

Engineer may allow traffic onto the surface before the two-hour period providing no adverse effects are encountered.)

The area shall be allowed to cure such that the moisture content is reduced to 1.5 percent or less, by total weight of mix, (this may take approximately 7 to 10 days) before placing hot bituminous concrete surfacing. The moisture content shall be determined from a 1.5 kg [**3.5 pound**] sample retrieved over the full-depth of the CIR layer. If the moisture content is above 1.5 percent by weight yet below 2.5 percent by weight, and has not changed by more than 0.2 percent over a period of five days, the Engineer may allow surfacing to proceed.

The hot mix bituminous overlay shall be placed on the CIR bituminous mixture within 30 days.

**(D) Thickness and Surface Requirements**

Upon completion of placement and compaction, the finished surface of the cold in-place recycled bituminous mixture shall be smooth and not vary more than 15 mm [**0.05 feet**] from the elevations prescribed from that point as determined from the grade staked by the Engineer and the typical sections shown on the Plans. In addition, the finished surface shall show no variations greater than 6 mm [**1/4 inch**] from the edge of a 3 m [**10 foot**] straightedge resting on any two points and laid parallel to and/or at right angles to the centerline. *All deviations from this tolerance shall be corrected at no additional cost to the Department.*

During the curing period, the surface of the cold in-place recycled bituminous mixture may be sealed, if necessary, to prevent raveling, as determined by the Engineer. A minimum amount of emulsion should be employed since the intent is to not seal the surface such that curing is precluded. Fog sealing shall be accomplished with CSS-1h or CSS-1 emulsion applied at an approximate rate of 0.23 to 0.45 liters per square meter [**0.05 to 0.10 gallons per square yard**] of dilute asphalt emulsion (50/50 mix of emulsion and water by volume). The fog seal, if required, shall be applied in accordance with Mn/DOT 2355.3. The Mn/DOT Bituminous Engineer shall be contacted prior to fog sealing. If, in the opinion of the Engineer, the recycled base surface is not subject to raveling prior to the application of the sealant, the Engineer has the right, as provided in Mn/DOT 1402, to delete the item, Fog Seal, from the Contract and not be subject to a value engineering proposal by the Contractor.

The Contractor shall be responsible for maintaining the finished surface of the cold in-place recycled material in a smooth, compacted condition free of ruts, distortion, potholes, loose aggregate, and to the grade and cross-section tolerances previously stated, until the first bituminous course required by the Contract is completed. All loose aggregate that develops on the surface of the recycled pavement shall be removed by power brooming. A rotary power broom capable of cleaning the road surface and removing loose particles shall be provided within 24 hours notice, if directed by the Engineer.

The Contractor shall repair any of the previously mentioned deficiencies to the completed cold in-place recycled bituminous mixture to the satisfaction of the Engineer. Said repair(s) shall be made at no additional cost to the Department. Failure to perform corrections will be considered unacceptable work as per Mn/DOT 1512.

S-134.3 **METHOD OF MEASUREMENT**

Cold In-place Recycle Bituminous Mixture will be measured by the square meter [**square yard**].

The Bituminous Material for Mixture of the type shown on the Plans or as specified in the special provisions will be measured by the Metric ton [**ton**]. Water added to aid mixing is incidental.

Bituminous Material for Fog Seal applied on the road will be measured by volume at 15<sup>0</sup> C [**60<sup>0</sup> F**] in Liter [**Gallon**].

S-134.4 **BASIS OF PAYMENT**

Payment for the accepted quantities of cold in-place recycle bituminous mixture at the Contract prices per unit of material will be compensation in full for all costs of constructing the cold in-place recycled bituminous mixture as specified, including any additives as permitted or required.

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**S-134            (2331) COLD RECYCLE INPLACE BITUMINOUS MIXTURE**SP2005-129

This work shall consist of milling the existing bituminous surface, to the depth and width shown on the Plans. The reclaimed asphalt pavement (RAP) shall be mixed with: an asphalt emulsion, water (if required), and other additives (if required). This cold in-place recycled bituminous mixture will then be placed and compacted in accordance with the Plans and specifications and as directed by the Engineer.

**S-134.1        MATERIALS**

Asphalt Emulsion: The Mix Emulsion shall be HFMS-2P or approved equal conforming to Mn/DOT 3151.2E.

Crushed/sized Bituminous Material: The crushed/sized bituminous material shall meet the following gradation requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
38.0 mm [1-1/2 inch]	100%
25.0 mm [1 inch]	90-100%

Mix Design: An asphalt emulsion add rate of 2% was used for estimating purposes. This rate may be adjusted at the start of construction.

Water: Shall be clear and free of deleterious materials, such as; acid, oil, alkali, organic material, salt, sugar, or other harmful materials.

Fog Seal Emulsion: If required, shall be CSS-1h, CSS-1 or approved equal conforming to Mn/DOT 3151.2E.

**S-134.2        CONSTRUCTION REQUIREMENTS****(A)      Equipment**

**A Full Recycling Train is required. This is a multi-unit train with milling, screening/crushing, and mixing units, used to process the material.**

Milling: The Contractor shall furnish a self-propelled machine capable of milling the existing bituminous surface to the depth shown on the Plans, in a single pass, and to a minimum width of not less than 3.8 m [12.5 feet]. This machine shall have automatic depth and cross-slope controls and maintain a constant cutting depth.

The automatic depth controls shall maintain the cutting depth to within plus or minus 6 mm [1/4 inch] of the depth shown on the Plans.

Crushing/sizing: The material will be crushed and sized prior to mixing with emulsion. The unit shall have a "closed circuit" system capable of continuously returning oversized material to the crusher.

Mixing: The pug mill type mixing unit shall be equipped with a continuous weighing system of the milled and sized material, coupled/interlocked to a computer controlled liquid metering device for the asphalt emulsion and other additives. The machine shall be capable of automatically metering liquids with a variation of not more than plus or minus 0.2 percent by weight of mix from the specified percentage. The unit shall be equipped with facilities so that the Contractor can verify and calibrate these items by a method acceptable to the Engineer.

Pick-up machine: The pick-up machine shall be capable of removing the entire windrow of cold in-place recycled bituminous material down to the remaining underlying material.

Paver: The paver shall meet the requirements of Mn/DOT 2331.3C2a.

Rollers: The rollers shall meet the requirements of Mn/DOT 2331.3H3a. A minimum of two rollers shall be required. When cold in-place recycling depths of 75 mm [**3 inch**] or more, one of the two rollers shall be a 28 to 33 metric ton [**25 to 30 ton**] pneumatic roller equipped with a watering device to prevent material from adhering to the tires. The 28 to 33 metric ton [**25 to 30 ton**] pneumatic roller should be used for breakdown rolling. The Steel-Wheeled rollers shall meet the requirements of Mn/DOT 2331.3H3a(1).

Distributor: The distributor shall meet the requirements of Mn/DOT 2321.3C1.

Broom: A rotary power broom may be used to remove the fillet of fine milled material produced by the milling operation. The broom must remove all loose material prior to placing and compacting the CIR bituminous mixture.

### **(B) Construction Operations**

Quality Control: Testing of the crushed/sized bituminous material will be performed at a rate of 1 per 4200 square meters [**1 per 5000 square yards**] or a minimum of 2 per day. These samples may be taken from the windrow of CIR bituminous mixture after the emulsion has been added. These samples will be taken and tested by the Agency.

Additional research samples: **The Contractor will be required** to take two samples per day. One sample of the crushed/sized material shall be taken prior to the addition of emulsion. The other sample shall be taken after the emulsion has been added. The sample sizes shall be approximately 11 kg. [**25 pounds**]. They shall be in sealed cylinder mold containers. The samples shall be given to the agency to be tested in the District Lab.

When commencing cold in-place recycling operations, the emulsified binder agent shall be applied to the milled bituminous material at the initial design rate as directed by the Mn/DOT Bituminous Office. The exact application rate of the emulsified binder agent will be determined and varied by the Engineer as required by existing pavement conditions. The temperature of the emulsified binder agent shall be within the temperature range specified for the mixing of the material being used, without overheating. An allowable tolerance of plus or minus 0.2 percent of the prescribed rate of application shall be maintained at all times. Variations beyond this range require the approval of the Engineer.

The Contractor may add water to the milled material to facilitate uniform mixing with the emulsified binder agent. Water may be added prior to or concurrently with the emulsified asphalt, provided that this water does not cause any adverse effect on the emulsified binder agent. The total liquid content of water added (during milling, crushing/sizing and mixing (if required)) plus asphalt emulsion should not exceed 4.0% - 4.5%, as tested on the material provided for above, as the "additional research samples" .

Fillets of fine, milled material which form adjacent to a vertical face shall be removed prior to placing the CIR bituminous mixture. Fillets adjacent to existing pavement which will be removed by overlapping during the next milling pass do not need to be removed.

The CIR bituminous mixture shall be placed without segregation, to the lines and grades and cross slope shown on the Plans. Any field deviations from this requires the approval of the Engineer.

Breakdown rolling shall not begin until the emulsion begins to break, on the surface of the placed mixture, unless otherwise directed by the Engineer. This is signified by a distinct change in color from brown to black. Typically this takes from 1/2 to 2 hours depending on the type of emulsion, lift thickness, and curing conditions of temperature, humidity, and wind velocity.

Compaction of the CIR bituminous mixture shall be by the "Ordinary Compaction Method" in accordance with Mn/DOT 2331.3H3 as modified below.

A control strip shall be used to establish a rolling pattern, which shall be used by the Contractor for the compaction of the CIR bituminous mixture until a new control strip is constructed. Each control strip shall have an area of at least 330 square meters [**400 square yards**], and shall be of the same thickness as the lift it represents. The control strips shall remain in-place and become a part of the completed work.

The equipment used in the construction of the control strip(s) shall be approved by the Engineer and shall be of the same type and mass used on the remainder of the CIR bituminous mixture represented by the control strip. The number, weight and type of rollers shall be sufficient to meet the minimum requirements in this specification and obtain the required compaction while the mixture is in a workable condition.

Construction of the control strips will be as directed by the Engineer. Compaction shall commence after the mixture has been spread to the desired thickness and the emulsion has broken. **Compaction typically begins with the pneumatic roller.** The pneumatic roller shall make six or more passes over an area until no further displacement of the mixture is evident. Compaction shall continue with the finish roller until no appreciable increase in density can be obtained by additional roller coverage. Densities shall be determined by means of a portable nuclear testing device.

To determine when no appreciable increase in density can be obtained, two to four test points shall be established in the control strip. Determine the test points, on a random basis, after completion of the pneumatic rolling. The density at each point shall be measured by, averaging two readings (180 degrees outset), of a portable nuclear testing device after each finish (steel) roller pass. Care must be taken to ensure that the nuclear gauge rests on a flat surface. Rolling shall be suspended when the testing shows either (a) a decline in density with additional roller passes, or (b) when no increase in density is obtained by additional roller pass. The rolling operation (pattern and timing) shall be temporarily discontinued and reevaluated if surface cracking or checking occurs behind the roller.

After this testing is accomplished, rolling on the remainder of that course shall be done in accordance with the pattern developed in the test strip. Densities shall be spot-checked with the nuclear testing device as ordered by the Engineer. These densities will be used for information only.

The Engineer will order a new control strip when there is a significant change in the RAP, or when the Engineer believes the control strip is not representative.

A nuclear testing device shall be furnished and operated by the Contractor. The furnishing of the nuclear testing device and operator shall be considered incidental to the furnishing and placing of the cold in-place recycled bituminous mixture and will not be compensated for separately.

The Contractor shall reshape and compact the in-place aggregate shoulder prior to placing the first overlay course, in accordance with Mn/DOT 2105.3G. Compaction shall be achieved by the Quality Compaction Method in accordance with Mn/DOT 2211.3C2.

**(C) Restrictions**

Recycling operations shall be performed when the atmospheric temperature is above 10<sup>0</sup> C [**50<sup>0</sup> F**] and rising. Additionally, recycling shall not be performed when the weather is foggy or rainy or when weather conditions are such that proper mixing, spreading, and compacting of the recycled material cannot be accomplished in the judgment of the Engineer.

The cold milling operation shall be performed on one-half of the roadway at a time, so that the opposite lane may carry traffic.

After the recycled material has been spread and compacted, NO TRAFFIC (this includes Contractor's equipment) will be permitted on the completed cold in-place recycled bituminous mixture for at least two hours. (The intent is to limit stopped or slow moving traffic on the newly placed surface. When traffic is allowed to resume normal speeds over the surface, such as at the end of the day or during train turnaround, the