



**CONSTRUCTION SPECIFICATION FOR
HOT IN-PLACE RECYCLING AND HOT IN-PLACE RECYCLING
WITH INTEGRAL OVERLAY**

TABLE OF CONTENTS

332.01	SCOPE
332.02	REFERENCES
332.03	DEFINITIONS
332.04	SUBMISSION AND DESIGN REQUIREMENTS
332.05	MATERIALS
332.06	EQUIPMENT
332.07	CONSTRUCTION
332.08	QUALITY ASSURANCE
332.09	MEASUREMENT FOR PAYMENT
332.10	BASIS OF PAYMENT

APPENDICES

332-A	Commentary
332.01	SCOPE

This specification covers the requirements for the preparation of the existing pavement surface; heating and hot milling the existing hot mix asphalt (HMA); adding and mixing in one or more of rejuvenating agent and beneficiating HMA; and redistribution and compaction of the Hot In-Place Recycled (HIR) mix in a single operation.

332.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

332.01.02 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.

332.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 308 Tack Coat
OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

LS-100 Rounding-Off of Test Data and Other Numbers
LS-101 Calculation of Per Cent within Limits
LS-262 Bulk Relative Density of Compacted Bituminous Mixes
LS-264 Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265 Determination of Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-284 Recovery of Asphalt from Solution by Abson Method or Rotavapor
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures – Ontario Procedure

LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-294	Measuring Pavement Lift Thickness
LS-306	Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-317	Determination of the Severity of a Segregated Asphalt Pavement Surface
LS-604	Relative Density and Absorption of Course Aggregate
LS-605	Relative Density and Absorption of Fine Aggregate

ASTM International

D 6752-11	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
E 178-08	Standard Practice for Dealing with Outlying Observations

American Association of State Highway and Transportation Officials (AASHTO)

R 35-14	Superpave Volumetric Design for Hot - Mix Asphalt
T 166-13	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 312-14	Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor

332.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 313, OPSS 1151, and the following definitions apply:

Asphalt Cement (AC) means asphalt binder as defined in OPSS 1101.

Attribute means one of the following properties: designated large sieve (DLS), 4.75 mm sieve, 75 µm sieve, AC content, air voids, lift thickness, compaction, or recovered asphalt cement (RAC) performance grade.

Beneficiating HMA means a HMA designed such that the final HIR mix shall be according to the Contract Documents.

Design Lift Thickness (T_D) means the thickness in millimetres of the HIR mix as specified in the Contract Documents.

Field Adjustment to the JMF means a change in the target gradation, AC content, or both of a HIR mix, within limits as specified in the Contract Documents without a redesign of the HIR mix, resulting in a revised JMF.

Hot In-Place Recycled (HIR) Mix means the mixture of hot milled material containing one or more of the following components: rejuvenating agent and beneficiating HMA.

Hot Milled Material means the material produced during the heating and hot milling of the existing HMA.

Hot Milling means the process of applying adequate heat to the pavement to sufficiently soften the pavement, followed by the use of milling heads to uniformly remove the heated material to the depth specified in the mix design submission with minimal fracturing of the existing aggregates.

Joint means a vertical contact between a HIR mix and any pavement or any rigid object that exists at the time the HIR mix is laid.

Lift Thickness means the thickness in millimetres of the placed and compacted HIR mix.

Loose Mix means a representative sample of uncompacted HIR mix for testing mix properties or the RAC performance grade.

Mix Design means the design of the proportions of new and existing aggregates; new and existing AC; rejuvenating agent; and additives; when uniformly mixed, that results in an acceptable HIR mix.

Mix Properties means the AC content, gradation, and air voids.

Payment Adjustment Sieves means the DLS, 4.75 mm, and 75 µm gradation sieves.

Recovered Asphalt Cement (RAC) means the AC recovered from the HIR mix according to the Rotavapor Method in LS-284, using re-agent grade trichloroethylene, or other solvent acceptable to the Owner.

Rejuvenating Agent means a product that when added to the hot milled material; the RAC from the HIR mix meets the requirements of the Contract Documents.

Screed means the unit of the placement unit of the recycling train that strikes off and imparts initial compaction to the HIR mix.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement, with severity levels:

- a) Slight Segregation – a pavement matrix is in place between the coarse aggregate particles; however, there are slightly more coarse aggregate particles in comparison with the surrounding acceptable mix.
- b) Medium Segregation – the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix.
- c) Severe Segregation – the pavement appears very coarse, with coarse aggregate particle against coarse aggregate particle and the pavement has little or no matrix.

332.04 SUBMISSION AND DESIGN REQUIREMENTS

332.04.01 Design Requirements

The HIR mix design shall be according to the Design Requirements subsection of OPSS 1151 and as specified in the Contract Documents.

332.04.02 Submission Requirements

A copy of all mix design and JMF documents, signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work, shall be submitted to the Contract Administrator.

The mix shall not be placed until the Contract Administrator provides written confirmation that the submitted mix design and JMF documents meet the Contract requirements. Within four Business Days following the delivery of all required documentation, the Contract Administrator shall provide written confirmation that the mix design and all samples meet the Contract requirements or; advise of any requirements that have not been met.

Confirmation of conformance to the Contract requirements of the submitted mix design 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.

The following additional information shall be submitted to the Contract Administrator in writing with the mix design:

- a) The amount, name, manufacturer, and supplier of the rejuvenating agent or beneficiating HMA or both, if to be used;
- b) The hot milling depth to meet the required mix properties and the design lift thickness with a maximum increase in pavement elevation of 15.0 mm;
- c) The mix proportions, gradation, and source of the materials in the beneficiating HMA, if to be used;
- d) A copy of all calculations that were completed to determine the amount of rejuvenating agent or beneficiating HMA or both, if to be used;
- e) Air void laboratory test results and calculations for the HIR mix; and
- f) A graph of temperature-kinematic viscosity relationship for the combined rejuvenating agent, the recovered AC present in the existing pavement, and the new AC in the beneficiating HMA.
- g) When applicable, a declaration that the percentage of the beneficiating HMA comprising quartzite and dolomitic sandstone aggregates, or combinations thereof, is more or less than 75%.

The mix design shall be valid for a maximum of 14 months from when the mix design was prepared and for the section of roadway it was designed for.

332.05 MATERIALS

332.05.01 Hot In-Place Recycled Mix

The HIR mix produced shall be according to the mix design and meet the requirements of Table 1.

332.05.01.01 Recovered Asphalt Cement

The RAC recovered from the HIR mix produced shall be according to OPSS 1101 and as specified in the Contract Documents.

332.05.01.02 Beneficiating Hot Mix Asphalt

Beneficiating HMA shall be according to OPSS 1151 for the specified mix type.

RAP, RST, or both shall not be used in the composition of the beneficiating HMA.

332.05.02 Release Agents

No release agents shall be used that may adversely affect the quality or performance of the HIR mix. Release agents shall be used according to the proprietary requirements.

Petroleum based release agents, excess water, or excess release agents shall not be used.

332.06 EQUIPMENT

332.06.01 Heating Unit

Heating units shall apply heat in a uniform manner to the surface of the existing pavement to be hot milled. Open flame heating of the existing HMA pavement shall not be permitted.

Heaters shall be spaced and operated such that:

- a) Sufficient heat penetration of the pavement shall be achieved, with heat penetration into the underlying pavement beneath the hot milling depth specified in the mix design submission,
- b) The desired HIR mix temperatures are achieved, and
- c) The existing HMA surface is not burnt or scorched.

332.06.02 Recycling Train

The recycling train shall be self-contained mechanical units specifically designed for HIR of HMA pavements. The recycling train shall have the capability to process the existing pavement to a depth of at least 50 mm.

Heaters used as part of the recycling train shall be according to the Heating Unit subsection.

The recycling train shall include hot milling, blending, and placement units.

332.06.02.01 Hot Milling Unit

The hot milling unit shall be capable of uniformly milling the preheated HMA to the hot milling depth specified in the mix design submission.

332.06.02.02 Blending Unit

The blending unit shall be capable of thoroughly mixing the hot milled material, rejuvenating agent, and beneficiating HMA.

332.06.03 Diamond Grinding

A diamond grinder shall be power-driven, self-propelled, and designed for grinding HIR mix or HMA. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall be equipped with the capability to adjust the depth, slope, and crossfall to remove HIR mix or HMA to the required profile and shall also include a slurry pick-up system.

332.07 CONSTRUCTION

332.07.01 Quality Control

QC procedures shall be conducted to ensure the HIR mix meets the requirements of the Contract Documents. Interpretation of QC inspections, test results, and measurements and the determination of any action to be taken shall be carried out to ensure that the work is according to the requirements of the Contract Documents.

A single sample for QC purposes may be obtained at the same time and location as QA acceptance samples. No additional loose mix samples shall be taken from the placed HIR mix.

If the Contractor wishes to obtain additional samples for QC purposes, up to three cores may be taken in each lot. Cores shall not be spaced closer than 1 m from any other core. If further additional samples are required, a written request shall be made to the Contract Administrator, and samples shall only be taken upon written approval of the Contract Administrator. All sample locations shall be restored as specified in the Contract Documents.

332.07.02 Laboratory Correlations

On request, the Contract Administrator shall provide the opportunity to conduct a correlation of mix properties, AC grading, or compaction, or a combination between the QA and QC laboratories prior to the HIR operation. The correlation may occur once for each mix type and shall be a maximum of three samples.

The Contract Administrator shall be provided with the samples and compaction temperature for the correlation testing. The Contract Administrator shall provide the QA test results on completion of the correlation testing.

332.07.03 Preparation of Existing Pavement

Prior to the HIR operation:

- a) Existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials.
- b) Milled existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials and shall be swept with a power broom.

Existing surfaces to be HIR may be corrected by additional cold milling, hot milling, addition of beneficiating HMA or a combination, in order to place and compact the HIR mix to the design thickness specified in the Contract Documents.

Removal of the existing pavement by the hot milling unit shall be performed in such a manner as to leave adjacent pavement and structures remaining in place undisturbed and undamaged. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. Broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

332.07.04 Transportation of Beneficiating Hot Mix Asphalt

Truck boxes used to transport HMA shall be clean and, if required, lightly coated with a uniform application of a release agent. Truck boxes shall be drained after each application and before loading.

332.07.05 Placing Hot In-Place Recycled Mix

332.07.05.01 Operational Constraints

The HIR process shall be carried out when the roadway is clean and free of standing water. The HIR process shall not proceed in the rain.

The supply of any materials to the recycling train shall be accomplished with no traffic on the uncompacted mat. Public traffic shall not be permitted on freshly laid HIR mix until the temperature of the mat is 50 °C or less.

332.07.05.02 Paving

The heating units and recycling train shall heat and hot mill the HMA pavement across the complete lane width, and partial width shoulder if applicable, to the hot milling depth specified in the mix design submission.

The underlying pavement shall be heated to a minimum temperature of 50 °C.

When inspection and testing indicates that the required average depth of heating and hot milling is not being met, the process shall be immediately corrected.

Rejuvenating agent and/or beneficiating HMA shall be added to and mixed with the hot milled material in the amount specified in the mix design. The HIR mix shall be homogeneous after mixing.

The final placement of the HIR mix by the recycling train shall be uniformly distributed to the specified profile and crossfall. The HIR mix shall be compacted to the design lift thickness specified in the Contract Documents and meet all acceptance criteria specified in the Contract Documents.

Each successive pass of the recycling train shall overlap the previously HIR adjacent surface by a minimum of 100 mm.

The HIR mix shall be of a minimum temperature, immediately behind the screed, to meet the compaction requirements specified in the Contract Documents.

Prior to roller compaction, obvious defects in the HIR mix placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected. Excess HIR mix shall not be cast onto the surface of the freshly laid mat. After final compaction the surface shall be smooth and true to the established crown and grade, uniform in texture and shall be free of any defects.

All through lane HIR mix shall be completed prior to the placement of adjacent sideroads, speed change lanes, and other paved areas.

Areas that are not accessible to the heating and hot milling equipment shall have the HMA removed to the depth required to meet the design lift thickness requirements specified in the Contract Documents. These areas shall be tacked coated according to OPSS 308 and paved with the mix type specified in the Contract Documents according to OPSS 313. The surface of each layer placed and compacted shall be level with the adjacent pavement. The paving of such areas shall be completed prior to the placing of any subsequent course on the HIR mix, if applicable, and as a separate operation from any other paving.

If the Contractor's actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct the Contractor to cease HIR operations until the problem has been corrected.

332.07.06 Longitudinal and Transverse Joints

All joints shall be made to obtain a complete bond between the two pavement edges and a smooth riding surface. The existing or previously placed pavement edge shall be a straight clean vertical surface for the full depth of the course. Where ramping or damage has occurred, trimming shall be required. All dirt or other foreign material and all loose material shall be removed from all vertical surfaces.

Longitudinal and transverse joints between the new HIR pavement and the existing pavement shall be butt joints as specified in the Contract Documents. All longitudinal joints at intersecting roads shall be butt joints. Heating beds on the heating units shall heat and soften material beyond the hot milling width by a minimum of 100 mm to achieve proper thermal bonding between the existing asphalt pavement and the HIR mix along the

longitudinal joints. The longitudinal joints shall be parallel to the lane and visually uniform longitudinally, and within 50 mm of the demarcation between the lanes specified in the Contract Documents.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction. The paver screed shall overlap the adjoining mat by at least 50 mm.

332.07.07 Compaction

Compaction of the HIR mix shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat according to the requirements of the Contract Documents.

At all places not accessible to rollers, the HIR mix shall be compacted by mechanical self-powered gas-, electric-, or air-powered equipment.

332.07.08 Field Adjustments to the Job Mix Formula

The JMF may be adjusted to more closely reflect the HIR mix being produced. Field adjustments to the JMF shall be limited in scope such that the net impact of all field adjustments to the JMF does not exceed any of the maximum field adjustments to the JMF in Table 2 in comparison to the original JMF submitted under the current mix design.

A field adjustment to the JMF during production shall be permitted under the following situations:

- a) To more closely reflect the actual HIR mix being produced, when test results for the last lot produced to the submitted JMF accrued a payment reduction for AC content or gradation or both but met all other specified HIR mix requirements. The test results (lot mean) shall show that the design requirements for VMA, percent G_{mm} at N_{max} , VFA, and dust proportion were met, and that there was no payment reduction for air voids. The adjusted JMF may be applied to the lot being placed at the time the confirmation of receipt of the adjusted JMF is issued and to the previous lot if requested as part of the written submission for a JMF adjustment.
- b) To permit minor changes in the constituent proportions, when test results for the last lot produced to the submitted JMF indicate no negative price adjustments for AC content or gradation, but changes are designed to improve either the air voids or RAC performance grade or both. For this situation, the air voids PWL shall be at least 50. The adjusted JMF may be applied to the lot being placed at the time the confirmation of receipt of the adjusted JMF is issued.

JMF adjustments shall not be accepted once placement of the HIR mix has been completed. The adjusted JMF shall be submitted in writing on a form supplied by the Contract Administrator. Within one Business Day of receiving the JMF adjustment submission, the Contract Administrator shall give a written confirmation of receipt of the adjusted JMF confirming conformance to the Contract requirements or advising of any non-conformance.

332.07.09 Sampling

332.07.09.01 Mix Properties and Recovered Asphalt Cement Performance Grade

Samples shall be appropriately labelled with the Contract number, highway number, Region, lot number, subplot number, mix type, station, and date and time of sampling.

The Contract Administrator shall advise the Contractor of each random sample location from which the sample is to be taken. A set of two samples shall be taken according to Table 3. One of these samples shall be for QA testing and the other shall be for referee testing. Samples for QA and referee testing shall be obtained concurrently.

When the mass of the sample does not meet the requirements of Table 3, the sample shall be discarded and a new one taken immediately.

332.07.09.02 Compaction

Upon completion of each subplot, the Contract Administrator shall provide notification of each random sample location in writing. Pavement core samples shall be obtained in duplicate from each subplot no later than the next Working Day after the completion of the subplot. Each core shall have a minimum nominal diameter of 150 mm and a maximum nominal diameter of 200 mm, and shall consist of the full layer being sampled and at least one underlying layer, if one is present. Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement.

Each set of samples shall be taken from the same lane, same transverse offset, and at a spacing of 1.0 m \pm 0.1 m between each individual core edge.

Care shall be taken to ensure that cores are not damaged during coring operations or in transit. If a core is damaged, a replacement core shall be extracted at a location adjacent to the original core.

When the design lift thickness is at least 40 mm, and the lift thickness of the pavement core is less than 35 mm, the core shall be submitted to the Contract Administrator and a replacement core shall be extracted at a location within the same subplot selected by the Contract Administrator. If the thickness of the replacement core is also less than 35 mm, the core shall be submitted to the Contract Administrator and the situation reviewed the Contract Administrator prior to any further coring of the subplot.

Core samples shall also include design lift thickness on the label. The lot and subplot numbers shall be clearly marked with a permanent marker on all compaction cores.

HIR mix and compaction requirements for filling the sample holes shall be the same as the adjacent undisturbed pavement. Sample holes shall be cleaned, dried, and filled and then compacted using a mechanical self-powered gas-, electric-, or air-powered compactor immediately after sampling.

332.07.09.03 Lift Thickness

Single cores consisting of the HIR mix placed shall be used to evaluate the lift thickness of the HIR tender item placed at each sample location. Sample locations shall be determined based on the surface area of the HIR mix placed on the Contract.

All areas of HIR paving within the Contract limits, including paved shoulders, shall be sampled for lift thickness.

Upon completion of each subplot, the Contract Administrator shall provide notification in writing of the location to be used for sampling. One pavement core sample shall be obtained from each subplot not later than the next Working Day after completion of the subplot. This one core shall be used for both QA and possible referee testing.

Each core shall have a nominal diameter of 50 mm and shall consist of the HIR mix placed in the subplot and at least one underlying HMA layer if one exists. Each core shall have its vertical side cored perpendicular to the upper surface of the core. Each sample shall be placed in a suitable container to protect the sample integrity during transport and until testing. The subplot number shall be clearly marked with a permanent marker on each core.

No replacement thickness cores shall be obtained for QA or referee testing. When a core thickness is reported as "indeterminate", a new 150 mm core shall be taken centred over the subplot's previously taken 50 mm core.

Holes resulting from the removal of thickness core samples shall be cleaned, dried, and filled with a material acceptable to the Contract Administrator immediately after sampling.

332.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

332.08 QUALITY ASSURANCE

332.08.01 Acceptance Criteria

The Owner shall conduct tests, carry out calculations, and provide values according to Table 4. The Contractor shall be provided with results from the completed tests. Payment factors and payment adjustments for each lot shall be determined by the Contract Administrator as specified in the Contract Documents, based on the QA test results, unless when applicable, the Contractor invokes referee testing, in which case referee results shall be used.

Acceptance of HIR mix shall be based on the following criteria:

- a) Air Voids and Compaction
- b) Gradation and AC Content
- c) RAC Performance Grade
- d) Surface Tolerance
- e) Surface Appearance
- f) Surface Smoothness
- g) Lift Thickness
- h) Geometrics and Longitudinal Joint Location

332.08.01.01 Air Voids and Compaction

332.08.01.01.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots, after discussion with the Contractor and before HIR operations start. Guidelines for the breakdown of the tender item quantity into lots are as listed in Table 5. Generally, lot size is 40,000 m² with sublots of 4,000 m²; however, subplot sizes shall be adjusted to ensure a minimum of three sublots per lot.

When the tender item quantity is less than 4,000 m², the sublots shall be determined by the Contract Administrator based upon such testing as is deemed necessary by the Contract Administrator to determine substantial conformance with the Contract.

When only 1 or 2 sublots are completed at the end of placement of the tender item due to a change in the JMF or when a delay of more than 20 Business Days occurs in placing the complete lot, the test results obtained shall be considered as part of the previous lot and the previous lot shall then have 11 or 12 sublots. When only 3 to 9 sublots are completed due to the above circumstances, then the 3 to 9 sublots shall be considered as a lot.

When a delay of more than 20 Business Days occurs in placing the complete lot and this lot shall be completed during the same calendar year, the Contractor may, prior to the end of the 20 Business Days, request in writing to the Contract Administrator that the lot be continued upon the resumption of placement of that tender item. If the request is not made or is not accepted by the Contract Administrator, the lot shall be terminated and evaluated for acceptance.

332.08.01.01.02 Basis of Acceptance

Acceptance for HIR mix for air voids and compaction is based on the lot PWL for each attribute. PWL shall be determined using lot test results, LS-101, and lower and upper limits as specified in Table 1. The PWL of the lot for each criterion shall be used to determine the payment adjustment factor from Table 6. If the PWL is less than 50% for air voids or compaction, the lot is rejectable and shall be subject to repair or payment adjustment.

When the tendered item quantity is less than 4,000 m², the HIR mix may be accepted by the Contract Administrator based upon such testing as is deemed necessary by the Contract Administrator to determine substantial conformance with the Contract. When three or more tests have been completed for a lot the Material shall be accepted at the full Contract price, subjected to a payment adjustment or rejected as specified in the Contract Documents.

The Contract Administrator shall determine if a rejectable lot may remain in the work without repairs. When the Contract Administrator has determined that a rejectable lot may remain in the work without repair, the lot shall be subjected to a payment adjustment. If the Contractor elects to repair the lot in lieu of a payment adjustment or if the Contract Administrator determines that a rejectable lot requires repair, the lot shall be repaired and re-evaluated as detailed in the Repairs subsection.

332.08.01.02 Gradation and Asphalt Cement Content

332.08.01.02.01 Lot Size

The lots and sublots for gradation and AC content shall be according to the Lot Size clause under the Air Voids and Compaction clause of the Acceptance Criteria subsection.

332.08.01.02.02 Basis of Acceptance

Acceptance for HIR mix for gradation and AC content shall be determined using the lot mean; LS-282, LS-291, or LS-292; the specification limits specified in Table 1; and subplot acceptability.

Sublot test results shall be acceptable if they meet the specification limits specified in Table 1. If a subplot test result for any payment adjustment sieve or AC content does not meet the specification limits specified in Table 1, the subplot shall be deemed rejectable and shall be repaired as detailed in the Repairs subsection. When a lot contains any subplot that is deemed rejectable, the lot is rejectable until the subplot has been repaired and re-evaluated as acceptable. The repaired subplot shall be re-evaluated using the test results for the repaired subplot and used in determining payment and acceptance of the lot. When the Contract Administrator allows a rejectable subplot to remain in place without repair, the subplot test result for the rejectable subplot shall be treated as a lot with one subplot, and the remaining sublots shall form a separate lot.

The Contract Administrator shall calculate the gradation payment adjustment and AC content payment adjustment for the lot once all subplot test results for the lot have been completed. The Contract Administrator shall calculate the lot mean to one decimal point and the lot gradation and the lot AC content payment adjustments based on all the subplot test results in the lot, according to LS-101. If the lot mean does not meet the specification limits specified in Table 1, the lot is rejectable.

332.08.01.03 Recovered Asphalt Cement Performance Grade

332.08.01.03.01 Basis of Acceptance

Acceptance of the RAC performance grade in the HIR mix shall be as specified in the Contract Documents.

332.08.01.03.02 Disposition of Hot In-Place Recycled Mix with Recovered Asphalt Cement with Borderline and Rejectable Lots

The Owner shall review the test results and determine the disposition of the HIR mix with any RAC that does not meet the requirements of the Contract Documents. This shall also include the identification of any trends evident through the analysis of the additional testing. HIR mix with RAC, for which test results indicate that the product did not meet the requirements of the Contract Documents shall be dealt with as follows:

Minor Borderline: HIR mix shall be accepted at full payment.

Major Borderline: HIR mix shall be accepted into the Work with a payment reduction, according to the Payment Adjustment for Recovered Asphalt Cement Performance Grade clause. Alternatively, at the Contractor's option, the HIR mix may be repaired according to the Repairs subsection.

Rejectable: HIR mix shall be repaired according to the Repairs subsection. The Contract Administrator shall determine if rejectable mix may remain in the work without repairs, with a payment adjustment.

332.08.01.04 Surface Tolerance

Surface tolerance shall be according to OPSS 313. Surface tolerance related repairs shall be carried out according to the Repairs subsection.

332.08.01.05 Surface Appearance

HIR mix deemed by visual appearance to have flushing, bleeding, segregation, fat spot, surface damage, chatter, or surface contamination but not limited to these, shall be considered deficient material or work. The Contractor shall provide traffic control, for all surface appearance assessments. Deficient material, mixture, and work shall be removed and replaced or repaired or assessed a payment reduction.

332.08.01.05.01 Segregation

HIR mix exhibiting medium or severe midlane segregation shall be assessed a payment reduction or shall be repaired at the discretion of the Contract Administrator.

HIR mix exhibiting other segregation shall be addressed in accordance with the following:

- a) Slightly segregated HIR mix shall be accepted into the work with no payment reduction.
- b) Medium segregated HIR mix shall be assessed a payment reduction, or repaired at the discretion of the Contract Administrator.

- c) Severely segregated HIR mix shall be repaired by removal and replacement according to the Repairs subsection.

Bullnoses and tapers that were not machine-laid and any areas of handwork shall not be assessed on the basis of segregation but on the basis of other workmanship-related problems.

332.08.01.06 Surface Smoothness

The acceptability of surface smoothness shall be as specified in the Contract Documents.

332.08.01.07 Lift Thickness

332.08.01.07.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots before the HIR process starts. Generally there shall be one lot of the total pavement quantity. When more than one T_D is specified for the HIR tender item, there shall generally be a separate lot for each T_D specified in the Contract Documents for the HIR tender item. Each lot shall be divided into sublots, which shall normally be 2,000 m² in size. A minimum of three sublots are required for each lot.

332.08.01.07.02 Basis of Acceptance

Acceptance of HIR mix for lift thickness is based on lift thickness measurements determined using subplot test results, LS-294, and the minimum lift thicknesses given in Table 7. The Contract Administrator shall calculate the thickness payment adjustment for the lot once all measurements for the lot have been completed.

Individual subplot thickness measurements shall be acceptable if they are equal to or greater than the minimum subplot lift thickness specified in Table 7. If an individual subplot thickness measurement is less than the minimum subplot lift thickness specified in Table 7, the subplot shall be deemed rejectable and shall be repaired.

The repaired subplot shall be re-evaluated using the lift thickness measurement for the repaired subplot and used in determining payment of the lot.

In addition, when a core taken for compaction testing does not meet the minimum lift thickness specified in Table 7, the thickness subplot in which the compaction core was located shall be rejectable and shall be repaired.

The Contract Administrator shall calculate the lot mean to one decimal point and the lot payment adjustment for lift thickness based on all the subplot lift thickness measurements in the lot, according to LS-101 and the Payment Adjustment for Lift Thickness clause. If the lot mean is less than 85% of the T_D , the lot will be rejectable.

When a lot contains any subplot that is deemed rejectable, the lot shall be rejectable until the subplot has been repaired and re-evaluated as acceptable. When the Contract Administrator allows a rejectable subplot to remain in place without repair, the Contractor shall receive a payment reduction for the subplot according to the Payment Adjustment for Lift Thickness clause. A subplot lift thickness measurement for a rejected subplot that receives a payment reduction shall not be used to assess the lot mean.

332.08.01.08 Geometrics and Longitudinal Joint Location

332.08.01.08.01 Basis of Acceptance

After final compaction, the HIR mix shall be smooth and true to the design profile and cross-section and constructed to the design width.

The Contract Administrator shall conduct spot checks of the width of the HIR mix to determine if the complete lane and shoulder widths, when specified in the Contract Documents, have been HIR processed, placed, and compacted for acceptance.

The width of HIR mix shall be accepted provided:

- a) the outside edges of the lanes and the paved shoulders are parallel to the lane and visually uniform longitudinally,
- b) the width across all the adjacent HIR lanes and shoulders, when specified, from the outside edge to outside edge is not less than the sum of the specified widths, and
- c) the width of retrofitted partially paved shoulder is not less than the specified width, when specified in the Contract Documents.

If the width is not acceptable at any location, the Contract Administrator shall notify the Contractor in writing that the pavement is rejectable and the Contractor shall submit a written proposal for corrective action to the Contract Administrator within three Business Days of receiving the notification.

Longitudinal joints not meeting the Contract requirements shall be removed and replaced, or assessed a payment reduction.

332.08.01.09 Optional Trial

When the HIR tender item quantity is 40,000 m² or more, an optional trial of one lot, not exceeding 4,000 m², with one subplot shall be permitted. If the Contractor elects to plan this optional trial, he shall advise the Contract Administrator in writing prior to placing the trial lot. The optional trial shall not be placed in a critical location. The optional trial will be treated as a small quantity lot for basis of acceptance and payment.

332.08.01.10 Small Quantity Lots

Any lot comprised of one or two sublots, shall not be subject to payment adjustment unless the HIR mix is rejectable. Acceptance for these lots shall be on a subplot by subplot basis. The subplot shall be considered acceptable if the HIR mix complies with the limits specified in Table 1. HIR mix that does not comply with Table 1 shall be considered rejectable.

332.08.02 Referee Testing

332.08.02.01 General

Referee testing by a referee laboratory can only be invoked for a given lot within five Business Days of the Contractor receiving the QA test results, and where applicable the Contract Administrator's calculated QA payment factors and payment adjustments for that lot.

Referee testing may only be invoked if all referee samples have been received in a condition suitable for testing.

332.08.02.02 Mix Properties and Compaction

Referee testing may only be requested for the entire lot, or a maximum of two sublots from that lot. Referee testing shall fall into one of three categories:

- a) mix properties only,

- b) compaction only, or
- c) mix properties and compaction.

The referee laboratory shall use the same test method as the QA laboratory except that when the QA laboratory chooses LS-292, the referee laboratory shall use that method provided the calibration requirements are met. If they are not met, the affected laboratory shall use LS-282.

When referee testing of mix properties is invoked, the referee laboratory shall conduct all necessary testing, with the exception of the combined aggregate density, which will be supplied by the Contract Administrator.

The results generated by the referee laboratory shall be used to re-evaluate the lot to determine the payment factors for the acceptance of the disputed properties for the disputed lots of HIR mix. The referee test results are binding on both the Owner and the Contractor.

332.08.02.03 Recovered Asphalt Cement Performance Grade

Referee testing for RAC performance grade shall be as specified in the Contract Documents.

332.08.02.04 Challenging Severity of Segregation

The Contractor may challenge, in writing, the severity of any segregated area assessed as either medium or severe, within five Business Days of receiving the Owner's first visual assessment. The written challenge shall list the dimensions and the Contractor's assessment of the severity of each disputed area.

For Contracts with up to 240,000 m² of HIR mix, the Contractor shall be allowed a maximum of two separate written challenges for each tender item. However, for Contracts with more than 240,000 m² of HIR mix, the Contractor shall be allowed a maximum of four separate written challenges for each tender item. Each written challenge may involve more than one disputed segregated area.

A representative of the Owner, who did not carry out the original assessment and who is not the Contract Administrator shall make a second visual assessment of the disputed areas. This second visual assessment shall be carried out within five Business Days after the Contract Administrator has received the Contractor's written challenge and the results of that second visual assessment shall be binding on both the Owner and Contractor.

The Contractor may further challenge the Owner's second visual assessment of the segregation severity. Such a challenge shall be resolved by a representative of the Owner determining the Macrotexture Ratio, according to LS-317. Table 8 shall be used with the Macrotexture Ratio to determine the degree of severity and the disposition of the disputed area of segregation. The results of that testing shall be binding on both the Owner and the Contractor.

332.08.02.05 Lift Thickness

The Contractor may only challenge the individual lift thickness measurement by requesting referee testing within five Business Days of the Contractor receiving the subplot thickness measurement and shall submit the request in writing to the Contract Administrator. The Contractor shall then have the opportunity to view the re-measurement of the QA designated pavement core for that subplot at an alternative Owner designated QA laboratory together with the Owner's representative. The re-measured lift thickness measurement shall be considered binding and shall replace the original lift thickness measurement for assessment of the subplot.

332.08.02.06 Outlier in Referee Results

Where an entire lot of three or more sublots has been referee tested, the Contractor may question an individual value for any attribute of a subplot's test result, excluding lift thickness. The request shall be made within three Business Days of the Contractor receiving all of the test results for the lot, and only when the payment factor for the attribute with an outlier is less than 1.0 or a payment adjustment applies. The validity of the questioned attribute shall be ascertained in accordance with ASTM E 178 using a T test at a 10% significance level.

If the T test procedure shows that the questioned value of the attribute is not an outlier, then the test result shall be used in the calculations. If the T test procedure shows that the questioned value of the attribute is an outlier, then the test result for the subplot shall be checked for mathematical errors. If there are no mathematical errors, the subplot with the outlier is treated as a lot with one subplot and the remaining sublots shall form a separate lot with no further consideration for outliers.

If only two sublots remain, the two sublots shall be treated as two separate lots each with one subplot.

332.08.04 Repairs

332.08.04.01 General

The Contractor shall perform all repairs.

The materials and the construction of repairs shall meet the requirements specified in the Contract Documents.

Repairs shall be full lane or full shoulder width except where localized repairs are allowed as specified in the Contract Documents. The limits and type of repairs shall be subject to the approval of the Contract Administrator and shall be approved prior to the repairs being carried out.

All transverse joints in repairs shall butt up to a full depth vertical surface. Repairs shall consist of the removal and replacement of the full thickness of the HIR mix or the placement of an overlay when permitted by the Contract Administrator. A paver or recycling train shall be used in carrying out the repair.

Repairs of an urgent nature, including moderate to very severe aggregate loss, moderate to very severe flushing, and wheel track rutting 16 mm in depth or greater shall be repaired within seven Days, unless extended by mutual agreement. With the exception of urgent repairs, repairs shall be completed within 60 Days or prior to seasonal shutdown each year, whichever is the lesser, unless extended by mutual agreement.

332.08.04.02 Mix Properties, Compaction, and Recovered Asphalt Cement Performance Grade

The Contractor may elect to carry out repairs in lieu of accepting a payment adjustment, if the lot is not rejectable and for air voids and compaction the total payment factor for the lot is less than 0.940. When the Contract Administrator requires a rejectable lot to be repaired or the Contractor elects to carry out repairs in lieu of accepting a payment adjustment, the Contractor shall determine what areas of HIR mix in a lot are to be repaired subject to the minimum lengths and widths specified in the Contract Documents. Each repair area shall include at least one of the loose mix or core sample locations or both representing that subplot.

The minimum length of a single-repair to one lane shall be 250 m. The minimum length of a single-repair that extends over more than one lane shall be 250 lane-metres and no portion of the single-repair in a lane shall be less than 125 m in length.

The minimum limits of each repair shall be at least 125 lane-metres from the location of the loose mix or compaction core or both that represents the subplot; otherwise, a repair limit shall coincide with one end of the

Acceptance for lift thickness of the repaired subplot shall be based on the individual subplot lift thickness measurement and the lot thickness payment adjustment shall be calculated based on the re-evaluated subplot measurement.

332.09 MEASUREMENT FOR PAYMENT

332.09.01 Actual Measurement

332.09.01.01 Hot In-Place Recycled Mix

Measurement of HIR mix shall be by the horizontal area in square metres in place.

332.09.01.02 Tonne to Square Metre Conversion

When the Contract Documents refer to a quantity of material for HIR mix in tonnes and the Contract Documents do not already modify the quantity to relate to square metres, the Contract Administrator shall determine the theoretical quantity in square metres (Q_A) that shall replace the non-payment tonnage quantity (Q_t) references as follows:

$$Q_A = Q_t / [0.975 \times BRD_{MD} \times (T_D/1000)] \quad \text{(Formula 1)}$$

Where:

- BRD_{MD} = the bulk relative density in t/m^3 , provided in the HIR mix design submitted for HIR mix, the Q_A is calculated for
- T_D = the design thickness, in millimetres, of the HIR mix
- Q_t = non-payment tonnage quantity referred to elsewhere in the Contract Document for the HIR mix under the measurement by square metre item

332.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement. The Plan Quantity shall not be adjusted due to any of the exceptions specified in the Lift Thickness clause under the Sampling subsection.

332.10 BASIS OF PAYMENT

332.10.01 Hot In-Place Recycled Mix – Item

Payment at the Contract price for the above tender item shall include full compensation for all labour, Equipment, and Materials required to do the work, including rejuvenating agent and beneficiating HMA quantities if used, and the applicable payment adjustments.

No additional payment shall be made for the work, labour, Equipment, and Materials required to remove the existing pavement, and place HMA in areas not accessible to the heating and hot milling equipment.

The preparation and correction of existing HMA surfaces carried out in order to meet the requirements of the Contract Documents, including removal of materials such as cold mix patching material, crack sealant, and spray patch material; cold milling, hot milling, and the addition of beneficiating HMA; shall be at no cost to the Owner.

HMA required to retrofit partially paved shoulders or for pavement widening shall be paid for at the Contract price for the appropriate HMA tender item. No additional payment shall be made under this item for HMA required to retrofit partially paved shoulders or for pavement widening.

When repairing HIR mix, the Contractor shall be responsible for and shall carry out all associated work and replace or restore all associated damage and removals at no cost to the Owner.

When the Contract Administrator instructs the Contractor to cease HIR operations due to continued medium or severe segregation regardless of cause, the Owner shall not be held responsible for any additional costs that the Contractor may incur.

332.10.01.01 Payment Adjustment for Air Voids and Compaction

When the Contractor is not required to or does not elect to repair a lot, the payment adjustment for that lot due to air voids and compaction requirements shall be:

$$PA_{AVC} = \text{lot quantity} \times \text{Contract price} \times [PF_{AVC} - 1.0000] \times \text{TODRF} \quad (\text{Formula 2})$$

Where:

- PAAVC = payment adjustment for air voids and compaction
- lot quantity = the horizontal area of HIR mix in the lot in m²
- Contract price = for the purposes of payment adjustment due to air voids and compaction, means the Contract price of the HIR tender item
- PF_{AVC} = payment factor for combined air voids and compaction as determined according to the Calculations clause
- TODRF = means the tender opening date reduction factor given in Table 9

When the PF_{AVC} is:

- a) less than 1.0000, there shall be a reduction in payment,
- b) equal to 1.0000 there shall be no adjustment, and
- c) greater than 1.0000 there shall be an increase in payment for the lot.

332.10.01.01.01 Calculations

332.10.01.01.01.01 General

The PF_{AVC} shall be based on the individual payment factors obtained from Table 6, based on PWL, determined for air voids and compaction using LS-101 and the formulae in the Payment Factor for Combined Air Voids and Compaction clause. Rounding-off procedures for all calculations shall follow LS-100.

When there is no sampling or testing specified in the Contract Documents for an attribute or when the requirement for sampling or testing for an attribute is waived by the Owner, the payment factor for that attribute shall be equal to either:

- a) the payment factor it is added to in Formula 3, if that payment factor is less than 1.0000; or,
- b) 1.0000, if the payment factor it is added to in Formula 3, is equal to or greater than 1.0000.

332.10.01.01.01.02 Payment Factor for Combined Air Voids and Compaction

The payment factor for combined air voids and compaction (PF_{AVC}) shall be calculated using the following formulae:

$$PF_{AVC(SUB)} = PF_C + PF_{AV} \quad \text{(Formula 3)}$$

$$\text{If } PF_{AVC(SUB)} \text{ is greater than or equal to 2, then } PF_{AVC} = PF_{AVC(SUB)} - 1 \quad \text{(Formula 4)}$$

$$\text{If } PF_{AVC(SUB)} \text{ is less than 2, then } PF_{AVC} = PF_{AVC(SUB)} / 2 \quad \text{(Formula 5)}$$

Where:

PF_C = payment factor for compaction from Table 6

PF_{AV} = payment factor for air voids from Table 6

The PF_{AVC} shall be rounded and reported to four decimal places.

When the Contract Administrator decides that the unrepaired area of an original lot that has been partially repaired shall not be resampled, the PF_{AVC} for the unrepaired area shall be 1.0000.

332.10.01.01.01.03 Small Quantity Lots

For any lot comprised of one or two sublots, the lot shall be assigned a PF_{AVC} of 1.0000 if the lot is not rejectable. If the subplot is determined to be rejectable, it shall be administered as described in the Repairs subsection. If a rejectable subplot is allowed to remain in the work, a payment factor of 1.0000 shall be given to each attribute that is not rejectable, and the payment factor for PWL = 50% from Table 6 shall be given to each attribute that is rejectable. The PF_{AVC} for the subplot shall be calculated using the formulae detailed in the Calculations clause.

332.10.01.02 Payment Adjustment for Gradation

When the Contractor is not required to repair a lot, the payment adjustment for that lot due to gradation requirements shall be a reduction in payment. The payment adjustment for gradation shall be calculated using the following formula:

$$PA_G = \text{lot quantity} \times \text{Contract price} \times [PF_{DLS} + PF_{4.75} + PF_{75}] \times \text{TODRF} \quad \text{(Formula 6)}$$

If DLS gradation is rejectable then $PF_{DLS} = 0.04$

If DLS gradation is acceptable then $PF_{DLS} = 0$

If the 4.75 mm sieve gradation is rejectable then $PF_{4.75} = 0.04$

If the 4.75 mm sieve gradation is acceptable then $PF_{4.75} = 0$

If the 75 μ m sieve gradation is rejectable then $PF_{75} = 0.04$

If the 75 μ m sieve gradation is acceptable then $PF_{75} = 0$

Where:

PA_G = payment adjustment for gradation

PF_{DLS} = payment factor for the DLS gradation

$PF_{4.75}$ = payment factor for the 4.75 mm sieve gradation

PF_{75} = payment factor for the 75 μ m sieve gradation

lot quantity = shall be the horizontal area of HIR mix in the lot in m^2

Contract price = for the purposes of payment adjustment due to gradation, means the Contract price of the HIR tender item

TODRF = means the tender opening date reduction factor given in Table 9

332.10.01.03**Payment Adjustment for Asphalt Cement Content**

The payment adjustment for AC content shall apply to all placed and compacted HIR mix using the theoretical tonnage. The theoretical tonnage shall be calculated by the Contract Administrator as follows and rounded to one decimal according to LS-100:

$$T_{HIR} = [0.975 \times BRD_{HIR} \times (T_D/1000) \times \text{lot quantity}] \quad (\text{Formula 7})$$

Where:

T_{HIR}	=	the theoretical tonnage of HIR mix in the lot
BRD_{HIR}	=	the lot average bulk relative density in t/m ³ , calculated from values obtained in the testing of bulk samples obtained during production of the first complete lot of at least three sublots of HIR mix placed in the work. The values shall be the same as those used in calculating the final air voids payment factor for the lot.
T_D	=	the design thickness, in millimetres, of the HIR mix
lot quantity	=	shall be the horizontal area of HIR mix in the lot in m ²

A payment adjustment per tonne of AC shall be established for each lot.

The payment adjustment per tonne shall apply to the quantity of AC in the lot. The quantity of AC includes the existing AC and all grades of AC supplied by the Contractor with and without polymer modifiers.

A payment adjustment shall be applied based on the Ministry's PGAC price index. The price index is published monthly in the Contract Bulletin. The price index shall be used to calculate the amount of the payment adjustment per tonne of AC accepted into the Work.

The price index shall be based on the price, excluding taxes, FOB the depots in the Toronto area, of AC grade PG 58-28 or equivalent. One index shall be used to establish and calculate the payment adjustment for all grades.

The payment adjustment for AC content for each lot shall be calculated using the following formulae:

When $AC_{HIR} < AC_{SPEC} - 0.2\%$:

The payment adjustment for AC content shall be a reduction in payment for the lot.

$$PA_{AC} = T_{HIR} \times I_{TO} \times \{[AC_{HIR} - (AC_{SPEC} - 0.2)]/100\} \times TODRF \quad (\text{Formula 8})$$

When $AC_{HIR} \geq AC_{SPEC}$ and $\leq AC_{SPEC} + 0.5\%$:

The payment adjustment for AC content shall be an increase in payment for the lot.

$$PA_{AC} = T_{HIR} \times I_{TO} \times \{[AC_{HIR} - AC_{SPEC}]/100\} \times TODRF \quad (\text{Formula 9})$$

When $AC_{HIR} > AC_{SPEC} + 0.5\%$:

The payment adjustment for AC content shall be a reduction in payment for the lot.

$$PA_{AC} = T_{HIR} \times I_{TO} \times \{[(AC_{SPEC} + 0.5) - AC_{HIR}]/100\} \times TODRF \quad (\text{Formula 10})$$

Where:

AC_{HIR}	=	the lot mean percentage by mass of AC in the HIR mix
AC_{SPEC}	=	the percentage by mass of AC specified for the work as specified elsewhere in the Contract Documents
PA_{AC}	=	payment adjustment for AC content
T_{HIR}	=	the theoretical tonnage of HIR mix in the lot as calculated in Formula 7

I_{TO} = PGAC price index for the month prior to Tender Opening
 $TODRF$ = means the tender opening date reduction factor given in Table 9

332.10.01.04 Payment Adjustment for Recovered Asphalt Cement Performance Grade

The payment adjustment for RAC performance grade shall be a reduction in payment. The payment adjustment for RAC performance grade shall be calculated using the following formula:

$$PA_{RAC} = \text{sublot quantity} \times \text{Contract price} \times 0.05 \times TODRF \quad (\text{Formula 11})$$

Where:

PA_{RAC} = payment adjustment for RAC performance grade
sublot quantity = the horizontal area of HIR mix in the sublot in m^2
Contract price = the Contract price of the HIR tender item
 $TODRF$ = means the tender opening date reduction factor give in Table 9

332.10.01.05 Payment Adjustment for Segregated Hot In-Place Recycled Mix

Where a payment reduction for segregation is allowed in lieu of repairs, the payment reduction shall be calculated as follows:

- a) \$2,000 once for each tender item regardless of the existence of payment increases;
- b) an additional payment reduction of \$2.50/m for mid-lane segregation; and
- c) an additional payment reduction of \$5.00/ m^2 for other segregation. The area of each repair shall be computed by multiplying the full lane width by the length of the repair and rounded to the next whole square metre.

332.10.01.06 Payment Adjustment for Surface Smoothness

Payment adjustment for surface smoothness shall be as specified in the Contract Documents.

332.10.01.07 Payment Adjustment for Lift Thickness

The payment adjustment for lift thickness shall apply to all placed and compacted HIR mix using the horizontal area of the HIR mix in the lot. The payment adjustment for lift thickness shall be a reduction in payment. The payment adjustment for lift thickness shall be calculated using the following formula:

$$PA_T = \text{lot quantity} \times \text{Contract price} \times \{[1.000 - (T_L / T_D)] \times 2.0\} \times TODRF \quad (\text{Formula 12})$$

Where:

PA_T = payment adjustment for lift thickness
 T_L = lot mean, if lot mean is less than or equal to T_D (see definition)
or
 T_L = T_D , if lot mean is greater than T_D
lot quantity = the horizontal area of the HIR mix in the lot in m^2
Contract price = the Contract price of the HIR tender item
 $TODRF$ = means the tender opening date reduction factor given in Table 9

When a rejectable sublot remains in the work without repair, the sublot shall be subject to a payment adjustment. The payment adjustment shall be a reduction in payment. The payment adjustment for sublot lift thickness shall be:

$$PA_{\text{SUBLOT}} = \text{sublot quantity} \times \text{Contract price} \times 0.5 \times \text{TODRF}$$

(Formula 13)

Where:

PA_{SUBLOT}	=	payment adjustment for lift thickness of a subplot
sublot quantity	=	the horizontal area of HIR mix in the subplot in m ²
Contract price	=	the Contract price of the HIR tender item
TODRF	=	means the tender opening date reduction factor given in Table 9

332.10.02 Referee Testing and Segregation Challenge

332.10.02.01 Air Voids and Compaction

If the referee test results show that the referee payment factor for air voids or compaction is higher than the payment factor for air voids or compaction based on the original QA test results by more than 0.025 and the referee results show that the lot is not rejectable, the Owner shall bear the cost of the referee testing for that attribute.

If the referee test results show that the lot is rejectable or the referee test results show that the referee payment factor for air voids or compaction is not higher than the payment factor for air voids or compaction based on the original QA test results by more than 0.025, the Contractor shall be charged the cost of the referee testing.

When there is an outlier in the referee test results, the Contractor shall be charged 50 per cent of the total cost for referee testing of all sublots in the original lot.

The cost of the referee testing shall be based on the referee testing rates specified elsewhere in the Contract Documents.

332.10.02.02 Gradation and Asphalt Cement Content

The cost of the referee testing, including sample delivery, shall be borne by the Contractor, unless the testing confirms total conformance of the attribute to the Contract Documents, in which case the costs shall be borne by the Owner.

332.10.02.03 Recovered Asphalt Cement Performance Grade

The cost of the referee testing, including sample delivery, shall be borne by the Contractor, unless the testing confirms total conformance of the RAC performance grade to the Contract Documents or that the lot is categorized as minor borderline, in which case the costs shall be borne by the Owner.

332.10.02.04 Segregation Challenge

If under a challenge, as described in the Challenging Severity of Segregation clause, the Contractor is successful, then the Owner shall pay for the cost of the traffic control, if the traffic control was not necessary for any other reason. The Owner shall not be responsible for any other costs associated with the assessment, including the cost of delays.

If the Contractor is not successful, the Contractor shall be responsible for all costs associated with the assessment, including the cost of traffic control and delays.

332.10.02.05 Lift Thickness

If the referee test result is 3.0 mm or more greater than the original QA test result, the Owner shall bear the cost of the thickness measurement referee testing. If the referee test result is not 3.0 mm or more greater

than the original QA test result for the subplot retested, the Contractor shall be charged the cost of the referee testing.

332.10.03 Repairs

No payment shall be made for the:

- a) Quantity of HIR mix that is removed and replaced, overlaid, or otherwise repaired; or
- b) For additional shouldering, traffic control, and other work such as zone painting or bridge deck waterproofing,

when:

- a) in lieu of a reduction in payment, the Contractor repairs the lot, subplot, or visually defective HIR mix; or
- b) the Contract Administrator has determined that a rejectable lot or subplot requires repair.

No payment shall be made to repair areas of HIR mix damaged by traffic.

The Contractor shall be charged for all additional testing resulting from a repair to a lot at the rates established by the Owner for the year in which the testing was carried out.

TABLE 1
Specification Limits for Hot In-Place Recycled Mix Acceptance Attributes

Properties and Attributes	Mix Type HIR Mix is Required to Meet	Lower Limit (LL) %	Upper Limit (UL) %
AC Content	Any HMA type	$AC_{SPEC} - 0.2$ (Note 1)	$AC_{SPEC} + 0.5$ (Note 1)
Designated Large Sieve (DLS)	Superpave 12.5, 12.5FC 1, and 12.5FC 2	40	95
4.75 mm Sieve	Superpave 12.5, 12.5FC 1, and 12.5FC 2	40	65
75 µm Sieve	Superpave 12.5, 12.5FC 1, and 12.5FC 2	2	13
Air Voids	Any HMA type	2.0	5.5
Pavement Compaction	Superpave 12.5 and 12.5FC 1	91.5	97.0
	Superpave 12.5FC 2	91.5 (Note 2)	98.0

Notes:

1. AC_{SPEC} is the AC content specified in the Contract Documents.
2. Compaction shall be analyzed using a LL of 90.5% if the design lift thickness is less than 50 mm. If the PWL compaction using a LL of 90.5% is greater than 95, the compaction PWL shall also be calculated using a LL of 91.5%, and the payment factor shall be determined for each LL using Table 10. The highest calculated payment factor shall be used.

TABLE 2
Maximum Field Adjustments For Job Mix Formula

JMF Properties	Maximum Field Adjustment % (Notes 1 and 2)
AC Content	± 0.2
Per cent passing DLS sieve	± 5.0
Per cent passing 4.75 mm sieve	± 3.0
Per cent passing 75 µm sieve	± 1.0

Notes:

1. The maximum field adjustment is applied against the original JMF submitted with the mix design.
2. The adjusted JMF shall meet the requirements of the Contract, including AC content and gradation on all sieves.

**TABLE 3
Sample Size and Frequency**

Material Sample	Properties and Attributes	Quantity of Production Samples (Note 1)	Frequency of Sampling
HIR Loose Mix	Air Voids, Gradation, and AC Content	20 to 30 kg (Note 2)	Every subplot
	RAC Performance Grade	10 kg	Every lot
HIR Core	Compaction	One set of cores (Note 3)	Every subplot
	Lift Thickness	Single core	Every subplot

Notes:

1. Each material sample receptacle shall have a maximum mass of 30 kg. For ease of handling, especially when the larger sample size is required, splitting of material at the paving site is permitted such that a sample is contained in a maximum of two receptacles whose total mass does not exceed the maximum specified above. Once delivered to testing laboratories, combining of the material from the two receptacles is only mandatory if a single receptacle contains insufficient material to carry out the full suite of tests required.
2. The larger sample size shall be applicable when samples are designated for testing to the maximum number of gyrations. The frequency of the larger samples shall be one per lot, as designated by the Contract Administrator.
3. Each core a minimum thickness of 35 mm.

**TABLE 4
Testing Requirements**

Properties and Attributes	Testing Method (Note 1)	Calculations, Values, and Results Required
HIR Mix Properties		
AC Content and Gradation for HIR mix samples	LS-291, LS-282, or LS-292	% AC % passing DLS sieve % passing 4.75 mm sieve % passing 75 µm sieve
Volumetric Properties of HIR Mix		
Laboratory Compaction to: i. Design number of gyrations (N _{des}) ii. Maximum number of gyrations (N _{max}) Maximum Theoretical Specific Gravity (G _{mm})	AASHTO T 166 using the same laboratory compaction protocol as was used in mix design. (Note 2) AASHTO T 312, LS-264 In addition to compacting all samples to the design number of gyrations, one sample from each lot of HIR mix shall be compacted to the maximum number of gyrations. Bulk Relative Density for HIR mix samples, BRD _m	BRD _m BRD at N _{des} BRD at N _{max} G _{mm} %G _{mm} @ N _{des} %G _{mm} @ N _{max}
Voids in Mineral Aggregate (VMA)	LS-604, LS-605, AASHTO R 35 (Note 3)	VMA (Note 4)
Voids Filled with Asphalt (VFA)	AASHTO R 35	VFA (Note 4)
Air Voids for mix (V _a)	LS-265	V _a
Dust to Binder Ratio (D _p)	AASHTO R 35	D _p (Note 4)
Compaction of HIR Mix		
Compaction and Thickness of Cores	BRD _c = Bulk Relative Density for core samples, LS-262 (Note 2) MRD _m = G _{mm} (Maximum Relative Density for loose mix samples, LS-264) % Compaction = (100 x BRD _c /MRD _m)	Thickness of Core % Compaction
Lift Thickness of HIR Mix		
Lift Thickness	LS-294	Thickness of Lift
<p>Notes:</p> <ol style="list-style-type: none"> The rounding-off procedure, for all values, shall be according to LS-100. For all gyratory-compacted specimens and cores, if the per cent water absorbed by the specimen is found to exceed 2% by volume, as described in AASHTO T 166, then the bulk relative density shall be determined using either LS-306 or ASTM D 6752. Calculate to two decimal places for each subplot using the BRD_m for the subplot, and the combined aggregate densities of the blended coarse and blended fine aggregate, as specified in the Contract Documents, to provide a lot mean VMA to one decimal place. For information only. 		

TABLE 5
Breakdown of the Tender Item Quantity into Lots for Air Voids and Compaction

Quantity of Square Metres	Number of Lots
< 40,000	1
40,000 to 80,000	2
80,000 to 100,000	2 or 3 (Note 1)
> 100,000	3 +
Notes: 1. As determined by the Contract Administrator in consultation with the Contractor.	

TABLE 6
Payment Factors Based on Per Cent Within Limits

PWL	Air Voids	Compaction (Note 1)	PWL	Air Voids	Compaction (Note 1)	PWL	Air Voids	Compaction (Note 1)
100	1.020	1.030	64	0.858	0.773	28	0.280	0.364
99	1.013	1.024	63	0.839	0.764	27	0.270	0.351
98	1.007	1.018	62	0.820	0.755	26	0.260	0.338
97	1.000	1.012	61	0.799	0.746	25	0.250	0.325
96	1.000	1.006	60	0.778	0.738	24	0.240	0.312
95	1.000	1.000	59	0.755	0.729	23	0.230	0.299
94	1.000	1.000	58	0.731	0.720	22	0.220	0.286
93	1.000	1.000	57	0.706	0.711	21	0.210	0.273
92	1.000	1.000	56	0.680	0.703	20	0.200	0.260
91	1.000	1.000	55	0.653	0.694	19	0.190	0.247
90	1.000	1.000	54	0.624	0.685	18	0.180	0.234
89	1.000	0.991	53	0.595	0.676	17	0.170	0.221
88	1.000	0.983	52	0.564	0.668	16	0.160	0.208
87	1.000	0.974	51	0.533	0.659	15	0.150	0.195
86	1.000	0.965	50	0.500	0.650	14	0.140	0.182
85	1.000	0.956	49	0.490	0.637	13	0.130	0.169
84	1.000	0.948	48	0.480	0.624	12	0.120	0.156
83	1.000	0.939	47	0.470	0.611	11	0.110	0.143
82	1.000	0.930	46	0.460	0.598	10	0.100	0.130
81	1.000	0.921	45	0.450	0.585	9	0.090	0.117
80	1.000	0.913	44	0.440	0.572	8	0.080	0.104
79	0.999	0.904	43	0.430	0.559	7	0.070	0.091
78	0.998	0.895	42	0.420	0.546	6	0.060	0.078
77	0.995	0.886	41	0.410	0.533	5	0.050	0.065
76	0.991	0.878	40	0.400	0.520	4	0.040	0.052
75	0.986	0.869	39	0.390	0.507	3	0.030	0.039
74	0.980	0.860	38	0.380	0.494	2	0.020	0.026
73	0.973	0.851	37	0.370	0.481	1	0.010	0.013
72	0.964	0.843	36	0.360	0.468	0	0.000	0.000
71	0.955	0.834	35	0.350	0.455			
70	0.944	0.825	34	0.340	0.442			
69	0.933	0.816	33	0.330	0.429			
68	0.920	0.808	32	0.320	0.416			
67	0.906	0.799	31	0.310	0.403			
66	0.891	0.790	30	0.300	0.390			
65	0.875	0.781	29	0.290	0.377			

Notes:

1. HIR mix required to meet the requirements of Superpave 12.5FC 2 compaction with a design lift thickness less than 50 mm, shall be analyzed using a lower limit (LL) of 90.5%. If the PWL compaction using a LL of 90.5% is greater than 95, the compaction PWL shall also be calculated using a LL of 91.5%, and the payment factor shall be determined for each LL using Table 10. The highest calculated payment factor shall be used.

TABLE 7
Minimum Lift Thickness

Design Lift Thickness (T_D) mm	Minimum Sublot Lift Thickness mm
< 40	$T_D - 7$
≥ 40	$T_D - 10$

TABLE 8
Allowable Macrotecture Ratios for Hot In-Place Recycled Mixes

Macrotecture Ratio (M_R)		
Degree of Segregation		
Slight	Medium	Severe
< 1.6	1.6 to 2.2	> 2.2

TABLE 9
Tender Opening Date Reduction Factor

Year of Tender Opening	Tender Opening Date Reduction Factor (TODRF)
2015	0.50
2016	0.50
2017	0.75
2018 +	1.00

TABLE 10
Superpave 12.5FC 2 with Design Lift Thickness less than 50 mm
Pay Factors for Per Cent Within Limits > 95%

PWL	LL = 90.5%	LL = 91.5%
100	1.015	1.030
99	1.012	1.024
98	1.009	1.018
97	1.006	1.012
96	1.003	1.006

**Appendix 332-A, Commentary for OPSS 332, 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

No information provided here

Related Ontario Provincial Standard Drawings

No information provided here.