CONSTRUCTION SPECIFICATION FOR HOT IN-PLACE RECYCLING

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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.

332.02 REFERENCES

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 1003 Aggregates - Hot Mix Asphalt
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 Mixtures
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 Rotary Evaporator
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

American Association of State Highway and Transportation Officials (AASHTO)

T 166-16 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 312-19 Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

ASTM International

D6752 - 18 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
E178 - 16 Standard Practice for Dealing with Outlying Observations

332.03 DEFINITIONS

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

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 Job Mix Formula (JMF) means a change in the target gradation, rejuvenating agent content, beneficiating HMA content, or any combination, of a HIR mix without a redesign of the HIR mix, resulting in an adjusted 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.

Job Mix Formula (JMF) means the percentage passing on each designated sieve of the total mass of aggregate, the amount of rejuvenating agent, and the amount of asphalt cement as a percent by mass of the HIR mix that are based on specified mix design procedures.

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, measured according to LS-294, 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.

Recovered Asphalt Cement (RAC) means the AC extracted and recovered from the HIR mix according to 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.

332.04 DESIGN AND SUBMISSION REQUIREMENTS

332.04.01 Design Requirements

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

332.04.02 Submission Requirements

A copy of the technical data sheet and safety data sheet of the release agent(s) shall be submitted to the Contract Administrator.

The submission of additional information for HIR mixes shall be according to OPSS 1151 and as specified in the Contract Documents.

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. Asphalt cement, anti-stripping treatments, release agents, rejuvenating agents, and other additives shall be compatible with the other components of the HIR mix.

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

The aggregates used in the beneficiating HMA shall be according to OPSS 1003 for the HMA mix type the HIR mix is required to meet as specified in the Contract Documents. Asphalt cement, anti-stripping treatments, release agents, and other additives shall be compatible with the other components of the beneficiating HMA.

The PGAC used in the beneficiating HMA shall be according to OPSS 1101 and as specified in the Contract Documents for the performance grade specified for the HIR mix in the Contract Documents.

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

332.05.01.03 Rejuvenating Agents

The rejuvenating agent incorporated into the HIR mix shall not contain any wax components.

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 1.2 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

The 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.

Up to three additional cores may be taken in each surface lot for QC purposes. Cores shall not be spaced closer than one metre 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 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.

c) The Contractor shall be responsible for preparing the existing HMA surface by removing all materials such as cold mix patching material, crack sealant, and spray patch material, as the deemed necessary for the HIR mix to meet the requirements of the Contract Documents.

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.

332.07.03 Transportation of Beneficiating Hot Mix Asphalt

Truck boxes used to transport beneficiating 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.

332.07.04 Placing Hot In-place Recycled Mix

332.07.04.01 Operational Constraints

The HIR mix shall not be placed unless the ambient air temperature is at least 7 ºC.

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 ºC or less.

A lot shall be closed before paving begins on a different lot using the same tender item, the same mix design, or both, unless otherwise allowed by the Contract Administrator.

332.07.04.02 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, immediately in front of the placement unit, shall be heated to a temperature of 60 to 80 ºC.

When inspection and testing indicate 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 all the hot milled material from the road, in a blending unit, and 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 reprocess the edge of the previously HIR adjacent surface. Heating units shall overlap the previously HIR adjacent surface by a minimum of 100 mm such that it is heated to a temperature of 80 to 100 ºC immediately prior to placement of the HIR mix. The hot milling units shall reprocess the edge of the previously HIR adjacent surface by a minimum of 50 mm.

The HIR mix shall be a minimum temperature of 110 ºC, 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 including, but not limited to, cracks, segregation, fat spots, oil spills, chatter, and roller marks.

All through lane HIR mix shall be completed prior to the placement of adjacent sideroads.

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 tack coated according to OPSS 308, paved according to OPSS 313, and the HMA mix type and the HIR mix shall be as specified in the Contract Documents. 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 actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct to cease HIR operations until the problem has been corrected.

332.07.05 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 offset 50 mm from the edge of the demarcation between the lanes as specified in the Contract Documents.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction.

332.07.06 Compaction

Compaction of the HIR mix shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat as specified in 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.

332.07.07 Field Adjustments to the Job Mix Formula

The JMF may be adjusted to more closely reflect the HIR mix being produced unless a new mix design is required according to OPSS 1151 and as specified in the Contract Documents. The adjusted JMF shall be submitted in writing to the Contract Administrator within one Business Day of the field adjustment to the JMF.

332.07.08 Sampling

332.07.08.01 Mix Properties and Recovered Asphalt Cement Performance Grade

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

Each random sample location from which the sample is to be taken shall be as designated by the Contract Administrator. A set of two samples shall be taken according to Table 2. 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 at the paver once the rejuvenating agent, or beneficiating HMA, or both have been added.

When the mass of the sample does not meet the requirements of Table 2, the sample shall be discarded and a new one taken immediately.

332.07.08.02 Compaction

Upon completion of each sublot, the Contract Administrator shall submit in writing, notification of each random sample location. Pavement core samples shall be obtained in duplicate from each sublot no later than the next Business Day after the completion of the sublot. Each core shall meet the following requirements:

a) Have a minimum nominal diameter of 150 mm and a maximum nominal diameter of 200 mm, and

b) 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 ± 0.1 m between each individual core edge.

Cores shall not be 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.

Core samples shall also include design lift thickness on the label. The lot and sublot 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.

A one-litre sample of the release agent(s) shall be delivered to the Contract Administrator upon request.

332.07.08.03 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 as specified in the Contract Documents.

All areas of HIR paving as specified in the Contract Documents, including paved shoulders, shall be sampled for lift thickness.

Upon completion of each sublot, the Contract Administrator shall submit in writing notification of the location to be used for sampling. One pavement core sample shall be obtained from each sublot no later than the next Working Day after completion of the sublot. This one core shall be used for both QA and referee testing.

Each core shall have a nominal diameter of 50 mm, shall consist of the HIR mix placed in the sublot, 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 sublot 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 sublot’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.

332.07.09 Performance Graded Asphalt Cement

If beneficiating HMA is used, samples of the PGAC added to the beneficiating HMA shall be taken according to OPSS 1101 and as specified in the Contract Documents.

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 3. The Contractor shall be provided with results from the completed tests. Payment factors and payment adjustments for each lot shall be determined by the Contact Administrator based on the QA test results as specified in the Contract Documents. Unless referee testing is invoked, 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

i) PGAC Physical Requirements

332.08.01.01 Air Voids and Compaction

332.08.01.01.01 Lot Size

Before the HIR operation starts, a discussion with the Contract Administrator shall happen regarding their determination of the size and location of the lots and sublots. Guidelines for the breakdown of the tender item quantity into lots are as listed in Table 4. Generally, lot size is 40,000 m^2 with sublots of 4,000 m^2; however, sublot sizes shall be adjusted to ensure a minimum of three sublots per lot.

When the tender item quantity is less than 4,000 m^2, the lot shall be divided into at least three sublots as determined by the Contract Administrator, unless such division is deemed impractical by mutual agreement.

When only one or two 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 three to nine sublots are completed due to the above circumstances, then the three to nine 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, a request in writing prior to the end of the 20 Business Days, may be submitted 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 5. 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.

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 repair of the lot is chosen 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 or LS-292, the specification limits specified in Table 1, and sublot acceptability.

Sublot test results shall be acceptable if they meet the specification limits specified in Table 1. If a sublot test result for any payment adjustment sieve or AC content does not meet the specification limits specified in Table 1, the sublot shall be deemed rejectable and shall be repaired as detailed in the Repairs subsection. When a lot contains any sublot that is deemed rejectable, the lot is rejectable until the sublot has been repaired and re-evaluated as acceptable. The repaired sublot shall be re-evaluated using the test results for the repaired sublot and used in determining payment and acceptance of the lot. When the Contract Administrator allows a rejectable sublot to remain in place without repair, the sublot test result for the rejectable sublot shall be treated as a lot with one sublot 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 sublot 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 sublot test results in the lot according to LS-100. 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 according to OPSS 1101 and as specified in the Contract Documents.

Disposition of HIR mix with borderline or rejectable lots shall be according to OPSS 1101 and as specified in the Contract Documents.

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

The HMA deemed by visual appearance to have flushing, bleeding, segregation, fat spot, surface damage, cracking, chatter, or surface contamination but not limited to these, shall be considered deficient material or work. Traffic control shall be provided 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

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

The 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 based on segregation but because 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. There shall be one lot consisting of all HIR tender items when the entire Contract has the same T_D. 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 m^2 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 sublot lift thickness measurements and lot mean lift thickness of the tender item. The Contract Administrator shall calculate the thickness payment adjustment for the lot once all measurements for the lot have been completed.

Sublot lift thickness shall be acceptable if they are equal to or greater than the minimum sublot lift thickness specified in Table 6 for the tender item's T_D. The sublot shall be deemed rejectable and shall be repaired if the lift thickness measurement is less than the minimum sublot lift thickness specified in Table 6. The repaired sublot shall be re-evaluated using the lift thickness measurement for the repaired sublot and used in determining payment of the lot.

The Contract Administrator shall calculate the lot mean lift thickness for each tender item to one decimal point and the lot payment adjustment for lift thickness based on all the sublot lift thickness measurements in the lot according to LS-100 and the Payment Adjustment for Lift Thickness clause. If the lot mean is less than 85% of the T_D, the lot is rejectable.

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

The Owner shall determine if a rejectable lot may remain in the work without repairs. When the Owner has determined that a rejectable lot may remain in the work without repair, the lot shall be subject to a payment reduction as determined by the Owner.

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, as 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 provide notification in writing that the pavement is rejectable. A written proposal for corrective action shall be submitted 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 Performance Grade Asphalt Cement Physical Requirements

The Contract Administrator shall determine the acceptability of the PGAC incorporated into the beneficiating HMA according to OPSS 1101 and as specified in the Contract Documents.

332.08.01.10 Optional Trial

When the HIR tender item quantity is 40,000 m^2 or more, an optional trial of one lot, not exceeding 4,000 m^2, with one sublot shall be permitted. If this optional trial is chosen, the Contract Administrator shall be advised 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.

332.08.01.11 Small Quantity Lots

Small quantity lots shall not be subject to payment adjustment unless the HIR mix is rejectable. Acceptance for these lots shall be on a sublot-by-sublot basis. The sublot 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

A single request for referee testing for a given lot can only be invoked within five Business Days after the QA test results for that lot have been received and where applicable, the Contract Administrator's calculated QA payment factors and payment adjustments for that lot have been received.

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. For all sublots in the referee request, 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 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 referee laboratory shall use LS-282.

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

When referee testing for compaction is invoked, the referee laboratory shall determine the MRD of the referee loose mix sample for the sublot, and this value shall be used in the calculation of compaction for the referee core.

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 according to OPSS 1101 and as specified in the Contract Documents.

332.08.02.04 Challenging Severity of Segregation

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

For Contracts with up to 240,000 m^2 of HIR mix, a maximum of two separate written challenges for each tender item shall be permitted. For Contracts with more than 240,000 m^2 of HIR mix, a maximum of four separate written challenges for each tender item shall be permitted. Each written challenge may involve more than one disputed segregated area.

The Owner or 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. All necessary surface preparations and traffic control shall be provided so that this second visual assessment shall be carried out within five Business Days after the Contract Administrator has received the written challenge. The results of that second visual assessment shall be binding on both the Owner and Contractor.

A further challenge may be made to the Owner's second visual assessment of the segregation severity. Such a challenge shall be made in writing within five Business Days of receiving the Owner's second visual assessment. Such a challenge shall be resolved by the Owner or a representative of the Owner determining the macrotexture ratio, according to LS-317. All necessary surface preparations and traffic control shall be provided during the field measurements for macrotexture ratio. Table 7 shall be used with the macrotexture ratio to determine the degree of severity and the disposition of the disputed area of segregation. The macrotexture ratio results shall be binding on both the Owner and the Contractor.

332.08.02.05 Lift Thickness

An individual lift thickness measurement may be challenged by requesting referee testing in writing to the Contract Administrator within five Business Days after receiving the sublot thickness measurement. An opportunity shall be permitted to view the re-measurement of the QA designated pavement core for that sublot at an alternative Owner designated 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 sublot.

332.08.02.06 Outlier in Referee Results

Where an entire lot of three or more sublots has been referee tested, an individual value for any attribute of a sublot's test result, excluding lift thickness may be questioned. The request shall be made within three Business Days after receiving all 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 E178 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 sublot shall be checked for mathematical errors. If there are no mathematical errors, the sublot with the outlier is treated as a lot with one sublot 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 sublot.

332.08.03 Repairs

332.08.03.01 General

All repairs shall be performed at no additional cost to the Owner. No repairs are permitted prior to completion of a lot.

The materials and the construction of repairs shall meet the acceptance criteria and other 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. Except for 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.

332.08.03.02 Repairs for Mix Properties, Compaction, and Recovered Asphalt Cement Performance Grade

For a lot that is not rejected, repairs may be chosen in lieu of accepting a payment adjustment if 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 repairs are chosen in lieu of accepting a payment adjustment, areas of HIR mix in a lot that are to be repaired shall be determined 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 compaction core sample locations or both representing that sublot.

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 sublot; otherwise, a repair limit shall coincide with one end of the sublot when the sample location is less than 125 lane-metres from it. If the proposed limit of a single repair falls within the proposed limit of another single repair, the overlap shall count towards the 250 lane-metre minimum for both repairs. Repair areas within a single lane shall be separated by at least 100 m. If the delineation of repair areas results in patches less than 100 metres apart, these repair areas shall be re-established to form a continuous repair.

A list and sketch identifying the proposed locations of the repairs shall be submitted to the Contract Administrator for review at least five Business Days prior to the intended start of the repair work. Each sublot and single repair shall be uniquely labelled. Overlapping repair areas and discontinuous portions of a single repair shall be labelled so that they are readily identified with their single repair.

Prior to the repair, slab samples or cores shall be taken for testing of mix properties, RAC performance grade, or compaction, or all in the unrepaired area within 1 m of the limits of each end of the repair area. Additional samples or cores shall not be permitted to be taken beyond these locations until after QA, or referee testing demonstrates that the remaining Material in the sublot proposed for repair is deemed to be rejectable. If the proposed repair limit coincides with the beginning of a sublot that is being left unrepaired, samples are not required at this location. Sufficient Material shall be obtained for testing by the Owner's QA laboratory, and for possible referee testing.

Testing shall demonstrate that the remaining Material in the sublot proposed for repair is not rejectable. To determine if the HIR mix is rejectable, the mix properties, RAC performance grade, and compaction shall comply with the basis of acceptance of lots with one or two sublots. If the Material is deemed to be rejectable, the proposed limit of the repair shall be extended by a minimum of 25 m and the sampling and testing repeated. The repair area selected shall incorporate the location used for obtaining samples that shall be used to confirm that the remaining HIR mix is not rejectable. If the repair proposal results in the removal of at least half the sublot quantity, the Contract Administrator may waive testing demonstrating the suitability of the remainder of that sublot.

The unrepaired sublots combined with the unrepaired areas of any repaired sublots shall comprise one lot and shall be assessed based on the loose mix and core samples representing the unrepaired sublots. When a repaired sublot consists of two or more separate unrepaired areas, the Contract Administrator shall decide whether to combine these unrepaired areas as one sublot or to consider each unrepaired area as a separate sublot. If there are only one or two sublots in a lot that are not repaired, the Contract Administrator shall include those sublots as part of the previous or next lot.

The HIR or HMA mix used for the repair shall comprise a separate lot or, prior to beginning any repair, the Contract Administrator in conjunction with the Contractor may decide to include it as part of the current lot being produced. The repaired area shall be tested and assessed for all acceptance criteria specified in the Acceptance Criteria subsection and re-evaluated for acceptance.

The two reconfigured lots shall be accepted at the full Contract price, subjected to a payment adjustment or rejected according to the Payment Adjustment for Air Voids and Compaction clause, Payment Adjustment for Gradation clause, Payment Adjustment for Asphalt Cement Content clause, and Payment Adjustment for Recovered Asphalt Cement Performance Grade clause.

332.08.03.03 Repairs for Surface Tolerance

All areas not meeting the surface tolerance requirements shall be repaired by diamond grinding to a maximum of 5 mm or removed and replaced. Slurry produced from diamond grinding shall be removed from the site and managed as specified in the Contract Documents. The repaired areas shall be re-evaluated for surface tolerance acceptance by means of a 3 m straight edge as specified in the Surface Tolerance clause.

332.08.03.04 Repairs for Lift Thickness

Any repairs solely to correct for excess lift thickness shall not be permitted. The minimum length of a repair is the entire length of the sublot being repaired.

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

$Q_A = Q_t / [0.975 \times BRD_{MD} \times (T_D/1000)]$ (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 tender 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 additional cost to the Owner.

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, all associated work and replacing or restoring all associated damage and removals shall be carried out at no additional cost to the Owner.

When the Contract Administrator instructs to cease HIR operations due to continued medium or severe segregation regardless of cause, there shall be no additional cost to the Owner.

332.10.01.01 Payment Adjustment for Air Voids and Compaction

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

PA_{AVC} = lot quantity x Contract price x $[PF_{AVC} - 1.0000]$ (Formula 2)

Where:

PA_{AVC} = payment adjustment for air voids and compaction

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

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

When the PF_{AVC} is:

a) Less than 1.0000, there shall be a reduction in payment, and

b) Equal to 1.0000 there shall be no adjustment.

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 5, based on PWL, determined for air voids and compaction using LS-101, Table 1, 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 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:

$$PF_{AVC} = (PF_C + PF_{AV}) / 2 \qquad \text{(Formula 3)}$$

Where:
PF_C = payment factor for compaction from Table 5
PF_{AV} = payment factor for air voids from Table 5

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 small quantity lots, each sublot shall be assigned a PF_{AVC} of 1.0000 if the sublot is not rejectable. If the sublot is determined to be rejectable, it shall be administered as described in the Repairs subsection. When the Owner has determined that a rejectable sublot may remain in the work without repair, the lot shall be subject to a payment reduction reflecting the extent of the non-conformance as determined by the Owner.

332.10.01.02 Payment Adjustment for Gradation

When repair is not required or repair is not chosen for 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:

$$PA_G = \text{lot quantity} \times \text{Contract price} \times [PF_{DLS} + PF_{4.75} + PF_{75}] \qquad \text{(Formula 4)}$$

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

332.10.01.03 Payment Adjustment for Asphalt Cement Content and Changes in the Asphalt Cement Price Index

332.10.01.03.01 Hot In-place Recycled Mix Quantity Calculation

The quantity of HIR mix for use in the calculations (T_{HIR}) shall be the theoretical tonnage of HIR mix accepted into the work.

The theoretical tonnage shall be calculated by the Contract Administrator as follows and rounded to one decimal according to LS-100:

$T_{HIR} = [0.975 \times BRD_{HIR} \times (T_D/1000) \times \text{lot quantity}]$ (Formula 5)

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

332.10.01.03.02 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 as calculated in the Hot In-place Recycled Mix Quantity Calculation clause.

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 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 $AC_{HIR} < AC_{SPEC} - 0.1\%$:
The payment adjustment for AC content shall be a reduction in payment for the lot.

$PA_{AC} = T_{HIR} \times I_{TO} \times \{[AC_{HIR} - (AC_{SPEC} - 0.1)]/100\}$ (Formula 6)

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.

$PA_{AC} = T_{HIR} \times I_{TO} \times \{[AC_{HIR} - AC_{SPEC}]/100\}$ (Formula 7)

When $AC_{HIR} > AC_{SPEC} + 0.5\%$:
The payment adjustment for AC content shall be a reduction in payment for the lot.

$PA_{AC} = T_{HIR} \times I_{TO} \times \{[(AC_{SPEC} + 0.5) - AC_{HIR}]/100\}$ (Formula 8)

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 5
I_{TO} = PGAC price index for the month prior to Tender Opening

332.10.01.03.03 Payment Adjustment for Changes in the Asphalt Cement Price Index

When beneficiating HMA is used, a payment adjustment shall be applied based on changes to the Ministry's PGAC price index unless the Contract Administrator is notified in writing of the choice to opt out within five Business Days of receiving permission to start work. Once opted out of payment adjustments based on the price index, opt back in shall not be permitted. The price index is published monthly in the Contract Bulletin. The price index is used to calculate the amount of the payment adjustment per tonne of new AC accepted into the Work.

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

A payment adjustment per tonne of new AC is established for each moth in which paving occurs when the price index for the month differs by more than 5% from the price index for the month prior to Tender Opening. When the price index differential is less than 5%, there is no payment adjustment established for that month. Payment adjustments due to changes in the price index are independent of any other payment adjustments made to the HIR tender items.

The payment adjustment for the month is calculated from the following formulae:

When $I_P > 1.05\ I_{TO}$:
The payment adjustment for changes in the PGAC Price Index shall be an increase in payment for the lot.

$PA_{PI} = (I_P - 1.05\ I_{TO}) \times T_{AC}$ (Formula 9)

When $I_P < 0.95\ I_{TO}$:
The payment adjustment for changes in the PGAC Price Index shall be a reduction in payment for the lot.

$PA_{PI} = (0.95\ I_{TO} - I_P) \times T_{AC}$ (Formula 10)

Where:
PA_{PI} = payment adjustment for new AC due to changes in the PGAC price index, in dollars
I_P = PGAC price index for the month in which paving occurs
I_{TO} = PGAC price index for the month prior to Tender Opening
T_{AC} = quantity of new AC in the HIR mix, in tonnes calculated as follows:

$T_{AC} = [AC_{ben}/100] \times [\%ben/100] \times T_{HIR\_mnth}$ (Formula 11)

Where:
AC_{ben} = the percentage of new AC in the beneficiating HMA as required by the JMF
%ben = the percentage of beneficiating HMA in the HIR mix as required by the JMF
T_{HIR_mnth} = the tonnage of HIR mix, as calculated in the Hot In-place Recycled Mix Quantity Calculation clause, accepted into the work during the month for which the payment adjustment was calculated.

The payment adjustment per tonne applies to the quantity of new AC in the beneficiating HMA accepted into the Work during the month for which it is established. The quantity of new AC includes all grades of AC supplied with and without polymer modifiers.

For each month in which a payment adjustment has been established, the quantity is calculated using the percentage of beneficiating HMA in the HIR mix accepted into the Work and the corresponding AC content of the beneficiating HMA as required by the JMF.

For beneficiating HMA mixes containing an AST-AC, the percentage of AST-AC is deducted from the percentage of new AC in the beneficiating HMA. No other deductions are made for any other additives.

332.10.01.04 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;

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.

332.10.01.05 Payment Adjustment for Surface Smoothness

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

332.10.01.06 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 = lot quantity x Contract price x $\{[1.000 - (T_L / T_D)] \times 2.0\}$ (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

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

$PA_{TSUBLOT}$ = sublot quantity x Contract price x 0.5 (Formula 13)

Where:
$PA_{TSUBLOT}$ = sublot payment adjustment for lift thickness
sublot quantity = the horizontal area of HIR mix in the sublot in m^2
Contract price = the Contract price of the HIR tender item

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 is more than 0.025, the Owner shall charge the cost of the referee testing.

When there is an outlier in the referee test results, the Owner shall charge 50% 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 as specified in the Contract Documents.

332.10.02.02 Gradation and Asphalt Cement Content

The cost of the referee testing shall be charged, 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 Segregation Challenge

When a challenge is successful, as described in the Challenging Severity of Segregation clause, 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.

When a challenge is not successful, as described in the Challenging Severity of Segregation clause, all costs associated with the assessment, including the cost of traffic control and delays shall be at no additional cost to the Owner.

332.10.02.04 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. Otherwise, the Contractor shall be charged the cost of the thickness measurement 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, repairs to the lot, sublot, or visually defective HIR mix are completed; or

b) The Contract Administrator has determined that a rejectable lot or sublot requires repair.

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

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

No additional payment shall be made for the cost of tolerance measurements of the repaired areas that are required by the Contract Administrator.

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	All HMA types	AC_{SPEC} - 0.4 (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	All HMA types	2.0	5.5
Pavement Compaction	Superpave 12.5 and 12.5FC 1	92.0	97.0
	Superpave 12.5FC 2	92.0	98.0

Notes:
1. AC_{SPEC} is the AC content specified in the Contract Documents.

TABLE 2
Sample Size and Frequency

Material Sample	Properties and Attributes	Sample Size (Note 1)	Frequency of Sampling
HIR Loose Mix (Note 2)	Air Voids, Gradation, and AC Content	20 to 30 kg (Note 3)	Every sublot
	RAC Performance Grade	10 kg	Every lot
HIR Core	Compaction	150 to 200 mm diameter	Every sublot
	Lift Thickness	50 mm diameter	Every thickness sublot

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. Loose mix samples shall be representative of the final HIR mix and shall be taken at the paver after the rejuvenating agent or beneficiating HMA or both have been added.
3. 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.

TABLE 3
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-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}
Air Voids for mix (V_a)	LS-265	V_a
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

Notes:
1. The rounding-off procedure, for all values, shall be according to LS-100.

2. 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 D6752.

TABLE 4
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 5
Payment Factors Based on Per Cent Within Limits

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

TABLE 6
Minimum Sublot Lift Thickness

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

TABLE 7
Allowable Macrotexture Ratios for Hot In-place Recycled Mixes

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