MICHIGAN DEPARTMENT OF TRANSPORTATION
AIRPORTS DIVISION
STANDARD SPECIFICATION P-411
PLANT MIX BITUMINOUS PAVEMENTS

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DESCRIPTION

1.1 This item shall consist of pavement courses composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and as designated on the construction plans. Each shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved by the Project Engineer before the placement of the next course.

MATERIALS

2.1 **Aggregates.** Aggregates shall consist of crushed stone, crushed gravel, or crushed slag with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 4 (4.75 mm) sieve shall be known as coarse aggregate, the portion passing the No. 4 (4.75 mm) sieve and retained on the No. 200 (0.075 mm) sieve as fine aggregate, and the portion passing the No. 200 (0.075 mm) as 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 bituminous material and be free from organic matter and other deleterious substances. The percentage of wear for the coarse aggregate shall not be greater than 40 percent for surface and leveling courses when tested in accordance with ASTM C 131. The percentage of wear for aggregate used in base course shall not exceed 50 percent. If a slag aggregate is used for any course, the percentage of wear shall not exceed 50 percent.

Crushed aggregate content shall be the percentage of crushed material of a sample retained on all sieves down to and including the No. 4 (4.75 mm) sieve. A crushed particle is one in which at least one face is fractured. When two faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. The minimum crushed content shall be as designated in Tables IIIA and IIIB.

The aggregate shall not contain more than 8 percent, by weight, of flat or elongated particles when tested in accordance to ASTM D 4791. A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

The aggregate in the surface course shall not contain more than 5 percent, by weight, of soft particles in accordance with Michigan Test Method (MTM) 110 for Determining Deleterious and Objectionable Particles in Aggregate.

Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 70 pounds per cubic foot when tested in accordance with ASTM C 29. It shall contain no steel slag, no free (unhydrated) lime, and shall not contain excessive clay lumps or glassy pieces as judged by the Project Engineer. Coarse slag aggregate shall not be blended with coarse natural aggregate until they are incorporated into the mix.

(b) Fine Aggregate. Fine aggregate shall consist of clean, hard, durable, uncoated particles, free from clay lumps, organic materials, soft or flaky materials, and other foreign matter. These aggregates shall be natural sand, manufactured fine aggregate, or a blend meeting the grading and physical requirements specified. The fine aggregate, including any blended filler, shall have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318. The fine aggregate shall be tested in accordance with MTM 118 Measuring Fine Aggregate Angularity.

(c) Aggregate Sampling and Testing. All aggregate samples required for testing shall be furnished by the Contractor. Under the terms of this contract, the Contractor is responsible for making arrangements with an independent laboratory to perform material acceptance tests described herein. The Contractor shall be obligated to pay all charges incurred in performing these aggregate physical tests,

including shipping expenses to transport the test samples to the laboratory.

Samples shall be taken by the Contractor in accordance with procedures described in ASTM D 75 for coarse and fine aggregates and ASTM C 183 for mineral filler. Costs for testing additional sources shall be borne by the Contractor.

No aggregate shall be used in the production of mixtures unless it meets the specification requirements and the laboratory test reports have been approved by the Project Engineer.

The furnishing of the test reports shall be the responsibility of the Contractor. All applicable test results must be indicated; including dates the tests were performed. Each report furnished shall contain a definite statement by the testing laboratory indicating that the material tested either does or does not meet the applicable specification.

Approval of the source of aggregate does not relieve the Contractor in any way of the responsibility for delivery to the job site of aggregates that meet the requirements specified herein.

The Engineer has the right to request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

2.2 Mineral Filler. If mineral filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242. Sources for fly ash must be selected from an approved manufacturer in MDOT's Materials Source Guide.

2.3 Bituminous Material. The types, grades, and controlling specifications for the bituminous materials shall be as shown in Table I: Performance Graded Asphalt Binder Specification**.** The specific material to be used shall be as specified in the plans or contract documents. Sources for asphalt cement binder must be selected from an approved manufacturer in MDOT's Materials Source Guide.

Asphalt cement binder for each mix design within a given bituminous paving project shall be produced by a single manufacturer unless otherwise authorized by the Project Engineer.

Any anti-stripping agent or additive if required shall be heat stable, shall not change the asphalt cement viscosity beyond specifications in Table I, shall contain no harmful ingredients, shall be added in recommended proportion by approved method, and shall be a material approved by the Project Engineer.

2.4 Preliminary Material Acceptance. Prior to production of the bituminous mixture, the Contractor shall submit certified test reports to the Project Engineer for the following materials:

a. Coarse Aggregate.
   1. Percent of Wear
   2. Crushed content
   3. Flat & Elongated particles
   4. Soft Particles
   5. Unit weight of slag (if applicable)

b. Fine Aggregate**.**
   1. Plasticity Index
   2. Liquid Limit
   3. Fine Aggregate Angularity

c. Mineral Filler.
   1. Approved manufacturer (MDOT Materials Source Guide).

d. Bituminous material.
   1. Approved manufacturer (MDOT Materials Source Guide).

2.5 Release Agents. Use release agents that do not harm the properties of the mixture, or the environment and is approved by the Engineer. Do not use fuel oil or other distillate derivatives.

Table I : Performance Graded Asphalt Binder Specifications

Performance Grade	PG 58			PG 64		
	-22	-28	-34	-22	-28	-34
Avg 7-day Max. Pave Design Temp, °C (a)	<58			<64		
Minimum Pavement Design Temp, °C	>-22	>-28	>-34	>-22	>-28	>-34
Original Binder						
Flash Point Temp, T48: Min °C	230					
Viscosity, ASTM D 4402: Max 3 Pa s, Test Temp, °C (b)	135					
Dynamic Shear, TP5: G*/sin ð, Min. 1.00 kPa Test Temp at 10 rad/s, °C (c) (g)	58			64		
Rolling Thin Film Oven (T 240)						
Mass Loss, Max. Percent	1.00					
Dynamic Shear, TP5: G*/sin ð, Min. 2.20 kPa Test Temp at 10 rad/s, °C (g)	58			64		
Pressure Aging Vessel Residue (PP1)						
PAV Aging Temp, °C (d)	100			100		
Dynamic Shear, TP5: G*sin ð, Max. 5000 kPa Test Temp at 10 rad/s, °C (g)	22	19	16	25	22	19
Physical Hardening (e)	Report					
Creep Stiffness, TP1: S, Max. 300 MPa, m-value, Min. 0.300 Test Temp at 60 s, °C (f)	-12	-18	-24	-12	-18	-24
Direct Tension, TP3: Fail. Strain, Min. 1.0% Test Temp at 1.0 mm/min, °C (f)	-12	-18	-24	-12	-18	-24

a. Pavement temperatures are estimated from air temperatures using an algorithm contained in the Superpave software program, may be provided by the specifying agency, or by following the procedures as outlined in MP2 and PP28.

b. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

c. For quality control of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be used or supplement dynamic shear measurements of G*/sin at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary or rotational viscometer (AASHTO T 201 or T 202).

d. The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures 90 °C, 100 °C or 110 °C. The PAV aging temperature is 100 °C for PG 58- and above, except in desert climates, where it is 110 °C.

e. Physical Hardening--TP 1 is performed on a set of asphalt beams according to Section 13.1, except the conditioning time is extended to 24 hrs ± 10 minutes at 10 °C above the minimum performance temperature. The 24-hour stiffness and m-value are reported for information purposes only.

f. If the creep stiffness is below 300 Mpa, the direct tension test is not required. If the creep stiffness is between 300 and 600 Mpa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

g. G*/sin = high temperature stiffness and G*sin = intermediate temperature stiffness.

COMPOSITION

3.1 Composition of Mixture. The bituminous plant mix shall be composed of a mixture of well-graded aggregate, mineral filler, if required, and bituminous materials. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

3.2 Job Mix Formula (JMF). No bituminous mixtures shall be produced for payment until a JMF prepared specifically for this contract has been approved by the Project Engineer. The testing laboratory used to develop the JMF shall meet the requirements of ASTM D 3666 or be a certified laboratory under MDOT's Bituminous Laboratory Certification Program.

The JMF shall be submitted in writing by the Contractor to the Project Engineer at least 10 days prior to the start of paving operations and shall contain as a minimum:

a. Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percent by weight of each stockpile used in the JMF.

b. Percent of asphalt cement binder. Name of approved supplier & MDOT certifier number.

c. Asphalt performance penetration grade (PG grade specified).

d. Number of blows of hammer compaction per side of molded specimen.

e. Mixing temperature (ºF).

f. Compaction temperature (ºF).

g. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content.

h. Aggregate physical test results

The JMF for each mixture shall be in effect until modification is approved in writing by the Project Engineer. Should a change in sources of materials be made, a new JMF must be submitted before the new material is used.

The Contractor shall be responsible for the cost of the JMF, including the cost of providing materials for design and testing. Should a new or modified JMF be required due to variations in mixture components supplied by the Contractor, the cost of such shall be at the Contractor's expense. There will be no time extension given or considerations for extra costs associated with the stoppage of production paving or restart of production paving due to the time needed for the Engineer to approve the initial, new or modified JMF.

The bituminous mixture shall be designed using procedures contained in Chapter 5, MARSHALL MIX METHOD OF DESIGN, of the Asphalt Institute's Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete, current edition, and shall meet the requirements of Tables IIIA or IIIB.

The Marshall Mix Design MS-2 procedures are further amended as follows:

1. The Marshall specimen shall be compacted by means of a flat-faced mechanical compactor or hammer.

2. The design asphalt content shall be designated as that which would permit a 2.5 percent air void content in the total mix. (Refer to Table IIIA & IIIB.)

The gradations in Table IIIA & IIIB are listed for the designer and represent to the Contractor the limits which shall determine the suitability of aggregate for use from the sources of supply.

The aggregate, as designated on the plans, shall have a gradation within the limits designated in Table IIIA or IIIB when tested in accordance with ASTM C 136 and C 117. It 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. The percent, by weight, of bituminous material shall be within the limits of Table IIIA or IIIB.

The selection of any of the gradations shall be such that the maximum size aggregate used shall not be more than one-half of the thickness of the course being constructed. If highly absorbable aggregates are used, the bituminous content may exceed the

limits of Table IIIA or IIIB.

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

Job Control: Extraction tests for asphalt cement content and aggregate gradation will be made at least twice daily during full production. The mixture will be tested for asphalt cement content in accordance with ASTM D 2172 and for aggregate gradation in accordance with AASHTO T 30. These acceptance tests shall be performed by the Project Engineer or designated representative and are not a Contractor expense. The Contractor is responsible for providing quality control testing for asphalt content, aggregate gradation, temperatures, and aggregate moisture during bituminous mixture production.

After the JMF is established, the aggregate gradation and the asphalt cement content of the bituminous mixture furnished for the work shall be maintained within the Range 1 uniformity tolerance limits permitted for the JMF, as specified in Table IV. If two consecutive aggregate gradations on one sieve or two consecutive asphalt cement contents, each as determined by field extraction, are in excess of the Range 1 limits but not in excess of the Range 2 limits, mix production shall be suspended. Full production shall not begin until the mixture produced is within Range 1 limits. (Work days will be charged during the downtime). Before resuming any production, the Contractor shall make all necessary alterations to the materials or plant so that the JMF can be maintained within the deviations permitted under Table IV, Range 1.

At the start of full production, the Contractor will be responsible for obtaining one 16 ounce sample of the bituminous material. The contractor shall have this sample tested by an independent testing laboratory to verify conformance with the applicable specifications of Table I and to ensure the same bituminous material is being used that was documented by the MDOT Certified Supplier. The test results should be provided to the Project Engineer. The Project Engineer, at their discretion, may also request samples for quality assurance testing, prior to and during production.

In addition to the initial sample gathered for verification by the Contractor, the Contractor shall obtain one 16 ounce sample of the bituminous material during each remaining day of plant production. The material shall be drawn from a spigot located on the pipeline supplying asphalt binder to the plant, in a position between the asphalt binder pump and the point where the asphalt binder enters the mixture. It shall be placed in sealed containers which are marked by project, asphalt grade and date of sampling. The filled containers will be delivered to the Project Engineer at the beginning of each day of asphalt production. The Project Engineer shall retain the samples for twelve months after final acceptance of the contract.

Price Adjustments on Asphalt Binder:
When two or more samples of a specific PG binder grade, taken on consecutive days of production, fall within the ranges shown following in the price adjustment tables, the contract unit price for the mixture containing the out of specification binder shall be reduced by the percentage shown for the days of production represented by the samples. When multiple tests on a binder sample are out of specification, the price reductions will not be cumulative. The greatest price reduction on any test will apply. If the price reduction is 50 percent, the days of production will be evaluated by the Project Engineer. If the Project Engineer determines that removal is warranted, the Contractor shall remove and replace the pavement at no additional cost to the project. On projects that have only one day of mix production and paving, two samples will be taken and tested to determine if there are any price adjustments. The standard check tests will be performed if the potential for price adjustments exist.

If any of the following three situations occur:

- The asphalt binder supplier is not on the approved certifiers list.
- Less than the minimum grade of binder, as specified by the contract, is used in the mix.
- A daily binder sample is not taken, or the specified one 16 ounce sample tin is less than three quarters full.

The Engineer will evaluate the days of production and require the Contractor to remove and replace the pavement at no additional cost to the project, or if the pavement is not removed, a 50 percent reduction in the contract unit price shall be imposed on the mixture containing the non-specification binder.

Table II
Price Adjustment Tables:

Dynamic Shear Rheometer Original Material	
% Reduction	Spec. Range (kPa)
2.5	0.98 - <1.00
5	0.93 - <0.98
10	0.88 - <0.93
15	0.83 - <0.88
20	0.78 - <0.83
30	0.73 - <0.78
40	0.68 - <0.73
50	less than 0.68

Dynamic Shear Rheometer RTFO Material	
% Reduction	Spec. Range (kPa)
2.5	2.08 - <2.20
5	1.98 - <2.08
10	1.88 - <1.98
15	1.78 - <1.88
20	1.68 - <1.78
30	1.58 - <1.68
40	1.48 - <1.58
50	less than 1.48

Dynamic Shear Rheometer PAV Material	
% Reduction	Spec. Range (kPa)
2.5	>5000 - 5350
5	>5350 - 5600
10	>5600 - 5850
15	>5850 - 6100
20	>6100 - 6350
30	>6350 - 6600
40	>6600 - 6850
50	greater than 6850

Bending Beam Rheometer Stiffness	
% Reduction	Spec. Range (MPa)
2.5	>300 - 309
5	>309 - 324
10	>324 - 339
15	>339 - 351
20	>351 - 369
30	>369 - 384
40	>384 - 399
50	greater than 399

Bending Beam Rheometer M-Value	
% Reduction	Spec. Range
2.5	0.292 - <0.300
5	0.285 - <0.292
10	0.270 - <0.285
15	0.255 - <0.270
20	0.240 - <0.255
30	0.225 - <0.240
40	0.210 - <0.225
50	less than 0.210

Rejected Mixtures: If in any one mixture, two consecutive aggregate gradations on one sieve or asphalt cement content, as determined by field extractions, exceed the uniformity tolerance of Range 2 under Table IV, the mixture will be rejected. If such mixtures are placed in the pavement, the remaining portions of the field extraction samples, may, at the Contractor's request, be sent to the testing lab responsible for the mix design to confirm the field extraction test results. The cost of such laboratory tests shall be paid by the Contractor.

In instances where the test data from the field and the laboratory differ, the laboratory data shall be the basis for acceptance.

If the laboratory results confirm the field extraction test results and if in the Project Engineer's judgment the defective areas warrant removal, the Contractor shall remove and replace the areas, at the Contractor's expense, with mixtures meeting specification requirements.

Should a change in sources of materials be made, a new JMF shall be established and approved by the Project Engineer before the new material is used. Deviation from the final approved design for asphalt cement content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extraction.

3.3 Recycled Asphalt Pavement (RAP). Reclaimed material from pavements shall not be used unless such use is designated on the construction drawings or by supplemental specification.

3.4 Test Section. The Contractor shall not begin full bituminous production without approval by the Project Engineer. Prior to full production, the Contractor shall prepare and place a quantity of bituminous mixture in accordance to the JMF. This will be used as a test section. The test section affords the Contractor and the Project Engineer an

opportunity to determine the quality of the mixture in place, as well as performance of the plant and laydown equipment. The amount of mixture produced shall be sufficient to construct a test section not less than 50 feet long and 20 feet wide; however, the bituminous mixture placed shall not exceed 200 tons.

The test section shall be placed in two lanes and shall be of the same depth specified for the construction of the course which it represents. The underlying grade or pavement structure upon 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 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.

Test Section acceptance: The test section shall be evaluated for acceptance as a single lot.

Uncompacted mixture acceptance:
The Project Engineer will obtain a sample of the uncompacted mixture and run an extraction test on it to determine conformance with the JMF after applying the allowable deviations listed in Table IV, Range 1**.** The Project Engineer will also obtain a sample of the uncompacted mixture and run a maximum specific gravity test (ASTM D 2041) on the sample. For air voids determination, the maximum specific gravity of the mixture shall be measured twice for the sample lot in accordance with ASTM D 2041, Type C, D, or E container. The value used in the air voids computation for the sample shall be based on the average of the two maximum specific gravity measurements for the sample. The ASTM D2041 test will not be run on pavements designed for aircraft weights less than 12,500 pounds.

Compacted mixture acceptance:
Four core samples of each finished course shall be taken by the Contractor at locations mutually agreed upon with the Project Engineer. Where two or more courses are involved, the top course shall not be placed until the lower course has been completed and cored.

For pavements designed for aircraft weights of 12,500 pounds and over, the bulk specific gravity (ASTM D 2726) of each core sample shall be determined and used in computing the air voids of the four samples. Acceptable limits for the average in-place air voids of the test section are defined as 1.0 - 7.0 percent. A test section failing to meet this criteria shall be rejected and removed at the Contractor's expense.

For pavements designed for aircraft weights of less than 12,500 pounds, the pavement density shall be determined in accordance with Section 5.1 of this specification.

The Project Engineer shall inform the Contractor whether or not the test section meets specification requirements. If the test section fails to meet specification requirements, the Contractor shall determine the adjustments needed to the JMF, plant operation, placing procedures, and/or rolling procedures. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional test sections that are not acceptable shall be removed at the Contractor's expense. The procedures above shall be repeated until the Project Engineer determines that all the specification requirements tested have been met on a test section.

Test sections placed at the project site which meet all specification requirements will be paid for in accordance with Section 7.1. Payment of the test section is included with the bituminous work items for the project and shall not be paid for separately.

Delays which arise from the Contractor's failure to produce and place material which meets specification requirements will not be considered grounds for time extension to the contract.

TABLE IIIA
Marshall Design Criteria & Aggregate Gradations
for pavements designed for aircraft gross weights
< 60,000 lbs or tire pressures < 100 psi

Stability, pounds minimum		1000	
Number of Blows		50	
Air Voids*, %		2.5	
Flow, 0.01 in		8-18	
Voids in Mineral Aggregates (VMA), % minimum		14.5	
Fines to binder ratio (max) ****		1.2	
Sieve Size		Aggregate Series Number	
		20AAX**	20AX**
%	1-1/2" (37.5mm)	---	---
	1" (25.0 mm)	---	---
P	3/4" (19.0 mm)	100	100
A	1/2" (12.5 mm)	90-100	---
S	3/8" (9.5 mm)	65-95	60-90
S	No. 4 (4.75 mm)***	---	---
I	No. 8 (2.36 mm)	45-70	40-65
N	No. 30 (0.60 mm) ***	20-45	20-40
G	No. 200 (0.075 mm)****	3-10	3-10
% Asphalt Cement Binder in Mixture		5.4-7	5.4-7
% Crushed Material (Minimum)		40	25

* If the asphalt content at 2.5% air voids is less than 5.4%, and the asphalt content at 2.0% air voids is 5.4% or greater, then the asphalt content at 2.0% air voids shall be the design value. If the asphalt content at 2.5% air voids is greater than the upper limit shown above in Table IIIA and the asphalt content at 3.0% air voids is between 5.4% and the upper limit, than the asphalt content at 3.0% air voids shall be the design value.

If based upon the above procedure, the mix at the design asphalt content fails to meet stability, flow, or VMA requirements, the mix design is rejected and a new mix design with a different gradation and/or aggregate is undertaken. The above procedure may not be altered without prior approval of AERO.

**The "X" placed after the aggregate series number indicates that the physical requirements for aggregates used in airport mixtures differ from those specified by the MDOT for similarly numbered aggregate mixtures used in highway construction.

*** Sand ratio for 20AAX and 20AX: No more than 50% of the material passing the No. 4 Sieve is allowed to pass the No. 30 Sieve.

**** Ratio of the weight of aggregate passing the No. 200 sieve to total asphalt binder content by weight.

TABLE IIIB
Marshall Design Criteria & Aggregate Gradations
for pavements designed for aircraft gross weights ≥ 60,000 lbs or tire pressures ≥ 100 psi

Stability, pounds minimum		1800				
Number of Blows		75				
Air Voids*, %		2.5				
Flow, 0.01 in		8-18	8-16	8-16	8-16	8-16
Voids in Mineral Aggregates (VMA), % minimum		14.5	13	14	15	16
Grading Band		20AAAX **	A	B	C	D
Fines to binder ratio (max) ****		1.2	1.2	1.2	1.2	1.2
	Sieve Size		1-1/2 in. max.	1 in. max.	3/4 in. max.	½ in max.
%	1-1/2 in. (37.5 mm)	----	100	----	----	----
	1 in. (25.0 mm)	----	86-98	100	----	----
P	3/4 in. (19.0 mm)	100	68-93	76-98	100	----
A	½ in. (12.5 mm)	90-100	57-81	66-86	79-99	100
S	3/8 in. (9.5 mm)	65-95	49-69	57-77	68-88	79-99
S	No. 4 (4.75 mm)***	55-75	34-54	40-60	48-68	58-78
I	No. 8 (2.36 mm)	45-70	22-42	26-46	33-53	39-59
N	No. 16 (1.18 mm)	----	13-33	17-37	20-40	26-46
G	No. 30 (0.60 mm)***	20-45	8-24	11-27	14-30	19-35
	No. 50 (0.30 mm)	----	6-18	7-19	9-21	12-24
	No. 100 (0.15 mm)	----	4-12	6-16	6-16	7-17
	No. 200 (0.075 mm)****	3-10	3-6	3-6	3-6	3-6
%	Asphalt Cement Binder in Mixture	5.4-7.0	5.4-7.0	5.4-7.0	5.4-7.5	5.4-8.0
%	Crushed Content -(Minimum)	60	85	85	85	85
	One Face(85) or Two Face (70)		70	70	70	70

***** If the asphalt content at 2.5% air voids is less than 5.4%, and the asphalt content at 2.0% air voids is 5.4% or greater, then the asphalt content at 2.0% air voids shall be the design value. If the asphalt content at 2.5% air voids is greater than the upper limit shown above in Table IIIB and the asphalt content at 3.0% air voids is between 5.4% and the upper limit, than the asphalt content at 3.0% air voids shall be the design value.

If based upon the above procedure, the mix at the design asphalt content fails to meet stability, flow, or VMA requirements, the mix design is rejected and a new mix design with a different gradation and/or aggregate is undertaken. The above procedure may not be altered without prior approval of AERO.

**The "X" placed after the aggregate series number indicates that the physical requirements for aggregates used in airport mixtures differ from those specified by the MDOT for similarly numbered aggregate mixtures used in highway construction.

*** Sand ratio for 20AAAX, A, B, C and D: No more than 50% of the material passing the No. 4 Sieve is allowed to pass the No. 30 Sieve.

**** Ratio of the weight of aggregate passing the No. 200 sieve to total asphalt binder content by weight.

TABLE IV
UNIFORMITY TOLERANCE LIMITS FOR BITUMINOUS MIXTURES

Type of Course	Range	Percentage Passing Designated Sieves			
		No. 8 & Larger Sieves	No. 30	No. 200	Asphalt Cement
Top and Leveling Courses	Range 1*	± 5.0	± 4.0	± 1.0	± 0.40
	Range 2**	± 8.0	± 7.0	± 3.0	± 0.60
Base Courses	Range 1*	± 7.0	± 7.0	± 2.0	± 0.40
	Range 2**	± 10.0	± 9.0	± 4.0	± 0.60

* Range 1: Maximum allowable deviations permitted from JMF
** Range 2: If two consecutive aggregate gradations on one sieve or two consecutive asphalt cement contents, each as determined by field extraction, are in excess of the Range 1 limits, but not in excess of the Range 2 limits, mix production shall be suspended. Full production shall not begin until the mixture produced is within Range 1 limits.

TABLE V
TEMPERATURE AND SEASONAL LIMITATIONS

Seasonal Limits for Placing Bituminous Mixtures	
Location	Seasonal Limits
Upper Peninsula	June 1 thru Oct. 15
Lower Peninsula	
North of M-46	May 15 thru Nov. 1
M-46 and South	May 5 thru Nov. 15

Temperature Limitations Within the Seasonal Limits	
Minimum Temperature Base to be Overlaid ºF (as measured in shade)	Thickness of Bituminous Material
50	< 1 inch
40	1inch but <2 inches
35	2 inches or greater

CONSTRUCTION METHODS

4.1 Weather and Seasonal Limitations. Bituminous mixture shall not be placed nor the prime coat or tack coat applied when rain is threatening or when the surface to be paved is wet. Seasonal and temperature limitations for placement of the bituminous mix shall be in accordance with Table V.

4.2 Bituminous Mixing Plant. Bituminous mixtures shall be produced in continuous, batch, or drum mixer-type plants and operated within the plant manufacturer's recommendations.

Bituminous plants shall be in good mechanical condition and any defective plant equipment or malfunction that directly affects the mix quality must be repaired in a timely manner.

The Contractor shall provide adequate and safe stairways for accessibility to plant operations. Adequate safeguards shall be provided to prevent injury

to the personnel from plant components. The mixture sampling platform shall be of the proper height(s) for safe access to the mixture in all hauling units and shall have a safe and adequate stairway. Sampling platforms must comply with Part 45 of General Industries Fall Protection Standards and shall comply with MIOSHA regulations.

Continuous plants shall include a means to accurately proportion aggregate mineral filler and asphalt cement by volumetric measurement. Batch plants

shall accurately proportion aggregate mineral filler and asphalt cement by weight. Drum mixer plants shall be capable of simultaneously heating and mixing the aggregates with a controlled amount of bitumen and mineral filler in a rotating cylindrical dryer drum and discharging the mixture into a hot mix surge bin. The plant console shall have displays for both the rate of feed and accumulated weights of the aggregate, mineral filler, and asphalt binder. The plants shall meet the requirements specified herein.

(a) Asphalt Storage Tanks. Each tank shall identify the grade of asphalt binder being stored. Asphalt storage tanks shall be equipped for heating the bituminous material at uniform temperatures. There shall be provisions for effective and positive control of the temperature of the bituminous material within 250° to 350° F. Thermometers shall be installed in such locations as to accurately indicate the temperature of the bituminous material at all times.

(b) Aggregate Feed. Power driven feeders shall be provided which are capable of supplying an accurately adjustable and continuous flow of each aggregate to the drier. The feeders' rate of flow shall be readily and incrementally adjustable and shall be capable of being secured in any position. The plant shall have a minimum number of cold feed bins to meet mix blend requirements. The plant may not feed two materials from one cold feed bin. There must be a cold feed bin for each material required. The feeders shall be equipped with cut-offs which will automatically stop the operations of the asphalt plant at any time the flow of aggregate is stopped. The aggregate feed system shall be equipped with a mechanical screening device for the removal of oversized material. For bituminous base mixtures, the oversize screen shall have a one dimension opening of 1-3/4 inches (44mm). For all other mixes it shall have a one dimension opening ¼ inch (6mm) larger then the maximum aggregate size in the bituminous mixture being produced.

(c) Drier. The drier shall be designed so as to continuously heat and dry the aggregates to specification requirements. It shall be equipped with an automatic modulation device to control and maintain the temperature within the specified limits. The drier shall dry the aggregates uniformly. In the event that the drier does not dry the aggregates satisfactorily, the Contractor shall make the necessary adjustments to give satisfactory results. When excessive moisture is present in the mixture, production shall be discontinued until the necessary corrections are made.

(d) Indicating Pyrometer. An indicating pyrometer or other approved thermometric instrument shall be so located as to be in full view of the plant operator and so installed as to indicate the temperature of the material at the discharge end of the drier or drum mixer.

(e) Dust Collectors. Dust collectors shall be provided on all plants. When the plant is equipped to collect baghouse fines in a separate silo, these fines may not be used in subsequent mixtures. Surplus fine aggregate material collected in a silo may not be used in subsequent mixture unless it is a component of an approved mix design.

(f) Hot Aggregate Bins.

1. Batch Plants. The plant shall have hot aggregate bins of a total capacity of not less than 10 times the weight of the batch being mixed. Each hot aggregate bin shall be equipped with a bin-level indicator which shall indicate when the bin compartment is filled to approximately half the bin capacity.

2. Continuous Plants. The plant shall have hot aggregate bins of a total capacity of not less than 15 tons. If the rate of mixture production exceeds 75 tons per hour, the minimum bin capacity shall not be less than 30 tons of hot aggregate. The plants shall have a mineral filler storage compartment. Each bin compartment shall be equipped with a bin-level indicator which shall indicate when the bin compartment is filled to approximately one third of the total capacity of the bin.

(g) Mineral Filler Feed. When mineral filler is required by the JMF, the plant shall be equipped with a mineral filler silo. A method of accurately metering or weighing the mineral filler into the mixture shall be provided.

(h) Sampling Spigot. The pipeline supplying the bituminous material shall be equipped with a sampling spigot located in a position between the binder pump and the point where the material enters the mixture. Personnel safety is critical in selecting the position of the sampling spigot.

(i) Asphalt Binder Pumps.

1. Continuous Plants. The binder pump shall have a positive displacement type pump. It shall be synchronized with a non-reset revolution counter graduated to 0.01 revolutions to enable the Project Engineer to accurately check the calibration of the bitumen pump. The Contractor shall furnish accurate calibration tables for the bitumen pump designating the quantity pumped per revolution, and shall provide means for checking these calibration tables.

2. Drum Plants. The binder shall be continuously delivered to the dryer/mixer drum by a positive displacement pump, variable volume pump, or flow meter valve. The rate of feed of the binder shall be displayed on a totalizer located in the control room. The plan console shall contain provisions for setting the specific gravity of the asphalt content

(j) Interlock System for Aggregate, Mineral Filler or Asphalt Binder on Continuous and Drum Plants. An interlocking system shall be provided to halt production of bituminous mixtures if any one of the three feed systems (aggregate, mineral filler, or asphalt binder) malfunctions.

(k) Calibration of Continuous and Drum Plants. Provisions shall be made for diversion and calibration of the aggregate, mineral filler, and binder. The plant shall be calibrated by the Contractor prior to the start of the initial production of bituminous mixture for the project and at other intervals as directed by the Project Engineer.

The following tolerances shall be used for the calibration:
For asphalt binder, the accuracy required will be to within ±0.1 percent of the calculated weight of the mixture.

For each of the other components (coarse aggregate, fine aggregate, and mineral filler) the accuracy required will be to within ± 0.5 percent of the calculated weight of the mixture.

The plant shall be equipped with the following calibration facilities so that the electronic plant controls can be checked and controlled to assure proper proportions.

1. Aggregate. The plant shall be equipped with a diverting chute. The Contractor shall provide means for diverting and weighing the aggregate for a time period not to exceed five minutes. The Contractor has the option of running the aggregate into the surge bin during the plant calibration and weighing with a suspended weigh hopper or into a truck and weighing on approved platform scales.

2. Mineral Filler. The plant shall be equipped with a system to divert the mineral filler into an approved container. The container shall be of sufficient capacity to hold a calculated weight or volume equal to four percent of the rated capacity of the plant during the calibration test. The Contractor shall have an approved platform scale or suspended weigh hopper for the weighing of the mineral filler. The calibration will consist of diverting the filler for a period of time not to exceed five minutes. The calibration may be done simultaneously with the aggregate and bitumen, or separately. If done separately, the aggregate feed control portion of the console will be set at the anticipated production rate during the calibration period.

3. Asphalt Cement Binder. The plant shall be equipped with a tank for the calibration of the bitumen feed system. The calibration will consist of diverting the binder for a time period not to exceed five minutes. The calibration of the binder may be done simultaneously with the aggregate or may be done separately. If done separately, the aggregate feed control portion of the console will be set at the anticipated production rate during the calibration period.

(l) Scales. Platform, belt conveyor, and surge bin scales shall conform to the requirements of the National Institute of Standards and Technology (NIST) Handbook 44 with the following exceptions and additional requirements.

The zero-load balance may be adjusted, either by an electronic mechanism designed to be manually operated to provide an automatic zero balance condition (push-button zero) or by an automatic means to maintain a digital zero balance. This requirement shall apply to all platforms and surge bin scales used for weighing bituminous mixtures.

The tolerance applications of NIST Handbook 44 and to tests involving digital indications or representations, shall apply except that the tolerance value for platform scales shall be 2 pounds per 1000

pounds of load or the value of one scale division, whichever is larger.

A scale shall not be used for weighing a load totaling more than the nominal capacity marked on the scale by the manufacturer. Any portion of the load in excess of the nominal scale capacity will not be considered for payment.

The accuracy of the scale will be checked. The Contractor shall, at his own expense, secure a check from a local official sealer of weights and measures, or the Project Engineer may give tentative approval, based on check truckloads weighed on other scales which bear an official seal placed in the current calendar year. Upon request, the Contractor shall provide documentation to support the accuracy of the scale.

The total weight of a single highway vehicle shall be weighed as a single draft and shall not be determined by adding together the results obtained by separately weighing each end of such vehicle except that weighing of a coupled combination may be determined without uncoupling under the following conditions:

1. The brakes are released.

2. There is no tension or compression on the drawbar.

3. The approaches are straight and in the same level plane as the scale platform.

4. The approaches are paved at least 50 feet in each direction with a seal coat or higher type surfacing.

5. The approaches are of sufficient width and length to ensure level positioning of vehicles during the weighing operation.

When a printout system is employed on a platform or a surge bin scale, it shall be equipped with a printer which shall print the following information on a triplicate ticket for each truckload:

1. Job number;
2. Contractor's name;
3. Type of material being weighed;
4. Time;
5. Date;
6. Sequential ticket number (may be preprinted on a ticket);
7. Gross weight;
8. Tare weight (trucks shall be tared at least twice daily);
9. Net weight;
10. Net accumulated jobs daily total.

The system shall be so interlocked to allow printing only when the scale has come to a complete rest.

Batch Plants. The scales shall come to rest after the weighing of each ingredient to facilitate the monitoring of the proportioning operations. The scales shall comply with the requirements of the NIST Handbook 44, with the following exceptions and additions:

The value of the minimum graded interval for scales which have a minimal capacity of less than 5000 pounds shall not be greater than five pounds, except that the minimum graduated interval for the scale which weighs the bitumen shall not be greater than two pounds.

The value of the minimum graduated interval for scales which have a nominal capacity of 4000 pounds or more shall not be greater than 0.1 percent of the nominal capacity of the scale.

The tolerance value for all plant scales shall be 2 pounds per 825 pounds of load or the value of one minimum graduated interval, whichever is greater. At such times as the Project Engineer may direct, the Contractor shall suspend operations and shall provide such devices and assistance as are required to enable the Project Engineer to check the accuracy of the scales.

All scales shall be so located that they will be in plain view of the operator at all times.

(m) Mixers

1. Batch Plants. The plant shall be equipped with a batch mixer of the twin pugmill type. It shall be heat-jacked and equipped with a sufficient number of paddles or blades set in runaround order to produce properly mixed batches of any material required under these specifications. When the clearance between the tip of the paddle blades and mixer liner exceed one inch, either the blades or liner, or both, shall be replaced to reduce the clearance. Paddle blades reduced by wear in excess of 25 percent in face area from their new

condition shall be replaced.

The mixer shall be enclosed except for openings necessary to admit materials. It shall be capable of holding and properly mixing at least a 1650 pound batch of paving mixture. The mixer paddle shafts shall operate at a speed approved by the Project Engineer as sufficient to produce satisfactory mixing of the aggregates and the asphalt binder in the specified wet mixing time.

2. Continuous Plants. The continuous type twin shaft pugmill mixer shall be heat-jacked and shall be capable of producing a uniform mixture. It shall have a capacity of not less than 50 tons of bituminous mixture per hour. The paddles shall be adjustable for angular position on the shafts and shall be reversible to retard the flow of the mix. The mixer shall carry a manufacturer's rating plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. The mixer shall be equipped with a discharge hopper having a minimum capacity of 1,000 pounds of mix. The hopper shall be equipped with dump gates which will permit rapid and complete discharge of the bituminous mixture without segregation. If the mixture segregates during discharge from the pugmill into the hopper or from the hopper into the truck, the operations shall be discontinued and the Contractor shall make whatever changes may be necessary to prevent segregation.

3. Drum Plants. The slope of the drum, the flight configuration, and the rate of rotation of the drum shall be maintained and operated in accordance with the manufacturer's recommendation.

(n) Timing Device - Batch Plants. The plant shall be equipped with an approved accurate time lock system to control mixing operations. This system shall lock the weigh box gate after the charging of the mixer, until the closing of the mixer gate at the completion of the cycle. It shall lock the asphalt bucket throughout the dry mix period and the mixer gate throughout the dry and wet mix periods. The dry mix period is defined as the interval of time between the closing of the weigh box gate and the start of the discharge of the asphalt bucket. The wet mix period is defined as the interval of time from the start of the discharge of the asphalt bucket to the discharge of the pugmill. The timing device shall be enclosed in a suitable case that can be locked.

(o) Automatic Proportioning and Cycling Controls. Batch Plants. Batch plants will be required to have systems for automatic batching or proportioning of the various components of the mixture by weight or volume in the specified sequence and for controlling the mixing operations. Adjustable timing devices and other time delay circuits to space the individual component batching and mixing operations will be required, together with the auxiliary interlock cutoff circuits necessary to interrupt and stop the automatic cycling of the batching operations whenever an error in weighing occurs or there is a malfunctioning of any other portion of the control system.

The automatic control for each batching scale system shall be equipped with a device for stopping the automatic cycle in the underweight check position and in the overweight check position for each material so that the tolerance setting may be checked.

Each dial scale system shall be equipped with a removal dial puller which can be attached to the dial level system so the dial can be moved smoothly and slowly through its range to check the settings of the automatic control system. Digital display systems shall be capable of being cycled through a simulated batching operation to check the settings of the automatic control system.

Operation of the asphalt plant will not be permitted when the automatic proportioning and cycling controls are not operating properly or are not in proper adjustment. Manual operation due to a breakdown or malfunction will be permitted for the remainder of the workday in which the breakdown or malfunction occurs plus one additional work day provided this method of operation will produce results meeting the specification requirements. If the Contractor has not corrected the malfunction in the allotted time, production of mixture for the project will be stopped until all corrections have been made and the Project Engineer is assured that the automatic proportioning and cycling controls operate properly.

(p) Weight Batch Proportioning - Batch Plants. The accuracy required for the equipment weighing the batch components, based on a percentage of the total batch weight, will be within ± 0.1 percent for the binder and ± 0.5 percent for each of the other aggregate components. The weighing system shall be equipped with an interlock to cut off the cycling

and weighing operations at any time any individual component weight or the total batch weight exceeds the tolerances specified.

(q) Discharge Controls-Continuous Plants. Continuous type plants shall be equipped with an automatic discharge control, which is directly synchronized with the standard revolution counter and installed in such a manner that it will automatically discharge the mixture from the holding hopper after a predetermined number of plant revolutions.

(r) Hot Mix Surge Bins. Surge bins may be used to facilitate an uninterrupted supply of bituminous mixture and/or to store material during breakdowns or adverse weather conditions but shall not be used to facilitate the production of other bituminous mixes through the plant unless such use is approved.

Surge bins shall have a minimum capacity of at least 100 tons or be twice the capacity of the maximum hauling unit.

Surge bins shall be equipped with a gob hopper at the inlet of the bin. If it is determined that the use of a hot mix surge bin causes segregation, or adversely affects the quality of the mixture, its use shall be discontinued until corrective action has been taken.

(s) Testing Facilities. The Contractor shall provide fully equipped asphalt laboratory facilities at the plant or job site. The testing laboratory used to develop the JMF shall meet the requirements of ASTM D3666 or be a certified laboratory under MDOT's Bituminous Laboratory Certification Program.

It shall be available for joint use by the Contractor for quality control testing and by the Project Engineer for acceptance testing. It must have adequate equipment for the performance of the tests required by these specifications. The Project Engineer shall have priority in use of the equipment necessary for acceptance testing.

4.3 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth beds which have been thinly coated with a minimum amount of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds. Other petroleum type products shall not be used for coating truck beds. Each truck shall have an adequately secured cover of such size and material as to completely protect the mixture from the weather and to retard the escape of heat from the mixture.

Hauling units used to haul bituminous mixtures when the air temperature is below 50°F shall be insulated. The insulation shall be continuous along the bottom and four sidewalls.

Bituminous Base Course and Bituminous leveling Course Mixtures shall be covered while in the hauling units if the ambient air temperature is below 50°F and/or if the time in the hauling unit is more than 30 minutes.

Bituminous Top Course Mixtures shall be covered while in the hauling units if the ambient air temperature is below 60°F and/or if the time in the hauling unit is more than 30 minutes.

Hauling time is considered as the time between the completion of loading the hauling unit at the asphalt plant and the unloading of the hauling unit into the hopper of the paver.

When directed by the Project Engineer, the Contractor shall cover all loads for special mixes, for inclement weather, or if at any time the lack of covers is causing the mix temperature in the paver hopper to fall below the specified temperature range.

4.4 Bituminous Pavers. The paver shall be an approved self-powered machine capable of spreading and finishing the bituminous mixture in a uniform layer at the desired thickness and cross section, and ready for compaction. The use of any machine in poor mechanical or worn condition will not be permitted. The paver shall be of such design that the supporting wheels, treads, or other devices ride on the prepared base. The full width of bituminous mixture being applied shall be screeded by an oscillating or vibrating screed.

The paver shall, at all times, produce a uniformly finished surface, free from tearing or other blemishes that would require hand work. The screed shall be adjustable to provide for tilting to secure the proper drag or compressive action necessary to produce the desired surface texture.

The paver shall be equipped with a hopper and an automatic material depth control device so that each distributing auger and corresponding feeder shall respond automatically to provide for a constant level

of mix ahead of the screed unit to the full width being paved.

In order to ensure that adequate material shall be fed to the center of the paver, reverse pitch augers or paddles shall be installed at the inside of one or both ends of the auger shafts to force the mix to the center of the paver. If necessary to prevent segregation of the mix as it drops off the feed conveyor, baffle plates shall be installed at the required location.

When extensions are added to the paver, they shall be provided with the same vibrating screed or tamper action as the main unit of the paver, except for paving variable width areas. The extension shall also be equipped with a continuation of the automatically controlled spreading augers. The screed and any extensions shall be provided with an approved method of heat distribution.

Bituminous pavers shall be equipped with an automatically controlled and activated screed and strikeoff assembly capable of grade references and transverse slope control.

When paving ramps or shoulders, or when the grade of a concrete gutter or other existing installation must be met, the manner of use of the automatic grade reference and slope control devices shall be determined by the Project Engineer.

Whenever a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually for the remainder of the normal working day, provided this method of operation will produce results meeting the specification requirements.

4.5 Rollers. Rollers shall be in good condition and capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while the mixture is still in workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted. The number of rollers required will depend on the method of paving and the rate of production as specified under Section 4.10.

(a) Steel wheel rollers shall weigh at least eight tons, unless otherwise directed by the Project Engineer, and shall be self-propelled, vibratory or static, tandem rollers; or the roller shall be self-propelled static three-wheel rollers. Steel wheel rollers shall be free from backlash, faulty steering mechanism, or worn king bolts. The steering device shall respond readily and permit the roller to be directed on the alignment desired. Rollers shall be equipped with wheel sprinklers and scrapers. Roller wheels shall be smooth and free from openings or projections which will mar the surface of the pavement.

Vibratory rollers shall have a shutoff to deactivate the vibrators when the roller speed is less than 0.5 mph and shall have provisions to lock in the manufacturer's recommended speed, the vibrations per minute, and the amplitude of vibration (dynamic force) for the type of bituminous mixture being compacted.

(b) Pneumatic Tired. The pneumatic tired roller shall be of the self-propelled type with a total weight, including ballast, not greater than 30 tons. It shall be equipped with a minimum of seven wheels situated on the axles in such a way that the rear group of tires will not follow in the tracks of the forward group, but will be so spaced that a minimum tire path overlay of ½ inch is obtained. The tires shall be smooth and shall be capable of being inflated to or adapted to achieve a pressure necessary to provide ground contact pressures of at least 80 pounds per square inch. The tire pressures shall not vary by more than 5 pounds between individual tires. The Contractor shall furnish a tire gauge which shall be available at all times to enable the Project Engineer to check the tire pressures. The Contractor shall furnish the Project Engineer charts or tabulations showing the contact areas and the contact pressures for the full range of tire inflation pressures and tire loadings for the type and size roller used. The roller shall be equipped with a mechanism capable of reversing the motion of the roller smoothly. The roller shall be equipped with wheel sprinklers and scrapers or mats.

4.6 Preparation of Bituminous Material. The bituminous material shall be heated in a manner that will avoid local overheating and provide a continuous supply of the bituminous material delivered to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325°F unless otherwise required by the manufacturer.

4.7 Preparation of Aggregate. The aggregate for the mixture 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 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 of the aggregate particles and to provide a mixture of satisfactory workability.

4.8 Preparation of the Bituminous Mixture. . The aggregates and the bituminous material shall be weighed or metered and introduced into the mixer in the amount specified by the JMF.

The combined materials shall be mixed until the aggregate obtains a uniform coating of bitumen and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95 percent of coated particles. 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 mixer. The moisture content of all bituminous mixtures upon discharge shall not exceed 0.5 percent.

4.9 Transporting, Spreading, and Finishing. The mixture shall be transported from the mixing plant to the point of use in vehicles described in Section 4.3. Paraffin oil, lime solution, or another approved release agent shall be applied to the hauling units with atomizing spray equipment. Excessive use of release agents will be cause for rejection of the load.

All loads shall be sent out in time to allow placing and compacting the mixtures in daylight, unless approval has been granted to perform night work under adequate artificial light.

The surface of the bituminous mixture, as delivered to the paver, shall not become crusted.

The initial placement and compaction of the mixture shall occur at a temperature suitable for obtaining density, surface smoothness, and other specified requirements but not less than 250°F . Any load having a temperature below 250°F at time of discharge from the hauling unit will be rejected.

The mixture shall be laid only upon an approved underlying course which is dry and in suitable condition, and when weather conditions are favorable. The Project Engineer may permit work to continue when overtaken by sudden rains only to provide for laying that material which is in transit from the plant, provided the mixture is within the temperature limits specified.

The prepared foundation shall be treated with bituminous material for prime coat or tack coat if specified in the plans. A tack coat shall be applied to each layer of bituminous mixture before the succeeding layer is placed when directed by the Project Engineer or specified in the plans. The foundation shall be free from moisture during application. Under no circumstances shall pools of bituminous material be allowed to remain on the surface.

When the prime coat is applied, the surface course shall not be placed until the prime coat has been properly cured. The curing period shall be 24 hours, or longer if necessary. No blotting of the prime coat with aggregate in lieu of proper curing will be permitted.

The grade reference for the first course shall be a string or wire set parallel to plan grade and properly tensioned according to the manufacturer's recommendation when specified in the plans. Otherwise, a manufacturer-approved ski type attachment on the first and remaining courses is acceptable for grade control. When necessary, grade control shall be accomplished by grade stakes or steel pins placed in lanes parallel to the paving and at intervals sufficiently close for the stretching strings or wires between them.

This equipment will not be required for intersections, variable width sections, sections of pavement less than 1,000 feet in length or projects of less than 1,500 tons of bituminous mix, unless otherwise directed by the Project Engineer.

Placing shall commence at the point(s) farthest from the mixing plant and progress continuously toward the plant, unless otherwise ordered by the Project Engineer. Hauling over the material already placed

shall not be permitted until the material has been thoroughly compacted as specified, and allowed to cool to atmospheric temperature.

The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, placing shall begin along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips not less than 10 feet to complete the area. The longitudinal joint in one course shall offset that in the course immediately below by at least 1 foot; however, the joint in the top course shall be at the centerline of the pavement. Transverse joints for one course shall be offset by at least 10 feet from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools. Areas of segregation in the surface course, as determined by the Engineer, shall be corrected at the contractor's expense. The method of correction shall have prior approval by the Project Engineer.

The bituminous mixtures shall be placed in one or more layers to the required cross section and as called for in the plans. When necessary to take out irregularities in the existing surface, patching or wedging with bituminous mixture shall be done either by hand, by placing several layers with the paver, or as directed by the Project Engineer. Any corrections requiring additional bituminous mixture shall be rolled far enough ahead of paving operations to permit proper compaction.

All transverse and longitudinal construction joints shall be coated with tack material before the mixture is placed in the adjacent section.

4.10 Compaction of Mixture. After placing, the mixture shall be thoroughly and uniformly compacted with power rollers. Rolling of the mixture shall begin as soon after placing as it will bear the roller without undue displacement. Rolling shall be initiated with the drive wheel toward the paving machine. The sequence of rolling for the first paving lane should be to first roll the lower edge (with reference to the transverse slope) of the lane and then roll the upper edge. The interior of the lane should then be rolled from the lower side toward the upper with overlapping roller paths. On adjoining paving lanes rolling shall begin by overlapping the joint (with the previous lane) by six to eight inches and then rolling the outside edge of the new lane. The interior is rolled from the outside edge toward the compacted joint with overlapping wheel paths. Alternate paths of the roller shall be of slightly different lengths.

The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture 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 all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section, and the required field density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted. Pneumatic tired rollers may not require the use of water.

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 shall be done at the Contractor's expense. Skin patching shall 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 the courses and obtain the required density. 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 a 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.

For longitudinal joints, the adjoining lane is placed so that it uniformly overlaps the first lane by one or two inches. The overlapping material is then bumped with a lute back onto the hot lane, so that the roller can compress the small excess into the hot side of the joint. If the overlap is excessive, the material should be trimmed off and discarded so that the edge is uniform in thickness. The excess material should not be spread across the pavement surface.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot; however, the joint in the surface course shall be at the centerline of crowned pavements.

Transverse joints in one course shall be offset by at least ten feet from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back for a rake or a smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

4.12 Skid Resistant Surfaces/Saw-Cut Grooving. If shown on the plans, skid resistant surfaces for asphalt pavements shall be provided by construction of saw-cut grooves. Pavement shall be sufficiently cooled prior to grooving.

Transverse grooves shall be saw-cut in the pavement forming a ¼ inch wide by ¼ inch deep by 1-1/2 inches center to center configuration. The grooves shall be continuous for the entire length of the pavement. They shall be saw-cut transversely in the pavement to within 10 feet of the pavement edge to allow adequate space for equipment operation. The tolerances for saw-cut grooves shall meet the following:

(a). Alignment tolerance – Plus or minus 1 -1/2 inches in alignment for 75 feet.

(b). Groove tolerance – Minimum depth 3/16 inch, except that not more than 60 percent of the grooves shall be less than ¼ inch. Maximum depth 5/16 inch. Minimum width ¼ inch. Maximum width 5/16 inch.

(c). Center-to-center spacing – Minimum spacing 1-3/8 inches. Maximum spacing 1-5/8 inches.

Grooves shall not be less than 6 inches and not more than 18 inches from in-pavement light fixtures. Cleanup of waste material shall be continuous during the grooving operation. Waste material shall be disposed of in accordance with governing laws and regulations. All arrangements for disposal of waste material shall be made prior to the start of grooving. Waste material shall not be allowed to enter the airport storm or sanitary sewer system.

MATERIAL ACCEPTANCE

5.1 Acceptance Sampling and Testing Bituminous Mixture Unless otherwise specified, all acceptance sampling and quality assurance testing necessary to determine conformance with the requirements specified in this section will be performed by the Project Engineer at no cost to the Contractor except that coring as required shall be completed and paid for by the Contractor. The Contractor is responsible for ensuring quality control of the bituminous mixture.

1. Field Extractions
Extraction tests for asphalt cement content and aggregate gradation shall be made at least twice daily. The mixture will be tested for asphalt cement content in accordance with ASTM D 2172 and for aggregate gradation in accordance with AASHTO T 30. These tests shall be performed by the Project Engineer or designated representative and are not a Contractor expense.

The aggregate gradation and asphalt cement content of the mixture should be maintained within the Range 1 limits in accordance with Table IV. Should a test indicate values outside of these limits, the Contractor shall be advised that modifications may be needed. Should two consecutive tests on one sieve or bitumen content fall outside of the Range 1 limits, the Contractor shall be directed to suspend full production. Paving should not begin again until the Contractor can provide a mixture within the acceptable limits of Table IV.

In instances where the Project Engineer recommends rejection of the bituminous mixture, the Contractor

will be permitted to verify the test results at their expense. Only test data provided by the approved mix design laboratory will be accepted as verification of the test results. If the approved mix laboratory is owned by the Contractor, an independent laboratory shall verify the test results.

In situations where the Project Engineer's test results conflict with the laboratory test results, the independent laboratory's test results will be the basis of acceptance. It is recommended that a 30 lb. sample be taken for the extraction to permit at least three extraction tests to be run from one sample. Although a minimum of one test for each half day's (2 per day) production is required, this will provide sufficient material to permit verification of the original test results.

2. Compaction

(a) In-Place Air Voids. (Pavements designed for aircraft weights 12,500 pounds and over). The compaction of pavements designated for aircraft weights of 12,500 pounds and over will be determined on the basis of percent air voids in the completed, in-place bituminous course. Each bituminous course will be tested by the Project Engineer on a per lot basis.

A lot will consist of:

1. One day's production not expected to exceed 2,000 tons, or
2. A half day's production where a day's production is expected to consist of between 2,000 and 4,000 tons, or
3. Similar subdivisions for tonnages over 4,000 tons. When more than one asphalt plant is simultaneously producing material for a job, the lot sizes shall apply separately for each plant.

Bituminous mixture for determination of maximum specific gravity (ASTM D 2041) shall be sampled on a lot basis from trucks delivering material to the job site. Each lot shall be divided into four equal sublots. One sample shall be taken from a sublot on a random basis in accordance with procedures contained in ASTM D 3665. A random number generator function on a calculator or computer may be used if available, otherwise use the table provided in ASTM D 3665.

The maximum specific gravity of each sample will be determined in accordance with ASTM D 2041 using type C, D or E containers.

The percent air voids of each core sampled in accordance to the procedures of Section 5.3 shall be computed as follows:

$$V_a = \frac{100\,(G_{mm} - G_{mb})}{G_{mm}}$$

where:

G_{mm} = average of the sublot maximum specific gravities. (ASTM D 2041)

G_{mb} = bulk specific gravity of the core (ASTM D2726)

V_a = percent (%) air voids of the core

Acceptance of each lot is based upon the percentage of material within the in-place air voids specification limits (1%-7%).

The acceptance of each lot of bituminous course shall be based on the percentage of material within the in-place air voids specification limits (PWL).

All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average (X) and sample standard deviation (S_n) of the specified number (n) of sublots for the lot and the specification tolerance limits, L for lower and U for upper, for the particular acceptance parameter. From these values, the respective Quality Index(s), Q_L for Lower Quality Index and/or Q_u for Upper Quality Index, is computed and the PWL for the lot for the specified n is determined.

The PWL is determined using standard statistical techniques and involve the number of tests in each lot (n) and the Quality Indexes. The Quality Indexes are calculated using the following formulas:

$$Q_L = \frac{X - L}{S} \qquad Q_U = \frac{U - X}{S}$$

Q_U = Quality Index of the upper limit
Q_L = Quality Index of the lower limit
X = Average core air voids (%) of the lot
S =Standard Deviation of the sublot values
L = Lower specification limit, 1 %
U = Upper specification limit, 7 %
x_1, x_2, = individual sublot values
n = number of sublots

$$S = \sqrt{\frac{(X_1 - X)^2 + (X_2 - X)^2 + \ldots (X_n - X)^2}{n - 1}}$$

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table VI separately with Q_L and Q_U, using the column appropriate to the total number (n) of measurements, and determining the percent of material above P_L and percent of material below P_U for each tolerance limit. If the values of Q_L fall between values shown on the table, use the next higher value of P_L or P_U.

The total PWL will be determined by the following formula:

$$PWL = (P_L + P_U) - 100$$

Each lot of bituminous material shall be accepted at full payment when the total PWL equals or exceeds 90 percent. Each lot not meeting the 90 percent PWL requirement will be accepted at an adjusted contract unit price in accordance with Table VII.

When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, the following procedures shall be followed:

1. If three sublots have been sampled, they shall constitute a lot and the PWL determined accordingly.
2. If one or two sublots have been sampled, they shall be combined with the previous lot, and the PWL determined using the total number of sublots.

(b) Theoretical Density (Pavements designed for aircraft weights under 12,500 lbs).

The density of pavements designed for aircraft weights under 12,500 pounds will be determined by comparing the density of cores taken from the compacted pavement to the theoretical density of the bituminous mixture.

The theoretical density shall be computed as follows:

$$\text{Theoretical Density} = \frac{100}{\frac{\%\text{ aggregate by weight}}{\text{Effective sp. gr. of agg.}} + \frac{\%\text{ bitumen by weight}}{\text{Sp. gr. of bitumen}}}$$

The effective specific gravity of the aggregate shall be calculated based upon the maximum specific gravity of the mixture designated by the JMF.

Pavement density will be determined by the Project Engineer on a per lot basis.

A lot will consist of:

1. One day's production not expected to exceed 2,000 tons, or
2. A half day's production where a day's production is expected to consist of between 2,000 tons and 4,000 tons.

A lot shall be divided into four equal sublots. One core shall be taken from each sublot on a random basis in accordance with procedures contained in ASTM D 3665. A random number generator function on a calculator or computer may be used if available, otherwise use the table provided in ASTM D 3665.

The cores shall be taken in accordance with the requirements in Section 5.3. The density of each core shall be determined in accordance with ASTM D 2726 or D 1188, whichever is applicable.

Acceptance of each lot of each bituminous course shall be based upon the percentage of material placed which meets or exceeds 92 percent of the theoretical density. Any material determined not to meet 92 percent of the theoretical density shall be removed and replaced with acceptable bituminous mixture at Contractor's expense.

5.2 Surface Tests. Tests for conformity with the specified crown and grade shall be made by the Contractor immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.

The finished surface shall not vary more than 1/4 inch for top or leveling courses nor 3/8 inch for the base course when tested with a 16-foot straightedge applied parallel with, or at right angles to the centerline. The Contractor shall furnish a 16-foot straightedge and 4-foot carpenter's level for this purpose.

After the completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective

work and replacing with new material, as directed by the Project Engineer. This shall be done at the Contractor's expense. The finished surfaces of bituminous courses shall not vary from the gradeline, elevations, and cross sections shown in the contract drawings by more than ½ inch. Pavement areas varying in excess of this amount shall be corrected by the Contractor, as directed by the Project Engineer. Such corrections shall be made at the Contractor's expense. Skin patches will not be permitted.

5.3 Sampling Pavement. Core samples for determination of thickness and density of completed pavements shall be obtained by the Contractor at no extra cost. The size, number, and locations of the samples will be as directed by the Project Engineer. Samples shall be neatly cut with a saw, core drill, or other approved equipment. The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes shall be filled in a manner acceptable to the Project Engineer and within one day after sampling.

Locations of sampling sites for determining the density of the compacted pavement shall be taken. Core locations will be determined by the Project Engineer on a random basis in accordance with the procedures contained in ASTM D 3665 as referenced in the Asphalt Institute's "Construction of Hot Mix Asphalt Pavements", Manual Series No. 22. A random number generator function on a calculator or computer may be used if available, otherwise use the table provided in ASTM D 3665. In cases where test locations are within eight inches of the pavement edge or a pavement joint, a new random location will be used.

Re-sampling of the in-place lot may be permitted upon receipt by the Project Engineer of the Contractor's written request. Such requests will be permitted if received within one week from the time the original test results were received by the Contractor. Selective re-sampling of only certain sublots within the lot will only be permitted when it is necessary to replace a damaged sublot core which has not been tested. Only one re-sampling of the lot (all sublots) will be permitted.

When retested, the new Percent Within Limits for the lot shall be based on all cores taken, excluding outliers. Procedures contained in ASTM E178 shall be used to determine outliers, based on all values of the original cores and the resampled cores, and a five percent significance level. Outliers may not be excluded during first sampling of the lot.

If the retested lot should result in a higher Percent Within Limits figure than the original, based on all lot samples, the following will apply:

1. The cost of re-sampling and retesting will be borne by the Owner only if 100 percent payment results. If less than 100 percent payment results, the cost of retesting and re-sampling shall be at the Contractor's expense.
2. The new Percent Within Limits figure that was calculated based on all lot samples shall be used for the lot payment calculation.

If the retested lot should result in a Percent Within Limits figure equal to or less than the original, based on all the lot samples, the following will apply:

1. The cost of re-sampling and retesting will be at the Contractor's expense.

2. The new Percent Within Limits figure that was calculated based on all lot samples shall be used for the lot payment calculation.

5.4 Contractor Quality Control. The Contractor shall perform quality control sampling, testing, and inspection during all phases of the work and shall perform them at a rate sufficient to ensure that the work conforms to the contract requirements.

The Contractor shall monitor all elements that affect the quality of the pavement including, but not limited to:

a. Mix Design
b. Aggregate Grading
c. Quality of Materials
d. Stockpile Management
e. Proportioning
f. Mixing and Transportation
g. Placing and Finishing
h. Joints
i. Compaction
j. Surface Smoothness
k. Personnel
l. Laydown Plan

The Contractor shall be responsible for quality control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness.

Nuclear density determination shall not be permitted as the basis for acceptance. However, a nuclear gauge to monitor the pavement density in accordance with ASTM D 2950 may be used.

The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved.

Any additional testing that the Contractor deems necessary to control the quality control process may be performed at the Contractor's expense.
The Project Engineer reserves the right to monitor any or all of the quality control testing by the Contractor.

METHOD OF MEASUREMENT

6.1 Plant mix bituminous pavement shall be measured by the number of tons of bituminous mixture used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the weight.

BASIS OF PAYMENT

7.1 Payment shall be made at the respective contract prices for bituminous base, leveling or top course. These prices shall be full compensation for furnishing all materials including developing the mix design, asphalt cement and for all preparation of the underlying surface, mixing, manipulating, hauling, laying and rolling of the materials, furnishing and sealing scales, furnishing the weight house and weight tickets; and for all labor, equipment, tools, and incidentals necessary to complete these items, except for any specified prime or tack coat, unless otherwise noted on the plans.

Payment will be made under the nomenclature and seven digit item number specified in the plans and proposal for each type of bituminous base, leveling or top course, required per ton.

The first three digits of any item number for work included under this specification shall be 411, i.e. 411XXXX.

TABLE VI

TABLE FOR PERCENT OF LOT WITHIN LIMITS (PWL)

(STANDARD DEVIATION METHOD)

Percent Within Limits	N=3	N=4	N=5	N=6	N=7	N=8	N=9	N=10	N=11	N=12
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362	2.0656	2.08971
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630	1.8828	1.8989
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420	1.7566	1.7684
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454	1.6566	1.6655
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635	1.5721	1.5790
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4716	1.4829	1.4914	1.4981	1.5035
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265	1.4316	1.4358
92	11184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670	1.3709	1.3741
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118	1.3148	1.3172
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602	1.2623	1.2640
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115	1.2129	1.2141
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653	1.1661	1.1668
87	1.0597	1.1100	1.1173	1.1191	1.1199	1.1240	1.1208	1.1212	1.1215	1.1218
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789	1.0788	1.0787
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382	1.0377	1.0374
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990	0.9982	0.9976
83	0.9939	0.9900	0.9785	0.9715	0.9672	0.9643	0.9624	0.9160	0.9599	0.9591
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241	0.9228	0.9219
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882	0.8868	0.8857
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533	0.8517	0.8505
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192	0.8175	0.8161
78	0.8897	0.8400	0.8610	0.8036	0.7962	0.7915	0.7882	0.7858	0.7840	0.7862
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531	0.7513	0.7498
76	0.8417	0.7900	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211	0.7192	0.7177
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896	0.6877	0.6861
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587	0.6567	0.6551
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282	0.6262	0.6247
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.6982	0.5962	0.5947
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686	0.5667	0.5651
70	0.6787	0.6000	0.5719	0.5583	0.5504	0.5454	0.5419	0.5394	0.5375	0.5360
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105	0.5086	0.5072
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820	0.4820	0.4787
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537	0.4520	0.4506
66	0.5563	0.4800	0.4545	0.4424	0.4354	0.4310	0.4280	0.4257	0.4241	0.4227
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4031	0.4001	0.3980	0.3964	0.3951
64	0.4961	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705	0.3690	0.3678
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432	0.3418	0.3407
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161	0.3148	0.3137
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892	0.2880	0.2870
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624	0.2613	0.2604
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358	0.2348	0.2339
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093	0.2084	0.2076
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829	0.1821	0.1814
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566	0.1559	0.1553
55	0.1806	0.15000	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304	0.1298	0.1293
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1048	0.1042	0.1038	0.1034
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0792	0.0786	0.0781	0.0778	0.0775
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521	0.0518	0.0516
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0624	0.0262	0.0260	0.0259	0.0258
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260	-0.0259	-0.0258
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521	-0.0518	-0.0516
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781	-0.0778	-0.0775
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042	-0.1037	-0.1034
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304	-0.1298	-0.1293
44	-0.2164	-0.1800	-0.1688	-0.1637	-0.1607	-0.1588	-0.1575	-0.1566	-0.1559	-0.1553
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829	-0.1821	-0.1814
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093	-0.2084	-0.2076
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358	-0.2348	-0.2339
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624	-0.2613	-0.2604

39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892	-0.2880	-0.2870
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.2161	-0.3148	-0.3137
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3717	-0.3477	-0.3451	-0.3432	-0.3418	-0.3407
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705	-0.3690	-0.3678
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980	-0.3964	-0.3951
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4354	-0.4310	-0.4280	-0.4257	-0.4241	-0.4227
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537	-0.4520	-0.4506
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820	-0.4802	-0.5072
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105	-0.5087	-0.5360
30	-0.6787	-0.6000	-0.5719	-0.5583	-0.5504	-0.5454	-0.5419	-0.5394	-0.5375	-0.5651
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686	-0.5667	-0.5651
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982	-0.5962	-0.5947
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282	-0.6262	-0.6247
26	-0.7904	-0.7200	-0.6920	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587	-0.6567	-0.6551
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896	-0.6876	-0.6861
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211	-0.7192	-0.7177
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531	-0.7513	-0.7498
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858	-0.7840	-0.7826
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8246	-0.8214	-0.8192	-0.8175	-0.8161
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533	-0.8517	-0.8505
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882	-0.8868	-0.8857
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241	-0.9228	-0.9219
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9642	-0.9610	-0.9599	-0.9591
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990	-0.9982	-0.9976
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382	-1.0377	-1.0374
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789	-1.0788	-1.0787
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212	-1.1215	-1.1217
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653	-1.1661	-1.1668
11	-1.0864	-1.1700	-1.1909	-1.1195	-1.2043	-1.2075	-1.2098	-1.2115	-1.2129	-1.2141
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602	-1.2623	-1.2640
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118	-1.3148	-1.3172
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670	-1.3709	-1.3741
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265	-1.4316	-1.4358
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4716	-1.4829	-1.4914	-1.4981	-1.5035
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635	-1.5721	-1.5790
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5872	-1.6127	-1.6313	-1.6454	-1.6566	-1.6655
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6992	-1.7235	-1.7420	-1.7566	-1.7684
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8054	-1.8379	-1.8630	-1.8828	-1.8989
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362	-2.0657	-2.0897

TABLE VII
PRICE ADJUSTMENT SCHEDULE

Percent of Material Within The Specification Limits (PWL)	Percent of Contract Unit Price to be Paid
90-100	100
80-90	0.5 PWL + 55.0
65-80	2.0 PWL - 65.0
Below 65	1/

1/ The lot shall be removed and replaced. In lieu thereof and with prior Bureau approval, the Contractor and the Project Engineer may agree in writing that, for practical purposes, the deficient lot shall not be removed and will be paid for at 50 percent of the contract price.

All preliminary calculations used in determining the Percent Within Limits should be carried to a minimum of three significant figures past the decimal point. The PWL that is used for Table VII purposes should then be rounded to one significant figure past the decimal point to determine the percent of contract unit price to be paid. The final percent pay figure should be one significant figure past the decimal point.

TESTING REQUIREMENTS

Test and Short Title	
ASTM C 29	Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 117	Materials Finer than 75μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	Sampling and the Amount of Testing of Hydraulic Cement
ASTM D 75	Sampling Aggregates
ASTM D 995	Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 2041	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D2489	Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D 2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E 178	Dealing with Outlying Observations
AASHTO T30	Mechanical Analysis of Extracted Aggregate
The Asphalt Institute's Manual No. 2 (MS-2)	Mix Design Methods for Asphalt Concrete & Other Hot Mix Types
The Asphalt Institute's Series (MS-22)	Construction of Hot Mix Asphalt Pavements
MTM 110	Determining Deleterious and Objectionable Particles in Aggregate
	Contact MDOT Construction & Technology (517-322-1087)
MTM 118	Measuring Fine Aggregate Angularity
	Contact MDOT Construction & Technology (517-322-1087)

MATERIAL REQUIREMENTS

ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 946	Penetration Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
Material Source Guide	Contact MDOT Construction & Technology (517-322-1087)