

## ITEM P-401 PLANT HOT MIX ASPHALT

### DESCRIPTION

**401-1.1** This item shall consist of mineral aggregate and asphalt cement, mixed in a central mixing plant and placed on a prepared surface according to these Specifications; and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the Plans. Each layer shall be constructed to the depth, typical section, or elevation required by the Plans and shall be rolled, finished, and approved before the placement of the next layer.

### 401-1.2 ACRONYMS.

AASHTO	American Association of State Highway and Transportation Officials
ATM	Alaska Test Method
CPF	Composite Pay Factor
DPF	Density Pay Factor
HMA	Hot Mix Asphalt
JMD	Job Mix Design
MSG	Theoretical Maximum Specific Gravity
PAB	Price Adjustment Base
PRF	Pay Reduction Factor
RAP	Reclaimed Asphalt Pavment
TV	Target Value
WAQTC	Western Alliance for Quality in Transportation Construction

### MATERIALS

**401-2.1 AGGREGATE.** Aggregates shall consist of crushed stone or crushed gravel with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 4 sieve is coarse aggregate. The portion passing the No. 4 sieve and retained on the No. 200 sieve is fine aggregate, and the portion passing the No. 200 sieve is mineral filler.

- a. **Coarse Aggregate.** Coarse aggregate shall consist of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating and bonding with the asphalt cement and be free from organic matter and other deleterious substances. The percentage of wear shall not be greater than 40% when tested according to AASHTO T 96. The sodium sulfate soundness loss shall not exceed 10%, or the magnesium sulfate soundness loss shall not exceed 13%, after 5 cycles, when tested according to AASHTO T 104. The aggregate shall have a minimum degradation value of 30 when tested according to ATM 313.

The blended coarse aggregate shall have at least 90% by weight 2 fractured faces as determined by WAQTC FOP for AASHTO TP 61 and contain not more than 8%, by weight, of flat and elongated particles, when tested according to ATM 306. The ratio of the calipers used to determine flat and elongated particles will be set to 1:5.

- b. **Fine Aggregate.** Fine aggregate shall consist of clean, sound, durable, angular shaped particles produced by crushing stone, slag, or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls.

Natural (nonmanufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the hot mix asphalt. The amount of sand to be added shall be adjusted to produce hot mix asphalt conforming to requirements of this specification. The fine aggregate shall not contain more than 20% natural sand by weight of total aggregates.

The blended fine aggregate shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 when tested according to WAQTC FOPs for AASHTO T 89 and AASHTO T 90, and sand equivalent values of 35 or greater when tested according to WAQTC FOP for AASHTO T 176.

- c. **Sampling.** The Engineer will sample according to WAQTC FOP for AASHTO T 2 for coarse and fine aggregate, and according to AASHTO T 127 for mineral filler.

**401-2.2 MINERAL FILLER.** If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of AASHTO M 17.

**401-2.3 ASPHALT CEMENT.** Asphalt cement shall meet the following property requirements:

**TABLE 1. ASPHALT CEMENT PROPERTY REQUIREMENTS**

Performance Grade AASHTO M 320	Mix Design Class	Softening Point AASHTO T 53	Toughness ASTM D 5801	Tenacity ASTM D 5801
PG 52-28	A, B	N/A	N/A	N/A
PG 58-28	C, D	120° F, min.	110 in lbs, min.	75 in lbs, min.
PG 64-28	E, F	125° F, min.	110 in lbs, min.	75 in lbs, min.

The Contractor shall furnish a vendor's certificate of compliance and certified test reports for each lot of asphalt cement shipped to the project. The test reports shall also note the storage tanks used for each lot. Anti-strip additives required by the job mix design shall be added during load out for delivery to the project and a printed weight ticket for anti-strip shall be included with the asphalt cement weight ticket. The location where anti-strip is added may be changed with the written approval of the Engineer.

The following documents shall be furnished at delivery:

- a. Manufacturer's certificate of compliance.
- b. Certified test reports for the lot.
- c. Lot number, storage tanks, and shipping containers (if applicable) used.
- d. Date and time of load out for delivery.
- e. Type, grade, temperature, and quantity of asphalt cement loaded.
- f. Type and percent of anti-strip added.

All excess asphalt cement shall remain the property of the Contractor. Removal of excess asphalt cement from the project area is subsidiary to the contract and no separate payment will be made.

**401-2.4 PRELIMINARY MATERIAL ACCEPTANCE.** Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

- a. **Coarse Aggregate.**
  - (1) Percent of wear.
  - (2) Soundness.
  - (3) Degradation.
  - (4) Percent of fracture.
  - (5) Percent of flat and elongated particles.
- b. **Fine Aggregate.**

- (1) Liquid limit.
- (2) Plastic index.
- (3) Sand equivalent.

**c. Mineral Filler.**

- (1) Gradation
- (2) Plastic Index
- (3) Organic content

- d. Asphalt Cement.** The certification(s) shall show the appropriate test(s) for each material, the test results, and a statement that the material meets the specification requirement.

The Engineer will collect samples for testing, prior to and during hot mix asphalt production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

### COMPOSITION

**401-3.1 COMPOSITION OF HOT MIX ASPHALT.** The hot mix asphalt shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt cement. The several aggregate fractions shall be sized, handled in a minimum of three separate size stockpiles (coarse, intermediate, fine), and combined in such proportions that the resulting mixture meets the grading requirements of the job mix design.

**401-3.2 JOB MIX DESIGN.** No hot mix asphalt for payment shall be produced until a job mix design (JMD) has been approved by the Engineer. The hot mix asphalt (HMA) shall be designed using procedures contained in ATM 417, "Chapter 5, *Marshall Method of Mix Design*, of the Asphalt Institute's Manual Series No. 2 (MS-2), *Mix Design Methods for Asphalt Concrete*", and shall meet the requirements of Tables 2 and 3.

Anti-stripping agent shall be added to the asphalt cement in the amount determined by ATM 414. Anti-stripping agent is subsidiary to the asphalt cement pay item.

Contractor Furnished Job Mix Design. The Contractor may elect to furnish JMDs for each Type and Class of HMA specified. The JMDs shall be submitted in writing by the Contractor to the Engineer at least 15 calendar days prior to the start of paving operations and shall include as a minimum:

- a. Target gradation – percent passing each sieve size.
- b. Optimum asphalt cement content.
- c. Asphalt cement performance grade.
- d. Number of blows of hammer compaction per side of molded specimen.
- e. Mixing temperature range – from temperature-viscosity relationship, or manufacturers recommendations.
- f. Compaction temperature range.
- g. Plot of the combined gradation on the Federal Highway Administration (FHWA) 45 power gradation curve.
- h. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt cement content.
- i. Percent natural sand.
- j. Percent fractured faces.
- k. Percent flat and elongated.
- l. Brand and percentage of antistrip agent (if required).
- m. Theoretical Maximum Specific Gravity (MSG).
- n. Signature of a Professional Engineer registered in the State Of Alaska.

The Engineer has authority to review submitted JMDs and to reject JMDs that do not meet specifications. The Contractor shall submit samples to the Engineer, upon request, for JMD verification testing.

Department Designed Job Mix Design. The JMD may be designed by the Department. The Contractor shall submit representative samples of all materials at least 15 calendar days prior to the start of paving operations along with the hot mix asphalt target gradation and aggregate blend ratio.

The Contractor shall:

- a. Furnish representative samples from each aggregate size group in the proportions required for the proposed JMD gradation for a total of 500 pounds. Include gradations for the individual aggregate stockpiles and supporting process control information.
- b. Furnish 5 separate 1-gallon samples of the asphalt cement proposed for use in the JMD with conformance test reports, a Manufacturer's certificate of compliance, current Material Safety Data Sheet (MSDS), and a temperature-viscosity relationship or Manufacturer's recommended mixing and compaction temperatures.
- c. Furnish a minimum of one-half pint of the anti-strip additive proposed for use in the JMD with Manufacturer's data sheet and current MSDS.

The Department will furnish one JMD, that meets specifications, for each Type and Class of HMA specified. If additional JMDs are required, the Engineer will assess a fee of \$2,500.00 under Contract Item P-401b, Hot Mix Asphalt Price Adjustment, for each additional JMD furnished.

Job Mix Design Requirements.

**TABLE 2. MIX DESIGN REQUIREMENTS**

<b>Test Property</b>	<b>Class A, C, E Pavements Designed for Aircraft Gross Weights of 60,000 Lbs. or More or Tire Pressures of 100 Psi or More</b>	<b>Class B, D, F Pavements Designed for Aircraft Gross Weight Less Than 60,000 Lbs. or Tire Pressure Less Than 100 Psi</b>
Number of blows	75	50
Stability, pounds	2150	1350
Flow, 0.01 inch	10-14	10-18
Air voids %	2.8-4.2	2.8-4.2
Voids in mineral aggregate, %, min.	See Table 3	See Table 3
Asphalt Cement Content, %, min.	5.0	5.0

**TABLE 3. MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE**

<b>Maximum Particle Size Inch</b>	<b>Voids in Mineral Aggregate, %, Minimum</b>
1/2	14.0
3/4	13.0
1	12.0

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradation or gradations specified in Table 4 when tested according to WAQTC FOP for AASHTO T 27/T 11.

The gradations in Table 4 represent the limits that shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as selected (and used in the JMD), shall have a gradation within the limits designated in Table 4 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine when tested according to WAQTC FOP for AASHTO T 27/T 11.

For acceptance testing, the asphalt cement content and aggregate gradation from the JMD will have the full tolerance limits for individual measurements as specified in Table 6 applied. Except for the No. 200 sieve, the limits apply even if they fall outside the master grading band in Table 4. The limits for the No. 200 sieve will be confined by the master grading band in Table 4. Tolerance limits will not be applied to the largest sieve specified.

The maximum size aggregate used shall not be more than one-half of the thickness of the layer being constructed.

**TABLE 4. HOT MIX ASPHALT AGGREGATE**

Sieve Size	Percentage by Weight Passing Sieves		
	Type I 1.00 inch max	Type II 0.75 inch max	Type III 0.50 inch max
1 in.	100	--	--
3/4 in.	80-90	100	--
1/2 in.	60-84	75-90	100
3/8 in.	48-78	60-84	80-90
No. 4	28-63	33-70	44-81
No. 8	14-55	19-56	26-70
No.16	9-44	10-44	16-59
No.30	6-34	7-34	9-49
No.50	5-24	5-24	6-36
No.100	4-16	4-16	4-22
No.200	3-7	3-7	3-7

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute Manual Series No. 2 (MS-2), Appendix A.

Changing the Job Mix Design. If the HMA fails to conform to Table 2 and 3, or if there are changes in the source of asphalt cement, source of aggregates, aggregate quality, aggregate gradation, or blend ratio, then a new JMD may be required by the Engineer. The Contractor shall submit changes and new samples, when required or directed, in the same manner as the original submittal.

No payment for material for which a new JMD is required, will be made until the new JMD is approved. Approved changes apply only to asphalt mixture produced after the submittal of the changes.

**401-3.3 RECYCLED HOT MIX ASPHALT.** Recycled hot mix asphalt shall consist of reclaimed asphalt pavement (RAP), aggregate, mineral filler if necessary, asphalt cement, and recycling agent if necessary. Recycled hot mix asphalt may be used for all layers except the top layer.

The RAP shall be of a consistent gradation and asphalt content. The Contractor may obtain the RAP from the job site or from a Contractor supplied source.

All new aggregates used in the recycled hot mix asphalt shall meet the requirements of Subsection 401-2.1. New asphalt cement shall meet the requirements of Subsection 401-2.3. Recycling agents shall meet the requirements of AASHTO R 14.

The recycled hot mix asphalt shall be designed using procedures contained in the Asphalt Institute's Manual Series Number 20 (MS-20), *Asphalt Hot-Mix Recycling*, in conjunction with MS-2 and ATM 417. The JMD shall meet the requirements of Subsection 401-3.2. In addition to the requirements of Subsection 401-3.2, the JMD shall indicate the percent of RAP, the percent and performance grade of

new asphalt cement, the percent and grade of recycling agent (if used), and the properties (including the performance grade) of the asphalt cement blend.

The Contractor shall submit documentation to the Engineer, indicating that the mixing equipment proposed for use is adequate to mix the percent of RAP shown in the JMD and meet all local and national environmental regulations.

The recycled hot mix asphalt will be evaluated separately but will be sampled, tested, and paid for the same as hot mix asphalt.

**401-3.4 TEST SECTION.** Prior to full production, the Contractor shall prepare and place a test section consisting of a quantity of hot mix asphalt that conforms to the JMD. The location of the test section will be shown on the Plans, or as directed by the Engineer. The test section shall be 300 feet long, 20 to 40 feet wide, placed in two lanes, with a longitudinal cold joint. The test section shall be of the same thickness specified for the construction of the layer that it represents. The underlying surface or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the project represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the project represented by the test section.

Three random samples of the hot mix asphalt will be taken by the Engineer and tested by the Department for aggregate gradation and asphalt cement content according to Subsection 401-5.1. The three samples will be evaluated according to Subsection 401-8.1.a., except a determination for outliers will not be performed. If the Composite Pay Factor is less than 1.00, the test section is unacceptable.

Three 6-inch diameter core samples shall be cut from the finished hot mix asphalt by the Contractor, at the locations marked by the Engineer. The core samples will be tested by the Department for density according to Subsection 401-5.1. The Target Value for mat density is 94% of the theoretical maximum specific gravity (MSG) of the JMD. The three samples will be evaluated according to Subsection 401-8.1.a., except a determination for outliers will not be performed. If the Density Pay Factor is less than 1.00, the test section is unacceptable.

Three longitudinal joint cores centered on the longitudinal joint shall be cut by the Contractor, at the locations marked by the Engineer. The core samples will be tested by the Department according to Subsection 401-5.1. The Target Value for joint density is 92% of the JMD MSG. If the average density of the three joint cores is below 90%, the test section is unacceptable.

If the initial test section is unacceptable, the Contractor shall make necessary adjustments to the JMD, plant operation, placing procedures, or compaction efforts. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. All sections that are not acceptable shall be removed at the Contractor's expense.

Full production shall not begin until an acceptable test section has been constructed and approved by the Engineer.

The Department will not pay for hot mix asphalt and asphalt cement, in test sections that are not acceptable, except the initial test section. The initial test section whether acceptable or unacceptable, and any subsequent test section that is acceptable, will be paid for at the contract unit prices for hot mix asphalt and asphalt cement. Test sections will be evaluated separately and not as part of a lot.

Hot mix asphalt quality control testing shall be performed by the Contractor at the start of plant production and in conjunction with the calibration of the plant for the JMD. If aggregates produced by the plant do not satisfy the gradation requirements or produce hot mix asphalt that meets the JMD, then it will be necessary to reevaluate and redesign the JMD using plant-produced aggregates. Specimens should be prepared and the optimum asphalt cement content determined in the same manner as for the original design tests. If the Department redesigns the JMD the Contractor will be assessed a fee according to Subsection 401-3.2.

**401-3.5 TESTING LABORATORY.** The laboratory used to develop the JMD shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements shall be submitted to the Engineer prior to the start of construction. The certification shall contain as a minimum:

- a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
- b. A listing of equipment to be used in developing the job mix design.
- c. A copy of the laboratory's quality control system.
- d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program

**CONSTRUCTION METHODS**

**401-4.1 WEATHER LIMITATIONS.** Hot mix asphalt shall not be placed upon a wet surface, when the base material is frozen, or when the surface temperature of the underlying layer is less than specified in Table 5. The top layer of hot mix asphalt must be placed before September 15th unless approved in writing by the Engineer.

**TABLE 5. BASE TEMPERATURE LIMITATIONS**

Mat Thickness	Base Temperature (Minimum)
Greater than 1 inch	40 °F
1 inch or less	50 °F

**401-4.2 HOT MIX ASPHALT PLANT.** Plants used for the preparation of hot mix asphalt shall conform to the requirements of AASHTO M 156 with the following changes:

- a. **Truck Scales.** The hot mix asphalt shall be weighed on approved certified scales furnished by the Contractor, or on certified public scales at the Contractor's expense. Scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. Scales shall conform to the requirements of Subsection G-130-2.5.
- b. **Testing Facilities.** The Contractor shall provide laboratory facilities at the plant or job site for the Contractor's quality control testing, according to Subsection 401-6.2.
- c. **Inspection of Plant.** The Engineer shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the hot mix asphalt.
- d. **Storage Bins and Surge Bins.** Paragraph 4.9 of ASTM D 995 is deleted. Instead, the following applies. Use of surge bins or storage bins for temporary storage of hot mix asphalt will be permitted as follows:
  - (1) The hot mix asphalt may be stored in surge bins for not longer than 3 hours.
  - (2) The hot mix asphalt may be stored in insulated storage bins for not longer than 24 hours.

The bins shall be such that hot mix asphalt drawn from them meets the same requirements as hot mix asphalt loaded directly into trucks.

If the Engineer determines that there is an excessive amount of heat loss, segregation or oxidation of the hot mix asphalt, no storage will be allowed.

- e. **Sampling Locations.** Provide a tap on the asphalt cement supply line just before it enters the plant (after the 3-way valve) for sampling asphalt cement. Aggregate and asphalt cement sampling locations shall meet OSHA safety requirements.
- f. **Scalping Screen.** A scalping screen shall be provided on the hot mix asphalt plant to prevent oversized material or debris from being incorporated into the hot mix asphalt.

**401-4.3 HAULING EQUIPMENT.** Trucks used for hauling hot mix asphalt shall have tight, clean, and smooth metal beds. To prevent the hot mix asphalt from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened, as directed by the Engineer.

**401-4.4 HOT MIX ASPHALT PAVERS.** Hot mix asphalt pavers shall be self-propelled, with an activated screed, heated as necessary, and shall be capable of spreading and finishing layers of hot mix asphalt which will meet the specified thickness, width, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the hot mix asphalt uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the hot mix asphalt layer.

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices that will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1%.

The controls shall be capable of working in conjunction with any of the following attachments:

- a. Ski-type device of not less than 30 feet in length.
- b. Taut stringline (wire) set to grade.
- c. Short ski or shoe.
- d. Laser control.

**401-4.5 ROLLERS.** The Contractor shall use rollers of the vibratory, steel wheel, and pneumatic-tired type. Pneumatic-tired rollers shall be fully skirted. Rollers shall be in good condition, capable of operating at slow speeds to avoid displacement of the hot mix asphalt. The number, type, and weight of rollers shall be sufficient to compact the hot mix asphalt to the required density while it is still in a workable condition.

The use of equipment that causes excessive crushing of the aggregate, pickup of the mix, washboard, uneven compaction, or other undesirable results, will not be permitted.

**401-4.6 PREPARATION OF ASPHALT CEMENT.** The asphalt cement shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt cement to the mixer at a uniform temperature. The temperature of the asphalt cement delivered to the mixer shall be sufficient to provide for adequate coating of the aggregate particles, but shall not exceed 335 °F or exceed manufacturers' recommendations.

**401-4.7 PREPARATION OF MINERAL AGGREGATE.** The aggregate for the hot mix asphalt shall be heated and dried prior to introduction into the mixer. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler



shall not exceed 350 °F when the asphalt cement is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide hot mix asphalt of satisfactory workability.

**401-4.8 PREPARATION OF HOT MIX ASPHALT.** The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMD.

The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt cement and is thoroughly distributed throughout the hot mix asphalt. For batch plants, the wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the hot plant. The mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in AASHTO T 195, for each individual plant and for each type of aggregate used. The mixing time will be set to achieve a minimum of 98% coated particles. The moisture content of all hot mix asphalt upon discharge shall not exceed 0.5% of the total weight of hot mix asphalt, as determined by WAQTC TM 6.

**401-4.9 PREPARATION OF THE UNDERLYING SURFACE.** Immediately before placing the hot mix asphalt, the underlying layer shall be cleaned of all dust and debris. A prime coat or tack coat shall be applied according to Sections P-602 or P-603, if required by the contract Specifications.

**401-4.10 TRANSPORTING, PLACING, AND FINISHING.** The hot mix asphalt shall be transported from the mixing plant to the site in vehicles conforming to the requirements of Subsection 401-4.3. Deliveries shall be scheduled so that placing and compacting of hot mix asphalt is uniform with minimum stopping and starting of the paver. Adequate artificial lighting shall be provided for night placements. Hauling over freshly placed hot mix asphalt will not be permitted until it has been compacted, as specified, and allowed to cool to ambient temperature. The Contractor may elect to use a material transfer vehicle to deliver hot mix asphalt to the paver.

Upon arrival, the hot mix asphalt shall be placed to the full width by a hot mix asphalt paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the hot mix asphalt mat. Unless otherwise permitted, placement of the hot mix asphalt shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The hot mix asphalt shall be placed in consecutive adjacent strips having a minimum width of 20 feet except where edge lanes require less width to complete the area.

The hot mix asphalt shall be placed and initial breakdown compaction started at a surface temperature greater than 235 °F. Compaction shall be finished before the surface temperature reaches 160 °F.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the hot mix asphalt may be spread by hand tools.

**401-4.11 COMPACTION OF MIXTURE.** After placing, the hot mix asphalt shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible when the hot mix asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations shall be at the discretion of the Contractor. The speed of the rollers shall, at all times, be sufficiently slow to avoid displacement of the hot mix asphalt and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained.

To prevent adhesion of the hot mix asphalt to the roller, the wheels shall be kept properly moistened (and scrapers used), but excessive water will not be permitted.

In areas not accessible to the roller, the hot mix asphalt shall be thoroughly compacted with hand operated compaction equipment.

**401-4.12 JOINTS.** The formation of all joints shall be made in such a manner as to ensure a continuous bond and obtain the required density. All joints shall have the same texture as other sections of the layer and meet the requirements for smoothness and grade.

The longitudinal joint in one layer shall offset the longitudinal joint in the layer immediately below by at least 12 inches; however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least 10 feet from transverse joints in the previous layer. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

The roller shall not pass over the unprotected end of the freshly laid hot mix asphalt except when necessary to form a transverse joint. When forming a transverse joint, it shall be made by means of placing a bulkhead or by tapering the layer. The tapered end shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing additional hot mix asphalt. When forming a transverse joint in the final lift, apply CrafcO Pavement Joint Adhesive No. 34524, or approved equal, to the joint surface before placing any fresh hot mix asphalt against the joint.

All longitudinal joints in the final lift shall be formed in such a manner that the joint meets density requirements of this specification. Joints that are irregular, damaged, uncompacted or otherwise defective shall be cut back to expose a clean, sound surface. When forming a longitudinal joint in the final lift, apply CrafcO Pavement Joint Adhesive No. 34524, or approved equal, to the joint surface before to placing any fresh hot mix asphalt against the joint. Joint edge preparation, and joint adhesive application temperature, thickness, and method shall be per the manufacturer's recommendations.

Joint sealant shall be applied over joints in the final lift of hot mix asphalt according to Subsection 401-5.2.f.(2). Joint sealant shall be applied over joints in the final lift formed by two panels of hot mix asphalt composed of different type or class of mix; or of new against existing hot mix asphalt pavement. Joint surface preparation, joint sealant application temperature, thickness, and method shall be per the manufacturer's recommendations.

All costs associated with joint preparation, applying joint sealant, and applying joint adhesive are subsidiary to the hot mix asphalt pay item.

**401-4.13 SURFACE REQUIREMENTS AND TOLERANCE.** The finished surfaces of the hot mix asphalt shall not vary more than the requirements of Subsection 401-5.2.f.(4).

The finished surface of asphalt concrete paving shall match dimensions shown on the Plans for horizontal alignment and width, profile grade and elevation, crown slope, and paving thickness. Water shall drain without puddles, across the pavement surface. The surface shall be of uniform texture and without ridges, humps, depressions, and roller marks. The surface shall be free of raveling, cracking, tearing, rutting, asphalt cement bleeding, and aggregate segregation. The asphalt concrete mixture shall be free of foreign material, uncoated aggregate and oversize aggregate.

Any finished surface area that does not meet the requirements of this Subsection is deemed unacceptable according to Subsection GCP 50-11. The Engineer will determine whether the unacceptable asphalt concrete mixture shall either be corrected, or removed and replaced. Submit correction methods to the Engineer for approval prior to correction work commencing. Skin patching shall not be allowed. This work is subsidiary and shall be done at the Contractor's expense.

## MATERIAL ACCEPTANCE

**401-5.1 ACCEPTANCE SAMPLING AND TESTING.** All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor. Testing organizations performing these tests will meet the requirements of ASTM D 3666.

Hot Mix Asphalt lots. The quantity of each type of hot mix asphalt produced and placed will be divided into lots and the lots evaluated individually for acceptance. The Department has the exclusive right and responsibility for determining the acceptability of all materials incorporated into the project. The results of the acceptance testing performed by the Engineer will be made available to the Contractor.

5,000 ton lot size. A lot of hot mix asphalt will be 5,000 tons, except as noted below. The lot will be divided into 10 equal sublots of 500 tons, each randomly sampled and tested for asphalt cement content, density and gradation according to this subsection.

If the project has more than 1 lot, and if less than 8 additional sublots have been sampled at the time a lot is terminated, either due to completion of paving operations or the end of the construction season (winter shutdown), the material in the shortened lot will be included as part of the prior lot and the price adjustment computed for the prior lot will include the samples from the shortened lot.

If 8 or 9 samples have been obtained at the time a lot is terminated, they will be considered as a lot and the price adjustment will be based on the actual number of test results (excluding outliers) in the shortened lot.

1,500 to 4,999 ton lot size. If the total Contract quantity of hot mix asphalt is between 1,500 tons and 4,999 tons, the total Contract quantity will be considered one lot. The lot will be divided into sublots of 500 tons and randomly sampled for asphalt cement content, density and gradation according to this subsection except a determination for outliers will not be performed. The lot will be evaluated for price adjustment according to Subsection 401-5.2 except as noted.

Hot mix asphalt quantities of less than 300 tons remaining after dividing the last lot into sublots will be included in the last subplot. Hot mix asphalt quantities of 300 tons or greater will be treated as an individual subplot.

Under 1,500 ton lot size. If the total Contract quantity of hot mix asphalt is less than 1,500 tons, the hot mix asphalt will be accepted for payment based on: the Engineer's approval of a JMD, placement and compaction of the hot mix asphalt to the specified thickness and density, meeting finished surface requirements and tolerances, and material testing.

The Engineer reserves the right to perform any testing required in order to determine acceptance. Hot mix asphalt that does not conform to the approved JMD shall be removed and replaced, or at the Engineer's discretion a pay adjustment will be made according to Subsection GCP 50-03. Removal and replacement of defective hot mix asphalt shall be at no additional cost to the Department.

Joint lot size. The lot size for longitudinal joint density in the final lift of hot mix asphalt will be the total length of longitudinal joint constructed by a lot of hot mix asphalt.

Asphalt Cement Property lot size. The normal lot size for Asphalt Cement property will be 200 tons. If the project has more than one lot and the quantity remaining is less than 150 tons, that quantity of asphalt cement will be added to the prior lot and the total quantity will be evaluated for price adjustment as one lot. If the remaining quantity is 150 tons or greater, it will be sampled, tested and evaluated as a separate lot.

If the contract quantity of asphalt cement property is between 85 – 199 tons, the contract quantity will be considered as one lot and sampled and tested according to this subsection. Quantities of asphalt cement

less than 85 tons will be accepted based on manufacturer's certified test reports and certification of compliance.

- a. **Sampling.** Samples collected at the plant from dry batched aggregates, the conveyor system, or the asphalt cement supply line shall be taken by the Contractor in the presence of the Engineer. The Engineer will take immediate possession of the samples.

- (1) **Asphalt Cement Content.** Hot mix asphalt samples taken solely for the determination of asphalt cement content will be taken randomly from behind the screed prior to initial compaction, at the auger, or from the windrow, as directed by the Engineer, according to WAQTC FOP for AASHTO T 168. Hot mix asphalt samples taken for the determination of both asphalt cement content and gradation will be taken randomly from behind the screed prior to initial compaction according to WAQTC FOP for AASHTO T 168.

Two separate samples will be taken, one for acceptance testing and one held in reserve for retesting if applicable.

- (2) **Aggregate Gradation.** Samples for the determination of aggregate gradation will be taken randomly, as directed by the Engineer, according to WAQTC FOP for AASHTO T 2. Two separate samples will be taken, one for acceptance testing and one held in reserve for retesting if applicable. The samples will be taken from one of the following locations:

- (a) The same location as specified for the determination of asphalt cement content;
- (b) For hot mix asphalt drum plants from the combined aggregate cold feed conveyor via a diverter device, a sampling device, or from the stopped conveyor belt. Diverter devices shall divert aggregate from the full width of the conveyor system and shall be maintained to provide a representative sample of aggregate incorporated into the hot mix asphalt; or
- (c) For hot mix asphalt batch plants from the dry batched aggregates in a manner that provides a representative sample of aggregate incorporated into the hot mix asphalt.

- (3) **Density.** The Contractor shall cut full depth core samples with a diameter of six inches, within 24 hours of final rolling. The Contractor shall cut one core sample from each HMA mat subplot, and core samples from the longitudinal joint in locations described below, for density acceptance testing. In addition, six-inch diameter core samples for assurance testing shall be cut as directed by the Engineer.

The core samples shall be neatly cut by a core drill at the random locations marked by the Engineer. A core extractor shall be used to prevent damage to the cores. All holes left by sampling shall be backfilled with new hot mix asphalt and compacted within 24 hours of sampling. Failure to cut core samples or backfill the holes left by sampling within the specified period will result in a deduction of \$100.00 per sample/hole per day. The accrued amount will be subtracted under Item P-401b, Hot Mix Asphalt Price Adjustment.

Core samples for mat density shall not be taken closer than one foot from a transverse or longitudinal joint.

Core samples for longitudinal joint density shall be centered on the longitudinal joint of the top layer, at each location the panel completing the joint is cored for mat density acceptance testing.

- (4) **Asphalt Cement Property.** Asphalt cement will be randomly sampled for acceptance testing according to WAQTC FOP for AASHTO T 40. Three separate samples from each lot will be taken, one for acceptance testing, one for Contractor retesting, and one held by the Engineer in reserve for referee testing if applicable.

**b. Testing.**

- (1) Asphalt Cement Content.** At the direction of the Engineer, the asphalt cement content will be determined according to ATM 405 or WAQTC FOP for AASHTO T 308. The method selected will be used for the duration of the project, including retests if applicable.
- (2) Aggregate Gradation.** Cold feed or dry batched aggregate gradations will be tested according to WAQTC FOP for AASHTO T 27/T 11. Hot mix asphalt gradations will be determined according to WAQTC FOP for AASHTO T 30 from aggregate remaining after the ignition oven (WAQTC FOP for AASHTO T 308) has burned off the asphalt cement.
- (3) Density.** The Target Value for mat density will be 94% of the MSG as determined by WAQTC FOP for AASHTO T 209. For the first lot of hot mix asphalt, the MSG will be determined by the JMD. For additional lots, the MSG will be determined from the randomly selected sample from the first subplot. The Target Value for longitudinal joint density in the final lift will be 92% of the MSG of the panel completing the joint. No adjustment will be made to the MSG or any other material property, due to application of joint adhesive, in evaluating joint density.

Core samples will be tested according to WAQTC FOP for AASHTO T 166/T 275.

- (4) Asphalt Cement Property.** Asphalt cement will be tested for conformance to the requirements specified in Subsection 401-2.3 and evaluated for acceptance according to Subsection 401-8.2.

**401-5.2 ACCEPTANCE CRITERIA.**

- a. General.** Acceptance will be based on the following characteristics of the hot mix asphalt as well as the implementation of the Contractor's Quality Control plan:

- (1)** Aggregate gradation
- (2)** Asphalt cement content
- (3)** Mat density
- (4)** Longitudinal Joint density
- (5)** Thickness
- (6)** Smoothness
- (7)** Asphalt Cement Property

Aggregate gradation, asphalt cement content, and mat density will be evaluated for acceptance on a lot basis using the method of estimating percentage of material within specification limits (PWL). Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L) or below the upper specification tolerance limit (U).

Thickness will be evaluated by the Engineer for compliance according to Subsection 401-5.2.f.(3). Acceptance for smoothness will be based on the criteria contained in Subsection 401-5.2.f.(4).

The Engineer may at any time reject and require the Contractor to dispose of any batch of hot mix asphalt which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may request that a representative sample of the rejected hot mix asphalt be tested. If all test results are within tolerance limits, payment will be made for the hot mix asphalt at the contract unit price. If any of the test results fall outside of the tolerance limits, no payment will be made on the batch of rejected hot mix asphalt, and the cost of the testing will be subtracted under Contract Item P-

401b, Hot Mix Asphalt Price Adjustment. The batch of rejected hot mix asphalt will be evaluated separately and not as part of a lot. All costs associated with disposal of rejected hot mix asphalt are the responsibility of the Contractor.

- b. **Aggregate Gradation, Asphalt Cement Content.** Evaluation for acceptance of each lot of plant-produced hot mix asphalt for aggregate gradation and asphalt cement content will be based on PWL.
- c. **Mat Density.** Evaluation for acceptance of each lot of in-place hot mix asphalt for mat density will be based on PWL.
- d. **Longitudinal Joint Density.** Evaluation for acceptance of each lot of in-place final lift hot mix asphalt for longitudinal joint density will be based on the average of the longitudinal joint densities within the lot.
- e. **Percentage of Material Within Specification Limits (PWL).** The PWL will be determined according to procedures specified in Section 110 of the General Provisions. The sample average (X) is rounded to the nearest tenth for density and all sieves except the No. 200, and to the nearest hundredth for asphalt cement content and the No. 200 sieve. The sample standard deviation ( $S_n$ ) is rounded to the nearest hundredth for density and all sieve sizes except the No. 200 sieve. The sample standard deviation ( $S_n$ ) is rounded to the nearest .001 for asphalt content and the No. 200 sieve. The specification tolerance limits (L) and (U) are contained in Table 6.
- f. **Acceptance Criteria.**

(1) **Mat Density, Aggregate Gradation, and Asphalt Cement Content.** Acceptance and payment for the lot will be determined according to Subsection 401-8.1.

(2) **Longitudinal Joint Density.** For the final lift of hot mix asphalt, if the average longitudinal joint density of a lot is less than 90%, the longitudinal joint shall be sealed with Asphalt Systems GSB-78, or approved equal, while the hot mix asphalt is still clean, free of moisture, and before striping. All costs associated with sealing the joints are subsidiary to the hot mix asphalt pay item. Longitudinal joint lots will be evaluated for payment according to Subsection 401-8.3.

Longitudinal joint sealing shall be per the sealant manufacturer's recommendations. The sealant application shall be at least 6 inches wide and centered on the longitudinal joint.

(3) **Thickness.** Thickness will be evaluated for compliance by the Engineer to the requirements shown on the Plans. Measurements of thickness will be made by the Engineer using the cores extracted from the mat for each subplot for density measurement.

(4) **Smoothness.** The finished surfaces of the hot mix asphalt shall not vary more than 1/4 inch for the surface layer when tested with a 12-foot straightedge. High points may be ground off, but skin patching will not be allowed.

(5) **Asphalt Cement Property.** Acceptance and payment for asphalt cement will be determined according to Subsection 401-8.2.

- g. **Outliers.** All individual tests for asphalt cement content, aggregate gradation, and mat density will be checked for outliers (test criterion) according to ATM SP-7 except as noted in Subsection 401-5.1. Outliers will be discarded, and the PWL will be determined using the remaining test values.

When gradation and asphalt cement content are determined from the same sample, if any sieve size on the gradation test or the asphalt cement content is an outlier, then the gradation test results and the asphalt cement content results for that sample will not be included in the price

adjustment. The density test result for that subplot will be included in the price adjustment provided it is not an outlier also. If the density test result is an outlier, the density test result will not be included in the price adjustment, however, the gradation and asphalt cement content results for the subplot will be included provided neither is an outlier.

When gradation and asphalt cement content are determined from separate samples, if any sieve size on the gradation test is an outlier, then the gradation test results for that sample will not be included in the price adjustment. The asphalt cement content and density test results for that subplot will be included in the price adjustment provided neither is an outlier. If the asphalt cement content test result is an outlier, it will not be included in the price adjustment but the gradation and density test results for the subplot will be included provided neither is an outlier. If the density test result is an outlier, it will not be included in the price adjustment but the gradation and asphalt cement content test results will be included provided neither is an outlier.

**TABLE 6. LOWER SPECIFICATION TOLERANCE LIMIT (L) AND UPPER SPECIFICATION TOLERANCE LIMIT (U)**

<b>Measured Characteristics</b>	<b>L</b>	<b>U</b>
3/4 in. sieve	TV -6.0	TV +6.0
1/2 in. sieve	TV -6.0	TV +6.0
3/8 in. sieve	TV -6.0	TV +6.0
No. 4 sieve	TV -6.0	TV +6.0
No. 8 sieve	TV -6.0	TV +6.0
No. 16 sieve	TV -5.0	TV +5.0
No. 30 sieve	TV -4.0	TV +4.0
No. 50 sieve	TV -4.0	TV +4.0
No. 100 sieve	TV -3.0	TV +3.0
No. 200 sieve	TV -2.0	TV +2.0
Asphalt Cement %	TV-0.4	TV+0.4
Mat Density	92%	98%
Joint Density	90%	98%

TV (Target Value) = Job Mix Design value for gradation and asphalt cement content.

**401-5.3 RETESTS.**

- a. **General.** Retesting of a sample which is outside the limits specified in Table 6, will be allowed if requested by the Contractor, in writing, within 7 days after receiving the written test results from the Engineer. Only one retest per sample will be permitted. The Engineer will mark the sample location for the density retest within a two-foot radius of the original core. The original test result will be discarded and the retest result will be used in the price adjustment calculation regardless of whether the retest result gives a higher or lower pay factor.

Except for the first lot, when gradation and asphalt cement content are determined from the same sample, retesting for gradation or asphalt cement content from the first subplot of a lot will include retesting for the MSG; when separate samples are used, retesting for asphalt cement content will include retesting for the MSG.

- (1) A redefined PWL will be calculated for the lot.
- (2) The cost for resampling shall be borne by the Contractor.

- b. **Payment for Resampled Lots.** The redefined PWL for a lot will be used to calculate the payment for that lot according to Table 7.

**401-5.4 LEVELING COURSE.** Any layer identified in the Plans as a leveling course, or any base layer approved by the Engineer for truing and leveling, shall meet the requirements of Subsections 401-3.2 and 401-5.2b, but will not be subject to the density requirements of Subsections 401-5.2.c and 401-5.2.d. The leveling layer shall be compacted with the same effort used to achieve density of the test section. The truing and leveling layer shall not exceed a nominal thickness of 1-1/2 inches.

**CONTRACTOR QUALITY CONTROL**

**401-6.1 GENERAL.** The Contractor shall develop a Quality Control Program according to the General Contract Provisions Section GCP-100, except that Subsection GCP-100-03 will not apply when Hot Mix Asphalt Contract quantities are less than 5,000 tons. The program shall address all elements that affect the quality of the hot mix asphalt including, but not limited to:

<b>a.</b> Mix Design	<b>f.</b> Mixing and Transportation
<b>b.</b> Aggregate Grading	<b>g.</b> Placing and Finishing
<b>c.</b> Quality of Materials	<b>h.</b> Joints
<b>d.</b> Stockpile Management	<b>i.</b> Compaction
<b>e.</b> Proportioning	<b>j.</b> Surface smoothness

The Contractor shall submit a paving and plant control plan at the pre-paving meeting scheduled by the Engineer a minimum of 5 working days before paving operations begin. The plan shall specifically address the sequence of operations and joint construction. In addition, steps to ensure product consistency, to minimize segregation, and to prevent premature cooling of the hot mix asphalt shall be addressed.

**401-6.2 TESTING LABORATORY.** The Contractor shall provide a fully equipped hot mix asphalt laboratory located at the plant or job site.

The effective working area of the laboratory shall be a minimum of 150 ft<sup>2</sup> with a ceiling height of not less than 7.5 feet. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70 °F ± 5 °F.

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work will be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

**401-6.3 QUALITY CONTROL TESTING.** The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to these Specifications and as set forth in the Quality Control Program. The testing program shall include, but not necessarily limited to, tests for the control of asphalt cement content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. All testing shall be according to the standard procedures specified in the contract and the options selected by the Engineer. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

- a. Asphalt Cement Content.** A minimum of four asphalt cement content tests shall be performed per lot according to Subsection 401-5.1b(1).
- b. Gradation.** Aggregate gradations shall be determined a minimum of four times per lot according to WAQTC FOP for AASHTO T 30 or WAQTC FOP for AASHTO T 27/T 11.



- c. **Moisture Content of Aggregate.** The moisture content of aggregate used for production shall be determined a minimum of twice per lot according to WAQTC FOP for AASHTO T 255/T 265.
- d. **Moisture Content of Hot Mix Asphalt.** The moisture content of the hot mix asphalt shall be determined a minimum of twice per lot according to WAQTC TM 6.
- e. **Temperatures.** Temperatures shall be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the asphalt cement in the storage tank, the hot mix asphalt at the plant, and the hot mix asphalt at the job site.
- f. **In-Place Density Monitoring.** The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the hot mix asphalt density according to WAQTC TM 8.
- g. **Additional Testing.** Any additional testing that the Contractor deems necessary to control the process may be performed at the Contractor's option.
- h. **Monitoring.** The Engineer reserves the right to monitor any or all of the above testing.

**401-6.4 SAMPLING.** When directed by the Engineer, the Contractor shall sample and test any hot mix asphalt that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be according to standard procedures specified.

**401-6.5 CONTROL CHARTS.** The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation and asphalt cement content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the Engineer may suspend production or acceptance of the material.

- a. **Individual Measurements.** Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation and asphalt cement content. The control charts shall use the JMD target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

**CONTROL CHART LIMITS FOR INDIVIDUAL MEASUREMENTS**

Sieve	Action Limit	Suspension Limit
3/4 in.	0%	0%
1/2 in.	+/-6%	+/-9%
3/8 in.	+/-6%	+/-9%
No. 4	+/-6%	+/-9%
No. 16	+/-5%	+/-7.5%
No. 50	+/-3%	+/-4.5%
No. 200	+/-2%	+/-3%
Asphalt Cement Content	+/-0.45%	+/-0.70%

The action and suspension limits for the largest sieve specified are 0%.

- b. **Range.** Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of  $n = 4$ .

**CONTROL CHART LIMITS BASED ON RANGE**

(Based on  $n = 4$ )

Sieve	Suspension Limit
1/2 in.	14%
3/8 in.	14%
No. 4	14%
No. 16	11%
No. 50	8%
No. 200	4.5%
Asphalt Cement Content	1%

- c. **Corrective Action.** The Quality Control Plan shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain sets of rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:
- (1) One point falls outside the Suspension Limit line for individual measurements or range; or
  - (2) Two points in a row fall outside the Action Limit line for individual measurements.

**METHOD OF MEASUREMENT**

**401-7.1 Hot Mix Asphalt.** The quantity of hot mix asphalt will be measured by the number of tons used in the accepted work, based on recorded truck scale weights. No deduction will be made for the weight of asphalt cement in the hot mix asphalt.

**401-7.2 Asphalt Cement.** The quantity of asphalt cement will be measured by the number of tons used in the accepted hot mix asphalt, determined as follows:

- a. Supplier's invoices minus waste, diversion and excess left over. This method may be used on projects where deliveries are made in sealed tankers and the plant is producing material for one project only. Method b. will be used to compute left over. Waste and diversion will be computed in a manner determined by the Engineer.
- b. Volume measure (tank stickings) of actual daily uses. It is the Contractor's responsibility to notify the Engineer whenever material is to be added to the calibrated volume measure or whenever material from the volume measure is to be used for work other than that specified in this contract.
- c. Percent of asphalt cement for each subplot as determined by ATM 405 or WAQTC FOP for AASHTO T 308 multiplied by the weight represented by that subplot. The same tests used for acceptance testing of asphalt cement content will be used for calculation of the asphalt cement quantity. If retesting of a sample for asphalt cement content is performed, the retest result will be used for calculating the asphalt cement quantity.

Method c. will be used for determining asphalt cement quantity unless otherwise directed in writing by the Engineer. No payment will be made for a portion of asphalt cement that is more than 0.4% above the optimum asphalt cement content specified in the JMD. When acceptance testing is not required because

of the small quantity of hot mix asphalt used, the percent of asphalt cement used in the calculation will be the optimum asphalt cement content specified in the JMD.

The method initially used will be used for the duration of the project.

**401-7.3 Longitudinal Joint.** The quantity of joint will be measured by the lineal foot of longitudinal joint in the accepted top layer. A joint is defined as the vertical intersection of two new hot mix asphalt panels. Transverse joints in any layer, and longitudinal joints in underlying layers, are not included. Joints next to buildings, sidewalks, existing asphalt pavement, or curb and gutter are not included.

### BASIS OF PAYMENT

**401-8.1 HOT MIX ASPHALT.** Payment for an accepted lot of hot mix asphalt will be made at the contract unit price per ton for hot mix asphalt.

Adjust Contract Item P-401b for hot mix asphalt according to Subsection 401-8.1.a.

The price will be compensation for furnishing all materials, for all preparation, mixing, placing, and compaction of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

- a. **Basis of Adjusted Payment for Hot Mix Asphalt.** The total hot mix asphalt price adjustment is the sum of the individual lot price adjustments, and will be added or deducted under Item P-401b, Hot Mix Asphalt Price Adjustment.

The lot Pay Factors for density, gradation and asphalt cement content are determined from Table 7 using Percent Within Limits (PWL) calculated from Section 110 of the General Provisions. The tolerance limits for the largest sieve specified will be plus 0 and minus 1 when performing PWL calculations. The maximum pay factor for the largest sieve size for gradation will be 1.00. The price adjustment will be based on the Composite Pay Factor (CPF) for asphalt cement content and aggregate gradation or the Density Pay Factor (DPF), whichever is the lowest value. CPF and DPF is rounded to the nearest hundredth. Table 8 is used to determine the weight factor (*f*) for each sieve size and asphalt cement content.

The hot mix asphalt Composite Pay Factor (CPF) is computed for asphalt cement content and all sieves using the following formula:

$$CPF = \frac{[f_{3/4in}(PF_{3/4in}) + f_{1/2in}(PF_{1/2in}) + \dots + f_{ac}(PF_{ac})]}{\Sigma f}$$

**TABLE 7. PRICE ADJUSTMENT SCHEDULE**

Percentage of Material Within the Specification Limit (PWL)	Pay Factor (PF)
96-100	1.05
90-95	0.01 PWL + 0.10
75-89	0.005 PWL + 0.55
55-74	0.014 PWL - 0.12
Below 55	0*

\* If the Composite Pay Factor or the Density Pay Factor falls below 0.65, the lot shall be removed and replaced. If the Engineer decides that the lot can be left in place, the Pay Factor for the lot will be 0.50.

**TABLE 8. WEIGHT FACTORS**

Sieve Size	Type I	Type II	Type III
	Factor “ <i>f</i> ”	Factor “ <i>f</i> ”	Factor “ <i>f</i> ”
1 in.	4		
¾ in.	4	4	
½ in.	4	5	4
3/8 in.	4	5	5
No. 4	4	4	5
No. 8	4	4	5
No. 16	4	4	5
No. 30	4	5	6
No. 50	4	5	6
No. 100	4	4	4
No. 200	20	20	20
Asphalt %	40	40	40

The price adjustment for each individual lot will be calculated as follows:

$$\text{Price Adjustment} = [(\text{CPF or DPF})^* - 1] \times (\text{tons in lot}) \times (\text{PAB})$$

PAB = Price Adjustment Base per ton (for mix including asphalt cement)  
 PAB for Hot Mix Asphalt with PG 52-28 = \$45.00  
 PAB for Hot Mix Asphalt with PG 58-28 = \$55.00  
 PAB for Hot Mix Asphalt with PG 64-28 = \$60.00

\* Composite Pay Factor (CPF) or Density Pay Factor (DPF), whichever is lower value.

**401-8.2 ASPHALT CEMENT.** Payment for an accepted lot of asphalt cement will be made at the contract unit price per ton for asphalt cement.

Adjust Contract Item P-401b for asphalt cement property according to Subsection 401-8.2.a. Adjust Contract Item P-401b for asphalt cement content according to Subsection 401-8.1.a.

The price will be compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

- a. Basis of Adjusted Payment for Asphalt Cement Property.** Asphalt cement property pay reduction factors for each lot will be determined from Table 9. The total asphalt cement price adjustment is the sum of the individual lot price adjustments, and will be added or deducted under Item P-401b, Hot Mix Asphalt Price Adjustment.

**TABLE 9. ASPHALT CEMENT PROPERTY PAY REDUCTION FACTORS**  
(Use the single, highest pay reduction factor)

	Spec	Pay Reduction Factor (PRF)								Reject or Engr Eval
		0	0.04	0.05	0.06	0.07	0.08	0.10	0.25	
<b>Tests On Original Binder</b>										
Viscosity	≤3 Pa-s	≤3		>3						
Dynamic Shear	≥1.00 kPa	≥1.00		0.88-0.99				0.71-0.87	0.50-0.70	<0.50
Toughness	≥110 in-lbs	≥93.5	90.0-93.4	85.0-89.9	80.0-84.9	75.0-79.9	70.0-74.9			<70.0
Tenacity	≥75 in-lbs	≥63.8	61.0-63.7	58.0-60.9	55.0-57.9	52.0-54.9	48.0-51.9			<48.0
<b>Tests On RTFO</b>										
Mass Loss	≤1.00 %	≤1.00		1.001-1.092				1.093-1.184	1.185-1.276	>1.276
Dynamic Shear	≥2.20 kPa	≥2.20		1.816-2.199				1.432-1.815	1.048-1.431	<1.048
<b>Test On PAV</b>										
Dynamic Shear	≤5000 kPa	≤5000		5001-5289				5290-5578	5579-5867	>5867
Creep Stiffness, S	≤300 Mpa	≤300		301-338				339-388	389-450	>450
Creep Stiffness, m-value	≥0.300	≥0.300		0.287-0.299				0.274-0.286	0.261-0.273	<0.261
Direct Tension	≥1.0 %	≥1.0		0.86-0.99				0.71-0.85	0.56-0.70	<0.56

Asphalt Cement Property Price Adjustment for each lot = 5 x PAB x Qty X PRF

PAB = Price Adjustment Base (See Subsection 401-8.1.a.)

Qty = Quantity of asphalt cement represented by lot

PRF = Pay Reduction Factor from Table 9

Failing asphalt cement test results will be re-evaluated if requested. Submit a written request within 14 calendar days of receiving a failing asphalt cement test result. Include all quality control test results for the project and the test results from an AASHTO accredited laboratory for the Contractor sample collected at the same time the sample for acceptance testing was collected. All costs associated with this testing are subsidiary to the Hot Mix Asphalt pay item. Accreditation will be in the applicable test methods. The Engineer will review the data and decide if the price reduction remains.

The Engineer's decision may be contested, in which case the referee sample will be sent to a mutually agreed upon independent AASHTO accredited laboratory for testing. The resulting test results will be binding. If the sample fails to meet specifications, all costs associated with this testing will be deducted under Item P-401b, Hot Mix Asphalt Price Adjustment.

**401-8.3 LONGITUDINAL JOINT.** The cost for all joints is subsidiary to hot mix asphalt, no payment will be made.

Adjust Contract Item P-401b for longitudinal joint density according to Subsection 401-8.3.a.

The subsidiary cost includes furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

- a. **Basis of Adjusted Payment for Longitudinal Joints.** Longitudinal joint density lots in the top layer that average less than 90% of MSG will be assessed a price adjustment of \$5.00 per foot. The accrued amount will be deducted under Item P-401b, Hot Mix Asphalt Price Adjustment.

Longitudinal joint density lots in the top layer that average greater than 92% of MSG will have an incentive of \$1.00 per foot applied. The accrued amount will be added under Item P-401b, Hot Mix Asphalt Price Adjustment.

**401-8.4 PAYMENT.** Payment will be made under:

- Item P-401a Hot Mix Asphalt Type \_\_, Class \_\_ - per ton
- Item P-401b Hot Mix Asphalt Price Adjustment - contingent sum
- Item P-401c Asphalt Cement [Performance Grade] - per ton

**TESTING REQUIREMENTS**

- WAQTC FOP for AASHTO T 2 Sampling Aggregates
- WAQTC FOP for AASHTO T 27/T 11 Sieve Analysis of Aggregate and Soils
- WAQTC FOP for AASHTO T 30 Mechanical Analysis of Extracted Aggregate
- WAQTC FOP for AASHTO T 40 Sampling Bituminous Materials
- WAQTC FOP for AASHTO TP 61 Percentage of Fracture in Coarse Aggregate
- WAQTC FOP for AASHTO T 89 Liquid Limit of Soils
- WAQTC FOP for AASHTO T 90 Plastic Limit and Plasticity Index of Soils
- WAQTC FOP for AASHTO T 166/T 275 Bulk Specific Gravity and Percent Compaction of Bituminous Mixes
- WAQTC FOP for AASHTO T 168 Sampling Bituminous Mixes
- WAQTC FOP for AASHTO T 176 Sand Equivalent
- WAQTC FOP for AASHTO T 209 Maximum Specific Gravity of Bituminous Mixes
- WAQTC FOP for AASHTO T 255/T 265 Moisture Content of Aggregate and Soils
- WAQTC FOP for AASHTO T 308 Asphalt Binder Content of Bituminous Mixes by Ignition Method
- WAQTC TM 6 Moisture Content of Bituminous Mixes by Oven Drying
- WAQTC TM 8 In-Place Density of Bituminous Mixes using the Nuclear Moisture-Density Gauge.
- ATM 306 Flat and Elongated
- ATM 313 Degradation Value of Aggregate
- ATM 405 Asphalt Cement Content of Asphalt Concrete Mixtures by the Nuclear Method
- ATM 414 Anti-Strip Requirements of Hot Mix Asphalt

ATM 417 Hot Mix Asphalt Design by the Marshall Method

ATM SP-7 Determination of Outlier Test Results

AASHTO T 53 Softening Point of Bitumen (Ring-and-Ball Apparatus)

AASHTO T 96 Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

AASHTO T 104 Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

AASHTO T 127 Sampling and Amount of Testing of Hydraulic Cement

AASHTO M 156 Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

AASHTO T 195 Determining Degree of Particle Coating of Bituminous-Aggregate Mixtures

AASHTO M 320 Performance-Graded Asphalt Binder

ASTM D 5801 Test Method for Toughness and Tenacity of Bituminous Materials

The Asphalt Institute *Mix Design Methods for Asphalt Concrete Manual No. 2 (MS-2)*

The Asphalt Institute *Hot-Mix Recycling Manual No. 20 (MS-20)*

#### **MATERIAL REQUIREMENTS**

AASHTO R 14 Classifying Hot-Mix Recycling Agents

AASHTO M 17 Mineral Filler for Bituminous Paving Mixtures