SUPPLEMENTAL SPECIFICATION

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:

Table 401-1

Road Classification	Compactive Effort Levels (Number of Marshall Hammer Blows- AASHTO T-245)
Primary and Secondary	75
Tertiary and Municipal	50

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[1] (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".*

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Table 401-2

PCS Control Point for Mixture Nominal Maximum Aggregate Size[2] (NMAS)				
Nominal Maximum Aggregate Size (NMAS)	1-inch	¾-inch	½-inch	3/8-inch
Primary Control Sieve (PCS)	No.4	No.4	No.8	No.8
PCS Control Point (%Passing)	40	47	39	47

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), ¾-inch (19 mm), ½-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).

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:

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Table 401-3

NOMINAL MAXIMUM AGGREGATE SIZE (NMAS)	COMPACTED THICKNESS FOR EACH COURSE (inches) Min – Max
NMAS = 3/8-inch	1.00 – 2.00
NMAS = ½-inch	1.50 – 2.50
NMAS = ¾-inch	2.25 – 3.75
NMAS = 1-inch	3.00 – 5.00

[2]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[3] (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.

[3]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**:

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Table 401-4

Compactive Effort Level	Stability (Lbs.) – (Minimum)	Flow (0.01 inch (25 mm)) (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 ±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**:

Table 401-5

NMAS	Minimum VMA (Percent)
3/8-inch	15
1/2-inch	14
3/4-inch	13
1-inch	12

(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

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 +/- 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 +/-

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**:

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

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:

Table 401-9

Procedure Designation (AASHTO)	Frequency	Testing
AASTHO T-164	1 per sub-lot	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 Section #11) / PRHTA T 401-50	1 per lot (use average of two split samples for acceptance)	Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt Paving Mixture

AASHTO T-245	1 per sub-lot (use average of three split samples for acceptance per lot)	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
AASHTO T-166 or T-275 as required		Bulk Specific Gravity of Compacted Hot Mix Asphalt Mixtures Using Saturated Surface Dry Specimens / Bulk Specific Gravity of Compacted 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	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

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", ¾", ½", 3/8", 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 $\mathbf{CPF_{lot}}$ 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.

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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

(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.

[4]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.

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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 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.

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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.

Table 401-10

Asphalt Binder	Storage Temperature Range (Minimum – Maximum) (ºF)
PG 64-22	285-315
PG 67-22	295-320
PG 70-22	300-325

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:

Table 401-11

Acceptable Production Temperature Range	
Minimum	Production Temperature -30º F
Maximum	Production Temperature +20º 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:

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.

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:

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Table 401-13

NMAS = 1-inch		
Acceptance Quality Characteristic[5] (AQC)	**Deviation from Target Value[6] (DTV)**	**Variability 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 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

Table 401-14

NMAS = 3/4-inch		
Acceptance Quality Characteristic (AQC)	**Deviation from Target Value (DTV)**	**Variability Range**
¾-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

[5]*Acceptance Quality Characteristic (AQC) – Characteristic or property of a mix that is measured for acceptance purposes*.

[6]*Target Value – Mix design values as reported in JMF for each acceptance quality characteristic*.

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Table 401-15

NMAS = 1/2-inch		
Acceptance Quality Characteristic (AQC)[4]	**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 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

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.

b. **Segregated HMA** (segregated areas and/or longitudinal streaks sections) – The acceptability of HMA pavement were segregation[7] 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[8] 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.

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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.

[7]*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*.

[8]*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>:

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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, ¾-inch and ½-inch (+/- 8*):

$$PF_{NMAS} = 1.25\ (\text{Variability Range})^{-0.161} \qquad \text{(Equation \#1)}$$

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*):

$$PF_{PCS} = 1.22\ (\text{Variability Range})^{-0.161} \qquad \text{(Equation \#2)}$$

If $PF_{PCS} > 1.00$ Then $PF_{PCS} = 1.00$

Pay Factor Equation for Control Sieves No. 200 (+/- 3*):

$$PF_{No.\ 200} = 1.10\ (\text{Variability Range})^{-0.161} \qquad \text{(Equation \#3)}$$

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, ¾-inch and ½-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:

$$PF_{Agg} = (0.10 \times PF_{NMAS}) + (0.15 \times PF_{PCS}) + (0.75 \times PF_{No.\ 200}) \qquad \text{(Equation \#4)}$$

If $PF_{Agg} > 1.00$ Then $PF_{Agg} = 1.00$

2. Binder Content (Pb):

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):

$$PF_{Pb} = 0.8\ (\text{Variability Range})^{-0.321} \qquad \text{(Equation \#5)}$$

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):

$$PF_{IPC} = 1.12\ (\text{Variability Range})^{-0.161} \qquad \text{(Equation \#6)}$$

If $PF_{IPC} > 1.00$ Then $PF_{IPC} = 1.00$

b. **Composite Lot Pay Factor (CPF_{Lot}) (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 **CPF_{Lot}** by using the following formula:

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Composite Lot Pay Factor (**CPF_{Lot}**) Equation:

$$\mathbf{CPF_{Lot}} = (0.2 \times \mathbf{PF_{Agg}}) + (0.3 \times \mathbf{PF_{Pb}}) + (0.5 \times \mathbf{PF_{IPC}}) \qquad \text{(Equation \#7)}$$

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	Pay Unit
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 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.