

DIVISION 400**SURFACE COURSES AND PAVEMENT****SECTION 401 - AGGREGATE SURFACE COURSE**

401.01 DESCRIPTION. This work shall consist of furnishing and placing a wearing course of approved aggregate on a prepared surface.

401.02 MATERIALS. Materials shall meet the requirements of the following Subsection:

Aggregate for Surface Course and Shoulders.....704.12

401.03 PLACING. The aggregate shall be placed and properly shaped using equipment that allows the typical cross-section and design grade to be attained. Should aggregate segregation occur, the Contractor shall remove and replace the segregated material or manipulate it until uniform gradation is obtained.

The maximum layer thickness for placement of any aggregate surface material shall be 150 ± 50 mm (6 ± 2 inches) after compaction. All layers shall be placed and compacted at approximately equal thickness. In the placement of layers, all joints shall be staggered at least 300 mm (12 inches).

After each layer of surface material is placed, it shall be thoroughly compacted to a uniform density of not less than 95 percent of the maximum dry density determined by AASHTO T 99, Method C. Suitable and effective equipment, meeting the approval of the Engineer, shall be used to obtain a true and even surface during compaction. All holes or depressions found during the compacting shall be filled with additional material, reworked, and compacted. If required, water shall be uniformly applied over the aggregate material during compaction in an amount necessary to produce proper consolidation. The aggregate shall be thoroughly compacted with an approved power roller with a mass (weight) not less than 7 metric tons (8 tons), or an approved rubber tired roller, or by other approved methods.

401.04 METHOD OF MEASUREMENT. The quantity of Aggregate Surface Course to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by the Plan dimensions of the compacted material or as ordered by the Engineer. No allowance will be made for material placed to a depth greater than that shown on the Plans unless ordered by the Engineer.

401.05 BASIS OF PAYMENT. The accepted quantity of Aggregate Surface Course will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to the item Aggregate Surface Course.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
401.10 Aggregate Surface Course	Cubic Meter (Cubic Yard)

SECTION 402 - AGGREGATE SHOULDERS

402.01 DESCRIPTION. This work shall consist of furnishing and placing shoulders of approved aggregate on a prepared surface.

402.02 MATERIALS. Materials shall meet the requirements of the following Subsection:

Aggregate for Surface Course and Shoulders..... 704.12

When specified for use on the project or as directed by the Engineer, Aggregate Shoulders, RAP, shall be grindings from cold planed bituminous concrete pavement crushed or screened by the Contractor such that 100% of the material passes the 37.5 mm (1 1/2 inch) sieve prior to placement.

402.03 PLACING. Shoulder material shall be placed with a machine that has been approved by the Engineer. The Contractor shall demonstrate to the Engineer the proposed placement procedure. If necessary, the procedure shall be adjusted to avoid grooving, marking, or other damage to the final pavement course.

Unless otherwise directed by the Engineer or shown on the Plans, the aggregate shall be placed in one course and shall not be placed until the adjacent wearing surface has been completed.

Should segregation occur, the Contractor shall remove and replace the segregated material or manipulate it until uniform gradation is obtained.

402.04 COMPACTION. The shoulder material shall be rolled with an approved roller after shaping, with a mass (weight) not less than 7 metric tons (8 tons), until thoroughly compacted. Water shall be applied to the material as necessary to obtain proper compaction. Should irregularities in the shoulder material develop during or after rolling, they shall be corrected.

Compaction around mailbox turnouts, driveways, and other obstacles shall be accomplished with equipment designed for that purpose and approved by the Engineer.

The maximum layer thickness for placement of any aggregate shoulder material shall be 150 ± 50 mm (6 ± 2 inches) after compaction. All layers shall be placed and compacted at approximately equal thickness. In the placement of layers, all joints shall be staggered at least 300 mm (12 inches).

After each layer of surface or shoulder material is placed, it shall be thoroughly compacted to a uniform density of not less than 95 percent of the maximum dry density determined by AASHTO T 99, Method C. Suitable and effective equipment, meeting the approval of the Engineer, shall be used to obtain a true and even surface during compaction. All holes or depressions found during the compacting shall be filled with additional material, reworked, and compacted as shown on the Plans. If required, water shall be uniformly applied over the aggregate material during compaction in an amount necessary to produce proper consolidation.

402.05 METHOD OF MEASUREMENT. The quantity of Aggregate Shoulders, In Place to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by the Plan dimensions of the compacted material or as ordered by the Engineer. No allowance will be made for material placed to a depth greater than that shown on the Plans unless ordered by the Engineer.

The quantity of Aggregate Shoulders, Truck Measurement to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by vehicle loads using three dimensional measurements. All vehicles shall be loaded to at least their water level capacity and any loads designated shall be leveled at the point of delivery when directed by the Engineer. A printed load ticket, which indicates truck identification and date and time of delivery, shall be furnished to the Engineer with each load delivered to the job site.

Truck measurement, when not specified in the Contract, may be used when ordered by the Engineer. Truck measurement will be converted to in-place measurement by dividing by 1.15.

When specified to be paid by mass (weight), the quantity of Aggregate Shoulders to be measured for payment will be the number of metric tons (tons) used in the complete and accepted work, as determined from the load tickets.

402.06 BASIS OF PAYMENT. The accepted quantity of Aggregate Shoulders will be paid for at the Contract unit price per cubic meter (cubic yard) or metric ton (ton). Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to the Aggregate Shoulders item in the Contract.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
402.10 Aggregate Shoulders, In Place	Cubic Meter (Cubic Yard)
402.11 Aggregate Shoulders, Truck Measurement	Cubic Meter (Cubic Yard)
402.12 Aggregate Shoulders	Metric Ton (Ton)
402.13 Aggregate Shoulders, RAP	Metric Ton (Ton)

SECTION 404 - SURFACE TREATMENT MATERIALS

404.01 DESCRIPTION. This work shall consist of furnishing and applying bituminous treatment when required on an approved surface.

404.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Bituminous Material.....	702.01
Emulsified Asphalt.....	702.04
Tar Emulsion.....	702.05
Application Temperatures	702.06

All additives for emulsified asphalts must be approved prior to their use.

404.03 WEATHER LIMITATIONS. Bituminous material shall be applied only when the following conditions prevail:

- (a) The ambient air temperature is at least 5 °C (40 °F) in the shade, and rising.
- (b) The road surface is sufficiently dry.
- (c) Weather conditions or other conditions are favorable and are expected to remain so for the performance of satisfactory work.

Bituminous material shall not be applied between November 1st and May 1st.

404.04 EQUIPMENT. The equipment used by the Contractor shall include transporting equipment, a bituminous distributor, and equipment for heating bituminous material.

- (a) Distributor. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surfaces up to 4.6 m (15 feet) at the specified rate for the item being placed. Distributor equipment shall include suitable hand spray nozzle and hose, a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

Distributors may be required to apply a 7.3 m (24 foot) wide strip at one time.

The mass (weight) of the loaded distributor shall not exceed the legal load limit.

Each pressure distributor shall be equipped with a squeegee and pouring pot, and labor shall be furnished to use the tools.

Each pressure distributor shall be equipped with a measuring stick.

Traveling or stationary plants or other equipment of proven performance may be used by the Contractor instead of the specified equipment if approved.

- (b) Transporting Equipment. Tanks for motor transport trucks shall be made of either steel or aluminum with a minimum capacity of 5.5 m³ (1500 gallons), insulated, equipped with baffle plates to prevent surging, and equipped with the necessary units in order to heat the bituminous content in accordance with these specifications. Heating of motor transport truck tanks by distributors to bring the material to the proper temperature will not be permitted. The Contractor shall furnish the necessary heating units for the motor transport trucks and the operators for the heating units.

404.05 PREPARATION OF SURFACES. All surfaces to be treated shall be patched, cleaned of loose or objectionable material, and free of irregularities to provide a reasonably smooth and uniform surface.

404.06 APPLICATION OF BITUMINOUS MATERIALS. The application rates of bituminous material shall be as directed by the Engineer.

The application shall not be made on more than 50 percent of the width of the road surface at a time, unless all traffic is detoured, in which case the application may be full width.

- (a) Tar Emulsion. Prior to treating the surface, it shall be wet with water by truck application or other methods approved by the Engineer. Any surplus water shall be removed so there is not any puddling.

The tar emulsion shall be spread in two uniform coats, each coat to be applied at the rate of 0.5 to 0.9 L/m² (0.1 to 0.2 gallons per square yard) as directed by the Engineer. The time lapse between the first and second application shall be left to the discretion of the Engineer but should not exceed 24 hours. Each coat shall be applied either by the use of soft rubber squeegees or by brushes of approved quality. At least 24 hours shall elapse before any other bituminous material is applied.

- (b) Emulsified Asphalt. Emulsified asphalt shall be applied between the temperature ranges specified in Section 702 by pressure distributors or other methods approved by the Engineer.

404.07 TRAFFIC CONTROL. To control traffic during bituminous surface treatment operations, flaggers shall be used in accordance with Section 630.

Signs informing the traveling public that bituminous surface treatment operations are underway shall be erected at each end of the section under construction during the day. The signs shall be designed, worded, and erected in a manner approved by the Engineer. The signs shall be removed at the end of each day's work unless the condition of the road, as determined by the Engineer, requires otherwise.

All traffic shall be kept off the bituminous material until the penetration is complete and the prime or seal coat will not "pick up" under traffic, or until cover material has been placed and lightly rolled.

On projects where it is necessary to maintain traffic, the traffic shall be controlled by using a pilot car traveling at a low speed.

404.08 THIS SUBSECTION RESERVED

404.09 MAINTENANCE. The Contractor shall maintain the treated surfaces until the Contract is completed and the work accepted. Holes or irregularities shall be repaired by filling with material acceptable to the Engineer. All maintenance work will be considered as part of the item and shall be included in the Contract unit price.

404.10 PROTECTION OF STRUCTURES AND TREES. The Contractor shall use care in applying bituminous material and protecting surfaces of adjacent structures and trees from being splattered with the material.

404.11 METHOD OF MEASUREMENT. The quantity of Tar Emulsion to be measured for payment will be the number of liters (gallons) or kilograms [hundredweight (CWT)] used in the complete and accepted work.

The quantity of Emulsified Asphalt to be measured for payment will be the number of kilograms [hundredweight (CWT)] used in the complete and accepted work.

404.12 BASIS OF PAYMENT. The accepted quantities of the specified material will be paid for at the Contract unit price per liter (gallon) or kilogram [hundredweight (CWT)] for the specified material applied. Payment will be full compensation for furnishing, transporting and placing the material and for furnishing all materials, signs, traffic control, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
404.45 Tar Emulsion	Liter (Gallon)
404.46 Tar Emulsion	Kilogram (CWT)
404.65 Emulsified Asphalt	Kilogram (CWT)

SECTION 406 – MARSHALL BITUMINOUS
CONCRETE PAVEMENT

406.01 DESCRIPTION. This work shall consist of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with these specifications and the specific requirements of the type of surface being placed, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

406.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Performance-Graded Asphalt Binder	702.02
Emulsified Asphalt, RS-1	702.04
Aggregate for Marshall Bituminous Concrete Pavement.....	704.10(a)

The grade of Performance-Graded (PG) asphalt binder used to produce bituminous concrete pavement shall be as shown on the Plans.

406.03 COMPOSITION OF MIXTURE.

- (a) Gradation. For each pavement type, the materials shall be combined and graded to meet the limits specified in the following table:

TABLE 406.03A - PERCENTAGE BY MASS PASSING
SQUARE MESH SIEVE

Sieve Size	Type I	Type II	Type III	Type IV	Type V
31.5 mm (1 ¼ inch)	100				
25.0 mm (1 inch)	95 – 100	100			
19.0 mm (¾inch)	74 – 86	95 – 100	100		
12.5 mm (½inch)	60 – 80	64 – 88	95 – 100	100	
9.5 mm (⅜ inch)	---	50 – 82	70 – 90	95 – 100	100
4.75 mm (No. 4)	35 – 60	32 – 62	42 – 75	48 – 78	85 – 100
2.36 mm (No. 8)	25 – 45	22 – 45	28 – 56	28 – 56	66 – 88
1.18 mm (No. 16)	---	13 – 35	14 – 41	14 – 41	45 – 67
600 µm (No. 30)	10 – 25	8 – 27	7 – 31	7 – 31	27 – 53
300 µm (No. 50)	---	3 – 20	3 – 22	3 – 22	13 – 40
75 µm (No. 200)	2 - 6	2 – 6	2 – 6	2 – 6	2 – 7
Total Aggr.	94 – 97	93 – 97	92 – 97	92 – 95	91 – 93
Bitumen (% of Total Mix)	3 - 6	3 - 7	3 - 8	5 – 8	7 – 9

- (b) Design Criteria. The materials shall be combined and graded to meet the following criteria:

TABLE 406.03B - DESIGN CRITERIA

Marshall Test Properties	Medium Duty Bituminous Concrete Pavement – 50 blows/side	Bituminous Concrete Pavement – 75 blows/side
Air Voids %	3.0 – 5.0	3.0 – 5.0
Voids in the Mineral Aggregate (VMA) % Type I	13.0 min.	13.0 min.
VMA % Type II	14.0 min.	14.0 min.
VMA % Type III	15.0 min.	15.0 min.
VMA % Type IV	16.0 min.	16.0 min.
Stability, Newtons (Pounds)	5340 (1200) min.	8010 (1800) min.
Flow, millimeters (0.01 inches)	2.0 – 4.5 (8.0 – 18.0)	2.0 – 4.0 (8.0 – 16.0)
% Stone Screenings (Fine Aggregate Portion) Passing 2.36 mm (No. 8) sieve	60.0 min.	75.0 min.

TABLE 406.03B1 - PG BINDER GRADE SELECTION

RAP CONTENT	BINDER GRADE
≤ 20.0%	PG 58-28
20.0% < to < 25.0%	PG 52-34
25.0% ≤ to ≤ 50.0% ¹	footnote 1

1 - The Contractor shall determine the grade of PG binder necessary so that when combined with the RAP asphalt cement, the composite asphalt material grades at a PG 58-28 as a minimum. The maximum acceptable low end temperature is -28°C (-18°F) and the minimum acceptable high end temperature is 58°C (136°F). The Engineer will sample haul units from the plant and have the material extracted for grading at the Agency's Materials and Research Laboratory in Berlin, VT to verify the binder grade of the mix being supplied. The Contractor's Quality Control Plan shall specify a grading frequency and include an action plan for when test results verify that the grade of PG binder is less than a PG 58-28.

- (1) Air Voids (Va). The percent of air voids of the mixture shall be calculated by the following formula:

$$Va = 100 X ((Gmm - Gmb)/Gmm)$$

where:

Gmm = Maximum specific gravity of uncompact mixture (AASHTO T 209)

Gmb = Bulk specific gravity of compacted mixture (AASHTO T 166, Method A)

Unless otherwise noted on the Plans, all bituminous concrete pavement shall be designed in conformance with the design criteria for Bituminous Concrete Pavement.

Unless otherwise specified for highways, Type I shall be used for base course, Types I or II shall be used for binder course, and Types II, III, or IV shall be used for wearing course. Unless otherwise specified for bridges, Type IV shall be used for binder course.

Type V mix will be designed to meet the gradation criteria of Subsection 406.03(a) only.

The mix design shall have a filler/asphalt ratio ranging between 0.50 and 0.90.

- (c) Mix Design. The Marshall Method of Mix Design will be used to develop a mix that will meet the specified Design Criteria. A copy of all test data, used in developing the mix design, including graphs, may be required with the submittal of the mix design.

The job-mix formula for each mixture shall establish a single percentage of aggregate passing each sieve and a single percentage of bituminous material to be added to the aggregate. No change in the job-mix formula may be made without the written approval of the Materials and Research Engineer. The job-mix formula must fall within the master range of the specification as shown in Subsection 406.03(a).

No work shall be started until the Contractor has submitted and the Materials and Research Engineer has approved a mix design including cold feed and hot bin gradations, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required in the Marshall Method of Mix Design. For mix designs containing RAP, the dry and wet mixing times shall be adjusted to assure moisture from the RAP is completely dissipated prior to adding the liquid PG binder.

The Materials and Research Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement, finishing, or compaction characteristics are determined by the Engineer to be unsatisfactory.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of 10 working days shall be allowed for testing and evaluation of the submitted mix design. Once a mix design is approved, the job-mix formula is valid until a change is made in aggregate source, PG asphalt binder grade, or asphalt source.

- (d) Control of Mixtures. The plant shall be operated so that no intentional deviations are made from the job-mix formula. The gradation of the actual mixture shall not vary from the job-mix formula by more than the following tolerances:

TABLE 406.03C – PRODUCTION TESTING TOLERANCES

Aggregate larger than 2.36 mm (No. 8) sieve	±	6.0 %
Aggregate passing the 2.36 mm (No. 8) sieve and larger than the 75 µm (No. 200) sieve	±	4.0 %
Aggregate passing 75 µm (No. 200) sieve	±	1.0 %
Temperature of Mixture	±	11°C (20°F)
Air Voids	=	4.0± 1.0%

The quantity of PG asphalt binder introduced into the mixer shall be that quantity specified as a percentage in the accepted job-mix formula and for batch plants will be accepted on the basis of the mass (weight) on the printed weight slip. For the use of drum-mix plants, the quantity of PG asphalt binder shall be specified as a percentage in the accepted job-mix formula and will be accepted on the basis of the percentage printed on the demand ticket from the approved automatic digital recording device in the plant.

For those projects having 2000 metric tons (tons) or less of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

If an analyzed sample is outside of the testing tolerances and/or other design criteria, immediate adjustments shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with these Specifications. With the permission of the Engineer, the plant may continue production pending results of these tests, but if the Engineer deems that it is in the best interest of the project, the Engineer may at any time order plant production stopped. In this event, additional adjustments shall be made and tested on a trial basis until the deficiency is corrected.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance sampling and testing will be conducted by Agency personnel in accordance with the Agency's Quality Assurance Program as approved by FHWA.

For those projects having more than 2000 metric tons (tons) of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

The Contractor shall operate in accordance with an approved Quality Control (QC) Plan, hereinafter referred to as the "QC Plan", sufficient to assure a product meeting the Contract requirements. The QC Plan shall meet the requirements of Subsection 106.03. An example "outline" is available through the Agency Materials and Research Laboratory's Bituminous Concrete Section.

The QC Plan shall address all elements that affect the quality of the Plant Mix, including but not limited to the following:

- a. Job-Mix formula(s)
- b. Bituminous concrete mix Plan details
- c. Stockpile management
- d. Name of Plan Administrator
- e. Name of Process Control Technician(s)
- f. Mixing
- g. Frequency and tests for Quality Control
- h. For mix designs containing ≥ 25.0 percent RAP, indicate the following: RAP percentage, PG Grade of virgin binder determined, testing frequency of mix to verify composite PG Grade, and actions to be taken when test results are outside of PG Grade limits.

The QC Plan shall incorporate the following personnel with the specified minimum requirements and qualifications:

- a. Plan Administrator. This individual shall be a Quality Assurance Technologist certified by the New England Transportation Technician Certification Program (NETTCP).
- b. Process Control Technician (PCT). This individual shall be certified as a "Hot Mix Asphalt (HMA)" Plant Technician by NETTCP. The PCT may have an interim certification from NETTCP as an HMA Plant Technician. Alternatively, the PCT may be a trainee performing duties under the direct supervision of a NETTCP certified technician, as specified in the VAOT approved QC Plan. In this case the Plan should address the following:
 1. A training period shall continue for a minimum of 30 working days, at which point the supervising certified technician shall sign off on the trainee.
 2. Upon completion of the training period and having been validated (signed off), the trainee will be qualified to work on QA projects without direct supervision for the remainder of the current construction season.

The PCT shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the job-mix formula(s). The PCT shall periodically inspect all equipment used in mixing to assure it is operating properly and that mixing conforms to the mix design(s) and other Contract requirements.

The QC Plan shall specify how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The QC Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

The QC Plan shall detail the coordination of the activities of the Plan Administrator and the PCT. The Plan Administrator shall be available to respond to the Engineer within one hour of a request.

Bituminous concrete pavement shall be sampled, tested, and evaluated by the Contractor for each mix type (each mix design) for each project on a continuous production basis in accordance with the following minimum quality control guidelines:

TABLE 406.03D - MINIMUM QUALITY CONTROL GUIDELINES

Test Action	Frequency	Test Method
Temperature of Mix	1 per 250 metric ton (ton) at plant (truck)	Verified Thermometer
Air Voids	1 per 500 metric ton (ton)	AASHTO T 269 (T 166, T 209)
Cold Feed Gradation ⁽¹⁾	1 per day	AASHTO T 27
PG Asphalt Binder content	1 per 500 metric ton (ton)	Batch Slip
Extracted Gradations	1 per 500 metric ton (ton)	AASHTO T 30 AASHTO T 164 AASHTO T 308
Fine Aggregate, Coarse Aggregate, and Recycled Asphalt Pavement (RAP) Moisture Content ⁽²⁾	2 times daily minimum ⁽³⁾	AASHTO T 255
Fine Aggregate, Coarse Aggregate, and RAP Specific Gravities	Day of initial paving and 1 per week ⁽⁴⁾⁽⁵⁾⁽⁶⁾	AASHTO T 84 AASHTO T 85
RAP PG Asphalt Binder content	1 per day	AASHTO T 164 AASHTO T 308
Determine composite PG binder grade ⁽⁷⁾	1 per 5000 metric ton (ton)	AASHTO R 29

1 - Include percent "fractured faces" and "thin and elongated" of particles retained on the No. 4 (4.75 mm) sieve and above.

2 - This requirement is for drum-mix plants only.

3 - Evenly spaced intervals throughout the day and when new material is being added to the stockpiles and utilized in the mix.

4 - Or 1 per every 5000 metric tons (tons), whichever is greater.

5 - Current (within the previous 2 to 10 days) specific gravities will need to be supplied prior to beginning paving operations.

6 - New specific gravities will be required when either absorbed asphalt is determined to be a negative or at the request of the Materials and Research Engineer.

7 - For mix containing > 25.0 percent RAP.

Upon approval of the Materials and Research Engineer, the Contractor may utilize innovative equipment or techniques not included in the specifications to produce or monitor the production of the mix.

(e) Quality Acceptance.

- (1) General. Bituminous concrete mixtures designated under these specifications will be sampled once per subplot on a statistically random basis, tested, and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following acceptance guidelines:

TABLE 406.03E - ACCEPTANCE GUIDELINES

PROPERTIES	POINT OF SAMPLING	LOT SIZE	SUBLOT SIZE	TEST METHOD
Air Voids	Truck at Plant	3000 Metric Ton (Ton)	500 Metric Ton (Ton)	AASHTO T 269 (T 166, T 209)

1 - Reference Subsection 106.03.

2 - Varies based on projected lot size.

- (2) Lot Size. For the purpose of evaluating acceptance test properties, the representative tonnage of bituminous material within each lot shall be 3000 tons. The final resultant partial lot shall be processed as a full lot if it consists of four or more acceptance samples. If the final resultant partial lot consists of less than four acceptance samples, it will be combined with the previous lot.
- (3) Sublot Size. A subplot shall be 500 tons with the exception of the final subplot of a partial lot, which will consist of the quantity of material required to complete the partial lot.

- (4) Pay Factor (PF) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Level (RQL) of 50%, the PF for each lot of bituminous concrete mixture, based on “air voids” test results, will be determined using the following equation:

$$PF(av) = ((0.28PWL + 75) / 100) - 1.0$$

- (5) Rejectable Material.

- a. Rejection by Contractor. The Contractor may at any time elect to remove any defective material and replace it with new material at no expense to the Agency. Any such new material will be sampled, tested, and evaluated for acceptance.
- b. For those lots with a PWL less than 50% and greater than or equal to 25%, the PF for each lot of bituminous concrete mixture, based on “air voids” test results, will be determined using the following equation:

$$PF(av) = ((2.16PWL - 29)/100) - 1.0$$

For those lots with a PWL less than 25%, the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency.

- (f) Boxed Samples. If daily testing and inspection functions are required to comply with provisions of the Agency’s Quality Assurance Program and plant inspectors are not available to perform these tasks, then box samples will be taken by the Engineer at the project site to afford verification of mixture volumetrics/properties. Boxed samples will be processed at the Agency Central Laboratory in Berlin, Vermont and results reported to the.
- (g) Certification. For projects that are designated as Level 3 in accordance with the Agency’s Quality Assurance Program, a Type D Certification shall be furnished in accordance with Subsection 700.02 for each day’s production of material for non-mainline paving.

406.04 WEATHER AND SEASONAL LIMITATIONS. The bituminous material shall not be placed when the ambient air temperature and temperature at the paving site in the shade and away from artificial heat is below 5°C (40°F) for courses 35 mm (1 ¼ inches) or greater in compacted thickness or below 10°C (50°F) for courses less than 35 mm (1 ¼ inches) in compacted thickness.

Bituminous material shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

Bituminous material shall not be applied between November 1st and May 1st. Bituminous wearing course materials shall not be applied before May 15th or after October 15th.

When it is in the public interest, the Construction Engineer may adjust the ambient air temperature requirements, pavement temperature requirements, or extend the dates of the paving season.

406.05 BITUMINOUS MIXING PLANT AND TESTING. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold storage bins. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

All existing plants shall be inspected and obtain approval each construction season by an authorized representative of the Agency. Written notification shall be given for any plant which has not been inspected so that an authorized representative of the Agency may inspect said plant prior to any mixing operation for Agency projects. A minimum of ten business days shall be allowed for the scheduling of the inspections. The plant shall be in operation at the time of inspection.

Plants used for the preparation of bituminous mixtures shall conform to all requirements specified in part (a) below, except that scale requirements shall apply only where mass (weight) proportioning is used. In addition, batch mixing plants shall conform to the requirements specified in part (b) below, continuous mixing plants shall conform to the requirements specified in part (c) below, and drum-mix plants shall conform to the requirements specified in part (d) below.

Scales for the weighing of materials shall conform to the restrictions specified herein and shall meet all specifications, tolerances, and regulations which have been or may be adopted periodically by the Director of Standards of the Vermont Department of Agriculture, and shall be subject to approval by the Materials and Research Engineer. The scales shall be checked and sealed as deemed necessary to assure accuracy.

Producers located outside Vermont shall observe all annual hopper scale mass, measurement, and seal requirements of their respective State or location.

- (a) Requirements for All Plants. The Contractor shall give the Materials and Research Engineer a two working day notice of intent to produce bituminous mixture so that arrangements can be made for plant inspection and control.

The plants shall be so designed, coordinated, and operated as to produce a uniform mixture within the mix design approved for the project.

The Contractor shall indemnify and hold the State harmless for any hazardous waste generated from plant operations in producing materials for use in Agency Contracts. The Contractor shall be responsible for properly disposing of such waste at no additional cost to the State.

All plants shall have automatic controls which coordinate the proportioning, timing, and discharge of mixture by the operation of a single switch or button. In addition to these controls, the plant shall have an approved recording system.

The recording system shall be capable of printing the total net mass (weight) of the load. Each weigh slip shall be automatically printed with the date and time of batching, shall show project and truck identification, and shall indicate the approved mix design number being produced.

All originals of recorded data pertaining to the weighing or proportioning of bituminous concrete, after recording, shall become the property of the Agency.

- (1) Truck Scales. Approved truck scales shall be provided at each plant. The scale platform shall be of such length and width that it will conveniently accommodate

all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft.

These scales may be used for spot checking the accuracy of the recording equipment. Any variance exceeding 0.5% of the net mass (weight) shall result in immediate corrective action by the Contractor.

A weatherproof building of sufficient size to house the scale operator and the Inspector shall be provided. It shall have adequate lighting, both natural and artificial, and it shall be adequately and safely heated.

If the Contractor's printer breaks down, the Contractor may continue to operate for the remainder of that day, provided the following conditions are met:

- a. The Engineer grants permission to operate and
- b. The Materials and Research Engineer assigns an Inspector to record the total aggregate and asphalt mass (weight) for each batch on the appropriate ticket.

- (2) Equipment for Preparation of Bituminous Material. Tanks for storage of bituminous material shall be insulated and capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications. The heating system shall provide uniform heating of the entire contents of the tanks.

Heating shall be accomplished by steam or oil coils, electricity, or other means so that no flame shall come in contact with the heating tank.

A circulating system for bituminous material shall be of adequate capacity to provide proper and continuous circulation between storage tank and the proportioning units during the entire operating period.

The discharge end of the circulating pipe shall be maintained below the surface of the bituminous

material in the storage tank to prevent the discharging of hot bituminous material into the open air.

All pipe lines and fittings shall be steam or oil jacketed or otherwise properly insulated to prevent heat loss.

- (3) Feeder for Dryer. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregate into the dryer so that uniform production and uniform temperatures will be obtained.
- (4) Dryer. The dryer shall be capable of heating and drying the mineral aggregates to specification requirements without leaving any visible unburned oil or carbon residue on the aggregate when it is discharged from the dryer. Black smoke from the exhaust stack shall not be permitted. Drying shall continue until all moisture is removed. If unusually wet aggregate is being used, the input to the dryer shall be reduced to an amount which the dryer is capable of drying.
- (5) Screens. Plant screens shall have the capacity and size range to separate the aggregates into sizes for proportioning so that they may be recombined within the limits of the specifications. The screen over the "fines bin" shall have a maximum square opening of 5.0 mm (3/16 inch).

Slotted screens may be used when approved by the Materials and Research Engineer. Screens are not applicable to drum-mix plants.

- (6) Cold Storage Bins. The plant shall have cold bin storage of sufficient capacity to ensure a uniform and continuous operation.

The bins shall be so constructed as to prevent any intermingling of aggregates from one bin to another. The use of loaders or trucks which are larger in width than the bins being charged shall not be allowed. The blending of two or more aggregates in the same bin shall not be permitted.

For all bituminous concrete supplied for use on Agency projects, uniform feeding of all fine aggregates shall be accomplished by the use of a variable speed continuous belt feeder on each cold storage bin of fine aggregate.

- (7) Hot Bins. The plant shall include hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The hot storage shall consist of at least four bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

When more than 15% of the material is undersized for that bin, based on the sieve analysis of hot bins used in determining the job-mix formula, all bins shall be emptied and the cause for such condition shall be corrected.

Each bin shall be provided with a free-flowing overflow pipe of such size and at such a location as to prevent backing up of material into other bins or into contact with the screen. This overflow material shall not be fed back into the system or into any accepted stockpiles.

All bins shall be equipped with a sensor device to indicate the position of the aggregate in the bins at the lower quarter point. An automatic plant shutoff device shall operate to interrupt the batching process when any aggregate bin becomes empty.

Adequate additional dry storage shall be provided when mineral filler is required. The system shall have a device to feed the mineral filler accurately and uniformly at adjustable rates consistent with the percent required. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

Adequate and convenient facilities shall be provided to obtain representative aggregate samples from each bin.

Hot bins are not applicable to drum-mix plants.

- (8) Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Metering devices for bitumen shall be accurate to within plus or minus two percent of the amount of bitumen delivered when tested for accuracy.

The section of the bitumen flow line between the charging valve and the spray bar shall be provided with a three-way valve and outlet whereby the rate of delivery of the metering device may be checked by actual mass.

Suitable means shall be provided, either by steam, oil-jacketing, or other insulation, for maintaining the specified temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

- (9) Thermometric Equipment. An armored thermometer shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit ~~to~~ for accurately indicating the temperature of the bitumen.

The plant shall also be equipped with an approved recording thermometer, pyrometers, or other approved recording thermometric instruments placed at the discharge chute of the dryer.

The Materials and Research Engineer may reject questionable thermometric instruments, may direct replacement of any instrument with an approved temperature recording apparatus, and may further require that daily temperature charts be filed with the Materials and Research Engineer.

- (10) Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time, unless otherwise approved by the Materials and Research Engineer.

- (11) Dust Collectors. The plant shall be equipped with adequate dust collectors so that exhaust will not be dispersed into the atmosphere. Provisions shall be made to waste or uniformly reintroduce all or any part of the heavier dust particles from primary collectors into the flow of aggregate.

The introduction of baghouse fines into bituminous concrete mixes will be allowed when the fines are introduced by an approved metering or weighing system which uniformly introduces the fines.

The Materials and Research Engineer has the authority to withdraw the approval for use of baghouse fines at any time that the bituminous concrete pavement mix provided by the Contractor is unsatisfactory as determined by the Materials and Research Engineer.

- (12) Testing Facilities. The Contractor shall provide a weatherproof building, with at least 22 square meters (240 square feet) of floor space, in which to house and use the testing equipment. This building shall be maintained for the use of the Agency Engineers or Inspectors, and shall be located so that details of the Contractor's plant are plainly visibly from at least one window of the building. Adequate lighting, heating, and electrical connections shall be provided 24 hours per day. Proper means for ventilation shall be provided.

The method of heating shall be such that a minimum temperature of 21°C (70°F) will be maintained at all times. Sanitary toilet facilities with lavatory, with proper sewage disposal, shall be furnished for the use of Agency personnel. Cleaning supplies shall be furnished by the Contractor. A private telephone service, dedicated for the use of Agency personnel, shall be provided in the laboratory. An internet connection that provides a minimum speed of 700 Kbps (Kilobits Per Second) download, without utilizing compression algorithms, shall be provided in the laboratory and dedicated for the use of Agency personnel. The connection bandwidth speed shall be verifiable using an online speed test.

The Contractor must have its office space separate from the office space used by Agency personnel. The Contractor's office space shall be located to afford privacy to Agency personnel.

A trailer type mobile laboratory may be used only in conjunction with a temporary plant. Any plant that occupies or has occupied the same location for more than one year will be classified as a permanent plant and will require a permanent building for a laboratory.

The facility shall be equipped with the following standard commercial quality equipment. Substitutes may be provided upon approval of the Materials and Research Engineer.

- One - Air conditioner for the capacity of the building capable of maintaining a maximum temperature below 25°C (77°F).
- Two - Two kilogram (5 pound) minimum capacity fire extinguishers, either ABC Dry Chemical or Carbon Dioxide, of standard commercial quality.
- One - Standard office desk with drawers, locks, and keys, 1200 mm x 750 mm (4 feet x 2 ½ feet) (minimum dimensions).
- One - Adjustable office chair.
- Two - Adjustable drafting stools.
- One - Electric calculator, four function, ten column, with memory.
- Two - Bench sections and storage compartments. The benches shall be approximately 900 mm (36 inches) high, 600 mm (24 inches) wide and three meters (10 feet) long.
- One/Two - Approved exhaust fan(s) and hood(s) shall be provided over the stoves and extractors. The exhaust fan(s) shall be high volume axial flow, at least 300 mm (12 inches) in diameter.
- One - Water cooler with supply of potable water.
- One - Sink with faucet within the office, with a continuous supply of pressurized clean water for the duration of the project. The sink shall drain to the outside of the office.

The facility shall be equipped with the following test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

- One - Marshall Test Set Reference AASHTO T 245 including:
 - One – Automatic Bituminous Compactor.
 - Two – Compaction molds with base plates.
 - One – Stability mold.
 - One – Flow meter.
 - One – Motorized compression and testing machine.
 - One – Water bath capable of maintaining a temperature of $60^{\circ} \pm 1^{\circ}\text{C}$ ($140^{\circ} \pm 2^{\circ}\text{F}$).
 - One – Motorized 3000 g (6.6 pound) centrifuge extractor with two small bowls with covers and two large bowls with covers, and/or an ignition oven that conforms to the apparatus requirements of AASHTO T 308 “Standard Method of Test Method for Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method” with the following related equipment: two full sets of sample basket(s), two catch pans, and one set of safety equipment as defined in AASHTO T 308.
 - One - Full set of 200 mm (8 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.
 - One- Full set of 300 mm (12 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.
 - One - Electronic balance, 6000 g (13.2 pound) minimum capacity.
 - One - Motorized sieve shaker with either rocking and tapping action or circular and tapping action capable of holding at least six sieves and one pan.
 - One - Mechanical aggregate shaker with a 0.028 m³ (1.0 ft³) capacity plus necessary screens. This may be placed in a separate enclosure outside of the trailer.

- One - Platform beam scale sensitive to 5.0 g (0.01 pound) with a minimum capacity of 45 kg (100 pounds).
- One - Sample splitter, 63.5 mm (2½ inch) chute.
- Two - Square pointed shovels; one long handled, one short handled.
- Two - Double burner hot plates, variable temperature.
- Twelve - Tin pans, 267 mm x 267 mm x 25 mm (10½ inches x 10½ inches x 1 inch).
- One - 0.028 m³ (1.0 ft³) minimum capacity electric oven.
- One - Flat triangular trowel.
- One - Brass wire bristle brush.
- One - Standard floor brush.
- One - Standard table brush.

Filter papers for duration of project.

- Two - 40 mm (1½ inch) soft bristle paint brushes.
- One - Automatic timer (interval 0-30 minutes).
- One - Sample Splitter (riffles) chute width 25 mm (1 inch).
- Two - Flexible spatulas with 150 mm (6 inch) long blade.
- One - 10 L (10 quart) pail.
- Two - Pair lined, heat resistant gloves.
- Two - Hand scoops (size #1).
- Two - Metal thermometers, 10 to 260°C (50 to 500°F), approximately 200 mm (8 inches) long with a 45 mm (1¾ inch) head.
- Two - Laboratory thermometers, capable of reading at least 60°C in 1°C (140°F in 2°F) increments.
- One - Cold chisel, approximately 40 mm (1½ inches) wide.
- Two - Volumetric flasks having a capacity of at least 2000 mL (68 ounces); for use with the flask, a rubber stopper, and a connection, either molded in the flask or attached to the rubber stopper.
- Two - Volumetric flasks having a capacity of at least 4000 mL (135 ounces); for use with the flask, a rubber stopper and a connection, either molded in the flask or attached to the rubber stopper.

- One - Vacuum pump or water aspirator for evacuating air from the container. Vacuum system must be capable of removing entrapped air by subjecting the contents to a partial vacuum and maintaining a residual pressure of 3.7 ± 0.3 kPa (1.1 ± 0.1 inches Hg) for 15 ± 2 minutes. The vacuum system shall be equipped with a residual pressure manometer which reads in kilopascals (inches Hg), and a pressure release valve.
 - One - Plastic funnel to introduce mix into volumetric flask.
 - One - Syringe to adjust water level in flask.
- Xylol for use as an asphalt solvent shall be furnished by the Contractor for the duration of the project.

For drum-mix plants, the facility shall be equipped with the following additional test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

- One - Microwave oven with a minimum interior volume of 0.028 m³ (1.0 ft³) with defrost as well as normal mode of operation.
- Six - Ovenproof glass dishes approximately 300 mm x 300 mm x 40 mm (12 inches x 12 inches x 1½ inches).

All of the foregoing testing equipment shall be in good condition, calibrated and/or verified according to the Contractor's QC Plan schedule and/or the Agency provided schedule as applicable, and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The above mentioned equipment is for a one plant operation only. In the event the Contractor chooses to use more than one plant, the Contractor shall provide adequate laboratory facilities as deemed necessary by the Materials and Research Engineer for making tests.

- (13) Safety Requirements. Adequate and safe stairways to the mixer platform shall be provided, and guarded ladders to other plant units shall be located where required for accessibility to plant operations.

All heated pipe lines adjacent to work areas, gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space. This space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. Adequate overhead protection shall be provided where necessary.

- (14) Surge or Storage Bins. Surge or storage bins will be permitted for use in the production of bituminous items provided they are approved and inspected by the Materials and Research Engineer. A surge or storage bin shall be capable of storing the mix without any degradation of its properties. The surge or storage bins shall be covered during inclement weather to protect the stored mix from the elements. Should circumstances preclude paving operations, the Agency will not be obligated to purchase mix remaining in a surge or storage bin.

For continuous mixing and drum-mix plants, an approved recording weigh system shall be used on all surge bins.

When a surge bin is used in conjunction with a batch plant, the determination of pay quantities for the applicable Contract item shall be in accordance with the following procedure:

- a. The plant will produce mix with the printer operating according to the standard requirements for this device. The mix will be deposited in the surge bin. A sequentially numbered ticket will be prepared for every normal load produced.

- b. As each truck is loaded from the surge bin, the driver will be given the ticket previously prepared when the mix was produced for that bin. The truck driver will then deliver the ticket to the paving Inspector upon reaching the paving site.
- c. The mass (weight) shown on the ticket will not be the actual mass (weight) of the mix contained in the truck since the truck was loaded from the surge bin. The bin shall be completely emptied at the end of every day, circumstances permitting, and all tickets delivered to the paving Inspector.
- d. Any rejected or held over material shall be weighed on the platform truck scales. This quantity shall be deducted from the daily totals.
- e. When paving ramps or other areas where a definite quantity is desired, the material required will be weighed on the platform scales and appropriate adjustments made in the daily totals obtained from the printer. These masses (weights) will be entered on the ticket or a separate ticket provided.
- f. The plant Inspector will sign the first ticket of each day instead of initialing it. If the Inspector changes during the day, this procedure will be followed for each change. At the end of each day, the plant Inspector will inspect the storage bin to determine that it is empty and so note on the last ticket.
- g. The paving Inspector will acknowledge receipt of the material at the paving site by initialing the lower right-hand corner of each ticket.
- h. All standard checks of the weighing apparatus at the plant will be made at the prescribed intervals.

- i. All mix produced for commercial customers and/or other projects must be discharged from bins other than those used for this project or directly from the pugmill into the haul vehicle; such mix shall not be loaded from the bin used for this project.
- j. All surge bins shall be emptied each day unless written permission is obtained from the Materials and Research Engineer.

(b) Requirements for Batching Plants.

- (1) Weigh Box or Hopper. The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales of ample size to hold a full batch without hand raking or running over.

The weigh box or hopper shall be supported on fulcrums and knife edges constructed so that they will not be easily thrown out of alignment or adjustment.

All edges, ends, and sides of weighing hoppers shall be free from contact with any supporting rods or columns or other equipment that will in any way affect proper functioning of the hopper. Also, there shall be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials.

The discharge gate of the weigh box shall be hung so that the aggregate will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing for the next batch.

- (2) Aggregate Scales. Scales for any weigh box or hopper shall be springless dial or load cell with digital readout and shall be of standard make and design sensitive to 0.1% of the maximum load that may be required. Dials shall be free of vibration and shall be located to be plainly visible and readable to the operator at all times.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of ten 20 kg (50 pound) test masses (weights) or by other methods approved by the Materials and Research Engineer. All test masses (weights) shall be certified annually by the Division of Weights and Measures.

- (3) Bitumen Bucket. The bucket for weighing bitumen shall be of sufficient capacity to hold and weigh the amount required for a batch in a single weighing.

The filling system and bucket shall be designed, sized, and shaped so that bitumen will not overflow, splash, or spill outside the confines of the bucket during filling and weighing.

The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units. It shall be able to deliver the bitumen in a thin uniform sheet or in multiple sprays over the full length of the mixer within a period of 15 consecutive seconds.

- (4) Bitumen Scales. Bituminous material shall be weighed on scales that conform to the specifications for the weighing of aggregate. The value of the minimum graduation shall not exceed 1.0 kg (2.0 pounds).

- (5) Mixer Unit for Batch Method. The plant shall include an approved, twin pugmill type batch mixer, jacketed or insulated and capable of producing a uniform mixture within the applicable job-mix tolerance. The mixer shall be so constructed as to prevent leakage and designed to provide a means of adjusting clearance between the mixer blades and liner plates.

- (6) Recording. The recording system of the batch plant shall print the mass (weight) of the bitumen, the mass (weight) of the aggregate, and the total combined mass (weight) of both in addition to printing the combined net mass (weight) of each load.

(c) Requirements for Continuous Mixing Plants.

- (1) Aggregate Proportioning. The plant shall be able to accurately proportion aggregate from each bin by mass (weight). The unit shall include interlocked feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to control the rate of flow of aggregate from each bin compartment. The opening shall be rectangular with one dimension adjustable by positive mechanical means. Locks shall be provided on each gate. Calibrated gauges with minimum graduations not exceeding 2.5 mm (0.1 inch) shall be provided for each gate to establish gate openings.
- (2) Calibration of Aggregate Feed. The plant shall include a method to calibrate gate openings by means of test samples. The materials fed out of the bins through separate openings shall be bypassed to a suitable test box with the material for each compartment being confined in a separate box section. The plant shall be able to conveniently handle test samples with a mass (weight) of up to 365 kg (800 pounds) and to weigh them on accurate scales.
- (3) Synchronization of Aggregate Feed and Bituminous Feed. Satisfactory interlocking control of the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source shall be provided. This control shall be accomplished by interlocking mechanical means or by another method under the Materials and Research Engineer's control and approved by the Materials and Research Engineer.
- (4) Mixer. The plant shall include an approved twin, pugmill type continuous mixer, insulated or jacketed, and capable of producing a uniform mixture within the applicable job-mix tolerance. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix.

The mixer shall carry a manufacturer's plate indicating the net volumetric contents at several heights on a permanent gauge. The plate shall also indicate the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by the following formula:

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in kilograms (pounds)}}{\text{Pugmill output in kilograms (pounds) per second}}$$

Pugmill output in kilograms (pounds) per second

The masses (weights) shall be determined by tests made under the direction of the Materials and Research Engineer.

(d) Requirements for Drum-Mix Plants.

- (1) Aggregate Cold Bin Feeders. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. The feeding orifice shall be adjustable. Gravity type feeders will not be permitted. Indicators graduated to not more than 2.5 mm (0.1 inch) shall be provided on each orifice. Each aggregate feeder shall be interlocked so that production is interrupted if one or more cold bins become empty or the flow is obstructed.

- (2) Mineral Filler System. When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall be able to feed the mineral filler at adjustable rates accurately and uniformly.

The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed. The filler shall be fed so that no filler is lost as fugitive dust.

- (3) Aggregate Weighing Equipment. All aggregates, including mineral filler, shall be weighed by a continuous weighing device, either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of the National Bureau of Standards Handbook 44 and shall be installed according to the scale manufacturer's recommendations by a technician licensed by the Division of Weights and Measures. Any other type of weighing device shall be approved by the Materials and Research Engineer prior to use.

- (4) Bitumen Control Unit. The bitumen shall be proportioned by a meter. A flow switch that will interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to 16°C (60°F).
- (5) Proportioning Controls. All proportioning controls for aggregates, mineral filler, and bitumen shall be located at the panel which controls the mixer and temperature. The panel shall have a master control capable of increasing or decreasing the production rate without having to reset the individual controls.
- a. Aggregate Feed Rate Control. The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The control shall maintain an aggregate flow accuracy such that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total mass (weight) of bituminous mixture per interval of time. When separate addition of mineral filler is required, it shall be added with an accuracy of 0.5% on the basis stated above for aggregates. The rate of aggregate flow shall be displayed on a meter and it shall be based on mass (weight) or percentage of dry aggregates.
- b. Aggregate Mass (Weight) Indicator. The plant shall have an aggregate mass (weight) indicator which will display in the control room the mass of combined aggregates and mineral filler; it shall continuously accumulate the dry aggregate mass (weight) of material during the production period, generally one day. The indicator shall be resettable to zero and lockable.

- c. Aggregate Moisture Compensator. The plant shall have a moisture compensation device capable of electronically changing the wet mass (weight) of aggregate to dry aggregate mass (weight). The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1%.
 - d. Bitumen Control. The plant shall have a bitumen control capable of presetting the actual bitumen content directly as a percentage based on total mass (weight) of mixture. The maximum gradation on the bitumen control shall be 0.1%. The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.
 - e. Bitumen Quantity Indicator. The plant shall have a bitumen quantity indicator in the control room indicating the accumulated quantity of bitumen during the production period, generally one day. The quantity indicated may be either mass (weight) or volume at 16°C (60°F). The indicator shall be resettable to zero and lockable.
- (6) Recording of Proportions. The plant shall be equipped with an automatic digital recording device approved by the Materials and Research Engineer that simultaneously records the accumulated mass (weight) of both dry aggregate and bitumen separately during production time and on demand. All recordings shall show the date, including day, month and year, and time to the nearest minute for each print. The original recordings shall become the property of the Agency.

- (7) Calibration of Feed Rates. The feed rates of aggregates from the cold bins, mineral filler when used and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous weighing device and the bitumen through the meter, respectively. The feed rates shall be checked periodically or at the direction of the Materials and Research Engineer.
- (8) Automatic Aggregate Sampling Device. The plant shall have an automatic aggregate sampling device which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing.

The sampling tray shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to it mixing with bitumen.

- (9) Mixer Unit. The plant shall have a drum mixer, approved by the Materials and Research Engineer, having an automatic burner control and capable of producing a uniform mixture within the job-mix tolerances. The mixture shall be discharged into a hot bituminous surge or storage bin meeting the requirements of this Section.

406.06 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be uniformly heated to the specified temperature. A continuous supply of the bituminous material shall be provided to the mixer at a uniform temperature at all times.

406.07 PREPARATION OF AGGREGATES. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid depositing soot or unburned fuel on the aggregate.

Immediately after heating, the aggregates shall be screened and conveyed into separate bins ready for batching and mixing with bituminous material.

If required to meet the gradation requirements, mineral filler shall be added in a manner approved by the Materials and Research Engineer after the aggregates have passed through the dryer.

The above preparation of aggregates does not apply for drum-mix plants.

406.08 MIXING. The dried aggregates shall be combined with the bituminous material in a manner that will produce a mixture which, when discharged from the mixing unit, shall be at the temperature specified on the approved mix design unless otherwise directed by the Materials and Research Engineer.

The dried aggregates shall be combined in the mixer in the appropriate proportions required to meet the job-mix formula and be thoroughly mixed prior to adding the bituminous material. Dry mix times shall be increased as deemed necessary by the Materials and Research Engineer in such cases that RAP material is introduced into the mixer.

The bituminous material shall be measured and introduced into the mixer in the amount determined by the Materials and Research Engineer for the material being used and at a temperature in accordance with Subsection 702.06, unless otherwise directed by the Materials and Research Engineer.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, 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 obtained. The wet mixing time shall be regulated by the Materials and Research Engineer and a suitable locking mechanism shall be provided for such regulation.

All plants shall have a means of eliminating oversized and foreign material from being incorporated into the mixer.

406.09 HAULING EQUIPMENT. To prevent the mixture from adhering to the beds, trucks used for hauling bituminous mixture shall have tight, clean, and smooth metal beds which have been thinly coated with a bond release agent. Petroleum based products will not be permitted.

The trucks used for hauling bituminous mixture shall be compatible with the equipment used for placing the bituminous mixture. Trucks are not to be cleaned and/or emptied on surfaces to be paved.

Each truck shall have a cover of canvas or other suitable material of sufficient size to extend over all sides of the haul vehicle to afford protecting the mix from the weather. When necessary to assure placement of material at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

406.10 PLACING EQUIPMENT. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly capable of being heated if necessary and capable of spreading the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross sectional shape.

Pavers shall be in good mechanical condition, equipped with all necessary attachments, and designed to operate electronically for controlling the grade of the finished surface. Bituminous pavers shall distribute the mixture over the entire width or over such partial width as may be practical. Additionally, pavers shall be equipped such that, upon extension of the screed a distance of 450 mm (18 inches) or more, auger extensions shall be used as directed by the Engineer.

The adjustments and attachments of the paver shall be checked and approved by the Engineer before placement of bituminous material.

Bituminous concrete pavers shall be equipped with a sloped plate to produce a tapered or notched tapered edge at longitudinal joints. The sloped plate shall produce a tapered or notched tapered edge having a minimum face slope of 1 vertical: 3 horizontal. The plate shall be able to accommodate compacted mat thicknesses from 35 mm to 100 mm (1¼ inches to 4 inches). The bottom of the sloped plate shall be mounted 10 mm to 15 mm (¾ inch to ½ inch) above the existing pavement.

Bituminous pavers shall be equipped with a joint heater of at least 6250 BTU/min (110,000 W) capacity to heat the longitudinal edge of the previously placed mat to a surface temperature of 95°C (200°F), or higher if necessary, to achieve bonding of the newly placed mat with the previously placed mat without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately ahead of the screed. The joint heater shall be equipped with automated controls which shut off the burners when the paving machine stops and reignites them with the forward movement of the paver. The joint heater shall heat the entire area of the previously placed wedge to the required temperature. Heating to the point of 95°C (200°F) or higher shall immediately precede placement of the bituminous material.

406.11 ROLLERS. Rollers shall be in good mechanical condition, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The mass (weight) of the rollers shall be sufficient to compact the mixture to the required density without crushing the aggregate. Rollers shall be equipped with tanks and sprinkling bars for wetting the rolls or tires.

Pneumatic-tired rollers shall be equipped with appropriate skirts at all times and be preheated prior to use in order to avoid picking. The Contractor shall remove all picked material from the surface.

Vibratory rollers shall have separate controls for energy and propulsion. They shall be equipped with automatic cutoffs that stop the vibration prior to the roller stopping and/or reversing its direction of travel.

406.12 CONDITIONING OF EXISTING SURFACE. All surfaces shall be cleaned and sprayed with an emulsion meeting the requirements of Emulsified Asphalt, RS-1 before placing of any bituminous mixture, unless otherwise ordered by the Engineer. The emulsion shall be applied under pressure at a rate of 0.05 to 0.14 L/m² (0.01 to 0.03 gallons/yd²). The application shall be made just prior to the placement of the bituminous concrete mixture and shall progress sufficiently ahead of the paving so that the surface to be paved will be “tacky”. Equipment used to apply the emulsion shall meet the requirements for distributors specified in Subsection 404.04.

Prior to paving, bridge decks shall be treated as detailed on the Plans.

Prior to paving, all large cracks in the bituminous surface shall be thoroughly cleaned and filled with a bituminous material or mixture approved by the Engineer. Large cracks are defined as at least 25 mm (1 inch) in width.

Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Emulsified Asphalt, RS-1 immediately before the bituminous concrete mixture is placed against them.

If there are deficiencies that require corrective action in the base course constructed under the Contract, a bituminous concrete mix approved by the Engineer shall be used to bring the base course to the designed grade and contour.

Where Bituminous Concrete Pavement is used to resurface existing pavements and the existing pavement contains irregularities, depressions, or waves, such deficiencies shall be eliminated by the use of extra bituminous material for spot leveling to bring existing base to uniform section and grade before placing of the required courses of bituminous concrete pavement.

406.13 PLACING AND FINISHING. The finished surface shall be of uniform texture and evenness and shall not show tearing, shoving, or pulling of the mixture.

At the time of discharge from the haul vehicle, the bituminous mixture shall be within 6°C (10°F) of the compaction temperature for the approved mix design.

The Contractor shall, during all phases of the paving operation, protect from damage all exposed surfaces that are not to be treated.

The bituminous mixture shall be placed and finished with the specified equipment, shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness, and shall conform to the grade and elevation specified.

When operating in tandem on multi-lane paving, the pavers shall be of the same type and have the same characteristics. Material for leveling may be spread by the use of a grader, if approved by the Engineer.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, luted, and compacted by hand methods.

All material shall be produced early enough in the day in order that the completion of spreading and compaction of the mixture will occur during daylight hours, unless night paving has been approved for the project.

No traffic will be permitted on placed material until the material has been thoroughly compacted and has cooled to 60°C (140°F) unless otherwise authorized by the Engineer.

The use of water to cool the pavement will not be permitted.

The Agency may require that all work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, be completed prior to placing the wearing course when such work could cause damage to the pavement.

When bituminous concrete pavement is to be placed on a bridge deck having a waterproofing membrane, a rubber-tired or rubber tracked paver shall be used to place the binder course of pavement.

On projects where traffic will be maintained, the Contractor may be required to schedule daily paving operations such that at the end of each work day all travel lanes of the roadway on which work is being performed will be paved to the same limits or as directed by the Engineer.

Suitable permanent aprons or temporary fillets shall be constructed at side road intersections and driveways as directed by the Engineer within 24 hours of adjacent mainline paving. Permanent aprons shall be constructed within 5 working days of adjacent mainline paving. Reasonable access to and from the mainline mat shall be maintained at all times.

406.14 COMPACTION. 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, tearing, or shoving. Should the mix exhibit these characteristics, and the Contractor is unable to remedy these conditions to the satisfaction of the Engineer, both placement and approval of the mix design will be terminated.

The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally, one breakdown roller will be needed for each paver used in the spreading operation.

Leveling courses shall be compacted using a self-propelled pneumatic-tired roller unless otherwise directed in writing by the Engineer. On base, binder, and wearing courses, the initial or breakdown rolling shall be done by using a two-axle tandem roller; intermediate rolling shall be done by using a two-axle tandem roller or self-propelled pneumatic-tired roller; and final rolling shall be done by using an additional two or three-axle tandem roller. The equipment used for shoulder construction shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

To prevent adhesion of the mixture to the rollers, the rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid and petroleum products will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hand tampers, smoothing irons, or mechanical tampers coated with a non-petroleum based bond release agent. On depressed areas, a trench roller or cleated compression strips under the roller may be used to transmit compression to the depressed area.

Unless otherwise directed, the longitudinal joint shall be rolled first and then rolling shall begin at the low side of the pavement and proceed towards the center or high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller shall be kept in as continuous an operation as practicable. Rolling shall continue until all roller marks and ridges have been eliminated.

Rollers shall not be stopped or parked on new, freshly placed bituminous material.

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 bitumen shall be removed and replaced. These replacements shall be at the Contractor's expense.

Should the Contractor choose to use vibratory rollers, the following additional criteria shall govern their operation:

Vibratory rollers may be used when operated at an amplitude, frequency, and speed that produces a mat conforming to specifications and which prevent the creation of transverse ridges in the mat. Vibratory rollers may be used as a breakdown roller, an intermediate roller, or a finish roller. They shall not be used as a substitute for a pneumatic-tired roller on leveling courses, nor shall they be used for compacting lifts of pavement under 25 mm (1 inch) in depth. A single vibratory roller shall not be used alone as the breakdown, intermediate and finish roller, but may be used as any one of the rollers in the roller train.

If the Engineer determines that unsatisfactory compaction is being obtained, unacceptable surface distortion is occurring, or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment and proceed in accordance with the fourth paragraph of this Subsection. All requirements of this Subsection shall apply regardless of compaction equipment used.

The Contractor assumes full responsibility for, and shall repair at the Contractor's expense, all damages which may occur to highway components and adjacent property if vibratory compaction equipment is used.

If the Agency elects to not take cores of any pavement course, the Density Pay Factor (PF(d)) will be considered equal to 0.000.

Leveling courses will not be analyzed for density.

For projects less than or equal to 0.8 km (0.5 miles) in length, Bituminous Concrete Pavement and Medium Duty Bituminous Concrete Pavement will be analyzed for density according to the procedure specified below.

The density of the compacted pavement shall be at least 92.5%, but not more than 96.5%, of the corresponding daily average maximum specific gravity for each mix type (each mix design) of bituminous mix placed during each day. For material that falls outside of this range, payment will be made by adjusting the daily production totals in accordance with the following Table:

TABLE 406.14A – DENSITY PAY FACTORS

AVERAGE DENSITY	DENSITY PAY FACTOR, PF(d)
90.5% - 90.9%	- 0.100
91.0% - 91.4%	- 0.075
91.5% - 91.9%	- 0.050
92.0% - 92.4%	- 0.025
92.5% - 93.4%	0.000
93.4% - 95.4%	0.010
95.5% - 96.5%	0.000
96.6% - 97.0%	- 0.025
97.1% - 97.4%	- 0.050
97.5% - 98.0%	- 0.075
98.1% - 98.5%	- 0.100

For material with an average density that is less than 90.5% or in excess of 98.5%, the Construction Engineer will evaluate whether the material will be removed and replaced by the Contractor at no expense to the Agency or a greater penalty imposed.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores extracted and provided by the Contractor.

Acceptance testing to verify density of the compacted pavement will be done by averaging the densities of a minimum of 4 cores for each day's production for each type of bituminous mix placed, excepting shim/leveling courses.

The cores taken for acceptance testing will be the final cores taken for determination of densities.

For projects greater than 0.8 km (0.5 miles) in length, Bituminous Concrete Pavement and Medium Duty Bituminous Concrete Pavement will be analyzed for density according to the procedures specified in Subsections 406.14 (a) and 406.14 (b).

- (a) Quality Level Analysis. Compacted bituminous concrete pavement specified to be sampled and tested using bituminous concrete pavement core samples for the purpose of determining density will be analyzed by utilizing the statistical quality level analysis "Percent Within Limits" (PWL) method as defined in Subsection 106.03.
- (b) Quality Acceptance.
 - (1) Bituminous concrete mixtures will be sampled once per subplot using a stratified random sampling procedure in accordance with ASTM D 3665 and tested and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following guidelines:

TABLE 406.14B- ACCEPTANCE GUIDELINES

PROPERTY	POINT OF SAMPLING	LOT SIZE	TEST METHOD
Density	Compacted In-Place	Daily -24 Hour Max	AASHTO T166 Method A, T 209

- (2) For the purpose of evaluating acceptance test properties, a lot shall consist of the total quantity of bituminous concrete mixture compacted in-place during any one day's production to a maximum of 24 hours. Sampling shall be performed at the rate of one sample per lane kilometer (0.6 mile), with the exception that there shall not be fewer than six samples taken per any one day's production. The quantity represented by each sample shall constitute a subplot.
- (3) Density Pay Factor (PF(d)) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Limit (RQL) of 60%, the PF for each lot of bituminous concrete mixture, based on density test results, will be determined by using the applicable equation below:

$$\text{Where } 85 \leq \text{PWL} \leq 100, \text{ PF(d)} = ((0.20 \text{ PWL} + 83) / 100) - 1.0$$

or

$$\text{Where } 60 \leq \text{PWL} < 85, \text{ PF(d)} = ((0.40 \text{ PWL} + 66) / 100) - 1.0$$

The PF for each lot of bituminous concrete mixture used for low production activities not associated with any traveled way paving operations will be 1.0. Low production activities are defined as those not associated with traveled way paving operations and having a maximum daily production of 500 metric tons (tons) of bituminous concrete mixture.

- (4) The density of the compacted pavement shall not be less than 92.5% nor more than 96.5% of the corresponding maximum specific gravity for each mix type (each mix design) placed per lot.
- (5) It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores provided by the Contractor in accordance with the coring protocol below.

- (c) Coring Protocol. Original core sampling locations will be restricted to travel lanes only and will not include those areas within 150 mm (6 inches) of a longitudinal joint nor within 15 m (50 feet) of a transverse joint. That area encompassing a longitudinal tapered joint will not be selected as a sampling location. Independent shoulder and mat area core sampling locations may be selected by the Engineer to afford verification of Subsection 406.14(b)(4).

Original core sampling locations will be selected by the Engineer or designee in accordance with ASTM D 3665 within two working days of the bituminous mixture being placed. The Contractor will be advised in writing of the selected sampling locations.

The Contractor may challenge whether any particular original sample location(s) is representative of any particular lot by notifying the Engineer. This notification shall be made immediately upon the subplot location(s) being selected, conveyed to the Contractor, and being prior to extracting the cores, and shall be further documented in any Contractor job records citing just reasoning for recommending a reselection of original sample location(s).

Upon receipt by the Engineer of a challenge from the Contractor, the Engineer will evaluate it within one working day and notify the Contractor in writing of either acceptance or rejection of the challenge. Rejection of a challenge will result in the Engineer using the original core sampling locations for the determination of density data in any compaction pay factor calculations. Acceptance of a challenge will result in the Engineer selecting alternate core sampling location(s) for those challenged samples. Alternate core sampling location(s) will be selected by the Engineer by use of a new random number(s) to determine a new longitudinal coordinate(s) within the subplot in question. The transverse coordinate(s) of the original core sampling location(s) will be used in conjunction with the new longitudinal coordinate(s) to determine the alternate sampling location(s). The alternate core sampling location(s) will not be subject to further challenge and will be used for the determination of density data in any compaction pay factor calculations. The Contractor will be notified in writing of the final core sampling location(s).

Within one working day of final selection of the core sampling locations, the Contractor shall core in the presence of the Engineer or designee and shall deliver the samples to the Engineer, in a suitable container provided by the Contractor, on the same day the samples are taken. The Engineer will identify and record the core samples. Any cores not delivered in a suitable container will be rejected and new cores taken at the Contractor's expense. The Contractor shall fill the core holes, at the Contractor's expense, with hot (minimum 90°C (200°F)) bituminous concrete pavement on the same day that cores are taken. Failure to comply with the provisions of this paragraph may result in payment being withheld for the representative lot of bituminous material.

Cores shall be taken in accordance with the 2004 version of AASHTO T 230, Method B. Agency personnel will process core samples within ten working days and will relay test results to both the Engineer and Contractor. Testing will be performed in accordance with AASHTO T 166, Method A for bulk specific gravity (B) and AASHTO T 209 for maximum specific gravity (M) from tests performed at the plant lab for that day. All cores will be sawcut. The Contractor shall mark the cores for sawcutting in the presence of the Engineer or designee for verification of cut locations. The degree of compaction (DC) will be determined as follows:

$$DC = (B/M) \times 100$$

To satisfy the requirements of part (d) of this Subsection, physical core samples will be retained for a period of two working days from the time that DC test results are relayed to the Engineer and Contractor. In addition, any subsequently "retested" or "recored" samples, as defined in part (d), will be retained to the point of fully satisfying part (d).

- (d) Core Result Verification. Upon the test results required in part (c) being relayed to both parties (the Engineer and Contractor), any individual core sample result considered to be an outlier as determined in accordance with ASTM E 178 will enter a core result verification process as defined herein. This process will consider only those core samples processed by the Agency as acceptance tested samples and does not preclude the provisions of Subsection 490.14(e).

The core result verification process consists of four levels as follows:

- (1) Level 1. The Agency will perform a statistical analysis on all lots of core sample compaction values to investigate any presence of statistical outlier(s) as determined in accordance with Table 1 of ASTM E 178 at a 5% significance level. In cases where a statistical outlier is not detected, all core sample results as reported under part (c) will be used in any compaction pay factor calculations.

When an outlier is determined to exist, the core sample representing that outlying result will be retested to ensure procedural integrity (support information accuracy, testing methodology, and mathematical accuracy). The core sample "retested" results will replace the original "outlier" core sample results for any future calculations within this Level. Should it be verified at this point that an outlier does in fact exist or the core sample retested results vary from those originally obtained, the options to either party will be either to compute any compaction pay factors using all core sample test results derived through this Level or to proceed to Level 2.

- (2) Level 2. Level 1 outlier core sample results will be replaced by virtue of "recored" sample results to be obtained under this Level. The recoring location shall be at the same transverse offset as the original location and shall be offset longitudinally forward 450 mm (18 inches) from the original location. The recored sample will be tested as specified in part (c) and may reenter Level 1 analysis of this Subsection up to and including the point of ensuring procedural integrity. The recored sample will not reenter Level 2 analysis.

Upon receiving recored sample test results of this Level, the options to either party will be either to compute any compaction pay factors using those recored sample test results or to state reasons for belief that said recored sample test results are in error. Receipt of reasons shall be cause for this verification process to proceed to Level 3.

- (3) Level 3. A final attempt at field resolution of core sample test results will be addressed under this Level by introduction of a third party testing facility. Selection of such a facility will be discussed and mutually agreed upon by both parties prior to beginning construction activities and will not be included in project QC or acceptance testing processes. Any findings of a third party facility will become final and will not be subject to further review. Payment to a third party for services rendered will be borne by the party having provided the Level 2 reasons leading to Level 3.

The recored samples from Level 2 shall be provided to the third party testing facility. The facility will process the recored samples and provide results to both the Agency and Contractor. Upon receipt of the third party recored sample test results, the options to either party will be either to compute any compaction pay factors using these results or to proceed to Level 4.

- (4) Level 4. At this level, the Agency and Contractor will defer to Subsection 105.02. Both parties shall submit to the Director of Program Development a written report describing the disparity, all subsequent actions taken to date, all documentation related to these actions, and a proposed course of action for settlement. The Director will review the submittals and all relevant project records and act in accordance with Subsection 105.02.

If the Contractor does not concur with any final decision by the Director, the Contractor may seek other remedies specified under Subsection 105.02 and the Contract.

- (e) Rejected Material. For those lots with a PWL less than 60% and having satisfied the requirements of part (d), the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency provided one of the following are met:

- lot standard deviation (\bar{s}) greater than 2.0 or
- lot average density (\bar{x}) greater than 98.0% or
- lot average density (\bar{x}) less than 90.0%.

In addition, and at the discretion of the Contractor, any lot of rejected material not meeting any of the above criteria may be removed and replaced at no additional cost to the Agency. If removal and replacement is not implemented, any lot of rejected material not meeting any of the above conditions will have any compaction pay factors calculated as follows:

$$PF(d) = (-0.05625 \bar{x}^2 + 10.575 \bar{x} - 496.125) - 1.0$$

In such cases that this Subsection applies, any PF(d) as computed above will be the solitary pay adjustment to the representative lot as per the provisions of Subsections 406.18 and 406.19. Other applicable pay adjustments of the representative lot will be considered to equal 1.00.

406.15 JOINTS. Joints between old and new pavements, or between successive day's work, shall have a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a transverse joint constructed.

Transverse butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at a location approved by the Engineer, where the pavement has a true surface as determined by the use of a straightedge at least 4.9 m (16 feet) long. The transverse joint shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to depositing new paving mixture.

Transverse tapered joints shall be formed by ramping down the last 450 to 600 mm (18 to 24 inches) of the course being placed to match the lower surface. Care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to resuming paving. As the paver places new mixture on the taper area, placement shall proceed such that an evenly graduated deposit of mixture will complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake and properly rolled, with coarse material discarded.

Longitudinal joints that have become cold shall be coated with Emulsified Asphalt, RS-1 before the adjacent mat is placed. If directed by the Engineer, such joints shall be cut back to a clean vertical edge prior to coating with the emulsion.

Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 150 mm (6 inches) from any joint in the lower courses of pavement. Transverse joints shall not be constructed nearer than 300 mm (12 inches) from the transverse joints constructed in lower courses.

Those projects having a centerline length in excess of 5 km (3 miles) shall also be subject to the following provisions:

- (a) **General.** For the purpose of evaluating longitudinal joint compaction acceptance, a lot shall consist of the total project length of joint constructed per pavement course and total project quantity of bituminous concrete mixture compacted in place per pavement course. Sampling on constructed joints shall be performed by way of minimum 150 mm (6 inch) diameter core samples taken at the rate of two per joint kilometer (two per joint mile) per lot. Sample locations will not include those areas within 15 m (50 feet) of a transverse joint. Each individual core sample shall represent a project subplot. Once selected per that method in part (b) below, sample locations will become final and not subject to revision, nor will any core sample be subject to the provisions of Subsection 406.14 (d).
- (b) **Sampling.** Bituminous concrete mixtures will be sampled once per subplot on a stratified random sampling procedure in the longitudinal direction in accordance with ASTM D 3665. For a longitudinal butt joint, the transverse location of the sample shall be centered on the visible surface joint line. For a tapered joint, the transverse location of the sample shall be offset from the visible surface joint line approximately 50% of the taper width as directed by the Engineer. Joint core samples shall be taken between any adjacent travel lanes and between any travel lane and shoulder provided the shoulder material was placed as a separate construction operation. All samples will be tested and evaluated by the Agency for each mix type (each mix design), excluding leveling/shim courses, for each project in accordance with the following:

TABLE 406.15A – ACCEPTANCE GUIDELINES

Property	Point of Sampling	Lot Size	Test Method
Density	Compacted-In-Place	Project (1)	AASHTO T 166, Method A and T 209

For determining the degree of compaction, the maximum specific gravity (Gmm) used in the calculation shall be the average of the two Gmm values of the materials placed to construct the joint. The calculated compaction of any individual joint core sample shall not be less than 90.0% of the corresponding maximum specific gravity of the average of the two Gmm values for each mix type (each mix design) placed per lot.

- (c) Longitudinal Joint Pay Factor (PF(j)) Determination. In such case that an individual core sample (sublot) is above the minimum compaction as specified in part (b) above, it shall be defined as above minimum.

Upon completion of any individual lot, the percentage of sublots equal to or above the acceptable minimum compaction shall be defined as the lot Percent Above Minimum (PAM) and shall be used as the basis for determining pay factors as follows:

For $85 \leq \text{PAM} \leq 100$, $\text{PF}(j) = 0.01$

For $75 \leq \text{PAM} < 85$, $\text{PF}(j) = 0.00$

For $0 \leq \text{PAM} < 75$, $\text{PF}(j) = -0.01$

406.16 SURFACE TOLERANCE. The surface will be tested by the Engineer using a straightedge at least 4.9 m (16 feet) in length at selected locations parallel with the centerline. Any variations exceeding 3 mm (1/8 inch) between any two contact points shall be satisfactorily eliminated. A straightedge at least 3 m (10 feet) in length may be used on a vertical curve. The straightedges shall be provided by the Contractor in accordance with Subsection 631.06.

For those projects having a centerline length of 0.8 km (0.5 miles) or greater, the surface roughness of the wearing course will be additionally measured by the Engineer or the Engineer's designee with an Agency provided Road Surface Profiler (RSP) to determine a surface tolerance pay factor (PF(r)). The Engineer will contact the Agency's Pavement Management Section Project Manager to arrange for surface testing.

The surface will be tested by Agency personnel by traveling at highway speeds once in each direction on two-lane/two-way non-limited access State Highways and other Routes as applicable. For those two-way limited or non-limited access highways containing truck or passing lanes, only the rightmost lane will be tested in any given direction. The reported International Roughness Index (IRI) value will be the average as calculated based upon travel in both directions. Two-lane divided Interstate Highways and other applicable limited access highways will have both of the passing and travel lanes tested at highway speeds, with the reported IRI value being the average as calculated based upon travel in both lanes. For those Interstate or other applicable limited access highways having both barrels of the highway constituting the project, the reported IRI value will be that average value as calculated based on travel in both lanes of both barrels.

Prior to the highway being surface tested, all Contract items shall be complete such that the project could be deemed substantially complete, unless otherwise directed by the Engineer, including but not limited to all guardrail, bridge joints, and permanent pavement markings installed, including all side road markings, and there shall not be lane closures or equipment present that would impede highway travel. Additionally, and prior to the highway being surface tested, the highway surface shall be dry and free of snow, ice, and loose debris, and the ambient air temperature shall be a minimum of 5°C (40°F).

The roughness value used in the applicable formula below will be the average of the International Roughness Index (IRI) values measured by the RSP in each lane. The roughness associated with any anomalous features beyond the control of the Contractor, such as bridges that remain unpaved, will be eliminated from the calculations of the final project average. The corresponding Surface Tolerance Pay Factor (PF(r)) will be determined as follows and applied to the corresponding lot as defined below:

Limited Access Highways:	$PF(r) = (-0.0029 \text{ IRI} + 1.1500) - 1.0$
All Other State Routes:	$PF(r) = (-0.0029 \text{ IRI} + 1.1786) - 1.0$

For the purpose of evaluating surface tolerance acceptance, a lot shall consist of the total project quantity of wearing surface of bituminous concrete pavement constructed and measured in place. Said measurement shall include all shoulders, side roads, drives, and any other miscellaneous mix as measured by the Engineer.

406.17 TRAFFIC CONTROL. Whenever traffic must be maintained during a paving operation, uniformed traffic officers and/or flaggers shall be stationed at each end of the section being paved and at such other locations as may be required by the Engineer. The uniformed traffic officers or flaggers shall conform to the requirements of Section 630.

Whenever one-way traffic is maintained by the Contractor, the traveling public shall not be delayed more than 10 minutes unless otherwise directed by the Engineer. Two-way traffic shall be maintained during non-working hours.

406.18 METHOD OF MEASUREMENT. The quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement to be measured for payment will be the number of metric tons (tons) for a lot of mixture (each type) complete in place in the accepted work as determined from the weigh tickets.

The quantities of all applicable Pay Adjustments calculated for the project will be determined as specified below.

When applicable, and when the air voids pay factor, PF(av), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine an Air Voids Pay Adjustment, (PA(av)), to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(av) = PF(av) \times Q \times B$$

When boxed samples are taken to determine mix properties, PF(av) shall be assumed as equal to 0.000 for a "single day" lot. Additionally, when the RQL of 50% is not attained for a lot, all other applicable pay factors for that lot shall not be greater than 1.000.

When applicable, and when the density pay factor, PF(d), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Mat Density Pay Adjustment, (PA(d)), to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(d) = PF(d) \times Q \times B$$

When applicable, and when the surface tolerance pay factor, PF(r), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of wearing surface of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed will be multiplied by such pay factor to determine a Surface Tolerance Pay Adjustment, (PA(r)), to the tonnage placed (Q) for that lot as based on the Contract bid price (B), as follows:

$$PA(r) = PF(r) \times Q \times B$$

When applicable, and when the longitudinal joint pay factor, PF(j), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Longitudinal Joint Compaction Pay Adjustment, (PA(j)), to the tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(j) = PF(j) \times Q \times B$$

When the material for any lot is removed from the project under any provisions of the Contract, no payment will be made for that material nor for any applicable Pay Adjustments under this Section.

406.19 BASIS OF PAYMENT. The accepted quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement will be paid for at the Contract unit price per metric ton (ton). Payment shall be full compensation for furnishing, mixing, hauling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for Pay Adjustments shall be debited or credited against the Contract prices (Lump Units) bid for the applicable Pay Adjustment items.

The costs of furnishing testing facilities and supplies at the plant will be considered included in the Contract unit price of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, as appropriate.

The costs of obtaining, furnishing, transporting, and providing the straightedges required by Subsection 406.16 will be paid for under the appropriate Section 631 pay item included in the Contract.

The cost of taking cores for acceptance testing and filling the cored holes will be incidental to the Contract item being cored. All other costs associated with obtaining samples for acceptance testing will be incidental to the cost of the Section 406 pay item. The cost of traffic control for taking cores for acceptance testing and filling the core holes will be paid under the appropriate Section 630 Contract item.

When not specified as items in the Contract, the costs of cleaning and filling joints and cracks, sweeping and cleaning existing paved surfaces, the emulsified asphalt applied to tack these surfaces, and tacking of manholes, curbing, gutters, and other contact surfaces will not be paid for directly, but will be incidental to the item of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, as appropriate.

Bituminous concrete mixture approved by the Engineer for use in correcting deficiencies in the base course constructed as part of the Contract will not be paid for as Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, but will be incidental to the Contract item for the specified type of base course.

The bituminous concrete mixture used to correct deficiencies in an existing pavement or to adjust the grade of a bituminous concrete surface completed under the Contract will be paid for at the Contract unit price for Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, as appropriate.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
406.25 Bituminous Concrete Pavement	Metric Ton (Ton)
406.27 Medium Duty Bituminous Concrete Pavement	Metric Ton (Ton)
406.28 Air Voids Pay Adjustment	Lump Unit
406.29 Mat Density Pay Adjustment	Lump Unit
406.30 Surface Tolerance Pay Adjustment	Lump Unit
406.31 Longitudinal Joint Compaction Pay Adjustment	Lump Unit

SECTION 409

THIS SECTION RESERVED

SECTION 415 - COLD MIXED RECYCLED
BITUMINOUS PAVEMENT

415.01 DESCRIPTION. This work shall consist of cold planing and crushing and/or screening the existing bituminous pavement, adding additional asphalt emulsion, and mixing and repaving of the material to the depths, lines, and grades shown on the Plans.

Recycling of the existing pavement shall be performed in a manner that does not disturb the underlying materials.

415.02 MATERIALS. The emulsified asphalt for Cold Mixed Recycled Bituminous Pavement shall meet the requirements of Section 404 and/or be as recommended by the Contractor as a result of Subsection 415.08 and as approved by the Engineer. The grade and initial application rate, based on emulsion rate-density curves (AASHTO T 245 - Mod., 50 blows) developed from test section material, shall be recommended by the Contractor and accepted by the Engineer. The value for the emulsion rate shall be based on the optimum for achieving maximum density. The exact application rate may be varied by the Contractor as required by existing pavement conditions and approved by the Engineer.

The Cold Mixed Recycled Bituminous Pavement shall meet the following gradation requirements for extracted aggregate taken from the pulverized material:

<u>Sieve Size</u>	<u>Percent Passing</u>
37.5 mm (1½ inches)	100
25.0 mm (1 inch)	90-100
4.75 mm (No. 4)	30- 70
75 µm (No. 200)	0- 12

415.03 EQUIPMENT. The Contractor shall furnish a self-propelled machine capable of planing the existing bituminous pavement to the depth shown on the Plans in one pass. The machine shall be equipped with standard automatic depth controls and must maintain a constant cutting depth and width. The machine shall be capable of producing the proper size material required, or additional screening and/or crushing will be required. Oversized particles shall be reduced to proper size by crushing.

Mixing equipment shall be provided which is capable of mixing the sized bituminous material and liquid binder into a homogeneous mixture. The mixing equipment shall be equipped with weighing and metering devices which assure that the correct amount of sized material and proper amount of emulsion are introduced into the Cold Mixed Recycled Bituminous mixture. The method of depositing the mixed material shall be such that segregation does not occur.

Placing of the Cold Mixed Recycled Bituminous Pavement shall be accomplished with a self-propelled bituminous paver. The Cold Mixed Recycled Bituminous material shall be spread without segregation to the lines and grades shown on the Plans or as directed by the Engineer. If a pick-up machine is used to feed a windrow of the bituminous material into the paver hopper, the pick-up machine shall be capable of picking up the entire windrow down to the underlying materials.

The number, mass, and type of rollers shall be sufficient to obtain the required uniform density, full depth, while the mixture is in a workable condition. A rubber tire roller shall perform the initial rolling after the emulsion initially "breaks" (indicated by color change from brown to black).

415.04 WEATHER AND SEASONAL LIMITATIONS. Recycling operations shall not be performed when the ambient air temperature is below 10°C (50°F), when the surface temperature of the pavement to be recycled is below 10°C (50°F), when the weather is foggy or rainy, or when weather conditions or predicted weather conditions are such that proper mixing, spreading and compacting of the recycled material cannot be accomplished.

When it is in the public interest for servicing traffic, the Construction Engineer may adjust the ambient air and/or pavement temperature requirements or extend the dates of the recycling season.

415.05 MOISTURE. The Contractor may add, under positive control, a small amount of water to the planed material to facilitate uniform mixing with the emulsion. The water may be added prior to the mixing phase of the operation. The water shall be added carefully so as not to cause any adverse affect.

415.06 COMPACTION. Compaction shall be performed while the emulsion is in a workable state. The Cold Mixed Recycled Bituminous Pavement material shall be finished within a grade tolerance of $\pm 12\text{mm}$ ($\frac{1}{2}$ inch), provided that this deviation is not maintained for a distance longer than 15 meters (50 feet), and provided that the required crown or superelevation is maintained.

The Cold Mixed Recycled Bituminous Pavement shall be compacted to a minimum of 95% of the target density approved by the Engineer in accordance with Subsection 415.08.

415.07 CURING AND STABILITY. The Cold Mixed Recycled Bituminous Pavement may be opened to traffic as approved by the Engineer.

Hot mixed bituminous concrete pavements shall not be placed until the Cold Mixed Recycled Bituminous Pavement material has been allowed to cure and the free moisture content is reduced to a maximum of one and one-half percent ($1\frac{1}{2}\%$).

The required density shall be achieved and maintained until a hot mixed bituminous concrete pavement has been placed. Any additional compactive effort or repair of imperfections in the Cold Mixed Recycled Bituminous material shall be performed as directed by the Engineer at no additional compensation to the Contractor.

415.08 CONTROL SECTION. The Contractor shall be responsible for performing all Process Control and Quality Control sampling and testing.

Process Control sampling and testing shall involve taking a set of four representative samples from the test section. The samples may be taken either before or after the cold recycling process. The four samples shall be combined to represent a uniform sample for determining maximum density. The material used, including that used for the Marshall series to determine the optimum emulsion rate, shall be in a processed pulverized state replicating the state which the material will be in immediately prior to the point when the emulsified asphalt is introduced during the recycling process.

The Contractor shall perform the Marshall Design series tests to determine the maximum density. A maximum density shall be obtained by performing a series of tests using the 50 blow Marshall Design method (AASHTO T 245 - Mod.). The series of Marshall tests shall be prepared using a minimum of five different percentages of emulsion. The maximum density obtained from these tests shall be used as the recommended target density to be approved by the Engineer.

The Contractor shall perform all tests necessary to verify that the target density is achieved and maintained prior to placement of a hot bituminous overlay. The necessity for additional testing will be determined by the Engineer. The Contractor shall provide the Engineer with the original copies of all Marshall Design series, Process Control, and Quality Control test results.

The Contractor shall construct a control section to assure the Engineer that the Contractor's equipment and procedure are suitable for the work specified and are capable in achieving the density specified. If the control section does not meet the requirements of this specification, or the density achieved does not appear suitable, the Contractor shall modify his/her procedure and either construct another control section or reconstruct the original until acceptable results are obtained. The suitability of results will be determined by the Engineer.

The length of the control section shall be 150 m to 300 m (500 feet to 1000 feet). No further recycling shall be performed on the project until all aspects of the test section are approved by the Engineer.

415.09 METHOD OF MEASUREMENT. The quantity of Cold Mixed Recycled Bituminous Pavement to be measured for payment will be the number of square meters (square yards) of existing pavement which has been recycled in an acceptable manner as determined by actual surface measurements of the lengths and widths of the recycled area as shown on the Plans or as directed by the Engineer. No additional compensation will be made for overlapping areas.

The quantity of Emulsified Asphalt, Cold Mix to be measured for payment will be the number of kilograms [hundredweight (CWT)] used in the complete and accepted work.

415.10 BASIS OF PAYMENT. The accepted quantity of Cold Mixed Recycled Bituminous Pavement will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Emulsified Asphalt, Cold Mix will be paid for at the Contract unit price per kilogram [hundredweight (CWT)] for the specified material applied. Payment will be full compensation for furnishing, transporting, and placing the material and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
415.20 Cold Mixed Recycled Bituminous Pavement	Square Meter (Square Yard)
415.25 Emulsified Asphalt, Cold Mix	Kilogram (CWT)

SECTION 417 - BITUMINOUS CRACK SEALING

417.01 DESCRIPTION. This work shall consist of furnishing and placing crack sealing material in the cracks of existing bituminous concrete pavement.

417.02 MATERIALS. Materials shall meet the requirements of the following Subsection:

Joint Sealer, Hot Poured 707.04(a)

The Contractor shall provide the Engineer with a copy of the material manufacturer’s recommendations pertaining to heating, application, and reheating prior to the beginning of operations or the changing of materials.

417.03 EQUIPMENT. Equipment shall meet the approval of the Engineer and shall be maintained in working condition at all times.

- (a) Air Compressor. Air compressors shall be portable and capable of furnishing not less than 2.8 m³ (3.7 yd³) of air per minute at not less than 620 kPa (90 psi) pressure at the nozzle. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water.
- (b) Hand Tools. Hand tools shall consist of brooms, shovels, metal bars with chisel-shaped ends, squeegees, and any other tools which may be required to accomplish the work.

- (c) Melting Kettle. The melting kettle shall be a double boiler, indirect fired portable type. The space between the inner and outer shells shall be filled with a suitable heat transfer oil or substitute having a flash point of not less than 277°C (531°F). The kettle shall be equipped with a satisfactory means of agitating the joint sealer. This may be accomplished by continuous stirring with mechanically operated paddles and/or by a continuous circulating gear pump attached to the heating unit. The kettle shall be equipped with thermostatic control calibrated between 93°C and 288°C (200°F and 550°F). The kettle shall be mounted on rubber tires and be equipped with a metal shield beneath the firebox to protect the pavement.
- (d) Application Wand. The application wand shall apply a controlled flow of material via an insulated or heated hose. The nozzle shall distribute the material as called for on the Plans or this specification. A pressure regulator shall be provided to regulate pressure at the nozzle. A bypass line into the holding tank is required for use when the nozzle is shut off.
- (e) Router. Equipment for preparing cracks shall be a rotary impact type cutter or a diamond-blade crack saw which will provide a reservoir of specified dimensions.
- (f) Hot-Air Lance. Equipment for blowing clean and drying cracks and joints shall be a propane gas and compressed air burner (ATAFA unit or approved equivalent) operating at 1650°C (3000°F) at a velocity of 915 m/s (3000 ft/s).

417.04 TEMPERATURE LIMITATIONS. The ambient air temperature shall be in the range of 5°C (40°F) to 40°C (104°F) and the pavement temperature shall be in the range of 10°C (50°F) to 60°C (140°F).

When it is in the public interest, the Construction Engineer may adjust the specified ambient air and/or pavement temperature requirements.

417.05 PREPARATION.

- (a) General. Care must be taken in the preparation of all cracks to receive sealant material. All cracks must be clean, dry, and heated to ensure optimal bonding of the sealant material to the existing pavement.
- (b) Bituminous Crack Sealing. All routed cracks shall be filled with sealant in the same workday as directed by the Engineer.

Cracks of 3 mm (1/8 inch) to 20 mm (3/4 inch) in width shall be shaped into a square cross section of approximately 20 mm (3/4 inch) in width by 20 mm (3/4 inch) in depth using a router or crack saw. All cracks to be sealed shall be routed or saw cut. All material removed from the cracks shall be immediately removed from the pavement. Cracks greater than 20 mm (3/4 inch) in width shall only be prepared and sealed at the direction of the Engineer.

Following crack routing or saw cuts, the entire pavement area shall be cleaned using a power broom or blower device. Special care must be exercised in urban areas to ensure that the pavement area is cleaned after the crack sealing operation and to minimize the creation of dust in the cleaning process. Immediately prior to the application of the sealer material, all cracks shall be cleared of loose pavement, vegetation, sand, dust, and any other debris using the hot-air lance. The full length of the cracks shall be heated with the hot-air lance to improve bonding of the sealant and pavement. Care shall be taken not to burn or char the pavement. Any charred pavement shall be cut out and removed and the crack prepared and resealed.

Areas of high density cracking indicating a structural failure should not be prepared for sealing as directed by the Engineer.

- (c) Bituminous Crack Sealing, "Blow and Go" Method. Bituminous Crack Sealing, "Blow and Go" Method shall be performed in accordance with part (b) of this Subsection, with the exception that no routing or saw cutting will be required prior to cleaning and sealing the crack.

417.06 PLACING OF SEALER. The joint sealer material shall be heated and applied at the temperature specified by the manufacturer and approved by the Engineer. Any material that has been heated above the manufacturer's specification shall not be used. Material that is reheated or held at temperature for an extended period of time may be used as allowed by the manufacturer's specification and approved by the Engineer. The Contractor shall provide the Engineer with a suitable device for verifying the sealant temperature in the kettle and at the application site. Sealant application temperature shall not be lowered below the manufacturer's recommended temperature to address pooling problems at the end of the rout. This problem shall be addressed by using sealant material with appropriate flow characteristics to prevent pooling.

All routed cracks shall be fully filled with joint sealer material. A strike-off device may be used to facilitate placement of the material provided it has a maximum width of 40 mm (1 ½ inches). The joint sealer material should be struck off such that only a thin film band 2 mm (1/16 inch) or less is left on the pavement. Optimally, the pavement aggregate should be visible through the thin film band.

Any over application or spills are to be removed to the satisfaction of the Engineer. Any sealed areas with damaged or contaminated sealer or visible voids are to be removed, prepared, and resealed. Any filled areas that have sunk below the surface more than 2 mm (1/16 inch) shall be repaired by applying additional material.

The sealant material shall be applied while the cracks/joints are still hot from the hot-air lance preparation. Any loose material on the surface or in the crack, which may contaminate the joint sealer or impede bonding of the sealant to the pavement, is to be removed by hand tools prior to crack sealing. No crack sealing material shall be applied in a crack that is wet or where frost, snow, or ice is present.

No vehicles or equipment should be allowed on the newly placed sealant material until it has cooled as specified by the manufacturer. If the pavement must be reopened to traffic prior to air cooling, the cooling process may be accelerated with water or other coolant as specified by the manufacturer and approved by the Engineer. As a last resort, sealant may be protected against tire pick-up by dusting with a fine sand, mineral dust or similar material as approved by the Engineer. Any procedure used to accelerate cooling time must be approved by the Engineer and be in compliance with the manufacturer's application specifications. Costs for all material and labor for dusting or cooling shall not be paid for directly, but shall be considered incidental to Bituminous Crack Sealing.

417.07 METHOD OF MEASUREMENT. The quantities of Bituminous Crack Sealing and Bituminous Crack Sealing, "Blow and Go" Method to be measured for payment will be the number of kilograms (pounds) of joint sealer complete and in place in the accepted work.

417.08 BASIS OF PAYMENT. The accepted quantities of Bituminous Crack Sealing and Bituminous Crack Sealing, "Blow and Go" Method will be paid for at the Contract unit price per kilogram (pound). Payment shall be full compensation for handling and placing the sealant material, including the cleaning and preparation of cracks, the removal and disposal of all bituminous grindings, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be under:

<u>Pay Item</u>	<u>Pay Unit</u>
417.10 Bituminous Crack Sealing	Kilogram (Pound)
417.20 Bituminous Crack Sealing, "Blow and Go" Method	Kilogram (Pound)

SECTION 490 - SUPERPAVE BITUMINOUS
CONCRETE PAVEMENT

490.01 DESCRIPTION. This work shall consist of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with these specifications and the specific requirements of the type of surface being placed, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

490.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Performance-Graded Asphalt Binder	702.02
Emulsified Asphalt, RS-1	702.04
Aggregate for Superpave Bituminous Concrete Pavement ..	704.10(b)

Performance-Graded (PG) asphalt binder and aggregate shall meet requirements relating to Superpave criteria, where so specified.

The grade of PG asphalt binder used to produce Superpave bituminous concrete pavement shall be as shown on the Plans.

490.03 COMPOSITION OF MIXTURE.

- (a) Gradation. For each pavement type, the materials shall be combined and graded to meet the limits specified in the following table:

TABLE 490.03A - SPECIFICATION RANGE CHART

Mix Type	MS	IS	IIS	IIS	IVS	VS
Nominal Maximum Size	37.5 mm (1 ½inch)	25.0mm (1inch)	19.0 mm (¾ inch)	12.5mm (½ inch)	9.5mm (⅜ inch)	4.75mm 3/16inch)
Sieve Size	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
50.0 mm(2 inch)	100 - x					
37.5 mm (1 ½ inch)	90 - 100	100 - x				
25.0 mm (1inch)	x - 90	90 - 100	100 - x			
19.0 mm (¾ inch)	--	x - 90	90 - 100	100 - x		
12.5 mm (½ inch)	--	--	x - 90	90 - 100	100 - x	100 - x
9.5 mm (⅜ inch)	--	--	--	x - 90	90 - 100	95 - 100
4.75 mm (No. 4)	--	--	--	--	x - 90	90 - 100
2.36 mm (No. 8)	15 - 41	19 - 45	23 - 49	28 - 58	32 - 67	--
1.18 mm (No. 16)	--	--	--	--	--	30 - 60
75 µm (No. 200)	0.0 – 6.0	1.0 – 7.0	2.0 – 8.0	2.0 – 10.0	2.0 – 10.0	6.0 – 12.0

The combined aggregate gradation shall be classified as fine graded when the job-mix formula contains a greater percentage of material passing than the Primary Control Sieve (PCS) control points as specified below. The primary control point accounts for allowable tolerances.

PCS Control Point for Mixture Nominal
Maximum Aggregate Size

Nominal Maximum Aggregate Size	37.5 mm (1 1/2 inch)	25.0 mm (1 inch)	19.0 mm (3/4 inch)	12.5 mm (1/2 inch)	9.5 mm (3/8 inch)
Primary Control Sieve	9.5 mm (3/8 inch)	4.75 mm (No. 4)	4.75 mm (No. 4)	2.36 mm (No. 8)	2.36 mm (No. 8)
PCS Control Point (% Passing)	53%	46%	53%	43%	51%

All coarse graded mixes shall meet the requirements of AASHTO M 323.

- (b) Design Criteria. The number of Gyration at N_{design} (for example 50, 65, or 80) is determined by the Agency and shall be as detailed on the Plans. Design criteria for Superpave mixtures shall be as follows:

TABLE 490.03B - DESIGN CRITERIA

TEST PROPERTIES						
	All Traffic (ESAL) Levels					
Air Voids	4.0% ($\pm 1.0\%$ Production Tolerance)					
Dust Proportion (Filler/Asphalt Ratio)	0.60 - 1.20 (Wet Sieve) (Dry Sieve for Production: 0.50 - 1.20)					
	Nominal Maximum Size Mix by Mix Type - mm (inches)					
	37.5 (1½) MS	25.0 (1) IS	19.0 (¾) IIS	12.5 (½) IIIS	9.5 (¾) IVS	4.75 (3/16) VS
Voids in Mineral Aggregate (VMA) %	11.5 min.	12.5 min.	13.5 min.	14.5 min.	15.5 min.	16.5 min.
	Traffic Level (ESALs)					
	<300,000	300,000 - 3,000,000		>3,000,000		
Compaction Parameters	$N_{initial} = 6$ $N_{design} = 50$ $N_{max} = 75$	$N_{initial} = 7$ $N_{design} = 65^1$ $N_{max} = 115$		$N_{initial} = 8$ $N_{design} = 80^2$ $N_{max} = 160$		
Voids Filled With Asphalt (VFA) %	70.0 – 80.0 ^{4,5}	65.0 – 78.0 ⁵		65.0 – 75.0 ^{3,5}		
PG BINDER GRADE SELECTION						
RAP CONTENT			BINDER GRADE			
$\leq 20.0\%$			PG 58-28			
20.0% < to < 25.0%			PG 52-34			
25.0% \leq to \leq 50.0% ⁶			footnote 6			

- (1) When estimated design traffic levels are between 300,000 and 1 million ESALs, the Agency may at its discretion specify N_{initial} at 6, N_{design} at 50, and N_{max} at 75.
- (2) When estimated design traffic levels are between 3 and < 10 million ESALs, the Agency may at its discretion specify N_{initial} at 7, N_{design} at 65, and N_{max} at 115.
- (3) For design traffic levels > 3,000,000 ESALs, the specified VFA range for 9.5 mm (3/8 inch) nominal maximum size mixtures shall be 73.0 to 76.0% and for 4.75 mm (3/16 inch) nominal maximum size mixtures shall be 75.0 to 78.0%.
- (4) For a Type IS pavement with ESALs < 300,000, Table 490.03B will apply with the exception of the VFA percentage, which shall have a range from 67.0 to 80.0%. For a Type IVS, 9.5 mm (3/8 inch) pavement with ESALs < 1,000,000, Table 490.03B will apply with the exception of the VFA percentage, which shall have a range from 70.0 to 82.0%.
- (5) For a Type MS pavement, all traffic levels (ESALs), Table 490.03B will apply with the exception of the VFA percentage, which shall have a lower limit of 64.0%.
- (6) The Contractor shall determine the grade of PG binder necessary so that when combined with the RAP asphalt cement, the composite asphalt material grades at a PG 58-28 as a minimum. The maximum acceptable low end temperature is -28°C (-18°F) and the minimum acceptable high end temperature is 58°C (136°F). The Engineer will sample haul units from the plant and have the material extracted for grading at the Agency's Materials and Research Laboratory in Berlin, VT to verify the binder grade of the mix being supplied. The Contractor's Quality Control Plan shall specify a grading frequency and include an action plan for when test results verify that the grade of PG binder is less than a PG 58-28.

Aggregate Consensus Properties	Traffic Level (ESALs)	
	< 30,000,000	≥ 30,000,000
Fractured Faces Coarse Aggregate, % min	95/90	100/100
Uncompacted Void Content of Fine Aggregate, % min	45	45
Sand Equivalent, % min	45	50
Flat and Elongated, % max	10	10

The following relationships are used to derive the various design criteria test properties (Reference AASHTO R 35 “Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)”):

Air Voids (V_a)

$$V_a = 100 \times ((G_{mm} - G_{mb})/G_{mm})$$

Dust Proportion (DP)

$$DP = P_{0.075}/P_{be}; P_{be} = P_b - ((P_s \times G_b) \times ((G_{se} - G_{sb})/(G_{se} \times G_{sb})))$$

Voids in Mineral Aggregate (VMA)

$$VMA = 100 - ((G_{mb} \times P_s)/G_{sb})$$

Voids Filled With Asphalt (VFA)

$$VFA = 100 \times ((VMA - V_a)/VMA)$$

Where:

- G_{mm} = Maximum specific gravity of uncompacted mixture (AASHTO T209)
 G_{mb} = Bulk specific gravity of compacted mixture (AASHTO T166, Method A)
 $P_{0.075}$ = Percent, by mass, of the material passing the 75 μm (No. 200) sieve
 P_{be} = Effective asphalt binder content, expressed as percent, by mass, of mix
 P_b = Asphalt content, as percent of total mass of mixture
 P_s = Aggregate, as percent of total mass of mixture
 G_b = Specific gravity of asphalt cement
 G_{se} = Effective specific gravity of aggregate
 G_{sb} = Bulk specific gravity of aggregate

Unless otherwise specified for highways, Superpave bituminous concrete pavement mixtures will be used as follows: Types MS or IS will be used for base course, Types IS or IIS for binder course, and Types IIS, IIIS, IVS, or VS for wearing course. Unless otherwise specified or directed by the Engineer, Type IVS or VS shall be used for binder course on bridges.

- (c) Mix Design. For Superpave Bituminous Concrete Pavement mixes AASHTO R 35 "Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt" will be the method used to develop a mix that will meet the specified Design Criteria in accordance with AASHTO M 323 "Standard Specification for Superpave Volumetric Mix Design." A copy of all design test data used in developing the mix design, including graphs, may be required with the submittal of the mix design or anytime following as directed by the Materials and Research Engineer.

The four principal parts of the Superpave Mix Design Method include:

- (1) Select materials (aggregate and PG asphalt binder; PG grade shall be as specified in the Plans).
- (2) Select design aggregate structure.
- (3) Select design asphalt binder content.
- (4) Evaluate moisture sensitivity (AASHTO T 283 "Standard Test Method for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage" is referenced, with a Tensile Strength Ratio (TSR) minimum criterion of 80%).

The job-mix formula (JMF) for each mixture shall establish a single percentage of aggregate passing each sieve, a single percentage of bituminous material to be added to the aggregate, a single percentage for VMA, and a single percentage for VFA. No change in the job-mix formula may be made without the written approval of the Materials and Research Engineer. The job-mix formula must fall within the master range of the specification as shown in Subsections 490.03(a) and 490.03(b). The job mix formula shall include values for the following sieves: 50 mm (2 inch), 37.5 mm (1 ½ inch), 25.0 mm (1 inch), 19.0 mm (¾ inch), 12.5 mm (½ inch), 9.5 mm (⅜ inch), 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 600 µm (No. 30), 300 µm (No. 50), 150 µm (No. 100) and 75 µm (No. 200).

No work shall be started until the Contractor has submitted and the Materials and Research Engineer has approved a mix design including cold feed and hot bin gradations, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required by AASHTO M 323. The stockpile and hot bin gradation data shall be derived by wet sieve analysis. For mix designs containing RAP, the dry and wet mixing times shall be adjusted to assure moisture from the RAP is completely dissipated prior to adding the liquid PG binder.

The Materials and Research Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement, finishing, or compaction characteristics are determined by the Materials and Research Engineer to be unsatisfactory.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of three weeks shall be allowed for the testing and evaluation of the submitted Superpave mix design. Once a mix design is approved, the job-mix formula is valid until a change is made in aggregate source, PG asphalt binder grade, or asphalt source. If a change is made in aggregate source, a new mix design shall be submitted and a minimum three week evaluation period shall be allowed prior to resuming production. If a change is made in the PG asphalt binder grade or PG asphalt source, a new PG asphalt binder selection evaluation shall be submitted and a minimum three week evaluation period allowed prior to resuming production.

- (d) Control of Mixtures. The plant shall be operated so that no intentional deviations are made from the job-mix formula. The gradation of the actual mixture shall not vary from the job-mix formula by more than the following tolerances:

TABLE 490.03C – PRODUCTION TESTING TOLERANCES

Aggregate larger than 2.36 mm (No. 8) sieve	±	6.0 %
Aggregate passing the 2.36 mm (No. 8) sieve and larger than the 75 µm (No. 200) sieve	±	4.0 %
Aggregate passing 75 µm (No. 200) sieve	±	1.0 %
Temperature of Mixture	±	11°C (20°F)
Air Voids	=	4.0± 1.0%
VMA	=	JMF ¹ ± 1.0%
VFA	=	JMF ¹ ± 5.0% ²

- 1 - JMF stands for the most current Job-Mix Formula value as approved by the Materials and Research Engineer or the Materials and Research Engineer's designee.
- 2 - The VFA value shall not exceed 80.0% at any time for Type I, II, III, and IV mixes. Type V mixes may be adjusted upward to 82.0% upon written approval of the Materials and Research Engineer, and only on a case by case basis.
- 3 - Mix temperatures shall not exceed 180°C (355°F).

The quantity of PG asphalt binder introduced into the mixer shall be that quantity specified as a percentage in the accepted job-mix formula for batch plants and will be accepted on the basis of the mass (weight) on the printed weight slip. For the use of drum-mix plants, the quantity of PG asphalt binder shall be specified as a percentage in the accepted job-mix formula and will be accepted on the basis of the percentage printed on the demand ticket from the approved automatic digital recording device in the plant.

For those projects having 2000 metric tons (tons) or less of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

If an analyzed sample is outside of the testing tolerances and/or other design criteria, immediate adjustments shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with these Specifications. With the permission of the Engineer, the plant may continue production pending results of these tests, but if the Engineer deems that it is in the best interest of the project, the Engineer may at any time order plant production stopped. In this event, additional adjustments shall be made and tested on a trial basis until the deficiency is corrected.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance sampling and testing will be conducted by Agency personnel in accordance with the Agency's Quality Assurance Program as approved by FHWA.

For those projects having more than 2000 metric tons (tons) of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

The Contractor shall operate in accordance with an approved Quality Control (QC) Plan, hereinafter referred to as the "QC Plan", sufficient to assure a product meeting the Contract requirements. A single QC Plan shall be submitted for all applicable work under the Contract. The QC Plan shall meet the requirements of Subsection 106.03. An example "outline" is available through the Agency Materials and Research Laboratory's Bituminous Concrete Section.

The QC Plan shall address all elements that affect the quality of the Plant Mix, including but not limited to the following:

- a. Job-Mix formula(s)
- b. Bituminous concrete mix Plan details
- c. Stockpile management
- d. Name of Plan Administrator
- e. Name of Process Control Technician(s)
- f. Mixing
- g. Frequency and tests for Quality Control
- h. For mix designs containing > 25.0 percent RAP, indicate the following: RAP percentage, PG Grade of virgin binder determined, testing frequency of mix to verify composite PG Grade, and actions to be taken when test results are outside of PG Grade limits.

The QC Plan shall incorporate the following personnel with the specified minimum requirements and qualifications:

- a. Plan Administrator. This individual shall be a Quality Assurance Technologist certified by the New England Transportation Technician Certification Program (NETTCP).
- b. Process Control Technician (PCT). This individual shall be certified as a "Hot Mix Asphalt (HMA)" Plant Technician by NETTCP. The PCT may have an interim certification from NETTCP as an HMA Plant Technician. Alternatively, the PCT may be a trainee performing duties under the direct supervision of a NETTCP certified technician, as specified in the VAOT approved QC Plan. In this case the Plan should address the following:

1. A training period shall continue for a minimum of 30 working days, at which point the supervising certified technician shall sign off on the trainee.
2. Upon completion of the training period and having been validated (signed off), the trainee will be qualified to work on QA projects without direct supervision for the remainder of the current construction season.
3. The PCT shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the job-mix formula(s). The PCT shall periodically inspect all equipment used in mixing to assure it is operating properly and that mixing conforms to the mix design(s) and other Contract requirements.
4. The QC Plan shall specify how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The QC Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

The QC Plan shall detail the coordination of the activities of the Plan Administrator and the PCT. The Plan Administrator shall be available to respond to the Engineer within one hour of a request.

Superpave bituminous concrete pavement shall be sampled, tested, and evaluated by the Contractor for each mix type (each mix design) for each project on a continuous production basis in accordance with the following minimum quality control guidelines:

TABLE 490.03D - MINIMUM QUALITY CONTROL
GUIDELINES

Test Action	Frequency	Test Method
Temperature of mix	1 per 250 metric ton (ton) at plant (truck)	Verified Thermometer
Air Voids	1 per 500 metric ton (ton)	AASHTO T 269 (T 166, T 209)
Cold Feed Gradation ⁽¹⁾	1 per day	AASHTO T 27
PG Asphalt Binder content	1 per 500 metric ton (ton)	Batch Slip
Extracted Gradations	1 per 500 metric ton (ton)	AASHTO T 30 AASHTO T 164 AASHTO T 308
Fine Aggregate, Coarse Aggregate, and Recycled Asphalt Pavement (RAP) Moisture Content ⁽²⁾	2 times daily minimum ⁽³⁾	AASHTO T 255
Fine Aggregate, Coarse Aggregate, and RAP Specific Gravities	Day of initial paving and 1 per week ⁽⁴⁾⁽⁵⁾⁽⁶⁾	AASHTO T 84 AASHTO T 85
RAP PG Asphalt Binder content	1 per day	AASHTO T 164 AASHTO T 308
Determine composite PG binder grade ⁽⁷⁾	1 per 5000 metric ton (ton)	AASHTO R 29

1 - Include percent "fractured faces" and "thin and elongated" of particles retained on the No. 4 (4.75 mm) sieve and above.

2 - This requirement is for drum-mix plants only.

3 - Evenly spaced intervals throughout the day and when new material is being added to the stockpiles and utilized in the mix.

4 - Or 1 per every 5000 metric tons (tons), whichever is greater.

5 - Current (within the previous 2 to 10 days) specific gravities will need to be supplied prior to beginning paving operations.

- 6 - New specific gravities will be required when either absorbed asphalt is determined to be a negative or at the request of the Materials and Research Engineer.
- 7 - For mix containing > 25 percent RAP.

Upon approval of the Materials and Research Engineer, the Contractor may utilize innovative equipment or techniques not included in the specifications to produce or monitor the production of the mix.

(e) Quality Acceptance.

- (1) General. Bituminous concrete mixtures designated under these specifications will be sampled once per subplot on a statistically random basis, tested, and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following acceptance guidelines:

TABLE 490.03E - ACCEPTANCE GUIDELINES

PROPERTIES	POINT OF SAMPLING	LOT SIZE	SUBLOT SIZE	TEST METHOD
Air Voids	Truck at Plant	3000 Metric Ton (Ton)	500 Metric Ton (Ton)	AASHTO T 269 (T 166, T 209)

1 - Reference Subsection 106.03.
 2 - Varies based on projected lot size.

- (2) Lot Size. For the purpose of evaluating acceptance test properties, the representative tonnage of bituminous material within each lot shall be 3000 tons. The final resultant partial lot shall be processed as a full lot if it consists of four or more acceptance samples. If the final resultant partial lot consists of less than four acceptance samples, it will be combined with the previous lot.
- (3) Sublot Size. A subplot shall be 500 tons with the exception of the final subplot of a partial lot, which will consist of the quantity of material required to complete the partial lot.

- (4) Pay Factor (PF) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Level (RQL) of 50%, the PF for each lot of bituminous concrete mixture, based on “air voids” test results, will be determined using the following equation:

$$PF(av) = ((0.28PWL + 75) / 100) - 1.0$$

- (5) Rejectable Material.

- a. Rejection by Contractor. The Contractor may at any time elect to remove any defective material and replace it with new material at no expense to the Agency. Any such new material will be sampled, tested, and evaluated for acceptance.
- b. For those lots with a PWL less than 50% and greater than or equal to 25%, the PF for each lot of bituminous concrete mixture, based on “air voids” test results, will be determined using the following equation:

$$PF(av) = ((2.16PWL - 29)/100) - 1.0$$

For those lots with a PWL less than 25%, the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency.

- (f) Boxed Samples. If daily testing and inspection functions are required to comply with provisions of the Agency’s Quality Assurance Program and plant inspectors are not available to perform these tasks, then box samples will be taken by the Engineer at the project site to afford verification of mixture volumetrics/properties. Boxed samples will be processed at the Agency Central Laboratory in Berlin, Vermont and results reported to the Engineer.
- (g) Certification. For projects that are designated as Level 3 in accordance with the Agency’s Quality Assurance Program, a Type D Certification shall be furnished in accordance with Subsection 700.02 for each day’s production of material for non-mainline paving.

490.04 WEATHER AND SEASONAL LIMITATIONS. Superpave bituminous concrete pavement shall not be placed when the ambient air temperature and temperature at the paving site in the shade and away from artificial heat is below 5°C (40°F) for courses 35 mm (1 ¼ inches) or greater in compacted thickness or below 10°C (50°F) for courses less than 35 mm (1 ¼ inches) in compacted thickness.

Bituminous material shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

Bituminous material shall not be applied between November 1st and May 1st. Bituminous wearing course materials shall not be applied before May 15th or after October 15th.

When it is in the public interest, the Construction Engineer may adjust the ambient air temperature requirements, pavement temperature requirements, or extend the dates of the paving season.

490.05 BITUMINOUS MIXING PLANT AND TESTING. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold storage bins. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

All existing plants shall be inspected and obtain approval each construction season by an authorized representative of the Agency. Written notification shall be given for any plant which has not been inspected so that an authorized representative of the Agency may inspect and approve said plant prior to any mixing operation for Agency projects. A minimum of ten business days shall be allowed for the scheduling of the inspections. The plant shall be in operation at the time of inspection.

Plants used for the preparation of bituminous mixtures shall conform to all requirements specified in part (a) below, except that scale requirements shall apply only where mass (weight) proportioning is used. In addition, batch mixing plants shall conform to the requirements specified in part (b) below; continuous mixing plants shall conform to the requirements specified in part (c) below; and drum-mix plants shall conform to the requirements specified in part (d) below.

Scales for the weighing of materials shall conform to the restrictions specified herein and shall meet all specifications, tolerances, and regulations which have been or may be adopted periodically by the Director of Standards of the Vermont Department of Agriculture, and shall be subject to approval by the Materials and Research Engineer. The scales shall be checked and sealed as deemed necessary to assure accuracy.

Producers located outside Vermont shall observe all annual hopper scale mass, measurement, and seal requirements of their respective State or location.

- (a) Requirements for All Plants. The Contractor shall give the Engineer a two working day notice of intent to produce bituminous mixture so that arrangements can be made for plant inspection and control.

The plants shall be so designed, coordinated, and operated as to produce a uniform mixture within the mix design approved for the project.

The Contractor shall indemnify and hold the State harmless for any hazardous waste generated from plant operations in producing materials for use in Agency Contracts. The Contractor shall be responsible for properly disposing of such waste at no additional cost to the State.

All plants shall have automatic controls which coordinate the proportioning, timing, and discharge of mixture by the operation of a single switch or button. In addition to these controls, the plant shall have an approved recording system.

The recording system shall be capable of printing the total net mass (weight) of the load. Each weigh slip shall be automatically printed with the date and time of batching, shall show project and truck identification and shall indicate the approved mix design number being produced.

All originals of recorded data pertaining to the weighing or proportioning of bituminous concrete, after recording, shall become the property of the Agency.

- (1) Truck Scales. Approved truck scales shall be provided at each plant. The scale platform shall be of such length and width that it will conveniently accommodate all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft.

These scales may be used for spot checking the accuracy of the recording equipment. Any variance exceeding 0.5% of the net mass (weight) shall result in immediate corrective action by the Contractor.

A weatherproof building of sufficient size to house the scale operator and the Inspector shall be provided. It shall have adequate lighting, both natural and artificial, and it shall be adequately and safely heated.

If the Contractor's printer breaks down, the Contractor may continue to operate for the remainder of that day, provided the following conditions are met:

- a. The Engineer grants permission to operate and
- b. The Materials and Research Engineer assigns an Inspector to record the total aggregate and asphalt mass (weight) for each batch on the appropriate ticket.

- (2) Equipment for Preparation of Bituminous Material. Tanks for storage of bituminous material shall be insulated and capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications. The heating system shall provide uniform heating of the entire contents of the tanks.

Heating shall be accomplished by steam or oil coils, electricity, or other means so that no flame shall come in contact with the heating tank.

A circulating system for bituminous material shall be of adequate capacity to provide proper and continuous circulation between storage tank and the proportioning units during the entire operating period.

The discharge end of the circulating pipe shall be maintained below the surface of the bituminous material in the storage tank to prevent the discharging of hot bituminous material into the open air.

All pipe lines and fittings shall be steam or oil jacketed or otherwise properly insulated to prevent heat loss.

- (3) Feeder for Dryer. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregate into the dryer so that uniform production and uniform temperatures will be obtained.
- (4) Dryer. The dryer shall be capable of heating and drying the mineral aggregates to specification requirements without leaving any visible unburned oil or carbon residue on the aggregate when it is discharged from the dryer. Black smoke from the exhaust stack shall not be permitted. Drying shall continue until all moisture is removed. If unusually wet aggregate is being used, the input to the dryer shall be reduced to an amount which the dryer is capable of drying.
- (5) Screens. Plant screens shall have the capacity and size range to separate the aggregates into sizes for proportioning so that they may be recombined within the limits of the specifications. The screen over the "fines bin" shall have a maximum square opening of 5.0 mm (3/16 inch).

Slotted screens may be used when approved by the Materials and Research Engineer. Screens are not applicable to drum-mix plants.
- (6) Cold Storage Bins. The plant shall have cold bin storage of sufficient capacity to ensure a uniform and continuous operation.

The bins shall be so constructed as to prevent any intermingling of aggregate from one bin to another. The use of loaders or trucks which are larger in width than the bins being charged shall not be allowed. The blending of two or more aggregates in the same bin shall not be permitted.

For all bituminous concrete supplied for use on Agency projects, uniform feeding of all fine aggregates shall be accomplished by the use of a variable speed continuous belt feeder on each cold storage bin of fine aggregate.

- (7) Hot Bins. The plant shall include hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The hot storage shall consist of at least four bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

When more than 15% of the material is undersized for that bin, based on the sieve analysis of hot bins used in determining the job-mix formula, all bins shall be emptied and the cause for such condition shall be corrected.

Each bin shall be provided with a free-flowing overflow pipe of such size and at such a location as to prevent backing up of material into other bins or into contact with the screen. This overflow material shall not be fed back into the system or into any accepted stockpiles.

All bins shall be equipped with a sensor device to indicate the position of the aggregate in the bins at the lower quarter point. An automatic plant shutoff device shall operate to interrupt the batching process when any aggregate bin becomes empty.

Adequate additional dry storage shall be provided when mineral filler is required. The system shall have a device to feed the mineral filler accurately and uniformly at adjustable rates consistent with the percent required. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

Adequate and convenient facilities shall be provided to obtain representative aggregate samples from each bin. Hot bins are not applicable to drum-mix plants.

- (8) Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Metering devices for bitumen shall be accurate to within plus or minus two percent of the amount of bitumen delivered when tested for accuracy.

The section of the bitumen flow line between the charging valve and the spray bar shall be provided with a three-way valve and outlet whereby the rate of delivery of the metering device may be checked by actual mass.

Suitable means shall be provided, either by steam, oil-jacketing, or other insulation, for maintaining the specified temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

- (9) Thermometric Equipment. An armored thermometer shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit for accurately indicating the temperature of the bitumen.

The plant shall also be equipped with an approved recording thermometer, pyrometers, or other approved recording thermometric instruments placed at the discharge chute of the dryer.

The Materials and Research Engineer may reject questionable thermometric instruments, may direct replacement of any instrument with an approved temperature recording apparatus and may further require that daily temperature charts be filed with the Materials and Research Engineer.

- (10) Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time, unless otherwise approved by the Materials and Research Engineer.

- (11) Dust Collectors. The plant shall be equipped with adequate dust collectors so that exhaust will not be dispersed into the atmosphere. Provisions shall be made to waste or uniformly reintroduce all or any part of the heavier dust particles from primary collectors into the flow of aggregate.

The introduction of baghouse fines into bituminous concrete mixes will be allowed when the fines are introduced by an approved metering or weighing system which uniformly introduces the fines.

The Materials and Research Engineer has the authority to withdraw the approval for use of baghouse fines at any time that the bituminous concrete pavement mix provided by the Contractor is unsatisfactory as determined by the Materials and Research Engineer.

- (12) Testing Facilities. The Contractor shall provide a weatherproof building, with at least 22 square meters (240 square feet) of floor space, in which to house and use the testing equipment. This building shall be maintained for the use of the Agency Engineers or Inspectors, and shall be located so that details of the Contractor's plant are plainly visible from at least one window of the building. Adequate lighting, heating, and electrical connections shall be provided 24 hours per day. Proper means for ventilation shall be provided. The method of heating shall be such that a minimum temperature of 21°C (70°F) will be maintained at all times. Sanitary toilet facilities with lavatory, with proper sewage disposal, shall be furnished for the use of Agency personnel. Cleaning supplies shall be furnished by the Contractor. A private telephone service, dedicated for the use of Agency personnel, shall be provided in the laboratory. An internet connection that provides a minimum speed of 700 Kbps (Kilobits Per Second) download, without utilizing compression algorithms, shall be provided in the laboratory and dedicated for the use of Agency personnel. The connection bandwidth speed shall be verifiable using an online speed test.

The Contractor must have its office space separate from the office space used by Agency personnel. The Contractor's office space shall be located to afford privacy to Agency personnel.

A trailer type mobile laboratory may be used only in conjunction with a temporary plant. Any plant that occupies or has occupied the same location for more than one year will be classified as a permanent plant and will require a permanent building for a laboratory.

The facility shall be equipped with the following standard commercial quality equipment. Substitutes may be provided upon approval of the Materials and Research Engineer.

- One - Air conditioner for the capacity of the building capable of maintaining a maximum temperature below 25 °C (77°F).
- Two - Two kilogram (5 pound) minimum capacity fire extinguishers, either ABC Dry Chemical or Carbon Dioxide, of standard commercial quality.
- One - Standard office desk with drawers, locks, and keys, 1200 mm x 750 mm (4 feet x 2 ½ feet) (minimum dimensions).
- One - Adjustable office chair.
- Two - Adjustable drafting stools.
- One - Electric calculator, four function, ten column, with memory.
- Two - Bench sections and storage compartments. The benches shall be approximately 900 mm (36 inches) high, 600 mm (24 inches) wide and three meters (10 feet) long.
- One/Two - Approved exhaust fan(s) and hood(s) shall be provided over the stoves and extractors. The exhaust fan(s) shall be high volume axial flow, at least 300 mm (12 inches) in diameter.
- One - Water cooler with supply of potable water.
- One - Sink with faucet within the office, with a continuous supply of pressurized clean water for the duration of the project. The sink shall drain to the outside of the office.

With the exception of the electronic balance, the following equipment may be placed in a supplemental unit outside the plant's approved testing facility. Such supplemental work space and its location must be approved by the Materials and Research Engineer. All equipment must be firmly and securely attached to a stable base to ensure proper and accurate test results.

- One - Superpave Gyrotory Compactor (SGC) as specified in AASHTO T 312 "Standard Method of Test for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor"; and a minimum of two (2) specimen molds specifically designed for use with the SGC provided. Calibration of the SGC shall be done at the initial setup, whenever the unit is disrupted/moved, at the start of each construction season and as directed by the Materials and Research Engineer.
- One - Forced draft oven, thermostatically controlled, capable of maintaining any desired temperature setting from room temperature to 260 °C (500°F), to within 3 °C (37.4°F), and capable of holding two (2) SGC specimen molds upright and two (2) metal oven pans, with a surface area of 0.25 m² (2 1/3 ft²) each.
- One - Electronic balance, 10 kg (22 pound) minimum capacity, sensitive/readable to 0.1g (.0002 pound).
- One - Sand Equivalent Test (Clay Content) Apparatus setup; reference AASHTO T 176 (Mechanical Shaker Method, Section 5.3.1 of T176).
- Two - Metal oven pans having a surface area of approximately 0.25 m² (2 1/3 ft²).

The facility shall be further equipped with the following test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

- One - Motorized 3000 g (6.6 pound) centrifuge extractor with two small bowls with covers and two large bowls with covers, and/or an ignition oven that conforms to the apparatus requirements of AASHTO T 308 "Standard Method of Test for Determining the Asphalt Content of Hot-Mix Asphalt (HMA) by the Ignition Method" with the following related equipment: two full sets of sample basket(s), two catch pans, and one set of safety equipment as defined in T308.
- One - Full set of 200 mm (8 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.
- One - Full set of 300 mm (12 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.
- One - Motorized sieve shaker with either rocking and tapping action or circular and tapping action capable of holding at least six sieves and one pan.
- One - Mechanical aggregate shaker with a 0.028 m³ (1.0 ft³) capacity plus necessary screens. This may be placed in a separate enclosure outside of the trailer.
- One - Platform beam scale sensitive to 5.0 g (.01 pound) with a minimum capacity of 45 kg (100 pounds).
- One - Sample splitter, 63.5 mm (2 ½ inch) chute.
- Two - Square pointed shovels; one long handled, one short handled.
- Two - Double burner hot plates, variable temperature.
- Twelve - Tin pans, 267 mm x 267 mm x 25 mm (10 ½ inches x 10 ½ inches x 1 inch).
- One - 0.028 m³ (1.0 ft³) minimum capacity electric oven.
- One - Flat triangular trowel.
- One - Brass wire bristle brush.
- One - Standard floor brush.
- One - Standard table brush.
- Filter papers for duration of project.
- Two - 40 mm (1 ½ inch) soft bristle paint brushes.
- One - Automatic timer (interval 0 - 30 minutes).

- One - Sample Splitter (riffles) chute width 25 mm (1 inch).
- Two - Flexible spatulas with 150 mm (6 inch) long blade.
- One - 10 L (10 quart) pail.
- Two - Pair lined, heat resistant gloves.
- Two - Hand scoops (size #1).
- Two - Metal thermometers, 10 to 260°C (50 to 500°F), approximately 200 mm (8 inches) long with a 45 mm (1 ¾ inch) head.
- Two - Laboratory thermometers, capable of reading at least 60 °C in 1 °C (140°F in 2°F) increments.
- One - Cold chisel, approximately 40 mm (1 ½ inches) wide.
- Two - Volumetric flasks having a capacity of at least 2000 mL (68 ounces); for use with the flask, a rubber stopper and a connection, either molded in the flask or attached to the rubber stopper.
- Two - Volumetric flasks having a capacity of at least 4000 mL (135 ounces); for use with the flask, a rubber stopper and a connection, either molded in the flask or attached to the rubber stopper.
- One - Vacuum pump or water aspirator for evacuating air from the container. Vacuum system must be capable of removing entrapped air by subjecting the contents to a partial vacuum and maintaining a residual pressure of 3.7 ± 0.3 kPa (1.1 ± 0.1 inches Hg) absolute pressure for 15 ± 2 minutes. The vacuum system shall be equipped with a residual pressure manometer which reads in kilopascals (inches Hg) and a pressure release valve.
- One - Plastic funnel to introduce mix into volumetric flask.
- One - Syringe to adjust water level in flask.
Xylol for use as an asphalt solvent shall be furnished by the Contractor for the duration of the project.

For drum-mix plants, the facility shall be equipped with the following additional test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

- One - Microwave oven with a minimum interior volume of 0.028 m³ (1.0 ft³) with defrost as well as normal mode of operation.
- Six - Ovenproof glass dishes approximately 300 mm x 300 mm x 40 mm (12 inches x 12 inches x 1 ½ inches).

All of the foregoing testing equipment shall be in good condition, calibrated and/or verified according to the Contractor's QC Plan schedule and /or the Agency provided schedule as applicable, and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The above mentioned equipment is for a one plant operation only. In the event the Contractor chooses to use more than one plant, the Contractor shall provide adequate laboratory facilities as deemed necessary by the Materials and Research Engineer for making tests.

- (13) Safety Requirements. Adequate and safe stairways to the mixer platform shall be provided, and guarded ladders to other plant units shall be located where required for accessibility to plant operations.

All heated pipe lines adjacent to work areas, gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space.

This space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. Adequate overhead protection shall be provided where necessary.

- (14) Surge or Storage Bins. Surge or storage bins will be permitted for use in the production of bituminous items provided they are approved and inspected by the Materials and Research Engineer. A surge or storage bin shall be capable of storing the mix without any degradation of its properties. The surge or storage bins shall be covered during inclement weather to protect the stored mix from the elements. Should circumstances preclude paving operations, the Agency will not be obligated to purchase mix remaining in a surge or storage bin.

For continuous mixing and drum-mix plants, an approved recording weigh system shall be used on all surge bins.

When a surge bin is used in conjunction with a batch plant, the determination of pay quantities for the applicable Contract item shall be in accordance with the following procedure:

- a. The plant will produce mix with the printer operating according to the standard requirements for this device. The mix will be deposited in the surge bin. A sequentially numbered ticket will be prepared for every normal load produced.
- b. As each truck is loaded from the surge bin, the driver will be given the ticket previously prepared when the mix was produced for that bin. The truck driver will then deliver the ticket to the paving Inspector upon reaching the paving site.

- c. The mass (weight) shown on the ticket will not be the actual mass (weight) of the mix contained in the truck since the truck was loaded from the surge bin. The bin shall be completely emptied at the end of every day, circumstances permitting, and all tickets delivered to the paving Inspector.
- d. Any rejected or held over material shall be weighed on the platform truck scales. This quantity shall be deducted from the daily totals.
- e. When paving ramps or other areas where a definite quantity is desired, the material required will be weighed on the platform scales and appropriate adjustments made in the daily totals obtained from the printer. These masses (weights) will be entered on the ticket or a separate ticket provided.
- f. The plant Inspector will sign the first slip of each day instead of initialing it. If the Inspector changes during the day, this procedure will be followed for each change. At the end of each day, the plant Inspector will inspect the storage bin to determine that it is empty and so note on the last ticket.
- g. The paving Inspector will acknowledge receipt of the material at the paving site by initialing the lower right-hand corner of the ticket.
- h. All standard checks of the weighing apparatus at the plant will be made at the prescribed intervals.

- i. All mix produced for commercial customers and/or other projects must be discharged from bins other than those used for this project or directly from the pugmill into the haul vehicle; such mix shall not be loaded from the bin used for this project.
- j. All surge bins shall be emptied each day unless written permission is obtained from the Materials and Research Engineer.

(b) Requirements for Batching Plants.

- (1) Weigh Box or Hopper. The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over.

The weigh box or hopper shall be supported on fulcrums and knife edges constructed so that they will not be easily thrown out of alignment or adjustment.

All edges, ends, and sides of weighing hoppers shall be free from contact with any supporting rods or columns or other equipment that will in any way affect proper functioning of the hopper. Also, there shall be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials.

The discharge gate of the weigh box shall be hung so that the aggregate will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing the next batch.

- (2) Aggregate Scales. Scales for any weigh box or hopper shall be springles dial or load cell with digital readout and shall be of standard make and design sensitive to 0.1% of the maximum load that may be required.

Dials shall be free of vibration and shall be so located to be plainly visible and readable to the operator at all times.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of ten 20 kg (50 pound) test masses (weights) or by other methods approved by the Materials and Research Engineer. All test masses (weights) shall be certified annually by the Division of Weights and Measures.

- (3) Bitumen Bucket. The bucket for weighing bitumen shall be of sufficient capacity to hold and weigh the amount required for a batch in a single weighing. The filling system and bucket shall be designed, sized, and shaped so that bitumen will not overflow, splash, or spill outside the confines of the bucket during filling and weighing.

The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units. It shall be able to deliver the bitumen in a thin uniform sheet or in multiple sprays over the full length of the mixer within a period of 15 consecutive seconds.

- (4) Bitumen Scales. Bituminous material shall be weighed on scales that conform to the specifications for the weighing of aggregate. The value of the minimum graduation shall not exceed 1.0 kg (2.0 pounds).
- (5) Mixer Unit for Batch Method. The plant shall include an approved, twin pugmill type batch mixer, jacketed or insulated and capable of producing a uniform mixture within the applicable job-mix tolerance. The mixer shall be so constructed as to prevent leakage and designed to provide a means of adjusting clearance between the mixer blades and liner plates.
- (6) Recording. The recording system of the batch plant shall print the mass (weight) of the bitumen, the mass (weight) of the aggregate, and the total combined mass (weight) of both in addition to printing the combined net mass (weight) of each load.

- (c) Requirements for Continuous Mixing Plants.
- (1) Aggregate Proportioning. The plant shall be able to accurately proportion aggregate from each bin by mass (weight). The unit shall include interlocked feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to control the rate of flow of aggregate from each bin compartment. The opening shall be rectangular with one dimension adjustable by positive mechanical means. Locks shall be provided on each gate. Calibrated gauges with minimum graduations not exceeding 2.5 mm (0.1 inches) shall be provided for each gate to establish gate openings.
 - (2) Calibration of Aggregate Feed. The plant shall include a method to calibrate gate openings by means of test samples. The materials fed out of the bins through separate openings shall be bypassed to a suitable test box with the material for each compartment being confined in a separate box section. The plant shall be able to conveniently handle such test samples with a mass (weight) of up to 365 kg (800 pounds) and to weigh them on accurate scales.
 - (3) Synchronization of Aggregate Feed and Bituminous Feed. Satisfactory interlocking control of the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source shall be provided. This control shall be accomplished by interlocking mechanical means or by another method under the Materials and Research Engineer's control and approved by the Materials and Research Engineer.
 - (4) Mixer. The plant shall include an approved twin pugmill type continuous mixer, insulated or jacketed, and capable of producing a uniform mixture within the applicable job-mix tolerance. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix.

The mixer shall carry a manufacturer's plate indicating the net volumetric contents at several heights on a permanent gauge. The plate shall also indicate the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by the following formula:

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in kilograms (pounds)}}{\text{Pugmill output in kilograms (pounds) per second}}$$

The masses (weights) shall be determined by tests made under the direction of the Materials and Research Engineer.

(d) Requirements for Drum-Mix Plants.

- (1) Aggregate Cold Bin Feeders. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. The feeding orifice shall be adjustable. Gravity type feeders will not be permitted. Indicators graduated to not more than 2.5 mm (0.1 inch) shall be provided on each orifice. Each aggregate feeder shall be interlocked so that production is interrupted if one or more cold bins become empty or the flow is obstructed.
- (2) Mineral Filler System. When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall be able to feed the mineral filler at adjustable rates accurately and uniformly.

The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed. The filler shall be fed so that no filler is lost in the form of fugitive dust.

- (3) Aggregate Weighing Equipment. All aggregates, including mineral filler, shall be weighed by a continuous weighing device, either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of the National Bureau of Standards Handbook 44 and shall be installed according to the scale manufacturer's recommendations by a technician licensed by the Division of Weights and Measures. Any other type of weighing device shall be approved by the Materials and Research Engineer prior to use.
- (4) Bitumen Control Unit. The bitumen shall be proportioned by a meter. A flow switch designed to interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to 16 °C (60°F).
- (5) Proportioning Controls. All proportioning controls for aggregates, mineral filler, and bitumen shall be located at the panel which controls the mixer and temperature. The panel shall have a master control capable of increasing or decreasing the production rate without having to reset the individual controls.
 - a. Aggregate Feed Rate Control. The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The control shall maintain an aggregate flow accuracy such that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total mass (weight) of bituminous mixture per interval of time. When separate addition of mineral filler is required, it shall be added with an accuracy of 0.5% on the basis stated above for aggregates. The rate of aggregate flow shall be displayed on a meter and it shall be based on mass (weight) or percentage of dry aggregates.

- b. Aggregate Mass (Weight) Indicator. The plant shall have an aggregate mass (weight) indicator which will display in the control room the mass of combined aggregates and mineral filler; it shall continuously accumulate the dry aggregate mass (weight) of material during the production period, generally one day. The indicator shall be resettable to zero and lockable.
- c. Aggregate Moisture Compensator. The plant shall have a moisture compensation device capable of electronically changing the wet mass (weight) of aggregate to dry aggregate mass (weight). The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1%.
- d. Bitumen Control. The plant shall have a bitumen control capable of presetting the actual bitumen content directly as a percentage based on total mass (weight) of mixture. The maximum gradation on the bitumen control shall be 0.1%. The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.
- e. Bitumen Quantity Indicator. The plant shall have a bitumen quantity indicator in the control room indicating the accumulated quantity of bitumen during the production period, generally one day. The quantity indicated may be either mass (weight) or volume at 16 °C (60°F). The indicator shall be resettable to zero and lockable.

- (6) Recording of Proportions. The plant shall be equipped with an automatic digital recording device approved by the Materials and Research Engineer that simultaneously records the accumulated mass (weight) of dry aggregate and bitumen separately during production time and on demand. All recordings shall show the date, including day, month, and year, and time to the nearest minute for each print. The original recordings shall be come the property of the Agency.
- (7) Calibration of Feed Rates. The feed rates of aggregates from the cold bins, mineral filler when used and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous weighing device and the bitumen through the meter, respectively. The feed rates shall be checked periodically or at the direction of the Materials and Research Engineer.
- (8) Automatic Aggregate Sampling Device. The plant shall have an automatic aggregate sampling device which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing.

The sampling tray shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

- (9) Mixer Unit. The plan shall have a drum mixer, approved by the Materials and Research Engineer, having an automatic burner control and capable of producing a uniform mixture within the job-mix tolerances. The mixture shall be discharged into a hot bituminous surge or storage bin meeting the requirements of this Section.

490.06 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be uniformly heated to the specified temperature. A continuous supply of the bituminous material shall be provided to the mixer at a uniform temperature at all times.

490.07 PREPARATION OF AGGREGATES. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid depositing soot or unburned fuel on the aggregate.

Immediately after heating, the aggregates shall be screened and conveyed into separate bins ready for batching and mixing with bituminous material.

If required to meet the gradation requirements, mineral filler shall be added in a manner approved by the Materials and Research Engineer after the aggregates have passed through the dryer.

The above preparation of aggregates does not apply for drum-mix plants.

490.08 MIXING. The dried aggregates shall be combined with the bituminous material in a manner that will produce a mixture which, when discharged from the mixing unit, shall be at the temperature specified on the approved mix design unless otherwise directed by the Materials and Research Engineer.

The dried aggregates shall be combined in the mixer in the appropriate proportions required to meet the job-mix formula and thoroughly mixed prior to adding the bituminous material. Dry mix times shall be increased as deemed necessary by the Materials and Research Engineer in such cases that RAP material is introduced into the mixer.

The bituminous material shall be measured and introduced into the mixer in the amount determined by the Materials and Research Engineer for the material being used and at a temperature in accordance with Subsection 702.06, unless otherwise directed by the Materials and Research Engineer.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, 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 obtained. The wet mixing time shall be regulated by the Materials and Research Engineer and a suitable locking mechanism shall be provided for such regulation.

All plants shall have a means of eliminating oversized and foreign material from being incorporated into the mixer.

490.09 HAULING EQUIPMENT. To prevent the mixture from adhering to the beds, trucks used for hauling bituminous mixture shall have tight, clean, and smooth metal beds which have been thinly coated with a bond release agent. Petroleum based products will not be permitted.

The trucks used for hauling bituminous mixture shall be compatible with the equipment used for placing the bituminous mixture. Trucks are not to be cleaned and/or emptied on surfaces to be paved.

Each truck shall have a cover of canvas or other suitable material of sufficient size to extend over all sides of the haul vehicle to afford protecting the mix from the weather. When necessary to assure placement of material at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

490.10 PLACING EQUIPMENT. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly capable of being heated if necessary and capable of spreading the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross sectional shape.

Pavers shall be in good mechanical condition, equipped with all necessary attachments, and designed to operate electronically for controlling the grade of the finished surface. Bituminous pavers shall distribute the mixture over the entire width or over such partial width as may be practical. Additionally, pavers shall be equipped such that, upon extension of the screed a distance of 450 mm (18 inches) or more, auger extensions shall be used as directed by the Engineer.

The adjustments and attachments of the paver shall be checked and approved by the Engineer before placement of bituminous material.

Bituminous concrete pavers shall be equipped with a sloped plate to produce a tapered or notched tapered edge at longitudinal joints. The sloped plate shall produce a tapered or notched tapered edge having a minimum face slope of 1 vertical: 3 horizontal. The plate shall be able to accommodate compacted mat thicknesses from 35 mm to 100 mm (1 ¼ inches to 4 inches). The bottom of the sloped plate shall be mounted 10 mm to 15 mm (¾ inch to ½ inch) above the existing pavement.

Bituminous pavers shall be equipped with a joint heater of at least 6250 BTU/min (110,000 W) capacity to heat the longitudinal edge of the previously placed mat to a surface temperature of 95 °C (200°F), or higher if necessary, to achieve bonding of the newly placed mat with the previously placed mat without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately ahead of the screed. The joint heater shall be equipped with automated controls which shut off the burners when the paving machine stops and reignites them with the forward movement of the paver. The joint heater shall heat the entire area of the previously placed wedge to the required temperature. Heating to the point of 95 °C (200°F) or higher shall immediately precede placement of the bituminous material.

490.11 ROLLERS. Rollers shall be in good mechanical condition, operated by competent personnel, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The mass (weight) of the rollers shall be sufficient to compact the mixture to the required density without crushing the aggregate. Rollers shall be equipped with tanks and sprinkling bars for wetting the rolls or tires.

Pneumatic-tired rollers shall be equipped with appropriate skirts at all times and be preheated prior to use in order to avoid picking. The Contractor shall remove all picked material from the surface.

Vibratory rollers shall have separate controls for energy and propulsion. They shall be equipped with automatic cutoffs that stop the vibration prior to the roller stopping and/or reversing its direction of travel.

490.12 CONDITIONING OF EXISTING SURFACE. All surfaces shall be cleaned and sprayed with an emulsion meeting the requirements of Emulsified Asphalt, RS-1 before placing of any bituminous mixture, unless otherwise ordered by the Engineer. The emulsion shall be applied under pressure at a rate of 0.05 to 0.14 L/m² (0.01 to 0.03 gallons/yd²). The application shall be made just prior to the placement of the bituminous concrete mixture and shall progress sufficiently ahead of the paving so that the surface to be paved will be “tacky”. Equipment used to apply the emulsion shall meet the requirements for distributors specified in Subsection 404.04.

Prior to paving, bridge decks shall be treated as detailed on the Plans. Prior to paving, all large cracks in the bituminous surface shall be thoroughly cleaned and filled with a bituminous material or mixture approved by the Engineer. Large cracks are defined as at least 25 mm (1 inch) in width.

Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Emulsified Asphalt, RS-1 immediately before the bituminous concrete mixture is placed against them.

If there are deficiencies that require corrective action in the base course constructed under the Contract, a bituminous concrete mix approved by the Engineer shall be used to bring the base course to the designed grade and contour.

Where Superpave Bituminous Concrete Pavement is used to resurface existing pavements and the existing pavement contains irregularities, depressions, or waves, such deficiencies shall be eliminated by the use of extra bituminous material for spot leveling to bring existing base to uniform section and grade before placing of the required courses of bituminous concrete.

490.13 PLACING AND FINISHING. The finished surface shall be of uniform texture and evenness and shall not show tearing, shoving, or pulling of the mixture.

At the time of discharge from the haul vehicle, the bituminous mixture shall be within 6 °C (10°F) of the compaction temperature for the approved mix design.

The Contractor shall, during all phases of the paving operation, protect from damage all exposed surfaces which are not to be treated.

The bituminous mixture shall be placed and finished with the specified equipment, shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness and shall conform to the grade and elevation specified.

When operating in tandem on multi-lane paving, the pavers shall be of the same type and have the same characteristics. Material for leveling may be spread by the use of a grader, if approved by the Engineer.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, luted, and compacted by hand methods.

All material shall be produced early enough in the day in order that the completion of spreading and compaction of the mixture will occur during daylight hours, unless night paving has been approved for the project.

No traffic will be permitted on placed material until the material has been thoroughly compacted and has cooled to 60 °C (140°F) unless otherwise authorized by the Engineer.

The use of water to cool the pavement will not be permitted.

The Agency may require that all work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, be completed prior to placing the wearing course when such work could cause damage to the pavement.

When bituminous concrete pavement is to be placed on a bridge deck having a waterproofing membrane, a rubber-tired or rubber tracked paver shall be used to place the binder course of pavement.

On projects where traffic will be maintained, the Contractor may be required to schedule daily paving operations such that at the end of each work day all travel lanes of the roadway on which work is being performed will be paved to the same limits or as directed by the Engineer.

Suitable permanent aprons or temporary fillets shall be constructed at side road intersections and driveways as directed by the Engineer within 24 hours of adjacent mainline paving. Permanent aprons shall be constructed within 5 working days of adjacent mainline paving. Reasonable access to and from the mainline mat shall be maintained at all times.

490.14 COMPACTION. 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, tearing, or shoving. Should the mix exhibit these characteristics, and the Contractor is unable to remedy these conditions to the satisfaction of the Engineer, both placement and approval of the mix design will be terminated.

The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally, one breakdown roller will be needed for each paver used in the spreading operation.

Leveling courses shall be compacted using a self-propelled pneumatic-tired roller unless otherwise directed in writing by the Engineer. On base, binder, and wearing course, the initial or breakdown rolling shall be done by using a two-axle tandem roller; intermediate rolling shall be done by using a two-axle tandem roller or self-propelled pneumatic-tired roller; and final rolling shall be done by using an additional two or three-axle tandem roller. The equipment used for shoulder construction shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

To prevent adhesion of the mixture to the rollers, the rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid and petroleum products will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hand tampers, smoothing irons or mechanical tampers coated with a non-petroleum based bond release agent. On depressed areas, a trench roller or cleated compression strips under the roller may be used to transmit compression to the depressed area.

Other combinations of rollers and/or methods of compacting may be used if approved in writing by the Engineer, provided the compaction requirements are met.

Unless otherwise directed, the longitudinal joint shall be rolled first and then rolling shall begin at the low side of the pavement and proceed towards the center or high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller should be kept in as continuous an operation as practicable. Rolling shall continue until all roller marks and ridges have been eliminated.

Rollers shall not be stopped or parked on new, freshly placed bituminous material.

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 bitumen shall be removed and replaced. These replacements shall be at the Contractor's expense.

Should the Contractor choose to use vibratory rollers, the following additional criteria shall govern their operation:

Vibratory rollers may be used when operated at an amplitude, frequency, and speed that produces a mat conforming to specifications and which prevent the creation of transverse ridges in the mat. Vibratory rollers may be used as a breakdown roller, an intermediate roller, or a finish roller. They shall not be used as a substitute for a pneumatic-tired roller on leveling courses, nor shall they be used for compacting lifts of pavement under 25 mm (1 inch) in depth. A single vibratory roller shall not be used alone as the breakdown, intermediate, and finish roller, but may be used as any one of the rollers in the roller train.

If the Engineer determines that unsatisfactory compaction is being obtained, unacceptable surface distortion is occurring, or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment and proceed in accordance with the fourth paragraph of this Subsection. All requirements of this Subsection shall apply regardless of compaction equipment used.

The Contractor assumes full responsibility for, and shall repair at the Contractor's expense, all damages which may occur to highway components and adjacent property if vibratory compaction equipment is used.

If the Agency elects to not take cores of any pavement course, the Density Pay Factor (PF(d)) will be considered equal to 0.000.

Leveling courses will not be analyzed for density.

For projects less than or equal to 0.8 km (0.5 miles) in length, Superpave Bituminous Concrete Pavement will be analyzed for density according to the procedure specified below.

The density of the compacted pavement shall be at least 92.5%, but not more than 96.5%, of the corresponding daily average maximum specific gravity for each mix type (each mix design) of bituminous mix placed during each day. For material that falls outside of this range, payment will be made by adjusting the daily production totals in accordance with the following Table:

TABLE 490.14A – DENSITY PAY FACTORS

AVERAGE DENSITY	DENSITY PAY FACTOR, PF(d)
90.5% - 90.9%	- 0.100
91.0% - 91.4%	- 0.075
91.5% - 91.9%	- 0.050
92.0% - 92.4%	- 0.025
92.5% - 93.4%	0.000
93.4% - 95.4%	0.010
95.5% - 96.5%	0.000
96.6% - 97.0%	- 0.025
97.1% - 97.4%	- 0.050
97.5% - 98.0%	- 0.075
98.1% - 98.5%	- 0.100

For material with an average density that is less than 90.5% or in excess 98.5%, the Construction Engineer will evaluate whether the material will be removed and replaced by the Contractor at no expense to the Agency or a greater penalty imposed.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores extracted and provided by the Contractor.

Acceptance testing to verify density of the compacted pavement will be done by averaging the densities of a minimum of 4 cores for each day's production for each type of bituminous mix placed, excepting shim/leveling courses.

The cores taken for acceptance testing will be the final cores taken for determination of densities.

For projects greater than 0.8 km (0.5 miles) in length, Superpave Bituminous Concrete will be analyzed for density according to the procedures specified in Subsections 490.14 (a) and 490.14 (b).

- (a) Quality Level Analysis. Compacted bituminous concrete pavement specified to be sampled and tested using bituminous concrete pavement core samples for the purpose of determining density will be analyzed by utilizing the statistical quality level analysis "Percent Within Limits" (PWL) method as defined in Subsection 106.03.
- (b) Quality Acceptance.
 - (1) Bituminous concrete mixtures will be sampled once per subplot using a stratified random sampling procedure in accordance with ASTM D 3665 and tested and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following guidelines:

TABLE 490.14B – ACCEPTANCE GUIDELINES

PROPERTY	POINT OF SAMPLING	LOT SIZE	TEST METHOD
Density	Compacted In-Place	Daily – 24 Hour Max	AASHTO T166 Method A, T 209

- (2) For the purpose of evaluating acceptance test properties, a lot shall consist of the total quantity of bituminous concrete mixture compacted in-place during any one day's production to a maximum of 24 hours. Sampling shall be performed at the rate of one sample per lane kilometer (0.6 mile), with the exception that there shall not be fewer than six samples taken per any one days production. The quantity represented by each sample shall constitute a subplot.
- (3) Density Pay Factor (PF) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Limit (RQL) of 60%, the PF for each lot of Superpave bituminous concrete mixture, based on density test results, will be determined by using the applicable equation below:

Where $80 \leq \text{PWL} \leq 100$, $\text{PF}(d) = ((0.10 \text{ PWL} + 92) / 100) - 1.0$
 or
 Where $60 \leq \text{PWL} < 80$, $\text{PF}(d) = ((0.50 \text{ PWL} + 60) / 100) - 1.0$

The PF for each lot of Superpave bituminous concrete mixture used for low production activities not associated with any traveled way paving operation will be 1.0. Low production activities are defined as those not associated with traveled way paving operations and having a maximum daily production of 500 metric tons (tons) of Superpave bituminous concrete mixture.

- (4) The density of the compacted pavement shall not be less than 92.5% nor more than 96.5% of the corresponding maximum specific gravity for each mix type (each mix design) placed per lot.
 - (5) It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores provided by the Contractor in accordance with the coring protocol below.
- (c) Coring Protocol. Original core sampling locations will be restricted to traveled lanes only and will not include those areas within 150 mm (6 inches) of the top of a longitudinal joint nor within 15 m (50 feet) of a transverse joint. That area encompassing a longitudinal tapered joint will not be selected as a sampling location. Independent shoulder and mat area core sampling locations may be selected by the Engineer to afford verification of Subsection 490.14(b)(4).

Original core sampling locations will be selected by the Engineer or designee in accordance with ASTM D 3665 within two working days of the bituminous mixture being placed. The Contractor will be advised in writing of the selected sampling locations.

The Contractor may challenge whether any particular original sample location(s) is representative of any particular lot by notifying the Engineer. This notification shall be made immediately upon the subplot location(s) being selected, conveyed to the Contractor, and being prior to extracting the cores, and shall be further documented in any Contractor job records citing just reasoning for recommending a reselection of original sample location(s).

Upon receipt by the Engineer of a written challenge from the Contractor, the Engineer will evaluate it within one working day and notify the Contractor in writing of either acceptance or rejection of the challenge. Rejection of a challenge will result in the Engineer using the original core sampling locations for the determination of density data in any compaction pay factor calculations. Acceptance of a challenge will result in the Engineer selecting alternate core sampling location(s) for those challenged samples. Alternate core sampling location(s) will be selected by the Engineer by use of a new random number(s) to determine a new longitudinal coordinate(s) within the subplot in question. The transverse coordinate(s) of the original core sampling location(s) will be used in conjunction with the new longitudinal coordinate(s) to determine the alternate sampling location(s). The alternate core sampling location(s) will not be subject to further challenge and will be used for the determination of density data in any compaction pay factor calculations. The Contractor will be notified in writing of the final core sampling location(s).

Within one working day of final selection of the core sampling locations, the Contractor shall core in the presence of the Engineer or designee and shall deliver samples to the Engineer, in a suitable container provided by the Contractor, on the same day the samples are taken. The Engineer will identify and record the core samples. Any cores not delivered in a suitable container will be rejected and new cores taken at the Contractor's expense. The Contractor shall fill the core holes, at the Contractor's expense, with hot (minimum 90°C (200°F)) bituminous concrete pavement on the same day that the cores are taken. Failure to comply with the provisions of this paragraph may result in payment being withheld for the representative lot of bituminous material.

Cores, 150 mm (6 inch) in diameter, shall be taken in accordance with the 2004 version of AASHTO T 230, Method B. Agency personnel will process core samples within ten working days and will relay test results to both the Engineer and Contractor. Testing will be performed in accordance with AASHTO T 166, Method A for bulk specific gravity (B) and AASHTO T 209 for maximum specific gravity (M) from tests performed at the plant lab for that day. All cores will be sawcut. The Contractor shall mark the cores for sawcutting in the presence of the Engineer or designee for verification of cut locations. The degree of compaction (DC) will be determined as follows:

$$DC = (B/M) \times 100$$

To satisfy the requirements of part (d) of this Subsection, physical core samples will be retained for a period of two working days from the time that DC test results are relayed to the Engineer and Contractor. In addition, any subsequently "retested" or "recored" samples, as defined in part (d), will be retained to the point of fully satisfying part (d).

- (d) Core Result Verification. Upon the test results required in part (c) being relayed to both parties (the Engineer and Contractor), any individual core sample result considered to be an outlier as determined by ASTM E 178 will enter a core result verification process as defined herein. This process will consider only those core samples processed by the Agency as acceptance tested samples and does not preclude the provisions of Subsection 490.14 (e).

The core result verification process consists of four levels as follows:

- (1) Level 1. The Agency will perform a statistical analysis on all lots of core sample compaction values to investigate any presence of statistical outlier(s) as determined in accordance with Table 1 of ASTM E 178 at a 5% significance level. In cases where a statistical outlier is not detected, all core sample results as reported under part (c) will be used in any compaction pay factor calculations.

When an outlier is determined to exist, the core sample representing that outlying result will be retested to ensure procedural integrity (support information accuracy, testing methodology, and mathematical accuracy). The core sample "retested" results will replace the original "outlier" core sample results for any future calculations within this Level. Should it be verified at this point that an outlier does in fact exist or the core sample retested results vary from those originally obtained, the options to either party will be either to compute any compaction pay factors using all core sample test results derived through this Level or to proceed to Level 2.

- (2) Level 2. Level 1 outlier core sample results will be replaced by virtue of "recored" sample results to be obtained under this Level. The recoring location shall be at the same transverse offset as the original location and shall be offset longitudinally forward 450 mm (18 inches) from the original location. The recored sample will be tested as specified in part (c) and may reenter Level 1 analysis of this Subsection up to and including the point of ensuring procedural integrity. The recored sample will not reenter Level 2 analysis.

Upon receiving recored sample test results of this Level, the options to either party will be either to compute any compaction pay factors using those recored sample test results or to state reasons for belief that said recored sample test results are in error. Receipt of reasons shall be cause for this verification process to proceed to Level 3.

- (3) Level 3. A final attempt at field resolution of core sample test results will be addressed under this Level by introduction of a third party testing facility. Selection of such a facility will be discussed and mutually agreed upon by both parties prior to beginning construction activities and will not be included in project QC or acceptance testing processes. Any findings of a third party facility will become final and will not be subject to further review. Payment to a third party for services rendered will be borne by the party having provided the Level 2 reason leading to Level 3.

The recored samples from Level 2 shall be provided to the third party testing facility. The facility will process the recored samples and provide results to both the Agency and Contractor. Upon receipt of the third party recored sample test results, the options to either party will be either to compute any compaction pay factors using these results or to proceed to Level 4.

- (4) Level 4. At this level, the Agency and Contractor will defer to Subsection 105.02. Both parties shall submit to the Director of Program Development a written report describing the disparity, all subsequent actions taken to date, all documentation related to these actions, and a proposed course of action for settlement. The Director will review the submittals and all relevant project records and act in accordance with Subsection 105.02.

If the Contractor does not concur with any final decision by the Director, the Contractor may seek other remedies specified under Subsection 105.02 and the Contract.

- (e) Rejected Material. For those lots with a PWL less than 60% and having satisfied the requirements of part (d), the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency provided one of the following are met:

- lot standard deviation (\bar{s}) greater than 2.0 or
- lot average density (\bar{x}) greater than 98.0% or
- lot average density (\bar{x}) less than 90.0%.

In addition, and at the discretion of the Contractor, any lot of rejected material not meeting any of the above criteria may be removed and replaced at no additional cost to the Agency. If removal and replacement is not implemented, any lot of rejected material not meeting any of the above conditions will have any compaction pay factors calculated as follows:

$$PF(d) = (-0.05625 \bar{x}^2 + 10.575 \bar{x} - 496.125) - 1.0$$

In such cases that this Subsection applies, any PF(d) as computed above will be the solitary pay adjustment to the representative lot as per the provisions of Subsections 490.18 and 490.19. Other applicable pay adjustments of the representative lot will be considered to equal 1.00.

490.15 JOINTS. Joints between old and new pavements, or between successive day's work, shall have a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a transverse joint constructed.

Transverse butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at a location approved by the Engineer, where the pavement has a true surface as determined by the use of a straightedge at least 4.9 m (16 feet) long. The transverse joint shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to depositing new paving mixture.

Transverse tapered joints shall be formed by ramping down the last 450 to 600 mm (18 to 24 inches) of the course being placed to match the lower surface. Care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to resuming paving. As the paver places new mixture on the taper area, placement shall proceed such that an evenly graduated deposit of mixture will complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake and properly rolled, with coarse material discarded.

Longitudinal joints that have become cold shall be coated with Emulsified Asphalt, RS-1 before the adjacent mat is placed. If directed by the Engineer, such joints shall be cut back to a clean vertical edge prior to coating with the emulsion.

Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 150 mm (6 inches) from any joint in the lower courses of pavement. Transverse joints shall not be constructed nearer than 300 mm (12 inches) from the transverse joints constructed in lower courses.

Those projects having a centerline length in excess of 5 km (3 miles) shall also be subject to the following provisions:

- (a) General. For the purpose of evaluating longitudinal joint compaction acceptance, a lot shall consist of the total project length of joint constructed per pavement course and total project quantity of bituminous concrete mixture compacted in place per pavement course. Sampling on constructed joints shall be performed by way of minimum 150 mm (6 inch) diameter core samples taken at the rate of two per joint kilometer (two per joint mile) per lot. Sample locations will not include those areas within 15 m (50 feet) of a transverse joint. Each individual core sample shall represent a project subplot. Once selected per that method in part (b) below, sample locations will become final and not subject to revision, nor will any core sample be subject to the provisions of Subsection 490.14 (d).

- (b) Sampling. Superpave Bituminous concrete mixtures will be sampled once per subplot on a stratified random sampling procedure in the longitudinal direction in accordance with ASTM D 3665. For a longitudinal butt joint, the transverse location of the sample shall be centered on the visible surface joint line. For a tapered joint, the transverse location of the sample shall be offset from the visible surface joint line approximately 50% of the taper width as directed by the Engineer. Joint core samples shall be taken between any adjacent travel lanes and between any travel lane and shoulder provided the shoulder material was placed as a separate construction operation. All samples will be tested and evaluated by the Agency for each mix type (each mix design), excluding leveling/shim courses, for each project in accordance with the following:

TABLE 490.15A – ACCEPTANCE GUIDELINES

Property	Point of Sampling	Lot Size	Test Method
Density	Compacted-In-Place	Project (1)	AASHTO T 166, Method A and T 209

For determining the degree of compaction, the maximum specific gravity (Gmm) used in the calculation shall be the average of the two Gmm values of the materials placed to construct the joint. The calculated compaction of any individual joint core sample shall not be less than 90.0% of the corresponding maximum specific gravity of the average of the two Gmm values for each mix type (each mix design) placed per lot.

- (c) Longitudinal Joint Pay Factor (PF(j)) Determination. In such case that an individual core sample (sublot) is above the minimum compaction as specified in part (b) above, it shall be defined as above minimum.

Upon completion of any individual lot, the percentage of sublots equal to or above the acceptable minimum compaction shall be defined as the lot Percent Above Minimum (PAM) and shall be used as the basis for determining pay factors as follows:

$$\begin{aligned} \text{For } 85 \leq \text{PAM} \leq 100, \text{ PF(j)} &= 0.01 \\ \text{For } 75 \leq \text{PAM} < 85, \text{ PF(j)} &= 0.00 \\ \text{For } 0 \leq \text{PAM} < 75, \text{ PF(j)} &= -0.01 \end{aligned}$$

490.16 SURFACE TOLERANCE. The surface will be tested by the Engineer using a straightedge at least 4.9 m (16 ft) in length at selected locations parallel with the centerline. Any variations exceeding 3 millimeters (1/8 inch) between any two contact points shall be satisfactorily eliminated. A straightedge at least 3 meters (10 feet) in length may be used on a vertical curve. The straightedges shall be provided by the Contractor in accordance with Subsection 631.06.

For those projects having a centerline length of 0.8 km (0.5 miles) or greater, the surface roughness of the wearing course will be additionally measured by the Engineer or the Engineer's designee with an Agency provided Road Surface Profiler (RSP) to determine a surface tolerance pay factor (PF(r)). The Engineer will contact the Agency's Pavement Management Section Project Manager to arrange for surface testing.

The surface will be tested by Agency personnel by traveling at highway speeds once in each direction on two-lane/two-way non-limited access State Highways and other Routes as applicable. For those two-way limited or non-limited access highways containing truck or passing lanes, only the rightmost lane will be tested in any given direction. The reported International Roughness Index (IRI) value will be the average as calculated based upon travel in both directions. Two-lane divided Interstate Highways and other applicable limited access highways will have both of the passing and travel lanes tested at highway speeds, with the reported IRI value being the average as calculated based upon travel in both lanes. For those Interstate or other applicable limited access highways having both barrels of the highway constituting the project, the reported IRI value will be that average value as calculated based on travel in both lanes of both barrels.

Prior to the highway being surface tested, all Contract items shall be complete such that the project could be deemed substantially complete, unless otherwise directed by the Engineer, including but not limited to all guardrail, bridge joints, and permanent pavement markings installed, including all side road markings, and there shall not be lane closures or equipment present that would impede highway travel. Additionally, and prior to the highway being surface tested, the highway surface shall be dry and free of snow, ice, and loose debris, and the ambient air temperature shall be a minimum of 5°C (40°F).

The roughness value used in the applicable formula below will be the average of the International Roughness Index (IRI) values measured by the RSP in each lane. The roughness associated with any anomalous features beyond the control of the Contractor, such as bridges that remain unpaved, will be eliminated from the calculations of the final project average. The corresponding Surface Tolerance Pay Factor (PF(r)) will be determined as follows and applied to the corresponding lot as defined below:

Limited Access Highways: $PF(r) = (-0.0029 \text{ IRI} + 1.1500) - 1.0$

All Other State Routes: $PF(r) = (-0.0029 \text{ IRI} + 1.1786) - 1.0$

For the purpose of evaluating surface tolerance acceptance, a lot shall consist of the total project quantity of wearing surface of bituminous concrete pavement constructed and measured in place. Said measurement shall include all shoulders, side roads, drives, and any other miscellaneous mix as measured by the Engineer.

490.17 TRAFFIC CONTROL. Whenever traffic must be maintained during a paving operation, uniformed traffic officers and/or flaggers shall be stationed at each end of the section being paved and at such other locations as may be required by the Engineer. The uniformed traffic officers or flaggers shall conform to the requirements of Section 630.

Whenever one-way traffic is maintained by the Contractor, the traveling public shall not be delayed more than 10 minutes unless otherwise directed by the Engineer. Two-way traffic shall be maintained during non-working hours.

490.18 METHOD OF MEASUREMENT. The quantity of Superpave Bituminous Concrete Pavement to be measured for payment will be the number of metric tons (tons) for a lot of mixture (each type) complete in place in the accepted work as determined from the weigh tickets.

The quantities of all applicable Pay Adjustments calculated for the project will be determined as specified below.

When applicable, and when the air voids pay factor, PF(av), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine an Air Voids Pay Adjustment, (PA(av)), to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(av) = PF(av) \times Q \times B$$

When boxed samples are taken to determine mix properties, PF(av) shall be assumed as equal to 1.000 for a "single day" lot. Additionally, when the RQL of 50% is not attained for a lot, all other applicable pay factors for that lot shall not be greater than 1.000.

When applicable, and when the density pay factor, PF(d), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Mat Density Pay Adjustment, (PA(d)), to the accepted tonnage placed (Q) for that based on the Contract bid price (B), as follows:

$$PA(d) = PF(d) \times Q \times B$$

When applicable, and when the surface tolerance pay factor, PF(r), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of wearing surface of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Surface Tolerance Pay Adjustment, (PA(r)), to the tonnage placed (Q) for that lot per based on the Contract bid price (B), as follows:

$$PA(r) = PF(r) \times Q \times B$$

When applicable, and when the longitudinal joint pay factor, PF(j), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Longitudinal Joint Pay Adjustment, (PA(j)), to the tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(j) = PF(j) \times Q \times B$$

When the material for any lot is removed from the project under any provisions of the Contract, no payment will be made for that material nor for any applicable Pay Adjustments under this Section.

490.19 BASIS OF PAYMENT. The measured quantity of Superpave Bituminous Concrete Pavement will be paid for at the Contract unit price per metric ton (ton) Payment shall be full compensation for furnishing, mixing, hauling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for Pay Adjustments shall be debited or credited against the Contract prices (Lump Units) bid for the applicable Pay Adjustment items.

The costs of furnishing testing facilities and supplies at the plant will be considered included in the Contract unit price of Superpave Bituminous Concrete Pavement.

The costs of obtaining, furnishing, transporting, and providing the straightedges required by Subsection 490.16 will be paid for under the appropriate Section 631 pay item included in the Contract.

The cost of taking cores for acceptance testing and filling the core holes will be incidental to the Contract item being cored. All other costs associated with obtaining samples for acceptance testing will be incidental to the cost of the Section 490 pay item. The cost of traffic control for taking cores for acceptance testing and filling the core holes will be paid under the appropriate Section 630 Contract item.

When not specified as items in the Contract, the costs of cleaning and filling joints and cracks, sweeping and cleaning existing paved surfaces, the emulsified asphalt applied to tack these surfaces, and tacking of manholes, curbing, gutters, and other contact surfaces will not be paid for directly, but will be incidental to the item Superpave Bituminous Concrete Pavement.

Superpave bituminous concrete mixture approved by the Engineer for use in correcting deficiencies in the base course constructed as part of the Contract will not be paid for as Superpave Bituminous Concrete Pavement, but will be incidental to the Contract item for the specified type of base course.

Superpave bituminous concrete mixture used to correct deficiencies in an existing pavement or to adjust the grade of a bituminous concrete surface completed under the Contract will be paid for at the Contract unit price for Superpave Bituminous Concrete Pavement.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
490.30 Superpave Bituminous Concrete Pavement	Metric Ton (Ton)
490.31 Air Voids Pay Adjustment	Lump Unit
490.32 Mat Density Pay Adjustment	Lump Unit
490.33 Surface Tolerance Pay Adjustment	Lump Unit
490.34 Longitudinal Joint Compaction Pay Adjustment	Lump Unit