (**JMF**) - The Contractor shall develop and submit in writing for the Engineer's approval, at least thirty five (35) calendar days in advance

## **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

of the date he intends to start paving operations, a job-mix formula based upon a Marshall mix design, meeting the requirements of this Specification, for each type of mixture to be used in the project.

Each job-mix formula shall be supported by qualified laboratory test data used in the mix design process including, but not limited to, the design charts used. The submission shall also identify the proposed sources of the asphalt binder and aggregates to be used, including the FHWA 0.45 power gradation chart of the proposed mix. The five-week lead requirement may be waived at the discretion of the Authority. The submittal shall comply with the proposed job-mix formula and with all specification requirements.

Each proposed job-mix formula and mix design shall be designed and submitted to the Authority's Materials Testing Office on a three year basis or when a statistical analysis of the Acceptance and/or Contractor Quality Control test results shows significant difference in mix properties, which ever occur first. No mix shall be placed on this project without an approved job-mix formula and a corresponding mix design. The Authority reserves the right of being present at the Contractor's laboratory during the development of the mix designs.

<sup>3</sup>Job-mix formula (JMF) is the proposed combined aggregate gradation, percent of asphalt binder, dust to effective asphalt ratio and volumetric properties used to establish target values for mix production based upon a mix design

Verification of the proposed mix design may be performed at the Authority's laboratory by the Authority personnel at the time of submission of JMF. When determined by the Authority, the Contractor shall coordinate with the Authority the sampling of all materials proposed for use in the mix. Verification of mix design will consist in checking the selection of the optimum asphalt content made by the Contractor. Furthermore, the above procedure will also include verification of moisture susceptibility and relative permeability requirements established in this specification.

b. **Mix Requirements** - Each mix shall be designed according to the Marshall Mix Design Method as described in the Asphalt Institute Manual MS-2 and shall meet the following requirements:

(1) Mix Stability and Flow as determined by AASHTO T 245 shall meet the requirements of **Table 401-4**:
# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

1 abic 401-4		
Compactive Effort	Stability (Lbs.) – (Minimum)	Flow (0.01 inch (25 mm))
Level		(Minimum - Maximum)
50	1,200	8-16
75	1,800	8-14

Table 401-4

(2) Moisture Susceptibility Requirements – Mixes shall meet the following requirements:

a. AASHTO T 283 for Laboratory Mixed - Laboratory Compacted Specimens:

i.For AASHTO T 283 procedures include the freeze and thaw cycle (severity conditioning). In addition, all samples shall be compacted to  $7 \pm 1.0$  percent air voids. The test specimens shall be 6-inch diameter samples compacted using a gyratory compactor (AASHTO T 312).

- ii.Tensile Strength The minimum dry and unconditioned tensile strength shall be 80-psi for surface mixes and 70-psi for other mixes. This requirement will not be applied to contracts which bids are opened prior to June 30, 2010.
- iii.Retained Tensile Strength Ratio (TSR) Minimum 65 percent of Tensile Strength.

(3) Air Voids Content (Va) Requirements – The mix shall have an air void content of 4.0 percent at the design Compactive Effort Level as determined by AASHTO T 166, T 209 and T 269.

(4) Voids in Mineral Aggregate (VMA) Requirements – The mix shall have a VMA based upon the NMAS of the mix as indicated in **Table 401-5**:

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

NMAS	Minimum VMA (Percent)
3/8-inch	15
1/2-inch	14
3/4-inch	13
1-inch	12

#### Table 401-5

(5) Voids Filled with Asphalt (VFA) Requirements – The mix shall have a VFA (percent) based upon the Compactive Effort Level as indicated in **Table 401-6**:

<b>Table 401-6</b>		
<b>Compactive Effort Level</b>	VFA (Percent)	
	(Min – Max)	
50	65-78	
75	65-75	

(6) The Dust to Effective Asphalt Binder ratio (DEAR) of the mix, computed by dividing the percentage of material passing the No. 200 sieve by the percent of effective asphalt binder (Pbe) in the mix, shall be as indicated in **Table 401-7**:

I WOIV IVI /	Т	abl	e	40	1-7	
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Mix Category	Dust to Effective Asphalt Binder Ratio (DEAR) / Specification Limits (Min – Max)	
Fine-Graded	0.6 - 1.2	
Coarse-Graded	0.8 - 1.6	

(7) Laboratory Mixing Temperature – Mixing temperature shall be the temperature at which the binder viscosity is approximately  $0.17 \pm 0.02$  Pa-s in accordance with AASHTO T 245. This mixing temperature will be for laboratory use only.

(8) Laboratory Compacting Temperature – Compacting temperature shall be the temperature at which the binder viscosity is approximately 0.28 +/-

#### **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

0.03 Pa-s in accordance with AASHTO T 245. This compacting temperature will be for laboratory use only.

c. **Mix Values -** Each job-mix formula submitted shall propose definite values for:

- (1) The type of mix to be used (**S**, **B**, **L**).
- (2) The category (fine-graded or coarse-graded) of the mix to be designed.
- (3) Nominal Maximum Aggregate Size (NMAS) of the aggregate mixture.
- (4) Compactive Effort Level (Number of Hammer Blows).

(5) The source and materials to be used; Single percentage of aggregates passing each required sieve size.

(6) Single percentage of asphalt binder (Pb) to be added based on total weight of the mixture.

(7) The kind and percentage of mineral filler to be used, if any.

(8) Production Temperature - The target temperature at which the mixture is to be discharged from the asphalt plant.

(9) Bulk Specific gravity and Apparent Specific gravity of each separate mixture component.

(10) Specific gravity of the Binder at 25 degrees Celsius.

(11) Polish Stone Value (PSV) of coarse aggregate (Only for S mixes).

(12) Coarse Aggregate Angularity, Flat and Elongated Particles and Percent Wear (abrasion loss), etc.).

(13) Design Gradation on FHWA's 0.45 Power Gradation Chart.

(14) Provide all the physical properties achieved at the different asphalt binder contents used to determine the optimum asphalt content.

### **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

(15) Percent Asphalt Binder Content (Pb) (optimum) and Effective Asphalt Binder Content (Pbe).

(16) Dust to Effective Asphalt Binder Content Ratio (**DEAR**).

(17) Theoretical Maximum Specific Gravity and Density of Asphalt Paving Mixtures (Gmm (AASHTO T 209) at Target Binder Content).

(18) Bulk Specific Gravity, Effective Specific Gravity of Mix at the Design Compactive effort level.

(19) Air Void Content (Va) at Design Compactive effort level

(20) Voids in Mineral Aggregate (VMA) at Design Compactive effort level Voids Filled with Asphalt (VFA) at Design Compactive effort level Laboratory Density in Lb/ft^3.

(21) Required In-place Compaction.

(22) Type and quantity of chemical anti-strip agent and/or hydrated lime, if required, including all data to perform the optimization procedure.

(23) Moisture Susceptibility data sheet of the proposed mix in accordance with AASHTO T-283.

(24) Retained tensile strength ratio, tensile strength (dry and unconditioned) and tensile strain (dry and unconditioned).

d. Additional Mix Values – With each job-mix formula report the following values or mix properties as available:

(1) Aggregate geological and mineralogical descriptions.

(2) Fine Aggregate Angularity and Sand Equivalent of Aggregate mixture.

(3) Field Compaction Temperature - The target temperature at which the mixture is to be compacted during lay-down operations.

(4) Bailey Method Ratio's for each Marshall Mix.

(5) Asphalt film thickness for each mix.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

(6) Results from AASHTO T-182 (Coating and Stripping of Bitumen-Aggregate Mixtures).

(7) FM 5-508 (Laboratory Testing the Effectiveness of Anti-Strip Additives) test results performed on mix.

(8) AASHTO T-283 optimization test results obtained at other anti-strip and/or hydrated lime dosages.

e. **Changes and resubmissions.** If a job-mix formula is rejected or a material source (including the recycled asphalt pavement) has changed, submit a new job-mix formula for acceptance. Up to twenty one (21) calendar days may be required to evaluate a change. Approved changes in target values will not be applied retroactively for payment.

# 401-3.07 Sampling and Testing -

a. All acceptance sampling and testing activities will be performed by the Authority. Samples will be taken at random locations during production and will remain in the custody of the Authority at all times. Each sample shall provide enough material to adequately perform all testing as determined in each test procedure. The Contractor or his authorized representative may be present, if so desired, when these sampling and testing operations are being performed. All testing will be done at the producer's plant laboratory provided it has been qualified by the Authority's Materials Testing Office in accordance with **PRHTA Q 401-10 - Qualification of Hot Mix Asphalt (HMA) Laboratories.** However, the Authority may, at its discretion, perform the testing at the Authority's laboratory. Sampling for acceptance testing will be performed by the Authority in accordance with **Table 401-8**:

Description	<b>Procedure Designation</b>
Qualification of Hot Mix Asphalt (HMA) Laboratories	PRHTA Q 401-10
Determination of Random Sampling Location	PRHTA M 401-10
Sampling of Asphalt Binder	AASHTO T-40
Sampling of Aggregates	AASHTO T-2
Sampling of Bituminous Paving Mixtures	AASTHO T-168
Reducing Samples of Hot-Mix Asphalt to Testing Size	AASHTO T-328
Sampling of Compacted HMA Pavement	PRHTA M 401-20

Table 401-8

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

b. Provide at the mixing plant laboratory and at the field all the equipment, tools, supplies and other apparatus required for sampling the mix, preparing specimens and testing for compliance of the mix being produced and its components with all the requirements stated in this specification, applicable AASHTO or ASTM Standards or Puerto Rico Highway and Transportation Authority's procedures. The use of microwave oven shall not be used for acceptance testing procedures.

c. The Authority will take, at its discretion, random samples of the asphalt binder and aggregates at the plant (prior to and during mix production) to test for the compliance of these materials with their specifications requirements.

d. Samples of the mix material being produced for delivery to the project will be taken by the Engineer at the plant following the procedures established in **Table 401-8**. The control unit for sampling, testing and acceptance purposes will be a lot which is defined as 900 tons, 750 tons or 600 tons or fraction thereof placed each day, subdivided into three equal sub-lots of 300 tons, 250 or 200 tons respectively. Any fraction produced that amounts to 100 tons or less will be incorporated in the previous lot. Any fraction produced that amounts to more than 100 tons will be considered a sub lot of a new lot. Lot size shall be determined by the Contractor in writing to the Authority prior to the Pre-Paving Meeting.

e. Acceptance testing will consist of evaluating the number of samples as indicated in **Table 401-9** below per each lot. Each sample shall provide enough material to adequately perform all testing as determined in each individual test procedure. Acceptance testing procedures are as follows:

Procedure Designation (AASHTO)	Frequency	Testing
AASTHO T-164		Quantitative Extraction of
		Bitumen from Bituminous
		Paving Mixtures
AASHTO T-30/11B		Mechanical Analysis of
	1 per sub-lot	Extracted Aggregate / Materials
		Finer than No. 200 Sieve in
		Mineral Aggregates by
		Washing Using a Wetting
		Agent
AASHTO T-209 (including	1 per lot (use average of	Theoretical Maximum Specific
Section #11) /	two split samples for	Gravity and Density of Hot Mix
PRHTA T 401-50	acceptance)	Asphalt Paving Mixture

Table 401-9

## **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

AASHTO T-245		Resistance to Plastic Flow of	
		Bituminous Mixtures Using	
		Marshall Apparatus	
AASHTO T-166 or T-275 as		Bulk Specific Gravity of	
required		Compacted Hot Mix Asphalt	
	1 per sub lot (use overage	Mixtures Using Saturated	
	of three split samples for	Surface Dry Specimens / Bulk	
	acceptance per lot)	Specific Gravity of Compacted	
	acceptance per lot)	Hot Mix Asphalt Mixtures	
		Using Paraffin-Coated	
		Specimens	
AASHTO T-269		Percent Air-Void in Compacted	
		Dense and Open Asphalt	
		Mixtures	
PRHTA T 401-10		Mixture conditioning for	
	As required	determining volumetric	
		properties of HMA	
PRHTA T 401-20		Determination of HMA in-	
	6 per lot (2 per sub-lot)	place compaction and layer	
		thickness	
PRHTA T 401-30	As required	Determination of HMA	
	As required	pavement density profile	
PRHTA T 401-40		Determination of asphalt binder	
	As required	content of compacted HMA	

f. The Authority may, at its discretion, take samples of the mix being delivered to the project site for testing at any location including behind the paver before compaction. Test results of these samples will be for informational purposes only and will not form part of the acceptance process.

401-3.08 **Reporting Results** – The following mix properties shall be determined, calculated and reported for each sub lot:

a. Bulk Specific Gravity (Gmb) – AASHTO T-166 / AASHTO T-275 as applicable

b. Maximum Specific Gravity (Gmm) - AASHTO T-209 (including Section #11) / PRHTA T 401-50

c. Asphalt Binder Content (**Pb**) – AASHTO T-164

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

- d. Air Voids Content (Va) AASHTO T-269
- e. Voids in Mineral Aggregate (VMA)
- f. Voids Filled with Asphalt (**VFA**)
- g. Effective Asphalt Binder Content (**Pbe**)
- h. Effective Specific Gravity of Mix (Gse)

i. Mass Retained (g), Mass Retained (percent), Percent Passing for the following sieve designations: 1-1/2", 1",  $\frac{3}{4}$ ",  $\frac{1}{2}$ ",  $\frac{3}{8}$ ",  $\frac{1}{4}$ ", No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, No. 200 – AASHTO T-30 / T- 11 B.

j. Dust to Effective Asphalt Binder Content Ratio (**DEAR**).

# 401-4 CONSTRUCTION REQUIREMENTS

**401-4.01 Production Start-Up Procedures** – Use these start-up procedures when producing material for the first time in the project, when using materials from different plants, or when resuming production after a termination of production due to unsatisfactory quality as determined by the Engineer.

a. **Control Strip Section** – Produced, place, and compact the proposed HMA in order to establish that the equipment and the processes planned for placement and compaction are satisfactory. Provide fourteen (14) calendar days notice before beginning production of an asphalt concrete mix.

On the first day of production, produce sufficient mix to construct a 300 to 600 tons control strip, as determined by the Contractor, one-lane wide, and at the designated lift thickness. Construct the control strip on the project at an approved location.

Construct the control strip using mix production, lay-down, and compaction procedures intended for the entire mix. The mix is acceptable with full payment if all test results are in conformity with specification limits with a  $CPF_{lot}$  equal or greater than 0.70. Mix that is not acceptable will be removed at no cost to the Authority and shall be replaced during full production operation through applicable hot plant bituminous mix pay items.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

1) **Mixture.** Take and test at least three control strip asphalt concrete mix samples and evaluate according to article 401.3.07

2) **Compaction.** Take nuclear density readings behind each roller pass to determine the roller pattern necessary to achieve required density. Keep records of compaction effort frequency and amplitude settings of equipment used.

At a minimum of five locations within the control strip, take nuclear gauge readings, and cut and test core samples according to article 401.3.07. Density is acceptable if all tests are within the specification limit. Furnish the Engineer with the nuclear gauge readings and correlations of the readings to the core specific gravities.

The Contractor shall address any production and/or placement deficiencies identified by the Contractor and the Engineer during this operation as part of the quality control and acceptance plan during the Pre-paving meeting. Tests used for the control strip will not be included in the evaluation for payment according to article 401-5. Based on the Contractor's evaluation of the initial control strip, paving may continue at the Contractor's risk once the Pre-paving meeting per section 401.4.01(b) is completed.

(b) **Pre-paving Meeting** – After the construction of a control strip and at least seven (7) calendar days before the start of production paving operation, the Engineer shall arrange for a pre-paving meeting. Attendance of Contractor, the Contractor's Paving Quality Assurance Manager, subcontractors, and all other applicable suppliers is mandatory. At the meeting the Contractor's Paving Quality Assurance Manager shall submit and discuss the proposed production and lay-down operations plan. After the meeting, the contractor shall submit a written final detailed plan (at least three (3) calendar days before the proposed start of paving operations) to be revised by the Engineer that as a minimum includes the following:

(1) Proposed schedule of paving operations;

(2) List of all necessary equipment and key personnel used in the production and construction of the work;

(3) Proposed traffic control plan for paving operations including provisions for pavement drop-offs and moving operations;

(4) Contractor quality control and materials acceptance plan, corrective action  $plan^4$  in accordance with this specification

## **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

(5) Placement operation including production, delivery, placing, finishing, compacting, and smoothness procedures. Include also the proposed rolling patterns, frequency and amplitude to be utilized in the placement operations.

<sup>4</sup>Corrective Action Plans - Contractor's proposed strategies and related work to be performed to prevent repeated deficiencies.

(6) Production and placement strategies to minimize segregation of HMA. Prior to the start of using the paver for placing plant mix, the Contractor shall submit for approval a full description in writing of the means and methodologies that will be used to prevent bituminous paver segregation. Use of the paver shall not commence prior to receiving approval from the Engineer.

**401-4.02 Bituminous Mixing Plant -** Plants used for the preparation of bituminous mixes shall conform to AASHTO M 156 modified and supplemented as follows:

a. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mix, the Engineer, or his authorized representative, shall have access, at all times, to all portions of the mixing plant, aggregates plant, storage yards, and other facilities for producing and processing the mix materials.

b. Scales shall be inspected and certified by the Division of Weights and Measures of the Commonwealth Department of Consumers Affairs (DACO) on yearly basis or as required by the Engineer. Any cost involved in the inspection and sealing of the scales shall be at the Contractor's expense. No asphalt mix shall be produced and delivered to the project from a producer plant that does not comply with the above requirements.

c. All projects involving 2,000 Tons or more of bituminous mixture shall be served by a plant having automatic controls which coordinate the proportioning, timing and discharge of the mixture.

d. All plants shall be equipped with air pollution control devices which meet the requirements of the Environmental Quality Board.

e. The completed bituminous mixture may be weighed on approved scales furnished by the Contractor at his expense. The scales shall be inspected and calibrated at least once a year by an independent entity.

## **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

**401-4.03 Hauling Equipment** - Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution or other approved material to prevent the mixture from adhering to the beds. No gas oil or diesel fuel will be allowed for preventing the mixture adhering to the truck bed. Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture and for use during hauling operations. No truck will be allowed to leave the plant without covering the mix with the cover of canvas. Each day before delivery to the project the Contractor shall provide to the Engineer a certification attesting to the compliance of each delivery truck with these requirements.

**401-4.04 Delivery Trucks** – Furnish delivery tickets to the Engineer, before unloading at the site of the work the bituminous mix supplier, containing the following information concerning the bituminous mix in the truck:

- a. Name of bituminous mixing plant
- b. Serial number of ticket
- c. Date, time and truck number
- d. Name of Contractor
- e. Specific designation of job (name, number and location)
- f. Type of mix
- g. Weight of mix in the truck

h. Space for signature of Authority's inspector at the paving site and at the scales.

- i. Temperature of the asphalt mix measured at the plant
- j. Temperature of the asphalt mix measured at the site

## 401-4.05 Bituminous Pavers

a. Provide Bituminous pavers self-contained, power propelled units with a vibrating or tamper screed and strike-off assembly covering the full lay-down width, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material which will meet the specified typical section, thickness,

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in the widths shown on the plans.

b. The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed and strike-off assembly shall effectively produce a finished surface of the required smoothness and texture without segregating, tearing, shoving, or gouging the mixture.

c. The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

d. The paver shall be equipped with a grade and slope control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made inoperative and the screed shall be controlled by sensor directed automatic mechanisms, which will independently control the elevation of each end of the screed from the reference lines or surfaces. The controls shall work in conjunction with any of the following attachments:

(1) Ski-type device, floating beam of not less than 30 feet (9.14 m) in length and short ski or shoe to match adjoining lanes either fresh or old layer or as directed by the Engineer.

(2) Taut stringline wire set by the Contractor to the specified grade.

(3) A non-contacting laser or sonar-type ski with at least four referencing stations may be used with a reference at least 24 feet (7.3 m) long.

e. Except as presented on Article 401-4.05(g) below, furnish, as a minimum, automatic control systems such as long ski, short ski/shoe or furnish and install all required stakes and wire for a taut string line. Should the automatic control system become inoperative during the day's work, the Contractor may be permitted, at the discretion of the Authority, to finish the day's paving work using manual controls. However, work shall not be resumed thereafter until the automatic control system has been made operative.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

f. The Contractor may be exempt from the use of the automatic control system at locations where the Engineer determines that pavement geometry or widths makes its use impracticable.

g. Laser Control and/or Profilograph Control equipments may be used by the Contractor. The use of this equipment shall be subject to the following requirements at no cost to the Authority:

1. Present a written notice to the Engineer at the beginning of the project proposing the use of such equipment. The written notice shall include, as a minimum, the brand, type, model and manufacturer of the proposed equipment.

2. Provide a copy to the Engineer of the manufacturer's instruction and operation manual as well as any other literature related to computer software.

h. Provide bituminous pavers that are equipped with a means of preventing the segregation of the coarse aggregate particles from the remainder of the bituminous plant mix when that mix is carried from the paver hopper back to the paver augers. The means and methods used shall be approved by the paver manufacturer and may consist of chain curtains, deflector plates, or other such devices and any combination of these.

The following specific requirements shall apply to the identified bituminous pavers:

(1) Blaw-Knox bituminous pavers shall be equipped with the Blaw-Knox Materials Management Kit (MMK).

(2) Cedarapids bituminous pavers shall be those that were manufactured in 1989 or later.

(3) Caterpillar bituminous pavers shall be equipped with deflector plates as identified in the December 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630, 6631, 6640}".

**401-4.06 Rollers** - Rollers may be of the vibratory or tandem steel wheel type. Pneumatic-tired rollers may be used in conjunction with either of the steel wheel types. Rollers shall be in good condition, be capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

density without detrimentally affecting the compacted material. For leveling courses, at least one pneumatic tire roller shall be used.

**401-4.07** Weather Limitations - Bituminous plant mix shall not be placed on any wet surface or when weather conditions prevent the proper production, handling placing or finishing of the bituminous mixture.

# 401-4.08 Preparation of Surface to be Paved -

a. The surface to be paved shall be true to line and grade, dry and free from loose or deleterious material immediately before the placing of bituminous mixture. If necessary, the surface shall be cleaned by brooming or other approved means.

b. When the surface of an existing pavement or old base to be paved is irregular, it shall be brought to uniform grade and cross section by a leveling course as directed, which shall be compacted to the satisfaction of the Engineer before placing subsequent paving courses.

c. When a leveling course is not required, all depressions and other irregularities shall be patched or corrected in a manner satisfactory to the Engineer. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material, shall be removed from the area to be paved. Blotting of excessive deposits of asphalt with sand or stone will not be permitted.

d. Where the area to be paved is an untreated soil or aggregate, it shall be compacted to the required density and then primed in accordance with the provisions of Specification 408 - Bituminous Prime Coat. The prime coat shall be allowed to cure properly in accordance with the provisions of Specification 408 before any further operations are permitted on the primed area.

e. Apply bituminous tack coat upon all portland cement concrete surface or a bituminous surface before placing new HMA in accordance with the provisions of Specification 407 - Bituminous Tack Coat shall be applied.

f. Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of bituminous material as specified for the tack coat prior to the bituminous mixture being placed against them.

## **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

**401-4.09 Preparation of Bituminous Material** – Heat the bituminous material in a manner to avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature within the regents specified in **Table 401-10**. Asphalt binder shall not be used while it is foaming nor shall it be heated above 350 degrees F at any time after delivery to the plant.

1 able 401-10		
Asphalt Binder	Storage Temperature Range	
	(Minimum – Maximum) (°F)	
PG 64-22	285-315	
PG 67-22	295-320	
PG 70-22	300-325	

Table 401-10

## 401-4.10 Mixing -

a. Combine the aggregates in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. Measure or gauge the bituminous material shall and introduced it into the mixer in the amount specified by the job-mix formula. Mix the materials until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured.

b. **Production Temperature** - The production temperature will be measured at the truck bed prior to delivery of mix to project. Temperature of the mix will be the average of three readings measured at the top of the mix pile in each truck. Measurement shall be taken using a properly calibrated thermometer provided by the Contractor. Calibration shall be accomplished on a yearly basis. Mixes shall have a production temperature between the acceptable ranges in Table 401-11:

<b>Table 401-11</b>			
Acceptable Production Temperature Range			
Minimum	Production Temperature -30° F		
Maximum	Production Temperature +20° F		

(1) Mixes with production temperature below the minimum temperature established in Table 401-11 above shall be allowed to be delivered to the project. In such cases the Engineer will record the final location of the pavement section or area that represents each truck for further evaluation.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

Evaluation will be performed once the Contractor has achieved compaction of mix. Evaluation will be following the procedure indicated in Section 5 - Procedure for Determination In-Place Compaction of PRHTA T 401-20 (Determination of HMA In-Place Compaction and Layer Thickness), except that only one core will be extracted and evaluated. If In-Place Compaction is within the range indicated in Table 401-12 below the mix will be considered acceptable, otherwise the mix will be paid with a 50 percent pay factor (PF = 50%). No retesting will be allowed.

(2) Mixes with production temperature above the maximum temperature established in Table 401-11 above will not be allowed to be delivered to the project.

c. Deliver all mixes at the paving site at a temperature of no less than 225 degrees F. Mixes shall have at least 225 degrees F prior to its placement in front of the paver. Temperature of the mix will be as determined by the Materials Testing Office.

# 401-4.11 Transporting, Spreading and Finishing -

a. Transport the mixture from the mixing plant to the paving site in vehicles conforming to the requirements of Article 401-4.03. Place the protective cover over the mix prior to departing the plant and retained in place until the mix is delivered. Failure to comply with the above requirement will be cause for rejection of the mix contained in the truck.

b. Lay the bituminous mixture upon an approved clean surface, spread and struck off to the established grade and elevation. Use bituminous pavers to distribute the mixture either over the entire width or over such partial width as may be practicable.

c. The longitudinal joint in one layer shall be offset from that in the layer immediately below by approximately 6-inch; however, the joint in the top layer shall be at the center line of the pavement if the roadway comprises two lanes of width, or at lane lines if the roadway is more than two lanes in width, unless otherwise directed. Failure of the Contractor to observe the above dispositions and the placement of the longitudinal joint at any wheel path will allow the Authority to reject the mix or to accept the same at a 50 percent reduction in price.

d. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

spread and finished by hand tools. For such areas the mixture shall be dumped, spread and screeded to provide the required section and compacted thickness. Provide suitable heating equipment or non petroleum based asphalt release agents for keeping hand tools free from asphalt. The temperature of the tools when used shall not be greater than the temperature of the mix placed. The use of petroleum oils, diesel fuels or volatiles will not be permitted.

e. Place the mixtures in layers as indicated on the plans. No single layer shall exceed 10 cm. (5") in compacted thickness.

f. When using a Material Transfer Vehicle (MTV) during lay-down operations, a paver hopper insert shall be used at all times.

# 401-4.12 Compaction Requirements -

a. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, compact it thoroughly and uniformly by rolling. Roll the surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in workable condition. The sequence of rolling operations and the selection of roller types shall be such as to meet the in-place compaction requirements. In-place compaction shall be determined in accordance with **PRHTA T 401-20 – Determination of HMA In-Place Compaction and Layer Thickness**. Acceptable In-Place Compaction Range shall be as indicated in Table 401-12:

Table 401-12
In-Place Compaction Requirements
(Percent, Minimum – Maximum)
92 - 97

b. Unless otherwise directed, begin rolling at the sides and proceed longitudinally parallel to the road centerline, gradually progressing to the crown of the road. Place consecutive layers by overlapping all joints a minimum of 6-inch (15 cm.). When paving in echelon or abutting a previously placed lane, roll the longitudinal joint first followed by the regular rolling procedure. On super-elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the center line.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

c. Move rollers at a slow but uniform speed with the drive roll or wheels nearest the paver except when rolling an incline, then the procedure is reversed.

d. Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. Keep wheels properly moistened with water or water mixed with very small quantities of detergent or other approved material to prevent adhesion of the mixture to the rollers.

e. Compact the mixture thoroughly with mechanical tampers along forms, curbs, headers, walls and other places not accessible to the roller. Use a trench or small vibratory roller, or cleated compression strips under the roller on depressed areas to transmit compression.

f. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous mix material shall be corrected to the satisfaction of the Engineer.

# 401-4.13 Joints, Trimming Edges and Cleanup -

a. Complete pavement construction of adjacent traffic lanes to the same elevation within 24 hours. If drop-offs are left overnight, sign the drop-offs in excess of 2 inches with *"Uneven Lanes"* warning signs and provide a 1V:3H fillet for drop-offs in excess of 4 inches. At connections to existing pavements and previously placed lifts, make the joints vertical to the depth of the new pavement. Form joints by cutting back the previous run to expose the full-depth course.

b. Placing of the bituminous mix shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Apply an asphalt tack coat meeting the requirements of specification 407 to the joint edge to both transverse and longitudinal joints before additional mixture is placed against the previously rolled material.

c. At the beginning or end of a project connecting to an existing pavement the feathering of the new surface course to match the existing grade of the old pavement will not be permitted. To transition and match the grades, the old pavement shall be undercut to a depth equal to the compacted depth of the new surface course being

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

connected to it. This work shall be a subsidiary obligation of the Contractor under the new pavement pay items.

d. Material trimmed from the edges and any other discarded bituminous mixture shall be removed from the roadway and disposed of by the Contractor outside the project limits or in an approved area out of sight from the road. No deduction in payment will be made for the fillet material removed.

**401-4.14 Surface Requirements** – Measure the smoothness/roughness in accordance with Specification 410 – Hot Plant Mix Bituminous Pavement Smoothness to the applicable smoothness level indicated in contract. Payment for compliance to surface requirements will be as determine in Specification 410 through applicable hot plant mix bituminous item.

**401-4.15 Protection of Pavement** - Protect sections of newly finished work from traffic of any kind until the mixture has become properly hardened by the cooling method stated below.

Provide at all times in the project water supply trucks capable of applying potable water to the compacted mix in order to cool it to a temperature below 150 degrees Fahrenheit. Apply water after the mix has achieved the compaction level as required in this specification. Also, provide to the Authority a calibrated infrared thermometer capable of measuring temperatures in the range of 100 degrees Fahrenheit and 350 degrees Fahrenheit. All of the equipment indicated above shall be a subsidiary obligation of the contract.

Do not open to traffic the compacted mix until all measurements with infrared thermometer taken in the mat by the Authority show temperatures below 150 degrees Fahrenheit.

# 401-5 BASIS OF ACCEPTANCE

a. **Measured Conformance** - The acceptability of the quality of the hot plantmix bituminous pavement will be based on the tested conformance of the material with the requirements of Articles 401-3.07 and 401-4.14 above and the tolerances for the acceptance quality characteristics per lot as follows:

1. The average of each acceptance quality characteristic per lot shall be within the deviation parameters established from JMF target values, and

2. The measured variability of each acceptance quality characteristic per lot as shown in Tables 401-13 to 401-16:

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

Table 401-13				
NMAS = 1-inch				
Acceptance Quality Characteristic <sup>5</sup> (AOC)	Deviation from Target Value <sup>6</sup>	Variability Range		
Characteristic (AQC)	(DTV)			
1-inch (Control Sieve)	+/-8*	4		
No. 4 (Control Sieve)	+/-7*	3.5		
No. 200 (Control Sieve)	+/-3*	1.5		
Amount of performance graded		0.26		
binder (Pb)	+/- 0.52			
In-Place Compaction (IPC)	92 - 97%	2		
Thickness (min. total for	80% of specified layer	N/A		
project)	thickness			
Thickness (max. total for	115% of specified layer	N/A		
project)	thickness			

### Table 401-14

NMAS = 3/4-inch			
Acceptance Quality Deviation from Target Variability Ra			
Characteristic (AQC)	Value		
	(DTV)		
<sup>3</sup> / <sub>4</sub> -inch (Control Sieve)	+/-8*	4	
No. 4 (Control Sieve)	+/-7*	3.5	
No. 200 (Control Sieve)	+/-3*	1.5	
Amount of performance graded		0.26	
binder (Pb)	+/- 0.52		
In-Place Compaction (IPC)	92-97%	2	
Thickness (min. total for	80% of specified layer	N/A	
project)	thickness		
Thickness (max., total for	115% of specified layer	N/A	
project)	thickness		

<sup>5</sup>Acceptance Quality Characteristic (AQC) – Characteristic or property of a mix that is measured for acceptance purposes.

<sup>6</sup>*Target Value – Mix design values as reported in JMF for each acceptance quality characteristic.* 

SS-401/Page 24 of 30

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

NMAS = 1/2-inch			
Acceptance Quality Characteristic (AQC) <sup>4</sup>	Deviation from Target Value (DTV)	Variability Range	
1/2-inch (Control Sieve)	+/-8*	4	
No. 8 (Control Sieve)	+/-7*	3.5	
No. 200 (Control Sieve)	+/-3*	1.5	
Amount of performance graded		0.26	
binder (Pb)	+/- 0.52		
In-Place Compaction (IPC)	92-97%	2	
Thickness (min. total for	80% of specified layer	N/A	
project)	thickness		
Thickness (max. total for	115% of specified layer	N/A	
project)	thickness		

T 11 401 15

### **Table 401-16**

NMAS = 3/8-inch			
Acceptance Quality Characteristic (AQC)	Deviation from Target Value (DTV)	Variability Range	
3/8-inch	+/-7*	3.5	
No. 8	+/-7*	3.5	
No. 200	+/-3*	1.5	
Amount of performance graded binder (Pb)	+/- 0.52	0.26	
In-Place Compaction (IPC)	92-97%	2	
Thickness (min, total for project)	80% of specified layer thickness	N/A	
Thickness (max. total for project)	115% of specified layer thickness	N/A	

(\*)Upper gradation deviation shall not be outside the grading composition requirements of Table 703-3. In such cases the DTV will be reduced accordingly (Allowable Deviation from Target Value (ADTV)). Deviations are subject to selected target value in the approved JMF.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

b. Segregated HMA (segregated areas and/or longitudinal streaks sections) – The acceptability of HMA pavement were segregation<sup>7</sup> is perceived to be present will be determined in conformance with PRHTA T 401-30 - Determination of HMA Pavement Density Profile and based upon the following criteria:

- 1. HMA material will be considered acceptable if both of the following conditions are met:
  - a. Maximum minimum density range is less than 6.0 pcf.
  - b. Mean minimum density range is less than 3.0 pcf.

2. HMA material will be rejected if any of the requirements above are not met. The section(s) shall be removed at the contractor expense and replaced.

c. **HMA with Bleeding** - The acceptability of HMA pavement were bleeding<sup>8</sup> is perceive to be present will be determined in conformance with **PRHTA T 401-40** - **Determination of Asphalt Binder Content of Compacted HMA** and based upon the following criteria:

- 1. Will be considered acceptable if the following condition is met:
  - a. Asphalt content (Pb) is within the range of  $\pm -0.70$  from JMF.

2. Will be rejected if it does not meet the requirement above. The section(s) shall be removed at the contractor expense and replaced.

d. Contractor costs related to the activities stated in b and c above will be reimbursed to the Contractor on a force account basis if the HMA material is considered acceptable.

# 401-6 METHOD OF MEASUREMENT

**401-6.01** Plant-mix bituminous pavement courses will be measured by the ton of compacted mixture placed in the accepted work, as called for in the contract documents. Measurement will be by weighing the delivery trucks at approved scales. Batch weights will not be accepted as a method of measurement.

**401-6.02** Any excess tonnage due to excess thickness, determined as provided in Article 401-3.07e and 401-5 as applicable, will be deducted from the measurement for payment.

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

401-6.03 Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the contract quantities and no adjustment in the contract unit price will be made because of such variation.

**401-6.04** Work prescribed under Article 401-4.08, Preparation of Surface to be Paved, except for the leveling course and mix material used for patching and correcting irregularities in old surfaces, will not be measured directly for payment, but will be considered as a subsidiary obligation of the Contractor under the various items of hot plant-mix bituminous pavement. Hot plant-mix material used for patching and leveling in this work will be measured for payment under the respective unit prices.

<sup>7</sup>Segregation - The non-uniform distribution of HMA coarse and fine aggregate components. Segregation can be determined visually as pavement sections that have a significantly different texture than the surrounding material.

<sup>8</sup>Bleeding (Excess surface asphalt) - A shiny, black surface caused by liquid asphalt migrating to the pavement surface. The result can mean a loss of surface texture on the pavement.

# 401-7 BASIS OF PAYMENT

**401-7.01** The completed and accepted quantities of each class of hot plant mix pavement, measured as provided above, will be paid for at the contract unit price per unit of measurement except as specified in Article 401-7.02 below. Such prices and payment shall constitute full compensation for the cost of the mix design and other related costs, preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting and finishing of all required materials for the pavement; smoothness of the final pavement surface and for all labor, equipment, tools and incidentals necessary to complete each item of work as indicated in this specification.

**401-7.02** Payment for hot plant mix pavement will be paid for by Lot at unit price multiplied by the applicable Composite Lot Pay Factor (**CPF** Lot) as follows:

# a. Individual Acceptance Quality Characteristics (AQC) Pay Factor Determination:

- 1. <u>Aggregate Gradation</u>:
  - a) <u>Average Requirements</u>:

#### **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

For All Control Sieves (\*):

If average of lot is within (JMF – DTV, JMF + ADTV) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise **CPF**  $_{Lot} = 0.50$ .

b) <u>Variability Range Requirements</u>:

Pay Factor Equation for Control Sieves 1-inch, <sup>3</sup>/<sub>4</sub>-inch and <sup>1</sup>/<sub>2</sub>-inch (+/- 8\*):

**PF** NMAS = 1.25 (Variability Range)  $^{-0.161}$  (Equation #1)

If PF  $_{NMAS} > 1.00$  Then PF  $_{NMAS} = 1.00$ 

Pay Factor Equation for Control Sieves 3/8-inch No. 4 and No. 8 (+/- 7\*):

**PF**  $_{PCS} = 1.22$  (Variability Range)<sup>-0.161</sup> (Equation #2)

If PF  $_{PCS} > 1.00$  Then PF  $_{PCS} = 1.00$ 

Pay Factor Equation for Control Sieves No. 200 (+/- 3\*):

PF No. 200 = 1.10 (Variability Range)  $^{-0.161}$  (Equation #3)

If PF No. 200 > 1.00 Then PF No. 200 = 1.00

(\*)Upper gradation deviation shall not be outside the grading composition requirements of Table 703-3. In such cases the DTV will be reduced accordingly (Allowable Deviation from Target Value (ADTV)). Deviations are subject to selected target value in the approved JMF.

Pay Factor Equation for Aggregate Grading (**PF**  $_{Agg}$ ): Pay Factor for aggregate grading will be calculated based on the Pay Factors (PF) of corresponding mix control sieves with the following weighting applied: 10 percent for control sieves 1-inch, <sup>3</sup>/<sub>4</sub>-inch and <sup>1</sup>/<sub>2</sub>-inch (NMAS sieves), 15 percent for Control Sieves 3/8-inch No. 4 and No. 8 (PCS sieves) and 75 percent for Control Sieve No. 200. Calculate the **PF**  $_{Agg}$  by using the following formula:

 $PF_{Agg} = (0.10 \text{ x } PF_{NMAS}) + (0.15 \text{ x } PF_{PCS}) + (0.75 \text{ x } PF_{No. 200}) \quad (Equation \#4)$ 

If PF  $_{Agg} > 1.00$  Then PF  $_{Agg} = 1.00$ 

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

# 2. <u>Binder Content (Pb):</u>

a) <u>Average Requirements</u>:

If Average Binder Content of lot is within (JMF – 0.52, JMF + 0.52) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise CPF Lot = 0.50.

b) <u>Variability Range Requirements</u>:

Pay Factor Equation for **Pb** (+/- 0.52):

**PF** Pb = **0.8** (Variability Range)<sup>-0.321</sup> (Equation #5)

If PF  $_{Pb} > 1.00$  Then PF  $_{Pb} = 1.00$ 

- 3. <u>In-Place Compaction (IPC)</u>:
  - a) <u>Average Requirements</u>:

If average IPC of lot is within (92% and 97%) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise CPF Lot = 0.50.

b) <u>Variability Range Requirements</u>:

Pay Factor Equation for In-Place Compaction (IPC):

**PF**  $_{IPC}$  = 1.12 (Variability Range)<sup>-0.161</sup> (Equation #6)

If PF  $_{IPC} > 1.00$  Then PF  $_{IPC} = 1.00$ 

b. Composite Lot Pay Factor (CPF<sub>Lot</sub>) (value of work): A Composite Lot Pay Factor will be calculated based on the individual AQC Pay Factors (PF) determined above with the following weighting applied: 20 percent aggregate gradation, 30 percent Binder Content (Pb) and 50 percent In-place Compaction (IPC). Calculate the <u>CPF<sub>Lot</sub></u> by using the following formula:

SS-401/Page 29 of 30

Pay Unit

# SUPPLEMENTAL SPECIFICATION

# **SPECIFICATION 401 – HOT PLANT-MIX BITUMINOUS PAVEMENT**

Composite Lot Pay Factor (<u>CPF<sub>Lot</sub></u>) Equation:

**CPF** Lot =  $(0.2 \times PF_{Agg}) + (0.3 \times PF_{Pb}) + (0.5 \times PF_{IPC})$  (Equation #7)

c. The above  $CPF_{Lot}$  will be in addition to any reduction in payment for excess tonnage in pavement thickness provided under Article 401-5.

**401-7.03 Control Strip Section** – Control Strip Section will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for the cost of cold milling, if required, preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting and finishing of all required materials for the control strip section; and for all labor, equipment, tools and incidentals necessary to complete said work.

401-7.04 Payment will be made under:

## Pay Item

# 

\* Indicates the number of applicable hammer blows (AASHTO T 245)

\*\* Indicate the applicable Nominal Maximum Aggregate Size (NMAS) of Mix as follows:

38 = Mix NMAS of 3/8-inch 12 = Mix NMAS of 1/2-inch 34 = Mix NMAS of 3/4-inch 1 = Mix NMAS of 1-inch

In those cases in which the Authority does not require a specific NMAS in the mix pay item, the Contractor will have the option of selecting the NMAS of the mix to be designed, produced and placed in the project. The selection by the Contractor of the above mix properties shall be based upon mix compliance with all specification requirements.

SS-401/Page 30 of 30

# **401-1 DESCRIPTION**

### 401-1.01 Scope

a. This work shall consist of constructing one or more courses of Marshall hot plant-mix bituminous pavement on a prepared foundation in accordance with these specifications, and in conformance with the lines, grades, thickness and typical cross sections and smoothness requirements shown on the plans or established by the Engineer. Courses will be identified as, leveling (L), base (B) surface (S) and for preservation purpose only a surface mix with 3/8" Nominal Maximum Aggregate Size (NMAS) will be classified as a surface mix or preservation (S-P).

b. The work shall also include the application of any required tack and prime coats as specified in Specifications 407 and 408 respectively.

# 401-2 COMPACTIVE EFFORT LEVELS, CATEGORIES AND TYPES OF MIXES, AND THICKNESS REQUIREMENTS

**401-2.01 General** - The bituminous plant mix shall consist of a mixture of aggregates, asphalt binder, hydrated lime and anti-stripping additives, if required.

**401-2.02 Compactive Effort Levels** - The contract documents will specify the number of hammer blows to be used in the Marshall Test (AASHTO T 245) for each mix. When the number of hammer blows is not specified, the requirements for mixes will be based on the road classification as indicated on **Table 401-1** below:

<b>Road Classification</b>	Compactive Effort Levels (Number of Marshall Hammer Blows- AASHTO T-245)	
Primary and Secondary	75	
Tertiary and Municipal	50	

**Table 401-1** 

**401-2.03 Categories of Mixes** – The Combined aggregate gradation of Mixes designed and produced under this specification shall be categorized as coarse-graded when it passes below the Primary Control Sieve<sup>1</sup> (PCS) control points defined in **Table 401-2**. Other gradations shall be categorized as fine-graded.

<sup>&</sup>lt;sup>1</sup> PCS – The Primary Control Sieve is the aggregate size that determines what is coarse and what is fine for any aggregate combination. The weight or mass of coarse aggregate (passing the PCS) determines if a mix is a "coarse graded mix" or "fine graded mix".

PCS Control Point for Mixture Nominal Maximum Aggregate Size <sup>2</sup> (NMAS)				
Nominal Maximum Aggregate Size (NMAS) 1-inch <sup>3</sup> / <sub>4</sub> -inch <sup>1</sup> / <sub>2</sub> -inch 3/8-inch				
Primary Control Sieve (PCS)	No.4	No.4	No.8	No.8
PCS Control Point (%Passing)	40	47	39	47

**Table 401-2** 

**401-2.04 Types of Mixes** – Mixes as designed and produced under this specification shall be of the following types in conformance with Article 401-3.02 of this specification.

a. Leveling mixes (L) - Leveling mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1-inch (25 mm),  $\frac{3}{4}$ -inch (19 mm),  $\frac{1}{2}$ -inch (12.5 mm) or 3/8-inch (9.5 mm).

b. Base mixes (B) – Base mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1-inch (25 mm), 3/4-inch (19 mm) or ½-inch (12.5 mm).

c. Surface mixes (S) - Surface mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1/2-inch (12.5 mm) or 3/8-inch (9.5 mm).

d. Surface mixes for preservation purpose only (S-P) – Surface mixes for preservation purpose only, for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 3/8-inch (9.5 mm).

The Contractor will select, for all types of mixes described herein, the category (fine-graded or coarse-graded) of the mix to be designed, produced and placed in the project. Also, in those cases in which the Authority does not require a specific NMAS of mix in the mix pay item, the Contractor will have the option of selecting, from the sizes specified above, the NMAS of the mix to be designed, produced and placed in the project. The selection by the Contractor of the above mix properties shall be based upon mix compliance with all specification requirements.

**401-2.05 Layer (course) Thickness** – Compacted thickness for each course of mix shall be as indicated in **Table 401-3** as follows:

1401-5		
NOMINAL MAXIMUMCOMPACTED THICKAGGREGATE SIZEFOR EACH COURSE (i(NMAS)Min		
(INMAS)	Iviin – Iviax	
$\mathbf{NMAS} = 3/8 \text{-inch}$	1.00 - 2.00	
$NMAS = \frac{1}{2}$ -inch	1.50 - 2.50	
$NMAS = \frac{3}{4}-inch$	2.25 - 3.75	
NMAS = 1-inch	3.00 - 5.00	

<b>Fable</b>	401-3
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<sup>2</sup>Nominal Maximum Aggregate Size (NMAS) is defined as being one sieve larger than the first sieve to have a percent passing less than 90 percent by weight.

## 401-3 MATERIALS

**401-3.01 Asphalt Binder -** The asphalt binder shall conform to the requirements of Section 702-1 of Specification 702 – Bituminous Materials.

**401-3.02 Aggregates** - Aggregates, including mineral filler, shall meet the requirements of Section 703-3 of Specification 703 - Aggregates.

**401-3.03 Reclaimed Asphalt Pavement (RAP)** – Reclaimed Asphalt Pavement materials shall meet the requirements of Section 703-3.02 of Specification 703-Aggregates.

**401-3.04 Hydrated Lime** - Hydrated lime shall meet the requirements of section 712-3 of specification 712 – Miscellaneous Materials. The Contractor shall submit certified laboratory reports on tests of the hydrated lime to be used showing its compliance with the specifications.

**401-3.05 Chemical Anti-Strip Agent** - Furnish commercially produced, heat stable liquid products that when added to an asphalt have the chemical and physical properties to prevent separation of the asphalt from aggregates. The Contractor shall submit for approval the certified laboratory reports of the proposed chemical anti-strip agents. Contractor shall be responsible for verifying the affinity/compatibility of the proposed quantity and source of anti-strip agent with all mix components. The chemical anti-strip agent and/or hydrated lime is mandatory for all the surfaces mixes for preservation purpose only (**S-P**).

# 401-3.06 Composition of Mixtures

a. **Job-Mix Formula<sup>3</sup>** (**JMF**) - The Contractor shall develop and submit in writing for the Engineer's approval, at least thirty five (35) calendar days in advance of the date he intends to start paving operations, a job-mix formula based upon a Marshall mix design, meeting the requirements of this Specification, for each type of mixture to be used in the project.

Each job-mix formula shall be supported by qualified laboratory test data used in the mix design process including, but not limited to, the design charts used. The submission shall also identify the proposed sources of the asphalt binder and aggregates to be used, including the FHWA 0.45 power gradation chart of the proposed mix. The five-week lead requirement may be waived at the discretion of the Authority. The submittal shall comply with the proposed job-mix formula and with all specification requirements.

Each proposed job-mix formula and mix design shall be designed and submitted to the Authority's Materials Testing Office on a three year basis or when a statistical analysis of the Acceptance and/or Contractor Quality Control test results shows significant difference in mix properties, which ever occur first. No mix shall be placed on this project without an approved job-mix formula and a corresponding mix design. The Authority reserves the right of being present at the Contractor's laboratory during the development of the mix designs.

<sup>3</sup>Job-mix formula (JMF) is the proposed combined aggregate gradation, percent of asphalt binder, dust to effective asphalt ratio and volumetric properties used to establish target values for mix production based upon a mix design

Verification of the proposed mix design may be performed at the Authority's laboratory by the Authority personnel at the time of submission of JMF. When determined by the Authority, the Contractor shall coordinate with the Authority the sampling of all materials proposed for use in the mix. Verification of mix design will consist in checking the selection of the optimum asphalt content made by the Contractor. Furthermore, the above procedure will also include verification of moisture susceptibility and relative permeability requirements established in this specification.

b. **Mix Requirements** - Each mix shall be designed according to the Marshall Mix Design Method as described in the Asphalt Institute Manual MS-2 and shall meet the following requirements:

(1) Mix Stability and Flow as determined by AASHTO T 245 shall meet the requirements of **Table 401-4**:

1 able 401-4			
Compactive Effort	Flow (0.01 inch (25 mm))		
Level		(Minimum - Maximum)	
50	1,200	8-16	
75	1,800	8-14	

Table 401 4

(2) Moisture Susceptibility Requirements – Mixes shall meet the following requirements:

a. AASHTO T 283 for Laboratory Mixed - Laboratory Compacted Specimens:

i. For AASHTO T 283 procedures include the freeze and thaw cycle (severity conditioning). In addition, all samples shall be compacted to  $7 \pm 1.0$  percent air voids. The test specimens shall be 6-inch diameter samples compacted using a gyratory compactor (AASHTO T 312).

ii. Tensile Strength - The minimum dry and unconditioned tensile strength shall be 80-psi for surface mixes and 70-psi for other mixes. This requirement will not be applied to contracts which bids are opened prior to June 30, 2010.

iii.Retained Tensile Strength Ratio (TSR) – Minimum 65 percent of Tensile Strength.

(3) Air Voids Content (Va) Requirements – The mix shall have an air void content of 4.0 percent at the design Compactive Effort Level as determined by AASHTO T 166, T 209 and T 269.

(4) Voids in Mineral Aggregate (VMA) Requirements - The mix shall have a VMA based upon the NMAS of the mix as indicated in Table 401-5:

NMAS	Minimum VMA (Percent)	
3/8-inch	15	
<sup>1</sup> /2-inch	14	
<sup>3</sup> /4-inch	13	
1-inch	12	

Table 401-5

(5) Voids Filled with Asphalt (VFA) Requirements – The mix shall have a VFA (percent) based upon the Compactive Effort Level as indicated in Table 401-6:

<b>Table 401-6</b>		
Compactive Effort Level	VFA (Percent) (Min – Max)	
50	65-78	
75	65-75	

(6) The Dust to Effective Asphalt Binder ratio (DEAR) of the mix, computed by dividing the percentage of material passing the No. 200 sieve by the percent of effective asphalt binder (Pbe) in the mix, shall be as indicated in **Table 401-7**:

<b>Table 401-7</b>		
Mix Category	Dust to Effective Asphalt Binder Ratio (DEAR) / Specification Limits (Min – Max)	
Fine-Graded	0.6 - 1.2	
Coarse-Graded	0.8 - 1.6	

(7) Laboratory Mixing Temperature – Mixing temperature shall be the temperature at which the binder viscosity is approximately  $0.17 \pm 0.02$  Pa-s in accordance with AASHTO T 245. This mixing temperature will be for laboratory use only.

(8) Laboratory Compacting Temperature – Compacting temperature shall be the temperature at which the binder viscosity is approximately  $0.28 \pm 0.03$  Pa-s in accordance with AASHTO T 245. This compacting temperature will be for laboratory use only.

c. Mix Values - Each job-mix formula submitted shall propose definite values for:

- (1) The type of mix to be used (**S**, **B**, **L**).
- (2) The category (fine-graded or coarse-graded) of the mix to be designed.
- (3) Nominal Maximum Aggregate Size (NMAS) of the aggregate mixture.
- (4) Compactive Effort Level (Number of Hammer Blows).

(5) The source and materials to be used; Single percentage of aggregates passing each required sieve size.

(6) Single percentage of asphalt binder (Pb) to be added based on total weight of the mixture.

(7) The kind and percentage of mineral filler to be used, if any.

(8) Production Temperature - The target temperature at which the mixture is to be

discharged from the asphalt plant.

(9) Bulk Specific gravity and Apparent Specific gravity of each separate mixture component.

(10) Specific gravity of the Binder at 25 degrees Celsius.

(11) Polish Stone Value (PSV) of coarse aggregate (Only for S mixes).

(12) Coarse Aggregate Angularity, Flat and Elongated Particles and Percent Wear (abrasion loss), etc.).

(13) Design Gradation on FHWA's 0.45 Power Gradation Chart.

(14) Provide all the physical properties achieved at the different asphalt binder contents used to determine the optimum asphalt content.

(15) Percent Asphalt Binder Content (Pb) (optimum) and Effective Asphalt Binder Content (Pbe).

(16) Dust to Effective Asphalt Binder Content Ratio (DEAR).

(17) Theoretical Maximum Specific Gravity and Density of Asphalt Paving Mixtures (Gmm (AASHTO T 209) at Target Binder Content).

(18) Bulk Specific Gravity, Effective Specific Gravity of Mix at the Design Compactive effort level.

(19) Air Void Content (Va) at Design Compactive effort level.

(20) Voids in Mineral Aggregate (VMA) at Design Compactive effort level Voids Filled with Asphalt (VFA) at Design Compactive effort level Laboratory Density in Lb/ft^3.

(21) Required In-place Compaction.

(22) Type and quantity of chemical anti-strip agent and/or hydrated lime, if required, including all data to perform the optimization procedure.

(23) Moisture Susceptibility data sheet of the proposed mix in accordance with AASHTO T-283.

(24) Retained tensile strength ratio, tensile strength (dry and unconditioned) and tensile strain (dry and unconditioned).

d. **Additional Mix Values** – With each job-mix formula report the following values or mix properties as available:

(1) Aggregate geological and mineralogical descriptions.

(2) Fine Aggregate Angularity and Sand Equivalent of Aggregate mixture.

(3) Field Compaction Temperature - The target temperature at which the mixture is to be compacted during lay-down operations.

(4) Bailey Method Ratio's for each Marshall Mix.

(5) Asphalt film thickness for each mix.

(6) Results from AASHTO T-182 (Coating and Stripping of Bitumen-Aggregate Mixtures).

(7) FM 5-508 (Laboratory Testing the Effectiveness of Anti-Strip Additives) test results performed on mix.

(8) AASHTO T-283 optimization test results obtained at other anti-strip and/or hydrated lime dosages.

e. **Changes and resubmissions.** If a job-mix formula is rejected or a material source (including the recycled asphalt pavement) has changed, submit a new job-mix formula for acceptance. Up to twenty one (21) calendar days may be required to evaluate a change. Approved changes in target values will not be applied retroactively for payment.

## 401-3.07 Sampling and Testing

a. All acceptance sampling and testing activities will be performed by the Authority. Samples will be taken at random locations during production and will remain in the custody of the Authority at all times. Each sample shall provide enough material to adequately perform all testing as determined in each test procedure. The Contractor or his authorized representative may be present, if so desired, when these sampling and testing operations are being performed. All testing will be done at the producer's plant laboratory provided it has been qualified by the Authority's Materials Testing Office in accordance with **PRHTA Q 401-10 - Qualification of Hot Mix Asphalt (HMA) Laboratories.** However, the Authority may, at its discretion, perform the testing at the Authority's laboratory. Sampling for acceptance testing will be performed by the Authority in accordance with **Table 401-8**:

Description	<b>Procedure Designation</b>
Qualification of Hot Mix Asphalt (HMA) Laboratories	PRHTA Q 401-10
Determination of Random Sampling Location	PRHTA M 401-10
Sampling of Asphalt Binder	AASHTO T-40
Sampling of Aggregates	AASHTO T-2
Sampling of Bituminous Paving Mixtures	AASTHO T-168
Reducing Samples of Hot-Mix Asphalt to Testing Size	AASHTO T-328
Sampling of Compacted HMA Pavement	PRHTA M 401-20

**Table 401-8** 

b. Provide at the mixing plant laboratory and at the field all the equipment, tools, supplies and other apparatus required for sampling the mix, preparing specimens and testing for compliance of the mix being produced and its components with all the requirements stated in this specification, applicable AASHTO or ASTM Standards or Puerto Rico Highway and Transportation Authority's procedures. The use of microwave oven shall not be used for acceptance testing procedures.

c. The Authority will take, at its discretion, random samples of the asphalt binder and aggregates at the plant (prior to and during mix production) to test for the compliance of these materials with their specifications requirements.

d. Samples of the mix material being produced for delivery to the project will be taken by the Engineer at the plant following the procedures established in **Table 401-8**. The control unit for sampling, testing and acceptance purposes will be a lot which is defined as 900 tons, 750 tons or 600 tons or fraction thereof placed each day, subdivided into three equal sub-lots of 300 tons, 250 or 200 tons respectively. Any fraction produced that amounts to 100 tons or less will be incorporated in the previous lot. Any fraction produced that amounts to more than 100 tons will be considered a sub lot of a new lot. Lot size shall be determined by the Contractor in writing to the Authority prior to the Pre-Paving Meeting.

e. Acceptance testing will consist of evaluating the number of samples as indicated in **Table 401-9** below per each lot. Each sample shall provide enough material to adequately perform all testing as determined in each individual test procedure. Acceptance testing procedures are as follows:

Procedure Designation (AASHTO)	Frequency	Testing
AASTHO T-164		Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
AASHTO T-30/11B	1 per sub-lot	Mechanical Analysis of Extracted Aggregate / Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing Using a Wetting Agent
AASHTO T-209 (including Section #11) /	1 per lot (use average of two split samples for	Theoretical Maximum Specific Gravity and Density of Hot Mix
PRHTA T 401-50	acceptance)	Asphalt Paving Mixture
AASHTO T-245 AASHTO T-166 or T-275 as required AASHTO T-269	1 per sub-lot (use average of three split samples for acceptance per lot)	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus Bulk Specific Gravity of Compacted Hot Mix Asphalt Mixtures Using Saturated Surface Dry Specimens / Bulk Specific Gravity of Compacted Hot Mix Asphalt Mixtures Using ParaffinCoated Specimens Percent Air-Void in Compacted Dense and Open Asphalt Mixtures
PRHTA T 401-10	As required	Mixture conditioning for determining volumetric properties of HMA
PRHTA T 401-20	6 per lot (2 per sub-lot)	Determination of HMA in-place compaction and layer thickness
PRHTA T 401-30	As required	Determination of HMA pavement density profile
PRHTA T 401-40	As required	Determination of asphalt binder content of compacted HMA

**Table 401-9**
f. The Authority may, at its discretion, take samples of the mix being delivered to the project site for testing at any location including behind the paver before compaction. Test results of these samples will be for informational purposes only and will not form part of the acceptance process.

**401-3.08** – **Reporting Results** – The following mix properties shall be determined, calculated and reported for each sub lot:

a. Bulk Specific Gravity (Gmb) – AASHTO T-166 / AASHTO T-275 as applicable

b. Maximum Specific Gravity (**Gmm**) - AASHTO T-209 (including Section #11) / PRHTA T 401-50

- c. Asphalt Binder Content (**Pb**) AASHTO T-164
- d. Air Voids Content (Va) AASHTO T-269
- e. Voids in Mineral Aggregate (VMA)
- f. Voids Filled with Asphalt (VFA)
- g. Effective Asphalt Binder Content (**Pbe**)
- h. Effective Specific Gravity of Mix (Gse)

i. Mass Retained (g), Mass Retained (percent), Percent Passing for the following sieve designations: 1-1/2", 1",  $\frac{3}{4}$ ",  $\frac{1}{2}$ ",  $\frac{3}{8}$ ",  $\frac{1}{4}$ ", No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, No. 200 – AASHTO T-30 / T- 11 B.

j. Dust to Effective Asphalt Binder Content Ratio (**DEAR**).

# **401- 4 CONSTRUCTION REQUIREMENTS**

**401-4.01 Production Start-Up Procedures** – Use these start-up procedures when producing material for the first time in the project, when using materials from different plants, or when resuming production after a termination of production due to unsatisfactory quality as determined by the Engineer.

a. **Control Strip Section** – Produced, place, and compact the proposed HMA in order to establish that the equipment and the processes planned for placement and compaction are satisfactory. Provide fourteen (14) calendar days notice before beginning production of an asphalt concrete mix.

On the first day of production, produce sufficient mix to construct a 300 to 600 tons control strip, as determined by the Contractor, one-lane wide, and at the designated lift thickness. Construct the control strip on the project at an approved location.

Construct the control strip using mix production, lay-down, and compaction procedures intended for the entire mix. The mix is acceptable with full payment if all test results are in conformity with specification limits with a  $CPF_{lot}$  equal or greater than 0.70. Mix that is not acceptable will be removed at no cost to the Authority and shall be replaced during full production operation through applicable hot plant bituminous mix pay items.

1) **Mixture.** Take and test at least three control strip asphalt concrete mix samples and evaluate according to article 401.3.07

2) **Compaction.** Take nuclear density readings behind each roller pass to determine the roller pattern necessary to achieve required density. Keep records of compaction effort frequency and amplitude settings of equipment used.

At a minimum of five locations within the control strip, take nuclear gauge readings, and cut and test core samples according to article 401.3.07. Density is acceptable if all tests are within the specification limit. Furnish the Engineer with the nuclear gauge readings and correlations of the readings to the core specific gravities.

The Contractor shall address any production and/or placement deficiencies identified by the Contractor and the Engineer during this operation as part of the quality control and acceptance plan during the Pre-paving meeting. Tests used for the control strip will not be included in the evaluation for payment according to article 401-5. Based on the Contractor's evaluation of the initial control strip, paving may continue at the Contractor's risk once the Pre-paving meeting per section 401.4.01(b) is completed.

b. **Pre-Paving Meeting** – After the construction of a control strip and at least seven (7) calendar days before the start of production paving operation, the Engineer shall arrange for a pre-paving meeting. Attendance of Contractor, the Contractor's Paving Quality Assurance Manager, subcontractors, and all other applicable suppliers is mandatory. At the meeting the Contractor's Paving Quality Assurance Manager shall submit and discuss the proposed production and lay-down operations plan. After the meeting, the contractor shall submit a written final detailed plan (at least three (3) calendar days before the proposed start of paving operations) to be revised by the Engineer that as a minimum includes the following:

- (1) Proposed schedule of paving operations;
- (2) List of all necessary equipment and key personnel used in the production and construction of the work;
- (3) Proposed traffic control plan for paving operations including provisions for pavement drop-offs and moving operations;
- (4) Contractor quality control and materials acceptance plan, corrective action plan<sup>4</sup> in accordance with this specification

(5) Placement operation including production, delivery, placing, finishing, compacting, and smoothness procedures. Include also the proposed rolling patterns, frequency and amplitude to be utilized in the placement operations.

<sup>4</sup>Corrective Action Plans - Contractor's proposed strategies and related work to be performed to prevent repeated deficiencies.

(6) Production and placement strategies to minimize segregation of HMA. Prior to the start of using the paver for placing plant mix, the Contractor shall submit for approval a full description in writing of the means and methodologies that will be used to prevent bituminous paver segregation. Use of the paver shall not commence prior to receiving approval from the Engineer.

**401-4.02 Bituminous Mixing Plant -** Plants used for the preparation of bituminous mixes shall conform to AASHTO M 156 modified and supplemented as follows:

a. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mix, the Engineer, or his authorized representative, shall have access, at all times, to all portions of the mixing plant, aggregates plant, storage yards, and other facilities for producing and processing the mix materials.

b. Scales shall be inspected and certified by the Division of Weights and Measures of the Commonwealth Department of Consumers Affairs (DACO) on yearly basis or as required by the Engineer. Any cost involved in the inspection and sealing of the scales shall be at the Contractor's expense. No asphalt mix shall be produced and delivered to the project from a producer plant that does not comply with the above requirements.

c. All projects involving 2,000 Tons or more of bituminous mixture shall be served by a plant having automatic controls which coordinate the proportioning, timing and discharge of the mixture.

d. All plants shall be equipped with air pollution control devices which meet the requirements of the Environmental Quality Board.

e. The completed bituminous mixture may be weighed on approved scales furnished by the Contractor at his expense. The scales shall be inspected and calibrated at least once a year by an independent entity.

**401-4.03 Hauling Equipment -** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution or other approved material to prevent the mixture from adhering to the beds. No gas oil or diesel fuel will be allowed for preventing the mixture adhering to the truck bed. Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture and for use during hauling operations. No truck will be allowed to leave the plant without covering the mix with

the cover of canvas. Each day before delivery to the project, the Contractor shall provide to the Engineer a certification attesting to the compliance of each delivery truck with these requirements.

**401-4.04 Delivery Trucks** – Furnish delivery tickets to the Engineer, before unloading at the site of the work the bituminous mix supplier, containing the following information concerning the bituminous mix in the truck:

- a. Name of bituminous mixing plant
- b. Serial number of ticket
- c. Date, time and truck number
- d. Name of Contractor
- e. Specific designation of job (name, number and location)
- f. Type of mix
- g. Weight of mix in the truck
- h. Space for signature of Authority's inspector at the paving site and at the scales.
- i. Temperature of the asphalt mix measured at the plant
- j. Temperature of the asphalt mix measured at the site

## 401-4.05 Bituminous Pavers

a. Provide Bituminous pavers self-contained, power propelled units with a vibrating or tamper screed and strike-off assembly covering the full lay-down width, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material which will meet the specified typical section, thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in the widths shown on the plans.

b. The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed and strike-off assembly shall effectively produce a finished surface of the required smoothness and texture without segregating, tearing, shoving, or gouging the mixture.

c. The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

d. The paver shall be equipped with a grade and slope control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made inoperative and the screed shall be controlled by sensor directed automatic mechanisms, which will independently control the elevation of each end of the screed from the reference lines or surfaces. The controls shall work in conjunction with any of the following attachments:

(1) Ski-type device, floating beam of not less than 30 feet (9.14 m) in length and short ski or shoe to match adjoining lanes either fresh or old layer or as directed by the Engineer.

(2) Taut stringline wire set by the Contractor to the specified grade.

(3) A non-contacting laser or sonar-type ski with at least four referencing stations may be used with a reference at least 24 feet (7.3 m) long.

e. Except as presented on Article 401-4.05(g) below, furnish, as a minimum, automatic control systems such as long ski, short ski/shoe or furnish and install all required stakes and wire for a taut string line. Should the automatic control system become inoperative during the day's work, the Contractor may be permitted, at the discretion of the Authority, to finish the day's paving work using manual controls. However, work shall not be resumed thereafter until the automatic control system has been made operative.

f. The Contractor may be exempt from the use of the automatic control system at locations where the Engineer determines that pavement geometry or widths makes its use impracticable.

g. Laser Control and/or Profilograph Control equipments may be used by the Contractor. The use of this equipment shall be subject to the following requirements at no cost to the Authority:

1. Present a written notice to the Engineer at the beginning of the project proposing the use of such equipment. The written notice shall include, as a minimum, the brand, type, model and manufacturer of the proposed equipment.

2. Provide a copy to the Engineer of the manufacturer's instruction and operation manual as well as any other literature related to computer software.

h. Provide bituminous pavers that are equipped with a means of preventing the segregation of the coarse aggregate particles from the remainder of the bituminous plant mix when that mix is

carried from the paver hopper back to the paver augers. The means and methods used shall be approved by the paver manufacturer and may consist of chain curtains, deflector plates, or other such devices and any combination of these.

The following specific requirements shall apply to the identified bituminous pavers:

(1) Blaw-Knox bituminous pavers shall be equipped with the Blaw-Knox Materials Management Kit (MMK).

(2) Cedarapids bituminous pavers shall be those that were manufactured in 1989 or later.

(3) Caterpillar bituminous pavers shall be equipped with deflector plates as identified in the December 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630, 6631, 6640}".

**401-4.06 Rollers** - Rollers may be of the vibratory or tandem steel wheel type. Pneumatic-tired rollers may be used in conjunction with either of the steel wheel types. Rollers shall be in good condition, be capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. For leveling and for preservation surface courses (S-P), at least one pneumatic tire roller shall be used.

**401-4.07 Weather Limitations -** Bituminous plant mix shall not be placed on any wet surface or when weather conditions prevent the proper production, handling placing or finishing of the bituminous mixture.

# 401-4.08 Preparation of Surface to be Paved -

a. The surface to be paved shall be true to line and grade, dry and free from loose or deleterious material immediately before the placing of bituminous mixture. If necessary, the surface shall be cleaned by brooming or other approved means.

b. When the surface of an existing pavement or old base to be paved is irregular, it shall be brought to uniform grade and cross section by a leveling course as directed, which shall be compacted to the satisfaction of the Engineer before placing subsequent paving courses.

c. When a leveling course is not required, all depressions and other irregularities shall be patched or corrected in a manner satisfactory to the Engineer. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material, shall be removed from the area to be paved. Blotting of excessive deposits of asphalt with sand or stone will not be permitted.

d. Where the area to be paved is an untreated soil or aggregate, it shall be compacted to the required density and then primed in accordance with the provisions of Specification 408 - Bituminous Prime Coat. The prime coat shall be allowed to cure properly in accordance with the provisions of Specification 408 before any further operations are permitted on the primed area.

e. Apply bituminous tack coat upon all Portland cement concrete surface or a bituminous surface before placing new HMA in accordance with the provisions of Specification 407 - Bituminous Tack Coat shall be applied.

f. Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of bituminous material as specified for the tack coat prior to the bituminous mixture being placed against them.

**401-4.09 Preparation of Bituminous Material** – Heat the bituminous material in a manner to avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature within the regents specified in **Table 401-10**. Asphalt binder shall not be used while it is foaming nor shall it be heated above 350 degrees F at any time after delivery to the plant.

Asphalt Binder	Storage Temperature Range (Minimum – Maximum) (°F)
PG 64-22	285-315
PG 67-22	295-320
PG 70-22	300-325

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## 401-4.10 Mixing

a. Combine the aggregates in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. Measure or gauge the bituminous material shall and introduced it into the mixer in the amount specified by the job-mix formula. Mix the materials until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured.

b. **Production Temperature** - The production temperature will be measured at the truck bed prior to delivery of mix to project. Temperature of the mix will be the average of three readings measured at the top of the mix pile in each truck. Measurement shall be taken using a properly calibrated thermometer provided by the Contractor. Calibration shall be accomplished on a yearly basis. Mixes shall have a production temperature between the acceptable ranges in Table 401-11:

<b>Table 401-11</b>		
Acceptable Production Temperature Range		
Minimum Production Temperature -30° F		
Maximum	Production Temperature +20° F	

(1) Mixes with production temperature below the minimum temperature established in Table 401-11 above shall be allowed to be delivered to the project. In such cases the Engineer will record the final location of the pavement section or area that represents each truck for further

evaluation. Evaluation will be performed once the Contractor has achieved compaction of mix. Evaluation will be following the procedure indicated in Section 5 - Procedure for Determination In-Place Compaction of PRHTA T 401-20 (Determination of HMA In-Place Compaction and Layer Thickness), except that only one core will be extracted and evaluated. If In-Place Compaction is within the range indicated in Table 401-12 below the mix will be considered acceptable, otherwise the mix will be paid with a 50 percent pay factor (PF = 50%). No retesting will be allowed.

(2) Mixes with production temperature above the maximum temperature established in Table 401-11 above will not be allowed to be delivered to the project.

c. Deliver all mixes at the paving site at a temperature of no less than 225 degrees F. Mixes shall have at least 225 degrees F prior to its placement in front of the paver. Temperature of the mix will be as determined by the Materials Testing Office.

## 401-4.11 Transporting, Spreading and Finishing -

a. Transport the mixture from the mixing plant to the paving site in vehicles conforming to the requirements of Article 401-4.03. Place the protective cover over the mix prior to departing the plant and retained in place until the mix is delivered. Failure to comply with the above requirement will be cause for rejection of the mix contained in the truck.

b. Lay the bituminous mixture upon an approved clean surface, spread and struck off to the established grade and elevation. Use bituminous pavers to distribute the mixture either over the entire width or over such partial width as may be practicable.

c. The longitudinal joint in one layer shall be offset from that in the layer immediately below by approximately 6-inch; however, the joint in the top layer shall be at the center line of the pavement if the roadway comprises two lanes of width, or at lane lines if the roadway is more than two lanes in width, unless otherwise directed. Failure of the Contractor to observe the above dispositions and the placement of the longitudinal joint at any wheel path will allow the Authority to reject the mix or to accept the same at a 50 percent reduction in price.

d. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread and finished by hand tools. For such areas the mixture shall be dumped, spread and screeded to provide the required section and compacted thickness. Provide suitable heating equipment or non petroleum based asphalt release agents for keeping hand tools free from asphalt. The temperature of the tools when used shall not be greater than the temperature of the mix placed. The use of petroleum oils, diesel fuels or volatiles will not be permitted.

e. Place the mixtures in layers as indicated on the plans. No single layer shall exceed 10 cm. (5") in compacted thickness.

f. When using a Material Transfer Vehicle (MTV) during lay-down operations, a paver hopper insert shall be used at all times.

## **401-4.12** Compaction Requirements

a. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, compact it thoroughly and uniformly by rolling. Roll the surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in workable condition. The sequence of rolling operations and the selection of roller types shall be such as to meet the in-place compaction requirements. In-place compaction shall be determined in accordance with **PRHTA T 401-20** – **Determination of HMA In-Place Compaction and Layer Thickness**. Acceptable In-Place Compaction Range shall be as indicated in Table 401-12:

<b>Table 401-12</b>		
In-Place Compaction Requirements		
(Percent, Minimum – Maximum)		
92 - 97		

b. Unless otherwise directed, begin rolling at the sides and proceed longitudinally parallel to the road centerline, gradually progressing to the crown of the road. Place consecutive layers by overlapping all joints a minimum of 6-inch (15 cm.). When paving in echelon or abutting a previously placed lane, roll the longitudinal joint first followed by the regular rolling procedure. On super-elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the center line.

c. Move rollers at a slow but uniform speed with the drive roll or wheels nearest the paver except when rolling an incline, then the procedure is reversed.

d. Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. Keep wheels properly moistened with water or water mixed with very small quantities of detergent or other approved material to prevent adhesion of the mixture to the rollers.

e. Compact the mixture thoroughly with mechanical tampers along forms, curbs, headers, walls and other places not accessible to the roller. Use a trench or small vibratory roller, or cleated compression strips under the roller on depressed areas to transmit compression.

f. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous mix material shall be corrected to the satisfaction of the Engineer.

## 401-4.13 Joints, Trimming Edges and Cleanup -

a. Complete pavement construction of adjacent traffic lanes to the same elevation within 24 hours. If drop-offs are left overnight, sign the drop-offs in excess of 2 inches with "Uneven Lanes" warning signs and provide a 1V:3H fillet for drop-offs in excess of 4 inches. At connections to existing pavements and previously placed lifts, make the joints vertical to the depth of the new pavement. Form joints by cutting back the previous run to expose the full-depth course.

b. Placing of the bituminous mix shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Apply an asphalt tack coat meeting the requirements of specification 407 to the joint edge to both transverse and longitudinal joints before additional mixture is placed against the previously rolled material.

c. At the beginning or end of a project connecting to an existing pavement the feathering of the new surface course to match the existing grade of the old pavement will not be permitted. To transition and match the grades, the old pavement shall be undercut to a depth equal to the compacted depth of the new surface course being connected to it. This work shall be a subsidiary obligation of the Contractor under the new pavement pay items.

d. Material trimmed from the edges and any other discarded bituminous mixture shall be removed from the roadway and disposed of by the Contractor outside the project limits or in an approved area out of sight from the road. No deduction in payment will be made for the fillet material removed.

**401-4.14 Surface Requirements** – Measure the smoothness/roughness in accordance with Specification 410 – Hot Plant Mix Bituminous Pavement Smoothness to the applicable smoothness level indicated in contract. Payment for compliance to surface requirements will be as determine in Specification 410 through applicable hot plant mix bituminous item.

**401-4.15 Protection of Pavement** - Protect sections of newly finished work from traffic of any kind until the mixture has become properly hardened by the cooling method stated below.

Provide at all times in the project water supply trucks capable of applying potable water to the compacted mix in order to cool it to a temperature below 150 degrees Fahrenheit. Apply water after the mix has achieved the compaction level as required in this specification. Also, provide to the Authority a calibrated infrared thermometer capable of measuring temperatures in the range of 100 degrees Fahrenheit and 350 degrees Fahrenheit. All of the equipment indicated above shall be a subsidiary obligation of the contract.

Do not open to traffic the compacted mix until all measurements with infrared thermometer taken in the mat by the Authority show temperatures below 150 degrees Fahrenheit.

## 401- 5 BASIS OF ACCEPTANCE

a. **Measured Conformance -** The acceptability of the quality of the hot plant-mix bituminous pavement will be based on the tested conformance of the material with the requirements of Articles 401-3.07 and 401-4.14 above and the tolerances for the acceptance quality characteristics per lot as follows:

1. The average of each acceptance quality characteristic per lot shall be within the deviation parameters established from JMF target values, and

2. The measured variability of each acceptance quality characteristic per lot as shown in Tables 401-13 to 401-16:

NMAS = 1-inch			
Acceptance Quality	<b>Deviation from Target Value</b> <sup>6</sup>	Variability	
<b>Characteristic</b> <sup>5</sup> (AQC)	(DTV)	Range	
1-inch (Control Sieve)	+/-8*	4	
No. 4 (Control Sieve)	+/-7*	3.5	
No. 200 (Control Sieve)	+/-3*	1.5	
Amount of performance graded		0.26	
binder (Pb)	+/- 0.52		
In-Place Compaction (IPC)	92 - 97%	2	
Thickness (min. total for project)	80% of specified layer thickness	N/A	
Thickness (max. total for project)	115% of specified layer thickness	N/A	

Table 4	01-13
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#### Table 401-14

$\mathbf{NMAS} = 3/4$ -inch		
Acceptance Quality Characteristic (AQC)	<b>Deviation from Target Value (DTV)</b>	Variability Range
<sup>3</sup> / <sub>4</sub> -inch (Control Sieve)	+/-8*	4
No. 4 (Control Sieve)	+/-7*	3.5
No. 200 (Control Sieve)	+/-3*	1.5
Amount of performance graded binder (Pb)	+/- 0.52	0.26
In-Place Compaction (IPC)	92-97%	2
Thickness (min. total for project)	80% of specified layer thickness	N/A
Thickness (max., total for project)	115% of specified layer thickness	N/A

<sup>5</sup>Acceptance Quality Characteristic (AQC) – Characteristic or property of a mix that is measured for acceptance purposes.

<sup>6</sup>*Target Value – Mix design values as reported in JMF for each acceptance quality characteristic.* 

Table 401-15		
$\mathbf{NMAS} = 1/2$ -inch		
Acceptance Quality	<b>Deviation from Target Value (DTV)</b>	Variability Range
Characteristic (AQC) <sup>4</sup>		
1/2-inch (Control Sieve)	+/-8*	4
No. 8 (Control Sieve)	+/-7*	3.5
No. 200 (Control Sieve)	+/-3*	1.5
Amount of performance graded		0.26
binder (Pb)	+/- 0.52	
In-Place Compaction (IPC)	92-97%	2
Thickness (min. total for project)	80% of specified layer thickness	N/A
Thickness (max. total for project)	115% of specified layer thickness	N/A

## Table 401-16

NMAS = 3/8-inch		
Acceptance Quality Deviation from Target Value (DTV) Variab		Variability
Characteristic (AQC)		Range
3/8-inch	+/-7*	3.5
No. 8	+/-7*	3.5
No. 200	+/-3*	1.5
Amount of performance graded	+/- 0.52	0.26
binder (Pb)		
In-Place Compaction (IPC)	92-97%	2
Thickness (min, total for project)	80% of specified layer thickness	N/A
Thickness (max. total for project)	115% of specified layer thickness	N/A

(\*)Upper gradation deviation shall not be outside the grading composition requirements of Table 703-3. In such cases the DTV will be reduced accordingly (Allowable Deviation from Target Value (ADTV)). Deviations are subject to selected target value in the approved JMF.

b. Segregated HMA (segregated areas and/or longitudinal streaks sections) – The acceptability of HMA pavement were segregation<sup>7</sup> is perceived to be present will be determined in conformance with **PRHTA T 401-30** - **Determination of HMA Pavement Density Profile** and based upon the following criteria:

1. HMA material will be considered acceptable if both of the following conditions are met:

a. Maximum - minimum density range is less than 6.0 pcf.

b. Mean – minimum density range is less than 3.0 pcf.

2. HMA material will be rejected if any of the requirements above are not met. The section(s) shall be removed at the contractor expense and replaced.

c. HMA with Bleeding - The acceptability of HMA pavement were bleeding8 is perceive to be present will be determined in conformance with PRHTA T 401-40 - Determination of Asphalt Binder Content of Compacted HMA and based upon the following criteria:

1. Will be considered acceptable if the following condition is met:

a. Asphalt content (Pb) is within the range of +/-0.70 from JMF.

2. Will be rejected if it does not meet the requirement above. The section(s) shall be removed at the contractor expense and replaced.

d. Contractor costs related to the activities stated in b and c above will be reimbursed to the Contractor on a force account basis if the HMA material is considered acceptable.

# 401-6 METHOD OF MEASUREMENT

**401-6.01** Plant-mix bituminous pavement courses will be measured by the ton of compacted mixture placed in the accepted work, as called for in the contract documents. Measurement will be by weighing the delivery trucks at approved scales. Batch weights will not be accepted as a method of measurement.

**401-6.02** Any excess tonnage due to excess thickness, determined as provided in Article 401-3.07e and 401-5 as applicable, will be deducted from the measurement for payment.

**401-6.03** Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the contract quantities and no adjustment in the contract unit price will be made because of such variation.

**401-6.04** Work prescribed under Article 401-4.08, Preparation of Surface to be Paved, except for the leveling course and mix material used for patching and correcting irregularities in old surfaces, will not be measured directly for payment, but will be considered as a subsidiary obligation of the Contractor under the various items of hot plant-mix bituminous pavement. Hot plant-mix material

used for patching and leveling in this work will be measured for payment under the respective unit prices.

<sup>7</sup>Segregation - The non-uniform distribution of HMA coarse and fine aggregate components. Segregation can be determined visually as pavement sections that have a significantly different texture than the surrounding material.

<sup>8</sup>Bleeding (Excess surface asphalt) - A shiny, black surface caused by liquid asphalt migrating to the pavement surface. The result can mean a loss of surface texture on the pavement.

# 401-7 BASIS OF PAYMENT

**401-7.01** The completed and accepted quantities of each class of hot plant mix pavement, measured as provided above, will be paid for at the contract unit price per unit of measurement except as specified in Article 401-7.02 below. Such prices and payment shall constitute full compensation for the cost of the mix design and other related costs, preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting and finishing of all required materials for the pavement; smoothness of the final pavement surface and for all labor, equipment, tools and incidentals necessary to complete each item of work as indicated in this specification.

**401-7.02** Payment for hot plant mix pavement will be paid for by Lot at unit price multiplied by the applicable Composite Lot Pay Factor (**CPF** Lot) as follows:

# a. Individual Acceptance Quality Characteristics (AQC) Pay Factor Determination:

- 1. Aggregate Gradation:
  - a) Average Requirements:

For All Control Sieves (\*):

If average of lot is within (JMF - DTV, JMF + ADTV) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise **CPF** Lot = **0.50**.

b) Variability Range Requirements:

Pay Factor Equation for Control Sieves 1-inch, <sup>3</sup>/<sub>4</sub>-inch and <sup>1</sup>/<sub>2</sub>-inch (+/- 8\*):

PF<sub>NMAS</sub> = 1.25 (Variability Range) <sup>-0.161</sup>

(Equation #1)

If PF  $_{NMAS} > 1.00$  Then PF  $_{NMAS} = 1.00$ 

Pay Factor Equation for Control Sieves 3/8-inch No. 4 and No. 8 (+/- 7\*):

**PF** PCS = 1.22 (Variability Range)<sup>-0.161</sup> (Equation #2)

If **PF** PCS > **1.00** Then **PF** PCS = **1.00** 

Pay Factor Equation for Control Sieves No. 200 (+/- 3\*):

PF No. 200 = 1.10 (Variability Range) -0.161	(Equation #3)

If PF  $_{No.\ 200} > 1.00$  Then PF  $_{No.\ 200} = 1.00$ 

(\*)Upper gradation deviation shall not be outside the grading composition requirements of Table 703-3. In such cases the DTV will be reduced accordingly (Allowable Deviation from Target Value (ADTV)). Deviations are subject to selected target value in the approved JMF.

Pay Factor Equation for Aggregate Grading (**PF** Agg): Pay Factor for aggregate grading will be calculated based on the Pay Factors (PF) of corresponding mix control sieves with the following weighting applied: 10 percent for control sieves 1-inch, <sup>3</sup>/<sub>4</sub>-inch and <sup>1</sup>/<sub>2</sub>-inch (NMAS sieves), 15 percent for Control Sieves 3/8-inch No. 4 and No. 8 (PCS sieves) and 75 percent for Control Sieve No. 200. Calculate the **PF** Agg by using the following formula:

 $\mathbf{PF}_{Agg} = (0.10 \text{ x } \mathbf{PF}_{NMAS}) + (0.15 \text{ x } \mathbf{PF}_{PCS}) + (0.75 \text{ x } \mathbf{PF}_{No. 200})$ (Equation #4)

If  $PF_{Agg} > 1.00$  Then  $PF_{Agg} = 1.00$ 

- 2. <u>Binder Content (Pb):</u>
  - a) Average Requirements:

If Average Binder Content of lot is within (JMF - 0.52, JMF + 0.52) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise **CPF** Lot = **0.50**.

b) Variability Range Requirements:

Pay Factor Equation for **Pb** (+/- 0.52):

PF Pb = 0.8 (Variability Range)<sup>-0.321</sup>

(Equation #5)

## If **PF** <sub>Pb</sub> > **1.00** Then **PF** <sub>Pb</sub> = **1.00**

- 3. In-Place Compaction (IPC):
  - a) Average Requirements:

If average IPC of lot is within (92% and 97%) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise **CPF**  $_{Lot} = 0.50$ .

b) Variability Range Requirements:

Pay Factor Equation for In-Place Compaction (IPC):

 $PF_{IPC} = 1.12 (Variability Range)^{-0.161}$ (Equation #6)

If **PF**  $_{IPC} > 1.00$  Then **PF**  $_{IPC} = 1.00$ 

**b.** Composite Lot Pay Factor (CPFLot) (value of work): A Composite Lot Pay Factor will be calculated based on the individual AQC Pay Factors (PF) determined above with the following weighting applied: 20 percent aggregate gradation, 30 percent Binder Content (Pb) and 50 percent In-place Compaction (IPC). Calculate the CPFLot by using the following formula:

Composite Lot Pay Factor (<u>CPFLot</u>) Equation:

**CPF** Lot =  $(0.2 \times PF_{Agg}) + (0.3 \times PF_{Pb}) + (0.5 \times PF_{IPC})$  (Equation #7)

c. The above  $CPF_{Lot}$  will be in addition to any reduction in payment for excess tonnage in pavement thickness provided under Article 401-5.

**401-7.03 Control Strip Section** – Control Strip Section will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for the cost of cold milling, if required, preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting and finishing of all required materials for the control strip section; and for all labor, equipment, tools and incidentals necessary to complete said work.

## 401-7.04 Payment will be made under:

Pay Item		<u>Pay Unit</u>
Hot Plant-Mix Bituminous Pavement – S-P (50 or 75)* (38, 12, 34 or 1)**	·	Ton
Hot Plant-Mix Bituminous Pavement - S (50 or 75)* (38 or 12)**		Ton
Hot Plant-Mix Bituminous Pavement - B (50 or 75)* (12, 34 or 1)**		Ton
Hot Plant-Mix Bituminous Pavement - L (50 or 75)* (38, 12, 34 or 1)**		Ton
Control Strip Section		Ton

\* Indicates the number of applicable hammer blows (AASHTO T 245)

\*\* Indicate the applicable Nominal Maximum Aggregate Size (NMAS) of Mix as follows:

38 = Mix NMAS of 3/8-inch 12 = Mix NMAS of ½-inch 34 = Mix NMAS of ¾-inch 1 = Mix NMAS of 1-inch

In those cases in which the Authority does not require a specific NMAS in the mix pay item, the Contractor will have the option of selecting the NMAS of the mix to be designed, produced and placed in the project. The selection by the Contractor of the above mix properties shall be based upon mix compliance with all specification requirements.

# **401-1 DESCRIPTION**

## 401-1.01 Scope

a. This work shall consist of constructing one or more courses of Marshall hot plant-mix bituminous pavement on a prepared foundation in accordance with these specifications, and in conformance with the lines, grades, thickness and typical cross sections and smoothness requirements shown on the plans or established by the Engineer. Courses will be identified as, leveling (L), base (B) surface (S) and for preservation purpose only a surface mix with 3/8" Nominal Maximum Aggregate Size (NMAS) will be classified as a surface mix or preservation (S-P).

b. The work shall also include the application of any required tack and prime coats as specified in Specifications 407 and 408 respectively.

# 401-2 COMPACTIVE EFFORT LEVELS, CATEGORIES AND TYPES OF MIXES, AND THICKNESS REQUIREMENTS

**401-2.01 General** - The bituminous plant mix shall consist of a mixture of aggregates, asphalt binder, hydrated lime and anti-stripping additives, if required.

**401-2.02 Compactive Effort Levels** - The contract documents will specify the number of hammer blows to be used in the Marshall Test (AASHTO T 245) for each mix. When the number of hammer blows is not specified, the requirements for mixes will be based on the road classification as indicated on **Table 401-1** below:

Road Classification	Compactive Effort Levels (Number of Marshall Hammer Blows-AASHTO T-245)
Primary and Secondary	75
Tertiary and Municipal	50

Table 401-1

**401-2.03 Categories of Mixes** – The Combined aggregate gradation of Mixes designed and produced under this specification shall be categorized as coarse-graded when it passes below the Primary Control Sieve<sup>1</sup> (PCS) control points defined in **Table 401-2**. Other gradations shall be categorized as fine-graded.

<sup>&</sup>lt;sup>1</sup> PCS – The Primary Control Sieve is the aggregate size that determines what is coarse and what is fine for any aggregate combination. The weight or mass of coarse aggregate (passing the PCS) determines if a mix is a "coarse graded mix" or "fine graded mix".

PCS Control Point for Mixture Nominal Maximum Aggregate Size <sup>2</sup> (NMAS)				
Nominal Maximum Aggregate Size (NMAS)	1-inch	<sup>3</sup> / <sub>4</sub> -inch	<sup>1</sup> / <sub>2</sub> -inch	3/8-inch
Primary Control Sieve (PCS)	No.4	No.4	No.8	No.8
PCS Control Point (%Passing)	40	47	39	47

**Table 401-2** 

**401-2.04 Types of Mixes** – Mixes as designed and produced under this specification shall be of the following types in conformance with Article 401-3.02 of this specification.

a. Leveling mixes (L) - Leveling mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1-inch (25 mm),  $\frac{3}{4}$ -inch (19 mm),  $\frac{1}{2}$ -inch (12.5 mm) or  $\frac{3}{8}$ -inch (9.5 mm).

b. Base mixes  $(\mathbf{B})$  – Base mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1-inch (25 mm), 3/4-inch (19 mm) or  $\frac{1}{2}$ -inch (12.5 mm).

c. Surface mixes (S) - Surface mixes for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 1/2-inch (12.5 mm) or 3/8-inch (9.5 mm).

d. Surface mixes for preservation purpose only (S-P) – Surface mixes for preservation purpose only, for all Compactive Effort Levels shall be categorized as either fine-graded or coarse-graded mixes, containing, after blending of all aggregates, a Nominal Maximum Aggregate Size of 3/8-inch (9.5 mm).

The Contractor will select, for all types of mixes described herein, the category (fine-graded or coarse-graded) of the mix to be designed, produced and placed in the project. Also, in those cases in which the Authority does not require a specific NMAS of mix in the mix pay item, the Contractor will have the option of selecting, from the sizes specified above, the NMAS of the mix to be designed, produced and placed in the project. The selection by the Contractor of the above mix properties shall be based upon mix compliance with all specification requirements.

**401-2.05 Layer (course) Thickness** – Compacted thickness for each course of mix shall be as indicated in **Table 401-3** as follows:

Table 401-5		
NOMINAL MAXIMUM	COMPACTED THICKNESS	
AGGREGATE SIZE	FOR EACH COURSE (inches)	
(NMAS)	Min – Max	
NMAS = 3/8-inch	<u>1.125 – 2.00</u>	
$NMAS = \frac{1}{2}-inch$	1.50 - 2.50	
$NMAS = \frac{3}{4}-inch$	2.25 - 3.75	
NMAS = 1-inch	3.00 - 5.00	

Table 401-3

<sup>2</sup>Nominal Maximum Aggregate Size (NMAS) is defined as being one sieve larger than the first sieve to have a percent passing less than 90 percent by weight.

#### 401-3 MATERIALS

**401-3.01 Asphalt Binder -** The asphalt binder shall conform to the requirements of Section 702-1 of Specification 702 – Bituminous Materials.

**401-3.02 Aggregates** - Aggregates, including mineral filler, shall meet the requirements of Section 703-3 of Specification 703 - Aggregates.

**401-3.03 Reclaimed Asphalt Pavement (RAP)** – Reclaimed Asphalt Pavement materials shall meet the requirements of Section 703-3.02 of Specification 703-Aggregates.

**401-3.04 Hydrated Lime** - Hydrated lime shall meet the requirements of section 712-3 of specification 712 – Miscellaneous Materials. The Contractor shall submit certified laboratory reports on tests of the hydrated lime to be used showing its compliance with the specifications.

**401-3.05 Chemical Anti-Strip Agent** - Furnish commercially produced, heat stable liquid products that when added to an asphalt have the chemical and physical properties to prevent separation of the asphalt from aggregates. The Contractor shall submit for approval the certified laboratory reports of the proposed chemical anti-strip agents. Contractor shall be responsible for verifying the affinity/compatibility of the proposed quantity and source of anti-strip agent with all mix components. The chemical anti-strip agent and/or hydrated lime is mandatory for all the surfaces mixes for preservation purpose only (**S-P**).

#### 401-3.06 Composition of Mixtures

a. **Job-Mix Formula**<sup>3</sup> (**JMF**) - The Contractor shall develop and submit in writing for the Engineer's approval, at least thirty five (35) calendar days in advance of the date he intends to start paving operations, a job-mix formula based upon a Marshall mix design, meeting the requirements of this Specification, for each type of mixture to be used in the project.

Each job-mix formula shall be supported by qualified laboratory test data used in the mix design process including, but not limited to, the design charts used. The submission shall also identify the proposed sources of the asphalt binder and aggregates to be used, including the FHWA 0.45 power gradation chart of the proposed mix. The five-week lead requirement may be waived at the discretion of the Authority. The submittal shall comply with the proposed job-mix formula and with all specification requirements.

Each proposed job-mix formula and mix design shall be designed and submitted to the Authority's Materials Testing Office on a three year basis or when a statistical analysis of the Acceptance and/or Contractor Quality Control test results shows significant difference in mix properties, which ever occur first. No mix shall be placed on this project without an approved job-mix formula and a corresponding mix design. The Authority reserves the right of being present at the Contractor's laboratory during the development of the mix designs.

<sup>3</sup>Job-mix formula (JMF) is the proposed combined aggregate gradation, percent of asphalt binder, dust to effective asphalt ratio and volumetric properties used to establish target values for mix production based upon a mix design

Verification of the proposed mix design may be performed at the Authority's laboratory by the Authority personnel at the time of submission of JMF. When determined by the Authority, the Contractor shall coordinate with the Authority the sampling of all materials proposed for use in the mix. Verification of mix design will consist in checking the selection of the optimum asphalt content made by the Contractor. Furthermore, the above procedure will also include verification of moisture susceptibility and relative permeability requirements established in this specification.

b. **Mix Requirements** - Each mix shall be designed according to the Marshall Mix Design Method as described in the Asphalt Institute Manual MS-2 and shall meet the following requirements:

(1) Mix Stability and Flow as determined by AASHTOT 245 shall meet the requirements of Table 401-4:

Table 401-4		
Compactive Effort	Stability (Lbs.) – (Minimum)	Flow (0.01 inch (25 mm))
Level		(Minimum - Maximum)
50	1,200	8-16
75	1,800	8-14

(2) Moisture Susceptibility Requirements – Mixes shall meet the following requirements:

a. AASHTO T 283 for Laboratory Mixed - Laboratory Compacted Specimens:

i. For AASHTO T 283 procedures include the freeze and thaw cycle (severity conditioning). In addition, all samples shall be compacted to  $7 \pm 1.0$  percent air voids. The test specimens shall be 6-inch diameter samples compacted using a gyratory compactor (AASHTO T 312).

ii. Tensile Strength – The minimum dry and unconditioned tensile strength shall be 80-psi for surface mixes and 70-psi for other mixes. This requirement will not be applied to contracts which bids are opened prior to June 30, 2010.

iii.Retained Tensile Strength Ratio (TSR) – Minimum 65 percent of Tensile Strength.

(3) Air Voids Content (Va) Requirements – The mix shall have an air void content of 4.0 percent at the design Compactive Effort Level as determined by AASHTO T 166, T 209 and T 269.

(4) Voids in Mineral Aggregate (VMA) Requirements – The mix shall have a VMA based upon the NMAS of the mix as indicated in Table 401-5:

NMAS	Minimum VMA (Percent)	
3/8-inch	15	
<sup>1</sup> /2-inch	14	
<sup>3</sup> /4-inch	13	
1-inch	12	

Table 401-5

(5) Voids Filled with Asphalt (VFA) Requirements – The mix shall have a VFA (percent) based upon the Compactive Effort Level as indicated in Table 401-6:

Table	401-6
Compactive Effort Level	VFA (Percent)
	(Min - Max)
50	65-78
75	65-75

(6) The Dust to Effective Asphalt Binder ratio (DEAR) of the mix, computed by dividing the percentage of material passing the No. 200 sieve by the percent of effective asphalt binder (Pbe) in the mix, shall be as indicated in **Table 401-7**:

Table	401-7
I ant	TV1-/

Mix Category	Dust to Effective Asphalt Binder Ratio (DEAR) / Specification Limits (Min – Max)
Fine-Graded	0.6 - 1.2
Coarse-Graded	0.8 - 1.6

(7) Laboratory Mixing Temperature – Mixing temperature shall be the temperature at which the binder viscosity is approximately  $0.17 \pm 0.02$  Pa-s in accordance with AASHTOT 245. This mixing temperature will be for laboratory use only.

(8) Laboratory Compacting Temperature – Compacting temperature shall be the temperature at which the binder viscosity is approximately  $0.28 \pm 0.03$  Pa-s in accordance with AASHTO T 245. This compacting temperature will be for laboratory use only.

c. Mix Values - Each job-mix formula submitted shall propose definite values for:

(1) The type of mix to be used (**S-P**, **S**, **B**, and **L**).

(2) The category (fine-graded or coarse-graded) of the mix to be designed.

(3) Nominal Maximum Aggregate Size (NMAS) of the aggregate mixture.

(4) Compactive Effort Level (Number of Hammer Blows).

(5) The source and materials to be used; single percentage of aggregates passing each required sieve size.

(6) Single percentage of asphalt binder (Pb) to be added based on total weight of the mixture.

(7) The kind and percentage of mineral filler to be used, if any.

(8) Production Temperature - The target temperature at which the mixture is to be discharged from the asphalt plant.

(9) Bulk Specific gravity and Apparent Specific gravity of each separate mixture component.

(10) Specific gravity of the Binder at 25 degrees Celsius.

(11) Polish Stone Value (PSV) of coarse aggregate (Only for S mixes).

(12) Coarse Aggregate Angularity, Flat and Elongated Particles and Percent Wear (abrasion loss), etc.

(13) Design Gradation on FHWA's 0.45 Power Gradation Chart.

(14) Provide all the physical properties achieved at the different asphalt binder contents used to determine the optimum asphalt content.

(15) Percent Asphalt Binder Content (Pb) (optimum) and Effective Asphalt Binder Content (Pbe).

(16) Dust to Effective Asphalt Binder Content Ratio (DEAR).

(17) Theoretical Maximum Specific Gravity and Density of Asphalt Paving Mixtures (Gmm (AASHTO T 209) at Target Binder Content).

(18) Bulk Specific Gravity, Effective Specific Gravity of Mix at the Design Compactive effort level.

(19) Air Void Content (Va) at Design Compactive effort level.

(20) Voids in Mineral Aggregate (VMA) at Design Compactive effort level Voids Filled with Asphalt (VFA) at Design Compactive effort level Laboratory Density in Lb/ft<sup>3</sup>.

(21) Required In-place Compaction.

(22) Type and quantity of chemical anti-strip agent and/or hydrated lime, if required, including all data to perform the optimization procedure.

(23) Moisture Susceptibility data sheet of the proposed mix in accordance with AASHTO T-283.

(24) Retained tensile strength ratio, tensile strength (dry and unconditioned) and tensile strain (dry and unconditioned).

d. Additional Mix Values – With each job-mix formula report the following values or mix properties as available:

(1) Aggregate geological and mineralogical descriptions.

(2) Fine Aggregate Angularity and Sand Equivalent of Aggregate mixture.

(3) Field Compaction Temperature - The target temperature at which the mixture is to be compacted during lay-down operations.

(4) Bailey Method Ratio's for each Marshall Mix.

(5) Asphalt film thickness for each mix.

(6) Results from AASHTO T-182 (Coating and Stripping of Bitumen-Aggregate Mixtures).

(7) FM 5-508 (Laboratory Testing the Effectiveness of Anti-Strip Additives) test results performed on mix.

(8) AASHTO T-283 optimization test results obtained at other anti-strip and/or hydrated lime dosages.

e. **Changes and resubmissions.** If a job-mix formula is rejected or a material source (including the recycled asphalt pavement) has changed, submit a new job-mix formula for acceptance. Up to twenty one (21) calendar days may be required to evaluate a change. Approved changes in target values will not be applied retroactively for payment.

#### 401-3.07 Sampling and Testing

a. All acceptance sampling and testing activities will be performed by the Authority. Samples will be taken at random locations during production and will remain in the custody of the Authority at all times. Each sample shall provide enough material to adequately perform all testing as determined in each test procedure. The Contractor or his authorized representative may be present, if so desired, when these sampling and testing operations are being performed. All testing will be done at the producer's plant laboratory provided it has been qualified by the Authority's Materials Testing Office in accordance with **PRHTA Q 401-10 - Qualification of Hot Mix Asphalt (HMA) Laboratories.** However, the Authority may, at its discretion, perform the testing at the Authority's laboratory. Sampling for acceptance testing will be performed by the Authority in accordance with **Table 401-8**:

Description	Procedure Designation
Qualification of Hot Mix Asphalt (HMA) Laboratories	PRHTA Q 401-10
Determination of Random Sampling Location	PRHTA M 401-10
Sampling of Asphalt Binder	AASHTO T-40
Sampling of Aggregates	AASHTO T-2
Sampling of Bituminous Paving Mixtures	AASTHO T-168
Reducing Samples of Hot-Mix Asphalt to Testing Size	AASHTO T-328
Sampling of Compacted HMA Pavement	PRHTA M 401-20

**Table 401-8** 

b. Provide at the mixing plant laboratory and at the field all the equipment, tools, supplies and other apparatus required for sampling the mix, preparing specimens and testing for compliance of the mix being produced and its components with all the requirements stated in this specification, applicable AASHTO or ASTM Standards or Puerto Rico Highway and Transportation Authority's procedures. The use of microwave oven shall not be used for acceptance testing procedures.

c. The Authority will take, at its discretion, random samples of the asphalt binder and aggregates at the plant (prior to and during mix production) to test for the compliance of these materials with their specifications requirements.

d. Samples of the mix material being produced for delivery to the project will be taken by the Engineer at the plant following the procedures established in **Table 401-8**. The control unit for sampling, testing and acceptance purposes will be a lot which is defined as 900 tons, 750 tons or 600 tons or fraction thereof placed each day, subdivided into three equal sub-lots of 300 tons, 250 or 200 tons respectively. Any fraction produced that amounts to 100 tons or less will be incorporated in the previous lot. Any fraction produced that amounts to more than 100 tons will be considered a sub lot of a new lot. Lot size shall be determined by the Contractor in writing to the Authority prior to the Pre-Paving Meeting.

e. Acceptance testing will consist of evaluating the number of samples as indicated in **Table 401-9** below per each lot. Each sample shall provide enough material to adequately perform

all testing as determined in each individual test procedure. Acceptance testing procedures are as follows:

Procedure Designation (AASHTO)	Frequency	Testing
AASTHO T-164		Quantitative Extraction of
		Bitumen from Bituminous Paving
		Mixtures
AASHTO T-30/11B		Mechanical Analysis of Extracted
		Aggregate / Materials Finer than
		No. 200 Sieve in Mineral
		Aggregates by Washing Using a
		Wetting Agent
AASHTO T-209 (including	1 per lot (use average of	Theoretical Maximum Specific
Section #11) /	two split samples for	Gravity and Density of Hot Mix
PRHTA T 401-50	acceptance)	Asphalt Paving Mixture
AASHTO T-245		Resistance to Plastic Flow of
		Bituminous Mixtures Using
		Marshall Apparatus
AASHTO T-166 or T-275 as		Bulk Specific Gravity of
required		Compacted Hot Mix Asphalt
		Mixtures Using Saturated Surface
		Dry Specimens / Bulk Specific
		Gravity of Compacted Hot Mix
		Asphalt Mixtures Using
		ParaffinCoated Specimens
AASHTO T-269		Percent Air-Void in Compacted
		Dense and Open Asphalt
		Mixtures
PRHTA T 401-10		Mixture conditioning for
	As required	determining volumetric properties
		of HMA
PRHTA T 401-20	6 per lot (2 per sub-lot)	Determination of HMA in-place
	o por lot (2 por sub lot)	compaction, layer thickness.
PRHTA T 401-30	As required	Determination of HMA pavement
		density profile
PRHTA T 401-40	As required	Determination of asphalt binder
		content of compacted HMA

Table 401-9

Bond Test will be carried out by the contractor according to PRHTA T 401-10, one core per sub-lot. The information collected from this test procedure shall be documented on the

random sheet provided by the inspection and a copy shall be submitted together with the core sheet for the PRHTA laboratory. This test method covers the determination of the interface bond shear strength between pavement layers using core samples. The results of this test shall be graphed (PSI vs area of the sample taken in the project area in the specific Km) by the contractor in order to document the results. The pull off adhesion test, measures the bond strength or tensile strength of asphalt, also, measure the near surface strength of a substrate in order to determine the substrates quality before applying an overlay after the material is applied to the surface by the direct tension or pull off method. The locations will be determined by the PRHTA T 401-20 and the results will be collected for data purpose only. The test shall be performed on a 6-in diameter cores or specimens of asphalt concrete as applicable if the asphalt overlay thickness as well as the thickness of the base concrete retrieved by coring are not less than 2 in, and not greater than 6 in, each. This requirement does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. This standard may involve hazardous materials, operations, and equipment.

f. The Authority may, at its discretion, take samples of the mix being delivered to the project site for testing at any location including behind the paver before compaction. Test results of these samples will be for informational purposes only and will not form part of the acceptance process.

401-3.08 – Reporting Results – The following mix properties shall be determined, calculated and reported for each sub lot:

a. Bulk Specific Gravity (Gmb) – AASHTO T-166 / AASHTO T-275 as applicable.

b. Maximum Specific Gravity (Gmm) - AASHTO T-209 (including Section #11)/ PRHTA T 401-50.

- c. Asphalt Binder Content (Pb) AASHTO T-164
- d. Air Voids Content (Va) AASHTO T-269
- e. Voids in Mineral Aggregate (VMA)
- f. Voids Filled with Asphalt (VFA)
- g. Effective Asphalt Binder Content (Pbe)
- h. Effective Specific Gravity of Mix (Gse)

i. Mass Retained (g), Mass Retained (percent), Percent Passing for the following sieve designations: 1-1/2", 1",  $\frac{3}{4}$ ",  $\frac{1}{2}$ ",  $\frac{3}{8}$ ",  $\frac{1}{4}$ ", No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, No. 200 – AASHTO T-30 / T- 11 B.

j. Dust to Effective Asphalt Binder Content Ratio (DEAR).

## **401-4 CONSTRUCTION REQUIREMENTS**

**401-4.01 Production Start-Up Procedures** – Use these start-up procedures when producing material for the first time in the project, when using materials from different plants, or when resuming production after a termination of production due to unsatisfactory quality as determined by the Engineer.

a. **Control Strip Section** – Produced, place, and compact the proposed HMA in order to establish that the equipment and the processes planned for placement and compaction are satisfactory. Provide fourteen (14) calendar days notice before beginning production of an asphalt concrete mix.

On the first day of production, produce sufficient mix to construct a 300 to 600 tons control strip, as determined by the Contractor, one-lane wide, and at the designated lift thickness. Construct the control strip on the project at an approved location.

Construct the control strip using mix production, lay-down, and compaction procedures intended for the entire mix. The mix is acceptable with full payment if all test results are in conformity with specification limits with a  $CPF_{lot}$  equal or greater than 0.70. Mix that is not acceptable will be removed at no cost to the Authority and shall be replaced during full production operation through applicable hot plant bituminous mix pay items.

1) **Mixture.** Take and test at least three control strip asphalt concrete mix samples and evaluate according to article 401.3.07

2) **Compaction.** Take nuclear density readings behind each roller pass to determine the roller pattern necessary to achieve required density. Keep records of compaction effort frequency and amplitude settings of equipment used.

At a minimum of five locations within the control strip, take nuclear gauge readings, and cut and test core samples according to article 401.3.07. Density is acceptable if all tests are within the specification limit. Furnish the Engineer with the nuclear gauge readings and correlations of the readings to the core specific gravities.

The Contractor shall address any production and/or placement deficiencies identified by the Contractor and the Engineer during this operation as part of the quality control and acceptance plan during the Pre-paving meeting. Tests used for the control strip will not be included in the evaluation for payment according to article 401-5. Based on the Contractor's evaluation of the initial control strip, paving may continue at the Contractor's risk once the Pre-paving meeting per section 401.4.01(b) is completed.

b. **Pre-Paving Meeting** – After the construction of a control strip and at least seven (7) calendar days before the start of production paving operation, the Engineer shall arrange for a pre-paving

meeting. Attendance of Contractor, the Contractor's Paving Quality Assurance Manager, subcontractors, and all other applicable suppliers is mandatory. At the meeting the Contractor's Paving Quality Assurance Manager shall submit and discuss the proposed production and lay-down operations plan. After the meeting, the contractor shall submit a written final detailed plan (at least three (3) calendar days before the proposed start of paving operations) to be revised by the Engineer that as a minimum includes the following:

- (1) Proposed schedule of paving operations;
- (2) List of all necessary equipment and key personnel used in the production and construction of the work;
- (3) Proposed traffic control plan for paving operations including provisions for pavement drop-offs and moving operations;
- (4) Contractor quality control and materials acceptance plan, corrective action plan<sup>4</sup> in accordance with this specification

(5) Placement operation including production, delivery, placing, finishing, compacting, and smoothness procedures. Include also the proposed rolling patterns, frequency and amplitude to be utilized in the placement operations.

<sup>4</sup>Corrective Action Plans - Contractor's proposed strategies and related work to be performed to prevent repeated deficiencies.

(6) Production and placement strategies to minimize segregation of HMA. Prior to the start of using the paver for placing plant mix, the Contractor shall submit for approval a full description in writing of the means and methodologies that will be used to prevent bituminous paver segregation. Use of the paver shall not commence prior to receiving approval from the Engineer.

**401-4.02 Bituminous Mixing Plant** - Plants used for the preparation of bituminous mixes shall conform to AASHTO M 156 modified and supplemented as follows:

a. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mix, the Engineer, or his authorized representative, shall have access, at all times, to all portions of the mixing plant, aggregates plant, storage yards, and other facilities for producing and processing the mix materials.

b. Scales shall be inspected and certified by the Division of Weights and Measures of the Commonwealth Department of Consumers Affairs (DACO) on yearly basis or as required by the Engineer. Any cost involved in the inspection and sealing of the scales shall be at the Contractor's expense. No asphalt mix shall be produced and delivered to the project from a producer plant that does not comply with the above requirements.

c. All projects involving 2,000 Tons or more of bituminous mixture shall be served by a plant having automatic controls which coordinate the proportioning, timing, and discharge of the mixture.

d. All plants shall be equipped with air pollution control devices meeting the requirements of the Environmental Quality Board.

e. The completed bituminous mixture may be weighed on approved scales furnished by the Contractor at his expense. The scales shall be inspected and calibrated at least once a year by an independent entity.

**401-4.03 Hauling Equipment -** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution or other approved material to prevent the mixture from adhering to the beds. No gas oil or diesel fuel will be allowed for preventing the mixture adhering to the truck bed. Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture and for use during hauling operations. No truck will be allowed to leave the plant without covering the mix with the cover of canvas. Each day before delivery to the project, the Contractor shall provide to the Engineer a certification attesting to the compliance of each delivery truck with these requirements.

**401-4.04 Delivery Trucks** – Furnish delivery tickets to the Engineer, before unloading at the site of the work the bituminous mix supplier, containing the following information concerning the bituminous mix in the truck:

- a. Name of bituminous mixing plant
- b. Serial number of ticket
- c. Date, time and truck number
- d. Name of Contractor
- e. Specific designation of job (name, number and location)
- f. Type of mix
- g. Weight of mix in the truck
- h. Space for signature of Authority's inspector at the paving site and at the scales.
- i. Temperature of the asphalt mix measured at the plant
- j. Temperature of the asphalt mix measured at the site

## 401-4.05 Bituminous Pavers

a. Provide Bituminous pavers self-contained, power propelled units with a vibrating or tamper screed and strike-off assembly covering the full lay-down width, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material which will meet the specified typical section, thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in the widths shown on the plans.

b. The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed and strike-off assembly shall effectively produce a finished surface of the required smoothness and texture without segregating, tearing, shoving, or gouging the mixture.

c. The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

d. The paver shall be equipped with a grade and slope control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made inoperative and the screed shall be controlled by sensor directed automatic mechanisms, which will independently control the elevation of each end of the screed from the reference lines or surfaces. The controls shall work in conjunction with any of the following attachments:

(1) Ski-type device, floating beam of not less than 30 feet (9.14 m) in length and short ski or shoe to match adjoining lanes either fresh or old layer or as directed by the Engineer.

(2) Taut stringline wire set by the Contractor to the specified grade.

(3) A non-contacting laser or sonar-type ski with at least four referencing stations may be used with a reference at least 24 feet (7.3 m) long.

e. Except as presented on Article 401-4.05(g) below, furnish, as a minimum, automatic control systems such as long ski, short ski/shoe or furnish and install all required stakes and wire for a taut string line. Should the automatic control system become inoperative during the day's work, the Contractor may be permitted, at the discretion of the Authority, to finish the day's paving work using manual controls. However, work shall not be resumed thereafter until the automatic control system has been made operative.

f. The Contractor may be exempt from the use of the automatic control system at locations where the Engineer determines that pavement geometry or widths makes its use impracticable.

g. Laser Control and/or Profilograph Control equipments may be used by the Contractor. The use of this equipment shall be subject to the following requirements at no cost to the Authority:

1. Present a written notice to the Engineer at the beginning of the project proposing the use of such equipment. The written notice shall include, as a minimum, the brand, type, model and manufacturer of the proposed equipment.

2. Provide a copy to the Engineer of the manufacturer's instruction and operation manual as well as any other literature related to computer software.

h. Provide bituminous pavers that are equipped with a means of preventing the segregation of the coarse aggregate particles from the remainder of the bituminous plant mix when that mix is

carried from the paver hopper back to the paver augers. The means and methods used shall be approved by the paver manufacturer and may consist of chain curtains, deflector plates, or other such devices and any combination of these.

The following specific requirements shall apply to the identified bituminous pavers:

(1) Blaw-Knox bituminous pavers shall be equipped with the Blaw-Knox Materials Management Kit (MMK).

(2) Cedarapids bituminous pavers shall be those that were manufactured in 1989 or later.

(3) Caterpillar bituminous pavers shall be equipped with deflector plates as identified in the December 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630, 6631, 6640}".

**401-4.06 Rollers -** Rollers may be of the vibratory, oscillatory or tandem steel wheel type. Pneumatic-tired rollers may be used in conjunction with either of the steel wheel types. Rollers shall be in good condition, be capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. For leveling (L) and for preservation surface courses (S-P), at least one pneumatic tire roller is recommended to be used.

**401-4.07 Weather Limitations** - Bituminous plant mix shall not be placed on any wet surface or when weather conditions prevent the proper production, handling placing or finishing of the bituminous mixture.

## 401-4.08 Preparation of Surface to be Paved -

a. The surface to be paved shall be true to line and grade, dry and free from loose or deleterious material immediately before the placing of bituminous mixture. If necessary, the surface shall be cleaned by brooming or other approved means.

b. When the surface of an existing pavement or old base to be paved is irregular, it shall be brought to uniform grade and cross section by a leveling course as directed, which shall be compacted to the satisfaction of the Engineer before placing subsequent paving courses.

c. When a leveling course is not required, all depressions and other irregularities shall be patched or corrected in a manner satisfactory to the Engineer. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material, shall be removed from the area to be paved. Blotting of excessive deposits of asphalt with sand or stone will not be permitted.

d. Where the area to be paved is an untreated soil or aggregate, it shall be compacted to the required density and then primed in accordance with the provisions of Specification 408 - Bituminous Prime Coat. The prime coat shall be allowed to cure properly in accordance with the provisions of Specification 408 before any further operations are permitted on the primed area.

- e. Apply bituminous tack coat upon all Portland cement concrete surface or a bituminous surface before placing new HMA in accordance with the provisions of Specification 407 - Bituminous Tack Coat shall be applied. Also when a contractor must apply a tack coat that is not trackless tack, the contractor or sub-contractor shall take measures to prevent that equipment or an event of sporadic rain wash that remove the material already applied before paving. This information shall be detailed in the paving plan and discussed in the prepaving meeting.
- f. Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of bituminous material as specified for the tack coat prior to the bituminous mixture being placed against them.

**401-4.09 Preparation of Bituminous Material** – Heat the bituminous material in a manner to avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature within the regents specified in Table 401-10. Asphalt binder shall not be used while it is foaming nor shall it be heated above 350 degrees F at any time after delivery to the plant.

1able 401-10	
Asphalt Binder	Storage Temperature Range
	(Minimum – Maximum) (°F)
PG 64-22	285-315
PG 67-22	295-320
PG 70-22	300-325

## Table 401 10

#### 401-4.10 Mixing

a. Combine the aggregates in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. Measure or gauge the bituminous material shall and introduced it into the mixer in the amount specified by the job-mix formula. Mix the materials until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured.

b. **Production Temperature** - The production temperature will be measured at the truck bed prior to delivery of mix to project. Temperature of the mix will be the average of three readings measured at the top of the mix pile in each truck. Measurement shall be taken using a properly calibrated thermometer provided by the Contractor. Calibration shall be accomplished on a yearly basis. Mixes shall have a production temperature between the acceptable ranges in Table 401-11:

1 able 401-11		
Acceptable Production Temperature Range		
Minimum	Production Temperature -30° F	
Maximum	Production Temperature +20° F	

Table 401 11

(1) Mixes with production temperature below the minimum temperature established in Table 401-11 above shall be allowed to be delivered to the project. In such cases the Engineer will record the final location of the pavement section or area that represents each truck for further evaluation. Evaluation will be performed once the Contractor has achieved compaction of mix. Evaluation will be following the procedure indicated in **Section 5 - Procedure for Determination In-Place Compaction** of PRHTA T 401-20 (**Determination of HMA In-Place Compaction and Layer Thickness**), except that only one core will be extracted and evaluated. If **In-Place Compaction** is within the range indicated in **Table 401-12** below the mix will be considered acceptable, otherwise the mix will be paid with a 50 percent pay factor (PF = 50%). No retesting will be allowed.

(2) Mixes with production temperature above the maximum temperature established in Table 401-11 above will not be allowed to be delivered to the project.

c. Deliver all mixes at the paving site at a temperature of no less than 225 degrees F. Mixes shall have at least 225 degrees F prior to its placement in front of the paver. Temperature of the mix will be as determined by the Materials Testing Office.

#### 401-4.11 Transporting, Spreading and Finishing -

a. Transport the mixture from the mixing plant to the paving site in vehicles conforming to the requirements of Article 401-4.03. Place the protective cover over the mix prior to departing the plant and retained in place until the mix is delivered. Failure to comply with the above requirement will be cause for rejection of the mix contained in the truck.

b. Lay the bituminous mixture upon an approved clean surface, spread and struck off to the established grade and elevation. Use bituminous pavers to distribute the mixture either over the entire width or over such partial width as may be practicable.

c. The longitudinal joint in one layer shall be offset from that in the layer immediately below by approximately 6-inch; however, the joint in the top layer shall be at the center line of the pavement if the roadway comprises two lanes of width, or at lane lines if the roadway is more than two lanes in width, unless otherwise directed. Failure of the Contractor to observe the above dispositions and the placement of the longitudinal joint at any wheel path will allow the Authority to reject the mix or to accept the same at a 50 percent reduction in price.

d. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread and finished by hand tools. For such areas the mixture shall be dumped, spread and screeded to provide the required section and compacted thickness. Provide suitable heating equipment or non petroleum based asphalt release agents for keeping hand tools free from asphalt. The temperature of the tools when used shall not be greater than the temperature of the mix placed. The use of petroleum oils, diesel fuels or volatiles will not be permitted.
#### $SUPPLEMENTAL\ SPECIFICATION\ 401-HOT\ PLANT-MIX\ BITUMINOUS\ PAVEMENT$

e. Place the mixtures in layers as indicated on the plans. No single layer shall exceed 10 cm. (5") in compacted thickness.

f. When using a Material Transfer Vehicle (MTV) during lay-down operations, a paver hopper insert shall be used at all times.

#### 401-4.12 Compaction Requirements

a. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, compact it thoroughly and uniformly by rolling. Roll the surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in workable condition. The sequence of rolling operations and the selection of roller types shall be such as to meet the in-place compaction requirements. In-place compaction shall be determined in accordance with **PRHTA T 401-20 – Determination of HMA In-Place Compaction and Layer Thickness**. Acceptable In-Place Compaction Range shall be as indicated in Table 401-12:

#### Table 401-12

(AASHTO T-209 / AASHTO T-166 – Determined from field cores)					
Acceptance Quality Characteristic (AQC)*	Specification Limits				
In-Place Compaction	95.0 % of Gmm -2.0				

<sup>\*</sup>Acceptance Quality Characteristic (AQC) – Characteristic or property of a mix that is measured for acceptance purposes.

b. Unless otherwise directed, begin rolling at the sides and proceed longitudinally parallel to the road centerline, gradually progressing to the crown of the road. Place consecutive layers by overlapping all joints a minimum of 6-inch (15 cm.). When paving in echelon or abutting a previously placed lane, roll the longitudinal joint first followed by the regular rolling procedure. On super-elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the center line.

c. Move rollers at a slow but uniform speed with the drive roll or wheels nearest the paver except when rolling an incline, then the procedure is reversed.

d. Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. Keep wheels properly moistened with water or water mixed with very small quantities of detergent or other approved material to prevent adhesion of the mixture to the rollers.

#### SUPPLEMENTAL SPECIFICATION 401 - HOT PLANT-MIX BITUMINOUS PAVEMENT

e. Compact the mixture thoroughly with mechanical tampers along forms, curbs, headers, walls and other places not accessible to the roller. Use a trench or small vibratory roller, or cleated compression strips under the roller on depressed areas to transmit compression.

f. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous mix material shall be corrected to the satisfaction of the Engineer.

#### 401-4.13 Joints, Trimming Edges and Cleanup

a. Complete pavement construction of adjacent traffic lanes to the same elevation within 24 hours. If drop-offs are left overnight, sign the drop-offs in excess of 2 inches with "Uneven Lanes" warning signs and provide a 1V:3H fillet for drop-offs in excess of 4 inches. At connections to existing pavements and previously placed lifts, make the joints vertical to the depth of the new pavement. Form joints by cutting back the previous run to expose the full-depth course.

b. Placing of the bituminous mix shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Apply an asphalt tack coat meeting the requirements of specification 407 to the joint edge to both transverse and longitudinal joints before additional mixture is placed against the previously rolled material.

c. At the beginning or end of a project connecting to an existing pavement the feathering of the new surface course to match the existing grade of the old pavement will not be permitted. To transition and match the grades, the old pavement shall be undercut to a depth equal to the compacted depth of the new surface course being connected to it. This work shall be a subsidiary obligation of the Contractor under the new pavement pay items.

d. Material trimmed from the edges and any other discarded bituminous mixture shall be removed from the roadway and disposed of by the Contractor outside the project limits or in an approved area out of sight from the road. No deduction in payment will be made for the fillet material removed.

**401-4.14 Surface Requirements** – Measure the smoothness/roughness in accordance with Specification 410 – Hot Plant Mix Bituminous Pavement Smoothness to the applicable smoothness level indicated in contract. Payment for compliance to surface requirements will be as determine in Specification 410 through applicable hot plant mix bituminous item.

**401-4.15 Protection of Pavement** – Protect sections of newly finished work from traffic of any kind until the mixture has become properly hardened by the cooling method stated below.

Provide at all times in the project water supply trucks capable of applying potable water to the compacted mix in order to cool it to a temperature below 150 degrees Fahrenheit. Apply water after the mix has achieved the compaction level as required in this specification. Also, provide to the

### SUPPLEMENTAL SPECIFICATION 401 - HOT PLANT-MIX BITUMINOUS PAVEMENT

Authority a calibrated infrared thermometer capable of measuring temperatures in the range of 100 degrees Fahrenheit and 350 degrees Fahrenheit. All of the equipment indicated above shall be a subsidiary obligation of the contract.

Do not open to traffic the compacted mix until all measurements with infrared thermometer taken in the mat by the Authority show temperatures below 150 degrees Fahrenheit.

## 401-5 BASIS OF ACCEPTANCE

a. **Measured Conformance** - The acceptability of the quality of the hot plant-mix bituminous pavement will be based on the tested conformance of the material with the requirements of Articles 401-3.07 and 401-4.14 above and the tolerances for the acceptance quality characteristics per lot as follows:

1. The average of each acceptance quality characteristic per lot shall be within the deviation parameters established from JMF target values, and

2. The measured variability of each acceptance quality characteristic per lot as shown in Tables 401-13 to 401-16:

NMAS = 1-inch					
Acceptance Quality	<b>Deviation from Target Value</b> <sup>6</sup>	Variability			
<b>Characte ristic</b> <sup>5</sup> (AQC)	(DTV)	Range			
1-inch (Control Sieve)	+/-8*	4			
No. 4 (Control Sieve)	+/-7*	3.5			
No. 200 (Control Sieve)	+/-3*	1.5			
Amount of performance graded		0.26			
binder (Pb)	+/- 0.52				
In-Place Compaction (IPC)	95.0 % of Gmm -2.0%	2			
Thickness (min. total for project)	80% of specified layer thickness	N/A			
Thickness (max. total for project)	115% of specified layer thickness	N/A			

Table 401-13

#### Table 401-14

NMAS = 3/4-inch					
Acceptance Quality Characteristic (AQC)	Deviation from Target Value (DTV)	Variability Range			
<sup>3</sup> / <sub>4</sub> -inch (Control Sieve)	+/-8*	4			

# $SUPPLEMENTAL\ SPECIFICATION\ 401-HOT\ PLANT-MIX\ B ITUMINOUS\ PAVEMENT$

No. 4 (Control Sieve)	+/-7*	3.5
No. 200 (Control Sieve)	+/-3*	1.5
Amount of performance graded binder (Pb)	+/- 0.52	0.26
In-Place Compaction (IPC)	95.0 % of Gmm -2.0%	2
Thickness (min. total for project)	80% of specified layer thickness	N/A
Thickness (max., total for project)	115% of specified layer thickness	N/A

 $^{5}$ Acceptance Quality Characteristic (AQC) – Characteristic or property of a mix that is measured for acceptance purposes.

<sup>6</sup>Target Value – Mix design values as reported in JMF for each acceptance quality characteristic.

NMAS = 1/2-inch					
Acceptance Quality	Deviation from Target Value (DTV)	Variability Range			
Characte ristic (AQC) <sup>4</sup>					
1/2-inch (Control Sieve)	+/-8*	4			
No. 8 (Control Sieve)	+/-7*	3.5			
No. 200 (Control Sieve)	+/-3*	1.5			
Amount of performance graded		0.26			
binder (Pb)	+/- 0.52				
In-Place Compaction (IPC)	95.0 % of Gmm -2.0%	2			
Thickness (min. total for project)	80% of specified layer thickness	N/A			
Thickness (max. total for project)	115% of specified layer thickness	N/A			

Table 401-16						
NMAS = 3/8-inch						
Acceptance Quality Characteristic (AQC)	Deviation from Target Value (DTV)	Variability Range				
3/8-inch	+/-7*	3.5				
No. 8	+/-7*	3.5				
No. 200	+/-3*	1.5				
Amount of performance graded binder (Pb)	+/- 0.52	0.26				
In-Place Compaction (IPC)	<mark>95.0 % of Gmm -2.0%</mark>	2				
Thickness (min, total for project)	80% of specified layer thickness	N/A				
Thickness (max. total for project)	115% of specified layer thickness	N/A				

#### $SUPPLEMENTAL\ SPECIFICATION\ 401-HOT\ PLANT-MIX\ B ITUMINOUS\ PA\ VEMENT$

(\*)Upper gradation deviation shall not be outside the grading composition requirements of Table 703-3. In such cases the DTV will be reduced accordingly (Allowable Deviation from Target Value (ADTV)). Deviations are subject to selected target value in the approved JMF.

b. Segregated HMA (segregated areas and/or longitudinal streaks sections) – The acceptability of HMA pavement were segregation<sup>7</sup> is perceived to be present will be determined in conformance with PRHTA T 401-30 - Determination of HMA Pavement Density Profile and based upon the following criteria:

1. HMA material will be considered acceptable if both of the following conditions

are met:

- a. Maximum minimum density range is less than 6.0 pcf.
- b. Mean minimum density range is less than 3.0 pcf.

2. HMA material will be rejected if any of the requirements above are not met. The section(s) shall be removed at the contractor expense and replaced.

c. **HMA with Bleeding** - The acceptability of HMA pavement were bleeding<sup>8</sup> is perceive to be present will be determined in conformance with PRHTA T 401-40 - Determination of Asphalt Binder Content of Compacted HMA and based upon the following criteria:

- 1. Will be considered acceptable if the following condition is met:
  - a. Asphalt content (Pb) is within the range of +/-0.70 from JMF.

2. Will be rejected if it does not meet the requirement above. The section(s) shall be removed at the contractor expense and replaced.

d. Contractor costs related to the activities stated in b and c above will be reimbursed to the Contractor on a force account basis if the HMA material is considered acceptable.

#### **401-6 METHOD OF MEASUREMENT**

**401-6.01** Plant-mix bituminous pavement courses will be measured by the ton of compacted mixture placed in the accepted work, as called for in the contract documents. Measurement will be by weighing the delivery trucks at approved scales. Batch weights will not be accepted as a method of measurement.

**401-6.02** Any excess tonnage due to excess thickness, determined as provided in Article 401-3.07e and 401-5 as applicable, will be deducted from the measurement for payment.

## $SUPPLEMENTAL\ SPECIFICATION\ 401-HOT\ PLANT-MIX\ BITUMINOUS\ PAVEMENT$

**401-6.03** Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the contract quantities and no adjustment in the contract unit price will be made because of such variation.

**401-6.04** Work prescribed under Article 401-4.08, Preparation of Surface to be Paved, except for the leveling course and mix material used for patching and correcting irregularities in old surfaces, will not be measured directly for payment, but will be considered as a subsidiary obligation of the Contractor under the various items of hot plant-mix bituminous pavement. Hot plant-mix material used for patching and leveling in this work will be measured for payment under the respective unit prices.

<sup>7</sup>Segregation - The non-uniform distribution of HMA coarse and fine aggregate components. Segregation can be determined visually as pavement sections that have a significantly different texture than the surrounding material.

<sup>8</sup>Bleeding (Excess surface asphalt) - A shiny, black surface caused by liquid asphalt migrating to the pavement surface. The result can mean a loss of surface texture on the pavement.

## 401-7 BASIS OF PAYMENT

**401-7.01** The completed and accepted quantities of each class of hot plant mix pavement, measured as provided above, will be paid for at the contract unit price per unit of measurement except as specified in Article 401-7.02 below. Such prices and payment shall constitute full compensation for the cost of the mix design and other related costs, preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting and finishing of all required materials for the pavement; smoothness of the final pavement surface and for all labor, equipment, tools and incidentals necessary to complete each item of work as indicated in this specification.

**401-7.02** Payment for hot plant mix pavement will be paid for by Lot at unit price multiplied by the applicable Composite Lot Pay Factor ( $CPF_{Lot}$ ) as follows:

# a. Individual Acceptance Quality Characteristics (AQC) Pay Factor Determination:

- 1. Aggregate Gradation:
  - a) Average Requirements:

For All Control Sieves (\*):

If average of lot is within (JMF - DTV, JMF + ADTV) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise **CPF** Lot = **0.50**.

#### SUPPLEMENTAL SPECIFICATION 401 - HOT PLANT-MIX BITUMINOUS PAVEMENT

b) Variability Range Requirements:

Pay Factor Equation for Control Sieves 1-inch, <sup>3</sup>/<sub>4</sub>-inch and <sup>1</sup>/<sub>2</sub>-inch (+/- 8<sup>\*</sup>):

**PF**<sub>NMAS</sub> = 1.25 (Variability Range)  $^{-0.161}$  (Equation #1)

If PF  $_{NMAS} > 1.00$  Then PF  $_{NMAS} = 1.00$ 

Pay Factor Equation for Control Sieves 3/8-inch No. 4 and No. 8 (+/- 7\*):

$PF_{PCS} = 1.22 (Variability Range)^{-0.161} $ (Equation	on #2)
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If **PF** <sub>PCS</sub> > **1.00** The **n PF** <sub>PCS</sub> = **1.00** 

If PF No. 200 > 1.00 Then PF No. 200 = 1.00

Pay Factor Equation for Control Sieves No. 200 (+/- 3\*):

<b>PF</b> No. 200 = <b>1.10</b> (Variability Range) $^{-0.161}$	(Equation #3)

(\*)Upper gradation deviation shall not be outside the grading composition requirements

of Table 703-3. In such cases the DTV will be reduced accordingly (Allowable Deviation from Target Value (ADTV)). Deviations are subject to selected target value in the approved JMF.

Pay Factor Equation for Aggregate Grading (**PF**  $_{Agg}$ ): Pay Factor for aggregate grading will be calculated based on the Pay Factors (PF) of corresponding mix control sieves with the following weighting applied: 10 percent for control sieves 1-inch, <sup>3</sup>/<sub>4</sub>-inch and <sup>1</sup>/<sub>2</sub>-inch (NMAS sieves), 15 percent for Control Sieves 3/8-inch No. 4 and No. 8 (PCS sieves) and 75 percent for Control Sieve No. 200. Calculate the **PF**  $_{Agg}$  by using the following formula:

 $\mathbf{PF}_{Agg} = (0.10 \text{ x } \mathbf{PF}_{NMAS}) + (0.15 \text{ x } \mathbf{PF}_{PCS}) + (0.75 \text{ x } \mathbf{PF}_{No.200}) \qquad (\underline{\text{Equation } \#4})$ 

If PF  $_{Agg} > 1.00$  Then PF  $_{Agg} = 1.00$ 

### SUPPLEMENTAL SPECIFICATION 401 - HOT PLANT-MIX BITUMINOUS PAVEMENT

- 2. <u>Binder Content (Pb):</u>
  - a) Average Requirements:

If Average Binder Content of lot is within (JMF - 0.52, JMF + 0.52) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise **CPF**<sub>Lot</sub> = 0.50.

b) Variability Range Requirements:

Pay Factor Equation for **Pb** (+/- 0.52):

**PF**<sub>Pb</sub> = 0.8 (Variability Range)<sup>-0.321</sup>

(Equation #5)

If **PF**  $_{Pb} > 1.00$  Then **PF**  $_{Pb} = 1.00$ 

- 3. In-Place Compaction (IPC):
  - a) Average Requirements:

If average IPC of lot is within (92% and 97%) Then determine Pay Factor of AQC based upon variability range requirements stated in b); Otherwise  $CPF_{Lot} = 0.50$ .

b) Variability Range Requirements:

Pay Factor Equation for In-Place Compaction (IPC):

**PF**  $_{\text{PC}} = 1.12$  (Variability Range)<sup>-0.161</sup> (Equation #6)

If **PF PC** > **1.00** Then **PF PC** = **1.00** 

**b.** Composite Lot Pay Factor (CPFLot) (value of work): A Composite Lot Pay Factor will be calculated based on the individual AQC Pay Factors (PF) determined above with the following weighting applied: 20 percent aggregate gradation, 30 percent Binder Content (Pb) and 50 percent In-place Compaction (IPC). Calculate the CPFLot by using the following formula:

Composite Lot Pay Factor (<u>CPFLot</u>) Equation:

$$\mathbf{CPF}_{\mathbf{Lot}} = (0.2 \text{ x } \mathbf{PF}_{\mathbf{Agg}}) + (0.3 \text{ x } \mathbf{PF}_{\mathbf{Pb}}) + (0.5 \text{ x } \mathbf{PF}_{\mathbf{PC}})$$
 (Equation #7)

c. The above  $CPF_{Lot}$  will be in addition to any reduction in payment for excess tonnage in pavement thickness provided under Article 401-5.

### $SUPPLEMENTAL\ SPECIFICATION\ 401-HOT\ PLANT-MIX\ BITUMINOUS\ PAVEMENT$

**401-7.03 Control Strip Section** – Control Strip Section will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for the cost of cold milling, if required, preparation of the surface to be paved; the furnishing and placing of any required prime or tack coat; and the furnishing, placing, compacting, and finishing of all required materials for the control strip section; and for all labor, equipment, tools and incidentals necessary to complete said work.

#### 401-7.04 Payment will be made under:

Pay Item		<u>Pay Unit</u>
Hot Plant-Mix Bituminous Pavement – S-P (50 or 75)* (38)**	•••••	Ton
Hot Plant-Mix Bituminous Pavement - S (50 or 75)* (38 or 12)**		Ton
Hot Plant-Mix Bituminous Pavement - B (50 or 75)*(12, 34 or 1)**		Ton
Hot Plant-Mix Bituminous Pavement - L (50 or 75)* (38, 12, 34 or 1)**		Ton
Control Strip Section		Ton

\* Indicates the number of applicable hammer blows (AASHTOT 245)

\*\* Indicate the applicable Nominal Maximum Aggregate Size (NMAS) of Mix as follows:

38 = Mix NMAS of 3/8-inch
12 = Mix NMAS of <sup>1</sup>/2-inch
34 = Mix NMAS of <sup>3</sup>/4-inch
1 = Mix NMAS of 1-inch

In those cases in which the Authority does not require a specific NMAS in the mix pay item, the Contractor will have the option of selecting the NMAS of the mix to be designed, produced, and placed in the project. The selection by the Contractor of the above mix properties shall be based upon mix compliance with all specification requirements.

# SUPPLEMENTAL SPECIFICATION

# **REVISIONS TO STANDARD SPECIFICATION 403 -COLD MILLING OF BITUMINOUS CONCRETE PAVEMENT**

# 403-4 METHOD OF MEASUREMENT

# Article 403-4.01 is revised to read as follows:

**403-4.01** Cold milling of bituminous concrete pavement will be measured by the cubic meter of pavement acceptably milled to the depth, cross section of profile grade specified in the contract documents or ordered by the engineer.

a. For each strip of existing pavement removed by the cold milling process, the volume removed will be determined by multiplying the average depth removed, measured to the nearest millimeter, by the length and width of the strip measured to the nearest centimeter.

b. The average depth of each strip will be determined by measuring the depth removed at the lip along the longitudinal edge of the strip, every 6.0 meters or fraction thereof, and averaging these measurements.

c. Pavement removed in excess of the depth, cross section or profile grade specified in the plans, or ordered by the Engineer, will not be included in the measurement for payment.

# 403-5 BASIS OF PAYMENT

403-5.02 Payment will be made under:

The pay unit is revised to read as follows:

Pay Item

Pay Unit

Cold Milling Bituminous Concrete Pavement ......Cubic Meter

# 638-1 DESCRIPTION

# 638-1.01 Scope

## The following paragraph is revised to read as follows:

d. All traffic control devices and traffic control operations shall be in accordance with the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA) and the Standard Drawings.

# 638-2 MATERIALS

# 638-2.01 General

### The following paragraph is revised:

a. All traffic control devices shall conform to the design, dimensions, materials, colors, fabrication and installation requirements specified on the plans, the "Manual de Señales de Tránsito (MST) of the DTPW, the standard drawings of the Authority, the standard specifications as may be modified by the specification and the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA).

# Add the following paragraph:

e. All traffic control devices shall have been successfully crash tested to meet the requirements of NCHRP 350 and/or been approved by the Federal Highway Administration. The Contractor shall submit the Engineer a certificate of compliance for this in a form meeting the requirement of section 106.06 of the General Provisions.

#### The following articles are revised to read as follows:

#### 638-2.02 Construction Signs

- Sign panels may be made of aluminum, galvanized steel or marine plywood. a. Sign posts shall be metallic as shown on standard drawings but wood supports may be used when so designed to yield when impacted by a moving vehicle. Wood posts shall be according to temporary traffic sign mounting details included in the contract documents.
- b. Reflective sheeting shall be fluorescent orange prismatic retro-reflective consisting of prismatic lenses formed in a transparent fluorescent orange synthetic resin, sealed, and backed with an aggressive pressure sensitive adhesive protected by a removable liner. The sheeting shall have a smooth surface.
  - (1)Physical Properties -
    - Photometric Coefficient of Retroreflection  $R_A$  . When the (a) sheeting applied on test panels is measured in accordance with ASTM E 810, it shall have minimum coefficient of retroreflection values as shown in Table I. The rotation angle shall be as designated by the manufacturer for test purposes, the observation angles shall be 0.2 degrees and 0.5 degrees, the entrance angles (component  $B_1$ ) shall be -4 degrees and +30 degrees.

Minimum Coefficient of Retrofenection R <sub>A</sub>						
Candelas per footcandle per square foot						
Observation	Entrance	R <sub>A</sub>				
Angle (deg.)	Angle (deg.)	Orange				
0.2	- 4	200				
0.2	+ 30	90				
0.5	- 4	80				
0.5	+ 30	50				

<u>TABLE I</u> Minimum Coefficient of Potroroflaction P

The rotation shall be as designated by the manufacturer.

Daytime Color - Color shall conform to the requirements of (b) Table II. Daytime color and maximum spectral radiance factor

(peak reflectance) of sheeting mounted on test panels shall be determined instrumentally in accordance with ASTM E 991. The values shall be determined on a Hunter Lab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559 (or approved equal 0/45 instrument with circumferential viewing illumination). Computations shall be done in accordance with ASTM E 308 for the 2 degree observer.

			-			` <b>`</b>	,			
		1	~	, ,		2	4		Reflectance	
Color		1	2		3		2	+	Limit	Y (%)
	X	Y	Х	Y	Х	Y	Х	Y	MIN	MAX
Orange (new)	.58	.416	.523	.397	.560	.360	.631	.369	28	-
Orange (weathered)	.58	.416	.523	.397	.560	.360	.631	.369	20	45

TABLE II Color Specification Limits\*\* (Daytime)

Maximum Spectral Radiance Factor,

new: 110%, min.

weathered: 60%, min.

\*\* The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

(c) Nightime Color - Nightime color of the sheeting applied to test panels shall be determined instrumentally in accordance with ASTM E 811 and calculated in the u', v' coordinate system in accordance with ASTM E 308. Sheeting shall be measured at 0.33 degrees observation and -4 degree entrance at rotation as determined by the manufacturer for test purposes. Color shall conform to the requirements of Table III.

Color Specification Limits · · (Nighttime)								
Calar		1	2		3		4	
Color	u'	v'	u'	v'	u'	v'	u'	v'
Orange	.400	.540	.475	.529	.448	.522	.372	.534
(new an d								
weathered)								

TABLE III lor Specification Limits \*\* (Nighttime)

(d) Field Performance – Retroreflective sheeting processed and applied to sign blank materials in accordance with the sheeting manufacturer's recommendations, shall perform effectively for a minimum of 3 years. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than 100 when measured at 0.2 degrees observation and -4 degree entrance. All measurements shall be made after sign cleaning according to the sheeting manufacturer's recommendations.

# 638-2.03 Barricades, Drums and Cones (limited use)

Barricades shall be constructed of wood or plastic. Drums shall be plastic with conic, round or square section, approximately 36 inches high and a minimum of 18 inches in diameter. Cones shall be used on low-volume, low-speed (40MPH or less) roadways only. Never shall be used on expressway, freeway or toll roads. They shall be a minimum of 28 inches in height with a broadened base, orange colored and shall be made of a material that can be struck without causing damage to the impacting vehicle. Barricades, drums and cones shall be marked and reflectorized in accordance with the requirements of the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA).

## 638-2.04 Temporary Pavement Markings

#### Add the following paragraph:

e. When temporary pavement markings will remain for more than fourteen (14) calendar days, thermoplastic pavement markings in conformance to the requirements of article 716-4 or preformed plastic pavement markings in conformance to the requirements of article 716-5 shall be used.

## 638-2.11 Warning Lights

Warning lights shall be of the steady burning type meeting the requirements of the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA).

### Add the following articles:

# 638-2.13 Portable Changeable Message Signs (PCMS) –

- a. PCMS's shall meet all physical display and operational requirements as described in the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA).
- b. Display panel and housing shall comply with the following requirements:
  - (1) Shall be weather-tight.
  - (2) All nuts, bolts, washer and other fasteners shall be made of a corrosive resistant material.
  - (3) The message matrix panel background and frame for PCMS assembly shall be painted flat black according to Federal Specification TT-E-489.
  - (4) Servicing of all massage matrix panel components shall be accomplished from the front of the message matrix panel.
  - (5) Each message matrix panel shall provide a glare screen for each message line to aid against sun glare.
  - (6) The display panel, when raised in the upright position, will have a minimum height of 2.1 meters from the bottom of the panel to the ground.

- (7) The unit shall have an accessible mechanism to easily raise and lower the display assembly. A locking device shall also be provided to ensure the display panel will remain in the raised or lowered position.
- c. The message matrix shall comply with the following requirements:
  - (1) The PCMS message matrix shall be 2.1 meters height by 3.0 meters wide.
  - (2) The message matrix panel shall contain three separate lines. Each line shall consist of at least eight characters, equally spaced a minimum of 7.62 cm. Each character shall contain 35 pixels in a five by seven horizontal to vertical grid arrangement.
  - (3) Each message line of the PCMS shall provide for characters 33 cm wide by 45.7 cm high and variable graphic and symbol sizes to a minimum of 45.7 cm in height.
- d. The electrical system of the PCMS shall be solar powered and comply with the following requirements:
  - (1) The photovoltaic unit shall provide twenty one (21) days of continuous operation without sun light with a minimum of on site maintenance.
  - (2) Automatic recharging of power supply batteries shall be provided.
  - (3) The battery shall be equipped with a battery controller to prevent over charging and over discharging. An external battery level indicator shall be provided.
  - (4) The battery, controller, and power panel shall be protected from weather elements and vandalism.
- e. The controller shall comply with the following requirements:
  - (1) The controller and control panel shall be housed in a weather, dust and vandal proof cabinet.
  - (2) The keyboard shall be equipped with a security lockout feature to prevent unauthorized use of the controller.
  - (3) The controller shall be solid state in design and function.
  - (4) The control panel shall display a representative message that will be displayed on the sign panel.
  - (5) The flash rate shall be adjustable in the sign controller from one to ten.

- f. Operation and Performance
  - (1) The message shall be displayed in upper case except when lower case is project specific and is allowed by the current edition of the MUTCD.
  - (2) The message matrix shall be visible from 800 meters and legible from a distance of 200 meters under both day and night conditions. Under variable level conditions the sign shall automatically adjust it's light source so as to meet the 200 meters visibility requirement. The message panel shall have adjustable display rates, so that the entire message can be read at least twice at the posted highway speed.
  - (3) The control panel shall have the capability to store a minimum of fifty(50) preprogrammed messages.
  - (4) The controller in the control panel shall have a memory capable of maintaining the stored messages even during non-powered conditions.
  - (5) The controller shall allow the operator to generate additional messages on site via the keyboard.
  - (6) All messages shall be flashed or sequenced. In the sequence mode, the controller shall have the capability to sequence three lines during one cycle.

# 638-2.14 Truck-Mounted Attenuators (TMAs) and Shadow Vehicles

- a. Truck-Mounted Attenuator systems (TMA) consist of an energy absorbing component and a rear panel with a retro-reflective chevron panel and vehicle lighting system attached to a truck (shadow vehicle) using a back support assembly with an appropriate connecting mechanism. Truck-mounted attenuators shall be equipped with a system for tilting from the horizontal configuration where it has energy absorbing capacity to a vertical position on the truck when not in use. The unit shall have a mechanical locking device to secure the truck mounted attenuator energy absorbing component in the vertical upright travel position.
- b. A Trailer Mounted TMA consists of an energy absorbing mechanism attached to a specially designed trailer connected to a truck (shadow vehicle), a rear panel with a retro-reflective chevron panel and vehicle lighting system. The Trailer Mounted TMA shall be considered a TMA system for the purposes of this specification unless indicated otherwise. The Trailer Mounted TMA shall be designed for use as a trailer with different types of trucks normally used as shadow vehicles in maintenance and construction activities. The Trailer Mounted

TMA shall provide for easy attachment and detachment from the truck, including a trailer hitch or collar specifically designed and tested for this use. The Trailer Mounted TMA shall be complying with the requirements for a TMA system as per this specification, except the requirements in article 638-2.13 (a).

- c. The Authority reserves the right to reject a certain TMA for use in certain applications based on the crash test results, past and present equipment in-service performance and any other technical limitations noted in FHWA's letter of acceptance.
- d. The Contractor shall provide TMA systems manufactured in compliance with all requirements of this specification, the manufacturer's recommendations and the most current version of the MUTCD as adopted by the Authority.
- e. The TMA rear panel shall have a standard trailer lighting system in compliance with applicable motor vehicle laws, including but not limited to brake lights, tail lights and turn signals. Lights shall be visible in both the raised and lowered positions.
- f. The Truck-Mounted Attenuator shall be no less than 84 inches wide and no more than 108 inches wide. Color of the truck-mounted attenuators shall be yellow.
- g. All mechanical and electrical components of the TMA shall be completely compatible with the shadow vehicle following the manufacturer's recommendations. The Contractor shall be responsible to comply with all safety measures as recommended by the manufacturer. The uses of third party or homemade adapters, connectors or converters are not acceptable for the purposes of this specification.
- h. Truck-mounted attenuator systems shall conform to the requirements of the National Cooperative Highway Research Program (*NCHRP*) *Report 350*. Prior to their use, the Contractor shall submit the Engineer a certificate of compliance in a form meeting the requirements of section 106.06 of the General Provisions. The certificate of compliance shall be accompanied by the following:
  - 1) TMA product catalog, manuals and specifications.
  - 2) A copy of the Federal Highway Administration acceptance letter.
  - 3) Non-reflective and retro-reflective sheeting specifications.
  - 4) A copy of the weight ticket for the shadow vehicle as indicated in the article 638-2.13 (g.).

- i. Each TMA shall be like new. Furnish each unit with all equipment, options, and features as required by these specifications. If the TMA system is not furnished new, the Contractor shall document and demonstrate to the Engineer's satisfaction that the system conforms to the requirements of a new system or *NCHRP 350 at the Test Level for which it was originally designed* and may be used until the end of the attenuation device's useful service life. TMA systems without retro-reflective stripes or otherwise damaged shall not be acceptable to the Authority.
- j. Truck-mounted attenuators shall comply with crash tests according to NCHRP 350 Test Level 3 or Test Level 2, as required in each case. The Authority shall require that each truck mounted attenuator complies with the following Test Level based on the posted speed limits of the road under normal conditions, before implementing the work zone. The TMA Test Level shall comply with the following speed limits:

Posted Speed Limit of the road (Under normal conditions)	TMA Test Level required	
45 MPH or less	Test Level 2	
50 MPH or more	Test Level 3	

- k. The TMA unit shall have a chevron pattern that covers the rear face of the unit. The standard chevron pattern shall consist of stripes, alternating non-reflective black and yellow retro-reflective prismatic sheeting, slanted at 45 degrees in an inverted "V" pattern, centered on the rear of the unit. The width of the stripes shall be between 4 8 inches (100 200 millimeters). The chevron pattern shall cover a minimum of 75 percent of the rear panel area excluding the required vehicle or trailer lighting, and shall be visible to traffic at all times.
- 1. Each of the stripes in the chevron pattern shall consist of factory installed flexible sheeting, capable of absorbing minor impacts without cracking. Yellow retro-reflective prismatic sheeting material shall comply with the requirements of ASTM D4956 Type VIII or Type XI. The retro-reflective prismatic sheeting shall be installed by the manufacturer and shall comply with the performance requirements of this specification. The design and placement of the stripes shall follow this specification and the most current MUTCD requirements.

- m. The weight of the shadow vehicle shall be as recommended by the manufacturer of the TMA. The Contractor shall provide a copy of the manufacturer's recommendation to the Engineer and a copy of a weight ticket for the vehicle. The weight ticket shall contain adequate information to associate the ticket with the applicable vehicle. Additional weight may be added to the shadow vehicle to achieve the range recommended by the manufacturer of the TMA provided the total weight is within the Gross Vehicle Weight Recommendation of the shadow vehicle and is anchored to the vehicle or installed in its bed in such a way that no movement will occur during impacts.
- n. An electronic Flashing Arrow Sign complying with Supplemental Specification 638 shall be attached to the shadow vehicle or truck-mounted attenuator system as recommended by the manufacturer. The Flashing Arrow Sign installed with the TMA shall constitute a subsidiary obligation of the Contractor under the respective pay item. The use of the Flashing Arrow Sign shall be subject to the Plans, Standard Drawings and the most current version of the MUTCD as adopted by the Authority.
- o. The shadow vehicle shall have at least one rotating amber light or highintensity amber strobe light functioning while in operation. When indicated by the Plans or by the Engineer an electronic Flashing Arrow Sign operated in the caution mode may be used in lieu of the rotating or high-intensity amber strobe light.
- p. The transmission of the shadow vehicle with the truck-mounted attenuator in use shall be in second gear, except for those with an automatic transmission, which shall be in park. The parking brake shall be applied and the front wheels aligned straight ahead when operating in the stationary mode.

# 638-3 CONSTRUCTION REQUIREMENTS

### 638-3.02 Construction Signs

#### Paragraph b. is revised to read as follows:

b. The number of signs indicated in the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA), standard drawings, and the plans are a minimum and the Engineer may require additional signs. The Contractor shall have adequate quantities of these signs on hand prior to starting construction operations for use as required.

#### 638-3.03 Barricades, Drums and Cones

#### Paragraph a. is revised to read as follows:

a. The Contractor shall furnish, erect, maintain, move, replace and remove construction barricades, drums and cones where and as indicated on the plans, the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA) or as directed by the Engineer.

#### 638-3.04 Temporary Pavement Markings

#### Add the following paragraph:

c. When as required by article 2.04 e., thermoplastic or preformed plastic pavement markings are used, they shall be applied in accordance with Specification 618.

#### 638-3.11 Flag persons

#### Paragraph c. is revised to read as follows:

a. For daytime work the flagger's vest, shirt, or jacket shall be orange, yellow, yellow-green, or a fluorescent version of these colors. For nighttime work, similar outside garments shall be retro reflective. The flagmen operate in conformance with the procedures and requirements of the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway

Administration (MUTCD-FHWA).

# Add the following articles:

## 638-3.12 Portable Changeable Message Signs (PCMS) –

- a. When the pay item for PCMS's is included in the proposal schedule, the Contractor shall furnish, install, operate and maintain two PCMS's which shall be always available at the project.
- b. The Engineer will notify the Contractor the exact locations for the installation of the PCMS's and the messages to be displayed on the sign.
- c. The PCMS's shall be installed and be operating with the indicated messages within two hours after a written or oral request is issued by the Engineer. Failure to comply with this requirement may be cause for the assessment of liquidated damages in the amount of five hundred dollars (\$500.00) per each hour or fraction of hour of non-compliance. Liquidated damages in the same amount will be assessed for each hour or fraction of hour the PCMS's are not operating properly.

# 638-3.13 Truck-Mounted Attenuators (TMAs) and Shadow Vehicles -

- a. Shadow vehicles shall not be used for other purposes while the truck-mounted attenuator is being used. There shall be no additional devices in the bed of the shadow vehicle except the additional weight as allowed and the truck-mounted electronic Flashing Arrow Sign.
- b. The truck upon which the attenuator is to be mounted shall be fully operational. The TMA shall be installed according to manufacturer's specifications.
- c. TMA systems shall not be parked against rigid objects such as bridge piers and portable concrete barrier except as a temporary safety measure until a stationary crash cushion is installed. This use of TMAs shall be 72 hours maximum, or as shown in the Plans.

- d. Use of the TMA system as a stationary barrier vehicle or shadow protection vehicle for mobile or stop and go operations shall comply with the MPT Plans, the manufacturer's recommendations and the Engineer's instructions in regards to the following:
  - 1) In a stationary barrier vehicle operation, the TMA shall be positioned so that traffic does not pass any other object within the protected area (i.e. equipment, personnel, and vehicles) before reaching the TMA. When the TMA is a shadow vehicle in a mobile operation, approaching traffic shall not reach or overtake any object before passing the TMA.
  - 2) The TMA shall be positioned at a prudent distance before the area to be protected or the rear of the next vehicle in the mobile array depending on the type and speed of the operation, road conditions, traffic volumes and other site conditions.
  - 3) Each TMA in use shall have an assigned driver, who must remain in the service vehicle at all times that the TMA system is in use in a mobile operation or available to reposition the TMA within a 15-minute time frame in the case of a stationary vehicle barrier operation.
- e. In the event the truck-mounted attenuator is impacted, resulting in damage that would cause the unit to be ineffective, all work requiring the use of the truck-mounted attenuator shall cease until such time that the Contractor can provide an acceptable unit as defined in the Special Provision by means of repair or replacement. The Contractor shall complete replacement or repair operations of the defective or damaged equipment within seventy-two hours after discovery or notification of a failure.
- f. The Contractor performing the work shall provide, install, remove, relocate as necessary, and maintain the TMA system throughout the duration of the project. When not in use, the Contractor is responsible to keep the TMA system away from conflict with the roadway conditions to prevent confusion of the traveling public.

# 638-4 METHOD OF MEASUREMENT

#### 638-4.01

### Add the following paragraph:

- n. The unit of measurement for each PCMS will be by the month measured from the date the sign is available at the project site and ready for operations, as determined by the Engineer, to the date that it is indicated by the Engineer for not being necessary in the project. Periods of less than one month will be computed at the rate of 1/30 of the unit price per month for each day of use in the project.
- o. Truck-mounted attenuators (TMAs) of the type (test level, (TL)) specified in the proposal schedule will be measured by the number of hours (or fraction of an hour) of actual operation for each unit required and accepted by the Engineer and furnished by the Contractor. This shall include the shadow vehicle, the attenuator, amber or strobe lights, electric arrow panels, vehicle maintenance, driver and any other requirements established in this specification and/or indicated by the Engineer.
- p. Shadow vehicles, when required by the Maintenance of Traffic drawings or as requested by the Engineer will be measured by the number of hours (or fraction of an hour) of actual operation for each unit required and accepted by the Engineer and furnished by the Contractor. This shall include the vehicle, amber or strobe lights, vehicle maintenance, driver and any other requirements established in this specification and/or indicated by the Engineer.

# 638-5 BASIS OF PAYMENT

#### 638-5.01 Payment

#### The following paragraphs are revised as follows:

c. Any traffic control device or equipment included under this specification, that is damaged by traffic, vandalism or other cause <u>not attributable</u> to negligence on the part of the Contractor will be repaired by force account, by an agreed unit price, or will be replaced at the contract unit price when so approved by the Engineer. However, no payment will be made for required repair or replacement of traffic control devices damaged by the Contractor's

personnel or equipment, or as a result of negligence on his part, of for normal maintenance.

h. In the event that that the Contractor fails to maintain traffic in a satisfactory manner in accordance with the requirements of Articles 104.7, 107.08, and 107.11 of the General Provisions and of this specification, he will be assessed liquidated damages at the rates specified in Article 108.09 of the General Provisions for each day of such failure. The Engineer will notify the Contractor in writing of the effective date of the application of this penalty. This is in addition to non-payment for items that the Contractor failed to provide and maintain under the requirement of this specification.

These fines or penalties are not reimbursable and are in addition to nonpayment for items that the Contractor failed to provide and maintain under the requirements of this specification.

i. If the Contractor fails to maintain and protect traffic adequately and safely for a period of 24 hours or more, the Engineer will correct the adverse conditions by any means he deems appropriate and will deduct the cost of such corrective work from any monies due the Contractor. The cost of this work shall be in addition to the liquidated damages and nonpayment for items specified above.

# Add the following paragraph:

j. When a PCMS is malfunctioning or not operating for a period of time within 2 to 24 consecutive hours, a deduction in the amount of 1/30 of the contract unit price per month will be made to the payment to the contractor for said period of time remains in the project malfunctioning or not operational.

## 638-5.02 Pay Items – Payment will be made under:

### Add the following pay items:

Pay Item	<u>Pay Unit</u>
Portable Changeable Message Sign (PCMS) (Each Sign)	 Month
Truck Mounted Attenuator (TMA), TL-2 or 3	 Hour
Shadow Vehicle	 Hour

# Add the following article:

**638-5.03** Thermoplastic pavement markings found deficient in thickness but which are accepted by the Authority according to article 618-3.02 d. (2) will be paid for at a reduced unit price as established on article 618-5.02.

## SUPPLEMENTAL SPECIFICATION REVISIONS TO STANDARD SPECIFICATION 639 – PAINTED PAVEMENT MARKINGS

# 639-3 CONSTRUCTION REQUIREMENTS

#### 639-3.01 General

#### Paragraph c. is revised to read as follows:

c. All markings shall be as shown on the plans or as ordered by the Engineer. Details not shown on the plans shall be in accordance with the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA). All markings shall present a clear cut, uniform and workmanlike appearance. Any markings which fail to have a uniform, satisfactorily appearance, either day or night, shall be corrected at the Contractor's expense.

### SUPPLEMENTAL SPECIFICATION REVISIONS TO STANDARD SPECIFICATION 640 – RAISED PAVEMENT MARKINGS

### 640 – 3 CONSTRUCTION REQUIREMENTS

#### **640 – 3.01** Application of Markings

#### Paragraph b. is revised to read as follow:

b. All raised pavement markings shall be as shown on the plans or as ordered by the Engineer. Details not shown on the plans shall be in accordance with the current edition of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration (MUTCD-FHWA). All raised pavement markings shall present a clear cut, uniform and workmanlike appearance. Any raised pavement markings which fail to have a uniform, satisfactorily appearance, either day or night, shall be corrected at the Contractor's expenses.