

**Amendment to OPSS.MUNI 1101 (Nov 2016) –
Material Specification for
Performance Graded Asphalt Cement**

1101.02 REFERENCES

Section 1101.02 of OPSS.MUNI 1101 is amended by the addition of the following:

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

LS-284 Recovery of Asphalt from Solution by Abson or Rotavapor

ASTM International

D 7906-14 Recovery of Asphalt from Solution Using Toluene and the Rotary Evaporator

American Association of State Highway and Transportation Officials (AASHTO)

R 28-12 UL Standard Practice for Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

1101.03 DEFINITIONS

Section 1101.03 of OPSS.MUNI 1101, the existing definitions for the low temperature performance graded and PGAC are deleted in its entirety and replaced with the following:

Low Temperature Performance Grade (-YY) means the low temperature performance grade specified elsewhere in the Contract Documents, also referred to as the -YY specified for the performance graded asphalt cement where the PGAC grade specified is PG XX-YY, and equal to the minimum pavement design temperature.

Performance Graded Asphalt Cement (PGAC) means an asphalt binder that is produced from petroleum residue, modified using polymers, according to the latest version of AASHTO M 320 or M 332.

Section 1101.03 of OPSS.MUNI 1101 is amended by the addition of the following:

Recovered Performance Graded Asphalt Cement (PGAC) means an asphalt binder that has been extracted and recovered from the loose hot-mix asphalt (HMA) or from samples saw cut from the finished pavement.

1101.04 DESIGN AND SUBMISSION REQUIREMENTS

1101.04.01 Submission Requirements

1101.04.01.01 PGAC Test Documentation

Clause 1101.04.01.01 of OPSS.MUNI 1101 is amended by the addition of the following:

- f) Grade and grade loss according to LS-308 along with a copy of all LS-308 documentation.
- g) Average of the critical crack tip opening displacement (δt) as determined according to LS-299 along with a copy of all LS-299 documentation.
- h) A 2-litre sample of the tank asphalt cement for each grade according to Table 2 for possible Owner testing.
- i) Test results for the product demonstrating compliance to the requirements of the Contract Documents.

The mix shall not be placed until the Contract Administrator gives a written confirmation of conformance of the PGAC based on the submitted test results and Owner testing to the requirements of the Contract Documents.

Within 15 Days, commencing the day all submission deliverables have been received, the Contract Administrator shall provide the above confirmation or advise the Contractor of any non-conformance to the contract requirements. Confirmation of conformance to Contract requirements of the submissions does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of materials and workmanship.

1101.08 QUALITY ASSURANCE

1101.08.03 Sampling

Subsection 1101.08.03 of OPSS.MUNI 1101 is deleted in its entirety and replaced with the following:

The Contract Administrator shall determine the frequency of sampling and testing based on the HMA tender quantity for each grade of PGAC. PGAC and HMA shall be sampled when notified by the Contract Administrator. Sample containers shall be supplied by the Contractor. Sample quantities, labelling, and delivery requirements shall be as shown on Table 2. Samples shall be delivered in a condition suitable for testing.

A minimum of one HMA sample shall be taken for each 500 tonnes of HMA placed.

The QA and referee samples for possible Owner testing shall be taken at the same time.

All samples shall be obtained by the Contractor in the presence of the Contract Administrator's representative according to AASHTO T 40, ASTM D 3665, and the asphalt mix plant's health and safety plan. The asphalt mix plant's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

All PGAC tank sample shall be obtained during the production of the asphalt mix inside the asphalt mix plant from the storage tank which is directly feeding the production of the asphalt mix.

All loose HMA samples shall be obtained directly from the paving equipment during the construction of the pavement.

1101.08.04 Quality Assurance Testing

Subsection 1101.08.04 of OPSS.MUNI 1101 is deleted in its entirety and replaced with the following:

When the Contract Administrator elects to carry out QA testing, one of the samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing. QA testing will be evaluated against the requirements as specified in the Contract Documents.

Test results for samples that do not comply with the PGAC grading and the additional requirements of Table 1 shall be categorized as borderline or rejectable. PGAC shall be categorized based on the test result's deviation from: (i) the individual design maximum or minimum pavement temperature and the sum of the deviations from the design maximum or minimum pavement temperatures; (ii) the LS-299 CTOD acceptance criterion; and (iii) the LS-308 grade and grade loss criteria, given in Table 1. The actual AASHTO M 320 performance grading that is either higher than the design maximum pavement temperature or lower than the design minimum pavement temperature is not considered a deviation.

When a sample does not comply with more than one property, attribute, or PG grading, as specified in Table 1, acceptance of the HMA shall be dealt with using the property, attribute, or PG grading selected by the Owner.

The Owner may conduct elemental testing according to ASTM D7343 or other tests to determine if the PGAC meets the material requirements as specified in the Materials section.

If a test result for any sample indicates non-compliance to the specification, the Contract Administrator shall advise the Contractor of the test results. The Contract Administrator shall have 30 Days from the time of sample delivery by the Contractor to complete and provide each set of test results to the Contractor.

For any single day of paving with more than two borderline results for AASHTO M 320, LS-299 and LS-308 for two separate samples, the production for the entire day shall be rejectable.

1101.08.05 Disposition of HMA Produced with PGAC Not Conforming with the Requirements of the Contract Documents

Subsection 1101.08.05 of OPSS.MUNI 1101 is amended by the addition of the following:

The Owner's review of the test results to determine disposition of the HMA produced shall include all additional testing requirements for which acceptance requirements have been specified.

Subsection 1101.08.05 of OPSS.MUNI 1101 is amended by the deletion of the third paragraph in its entirety and replaced by the following:

Rejectable: The HMA shall not be accepted into the Work. The Contract Administrator shall notify the Contractor in writing within 12 Days of receipt of the non-conforming data. The Contractor has the option of either removing the HMA from the Work and replacing it with acceptable HMA or invoking referee testing. The Contractor may request a reduced price in-lieu of removal of the HMA. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1101.08.06 Referee Testing

Subsection 1101.08.06 of OPSS.MUNI 1101 is amended by the deletion of the first paragraph in its entirety and replaced with the following:

Referee testing by an independent laboratory may be invoked by the Contractor for any sample of PGAC or recovered PGAC within 5 Days of receiving all of the QA test results for the sample, provided the Contractor has taken and delivered all referee samples in a condition suitable for testing.

Table 1 of OPSS.MUNI 1101 is deleted in its entirety and replaced with the following:

Table 1 – Additional asphalt testing requirements and acceptance criteria for PGAC grades

PGAC Grade	Property and Attributes (Unit)	Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Borderline	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	LS-227	0.1	≤ 0.6	N/A	> 0.6
All PGAC Grades except PG 58-28 and PG 52-24	PGAC Grade (PG XX-YY)	ASTM 7643	0.1	XX $> [64 \text{ or } 70]$ and YY < -28	Individual XX and YY deviations ≤ 3.0 and the sum of deviations is ≤ 3.0	Individual XX and YY deviations > 3.0 or the sum of deviations > 3.0
	Non-recoverable creep compliance at 3.2 kPa (J _{nr-3.2}) (kPa ⁻¹)	Multiple Creep and Recovery (MSCR) testing according to AASHTO TP 70 testing conducted at a temperature of 58°C (Zone 3)	0.01	< 4.0	N/A	≥ 4.0
	Average percent recovery at 3.2 kPa (R _{3.2}) (%)		0.1	$> \text{the lesser of } [(29.371) (J_{nr-3.2})^{-0.2633}] \text{ or } 55$	N/A	$\leq \text{the lesser of } [(29.371) (J_{nr-3.2})^{-0.2633} - 10] \text{ or } 50$
	Average critical crack tip opening displacement (CTOD or δ_t) (mm)	LS-299	0.1	≥ 10.0	< 10.0 and ≥ 8.0	< 8.0
	Maximum Grade Loss with reference to the 1-hour results at -YY + 10 (°C)	LS-308, 72-hour results at -YY + 10	0.1	≤ 6.0	> 6.0 and ≤ 7.0	> 7.0
		LS-308, 72-hour results at -YY + 20	0.1	≤ 4.0	> 4.0 and ≤ 6.0	> 6.0
	Limiting Grade (°C)	LS-308	0.1	≤ -28	N/A	> -28

Note: The test results from recovered asphalt cement are carried out for information purposes only. Notes 1, 2, and 3 are applicable to City staff only.

Note 1 Test method ASTM 7643, AASHTO TP70, LS-299 and LS-308 shall be performed on PGAC extracted and recovered from the loose HMA samples taken during construction of the pavement or from samples saw cut from the finished pavement.

Note 2: Recovered samples shall be used in place of rolling thin film oven (RTFO) residues and only further aged in the pressure aging vessel (PAV) for the purpose of AASHTO M320, LS-299 and LS-308 grading.

Note 3: All recovered PGAC samples shall be obtained by extraction using reagent grade dichloromethylene (DCM), trichloroethylene (TCE), or toluene, from loose hot-mix asphalt or from saw cut samples from the finished pavement. Fines shall be removed from the solution prior to recovery using a high speed centrifuge method. Recovery shall be under a nitrogen atmosphere according to the Rotavapor method in LS-284 or ASTM D7906.



MATERIAL SPECIFICATION FOR PERFORMANCE GRADED ASPHALT CEMENT

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1101.01	SCOPE
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This specification covers the requirements for the properties and use of performance graded asphalt cements.

1101.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

1101.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

1101.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-227	Determination of Ash Content
LS-299	Determining Asphalt Cement's Resistance to Ductile Failure Using Double Edge Notched Tension Test (DENT)
LS-308	Determination of Performance Grade of Physically Aged Asphalt Cement Using Extended Bending Beam Rheometer (BBR) Method

ASTM International

D 3665-12	Standard Practice for Random Sampling of Construction Materials
D 7343-12	Standard Practice for Optimization, Sample Handling, Calibration, and Validation of X-ray Fluorescence Spectrometry Methods for Elemental Analysis of Petroleum Products and Lubricants

American Association of State Highway and Transportation Officials (AASHTO)

M 320-10	Standard Specification for Performance Graded Asphalt Binder
M 332-14	Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test
R 29-14	Grading or Verifying the Performance Grade of an Asphalt Binder

T 40-02 (2012) Sampling Bituminous Materials
T 350-14 Standard Method of Test for Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

1101.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Asphalt Binder means modified or unmodified asphalt cement.

CTOD means Critical Crack Tip Opening Displacement as defined in LS-299.

Hot Mix Asphalt (HMA) means as defined in OPSS 310.

Independent Laboratory means a third party laboratory that is not owned or corporately affiliated with the laboratory that prepared the mix design or with the Contractor.

Low Temperature Limiting Grade (LTLG) means the warmest of the Limiting Grades, T_L , obtained for 1 hour, 24 hours, 72 hours and the two conditioning temperatures according to LS-308, and Form B of LS-308.

Low Temperature Performance Grade (-YY) means the low temperature performance grade of PGAC specified in the Contract Documents where the PGAC grade specified is PGAC XX-YY.

Performance Graded Asphalt Cement (PGAC) means an asphalt binder that is produced from petroleum residue, either with or without the addition of non-particulate modifiers and meets the requirements of AASHTO M 320 or M 332.

PGAC XX-YY means PGAC with XX being the high temperature performance grade and -YY being the low temperature performance grade, as specified elsewhere in the Contract Documents, and meets the requirements of AASHTO M 320.

PGAC XXS-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for standard traffic level, as specified in the Contract Documents, and meets the requirements of AASHTO M 332.

PGAC XXH-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for high traffic level, as specified elsewhere in the Contract Documents, and meets the requirements of AASHTO M 332.

PGAC XXV-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for very high traffic level, as specified in the Contract Documents, and meets the requirements of AASHTO M 332.

PGAC XXE-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for extreme traffic level, as specified in the Contract Documents, and meets the requirements of AASHTO M 332.

Recompaction Temperature means the temperature to which plant produced mix is to be reheated for testing purposes and shall be the same as the laboratory mix design compaction temperature.

1101.04 DESIGN AND SUBMISSION REQUIREMENTS

1101.04.01 Submission Requirements

1101.04.01.01 PGAC Test Documentation

For each grade of PGAC specified in the Contract Documents, the Contractor shall supply the following items to the Contract Administrator at least 14 Days prior to the first use of each product:

- a) The PGAC supplier and the facility type and location that the product shall be supplied from.

- b) Applicable mixing and compaction temperatures for the product.
- c) Documentation of construction, storage and handling requirements, including the material safety data sheet, recompaction temperature, mix discharge temperature, and recommended extraction procedure.
- d) When the asphalt cement contains any zinc oxide or iron carboxylates or a combination, added as a Hydrogen Sulfide (H₂S) scavengers, they must be declared.
- e) When the PGAC contains any polyphosphoric acid (PPA) and a liquid anti-stripping additive is incorporated into the PGAC at the PGAC supplier's depot:
- i. Information on how much anti-stripping additive was added to the PGAC.
- ii. Documentation from the PGAC supplier stating that the PPA modified PGAC with the liquid anti-stripping additive added at the PGAC supplier's depot shall meet all asphalt cement material requirements specified in the Contract Documents including AASHTO M 320 for the PGAC grade specified.

1101.05 MATERIALS

PGAC shall be according to AASHTO M 320 for the performance grades specified in the Contract Documents when tested using the methods designated in AASHTO R 29, section Test Procedure for Verifying the Nominal Grade of an Asphalt Binder.

PGAC 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. Silicone oils are allowed as anti-foaming agents at less than five parts per million. Zinc oxide and iron carboxylates may be used as hydrogen sulfide (H₂S) scavengers..

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

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

The asphalt cement shall not contain any of the following additives added for PGAC 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). Asphalt cement supplier shall declare in writing that they have not added the PGAC 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 Owner is required.

Organic bases may be contained in the PGAC provided they are used as anti-stripping or warm mix additives or both. If any of the above additives are present in anti-stripping and/or warm mix asphalt additives, they shall be declared at the time of mix submission.

PGAC grades shall meet the additional requirements shown in Table 1.

PGAC shall be shipped, used, and handled at all times in accordance with the manufacturer's specifications.

1101.07 PRODUCTION

1101.07.01 Sampling and Testing

Sampling shall be as described in the Quality Assurance section.

1101.08 QUALITY ASSURANCE

1101.08.01 Basis of Acceptance

Material acceptance of asphalt cement for performance grading and the properties and attributes shown in Table 1 shall be determined by the Owner based on QA test results conducted by the Owner's designated laboratory, unless superseded by referee test results, according to the requirements of the Contract Documents.

The Contractor shall be provided with test results from the tests that are completed.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in the Contract Documents.

The Owner may conduct elemental testing according to ASTM D7343 or other tests to determine if the asphalt cement meets the material requirements as specified in the Materials section.

1101.08.01.01 Laboratory Requirements

The laboratory conducting PGAC testing shall have participated in the most recent AASHTO Materials Reference Laboratory proficiency sample correlation program for PGAC and the most recent MTO correlation for all PGAC testing to be carried out. All QA and referee labs shall be CCIL certified for the tests required.

1101.08.02 Anti-Stripping Additive

The Contractor may request that an allowance be made for the impact of the anti-stripping additive on a PGAC grade for QA or referee purposes provided that:

- a) It was not added at the supplier depot to a PGAC containing polyphosphoric acid (PPA); and that
- b) When production begins the Contractor submits to the Contract Administrator complete AASHTO M 320 test results rounded to the nearest 0.5 °C for the following:
 - i. Asphalt cement with anti-stripping additive at the percentage identified in the mix design.
 - ii. Asphalt cement without the anti-stripping additive.

1101.08.03 Sampling

The Contract Administrator shall determine the frequency of sampling and testing for each grade of PGAC based on the HMA tender quantity. The Contract Administrator shall determine the quantity and location of HMA to be represented by each PGAC sample. When only one sample is taken on the job, the sample shall be deemed to represent all HMA placed on the Contract with that PGAC grade. All samples shall be obtained during the production of the asphalt mix at the asphalt mix plant from the storage tank which is directly feeding the production of the asphalt mix according to AASHTO T 40 and the asphalt plant's health and safety plan. The asphalt plant's health and safety plan and procedure for sampling shall be reviewed in advance. The QA, referee, and other required samples for possible Owner testing shall be taken at the same time.

PGAC shall be sampled when notified by the Contract Administrator.
Sample quantity, labelling and delivery requirements shall be according to Table 2. Samples shall be delivered in a condition suitable for testing.

1101.08.03.01 Switching Performance Grade or Source of Supply

The Contract Administrator shall be advised in writing whenever there is a change in performance grade or source of supply.

1101.08.04 Quality Assurance Testing

When the Contract Administrator elects to carry out QA testing, one of the samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

Test results for samples that do not comply with the performance grading requirements shall be categorized as borderline or rejectable. PGAC shall be categorized based on its test result's deviation from the individual design maximum or minimum pavement temperature and the sum of the deviations from the design maximum or minimum pavement temperatures defined as follows. The actual performance grading that is either higher than the design maximum pavement temperature or lower than the design minimum pavement temperature is not considered a deviation.

Borderline: Individual deviations are less than or equal to 3 °C and the sum of deviations is less than or equal to 3 °C.

Rejectable: Not complying with the above.

When a sample does not comply with more than one property, attribute, and PG grading, acceptance of the HMA shall be dealt with using the property, attribute, or PG grading selected by the Owner.

The Owner may conduct elemental testing according to ASTM D7343 or other tests to determine if the asphalt cement meets the material requirements as specified in the Materials section.

1101.08.05 Disposition of HMA Produced with PGAC Not Conforming with the Requirements of the Contract Documents

The Owner shall review the test results and determine the disposition of the HMA produced using any PGAC that does not conform to all requirements of the Contract Documents. HMA produced using PGAC for which test results indicate that the product did not conform to the Contract Documents shall be dealt with as follows:

Borderline: The HMA shall be accepted at full payment.

Rejectable: The HMA shall not be accepted into the Work. The Contract Administrator shall notify the Contractor in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the HMA from the Work and replacing it with acceptable HMA or invoking referee testing. The Contractor may request a reduced price in- lieu of removal of the HMA. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When test results indicate non-compliance with the Contract Documents, all costs to the Owner to establish the degree and extent of the non-compliance shall be the responsibility of the Contractor.

1101.08.06 Referee Testing

Referee testing by an independent laboratory may be invoked by the Contractor for any sample of PGAC within 5 Days of receiving all the QA test results for the sample, provided the Contractor has taken and delivered all referee samples in a condition suitable for testing.

The Contract Administrator shall select a referee testing laboratory acceptable to the Owner within 3 Business Days following the Contractor's written notification to invoke referee testing. Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator.

The referee testing shall determine the actual performance high and low temperatures, rounded to the nearest 0.5 °C of the PGAC and the properties and attributes shown in Table 1.

Test results generated by the referee laboratory shall be used to re-evaluate the PGAC to determine whether the product conforms to the Contract Documents and the disposition of the HMA represented by the sample tested.

Referee testing shall be carried out in the presence of the Owner's designate. The Contractor may observe the testing at no cost to the Owner.

The Contractor and the Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of the testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitations, they shall also be permitted to observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance. The taking of photographs and videos shall not be permitted.

Concerns with sample condition or sample identification shall be made known to all observers prior to commencement of the referee testing. Comments on deviations from the applicable test method shall be made at the time of referee testing. Unresolved concerns shall be specific in nature and submitted in writing to the referee laboratory's designated representative and the other observers present, at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When referee test results show that the PGAC is rejectable, the HMA represented by the test results shall not be accepted. The Contractor shall remove the HMA from the Work at no cost to the Owner. The Contractor may request a reduced price in-lieu of removal of HMA produced with PGAC with rejectable test results. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results confirm total conformance of the PGAC sample to the Contract Documents. Otherwise, the Contractor shall be responsible for the cost.

Table 1
Additional Asphalt Cement Testing Requirements and Acceptance Criteria for All PG Grades

PGAC Grade	Property and Attributes (Unit)		Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	PG XX-28	LS-227	0.1	≤ 0.6	> 0.6
		PG XX-34			≤ 0.6	> 0.6
		PG XX-40			≤ 0.6	> 0.6
All PGAC Grades Except PG 58-28 and PG 52-34	Low temperature limiting grade (LTLG) (°C)		LS-308	0.5	$\leq (-YY + 3)$	$> (-YY + 3)$
	Grade Loss (°C)		LS-308	0.5	≤ 6.0	> 6.0
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr-3.2}$) (kPa ⁻¹)		AASHTO T 350 For testing temperature see Note 1	0.01	≤ 4.5	> 4.5
	Average percent recovery at 3.2 kPa ($R_{3.2}$) (%)			0.1	$\geq$ the lesser of $[(29.371) (J_{nr-3.2})^{-0.2633}]$ or 50	$<$ the lesser of $[(29.371) (J_{nr-3.2})^{-0.2633} - 10]$ or 50
	CTOD, δ_t (mm)	PG XX-28	LS-299	0.1	≥ 8.0	< 8.0
		PG XX-34			≥ 12.0	< 12.0
		PG XX-40			≥ 16.0	< 16.0
Notes: 1. The testing temperature shall be 52°C for PGAC Zone 1 and 58°C for PGAC Zones 2 and 3.						

TABLE 2
Sampling Requirements

Samples	Minimum Sample Quantity	Labelling	Delivery
QA	2 litres (Note 1)	Label shall include: • Contract number. • Date (i.e., yyyy-mm-dd) and time of sampling • Performance grade of the asphalt cement. • Supplier's name.	• Samples shall be delivered as specified in the Contract Documents. • Samples shall be delivered at the same time.
Referee	2 litres (Note 1)		

Notes:
1. 2 litres shall be provided in 2 suitable one litre containers or a container able to hold a minimum of 2 litres.

Appendix 1101-A, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should be aware that OPSS 1101 has been revised to reflect the adoption of performance grading of asphalt cements in Ontario and additional testing to further characterize properties of the asphalt cement.

The designer should be aware that in this specification asphalt binder means asphalt cement. The former term is used in the AASHTO references cited, while the latter continues to be used in OPS specifications.

The designer should be aware that for the purpose of PGAC grade designation, Ontario has been divided into three zones as follows:

Zone 1: The area north of the boundary formed by the French River, Lake Nipissing, and the Mattawa River.

Zone 2: The area south of Zone 1, and north of a line from Honey Harbour, to Longford, Taylor Corners, Cavan, Campbellford, and Mallorytown.

Zone 3: The area south of Zone 2.

For design purposes, the designer shall ensure:

- a) Towns located along a zone boundary line are to be included in the zone south of the boundary line.
- b) Projects located within 10 km of zone boundary lines may be included in either zone at the discretion of the designer so that they may be considered within one zone only.

Appendix Table A-1 provides the basic performance grades for each Ontario zone. Recycling ratios in excess of 15% should be addressed on a Contract specific basis.

The designer is advised to use LTPP-Bind (Version 3.1 or later) to confirm the cold temperature grade of PGAC. A percent reliability of greater than 90% is recommended for low volume and residential roads and greater than 95% is recommended for highways and major projects according to NCHRP Report 673. OHMPA is recommending selecting a grade based on 98% reliability.

The designer shall consider the following when selecting PGAC grades:

- a) The location of the Contract (i.e., the geographical zone in which it is located) percent reliability appropriate for facility and work being carried out, noting that some discretion is allowed.
- b) The type of hot mix, new versus recycled hot mix.
- c) Upgrades for heavy commercial traffic, frequent starts and stops, and vehicle speeds. The designer may bump the high temperature grade according to Appendix Table A-2, or when invoking Appendix B, use MSCR graded PGAC according to Appendix Table A-3.

The designer shall include delivery instructions for the asphalt cement samples elsewhere in the Contract Documents.

The designer may include Appendix B to require Multiple Stress Creep Recovery (MSCR) graded PGAC in lieu of bumping the high temperature grade. Appendix B uses the AASHTO M 332 standard which encompasses the MSCR grading system for asphalt cement. It is intended to replace the PG system for grading asphalt cement described in AASHTO M 320. AASHTO M 332 uses the MSCR test to determine the high temperature rutting properties and elastic response of the binder.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Note: When the Owner is concerned about testing variability they may request that the lab conducting quality assurance testing participate in MTO's PGAC correlation and may on request ask the laboratory to provide their correlation ranking. MTO typically requires a ranking of 4 or better for their QA labs. Municipalities may contact MTO Bituminous Section for a list of labs appropriate for carrying out PGAC referee testing.

Related Ontario Provincial Standard Drawings

No information provided here.

**Appendix Table A-1
OPSS 1101 - Grade Selection for Ontario**

	PGAC Zones		
	Zone 1	Zone 2	Zone 3
New Hot Mix or up to 15% RAP by Mass	52 - 34	58 - 34	58 - 28

**Appendix Table A-2
OPSS 1101 - Guidelines for the Adjustment of PGAC High Temperature Grade
Based on Roadway Classification and Traffic Conditions**

Highway Type	Increase from Standard	Optional Additional Grade Increase (Note 1)
Urban Freeway	2 Grades	N/A
Rural Freeway Urban Arterial	1 Grade	1 Grade
Rural Arterial Urban Collector	Consider increasing by 1 grade if heavy truck traffic is greater than 20% of AADT	1 Grade
Rural Collector Rural Local Urban/Suburban Collector	No Change	1 or 2 Grades
Notes: A. Upgrading of the high temperature grade is recommended for use in both surface and top binder courses, i.e., top 80 to 100 mm of hot mix. B. Alternatively, Multiple Stress Creep Recovery (MSCR) graded PGAC acceptance criteria, according to Appendix B and Appendix Table A-3, can be used. 1. Consideration should be given to an increase in the high temperature grade for roadways which experience a high percentage of heavy truck or bus traffic at slow operating speeds, frequent stops and starts, and historical concerns with instability rutting.		

Appendix Table A-3
OPSS 1101 - Guidelines for the Selection of PGAC Graded Using Multiple
Stress Creep Recovery (MSCR) Test When Invoking Appendix “B” Based on
Roadway Classification and Traffic Conditions

Highway Type	Recommended PGAC Grade Using MSCR Test	Optional Grade Increase (Note 1)
Urban Freeway	XXV-YY	N/A
Rural Freeway Urban Arterial	XXH-YY	XXV-YY
Rural Arterial Urban Collector	Consider specifying XXH-YY if heavy truck traffic is greater than 20% of AADT	XXV-YY
Rural Collector Rural Local Urban/Suburban Collector	XXS-YY	XXH-YY or XXV-YY
Toll Plaza Port Facility Dedicated Transitways Truck Marshaling Yards (standing traffic)	XXE-YY	N/A
Notes: A. It is recommended that Multiple Stress Creep Recovery (MSCR) graded PGAC is used in both surface and top binder courses, i.e., top 80 to 100 mm of hot mix. 1. Consideration should be given to an increase in the high temperature traffic level for roadways which experience a high percentage of heavy truck or bus traffic at slow operating speeds, frequent stops and starts, and historical concerns with instability rutting.		

Appendix 1101-B, November 2016

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Additional Requirements for Performance Graded Asphalt Cement Further Graded for Traffic Loading Using Multiple Stress Creep Recovery Testing

AASHTO M332 replaces AASHTO M320, unless superceded by requirements in Appendix B Table 1 below.

OPSS.MUNI 1101 Performance Graded Asphalt Cement, is amended as follows:

1101.04 DESIGN AND SUBMISSION REQUIREMENTS

1101.04.01 Submission Requirements

1101.04.01.01 PGAC Test Documentation

Point d) of clause 1101.04.01.01 of OPSS 1101 is deleted in its entirety and replaced with the following:

- d) When the PGAC contains any polyphosphoric acid (PPA) and a liquid anti-stripping additive is incorporated into the PGAC at the PGAC supplier's depot:
 - i. Information on how much anti-stripping additive was added to the PGAC.
 - ii. Documentation from the PGAC supplier stating that the PPA modified PGAC with the liquid anti-stripping additive added at the PGAC supplier's depot shall meet all asphalt cement material requirements specified in the Contract Documents including AASHTO M332 for the PGAC grade specified.

1101.05 MATERIALS

The first paragraph in Section 1101.05 of OPSS 1101 is deleted in its entirety and replaced with the following:

PGAC shall be according to AASHTO M 332 with the exception of percent difference in non-recoverable creep compliance between 0.1 kPa and 3.2 kPa (J_{nrdiff}) requirements, for the performance grades specified in the Contract Documents.

1101.08 QUALITY ASSURANCE

1101.08.02 Anti-Stripping Additive

Subsection 1101.08.02 of OPSS 1101 is deleted in its entirety and replaced with the following:

The Contractor may request that an allowance be made for the impact of the anti-stripping additive on a PGAC grade for QA or referee purposes provided that:

- a) It was not added at the supplier depot to a PGAC containing polyphosphoric acid (PPA); and that

b) When production begins the Contractor submits to the Contract Administrator complete AASHTO M 332 and Table 1 test results for the following:

i) Asphalt cement with anti-stripping additive at the percentage identified in the mix design.

ii) Asphalt cement without the anti-stripping additive.

Table 1 is deleted in its entirety and replaced with the following:

Appendix B Table -1
Additional Asphalt Cement Testing Requirements and Acceptance Criteria for All PG Grades

	Property and Attributes (Unit)		Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	for -YY = -28	LS-227	0.1	≤ 0.6	> 0.6
		for -YY = -34			≤ 0.6	> 0.6
		for -YY = -40			≤ 0.6	> 0.6
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXS-YY is specified		AASHTO T 350 testing conducted at high temperature grade of the PGAC (Note 1)	0.01	≤ 4.5	> 4.5
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXH-YY is specified			0.01	≤ 2.0	> 2.0
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXV-YY is specified			0.01	≤ 1.0	> 1.0
Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXE-YY is specified		0.01		≤ 0.55	> 0.55	
Average percent recovery at 3.2 kPa ($R_{3.2}$) (%)		0.1		$\geq$ the lesser of $[(29.371)(J_{nr-3.2})^{0.2633}]$ or 50	$<$ the lesser of $[(29.371)(J_{nr-3.2})^{0.2633} - 10]$ or 50	
All H, V and E Grades	Percent difference in non-recoverable creep compliance between 0.1 kPa and 3.2 kPa, $J_{nr\text{diff}}$ (%)		0.1	N/A Testing carried out for information purpose		
	All PGAC Grades Excluding PG 58S-28 and PG 52S-34	CTOD, δ_t (mm)	for -YY = -28	LS-299	0.1	≥ 8.0
for -YY = -34			≥ 12.0			< 12.0
for -YY = -40			≥ 16.0			< 16.0
	Low temperature limiting grade (LTLG) ($^{\circ}\text{C}$)		LS-308	0.5	$\leq (-YY + 3)$	$> (-YY + 3)$
	Grade Loss ($^{\circ}\text{C}$)		LS-308	0.5	≤ 6.0	> 6.0
Notes: 1. For example, the testing temperature for PG58V-28 is 58 $^{\circ}\text{C}$ and for 52H-34 it is 52 $^{\circ}\text{C}$.						