STANDARD SUPPLEMENTAL SPECIFICATION NO. P-411

This supplemental specification augments and amends the specification of like number published in Federal Aviation Administration Advisory Circular 150/5370-10A, Standards for Specifying Construction of Airports, published February, 1989, and such subsequent changes as may be published to date.

SPECIFICATION NO. P-411, BITUMINOUS BASE, LEVELING AND TOP COURSES, is amended as follows:

Any references to 85-100 penetration grade or AC-10 viscosity grade in the scope of the work can be replaced by PG 58-28 binder.

Any references to 120-150 penetration grade or AC-5 viscosity grade in the scope of the work can be replaced by PG 58-28 binder.

Any references to 200-250 penetration grade or AC 2.5, viscosity grade in the scope of the work can be replaced by PG 58-28 binder.

"Performance Graded Asphalt Binder Specifications" follow on the next page.

Table I in the P-411 Standard Specification will not be used. Where Performance Graded Binders are used they shall meet the requirements as shown on the following page.

Approved: June 13, 1997
Revised: September 30, 1998

Performance Graded Asphalt Binder Specifications

Performance Grade	PG-52	PG-52	PG-58
	-28	-34	-28
Avg 7-day Max. Pave Design Temp, ^0C[a]	<52	<52	<58
Minimum Pavement Design Temp. C[a]	>-28	>-34	>-28
Original Binder			
Flash Point Temp. T48: Min, ^0C	230		
Viscosity, ASTM D 4402;[b] Max. 3 Pa•s, Test Temp, ^0C	135		
Dynamic Shear, TP5,[c] G★/sin δ, Min. 1.00 kPa Test Temp @ 10 rad/s, ^0C	46	52	58
Rolling Thin Film Oven (T 240) or Thin Film Oven Residue (T 179)			
Mass Loss, Max. Percent	1.00		
Dynamic Shear, TP5; G★/sin δ, Min. 2.20 kPa Test Temp @ 10 rad/s, ^0C	46	52	58
Pressure Aging Vessel Residue (PP1)			
PAV Aging Temp. ^0C[d]	90	90	100
Dynamic Shear, TP5; G★sin δ, Max. 5000 kPa Test Temp @ 10 rad/s, ^0C	16	13	19
Physical Hardening[e]			
Creep Stiffness, TP1'S, Max. 300 MPa, m-value, Min. 0300 Test Temp @ 60 s, ^0C	-18	-24	-18
Direct Tension, TP3;[f] Fail Strain, Min. 1.0% Test Temp 2 @ 1.0 mm/min, ^0C	-18	-24	-18

a: Pavement temperatures can be estimated from air temperatures using an algorithm contained in the Superpave™ software program or may be provided by the specifying agency, or by following the procedures as outlined in PPX.

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 substituted for dynamic shear measurements of G★/sin δ 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 64- and above, except in desert climates, where it is 100◦C.

e: Physical Hardening - TP 1 is performed on a set of asphalt beams according to Section 13.1 of TP 1, except the conditioning time is extended to 24 hours ± 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.

DEPARTMENT OF TRANSPORTATION
BUREAU OF AERONAUTICS - STANDARD SPECIFICATION
P-411
Bituminous Base, Levelling and Top Courses

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DESCRIPTION

1.1 This work item shall consist of constructing a dense graded bituminous base, levelling or top course on a previously prepared surface. The bituminous mixture shall be composed of mineral aggregate, mineral filler, if required, 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 drawings.

Reclaimed material from pavements shall not be used unless such use is designated on the construction drawings or by supplemental specification.

Each course shall be constructed to the depth, typical section and grade required by the plans. Each course shall be rolled, finished and approved by the Project Engineer before placement of the next course.

MATERIAL

2.1 Aggregate. 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. 8 sieve shall be known as coarse aggregate, the portion passing the No. 8 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler.

(a) Coarse Aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from inherent films of matter that would prevent thorough coating with the bituminous material. The percentage of wear for the coarse aggregate shall not exceed 40 percent for top and levelling courses when tested in accordance with ASTM C131. The percentage of wear for aggregate used in base course shall not exceed 50 percent. Should a slag aggregate be designated for any course, the percentage of wear shall not shall not exceed 50 percent.

The coarse aggregate shall be tested for sodium sulfate soundness loss in accordance with ASTM C88 and shall not exceed nine percent after five cycles.

Crushed aggregate content shall be the percentage of crushed material of a sample retained on all sieves down to and including the No. 4 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 Table IV.

The aggregate shall not contain more than 8 percent, by weight, of flat or elongated pieces. 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 top course shall not contain more than 5%, by weight, of soft pieces as evidenced by MDOT certification or as determined in accordance with MDOT Aggregate Testing Procedures Manual.

Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 75 pound per cubic foot when tested in accordance with ASTM C29. It shall contain 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.

(b) Fine Aggregate. Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone, air-cooled blast furnace slag, or gravel.

Natural sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

The aggregate particles shall be free from coatings of clay, silt, or other objectional matter and shall contain no clay balls. The fine aggregate, including any blended filler, shall have a plasticity index of not more than six when tested in accordance with ASTM D424, and a liquid limit of not more than 25 when tested in accordance with ASTM D423.

(c) 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 tests, including shipping expenses to transport the test samples to the laboratory.

Samples shall be taken by the Contractor in accordance with procedures prescribed in ASTM D75 (coarse and fine aggregates) and ASTM C183 (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.

(d) Samples of Aggregates. Samples of aggregates shall be furnished by the Contractor at the start of production and at points of sampling designated by the Project Engineer. The samples will be the basis of approval of specific requirements of this section.

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 D242. When fly ash is used in the mixture, only material produced from Michigan Department of Transportation approved power plant sources will be permitted.

2.3 Bituminous Material. The types, grades, and controlling specifications for the bituminous materials shall be as shown in Table I. The specific material to be used shall be as specified in the plans or contract documents.

Asphalt cements for each mix design within a given bituminous paving project shall be produced by a single manufacturer unless authorized by the Project Engineer. The asphalt cement used in preparation of the job mix formula shall be tested by the mix design laboratory for conformance with the Table I requirements. The cost of these tests shall be paid by the Contractor.

The Contractor will obtain one 16 ounce sample of the asphalt cement during each day of plant production. The material shall be drawn at the plant and placed in sealed containers which are marked by job, grade and date of sampling. The filled containers will be delivered to the Project Engineer at the beginning of each day. The Project Engineer shall retain the samples for six months after final acceptance of the contract.

COMPOSITION

3.1 Composition of Mixture. The bituminous plant mix shall be composed of a mixture of aggregate, filler, if required, and bituminous material. 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.

3.2 Job Mix Formula. No bituminous mixture shall be produced for payment until a job mix formula prepared specifically for this contract has been approved by the Project Engineer and reviewed by the Bureau. The testing laboratory used to develop the job mix formula shall meet the requirements of ASTM D3666. A current approved certification that the laboratory meets these requirements shall be on file with the Engineer of the Bureau prior to developing the mix design.

The job mix formula 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 indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen and the target placement temperature of the completed mixture as discharged from the hauling unit. All test data used to develop the job mix formula shall also be submitted. The job mix formula for each mixture shall be in effect until modified by the Contractor and approved in writing by the Project Engineer. Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used.

The Contractor shall be responsible for the cost of the job mix formula, including the cost of providing materials for design and testing. Should an additional job mix formula be required due to extreme variations in mixture components supplied by the Contractor, the cost of such shall be at the Contractor's expense.

The bituminous mixture shall be designed using procedures contained in Chapter III, MARSHALL MIX METHOD OF DESIGN, of the Asphalt Institute's Manual Series No. 2 (MS-2), current edition, and shall meet the requirements of Tables II and III. The 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.

TABLE I.
PENETRATION-GRADED AND VISCOSITY-GRADED ASPHALT CEMENTS

TESTS	Asphalt Designations (Viscosity Graded in Parentheses)					
		85-100	120-150	200-250 (AC-2.5)	250-300	(AC-1)
Specific Gravity, 25/25c. min. ASTM D70				0.993		0.990
Viscosity, 25°C, P. max. ASTM D3205						120,000
*Viscosity, 60°C, P. ASTM D2171			00	200-300		80-120
Viscosity, 135°C, cSt. min. ASTM D2170	300	220	165	120	120	75
Flash Point, Cleveland Open Cup, °C min. ASTM D92	232.2	232.2	218.3	204.4	204.4	204.4
Ductility, 25°C cm. min. ASTM D113	100	100	100	100**	100**	
Solubility in Trichloroethylene, % min. ASTM D2042	99.5	99.5	99.5	99.5	99.5	99.5
Spot Test using 35% Xylene 65% Heptane Solvent Aniline No. 30°C + 2 degrees AASHTO T102	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Thin Film Oven Test, 1/8 in. 163°C 5 hr. ASTM D1754:						
Loss on Heating, % max. ASTM D6	0.8	1.0	1.3	1.5	1.5	2.5
Penetration of Residue, % of original, min. ASTM D5	54	50	46	40	40	
Ductility of Residue, 25°C, 5 cm/min. cm. min. ASTM D113	50	75	100	100**	100*	100**
*Viscosity 60°C, P., max. ASTM D2171	8000	4000	2000	1000		800
Penetration 25°C. 100 g. 5 sec. ASTM D5:						
Penetration-Graded Asphalt Cement		85-100	120-150	200-250	250-300	
Viscosity-Graded Asphalt Cement	50-70	75-100	120-175	175-275		

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* Viscosity-Graded Asphalts only

** If less than 100 at 25°C but more than 100 at 15.6°C, the material will be acceptable for ductility

2. The design asphalt content shall be designated as that which would permit a 2.5 percent air void content in the total mix.

If the asphalt content at 2.5 percent air voids is less than 5.4 percent, and the asphalt content at 2.0 percent air voids is 5.4 percent or greater, then the asphalt content at 2.0 percent air voids shall be the

design value.

If the asphalt content at 2.5 percent air voids is greater than the upper bitumen limit of Table IV and the asphalt content at 3.0 percent air voids is between 5.4 percent and the upper bitumen limit, then the asphalt content at 3.0 percent 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 V.M.A. requirements, the mix design is rejected and a new mix design with a different gradation and/or aggregate is undertaken.

The above procedures may not be altered without prior approval of the Engineer of the Bureau.

If the aggregate coating of the composite mixture, as determined by ASTM D1664, is less than 95 percent, the aggregates shall be rejected or the asphalt shall be treated with an antistripping agent. The amount of antistripping agent added to the asphalt shall be sufficient to produce an aggregate coating of not less than 95 percent.

The gradations in Table IV 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 IV when tested in accordance with ASTM Standard C136. 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 IV.

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 IV.

The job mix tolerances shown in Table V shall be applied to the job mix formula 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.

After the job mix formula is established, the aggregate gradation and the bitumen content of the bituminous mixture furnished for the work shall be maintained within the Range 1 uniformity tolerance limits permitted for the job mix formula, as specified in Table V. If two consecutive aggregate gradations on one sieve or two consecutive bitumen 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 job mix formula can be maintained within the deviations permitted under Table V, Range 1.

Rejected Mixtures: If in any one mixture, two consecutive aggregate gradations on one sieve or bitumen content as determined by field extractions exceed the uniformity tolerance of Range 2 under Table V, 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's 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 job mix formula shall be established before the new material is used. Deviation from the final approved design for bitumen content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extraction. Extraction tests for bitumen content and aggregate gradation will be made at least twice daily. The mixture will be tested for bitumen content in accordance with ASTM D2172 and for aggregate gradation in accordance with AASHTO T30. These tests shall be performed by the Project Engineer or designated inspector and are not a Contractor cost.

3.3 Test Section. The Contractor shall prepare a quantity of bituminous mixture according to the job mix formula which will be placed as a test section and tested by the Project Engineer. The cost of such testing is not a Contractor cost.

The amount of mixture produced should 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 prior to acceptance of the test section by the Project Engineer. The test section shall be placed in two paver widths 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.

TABLE II.

	Pavements designed for aircraft gross weights of 60,000 lbs. or more or tire pressure greater than 100 psi	Pavements designed for aircraft gross weights less than 60,000 lbs. and tire pressure less than 100 psi
Number of Blows	75	50
Stability, pounds minimum	1800	1000 (500 for gross aircraft weights under 12,500 lbs.)
Flow, 0.01 inc. (0.25mm)	See Table III.	See Table III.
Percent voids in mineral aggregate (minimum)	See Table III.	See Table III.

TABLE III.

Aggregate Series No.	Flow Hundredths of an Inch	Percent Voids in Mineral Aggregates (Minimum)
20CX	6-18	---
20BX/20AX	8-18	14.5
20AAX	8-18	14.5
20AAAX	8-18	14.5
Grading Band:		
A	8-16	13
B	8-16	14
C	8-16	15
D	8-16	16

*20CX AGGREGATE MIXTURES MAY ONLY BE USED FOR BASE COURSES IN PAVEMENTS DESIGNED FOR 12,500 LB. LOADINGS OR LESS. THE "X" PLACED AFTER THE AGGREGATE SERIES NUMBER INDICATES THAT THE PHYSICAL REQUIREMENTS FOR AGGREGATES USED IN AIRPORT MIXTURES MAY DIFFER FROM THOSE SPECIFIED BY THE MDOT FOR SIMILARLY NUMBERED AGGREGATE MIXTURES USED IN HIGHWAY CONSTRUCTION.

TABLE IV.

AGGREGATE GRADATIONS
FOR AIRCRAFT WEIGHTS LESS THAN 130,000 POUNDS

Minimum Stability Required		1800 lb. (75 Blow)	1000 lb. (50 Blow Marshall)		500 lb. (50 Blow Marshall)	
			Aggregate Series Number			
	Sieve Sizes	20AAAX	20AAX	20AX	20 BX	20 CX
%	1-1/2"	——	——	——	——	100
	1"	——	——	——	——	80-100
P	3/4"	100	100	100	100	——
A	1/2"	90-100	90-100	——	——	——
S	3/8"	65- 95	65- 95	60- 90	60- 95	55- 90
S	No. 4	55- 75	——	——	——	——
I	No. 8	45- 70	45- 70	40- 65	40- 70	30- 65
N	No. 30	20- 45	20- 45	20- 40	20- 45	15- 45
G	No. 200	3- 10	3- 10	3- 10	3- 12	3- 12
%	Bitumen in Mixture	5.4- 7	5.4- 7	5.4- 7	5.4- 8	5.4-6.2
%	Crushed Material (Minimum)	60	40	25	——	——

AGGREGATE GRADATIONS
FOR AIRCRAFT WEIGHTS OF 130,000 POUNDS AND GREATER

	Grading Band	A	B	C	D
	Sieve Size	1-1/4 in. max.	1 in. max.	3/4 in. max.	1/2 in. max.
%	1-1/4 in.	100	——	——	——
	1 in.	86 - 98	100	——	——
P	3/4 in.	69 - 93	76 - 100	100	——
A	1/2 in.	57 - 81	66 - 86	79 - 99	100
S	3/8 in.	49 - 69	57 - 77	68 - 88	79 - 99
S	No. 4	34 - 54	40 - 60	48 - 68	58 - 78
I	No. 8	22 - 42	26 - 46	33 - 53	39 - 59
N	No. 16	13 - 33	17 - 37	20 - 40	26 - 46
G	No. 30	8 - 24	11 - 27	14 - 30	19 - 35
	No. 50	6 - 18	7 - 19	9 - 21	12 - 24
	No. 100	4 - 12	6 - 16	6 - 16	7 - 17
	No. 200	3 - 7	3 - 7	3 - 7	3 - 7
%	Bitumen in Mix	5.4 -7.0	5.4 - 7.0	5.4 -7.5	5.4 -8.0
%	Crushed Content (minimum)				
	One Face	85	85	85	85
	Two Face	70	70	70	70

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

TABLE V.

UNIFORMITY TOLERANCE LIMITS FOR BITUMINOUS MIXTURES

Type of Course	Range	Percentage Passing Designated Sieves			
		No. 8 & Larger	No. 30	No. 200	Bitumen Content
Top and Levelling 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 job mix formula

**Range 2: If two consecutive aggregate gradations on one sieve or two consecutive bitumen 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 VI.
TEMPERATURE AND SEASONAL LIMITATIONS

Seasonal Limits for Placing Bituminous Mixtures		Temperature Limitations Within the Seasonal Limits	
Location	Seasonal Limits	Minimum Temperature Base to be Overlaid °F (as measured in shade)	Thickness of Bituminous Material
Upper Peninsula	June 1 thru Oct. 15	50	Less than 1 inch
Lower Peninsula:		40	1 to 1 3/4 inches
North of M-46	May 15 thru Nov. 1	35	More than 1 3/4 inches
M-46 and South	May 5 thru Nov. 15		

The Project Engineer will obtain a sample of the uncompacted mixture and run an extraction test on it to determine conformance with the job mix formula after applying the allowable deviations listed in Table V, Range 1. The Project Engineer shall also obtain a sample of the uncompacted mixture and run a maximum specific gravity test (ASTM D2041) on the sample. The average of the two values shall be used in the air voids determination. This test will not be run on pavements designed for aircraft weights under 12,500 pounds.

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 D2726) 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 4.12.b 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 field operations or material and a second test section shall be constructed. The procedures above shall be repeated until the Project Engineer determines that all the specification requirements tested have been met on a test section.

If the first test section does not meet specification requirements, the pavement shall be removed and replaced at the Contractor's expense. A marginal quality test section placed in a low traffic area may remain in place if approved by the Project Engineer. When additional test sections also do not meet specification requirements, the test sections shall be removed at the Contractor's expense.

The Contractor shall not begin full production until a test section which meets all specification requirements has been placed. Test sections placed at the project site which meet all specification requirements will be paid for in accordance with Section 6.1.

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

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 treated is wet. Seasonal and temperature limitations for placement of the bituminous mix shall be in accordance with Table VI.

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 maintained in good mechanical condition and any defective parts which, in the opinion of the Project Engineer, adversely affect the proper functioning of the plant or plant units, or which adversely affect the quality of the mixture in any manner, shall be replaced or repaired immediately.

The Contractor shall provide adequate and safe stairways to the mixing platform and ladders to other plant units where necessary to provide accessibility to plant operations. Ample and unobstructed space shall be provided on the mixing platform. Platforms shall be provided to give the inspector easy access for sampling of the hot aggregate bins and the mixture in trucks. The mixture sampling platform shall be of the proper height for access to the mixture in trucks and shall have adequate steps. The platform shall have provisions for holding the molds used to sample the bituminous mixture. The placement and adequacy of the sampling platforms shall be approved by the Project Engineer. Adequate safeguards shall be provided to prevent injury to personnel from plant components.

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 bitumen. The plants shall meet the requirements specified herein.

(a) Asphalt Storage Tanks. Asphalt storage tanks shall be equipped for heating the bituminous material by steam, hot oil or other approved means. There shall be provision for effective and positive control of the temperature of the bituminous material within 250°F to 325°F. Storage tanks which have been used for the storage of bituminous materials other than that specified for the work at hand shall not be used until such tanks have been completely drained. All piping, valves and pumps used for the transfer of bituminous material shall be constructed so as to prevent intermixing or contamination of the material. The lines for transferring asphalt from storage to the mixing plant shall be equipped with suitable heating jackets to maintain the bituminous

material at the required temperature. 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 shall be capable of delivering the amount of aggregates required in their proper ratios. The adjustments on the feeder flow shall be readily adjustable and shall be capable of being secured in any position. The plant shall have a minimum of three cold feed buns and shall be equipped with screens for removal of oversized material. For bituminous base mixtures, oversize screens shall have one dimension opening of 1-3/4 inches, for all other mixes it shall have a one-dimension opening 1/4 inch larger than the maximum aggregate size in the mixture being produced. The feeders shall be equipped with cutoffs which will automatically stop the operations of the asphalt plant at any time the flow of any aggregate fraction is changed so as to affect the uniformity of the finished product. For a drum plant, the aggregate feed rate shall be measured by an approved electronic weighing device. The accuracy of the weighing device will be checked by the Project Engineer prior to plant production. The weighing device shall also be used to control the rate of flow of bitumen and mineral filler to the drum mixer. The Contractor shall be responsible for monitoring the moisture content of the raw aggregate. Each plant shall have a speedy moisture tester (Speedy Moisture Tester, MC-330 Super Speedy, 200 gram capacity, 0-11 percent moisture range, or equivalent). The moisture content of the raw aggregate shall be determined at least three times each day; one test prior to the start of the day's production, and two tests during the day's production, as directed by the Project Engineer.

(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 modulating device to control and maintain the temperature.

(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. Dry or wet dust collectors shall be provided on all plants. Dry fine aggregate material removed from plant by the dust collector shall be returned to the mixture. The Contractor shall utilize a small air-tight bin or container placed on the fine aggregate return line between the dust collector and the plant mixer. Surplus fine aggregate material collected from previous work shall not be used in subsequent work. For plants with baghouse collector, only dry, fine aggregate shall be returned to the mixer.

(f) Hot Aggregate Bins.

1. Batch Plants. The plant shall have hot 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 1/2 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 plant 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 1/3 the total capacity of the bin.

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

(h) Sampling Spigot. The bitumen line supplying the plant shall be equipped with a sampling spigot located as close to the spray bar as possible.

(i) Bitumen Pumps.

1. Continuous Plants. The bitumen pump shall be a positive displacement type pump. It shall be synchronized with a non-reset revolution counter graduated to 0.01 revolution 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 bitumen 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 bitumen 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 cement.

(j) Interlock Systems for Aggregate, Mineral Filler and Bitumen Feed 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 bitumen) malfunctions.

(k) Calibration of Continuous and Drum Plants. Provisions shall be made for diversion and calibration of the aggregate, mineral filler, and bitumen. 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 bitumen, 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. Bitumen. The plant shall be equipped with a tank for the calibration of the bitumen feed system. The calibration will consist of diverting the bitumen for a time period not to exceed five minutes. The calibration of the bitumen 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 for Weighing Bituminous Mixtures. Plants shall be equipped with platform or suspended hopper scales. Scales shall conform to the requirements of the current edition of the National Bureau of Standards Handbook 44. The requirements that scales are to be equipped with means by which the zero-load balance may be adjusted, either by an electronic mechanism designed to be manually operated to provide an automatic means to maintain a digital zero balance indication shall apply to all platform and surge bin scales used for weighing bituminous mixtures.

The tolerance applications of Handbook 44, as applicable to underregistration and overregistration and to tests involving digital indications or representations, shall apply.

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.

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. Time

2. Date

3. Sequential ticket number (may be preprinted on ticket)

4. Gross weight

5. Tare weight (trucks shall be tared at least twice daily)

6. Net weight

7. Net accumulated job daily total

The system shall be so interlocked as 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 National Bureau of Standards Handbook 44, with the following exceptions and additions:

The value of the minimum graduated interval for scales which have a nominal 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 5,000 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 two pounds per 1,000 pounds of load or the value of one minimum graduated interval, whichever is greater.

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

Each installation of scales shall be provided with 10 standard weights meeting the requirements of the National Bureau of Standards for testing the weighing equipment. The accuracy of the scales will be checked by the Project Engineer. 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.

If plant vibration affects the accuracy of the scales, the Project Engineer may require them to be placed upon a separate foundation.

(m) Mixers. 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.

1. Batch Plants. The plant shall be equipped with a batch mixer of the twin pugmill type. It shall be heat-jacketed 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. The mixer shall be enclosed except for openings necessary to admit materials. It shall be capable of holding and properly mixing at least a 2,000 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 bitumen in the specified wet mixing time.

2. Continuous Plants. The continuous type twin shaft pugmill mixer shall be heat-jacketed 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) Time 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 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 bituminous mixtures meeting the following requirements:

The automatic proportioning controls shall include equipment for accurately proportioning batches 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 to within ±0.1 percent for the bitumen 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 is 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 70 tons and shall be equipped with a gob hopper at the inlet of the bin. Bins may be equipped with baffles to control segregation. Safe and permanent provisions shall be made so that the bituminous mixture may be sampled between the plant and the surge bin.

(s) Field Laboratory. A field laboratory for bituminous inspection shall be provided by the Contractor. The building exterior shall not be less than eight feet wide and shall have an interior floor area of not less than 140 square feet. The building shall contain at least three windows, each of which shall have an area not less than 540 square inches. It shall be furnished with at least 30 square feet of rigidly constructed counter space approximately 24 inches deep and approximately 32 inches above the floor, securely mounted against the wall and to the floor. The building shall be equipped with a quartering board two feet wide and four feet long, sink with end board and a firmly mounted stand to support a bituminous extractor. A grounded 110 volt electrical outlet shall be furnished, fitted to receive a three-prong grounded plug. The Contractor shall furnish an approved electrically powered mechanical sieving apparatus. The shaker shall be capable of handling a full complement of full height eight-inch standard sieves and of efficiently performing the necessary separation. A gas or liquid fueled stove with at least two burners and the fuel required for the stove shall be furnished by the Contractor for heating and drying the extracted aggregate. Storage and usage of the fuel shall be in accordance with the latest regulations of Michigan State Police, Fire Marshal Division. The Contractor shall provide a hood with an exhaust fan which will extend over the stove and the electrical extractor. The capacity of the exhaust fan shall be such that it will exhaust each minute a volume of air equal to at least two times the volume of the building.

The building shall be furnished with heating equipment that will maintain a temperature of not less than 70°F during working hours. The building shall be furnished with not less than two 75-watt electric lights. A portable gas generator of sufficient capacity shall be provided when electricity is not available at the site of the work. The building shall be provided with running water as required for making tests. For purposes of this specification, running water will be interpreted as water through a faucet under pressure.

Each field office or laboratory provided for the use of the Project Engineer shall be furnished with fire extinguishers meeting the following minimum requirements:

A 2 1/2 gallon pressurized fire extinguisher with an Underwriter's Laboratory rating of 2A and a 20-pound pressurized dry chemical fire extinguisher with an Underwriter's Laboratory rating of 20 BC.

A multipurpose dry chemical extinguisher with a combined Underwriter's Laboratory rating of 2A-20 BC may be furnished in lieu of the above two extinguishers.

These extinguishers shall be maintained in a satisfactory working condition by the Contractor.

The building shall have a tight board floor and the ceiling shall not be less than eight feet in height. The windows shall be single sash of the hinged or sliding type and placed in the positions directed by the Project Engineer. The door shall be of standard size and equipped with a cylinder lock.

It shall be located as directed by the Project Engineer with at least one window facing plant operations. It shall be left in place and maintained until the project is completed.

A trailer having an equal floor space and a height of not less than six feet six inches from floor to ceiling may be used in place of the required building. The minimum requirements for heat, lights, and equipment specified for buildings shall also apply to trailers.

4.3 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth beds which have been thinly coated with lime solution, or other approved release agent, to prevent the mixture from adhering to the 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 Levelling 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 <u>Bituminous Pavers</u>. 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 extensions 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 reference 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 <u>Rollers</u>. 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 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 rollers 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 1/2 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 five pounds per square inch 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 (160°C). Any bituminous material which has been overheated and which, in the opinion of the Project Engineer, has been injured thereby, will be rejected.

4.7 Preparation of Aggregate. Mix production shall not be allowed to start on any day unless the Contractor has properly stockpiled at the plant site sufficient quantities of each aggregate size for at least the day's production of mix.

The blending of aggregates by means of mechanical feeders to conform with the gradation specified immediately prior to feeding the blended aggregate into the mixing plant will be permitted in lieu of graded aggregate from approved stockpiles.

When blended aggregates are used, the following conditions and controls shall apply:

(a) The Contractor shall provide uniformity in the gradations of the aggregates placed in the cold feed bins so that the combination of aggregates produced for the mixture by blending the aggregates from two or more cold feed bins will be uniformly fed by means of adjustable feeders onto a belt supplying the asphalt plant. The feeders shall be equipped with cutoffs which will automatically stop the operations of the asphalt plant at any time the flow of any aggregate fraction is changed so as to affect the uniformity of the finished product. The Contractor has the option of using hot bins for proportioning the aggregates to meet tolerances.

(b) The owner reserves the right to require the Contractor to discontinue the use of blended coarse aggregate as provided herein and furnish graded aggregate from approved stockpiles if, in the opinion of the Project Engineer, the blended aggregate as incorporated in the bituminous mixture does not conform with the specifications. The Project Engineer may require the removal of any pavement wherein the gradation of the aggregates varies substantially from specification requirements.

Aggregates shall be completely dried and heated to a temperature necessary to give the required target placement temperature designated in the job formula, as determined on the mixing platform, but not greater than 350°F for mixtures containing asphalt cement. If the aggregates contain sufficient moisture to cause foaming or a soggy mixture, they shall be removed from the bins.

4.8 Preparation of the Bituminous Mixture. The Project Engineer shall have access to all parts of the paving plant at all times for the verification of weights, temperatures and the character of the work.

Before delivery, the aggregate shall be mixed with the bituminous material at a central mixing plant.

The mixture shall be prepared to meet the target placement temperature designated by the job mix formula within tolerances specified in Section 4.9. The maximum temperature of the completed mixture when discharged from the mixer shall not exceed 325°F.

The degree of aggregate particle coating shall not be less than 95 percent when tested in accordance with ASTM 1664. The moisture content of the mix shall not exceed 1.0 percent.

(a) Batch Plants. The aggregate, mineral filler, when required, and bituminous material shall be measured separately for each batch. The mixture shall be made by first charging the mixer with the aggregates and dry mixing for a minimum of five seconds and then adding the bituminous material. After all the bituminous material has been added, wet mixing shall be continued for at least 25 seconds, but not longer than 50 seconds, so as to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated. The length of mixing time for the dry aggregates and mineral filler may be varied at the discretion of the Project Engineer.

(b) Continuous Plants. The aggregate and the mineral filler, when required, shall be uniformly fed to the mixer through the gate openings. The flow of bituminous material into the mixer shall be at a rate determined by the Project Engineer, and shall be synchronized with the flow of the aggregate. These rates will be determined on the basis of the ability of construction equipment to produce and place satisfactory quality mixtures.

The mixing time will be determined by the weight method in accordance with the following formula, except that the mixing time shall not be less than 40 nor more than 80 seconds, unless otherwise directed by the Project Engineer. The weights will be determined for the job by tests made by the Project Engineer.

$$\text{Mixing Time} = \frac{\text{Pugmill Dead Capacity In Pounds}}{\text{Pugmill Output In Pounds Per Second}}$$

(c) Drum Mixer Plants. If at any time there is a failure of the automatic electronic weighing of the aggregate feed or of the bitumen feed control, the Contractor shall stop plant mixing operations until the failure has been corrected. Manual operation of the proportioning controls will not be permitted.

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. Release agents 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 temperature of the mixture as discharged from the hauling unit should be at the target temperature specified by the job mix formula as modified by the Project Engineer. The temperature of the mixture as discharged from the hauling unit may vary by as much as ±20°F from the specified target temperature. Occasional loads slightly outside the ±20°F limits may be permitted, provided that adjustments are being made to bring the temperature of the mixture back to the specified target temperature for placement.

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 on the first lane on the bituminous base material shall be a string or wire set parallel to plan grade and properly tensioned according to the manufacturer's recommendation. A manufacturer approved ski-type attachment or traveling string line, not less than 30 feet in length, may be used in lieu of the tensioned string or wire on all following lanes and bituminous courses. 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 layer shall offset that in the layer immediately below by at least one foot; however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least two feet from transverse joints in the previous layer. 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.

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 mixtures 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 spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Rolling of the mixture shall begin as soon after spreading as it will bear the roller without undue displacement. 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 land 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. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected.

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 defective shall be removed and placed 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 old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose 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 joint shall be placed so that it will not coincide with that in the base, levelling, or existing top course by at least one foot.

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 bevelled while still hot with the back of a rake or a smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

4.12 Acceptance Sampling and Testing of Bituminous Mixture (Compaction).

(a) In-Place Air Voids. (Pavements designed for aircraft weights 12,500 lbs. and over).

The compaction of pavements designated for aircraft weights of 12,500 lbs. 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 lot basis. A lot will consist of:

1. one day's production where it is not expected to exceed 2,000 tons.

2. a half day's production where one day's production is expected to consist of between 2,000 and 4,000 tons.

3. similar subdivisions for tonnages over 4,000 tons. When more than one asphalt plant is simultaneously producing material for a job, separate pavers shall be used and the above lot size will apply to each asphalt plant.

Bituminous mixture for determination of maximum specific gravity 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 D3665. The maximum specific gravity of each sample will be determined in accordance with ASTM D2041 using type C or D containers.

The percent air voids of each core sampled under the procedures of Section 4.14 shall be computed as follows:

$$Va = \frac{100\,(Gmm - Gmb)}{Gmm}$$

where

Gmm = average of the sublot maximum specific gravities

Gmb = bulk specific gravity of the core (ASTM D2726)

Va = percent air voids of the core

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). 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 formulae:

$$QL = \frac{\bar{X} - L}{S} \qquad QU = \frac{U - \bar{X}}{S}$$

QU = Quality Index of the upper limit
QL = Quality Index of the lower limit

$\bar{X}$ = Average core air-voids (%) of the lot
S = Standard Deviation of test results

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

L = Lower specification limit, 1%
U = Upper specification limit, 7%
X = individual test
n = number of tests

To determine the percentage of material above the lower specification limit (PWL_L), enter Table VII with QL using the column appropriate to the total number (n) of cored samples. To determine the percentage of material below the upper specification limit (PWL_U), enter Table VII with QU using the appropriate column as shown above. The total PWL will be determined by the following formula:

$$PWL = (PWL_L + PWL_U) - 100$$

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 VIII.

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

The density of pavements designed for aircraft weights under 12,500 lbs. 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:

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

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

Pavement density will be determined by the Project Engineer on a lot basis. A lot will consist of:

1. one day's production where it is not expected to exceed 2,000 tons.

2. a half day's production where one day's production is expected to consist of between 2,000 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 Appendix C of The Asphalt Institute's Specification Series No. 1, latest edition. The cores shall be taken in accordance with the requirements in Section 4.14. The density of each core shall be determined in accordance with ASTM D2726 or D1188, whichever is applicable.

Acceptance of each lot of each of 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.

4.13 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 levelling 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 sixteen- foot straightedge and four-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 1/2 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.

4.14 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. Prior to testing, samples may be retaken when it has been determined the first sample is defective or has become defective during transport. Test (ASTM D2726) results may not be discarded once taken. The Contractor shall furnish all tools, labor, and materials for cutting samples and replacing pavement.

Locations of sampling sites for determining the density of the compacted pavement shall be taken in accordance with the procedures listed in Appendix C of the Asphalt Institutes Manual Series No. 1. In cases where test locations are within two feet of the pavement edge or a pavement joint, a new random location will be used.

The bulk specific gravity of the cored samples shall be determined in accordance with ASTM D2726.

All tests necessary to determine initial conformance with specification requirements will be performed by the Project Engineer at no cost to the Contractor.

Resampling 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 resampling 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 resampling 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 recores, 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 resampling 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 resampling 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 resampling 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.

DENSITY DETERMINATION BY A NUCLEAR DEVICE SHALL NOT BE PERMITTED AS THE BASIS FOR ACCEPTANCE.

METHOD OF MEASUREMENT

5.1 Plant mix bituminous concrete 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 tonnage.

BASIS OF PAYMENT

6.1 Payment shall be made at the respective contract prices for bituminous base, levelling or top course. These prices shall be full compensation for furnishing all materials including bitumens 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, tack or seal coat.

Payment will be made under the nomenclature and seven digit item number specified in the plans and proposal for each type of bituminous base, levelling 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 VII.
TABLE FOR PERCENT OF LOT WITHIN LIMITS (PWL)
(STANDARD DEVIATION METHOD)

PERCENT WITHIN LIMITS	Q - VALUES, STANDARD DEVIATION METHOD									
	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	2.0897
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	1.1184	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	1.1204	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	0.9610	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	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858	0.7840	0.7826
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	0.5982	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	0.4802	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	0.4916	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

TABLE VII.
TABLE FOR PERCENT OF LOT WITHIN LIMITS (PWL)
(STANDARD DEVIATION METHOD)

PERCENT WITHIN LIMITS	Q - VALUES, STANDARD DEVIATION METHOD									
	N=3	N=4	N=5	N=6	N=7	N=8	N=9	N=10	N=11	N=12
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	0.1500	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	0.0264	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	-0.3161	-0.3148	-0.3137
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-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	-0.4787
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-05130	-0.5105	-0.5087	-0.5072
30	-0.6787	-0.6000	-0.5719	-0.5583	-0.5504	-0.5454	-0.5419	-0.5394	-0.5375	-0.5360
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

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PERCENT WITHIN LIMITS	Q - VALUES, STANDARD DEVIATION METHOD									
	N=3	N=4	N=5	N=6	N=7	N=8	N=9	N=10	N=11	N=12
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	-0.9624	-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	-1.1995	-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 VIII.
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 VIII 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 AND MATERIAL REQUIREMENTS

Test and Short Title	
ASTM C29	Unit Weight of Aggregate
ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C131	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
ASTM C136	Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C183	Sampling Hydraulic Cement
ASTM D75	Sampling Aggregates
ASTM D423	Liquid Limit of Soils
ASTM D424	Plastic Limit and Plasticity Index of Soils
ASTM D995	Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D1075	Effect of Water on Cohesion of Compacted Bituminous Mixtures
ASTM D1188	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D1559	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D2172	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D2489	Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
ASTM D3665	Random Sampling of Paving Materials
ASTM D3666	Inspection and Testing Agencies for Bituminous Paving Materials
AASHTO T30	Mechanical Analysis of Extracted Aggregate
The Asphalt Institute's Series (SS-1)	Model Construction Specifications for Asphalt Concrete and Other Plant-Type Mixes
The Asphalt Institute's Manual No. 2 (MS-2)	Mix Design Methods for Asphalt Concrete

Material and Short Title	
ASTM D242	Mineral Filler for Bituminous Paving Mixtures
ASTM D490	Tar
ASTM D946	Asphalt Cement for Use in Pavement Construction
ASTM D3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
AASHTO M226	Viscosity Graded Asphalt Cement