

ASPHALT CONCRETE - MARSHALL

1.0 GENERAL

1.1 Description

- .1 This section specifies the requirements for the supply of hot mix asphalt concrete paving.
- .2 The work includes the supply of aggregates and asphalt cement, and reclaimed asphalt pavement and liquid anti-strip where applicable; asphalt plant mixing, transporting, placement finishing, and compaction to all requirements of this specification.
- .3 The work includes all materials certification, quality control, verification and mix design testing, analysis and reporting to be completed as required in this specification.

1.2 Related Work

- .1 Performance Graded Asphalt Binder – Section 05135
- .2 Asphalt Tack – Section 05110
- .3 Asphalt Prime – Section 05120

1.3 Definitions

- .1 End Product Specification (EPS) - A specification whereby the methods of construction are not defined. Under EPS the Engineer will monitor the Contractor's control of the process that produces the items of construction and will accept or reject the end product according to a specified acceptance plan. The Contractor is responsible for quality control. End product acceptance, including quality assurance is the responsibility of the Engineer.
- .2 Engineer - As referenced to in this specification, applies to the City of Lethbridge or the designated project representative.
- .3 Hot Mix Asphalt (HMA) - Generally refers to the mixture of aggregates and asphalt cement, and other additives where applicable.
- .4 Asphalt Concrete - Generally refers to the final HMA product in place.
- .5 Pre-Production Quality Control - Materials and process quality control conducted in accordance with this specification prior to plant mixing.
- .6 Post-Production Quality Control - Materials and construction quality control conducted in accordance with this specification during and after plant mixing.
- .7 Quality Assurance - Acceptance testing and the monitoring undertaken on behalf of the Owner.
- .8 Job Mix Formula - The job mix formula (JMF) establishes the proportioning of aggregate, asphalt cement and reclaimed asphalt pavement (RAP) and/or liquid anti-strip where applicable, to be used for the production of hot mix asphalt (HMA).
- .9 Project Category - For the purposes of this specification, projects are to be identified in the Contract Special Provisions as Category A or Category B. Generally, Category A projects have asphalt concrete quantities greater 2000 tonne of any one mix type and Category B projects have quantities of any one mix type less than 2000 tonne. In all cases the Special Provisions govern with respect to the applicable Project Category.
- .10 Lot - A lot is a portion of the Work being considered for acceptance, and is defined as the following:

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- .1 Category A Projects - One day of plant production, per mix type, when the day's quantity is greater than 1000 tonne. When a day's production is less than 1000 tonne the material may be added to the previous or subsequent day(s) of production, at the Engineer's discretion. The maximum Category A lot size shall be 2000 tonne.
- .2 Category B Projects - The entire project quantity for each mix type.
- .3 At the Engineer's discretion, any portion of the Work may be deemed a Lot.

2.0 PRODUCTS

2.1 Materials

- .1 Performance Graded Asphalt Binder: - to Section 05135.
- .2 Aggregates:
 - .1 Coarse aggregate is aggregate retained on the 5.0 mm sieve; fine aggregate is aggregate passing the 5.0 mm sieve.
 - .2 Aggregate material shall be crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps cementation, organic material, frozen material and any other deleterious materials.
 - .3 Gradations to be within limits specified, when tested to ASTM C-136 and ASTM C-117 with sieve sizes to CAN/CGSB 8-GP-2M rather than ASTM E11.
 - .4 Aggregate shall be processed to meet the following requirements:
 - .1 Natural fines shall be pre-screened and stockpiled with not more than 10% of material retained on the 5.0 mm sieve and 100% passing the 10.0 mm sieve.
 - .2 Aggregate delivered to the crushing plant shall be pre-screened and shall contain not more than 5% passing the 5.0 mm sieve.
 - .3 Crushed aggregates shall be separated and stockpiled in accordance with the following:
 - .1 Coarse fraction to contain not more than 10% of material passing the 5.0 mm sieve.
 - .2 Fine fraction or manufactured sand to contain not more than 20% of material retained on the 5.0 mm sieve.
 - .5 Physical properties of aggregates to meet the requirements in Table 2.1.2.5.

Table 2.1.2.5: Aggregate Physical Property Requirements		
Requirement	ASTM Test Standard	Tolerance
Micro Deval (% Loss) Coarse Aggregate	D6928	15 max.
Micro Deval (% Loss) Fine Aggregate	D7428	20 max.
Lightweight Particles –(%)	C123	1.5 max.

- .6 Blend Sand:

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- .1 To consist of natural or manufactured sand passing the 5.0 mm sieve.
 - .2 Stockpile volumes shall be maintained to ensure a minimum of 5 000 tonne of plant mix production at all times.
- .7 Blended Aggregate Requirements:
- .1 Aggregate Gradation Requirements, including RAP, to meet the requirements of Table 2.1.2.7.1.

Table 2.1.2.7.1: Blended Aggregate Gradation Requirements						
Sieve Size (mm)	Percent Passing					
	Type I		Type II		Type III	
	Max	Min	Max	Min	Max	Min
25	-	-	100	100	-	-
20	-	100	95	85	-	-
16	100	97	88	77	-	100
12.5	95	85	80	65	100	90
10.0	85	70	72	57	90	75
5.0	65	50	55	40	75	60
2.50	50	40	42	30	60	45
1.25	40	30	33	23	45	30
0.630	30	20	27	17	36	22
0.315	23	15	22	12	27	12
0.160	16	6	15	6	18	6
0.80	8.0	4.0	8.0	4.0	10.0	4.0

- .2 Coarse Aggregate Fracture: Of coarse fraction (retained on 5.0 mm sieve size) the percentage of particles with two (2) or more fractured faces shall be by mass:
 - .1 Mix Type I – 90% minimum
 - .2 Mix Type II – 60% minimum
 - .3 Mix Type III – 80% minimum
- .3 Flat and Elongated Particles: Of coarse fraction (retained on 5.0 mm sieve size) the percentage of flat and elongated particles greater than a 5:1 ratio shall be by mass less than 10%.
- .4 Manufactured Sand: Of total fine fraction (passing 5.0 mm sieve size), manufactured sand shall be by mass:
 - .1 Mix Type I – 70% minimum
 - .2 .2 Mix Type II – 50% minimum
 - .3 .3 Mix Type III – 50% minimum
- .5 For mixes incorporating RAP, 50% of the RAP sand portion shall be considered manufactured sand.
- .6 The sand equivalent value (ASTM D2419, mechanical method) determined for the fine aggregate portion shall be:

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- .1 Mix Types I and III - 45% minimum
- .2 Mix Type II - 40% minimum
- .7 The allowable RAP content shall be 20% based on the percentage RAP binder contribution (or RAP Ratio) to the total binder content. The following formula is used to determine RAP Binder Contribution”

$$\text{RAPBC} = \frac{\text{Pb}_{\text{RAP}} \times \text{P}_{\text{RAP}}}{\text{Pb}_{\text{TOTAL}}}$$

Where:

RAPBC = RAP Binder Contribution

P_{RAP} = RAP Binder Content

P_{RAP} = Percentage RAP by weight of mixture

P_{TOTAL} = Total Binder Content in mixture (by mass of mix)

.8 Delivery and Storage

- .1 Aggregates: Stockpile minimum of 50% of total amount of aggregate required before commencing trial mix designs.
- .2 Reclaimed Asphalt Pavement (RAP): Stockpile minimum of 100% of total amount of RAP required before commencing trial mix designs.

2.2 Mix Design

- .1 An asphalt mix design must be prepared and submitted to the Engineer for review and approval at least one week prior to the Work. The Contractor shall use qualified engineering and testing services licensed to practice in the Province of Alberta.
- .2 The mix design shall follow the Marshall method of mix design as outlined in the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2), and shall include five separate trial values of asphalt content.
- .3 Design of Mix:
 - .1 Mix Types I and Type II – 75 Blows on each face of test specimens.
 - .2 Mix Type III – 50 Blows on each face of test specimens.
- .4 Include the following data with mix design submission:
 - .1 Aggregate specific gravity and asphalt absorption.
 - .2 Sand equivalent, coarse aggregate fracture, flat and elongated particles, and percent manufactured sand values.
 - .3 Asphalt cement supplier/refinery, specific gravity and mixing and compaction temperatures, based on temperature – viscosity properties of asphalt cement.
 - .4 Job mix formula including aggregate gradation and blending proportions, and design asphalt content.
 - .5 Maximum relative density at each trial asphalt content.

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.6 Where reclaimed asphalt pavement (RAP) is to be incorporated into the mix supply, RAP gradation, RAP asphalt cement content and design recycle percentage.

.7 Data to satisfy the requirements of the following:

Table 2.2.3.7: Mixture Physical Property Requirements			
Property	Requirements		
	Mix Type		
	I	II	III
Marshall Stability (kN)	10.0 min.	10.0 min.	5.4 min.
Marshall Flow (0.25 mm Units)	8-14	8-15	8-14
Air Voids (%)	3.8–4.2	4.3–4.7	2.8–3.2
Voids in Mineral Aggregate (VMA) (%)	13.5–15.0	12.5–14.0	14.0–16.0
Voids Filled with Asphalt (VFA) (%)	65-75	60–70	70 – 80
Tensile Strength Ratio (%) [1][2]	80 min.	80 min.	80 min.
Film Thickness (µm)	7.0–8.5	6.0–8.0	7.0 min.

[1] Tested in accordance with AASHTO T283 including the optional freeze cycle

[2] If not satisfied at 0.3% minimum antistrip, additional antistrip up to a maximum of 0.5% can be used

2.3 Job Mix Formula

- .1 Subject to approval by the Engineer, the aggregate proportioning (including RAP), target gradation, asphalt content and air void content from the Mix Design will become the Job Mix Formula for the supply of hot mix asphalt.
- .2 Once established, no alterations to the Job Mix Formula will be permitted unless the Contractor submits a new Job Mix Formula and approved by the Engineer.
- .3 If the sum of any alterations to the Job Mix Formula is in excess of any one of the following limits, a new Mix Design is required.

± 5% passing the 5.0 mm sieve size

± 1% passing the 0.080 mm sieve size

± 0.30% asphalt content

- .4 Any alteration to the Job Mix Formula shall not result in properties which do not meet the requirements of this Specification.

2.4 Production Tolerances

- .1 All mixtures shall be supplied to the Job Mix Formula within the range of tolerances specified.
- .2 Asphalt cement content: ±0.30% of JMF value.
- .3 Temperature: Mix temperature at point of plant discharge shall not vary from that specified in the job mix formula by more than ±10°C.

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.4 Aggregate Gradation:

Aggregate Passing Sieve Size (mm)	Tolerance (% by Mass)
Max. Size to 5.0	±5.0
2.50 and 1.25	±4.0
0.630 and 0.315	±3.0
0.160	±2.0
0.080	±1.5

.5 Air Voids: ±1.0% of the JMF value.

.6 Mixture Properties: Marshall Stability, Marshall Flow, Voids Filled with Asphalt, Voids in Mineral Aggregate and Film Thickness as per requirements identified in Table 2.2.3.7.

.7 Moisture in Mix: Maximum permissible moisture, at point of plant discharge, is 0.2% by mass of mix.

.8 Asphalt cement recovered from freshly produced hot mix by the Abson Method, ASTM D1856 and subsequently tested in accordance with ASTM D5, shall retain a minimum value of 50% of its original penetration value.

3.0 SAMPLING AND TESTING

3.1 General

- .1 The Engineer shall have access to all production processes and materials used for the work to monitor material quality as often as deemed necessary. Such inspection and testing shall not in any way relieve the Contractor of the responsibility for meeting the requirements of this specification.
- .2 At least three (3) weeks prior to commencing work, inform the Engineer of the proposed source of aggregates and provide access for sampling, and provide samples of asphalt cement in accordance with Section 05130.

3.2 Quality Control

- .1 Quality control is the responsibility of the Contractor throughout every stage of the Work from aggregate processing to the final accepted product. Tests performed by the Engineer will not be considered as quality control tests.
- .2 The Contractor shall be totally responsible for production of materials and construction that meet all specified requirements.
- .3 All quality control shall be conducted by qualified personnel. The Contractor shall bear the cost of all quality control testing and consulting services.
- .4 Pre-Production testing and sampling and minimum frequencies are described in Table 3.2.4, Pre-Production Quality Control Requirements.

Table 3.2.4: Pre-Production Quality Control Requirements		
Quality Control Requirement	Test Standard	Minimum Frequency
Asphalt Cement Certification	-	Once per Year or for change in supplier

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Aggregate Physical Properties Table 2.1.2.5	Table 2.1.2.5	Once per Year, or for change in source
Crushed Coarse Aggregate Gradation Analysis and Fracture Content	ASTM C 136 ASTM D 5821	One for every 1,000 tonne of each class of material processed into stockpile, or one analysis for each material every production day when production rate is less than 1,000 tonne
Manufactured Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Natural Fine Aggregate Gradation	ASTM C 117 ASTM C 126	
Blend Sand Aggregate Gradation	ASTM C 117 ASTM C 126	
Reclaimed Asphalt Pavement (RAP) Asphalt Content and Extracted Aggregate Gradation	ASTM D 2172 ASTM C 117 ASTM C 136	One for each 500 tonne delivered to stockpile, or one for each location when delivery rate is less than 500 tonne
Penetration of asphalt cement recovered from RAP by Abson Method	ASTM D 1856 ASTM D 5	One for each 2,000 tonne delivered to stockpile
Trial Mix Design by Marshall Method Section 2.2	ASPHALT INSTITUTE MS-2	One per mix type every 3 years, or as required for a change in Asphalt cement supply, Aggregate gradation or aggregate source. See Note 1
Plant Calibration	-	As required

Note 1: A laboratory/plant job mix formula verification is required each year when a trial mix design is not conducted.

- .5 Post-Production testing and sampling and minimum frequencies are described in Table 3.2.5, Recommended Post-Production Quality Control Requirements.

Table 3.2.5: Recommended Post-Production Quality Control Requirements		
Quality Control Requirement	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Asphalt Content, Aggregate Gradation, Marshall Density and Void Properties)	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 3203	One for every 500 tonne of each Mix type supplied under this specification. See Note 1.
Quality Control Charts (including 3 tests running Average for Binder Content, Aggregate Gradation, Marshall Density and Void Properties)	-	For each hot mix analysis. Test results and updated 3 test running average to be submitted to the Engineer as they become available.
Hot Mix Asphalt Temperature	-	Minimum frequency not specified.
Cold Feed Aggregate Analysis	ASTM C117 ASTM C 136	Minimum frequency not specified.
Maximum Relative Density of Hot Mix Asphalt	ASTM D 2041	Minimum frequency not specified.
Compaction Monitoring (Core or Nuclear Density)	ASTM D 2726 ASTM D 2950	Minimum frequency not specified. See Note 2

Note 1: Where an individual test indicates non-compliance, another test shall be initiated immediately.

Note 2: Coring is subject to approval by the Engineer.

- .6 Pre-Production Quality Control test data as specified in Table 3.2.4 shall be reported to the Engineer one week prior to commencing the project, or as requested.
- .7 Post-Production Quality Control test data as specified in Table 3.2.5 shall be reported to the Engineer daily as the Work proceeds.

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3.3 Quality Control Compliance with Specified Tolerances

- .1 Asphalt Content, Aggregate Gradation and Mixture Properties
 - .1 The test data derived by Post-Production Quality Control mix testing, described in Section 3.2, shall be compared to the tolerances set forth in Section 2.4 of this specification. The Contractor shall document, and make available to the Engineer, any adjustments made to correct noncompliance with the specified tolerances.
 - .2 The Contractor shall suspend mix production when the 3 test running average for any property is outside of the specified tolerance limits for three consecutive tests. Supply shall not commence again until it is demonstrated that corrective action has been taken.
- .2 Hot Mix Asphalt Temperature
 - .1 Plant mix that does not meet temperature requirements of Section 2.4.3, at the point of plant discharge shall be subject to rejection at the discretion of the Engineer.

3.4 Acceptance Sampling and Testing

- .1 Within this specification, certain requirements, limits and tolerances are specified regarding supplied materials and workmanship. Compliance with these requirements shall be determined from acceptance testing as described in this section.
- .2 Acceptance testing is the responsibility of the Engineer.
- .3 Initial acceptance testing will be undertaken free of cost to the Contractor.
- .4 Sampling and acceptance testing is described in Table 3.4.4, Acceptance Testing Requirements - Category A & B Projects.

Table 3.4.4: Acceptance Testing Requirements – Category A & B Projects		
Acceptance Testing	Test Standard	Minimum Frequency
Hot Mix Asphalt Analysis (including Binder Content, Aggregate Gradation, Marshall Density, Maximum Relative Density, Void Properties, Marshall Stability and Flow)	ASTM D 6307 ASTM C 117 ASTM C 136 ASTM D 2041 ASTM D 3203	For each mix type, one test for each 3,500 sq.m. of placement, or three tests per lot, which ever is greater. See Note 1.
Compaction Testing (Core Density) and Thickness Determination	ASTM D 2726 ASTM D 3549	For each mix type, one test for each 2,000 sq.m. of placement, or three tests per lot, whichever is greater.
Hot Mix Asphalt Temperature	-	No minimum frequency.

- .5 Acceptance Sampling Procedures:
 - .1 Loose mix samples shall be acquired from the Work site in accordance with Alberta Transportation Test (ATT) procedure ATT-37. Auger samples may be used if approved by both the Engineer and the Contractor.
 - .2 The timing of mix sampling shall be stratified, with each sample representing a similar production quantity.
 - .3 Core locations will be selected using stratified random sampling procedures. The lot will be divided into segments meeting or exceeding the minimum frequency in Table 3.4.4 and of approximately equal area. In

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each segment a test site will be located using random numbers to determine the longitudinal and transverse coordinates.

.4 Areas within 3m of transverse joints or 0.3m of a mat edge are excluded from compaction acceptance sampling and testing.

.6 Reporting Protocols

.1 Test reporting accuracy shall be as stipulated in the referenced test procedures, including:

- .1 Gradation to the nearest whole number, except the percent passing the 0.080 mm sieve, which shall be reported to the nearest 0.1%.
- .2 Binder content to the nearest 0.01%
- .3 Air voids and compaction to the nearest 0.1%.
- .4 Thickness to the nearest whole millimeter (mm).

.2 Lot averages shall be reported to the same accuracy as test results.

3.5 Appeal of Acceptance Testing Results

.1 General

.1 The Contractor may appeal the results of acceptance testing for Compaction Standard, Asphalt Content or Air Voids for any lot subject to rejection or unit price reduction. The notice of appeal shall be in writing and submitted to the Engineer within 48 hours of receipt of the acceptance testing results.

.2 Appeals will only be considered if cause can be shown and the requirements of Table 3.2.5 have been satisfied.

.3 Quality Control tests initiated after the Contractor's receipt of the acceptance test results will not be considered when evaluating cause for appeal.

.4 For Category A Projects, only Quality Control testing during production for the subject project will be considered when evaluating cause for appeal. For Category B Projects, Quality Control test results from production prior to the subject project may be considered when evaluating cause for appeal.

.2 Asphalt Content Appeal

.1 A stratified random sampling plan shall be developed by the Engineer with the same number of segments as the original number of samples for the subject lot. Sufficient core sample will be acquired from each segment to enable asphalt content determinations.

.2 For asphalt content appeal testing, the Contractor will have the option for the testing to be done by the testing laboratory undertaking the project acceptance testing, or an independent testing laboratory selected by the Engineer.

.3 The average of the appeal test results will be used for acceptance and unit price adjustment, and shall be binding on both the Owner and the Contractor.

.4 If the average appeal test result verifies that any unit price reduction or rejection applies for that Lot, the costs of the appeal sampling and testing will be borne by the Contractor. If the results show that a penalty or rejection no longer applies, the sampling and appeal costs will be the responsibility of the Owner.

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- .3 Compaction Standard or Air Void Appeals
 - .1 The testing laboratory conducting the project acceptance sampling and testing will routinely retain companion samples sufficient for the determination of maximum relative density and/or Marshall density.
 - .2 For compaction standard or air void (Marshall density) appeal testing, the Contractor will have the option for the testing to be done by the testing laboratory undertaking the project acceptance testing, or an independent testing laboratory selected by the Engineer.
 - .3 The average of the appeal tests will be used for acceptance and unit price adjustment, and shall be binding on both the Owner and the Contractor.
 - .4 If the new compaction standard verifies that any unit price reduction or rejection applies for that Lot, the costs of the appeal sampling and testing will be borne by the Contractor. If the result shows that a unit price reduction no longer applies, the appeal testing costs will be the responsibility of the Owner.
 - .5 If the new average air void content result verifies that any unit price reduction applies for that Lot, the costs of the appeal testing will be borne by the Contractor. If the results show that a unit price reduction no longer applies, the sampling and appeal costs will be the responsibility of the Owner.
- .4 Core Density and Thickness Appeals
 - .1 Core density and thickness appeals will only be considered if a case can be made that the stratified random sampling plan was biased or testing was in error.

4.0 EXECUTION

4.1 Continuity of Production

- .1 During the time period that work is in progress on any project for which this specification is in effect, and at the Engineers' discretion, the plant may be limited to producing only the mix type required for that project.

4.2 Mix Production

- .1 Preparation of Mineral Aggregate
 - .1 The mineral aggregates shall be at as low a temperature as is consistent with proper mixing and lay down and in no case to exceed 165°C.
- .2 Composition of Mixture
 - .1 The mineral aggregate, reclaimed asphalt pavement (where applicable) and asphalt cement shall be mixed in a manner to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.
 - .2 Incorporate RAP such that it does not come in direct contact with the burner flame.
 - .3 Plant emissions shall not exceed the limits set by Alberta Environment.

4.3 Preparation for Paving

- .1 The Contractor shall provide the Engineer a minimum of six hours notice of the intention to commence paving over any previously approved primed or tacked surface.

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- .2 The hot asphalt mixture shall be laid upon a dry firm surface, true to grade and cross-section and free from all loose or foreign material. No hot mix shall be placed when the surface is wet or when other conditions prevent proper spreading, finishing or compaction.
- .3 If undercutting, and subsequent backfill with asphalt concrete is done, the backfill operation shall be performed sufficiently far ahead of the paving operation to allow the asphalt concrete time to cool down enough to support equipment.

4.4 Hot Mix Asphalt Placing Temperature

- .1 No hot mix asphalt shall be dispatched to the field unless the temperature, as issued by Environment Canada, is rising and meets the following minimum temperature requirements:
 - .1 Thickness less than 50mm, 7°C
 - .2 Thickness greater than 50mm, 2°C
- .2 A tolerance will be permitted for plant start-up.
- .3 No surface lift asphalt shall be placed regardless of temperature until the road surface is 5°C or higher.

4.5 Hours of Operation

- .1 No loads of hot mix asphalt shall be dispatched from the plant after sunset or during hours of darkness unless loads can be placed and compacted in accordance with these specifications, and suitable artificial illumination is provided, all subject to the engineer's approval.

4.6 Transportation of Hot Mix Asphalt

- .1 Trucks shall be equipped with tarpaulins of sufficient weights and size to cover the entire open area of the truck box. Regardless of weather conditions, tarpaulins shall be used.
- .2 Vehicles used for the transportation of hot mix asphalt from the plant to the site of work shall have tight metal boxes previously cleaned of all foreign matter. The inside surface may be lightly lubricated with a soap solution just before loading. Excess lubrication will not be permitted.
- .3 For purposes of checking asphalt mixture temperatures, trucks shall have an accessible 13 mm diameter hole drilled into the driver's side of the truck box, at a distance of 0.3 metres from the bottom of the box and 150 mm clear of the reinforcing ribs.
- .4 The speed and weight of hauling trucks shall be regulated so that, in the opinion of the Engineer, no damage will occur to any portion of the work underway. The Contractor at their own expense shall repair any damage to the tack coat, prime coat or the existing surface caused by the Contractor's equipment.

4.7 Hot Mix Asphalt Spreaders

- .1 The spreading machine shall be self-propelled and capable of placing a uniform layer of asphalt mix to the depth and grades as shown on the plans or as indicated by the Engineer.
- .2 The screed shall include a tamping bar or vibratory strike-off device for use when required. The screed shall strike-off the mix to the depth and cross-section specified and produces a finished surface of uniform texture.
- .3 Control of the screed shall be by automatic sensing devices. Longitudinal control shall be accomplished by a sensor, which follows a string line, ski, or other reference. The grade sensor shall be moveable and mounts provided so that grade control can be established on either side of the paver. A slope control sensor shall also

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be provided to maintain the proper transverse slope of the screed. Use automatic grade control for paving operations.

4.8 Hand Tools

- .1 Only lutes shall be used during the spreading operation and when the asphalt is worked by hand in areas in which the paver cannot reach.
- .2 Tamping irons may be used to consolidate the material along structures inaccessible to the rollers. Mechanical compaction equipment, satisfactory to the Engineer, may be used instead of tamping irons.
- .3 For purposes of checking the finished surface, Contractors must provide and carry on each paving machine a 3 metre straight edge and slope measuring level.

4.9 Pre-leveling for Asphalt Concrete

- .1 Pre-levelling of uneven surfaces over which asphalt concrete is to be placed shall be accomplished by the use of asphalt concrete placed with a grader, paver, hand or by a combination of these methods as directed by the Engineer.
- .2 After placement, the asphalt concrete used for pre-levelling shall be compacted thoroughly with pneumatic-tired rollers.

4.10 Paving Operations

- .1 The asphalt concrete shall be placed to the design thickness as shown on the contract drawings. On new construction where an established reference is lacking, a string-line reference will be required. Adjacent mats on the same lift are to be controlled by use of the grade sensor. No relaxation of the above procedure will be permitted without written approval of the Engineer.
- .2 The spreader shall be operated in such a manner as to distribute the asphalt concrete mix to proper cross-section, width and thickness without causing segregation of the mix. Segregated areas, which may occur, shall be corrected immediately. The forward motion of the spreader shall be controlled so that no irregularities in the pavement surface are caused by excessive speed. The rate of placement of the mixture shall be uniform and shall be co-ordinated with the production rate of the asphalt plant without intermittent operation of the spreader.
- .3 Any failure of the machine or operation to produce a smooth, uniformly dense mat, free from irregularities, shall be corrected immediately to the satisfaction of the Engineer.

4.11 Areas Inaccessible to the Paving Machine

- .1 Areas that are inaccessible to the paving machine may be paved by other methods, as approved by the Engineer.
- .2 In small areas or where the use of mechanical equipment is not practical, the mix may be spread and finished by hand. The asphalt mixture shall be dumped on the area and immediately thereafter distributed into place by shovels and spread with lutes in a loose uniform layer of uniform density and correct depth. Material must be handled so as to avoid segregation.

4.12 Compaction

- .1 The Contractor shall supply sufficient compaction equipment to:
 - .1 Provide a compaction rate that will equal or exceed the placing rate of the spreader.

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.2 Ensure the specified compaction is attained before the temperature of the mat falls below 80°C.

4.13 Longitudinal and Transverse Joints

- .1 Longitudinal and transverse joints shall be made in a manner consistent with industry standards. Coarse aggregate removed from the hot mix during joint preparation shall not be broadcast on to the mat.
- .2 Paving joints shall not be placed in the same vertical plane. Longitudinal joints shall be offset at least 150 mm and transverse joints shall be offset at least 2 m.
- .3 Longitudinal joints shall not be located within travel lanes, unless approved by the Engineer.
- .4 Edges where additional pavement is to be placed shall be vertically formed to true line. A lute shall be used immediately behind the paver when required to obtain a true line and vertical edge.
- .5 The exposed edges of all cold asphalt joints and the face of concrete curb and gutter shall be cleaned and painted with a thin coat of asphalt tack.
- .6 At the end of each day's paving of the surface course and upper lift of the base course mix, the uncompleted paving mats shall be provided with vertically cut transverse joints. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to ensure a thorough and continuous bond between the old and new surfaces.

4.14 Opening to Traffic

- .1 Prior to any application of traffic, paving mats shall be sufficiently cool to resist any deformation or surface scuffing.
- .2 The Engineer may, at their discretion, require means of cooling (e.g. application of water) completed pavements prior to opening to traffic.
- .3 At their discretion, the Engineer may prohibit traffic from traveling on newly paved surfaces for any length of time deemed necessary.

5.0 END PRODUCT ACCEPTANCE OR REJECTION

5.1 General

- .1 The Contractor shall provide an end product conforming to the quality and tolerance requirements of this specification. Where no tolerances are specified, the standard of workmanship shall be in accordance with accepted industry standards.
- .2 Acceptance of any Lot at full or increased payment will occur if there are no obvious defects and the Lot mean results for asphalt content, pavement density, air voids and thickness meet or exceed the specified tolerances.
- .3 Unit price reductions will only be applied on the basis on full acceptance testing in accordance with Table 3.4.4.

5.2 Asphalt Content

- .1 For full payment, the Lot Mean Asphalt Content must be within $\pm 0.30\%$ of the approved JMF value, as specified in Section 2.4.
- .2 Payment adjustment for asphalt content is as follows:

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Asphalt Content Deviation from JMF Value (%)	Payment Adjustment Factor
±0.30 or less	1.00
±0.31 to ±0.50	As per Chart A
Greater than ±0.50	Reject (Note 1)

Note 1: Subject to removal and replacement at the discretion of the Engineer.

5.3 Pavement Compaction

- .1 For full or increased payment, the Lot Mean Pavement Compaction must be equal to or greater than 93% of the Lot Mean Maximum Relative Density.
- .2 Payment adjustment for pavement compaction is as follows:

Pavement Compaction % of Maximum Relative Density	Payment Adjustment Factor
94.6 to 95.5 (Note 1)	1.03
93.5 to 94.5 (Note 1)	1.02
93.0 to 93.4	1.00
90.0 to 92.9	As per Chart B
Less than 90.0	Reject (Note 2)

Note 1: Where no individual test result is less than 93%, otherwise the payment adjustment factor is 1.00.

Note 2: Subject to removal and replacement at the discretion of the Engineer.

5.4 Air Void Content

- .1 For full payment, the Lot Mean Air Voids must be within ± 1.0% of the JMF value, as specified in Section 2.4.
- .2 Payment adjustment for air void content is as follows:

Air Void Content % Deviation from JMF Value	Payment Adjustment Factor
Less than 1.0	1.00
1.0 to 2.0	As per Chart C
Greater than 2.0 (Lower Lifts)	0.80
Greater than 2.0 (Upper Lifts)	0.60

5.5 Thickness (New Construction and Top Lift Only)

- .1 Pavement of any type found to be deficient in thickness by more than 13.0 mm shall be removed and replaced by pavement of specified thickness, at the Contractor's expense.
- .2 The Lot Mean Thickness for any Lot will be determined on the basis of the acceptance cores described in Table 3.4.4. Core thickness shall be determined in accordance with ASTM D 3549.
- .3 If the deficiency of any individual core exceeds 13 mm, additional cores may be extracted in the proximity to the location of the core of excessive deficiency, to identify the extremities of the pavement area subject to be removed and replaced. The Contractor shall pay for such additional coring.
- .4 For full payment, the Lot Mean Thickness must be equal to, or greater than, the specified thickness.
- .5 Payment adjustment for thickness is as follows:

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Average Thickness Compared to Specified Thickness	Payment Adjustment Factor (Note 1)	
	Total Thickness (Single or Multiple Lifts)	Top Lift Thickness (Multiple Lifts)
Compliant or Greater	1.00	1.00
1mm to 13mm Deficient	As Per Chart D	As Per Chart D
More than 13mm Deficient	Reject (Note 2)	Reject (Note 2)

Note 1: A single Thickness Payment Adjustment Factor shall be applied, Total Thickness or Top Lift Thickness, whichever results in the greatest adjustment.

Note 2: Subject to removal and replacement at the discretion of the Engineer.

5.6 Smoothness

- .1 The completed asphalt concrete surface shall be true to the dimensional and tolerance requirements of the specifications and drawings. Unless detailed otherwise in the contract documents, the tolerances in both profile and crown are:
 - .1 Base Course - 10 mm in 3 m
 - .2 Surface Course - 5 mm in 3 m
- .2 When deviations in excess of the above tolerances are found, the pavement surface shall be corrected by methods satisfactory to the Engineer. Correction of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances.

5.7 Segregation

- .1 The finished surface shall have a uniform texture and be free of segregated areas. A segregated area is defined as an area of the pavement where the texture differs visually from the texture of the surrounding pavement.
- .2 All segregation will be evaluated by the Engineer to determine repair requirements.
- .3 The severity of segregation will be rated as follows:
 - .1 Slight - The matrix of asphalt cement and fine aggregate is in place between the coarse aggregate particles, however there is more stone in comparison to the surrounding acceptable mix.
 - .2 Moderate - Significantly more stone than the surrounding mix, and exhibit a lack of surrounding matrix.
 - .3 Severe - Appears as an area of very stony mix, stone against stone, with very little or no matrix.
- .4 Segregated areas shall be repaired by the Contractor as directed by the Engineer. The following methods of repair are identified.
 - .1 Slight - Squeegee asphalt to completely fill the surface voids.
 - .2 Moderate - slurry seal for full mat width.
 - .3 Severe - removal and replacement or overlay.
- .5 All repairs shall be regular in shape and finished using good workmanship practices to provide an appearance suitable to the Engineer.
- .6 Any other methods of repair proposed by the Contractor will be subject to the approval of the Engineer.
- .7 Repairs will be carried out by the Contractor at their expense.

6.0 MEASUREMENT AND PAYMENT

6.1 Measurement

- .1 Asphalt Concrete supplied will be measured in square metres or tonnes of material placed, as detailed in the Tender Form.
- .2 The Unit Price for Asphalt Concrete shall be full compensation for all materials, labour, tools, equipment and incidentals necessary to complete the work in accordance with these specifications.
- .3 The material shall be scaled and recorded by the Contractor on duplicate weight slips. Weight slips must be supplied at the time of delivery and a copy supplied to the Engineer.
- .4 The weight scale shall be inspected and certified by Weights and Measures Inspection Services of the Federal Department of Consumer and Corporate Affairs, at the Contractors' expense and as often as the Engineer may direct.

6.2 Payment

- .1 The Unit Price applicable to each Lot quantity of asphalt concrete will be calculated as follows:

$$\text{LOT UNIT PRICE} = \text{CONTRACT UNIT PRICE} \times \text{PAAC} \times \text{PACOM} \times \text{PAAV} \times \text{PAT}$$

Where:

PA_{AC} = Asphalt Content Payment Adjustment

PA_{COM} = Compaction Payment Adjustment

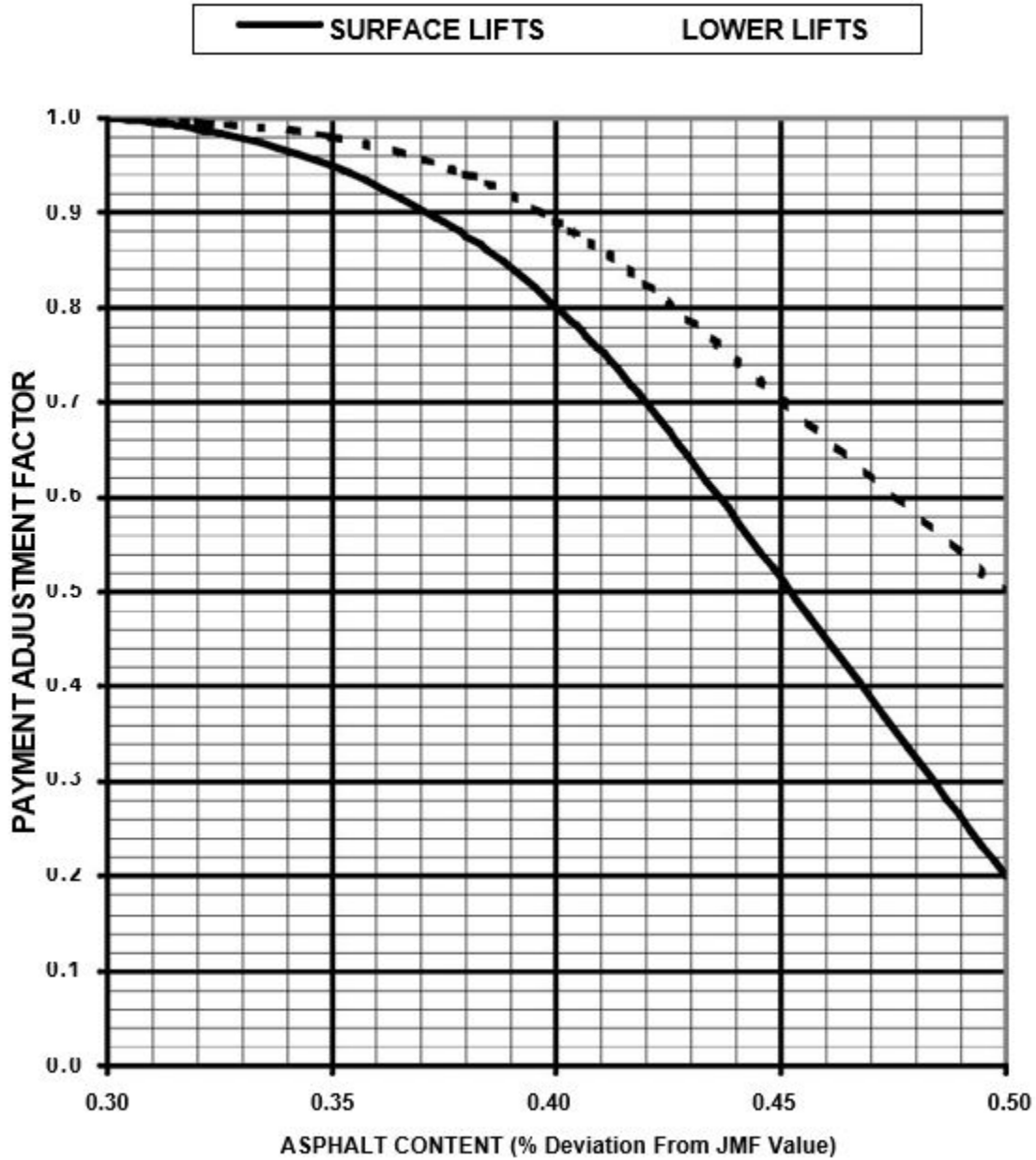
PA_{AV} = Air Void Payment Adjustment

PA_{T} = Thickness Payment Adjustment

- .2 Performance Grade Asphalt Cement shall be considered incidental to the unit price for asphalt concrete.

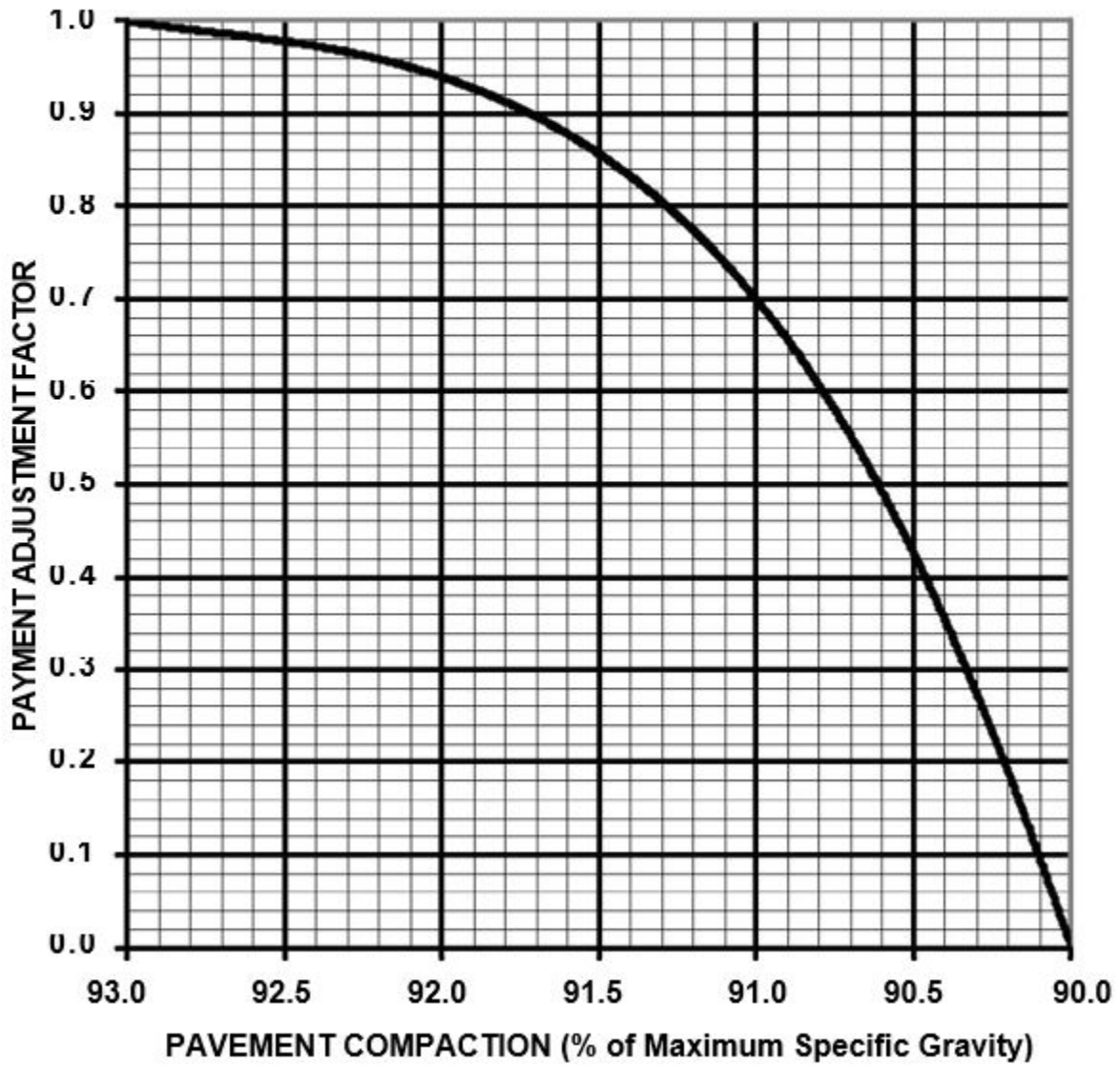
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CHART A
ASPHALT CONTENT
PAYMENT ADJUSTMENT FACTOR



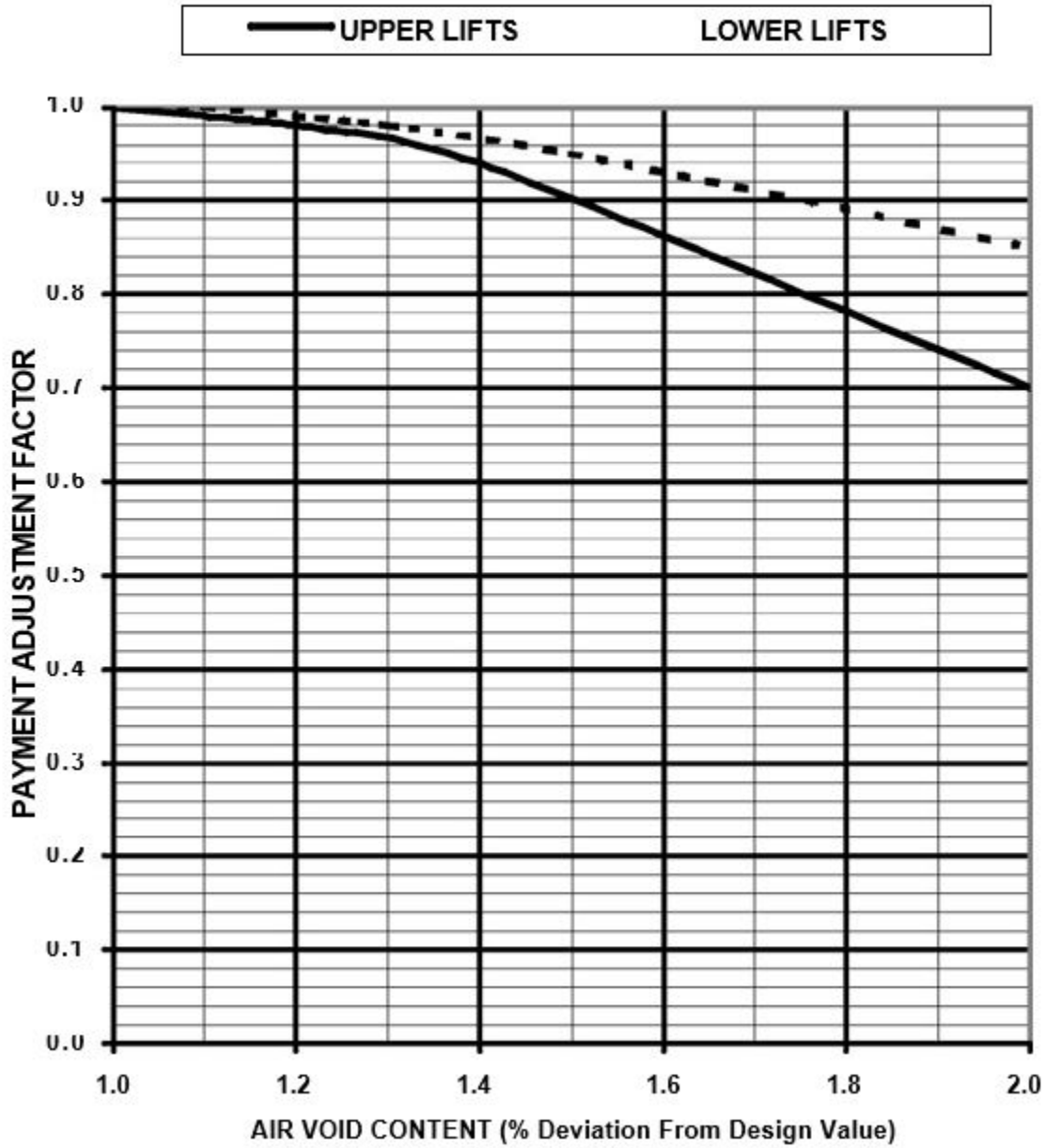
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CHART B
COMPACTION
PAYMENT ADJUSTMENT FACTOR



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CHART C
AIR VOID CONTENT
PAYMENT ADJUSTMENT FACTOR



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CHART D
AVERAGE THICKNESS
PAYMENT ADJUSTMENT FACTOR

