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PART 1 – GENERAL

This specification covers the supply and transportation of various grades of Performance Graded Asphalt Binder (PGAB) to the Contractor’s plant for use in the manufacturing of hot mix asphaltic concrete.

This standard does not address any safety concerns related to the use of its contents. It is the responsibility of the user of this specification to establish appropriate safe work practices applicable to the work detailed within.

1.1 Work Included

PGAB shall be comprised of asphaltic-based cement that is produced from petroleum residue either with or without the addition of non-particulate organic modifiers.

Quality Control (QC) and Quality Assurance (QA) procedures are described herein. The Contractor shall be responsible to submit the QC test results and to ensure that all materials meet specification.

Initial acceptance of PGAB shall be based on samples taken and tested by the supplier’s designated laboratory, subject to the conditions detailed in this specification.

To determine final acceptance of the product, the Engineer will conduct QA testing to confirm QC test results supplied by the Contractor. QA testing will be conducted on a random basis from samples recovered from the Contractor’s asphalt storage tank(s) located at the hot mix plant.

1.2 Related Sections

The latest editions of the following shall apply to this specification.

- .1 Specification for Hot-Mix Asphalt Concrete S-1

1.3 Reference Standards

- .1 AASHTO M 332, Standard Specification for Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery
- .2 ASTM D 140, Standard Practice for Sampling Asphalt Materials
- .3 ASTM D 4402, Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer

PART 2 - SUBMISSIONS AND DESIGN REQUIREMENTS

2.1 Contracts Completed in Calendar Year

For each grade of PGAB specified in the Contract, the Contractor shall supply the following items to the Engineer annually, and at any time when a change occurs:

- The PGAB Supplier and the facility type and location that the product will be supplied from.
- Applicable mixing compaction temperatures for the product.
- Documentation of construction, storage and handling requirements, including the material safety data sheet, recompaction temperature, mix discharge temperature, and recommended extraction procedure.
- When the asphalt cement contains any zinc oxide or iron carboxylates or a combination, added as Hydrogen Sulphide (H₂S) scavengers, they must be declared.
- When the PGAB contains any polyphosphoric acid (PPA) and a liquid anti-stripping additive is incorporated into the PGAB at the PGAB suppliers depot:
 - Information on how much anti-stripping additive was added to the PGAB
 - Documentation from the PGAB supplier stating that the PPA modified PGAB with the liquid anti-stripping additive added at the PGAB supplier's depot shall meet all asphalt cement material requirements specified in the Contract Documents including AASHTO M 332 for the PGAB grade specified.

In the event that the Contractor wishes to change the source of supply during the progress of the Contract, the Contractor shall apply for approval, in writing, to the Engineer. The application for change in source shall include all the documentation required above. Approval in writing must be given by the Engineer before the source of supply is changed.

Asphalt escalation/de-escalation shall be as per S-1 - Specification for Hot Mix Asphalt Concrete.

PART 3 - MATERIALS

3.1 Physical Requirements

The PGAB as outlined in Table 2 shall conform (**with or without liquid anti-stripping additive**, or other approved additives) to the

requirements of AASHTO M332 for the performance grade specified in the contract. In addition to the requirement of AASHTO M 332 and Table 2, the PGAB required in the contract shall comply with the additional requirements detailed in Table 3.

3.2 General Requirements

The PGAB shall be homogeneous, free of water and any contamination and shall not foam when heated to the temperatures specified by the manufacturer for the safe handling and use of the product.

PGAB shall not contain more than 0.3% PPA or 0.3% elemental sulfur (S) in addition to the typical sulfur that is naturally present in the asphalt binder, and these shall only be used as catalysts for the purpose of modification with epoxy (E)-type or styrene-butadiene (SB)-type polymer modifiers. PGAB shall not contain any orthophosphoric acid.

PGAB shall not be air blown or catalytically oxidized in any manner. PGAB shall not contain any air blown or catalytically oxidized residues.

The PGAB shall not contain any of the following additives added for PGAB modification: atactic polypropylene; carbon black polyisobutylene; polyisoprene; natural rubber; alkaline bases; insoluble particulates or fibres; salts of iron, copper, manganese and/or cobalt; silicates; styrene-butadiene rubber (random copolymer latex); synthetic waxes (paraffin waxes, naphthenic waxes); synthetic and saturated oils (including but not limited to the following: vegetable oils or modified vegetable oils; (paraffin oils, polyalphaolefins (PAO), lube oils, and re refined lube oils.); waste oils (including but not limited to the following: cracked residues, re-refined high vacuum distillate oils; tall oils, vacuum tower asphalt extenders; waste cooking oils, waste engine oils, waste engine oil residues, re-refined engine oil residue (REOB)). **The PGAB supplier shall declare in writing that they have not added the PGAB additives listed above.**

If modifiers or additives other than styrene-butadiene (e.g., SB diblock, SBS triblock, SBS radial, SBS high vinyl, SB tapered, etc.) or epoxy-type (e.g. reactive elastomeric terpolymers) polymers are used for the modification of neat asphalt cement, pre-approval from the Engineer is required.

PART 4 - CONSTRUCTION METHODS

4.1 Tankers, Storage Tanks Tankers used to transport PGAB and PGAB storage tanks located at asphalt concrete mixing plants shall meet the following requirements:

- Be free from hydrocarbon fuels or solvents, such as gasoline, diesel, varsol, etc.;
- Have a sampling spigot as outlined in ASTM D 140; and
- Be equipped with thermometers, accurate and capable of reading to the nearest 2°C.

PART 5 - QUALITY CONTROL / QUALITY ASSURANCE

5.1 PGAB Documentation

For each grade of PGAB specified in the Contract, the Contractor shall supply a copy of current test data to the Engineer prior to the use of the product(s). The PGAB shall have been graded by conducting the required testing specified in AASHTO Designation M 332 (Standard Specification for Performance Graded Asphalt Binder) and the additional tests required in Table 3 of this specification.

5.2 Laboratory Testing Qualifications

The laboratory conducting the QC and QA testing shall have participated in the most recent AASHTO proficiency sample correlation program for PGAB and shall have obtained proficiency ratings in the program satisfactory to the Engineer. Alternatively, the laboratory shall have satisfactorily participated in any equivalent correlation program acceptable to the Engineer. Documentation of the laboratory's participation and proficiency shall be provided to the Engineer upon request.

5.3 Anti-Stripping Additive

When a liquid anti-stripping agent is to be incorporated into the mix, samples of PGAB for QC and QA are to be taken after the anti-stripping agent has been added to the PGAB.

5.4 Samples for Testing

All QA samples shall be a minimum size of one litre and shall be taken from the Contractor's storage tank in accordance with ASTM D 140. Sampling will be conducted by the Contractor and witnessed by the Engineer. For each QA testing sample that is required to be taken, as instructed by the Engineer, an additional

sample shall be taken by the Contractor and provided to the Engineer in the event an appeal test is required. PGAB sampling will be based on a random basis determined by the Engineer.

The Engineer will verify the sampling, packaging, and transport of all samples (including set-aside samples) for QA testing.

5.5 Quality Control Plan

The Contractor shall provide a QC Plan to the Engineer detailing the QC activities related to the use of PGAB. The Supplier's QC Plan may be used for this purpose, provided that specific storage/handling details, are furnished by the Contractor. The QC Plan shall be submitted at least seven (7) days prior to the start of the construction season. Hot mix asphalt production shall not commence until the QC Plan is accepted by the Engineer.

As a minimum, the QC Plan shall provide the following information:

- The type of facility from which the product(s) will be supplied (refinery, terminal) and its location.
- The method and frequency for initial testing, specification compliance testing and any other testing employed to either guide the manufacturing process of the PGAB or to ensure the on-going compliance of the product(s) to Table 2.
- If specification compliance testing is carried out prior to shipping the product(s) from the Supplier's facility to the hot mix asphalt plant, the QC Plan shall provide an outline of the procedures to be followed for checking transport vehicles before loading to prevent contamination of shipments.
- The QC Plan shall provide an outline of procedures detailing how anti-strip additive products and dosage rates will be identified on shipping documentation. Tests employed to ensure compliance of the product(s) to Table 2 and Table 3, after anti-strip additives are incorporated in the product(s), shall be identified in the QC plan.
- The QC Plan shall detail the methods to be used to identify and provide for the exclusion of materials which do not conform to specifications, prior to incorporating into the asphalt mix. The QC Plan shall also detail how such materials will be identified and dealt with if they are inadvertently incorporated into the asphalt mix. The QC Plan shall detail how such occurrences

will be documented, and the methods of disposition of such materials.

5.6 Acceptance

.1 Lot Sizes

Each grade of PGAB in a tender will be a Lot. A change of the source of the PGAB will result in a new Lot.

.2 Quality Control

Initial acceptance of PGAB will be based on QC test results submitted by the Contractor, subject to the conditions specified herein. The Contractor shall be responsible to submit the Supplier's QC test result data for each Lot of PGAB, as described below. The PGAB shall meet the requirements of AASHTO M 332 for the specified performance grade and the additional requirements noted in Table 3 of this specification.

.3 Quality Assurance

At the discretion of the Engineer, QA testing will be carried out for a Lot of PGAB for the purposes of verifying QC testing results to ensure that the materials used in the work conform to the quality requirements of Table 2 and Table 3.

When requested by the Engineer, one PGAB sample shall be obtained from the plant for a Lot. All samples shall be appropriately labeled (date, time, contract, PGAB type, anti-stripping agent type/dosage) and delivered to the Engineer within 48 hours of sampling.

If a QA test result for any sample indicates non-compliance with this specification, the Engineer will advise the Contractor of the test result and may conduct a true grade classification to determine the actual high and low temperature grade of the sample, rounded to the nearest 0.5°C.

Test results for lots which do not comply with the performance grading requirements shall be categorized based on individual deviations from the design maximum or minimum temperature defined below. Price adjustments,

where applicable, will be expressed as a percentage of the Contractor's unit bid price for the hot mix within the lot.

Table 1 – Price Adjustment	
Temperature Deviation	Price Adjustment (% of Mix Price)
≤ 3°C	10 %
> 3 & ≤ 6°C	20 %

.4 Price Reduced / Rejected Lots

The Engineer will review the test results and determine the disposition of the mix using any PGAB product which does not conform to Table 2 and Table 3. Hot mix constructed using PGAB for which test results indicate that the product did not conform to specification will be dealt with as follows:

Price Reductions: As per the above table

Rejection: The Engineer reserves the right to reject all asphalt concrete mix produced with PGAB lot temperature deviations exceeding 6°C from the specified minimum and maximum temperature grade. Rejected lots shall be removed and replaced at the Contractor's expense.

For rejected lots the full thickness of the asphalt lift of pavement shall be removed by cold milling. The hot mix used to replace the rejected pavement shall meet the same requirements as those originally specified. Repair areas will be retested for acceptance with the cost of retesting to be borne by the Contractor.

5.7 Appeal Testing

The Contractor shall serve notice of appeal to the Engineer, in writing, within 5 business days of receipt of the QA test results. Appeal re-testing may be carried out on set-aside samples only if the cost of the impact of non-compliance, as determined by the Engineer, exceeds the cost of retesting.

The Contractor may have a representative present during testing at HRM's QA facility. During the period of testing, the Contractor's representative shall comment on anything concerning the testing

which they do not consider to be valid, and the Engineer shall respond to all comments to resolve them. All comments shall be presented in writing and shall be responded to be writing.

The appeal testing will determine the actual performance high and low temperatures, rounded to the nearest 0.5°C, of the PGAB, and the outcome is binding on HRM and the Contractor.

The cost of the appeal testing, including sample delivery, shall be borne by the Contractor unless the testing confirms total conformance of the material sample to contract specifications, in which case the cost will be borne by HRM.

PART 6 – MEASUREMENT FOR PAYMENT

6.1 General

- .1 Payment for all works carried out in accordance with this specification will be paid for per the payment items detailed in Section 01 22 00 Measurement and Payment, of the Contract.

Table 2 – Performance Graded Asphalt Binder Specification					
Performance Grade	PG-58				
	-16	-22	-28	-34	-40
Average 7-day Maximum Pavement Design Temperature, °C ⁽¹⁾	<58				
Minimum Pavement Design Temperature, °C	>-16	>-22	>-28	>-34	>-40
Original Binder					
Flash Point Temperature, T48: Minimum °C ⁽¹⁾	230				
Viscosity, ASTM D 4402: ⁽²⁾ Maximum, 3 Pa.s (3000cP) Test Temperature, °C	135				
Dynamic Shear, TP5 ⁽³⁾ G* $\sin\delta$ ⁽⁴⁾ , Minimum, 1.00 kPa Test Temperature @ 10 rad/s, °C	58				
Rolling Thin Film Oven (T240)					
Mass Loss, Maximum %	1.0				
Dynamic shear, TP5: G*/ $\sin\delta$ ⁽⁴⁾ , Minimum, 2.20 kPa Test Temperature @ 10 rad/s, °C	58				
MSCR, AASHTO T350 Standard Traffic, "S" J _{nr3.2} , max 4.5 kPa ⁻¹ J _{nrdiff} , max 75.0% Test Temperature, °C	58				
MSCR, AASHTO T350 Heavy Traffic, "H" J _{nr3.2} , max 2.0 kPa ⁻¹ J _{nrdiff} , max 75.0% R _{3.2} ⁽⁵⁾ Test Temperature, °C	58				
MSCR, AASHTO T350 Very Heavy Traffic, "V" J _{nr3.2} , max 1.0 kPa ⁻¹ J _{nrdiff} , max 75.0% R _{3.2} ⁽⁵⁾ Test Temperature, °C	58				
MSCR, AASHTO T350 Extremely Heavy Traffic, "E" J _{nr3.2} , max 0.5 kPa ⁻¹ J _{nrdiff} , max 75.0% R _{3.2} ⁽⁵⁾ Test Temperature, °C	58				
Pressure Aging Vessel Residue (R28)					
PAV Aging Temperature, °C ⁽⁶⁾	100				

Table 2 – Performance Graded Asphalt Binder Specification					
Performance Grade	PG-58				
	-16	-22	-28	-34	-40
Dynamic shear, TP5: G* $\sin\delta$ ⁽⁴⁾ , Maximum, 5000 kPa Test Temperature @ 10 rad/s, °C	25	22	19	16	13
Physical Hardening ⁽⁷⁾	Report				
Creep Stiffness, TP1 ⁽⁸⁾ S, Maximum, 300 Mpa m-value, Minimum, 0.300 Test Temperature, @ 1.0 mm/min, °C	-6	-12	-18	-24	-30
Direct Tension, TP3: ⁽⁸⁾ Failure strain, Minimum, 1.0% Test Temperature @ 1.0 mm/min, °C	-6	-12	-18	-24	-30

- (1) Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program and may be provided by the specifying agency, or by following the procedures as outlined in MP2 and PP28.
- (2) 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.
- (3) For quality control of unmodified PGAB production, measurement of the viscosity of the original PGAB may be used to supplement dynamic shear measurements of G*/ $\sin\delta$ at test temperatures where the asphalt is a Newtonian fluid.
- (4) G*/ $\sin\delta$ = high temperature stiffness, and G* $\sin\delta$ = intermediate temperature stiffness.
- (5) The following minimum percent recovery values shall be provided for asphalt binders carrying Heavy Traffic “H”, Very Heavy Traffic “V”, and Extremely Heavy Traffic “E”:
 - Heavy Traffic “H”: R_{3.2} ≥ 30.0%
 - Very Heavy Traffic “V”: R_{3.2} ≥ 35.0%
 - Extremely Heavy Traffic “E”:
 - For 0.25 kPa⁻¹ < J_{nr3.2} ≤ 0.5 kPa⁻¹: R_{3.2} ≥ 45.0%
 - For J_{nr3.2} ≤ 0.25 kPa⁻¹: R_{3.2} ≥ 55.0%
- (6) 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 PG58- and above, except in desert climates, where it is 110°C.
- (7) Physical Hardening - TP1 is performed on a set of asphalt beams according to Section 13.1, except that the conditioning time is extended to 24 hrs ± 10 minutes at 10°C above the minimum performance temperature. The 24-hour stiffness and m-value are reported for information purposes only.
- (8) 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.

Property/Attribute	Test Method	PGAC Grade	Requirement
Ash Content	ASTM D8078	All PGAB Grades	≤ 0.6
Low Temperature Limiting Grade (°C)	MTO LS 308	All PGAB Grades	≤ -28
Grade Loss (°C)		XX-28	≤ -6.0
Crack Tip Opening Displacement (mm)	MTO LS 299	All PGAB Grades	≥ 10.0