

332.02 REFERENCES

Section 332.02 of OPSS 332 is amended by the addition of the following:

American Association of State Highway and Transportation Officials (AASHTO):

R 66-16 Sampling Asphalt Materials

332.03 DEFINITIONS

The definitions of the following terms in Section 332.03 of OPSS 332 are deleted in their entirety and replaced by the following:

Beneficiating HMA means a HMA designed to be mixed with the hot milled material (HMM) and rejuvenating agent such that the final HIR mix shall be as specified in the Contract Documents.

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, in multiple stages, to the depth specified in the mix design submission with minimal fracturing of the existing aggregates.

Mix Design means the design of the proportions of hot milled materials; rejuvenating agent; and beneficiating HMA, if used, when uniformly mixed, that results in a final HIR mix as specified in the Contract Documents.

Rejuvenating Agent means an acceptable product that when added to the hot milled material and beneficiating HMA, if used; the RAC from the final HIR mix meets the requirements as specified in the Contract Documents.

Section 332.03 of OPSS 332 is amended by the addition of the following definition:

Shroud means a protective covering surrounding the heating beds of the recycling train for the purpose of containing emissions.

332.04 DESIGN AND SUBMISSION REQUIREMENTS

332.04.02 Submission Requirements

Subsection 332.04.02 of OPSS 332 is amended by the addition of the following:

The following information shall also be submitted in writing to the Contract Administrator no later than 14 Days prior to the start of the HIR operation:

- a) the company name under which the owner of the recycling train operates;
- b) the name, mailing address and telephone number of the owner of the recycling train;
- c) the serial number of each machine in the recycling train;

- d) the heating process used to soften the pavement;
- e) the design gaseous discharge flow rate of each machine in the recycling train stack and the most recent set of stack monitoring results;
- f) the maximum production rate in m³ per hour;
- g) the type of fuels used by each machine in the recycling train and the fuel consumption rates, in litres per hour or cubic metres per hour, at the maximum production rate;
- h) a description of the emission control equipment and their operating parameters;
- i) date of the latest maintenance of the emission control equipment; and
- j) a statement that the heating units and recycling train meet the requirements of Table A and signed by the equipment manufacturer.

332.05 MATERIALS

332.05.01 Hot In-place Recycled Mix

Subsection 332.05.01 of OPSS 332 is deleted in its entirety and replaced by the following:

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, and rejuvenating agents shall be compatible with the other components of the HIR mix.

332.05.01.02 Beneficiating Hot Mix Asphalt

The first paragraph of Subsection 332.05.01.02 of OPSS 332 is deleted in its entirety and replaced by the following:

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, and release agents shall be compatible with the other components of the beneficiating HMA.

332.05.01.03 Rejuvenating Agents

Clause 332.05.01.03 of OPSS 332 is deleted in its entirety and replaced by the following:

The rejuvenating agent incorporated into the HIR mix shall not contain any wax components and shall meet the requirements as specified in the Contract Documents.

332.06 EQUIPMENT

Section 332.06 of OPSS 332 is deleted in its entirety and replaced by the following:

332.06 EQUIPMENT

332.06.01 General

Individual heating units and the recycling train shall be equipped with emission control equipment such that the operator and other workers are not exposed to hazardous concentrations of fumes or gases produced from the operation, the heated pavement, or from the addition of the rejuvenating agent. Emissions from the HIR process shall not exceed the limits in Table A.

332.06.02 Heating Unit

A shroud must be in place during operation of any heating unit and the clearance between the lower extremity of the shroud and the road surface shall be less than or equal to 25 mm.

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.

332.06.03 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 and shall have the capability to be modified to accommodate a width of at least 4.5 m in a single pass of the recycling train.

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.

332.06.03.01 Blending Unit

The blending unit shall be capable of adding and thoroughly mixing the hot milled material, rejuvenating agent, and beneficiating HMA homogeneously in an onboard pugmill. The blending unit shall have:

- a) positive feed and shut off of the rejuvenating agent and beneficiating HMA, governed by the movement of the recycling train;
- b) mechanical or electrical control of the application of the rejuvenating agent and beneficiating HMA relative to and variable with the processing rate of the recycling train;
- c) a mechanical or electronic metering device capable of supplying an accurate indication of the quantity of rejuvenating agent and beneficiating HMA being added per m³;
- d) the equipment shall control the quantity of rejuvenating agent to within $\pm 5\%$ of the rejuvenating agent content in the JMF;
- e) a mechanical or electronic method of measuring the quantity of rejuvenating agent in the tank;

- f) a rejuvenating agent metering device capable of recording accumulated L to the accuracy of $\pm 2\%$ and be fully visible to the operator and Contract Administrator;
- g) heating of the rejuvenating agent shall be kept to within $\pm 5\text{ }^{\circ}\text{C}$ of the application temperature established by the manufacturer of the rejuvenating agent.

332.06.03.02 Hot Milling Unit

The hot milling unit shall be capable of uniformly milling the preheated HMA to the hot milling depth according to the mix design submission as specified in the Contract Documents using multi-stage hot milling.

332.06.04 Emission Control Equipment

Emission control equipment shall be provided to reduce gaseous hydrocarbon and particulate emissions from the HIR process. The emission control equipment shall collect any vapor and smoke through a vacuum duct and treat the effluent in an afterburner or central combustion unit.

Emission control equipment shall comply with the following:

- a) the combustion temperature of each afterburner unit must not be less than $650\text{ }^{\circ}\text{C}$;
- b) the temperature of each afterburner unit or central combustion unit must be displayed so it is observable at all times during the HIR process;
- c) the exhaust gas residence time within each afterburner unit shall not be less than 0.5 seconds;
- d) The afterburner units or central combustion unit shall be in operation at all times while pavement is being recycled.

332.06.05 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.

[* Designer Option, See Notes to Designer]

332.07 CONSTRUCTION

332.07.02 Preparation of Existing Pavement

Paragraph c) of Subsection 332.07.02 of OPSS 332 is deleted in its entirety and replaced by the following:

[** Designer Fill-in, See Notes to Designer]

[*** Designer Option, See Notes to Designer]

332.07.04 Placing Hot In-place Recycled Mix

332.07.04.01 Operational Constraints

Clause 332.07.04.01 of OPSS 332 is amended by the addition of the following:

The Contract Administrator may stop the HIR operation if any equipment is malfunctioning or deemed insufficient to place HIR mix as specified in the Contract Documents.

332.07.04.02 Paving

The first four paragraphs of Clause 332.07.04.02 of OPSS 332 are deleted in their entirety and replaced by the following:

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 according to the mix design submission as specified in the Contract Documents. The hot milling depth according to the mix design submission as specified in the Contract Documents shall be achieved by hot milling in multiple stages and shall not be completed in a single pass of a single milling head.

The underlying pavement, immediately in front of the placement unit, shall be heated to a temperature of 60 to 80 °C. The hot milled material shall not be heated over 150 °C.

When the average depth of heating and hot milling is not according to the mix design submission as specified in the Contract Documents, the process shall be immediately corrected.

Rejuvenating agent and beneficiating HMA, if used, shall be added to and mixed with the hot milled material, in a blending unit's onboard pugmill, in the amount according to the mix design submission as specified in the Contract Documents. All hot milled material shall be transferred to the onboard pugmill such that no hot milled material is left on the milled surface. The HIR mix shall be homogeneous after mixing.

332.07.08 Sampling

332.07.08.02 Compaction

Clause 332.07.08.02 of OPSS 332 is renamed Compaction and Lift Thickness.

[**** Designer Option, See Notes to Designer]

332.07.08.03 Lift Thickness

Clause 332.07.08.03 of OPSS 332 is deleted in its entirety.

Section 332.07 of OPSS 332 is amended by the addition of the following Subsection:

332.07.11 Rejuvenating Agent

At the Contract Administrator's request, a one litre sample of rejuvenating agent(s) shall be taken. All rejuvenating agent samples shall be representative of the material being used on site and shall be obtained at the paving site according to AASHTO R 66.

332.08 **QUALITY ASSURANCE**

332.08.01 **Acceptance Criteria**

332.08.01.07 **Lift Thickness**

332.08.01.07.01 **Lot Size**

Clause 332.08.01.07.01 of OPSS 332 is deleted in its entirety and replaced by the following:

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 be the same as the compaction sublots. A minimum of three sublots are required for each lot.

332.08.01.07.02 **Basis of Acceptance**

The first paragraph of Clause 332.08.01.07.02 of OPSS 332 is deleted in its entirety and replaced by the following:

Acceptance of HIR mix for lift thickness shall be based on subplot lift thickness measurements from compaction core samples and the 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.

332.08.01.08 **Geometrics and Longitudinal Joint Location**

332.08.01.08.01 **Basis of Acceptance**

[***** Designer Option, See Notes to Designer]

332.08.02 **Referee Testing**

332.08.02.02 **Mix Properties and Compaction**

Clause 332.08.02.02 of OPSS 332 is renamed Mix Properties, Compaction, and Lift Thickness and paragraph b) and c) are replaced by the following:

- b) Compaction and lift thickness only, or
- c) Mix properties, compaction, and lift thickness.

332.08.02.05 **Lift Thickness**

Clause 332.08.02.05 of OPSS 332 is deleted in its entirety.

Table 2 of OPSS 332 is deleted and replaced by the following:

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 subplot |
| | RAC Performance Grade | 10 kg | Every lot |
| HIR Core | Compaction | 150 to 200 mm diameter | 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. 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.

OPSS 332 is amended by the addition of the following Table:

TABLE A
Hot In-place Recycling Emission Limits

| Parameter | Concentration Limit (Note 1) | Production Limit |
|--------------------------------------|-------------------------------------|-------------------------|
| Carbon Monoxide | 500 mg/m ³ (1 h avg) max | 50 g/tonne max (Note 2) |
| Organics (Note 3) | 50 mg/m ³ (1 h avg) max | 2.5 g/tonne max |
| Organics Removal Efficiency (Note 4) | N/A | 80% max |
| Opacity (Note 5) | 20% | N/A |
| Particulates | 90 mg/m ³ max | N/A |

Notes:

1. Average concentrations for all afterburner or central combustion stacks in mg/m³ dry, corrected to 16% O₂ at 20 °C and 101.325 kPa.
2. Grams per tonne of asphalt recycled.
3. Sample for at least one continuous hour for each machine train unit.
4. Applies to direct fired infrared plants only and calculated as follows:
Organics Removal Efficiency = [(IC-OC)/IC] x 100
Where:
IC = organics entering the afterburner in grams per tonne, as a one hour average
OC = organics leaving the afterburner in grams per tonne, as a one hour average
5. For stack emissions and emissions which originate around the shroud.

NOTES TO DESIGNER:

- * Insert the following when recommended by the Regional Geotechnical Section in consultation with the Regional Quality Assurance Section. If this is not recommended, do not insert anything.

Section 332.06 is amended by the addition of the following subsection:

332.06.06 Material Transfer Vehicle

A Material Transfer Vehicle (MTV) shall be used to mechanically transfer the HIR mix from the blending unit to the placement unit. The MTV shall have a minimum surge capacity of 13.5 tonnes, shall be self-propelled, and capable of moving independent of the placement unit and shall be equipped with the following:

- a) front-dump hopper and conveyor that shall provide a positive restraint along the sides of the conveyor to prevent material spillage;
- b) paver hopper insert with minimum capacity of 12.7 tonnes; and
- c) mixer/agitator mechanism to re-mix consisting of a segmented, anti-segregation, re-mixing auger.

The MTV and HIR train shall work together to provide a continuous, uniform, segregation free flow of material. The number of units, speed of the placement unit, production rate, and speed of the MTV shall be coordinated to avoid stop and go operations. The wings of the paver receiving hopper shall not be raised (dumped) at any time during the paving operation. If the MTV malfunctions during HIR operations, the HIR operations may continue until such time as there is sufficient HIR placed to maintain traffic as determined by the Contract Administrator. HIR operations shall cease thereafter, until such time as the equipment is operational.

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- ** Insert Option A or Option B as recommended by the Regional Geotechnical Section.

OPTION A

- c) The existing HMA surface shall be prepared by removing all materials including but not limited to cold mix patching material, micro-surfacing, crack sealant, spray patch material, debris, etc., as the deemed necessary, to heat, hot mill, blend, and place the HIR mix to meet the requirements as specified in the Contract Documents.

OPTION B

- c) All of the following materials shall be removed prior to the HIR operation:

[List all materials present on the existing pavement that the Contractor must remove and cannot incorporated into the HIR mix (i.e. cold mix patching material, micro-surfacing, crack sealant, spray patch material, etc.)]

*** Insert the following when recommended by the Regional Geotechnical Section. Normally, this is only required for premium mixes (Superpave FC 1 or FC 2). If this is not recommended, do not insert anything.

332.07.02 Preparation of Existing Pavement

The fifth paragraph in Subsection 332.07.02 of OPSS 332 is deleted in its entirety by the following:

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 provided such corrections do not result in the existing binder course pavement materials being hot milled and added to the HIR mix.

**** Insert the following, when the Regional Geotechnical Section provides additional stations and/or roadways that should be exempt from Lift Thickness testing. List the additional areas, by station, that the Regional Geotechnical Section indicated should be exempt from Lift Thickness testing, including but not limited to areas that may require more or less thickness to match existing surfaces or road side features, areas requiring hand work, and entrances. If no areas are recommended, do not insert anything.

332.07.08.02 Compaction and Lift Thickness

Clause 332.07.08.02 of OPSS 332 is amended by the addition of the following:

All areas of HIR paving within the Contract limits, including paved shoulders, shall be measured for lift thickness with the following exceptions:

- [List the additional areas here.]
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***** Insert the following, when partially paved shoulders are to be retrofitted using the HIR process. If they are not required, do not insert anything.

332.08.01.08.01 Basis of Acceptance

Clause 332.08.01.08.01 of OPSS 332 is amended by the addition of the following:

Offset stakes, or other identifiers acceptable to the Contract Administrator, shall be installed and maintained at 25 m maximum intervals on both sides of the Roadway, for use in checking the pavement width. The stakes or identifiers shall be removed when the Contract Administrator provides notification that they are no longer required.

WARRANT: Always with OPSS 332, Construction Specification for Hot In-place Recycling.