ITEM P-401 BITUMINOUS SURFACE COURSE

MATERIAL REQUIREMENTS

ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 490	Tar
ASTM D 946	Asphalt Cement for Use in Pavement Construction
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
AASHTO M 226	Viscosity Graded Asphalt Cement

SPECIFICATION REQUIREMENTS

The Asphalt Institutes's Specification Series No. 1 (SS-1)	Model Construction Specifications for Asphalt Concrete and Other Plant-Mix Types

ITEM P-402 POROUS FRICTION COURSE (Central Plant Hot Mix)

1. DESCRIPTION

1.1 This item shall consist of an open-graded, bituminous surface course composed of mineral aggregate and bituminous material, mixed in a central mixing plant, and placed on a prepared surface in accordance with these specifications and shall conform to the dimensions shown on the plans.

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The porous friction course (PFC) is designed as a free-draining, wearing surface of uniform thickness which will provide a skid resistant and hydroplane resistant surface for aircraft landing and takeoff operations.

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2. MATERIALS

2.1 AGGREGATE. The aggregate shall consist of crushed stone, crushed gravel, or crushed slag with or without other inert finely divided mineral aggregate. The aggregate shall be composed of clean, sound, tough, durable particles, free from clay balls, organic matter, and other deleterious substances. The crushed aggregate portion which is retained on the 3/8-inch (9.5 mm) sieve shall not contain more than 15 percent by weight of flat or elongated particles as defined in ASTM D693.

The crushed aggregate portion which is retained on the No. 4 (4.75 mm) sieve shall not show a percentage of wear greater than [**_____] when tested in accordance with ASTM C131.

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Percentage of wear shall not exceed 30. However, if local aggregates cannot meet this requirement and hauling of aggregates that meet the requirement is economically infeasible, the Engineer may waive the requirement for a higher percentage loss than specified if local aggregates have proven satisfactory performance under similar conditions of service.

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The crushed aggregate portion which passes the 3/4-inch (19.0 mm) sieve and is retained on the No. 4 (4.75 mm) sieve shall not show a total weighted average loss greater than [**_____] percent in sodium sulfate solution or a magnesium soundness loss exceeding [**_____] percent after 5 cycles when tested in accordance with ASTM C88. The soundness test (ASTM C88) may be waived by the Engineer where porous friction course will not be subjected to freezing and thawing.

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Sodium sulfate loss should not exceed 9 percent; magnesium loss should not exceed 12 percent. In certain specific cases where aggregates cannot economically comply with these maximums, aggregates with a higher percentage loss may be specified, provided satisfactory service has been demonstrated.
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The crushed aggregate portion passing the 3/4-inch (19.0 mm) sieve and retained on the 1/4-inch (6.3 mm) sieve shall have an estimated coated area "above 95 percent" when tested in accordance with ASTM D1664. If coated area is "below 95 percent," the asphalt shall be treated with an antistripping agent. The amount of antistripping agent used shall be sufficient to produce a coated area "above 95 percent."

If crushed gravel aggregate is used, that portion retained on the No. 8 (2.36 mm) sieve and each succeeding coarser sieve shall contain at least 75 percent by weight of crushed pieces having two or more fractured faces and at least 90 percent by weight of particles containing one or more fractured faces. To count as a fractured face, the area of the fractured surface must be at least 75 percent of the smallest midsectional area of the particle being examined. To count as two fractured faces, the angle between two contiguous planes of fracture should be 30 degrees or more.

If crushed slag aggregates are used, the slag shall be air-cooled from the blast furnace process and shall have a compacted unit weight of not less than 70 pounds per cubic foot (1.12 Mg/cu.m) when tested in accordance with ASTM C29.

2.2 FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D242. When mineral filler is required to be batched separately, hydrated lime in the amount of 1.5 percent maximum by weight of the total aggregate shall be batched as part of the added mineral filler. No additional compensation will be allowed the Contractor for furnishing and using hydrated lime or other approved mineral filler that may be required by this specification.

2.3 BITUMINOUS MATERIAL. The bituminous material shall conform to the following requirements: [**_____.]

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The Engineer shall specify the type and grade of bituminous material based on geographical location and climatic conditions. The maximum mixing temperature and controlling specification shall also be specified. Types of material are listed below. 122 123 124 126 126

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Type and Grade		Specification	Maximum Mixing Temperature	
			deg. F	deg. C
Penetration Grade	60-70	ASTM D946	335	170
	85-100		325	165
	120-150		310	155
	200-300		295	146
Viscosity Grade	AC-5	AASHTO M226	295	145
	AC-10		315	155
	AC-20		330	165
Viscosity Grade	AR-2000	ATSM D3381	325	165
	AR-4000		325	165
	AR-8000		325	165

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In extremely hot climates, the Engineer should consider using AC-40 in lieu of AC-20. Experience of constructing PFC overlays in hot climates has shown the need for using a stiffer asphalt cement. 150 151 151 151

The Engineer may also want to consider using a neoprene additive in the asphalt cement. This modification exhibits improved elasticity, less tendency to flow, and greater stability at extreme temperatures. No more than 1-1/2 percent of the neoprene additive should be used in the total asphalt cement required, and it should be rejected if heated above 340 degrees F (171 degrees C). 153 154 156 157 157 158 158

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3. COMPOSITION 164

3.1 COMPOSITION OF MIXTURES. The porous friction course shall be composed of a mixture of aggregate, filler, bituminous material, and antistripping agent (if required). The several aggregate fractions shall be sized, graded, and combined in the proportions that meet the requirements of the job mix formula. 167 169 171 173 173

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3.2 JOB MIX FORMULA. No bituminous mixture shall be produced for payment until the Contractor has submitted samples of the materials and the Engineer has established a satisfactory job mix formula for each mixture to be used. The job mix formula for each mixture shall be in effect until modified in writing by the Engineer. The job mix formula for each mixture shall establish a single percentage passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, and a single temperature for the mixture as it is discharged into the hauling units. 176 176 177 179 179 180 181 181 182 182

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The job mix formula should be determined by taking samples from the plant's hot bins by trial runs. Due to the variability in normal plant operations, the job mix formula based on stockpile sampling could give misrepresentative results. 187 188 189 189 189

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The combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation shown in Table 1 when tested in accordance with ASTM C136. The range of bituminous contents shown in Table 1 is representative of most crushed stone and crushed gravel aggregates and is not intended to limit the bituminous content established in the job mix formula. 195 197 197 199 200 201 201

The gradations in Table 1 represent the limits which shall determine the suitability of the aggregate for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 1 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 uniformly graded from coarse to fine. 203 204 207 207 208 210 210

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TABLE 1. AGGREGATE - POROUS FRICTION COURSE

Sieve Size	Percentage by Weight Passing Sieve
3/4 in. (19.0 mm)	*
1/2 in. (12.5 mm)	*
3/8 in. (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 30 (600 micro m)	*
No. 200 (75 micro m)	*
Compacted Thickness	*
Bituminous Content	5-7 percent by weight of total mix

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The aggregate gradation band applicable to a project shall be specified by the Engineer from the gradations in this note. The gradation shall be inserted in Table 1. Insert points are denoted by asterisks.

AGGREGATE - POROUS FRICTION COURSE

Sieve Size	Percentage by Weight Passing Sieves	
	3/4 in. maximum	1/2 in. maximum
3/4 in. (19.0 mm)	100	--
1/2 in. (12.5 mm)	70-100	100
3/8 in. (9.5 mm)	45-75	80-100
No. 4 (4.75 mm)	20-40	20-40
No. 8 (2.36 mm)	12-20	12-20
No. 30 (600 micro m)	8-14	8-14
No. 200 (75 micro m)	3-5	3-5
Compacted Thickness	1 in. (25 mm)	3/4 in. (19 mm)
Bituminous Content	5-7 percent by weight of total mix	

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The gradations shown are based on aggregates of uniform specific gravity, and the percentages passing the various sieves will be subject to appropriate adjustments by the Engineer when aggregates of varying specific gravities are used. The adjustments to the job mix gradation curve should result in a curve of the same general shape as the median curve of the gradation band in Table 1 and fall within the gradation band.

Appendix A of The Asphalt Institute's Manual Series No. 2 (MS-2), 4th Edition, March 1975, contains a convenient procedure for "adjusting" the job mix gradation when aggregates of nonuniform specific gravity are proposed for use.

The bituminous content of porous friction courses shall be expressed as a percentage of the total mix by weight and shall be estimated by the Engineer on the basis of laboratory tests of the aggregates the Contractor proposes to use and the bituminous material specified.

The bituminous content estimated by the Engineer shall be within plus or minus 1 percent of the value obtained from the formula:

$$2\,K_{(sub\ c)} + 4.0$$

where K (sub c) is the surface constant for that part of the total dry aggregate that will pass a 3/4-inch (19.0 mm) sieve and be retained on the No. 4 (4.75 mm) sieve. Procedures for determining K (sub c) are contained in Chapter IV of The Asphalt Institute's Manual Series No. 2 (MS-2). The bituminous content so estimated is the percentage by weight of the total dry aggregates and must be converted to the percent by weight of the total mix in the approved job mix formula.

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The job mix tolerances shown in Table 2 shall be applied to the job mix formula to establish a job control grading band. The full tolerances will still apply if application of the job mix tolerances results in a job control grading band outside the master grading band.

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TABLE 2. JOB MIX FORMULA TOLERANCES 305
(Based on a Single Test) 306
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Material	Tolerance - Plus or Minus	309 310
Aggregate passing No. 4 sieve or larger	7.0 percent	312 313
Aggregate passing No. 8 and No. 30 sieves	4.0 percent	314 315
Aggregate passing No. 20 sieve	2.0 percent	316
Bitumen	0.40 percent	317
Temperature of mix	26 deg. F (14 deg. C)	318 319

If a change is made in any component of the bituminous mix, a new job mix formula shall be established and approved by the Engineer before any additional material on the project is produced and placed. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula. 322 323 324 325 326

3.3 TEST SECTIONS. Prior to full plant production, the Contractor shall prepare a quantity of PFC mixture according to the job mix formula. The amount of mixture should be sufficient to construct a test section [**_____] long and [**_____] wide. The test area will be designated by the Engineer. The mixture shall be placed in two sections and shall be of the same depth specified on the plans. The underlying pavement on which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment to be used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. 329 330 331 335 337 337 338 338 340 340 341 341

If the test section should prove to be unsatisfactory, the necessary adjustments to the mix design, plant operation, and/or rolling procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When test sections do not conform to specification requirements, the pavement shall be removed and replaced at the Contractor's expense. Full production shall not begin without approval of the Engineer. Test sections will be paid for in accordance with Paragraph 402-6.1. 344 346 348 348 349 350 351 352 352

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The test section should be a minimum of 50 feet (15 m) long and 20 feet (6 m) wide. The test section affords the Contractor and the Engineer an opportunity to determine the quality of the mixture in place, as well as performance of the plant and laydown equipment. Wherever possible, the test section should be placed in an area where it will receive little or no traffic so that marginal quality trial runs can be safely left in place.
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4. CONSTRUCTION METHODS

4.1 WEATHER AND SEASONAL LIMITATIONS. The porous friction course shall be constructed only on a dry surface when the atmospheric temperature is 50 degrees F (10 degrees C) and rising (at calm wind conditions) and when the weather is not foggy or rainy.

4.2 BITUMINOUS MIXING PLANT. The bituminous mixing plant shall include all facilities or equipment necessary to produce the bituminous mix. The facility shall include auxiliary items such as stockpile storage areas, equipment to construct and maintain the stockpiles, cold bin or silo storage, and the feeder system from the cold bin or silo storage to the drier(s).

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a), except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under (b), and continuous mixing plants shall conform to the requirements under (c).

(a) Requirements for All Plants. Mixing plants shall be of sufficient capacity to adequately produce the quantity of bituminous mixture for the proposed construction.

(1) Aggregate stockpiles. Sufficient storage space shall be provided so that each aggregate size can be kept in separate stockpiles. The stockpile will be constructed in uniform layers by using a clamshell or other approved method to prevent segregation. The use of bulldozers in stockpiling aggregates will not be permitted. The storage yard shall be neat and orderly, and the separate stockpiles shall be readily accessible for sampling.

(2) Cold bins. The plant shall have an adequate number of cold bins or silos for each aggregate size. These cold bins or silos shall be constructed so that no overflow from one bin to the other occurs. They shall also have individual,

adjustable outlet devices to provide a uniform and continuous flow of materials in the desired proportions. Prior to producing any mixture, the Contractor shall furnish the Engineer with calibrations showing the rate of feed of each aggregate for the cold bin or silo in which it is to be used. Change of material or change of cold bin or silo will require new calibrations. The calibration shall show the rate of feed per minute per unit of opening or setting of feed.

(3) Feeder for drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier to obtain uniform production and temperature.

(4) Drier. The plant shall include a drier(s) which continuously agitates the aggregate during the heating and drying process.

(5) Screens. Plant screens, capable of screening all aggregates to the specified size and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

(6) Dust collector. The plant shall be equipped with a dust collector to waste any material or to return all or any part of the material uniformly to the mixture as directed.

(7) Hot bins. The plant shall include hot bins of sufficient capacity to supply a mixer operating at full capacity. Hot bins shall be arranged to assure separate and adequate storage of appropriate fractions of the aggregates. When used, separate dry storage shall be provided for batching mineral filler and hydrated lime. The plant shall be equipped to proportion and feed the material into the mixer. Each bin shall be provided with overflow pipes located to prevent backup of material in other compartments or bins. Each compartment shall be provided with its individual outlet gate to prevent leakage. The gates shall cut off quickly and completely. Hot bins shall be constructed so that samples may be obtained readily. Hot bins shall be equipped with adequate telltale devices which indicate the position of the aggregates in the bins at the lower quarter points.

(8) Plant scales. Scales shall be accurate to 0.5 percent of the required load. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant scales, the Contractor may provide an approved automatic printer system to print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load.

Scales shall be inspected for accuracy and sealed as often as the Engineer may deem necessary. The Contractor shall have on hand not less than ten 50-pound (23 kg) weights for testing the scales.

(9) Equipment for preparation of bituminous material. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. Heating shall be accomplished by approved means so that flames will not contact the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring quantities and for sampling the material in the storage tanks.

(10) Bituminous control unit. Satisfactory means, either by weighing or by metering, shall be provided to obtain the specified amount of bituminous material in the mix. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

(11) Thermometric equipment. An approved thermometer of adequate range shall be placed in the bituminous feed line at a suitable location near the discharge valve of the mixer unit. The plant shall also be equipped with an approved thermometric instrument placed at the discharge chute of the dryer to indicate the temperature of the heated aggregates.

(12) Safety requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided. Guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a suitable device to enable the Engineer to obtain mixture samples and temperature data. A means shall be provided to raise and lower scale calibration equipment, sampling equipment, and other similar equipment between the ground and the mixer platform. All belts, gears, pulleys, chains, sprockets, projecting setscrews, keys, and other dangerous moving parts shall be guarded to prevent inadvertent contact by workmen or other moving equipment. Ample and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free of drippings from the mixing platform.

(13) Truck scales. The bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Scales shall be inspected for accuracy and sealed as often as the Engineer deems necessary.

(b) Requirements for Batching Plants

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(1) Weigh box or hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

(2) Bituminous control. The equipment used to measure the bituminous material shall be accurate to within plus or minus 0.5 percent. The bituminous material bucket shall be of a nontilting type with a loose sheet metal cover. The length of the discharge opening of the spray-bar shall be not less than three-fourths the length of the mixer, and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve(s), and the spray-bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be constructed so that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15 percent of the weight of bituminous material required in any batch. The plant shall have an adequately heated, quick-acting, nondrip charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used per batch. The controls shall be constructed to lock at any dial setting and automatically reset to that reading after each additional batch of bituminous material. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has begun. The size and spacing of the spray-bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray-bar shall have a valve and an outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

(3) Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture with well-coated aggregate in the prescribed mixing time within the job mix tolerance specified. If not enclosed, the mixer box shall be equipped with a hood to prevent loss of dust.

(4) Control of mixing time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh-box gate after the charging of the mixer and keep it locked until the closing of the mixer gate at the completion of the cycle. It shall lock the

bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is the time interval between the opening of the weigh-box gate and the introduction of bituminous material. The wet mixing period is the time interval between the introduction of the bituminous material and the opening of the mixer gate.

The timing control shall be flexible and shall be capable of settings at 5-second intervals or less throughout a 3-minute cycle. A mechanical batch counter shall be installed as a part of the timing device and shall be designed to register only completely mixed batches.

The setting of time intervals shall be at the direction of the Engineer who shall then lock the case covering the timing device. It shall remain locked until a change is made in the timing periods.

(c) Requirements for Continuous Plants.

(1) Aggregate proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for the volumetric measuring of material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means and provided with a lock.

Indicators shall be provided for each gate to show the respective gate opening in inches.

(2) Weight calibration of aggregate feed. The plant shall include a means to calibrate gate openings by weighing test samples. Provision shall also be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples of not less than 200 pounds (92 kg). Accurate scales shall be provided by the Contractor to weigh such samples. Charts showing the rate of feed per minute for each hot bin shall be provided.

(3) Synchronization of aggregate feed and bituminous materials feed. A satisfactory interlocking mechanical means or any other positive method approved by the Engineer shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device.

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(4) Mixer. The plant shall include an approved continuous mixer adequately heated and capable of producing a uniform mixture within the job mix tolerances. It shall be equipped with a discharge hopper with dump gates to permit rapid and complete discharge of the mixture. The paddles shall be adjustable for an angular position mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gage and the rate of feed of aggregate per minute at plant operating speed. Unless otherwise required, 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 mixer.

The weights for the job will be determined by tests made by the Engineer. The pugmill shall be equipped with a discharge hopper having a capacity of approximately 1 ton (90 kg). The hopper will be equipped with dump gates that will permit rapid and complete discharge of the bituminous mixture without segregation.

4.3 HAULING EQUIPMENT. Trucks used for hauling the bituminous mixture shall have tight, clean, smooth beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of concentrated hydrated lime and water solution. The truck beds shall be raised to drain any excess solution before loading the mixture in the trucks. Each truck shall have a suitable cover to protect the mixture from adverse weather or long hauls. An insulated bed may be required to maintain the mixture at the specified temperature during hauling.

4.4 BITUMINOUS PAVERS. Bituminous pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade.

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

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

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the screed elevation as specified herein. The

control system shall be automatically actuated from either a reference line or a surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

4.5 ROLLERS. A minimum of two self-propelled, steel-wheel rollers shall be furnished. They shall be in good condition, capable of reversing without backlash, and capable of operating at slow speeds to avoid displacement of the bituminous mixture. The wheels shall be equipped with adjustable scrapers, water tanks, and sprinkling apparatuses to prevent the bituminous mixture from sticking to the wheels. The weight of each roller shall be 6 to 12 tons (5 400 to 10 800 kg). The use of equipment which results in excessive crushing of the aggregate will not be permitted.

4.6 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated at the central mixing plant before entering the mixer. When introduced into the mixer, the combined aggregate moisture content (weighted according to the composition of the blend) shall be less than 0.25 percent for aggregate blends with water absorption of 2.5 percent or less and less than 0.50 percent for aggregate blends with water absorption greater than 2.5 percent. Water absorption of aggregates shall be determined by ASTM C127 and ASTM C128. The water absorption for the aggregate blend shall be the weighted average of the absorption values for the coarse aggregate retained on the No. 4 sieve (4.75 mm) and the fine aggregate passing the No. 4 sieve (4.75 mm). The water content test will be conducted in accordance with ASTM C566. In no case shall the moisture content be such that foaming of the mixture occurs prior to placement. At the time of mixing, the temperature of the aggregate shall be within the range specified in the job mix formula. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. Particular care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The aggregate shall be screened to specified sizes and conveyed in separate bins ready for mixing with bituminous material.

4.7 PREPARATION OF BITUMINOUS MIXTURE. The bituminous mixture shall be prepared in a central mixing plant. The mixture shall be prepared at the temperature designated by the Engineer within the range shown in Paragraph 402-2.3.

The dry aggregate shall be combined in the plant in the proportionate amounts of each aggregate size required to meet the specified gradation. The quantity of aggregate for each batch shall be determined, measured, and conveyed into the mixer. In

case of volumetric proportioning, the size of the openings shall be determined, and the gates shall be locked in position.

The quantity of bituminous material for each batch or the calibrated amount for continuous mixers shall be determined by the Engineer. It shall be measured by weight and introduced into the mixer within the temperature range specified in the job mix formula. For batch mixers, all aggregates shall be in the mixer before the bituminous material is added. In no case shall the temperature of the aggregate be more than 25 degrees F (4 degrees C) above the temperature of the bituminous material when adding the bituminous material. As determined by the Engineer, the mixing shall continue until all particles are coated uniformly. In no case shall the bituminous mixture be stored in storage silos or surge bins.

4.8 TRANSPORTATION AND DELIVERY OF THE MIXTURE. The mixture shall be transported from the central mixing plant to the paving job in trucks described in Paragraph 402-4.3. The mixture shall be placed at a temperature between 200 degrees F (94 degrees C) and 295 degrees F (146 degrees C). Delivery of the mixture shall be scheduled so that spreading and rolling of a day's production can be completed during daylight hours the same day.

4.9 SPREADING AND LAYING.

(a) Preparation of Existing Surfaces. All porous friction courses shall be constructed on an existing pavement surface that is structurally sound; is in good condition; is constructed to new pavement surface course smoothness criteria; and has Marshall stability and flow values comparable to those specified in Item P-401. The work involved in rehabilitating the existing pavement surface shall be otherwise provided for in the contract and is not a part of this PFC specification. Rehabilitation of the existing pavement including: construction of bituminous overlay; joint sealing; crack repair; reconstruction of failed pavement areas; removal of rubber deposits; removal of pavement markings; and cleaning of grease, oil, and fuel spills shall be completed and accepted by the Engineer prior to the placement of the porous friction course.

Immediately before placing the porous friction course, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed. A tack coat conforming to Item P-603 shall be placed, as directed by the Engineer, on those existing surfaces where a tack coat is necessary for bonding the PFC to the existing surface. If emulsified asphalt is used, placement of the PFC can be applied immediately. However, if cutback asphalt is used, placement of the PFC must be delayed until the tack coat has properly aired.

(b) Placing. Hauling over material already placed shall not be permitted until the material has been thoroughly compacted as specified and allowed to develop its stability for a period of, at least, 12 hours. In areas where extremely hot temperatures occur, it is suggested that no traffic be allowed on the PFC until it has cooled overnight. Traffic should be discontinued if any closing of the PFC is observed. The bituminous mixture shall be placed at the required minimum lane width with an approved bituminous paver as specified in Paragraph 402-4.4.

4.10 COMPACTION OF MIXTURE. After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Rolling of the mixture shall begin as soon after spreading as it will bear the roller without undue displacement or hair-checking. Rolling shall be initiated with the drive wheel toward the paving machine. The sequence of rolling the first paving lane should be to first roll the lower edge (with reference to the transverse slope) of the lane and then to roll the upper edge. The interior of the lane should then be rolled from the lower side toward the upper edge with overlapping roller paths. On adjoining paving lanes, rolling shall begin by overlapping the joint (with the previous lane) by 6 to 9 inches (15 to 23 cm) and then rolling the outside edge of the new lane. The interior should be rolled from the outside edge toward the compacted joint with overlapping wheel paths. Alternate trips of the roller shall be of slightly different lengths. The number of passes with a steel-wheel roller shall be as determined by the test section. The optimum weight of the roller shall also be determined during test section construction.

The speed of the roller shall be slow enough to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by raking and applying fresh mixture.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until all roller marks are eliminated and the surface is of uniform texture and conforms to the required cross section.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt, or in any way defective shall be removed and replaced with fresh hot

mixture and immediately compacted to conform to the surrounding area. This work will be done at the Contractor's expense. Skin patching and handworking of the PFC mixture will not be allowed.

4.11 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose vertical face. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The longitudinal joint shall offset that in the existing course by at least 1 foot (30 cm).

4.12 SHAPING EDGES. While the surface is being compacted and finished, the Contractor shall carefully shape the longitudinal outside edges of the PFC to a vertical face at the established edge. When transitioning from PFC to existing pavement, transverse edges shall be constructed with a finer graded bituminous mixture.

4.13 SURFACE TESTS. After completion of the final rolling, the finished surface shall be tested with a 16-foot (5 m) straightedge and shall not vary more than 1/4 inch (6 mm). The 16-foot (5 m) straightedge shall be applied parallel with and at right angles to the runway centerline in a pattern that includes longitudinal and transverse joints. The 16-foot (5 m) straightedge shall be advanced approximately 1/2 its length in the line of measurement.

Areas of the porous friction course exceeding the specified tolerances shall be corrected at the Contractor's expense by removing the defective work and replacing it with new material. Skin patching or handworking will not be permitted.

4.14 SAMPLING PFC MIXTURE AND HOT BINS. Samples of the PFC mixture shall be taken at the point of discharge in hauling units and tested to control uniformity in the bituminous content and gradation. Samples shall be taken in accordance with ASTM D979. Enough mixture shall be taken to prepare duplicate tests on each

sample of mixture in accordance with ASTM D2172. Samples shall be taken, at least, once for any central plant-run of more than 30 minutes and at least twice for any central plant-run of more than 5 hours.

Should the bituminous content of the duplicate tests agree within 0.50 percent, the average results shall be recorded. Variations greater than 0.50 percent between duplicate tests of the same sample shall also be recorded, and duplicate tests on an additional sample shall be run. The average value of the bituminous content should fall within the tolerance of the job mix formula as specified in Paragraph 402-3.2. Should the average bituminous content for four samples not fall within the job mix tolerances, the Engineer may order the Contractor to cease production until such out-of-tolerance conditions have been remedied by the Contractor. The gradation of the residual aggregate should be determined by using AASHTO T30 and compared to the approved job mix formula.

The samples of PFC mixture will be used to control the uniformity of the Contractor's plant production. In addition, the Contractor shall clearly mark each hauling unit from which the representative samples have been taken so that the same mixture sample may be located in the completed pavement.

Completed PFC shall be determined "acceptable" or "unacceptable" on the basis of visual inspection by the Engineer. The Engineer shall immediately notify the Contractor of visual defects such as nonuniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture, and evidence of aggregate crushing during the roller operations, or nonconformance to the surface smoothness criteria as specified in Paragraph 402-4.13.

"Unacceptable" PFC shall be removed, leaving a vertical face at the remaining PFC. The underlying surface shall be cleaned and a tack coat applied prior to replacing the PFC. All work shall be at the Contractor's expense. Unacceptable PFC shall not be measured for payment.

In addition to sampling and testing the PFC mixture, the Engineer shall sample each hot bin twice daily and furnish a gradation analysis of each hot bin according to ASTM C136. The combined gradation analysis of the hot bins shall fall within the job mix formula tolerances. Should the hot bin gradation analysis fail to meet the tolerances of the job mix formula (on the same sieve size), the Engineer may order another analysis in addition to the two analyses required each day to confirm the results of the previous tests or tell the Contractor to cease plant production until such out-of-tolerance conditions have been corrected.

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4.15 BITUMINOUS AND AGGREGATE MATERIAL (CONTRACTOR'S RESPONSIBILITY). Samples of the bituminous and aggregate materials that the Contractor proposes to use, together with a statement of their source and character, shall be submitted for approval prior to use. The Contractor shall require the manufacturer or producer of the bituminous and aggregate materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials which have been tested and approved for the intended use shall be acceptable.

The Engineer or the Engineer's authorized representative shall have access, at all times, to all parts of the paving plant to inspect the equipment, the conditions, and the operation of the plant; to verify the weights or proportions and character of materials; and to determine the temperatures maintained in the storage of the bituminous material and preparation of the mixtures.

The Contractor shall furnish the vendor's certified test reports for each carload or equivalent of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted to use the material. The vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All test reports shall be subject to verification by testing sample materials received for use on the project.

4.16 PROTECTION OF PAVEMENT. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cured at least 12 hours. Newly constructed pavement areas shall not be opened to aircraft traffic until 24 hours after completion or unless otherwise authorized by the Engineer.

5. METHOD OF MEASUREMENT

5.1 Porous friction course shall be measured by the number of [square yards (square meters)] [tons (kg)] of mixture used in the accepted work.

Only the areas of the porous friction course meeting the following thickness requirements shall be measured for payment:

To determine the thickness of the finished PFC, the Engineer shall take one core sample, not less than 2 inches (5 cm) in diameter, at random from each unit of the completed PFC area. A unit of the completed area shall be one paving lane wide by 1,000 feet (304 m) long. The last unit in any one paving lane shall include any remaining length in addition to the 1,000 feet (304 m).

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When the measurement of any core is more than the maximum or less than the minimum allowable thickness, as shown in Table 3, additional cores shall be taken at 20-foot intervals (6 m) (parallel to and at right angles to the runway centerline) until the completed PFC is within such maximum or minimum thickness for the subunit being tested. Out-of-tolerance areas shall be deducted from the total [square yards (square meters)] [tons (kg)] PFC for payment. If, in the Engineer's judgment, such out-of-tolerance areas warrant removal, the PFC shall be removed and the underlying course shall be cleaned (ready for reconstruction), all at the Contractor's expense.

TABLE 3. ALLOWABLE FINISHED PFC THICKNESS

	Nominal		Maximum		Minimum	
	in.	mm	in.	mm	in.	mm
3/4 in. Aggregate	1.0	25	1.50	37	0.75	19
1/2 in. Aggregate	0.75	19	1.25	32	0.50	12

6. BASIS OF PAYMENT

6.1 Payment shall be made at the respective contract prices per [square yard (square meter)] [ton (kg)] for porous friction course and per [gallon (liter)] [ton (kg)] for bituminous material. The prices shall be full compensation for furnishing all materials; for all preparation and storage of materials; for cleaning the existing surface; for mixing, hauling, placing, and compacting the mixture (including initial test section); and for all tools, equipment, and incidentals necessary to complete each item. No separate payment is included in the contract for furnishing and batching mineral filler, or antistripping agents, should such items be required.

Rehabilitation of the existing pavement surface and the tack coat shall be measured and paid for at their respective contract prices.

Payment will be made under:

Item P-402-6.1 Porous Friction Course - [Per square yard (square meter)] [ton (kg)]

Item P-402-6.1 Bituminous Material - [Per gallon (liter)] [ton (kg)]

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