

416-R-638 COLD IN-PLACE RECYCLING, CIR

(Adopted 05-19-16)

The Standard Specifications are revised as follows:

SECTION 416, BEGIN LINE 1, INSERT AS FOLLOWS:

**SECTION 416 - COLD IN-PLACE RECYCLING, CIR**

**416.01 Description**

*This work, cold in-place recycling, CIR, shall consist of milling and pulverizing a portion of the existing asphalt pavement to specified depth and maximum size, mixing asphalt emulsion, water and additives to produce a recycled asphalt layer. This material shall then be placed and compacted to the approved design properties in accordance with 105.03.*

**416.02 Quality Control**

*A quality control plan, QCP, shall be submitted to the Engineer a minimum of 15 calendar days prior to beginning the CIR operation. The QCP shall include the proposed CIR mix design, a start to finish process description to include discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, and the curing methods applied to the CIR. All Contractor QC test results shall be maintained during the duration of the contract and made available to the Engineer upon request.*

*The following table provides the type and minimum frequency for tests.*

| <b>QC TESTING</b>  |                                    |
|--|------------------------------------|
| <i>Test</i>  | <i>Frequency<sup>1,2</sup></i>     |
| <i>Depth of Pulverization</i>  | <i>1 per 500 ft</i>                |
| <i>Pulverized Material Gradation</i>   | <i>1 per 0.5 day of processing</i> |
| <i>Asphalt Emulsion Content</i>  | <i>1 per 500 ft</i>                |
| <i>Water Content</i>   | <i>1 per 500 ft</i>                |
| <i>Compacted In-Place Field Density</i>  | <i>1 per 1000 ft</i>               |
| <i>Note 1: The Contractor shall perform all quality control tests within the first 500 ft after startup or after any change in the mix design.</i> |                                    |
| <i>Note 2: Testing frequency is based upon linear feet of CIR processing.</i>  |                                    |

**MATERIALS**

**416.03 Materials**

*CIR shall consist of a homogenous blend of reclaimed asphalt pavement, RAP, combined with asphalt emulsion, water, recycling additives, corrective aggregate or cement, when required. The actual materials used are dependent on the CIR mix design and project requirements.*

*Materials for use in CIR shall be in accordance with the following:*

*Asphalt Emulsion .....As Defined\**

Aggregate to correct the CIR gradation:

1. Coarse or Dense Graded Aggregate, Class C or Higher .....904.03
  2. Fine Aggregate.....904.02
  3. Reclaimed asphalt pavement, RAP, shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.
- Portland Cement, Type I ..... 901.01(b)  
 Water .....913.01

\* The requirements for asphalt emulsion shall be in accordance with the following:

| <i>CIR ASPHALT EMULSION<sup>1</sup></i>   |                    |                |                |
|---|--------------------|----------------|----------------|
| <i>Test</i>   | <i>Procedure</i>   | <i>Minimum</i> | <i>Maximum</i> |
| <i>Viscosity, Saybolt Furol, @ 77 °F, SFS</i>   | <i>AASHTO T 59</i> | <i>20</i>      | <i>100</i>     |
| <i>Sieve Test, No. 20, retained on sieve, %</i>   | <i>AASHTO T 59</i> |                | <i>0.10</i>    |
| <i>Storage Stability Test, 24 hr, %</i>   | <i>AASHTO T 59</i> |                | <i>1.0</i>     |
| <i>Distillation Test<sup>2</sup>,<br/>Residue from distillation, %</i>  | <i>AASHTO T 59</i> | <i>64.0</i>    |                |
| <i>Oil distillate by volume, %</i>  | <i>AASHTO T 59</i> |                | <i>1.0</i>     |
| <i>Penetration, 77 °F, 100 g, 5 s, dmm</i>  | <i>AASHTO T 49</i> | <i>50</i>      | <i>200</i>     |
| <i>Note 1: The asphalt emulsion shall be selected for the project by the asphalt emulsion supplier based on the Contractor's mixture design. The penetration of the supplied asphalt emulsion shall be within ± 25% of the penetration of the design emulsified asphalt. The asphalt emulsion shall be received on the job site at a temperature no greater than 120°F.</i> |                    |                |                |
| <i>Note 2: Modified AASHTO T 59 – distillation temperature of 347 ± 9°F with a 20 minute hold.</i>  |                    |                |                |
| <i>Note 3: Type A certification will be required to furnished by the asphalt emulsion supplier.</i>   |                    |                |                |

**416.04 Mix Design**

The mix design and all associated testing shall be performed, using samples of the existing pavement material from the project site representing the recycling depth, by a design laboratory that is AMRL accredited in HMA and asphalt. Additional mix designs shall be performed when the in-place material changes significantly in order to establish representative mixes for the entire job. The Contractor shall be responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned CIR shall be the minimum sampling frequency for mix design preparation.

CIR mix designs shall be comprised of existing RAP, emulsified asphalt and recycling additives if necessary. The CIR mixture shall have a design gradation of 100% passing the 1 1/2 in. (37.5 mm) sieve. The minimum CIR mix design requirements shall meet all of the requirements specified in ITM 592.

The Contractor shall provide a mix design or designs for approval at least 15 calendar days prior to beginning the CIR operation. The mix design shall include all test results performed. If new materials are added, a new mix design, including the updated test results, shall be submitted at least one day prior to implementation.

**CONSTRUCTION REQUIREMENTS**

**416.05 Equipment**

*The recycling equipment shall be capable of milling the existing roadway, sizing the resulting RAP and mixing the RAP with the materials stipulated in the mix design. The recycling equipment shall be capable of meeting the specified sizing requirement with either the milling process or with additional sizing equipment. The recycling equipment shall be capable of producing a homogenous and uniformly coated CIR mixture by mixing the RAP with the asphalt emulsion, water and any other additives, either in the cold planer housing or in an additional mixing chamber. The equipment used for placement of the CIR mixture shall be capable of the placement in accordance to 105.03.*

*The CIR equipment shall consist of the following major components.*

***(a) Cold In-Place Recycler Equipment***

*The cold in-place recycling equipment will include either a single unit recycler or a multi-unit recycler.*

***1. Single Unit Recycler***

*The single-unit recycler shall be a self-propelled cold milling machine/cold recycling machine with a down cutting cutter head capable of pulverizing and recycling the existing HMA pavement to a maximum depth of 5 in., incorporate the asphalt emulsion and water and mix the materials to produce a homogenous mixture. The machine shall have two systems for adding emulsified asphalt and water, with each system having a full width spray bar with a positive displacement pump interlocked to the machine's ground speed to insure that the amount of emulsified asphalt and water being added is automatically adjusted with changes to the machine's ground speed. Each additive system shall have its own spray bar equipped with two nozzles per foot of spray bar and be capable of incorporating up to 7 gal./sq yd of asphalt emulsion or water. Individual valves on the spray bar shall be capable of being turned off as necessary to minimize asphalt emulsion and water overlap on subsequent passes.*

***2. Multi-Unit Recycler***

*A multi-unit recycler may be utilized instead of a single unit recycler. The multi-unit train shall contain the following:*

- a. A self-propelled cold milling machine that is capable of pulverizing the existing bituminous material in a single pass to the depth shown on the plans and to a minimum width of not less than 12 1/2 ft. The machine shall have automatic depth controls to maintain the cutting depth to within  $\pm 1/4$  in. of that shown on the plans, and shall have a positive means for controlling cross slope elevations. The use of a heating device to soften the pavement will not be allowed.*
- b. A material sizing unit having screening and crushing capabilities to reduce the cold pulverized material to the appropriate size. The screening and crushing unit shall have a closed circuit system capable of continuously returning oversized material to the*

*crusher. All of the pulverized material, 100%, shall be processed to the maximum size requirements specified.*

- c. A mixing unit equipped with a belt scale for the continuous weighing of the pulverized and sized bituminous material and a coupled/interlocked computer controlled liquid metering device. The mixing unit shall be an on-board completely self-contained pugmill. The liquid metering device shall deliver the amount of asphalt emulsion to within  $\pm 0.25\%$  of the required amount by weight of the pulverized bituminous material. The asphalt emulsion pump shall be sufficient capacity to allow emulsion contents up to 4.0% by weight of pulverized material. Also, automatic digital readings shall be displayed for both the flow rate and total amount of pulverized bituminous material and asphalt emulsion in appropriate units of weight and time.*

***(b) Spreaders for Dry Cement***

*Spreaders used to apply dry cement recycling additives shall be non-pressurized mechanical vane-feed, cyclone or screw type capable of providing a consistent, accurate and uniform distribution of material while minimizing dust during construction.*

***(c) Spreading of Corrective Aggregate***

*Corrective aggregate, when required shall be placed with a mechanical spreader or a conventional paver.*

***(d) Water Truck***

*A water truck for supplying water to the milling equipment during CIR operation shall be provided. The water truck system shall be able to supply the mixing chamber, if necessary, so as to provide an independent source of water to properly disperse the asphalt emulsion.*

***(e) Paving Equipment***

*The processed CIR mixture shall be spread uniformly across the recycling width using either a self-propelled paver or screed integral to the recycling equipment. In either case, the screed shall be controlled by electronic grade and cross slope control. The equipment shall be of sufficient size and power to spread the recycled material in one continuous pass, without segregation, in accordance with 105.03. Heating of the screed shall not be allowed. In utilizing a self-propelled paver, material shall either be loaded directly into the paver hopper from the recycling equipment or loaded by a pickup device from a windrow. If utilizing a pickup device, it shall be capable of removing and transferring the entire windrow of recycled mix in a single pass. The pick-up machine shall be within 150 ft of the mixing unit throughout the treatment process.*

***(f) Rollers***

*Compaction of the CIR mixture shall be completed using self-propelled rollers complete with properly operating scrapers and water spray systems. The number, weight, and types of rollers shall be as necessary to obtain required compaction. At a minimum, the following rollers shall be used:*

1. *At least one pneumatic tired roller with a minimum weight of not less than 22 tons. The tires on the pneumatic roller shall be evenly inflated and matched in size and profile as to maximize compactive effort.*
2. *At least one double drum vibratory roller with a minimum weight of not less than 10 tons.*

#### **416.06 Weather Restrictions**

*The Engineer may restrict work when the weather is foggy or rainy. CIR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50°F with overnight ambient temperatures above 35°F. Recycling may be performed during light precipitation so long as the Contractor can demonstrate that the performance of the CIR pavement will not be adversely affected. The Engineer may restrict work when the heat index is greater than 100°F. The CIR shall not be performed before May 1st or after October 1st.*

#### **416.07 Roadway Preparation**

*Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized bituminous material during milling operation.*

*Snowplowable raised pavement markers shall be removed prior to CIR operations in accordance with 808.11(e).*

*Grade adjustments of existing structures shall be made in accordance with 720.04 except existing structures shall be lowered prior to CIR operations, properly covered and filled with material compatible with the CIR mix design to maintain traffic prior to CIR operations.*

*All areas of soft or yielding subgrade, as indicated on project plans, shall be corrected prior to CIR operations.*

#### **416.08 Processing and Mixing Operation**

*For CIR mixtures, the pulverization shall produce a gradation that has 100% passing the 1 1/2 in. (37.5 mm) sieve.*

*Corrective aggregate, when required, shall be spread onto the existing surface using a mechanical spreader or a conventional paver.*

*The pulverized material shall be processed through a mixing unit capable of combining the pulverized material, asphalt emulsion, and any additives to produce a homogenous recycled mixture. The asphalt emulsion shall be incorporated into the pulverized bituminous material at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.*

*When a paving fabric is encountered during the pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the CIR does not affect the performance parameters or inhibit placement or compaction of the CIR. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. Additionally, no fabric piece shall have a dimension exceeding a length of 4 in.*

*Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed as observed from the roadway during the CIR process. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.*

*Any such materials retained in the mixture shall be appropriately sized and blended so as to not adversely affect the strength of the CIR.*

*Asphalt emulsion shall have an application tolerance determined by adding  $\pm 0.25\%$  to the percent total asphalt emulsion content recommended by the mix design.*

*The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design evaluated the CIR properties at or above the requested percentage. The request will be subject to approval by the Engineer.*

#### **416.09 Control Strip and Compaction**

*A minimum 500 ft long control strip shall be conducted the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:*

- 1. Demonstrate the proposed equipment, materials and processes can produce a CIR layer in accordance with specification requirements.*
- 2. Determine the optimal rates for the emulsified asphalt, water and any additives recommended for the reclaimed material.*
- 3. Determine the sequence and manner of rolling necessary to obtain specified density requirements.*

*The CIR density shall be achieved with the same equipment, materials and construction methods used on the accepted control strip.*

*A rolling pattern shall be determined during the control strip to achieve optimum field density. The Contractor shall provide a sequence and manner of rolling which will define maximum compaction by establishing a rolling versus density chart that shows the progress of densification from initial lay down through maximum obtainable density using a properly calibrated nuclear gauge in accordance to ASTM D 2950. The Contractor shall perform compaction testing during production to ensure compaction is*

*between 97% and 102% of the target density established during the control strip. If two successive tests indicate compaction is over 102% of the target density, a new rolling pattern shall be established.*

*All tests shall be conducted at the stated QC testing frequencies. A new control strip shall be constructed if changes are made to the original mix design, equipment or construction methods.*

#### **416.10 Opening to Traffic**

*After compaction of the recycled material, no traffic, including that of the Contractor, shall be allowed on the completed recycled material for at least two hours. After two hours, vehicle traffic may be allowed on the recycled material. This time may be adjusted by the Engineer to allow establishment of sufficient cure so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by power brooming.*

*After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.*

*If locations of failing subgrade are found below the CIR, the CIR shall be removed and subgrade treatment per geotechnical recommendations shall be placed in accordance with 207. HMA Patching Type B shall be placed in accordance with 304.*

#### **416.11 Maintenance**

*The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the surface course has been constructed.*

#### **416.12 Curing**

*The CIR mixture shall be cured for a time period that achieves in-place moisture contents below 2.5%, and approval by the Engineer prior to the placement of the HMA overlay. The planned method and duration of curing for CIR shall be in accordance with 416.02. The specified surface course shall be placed within two weeks of the pavement final cure, but no later than November 1.*

#### **416.13 Asphalt Milling**

*The CIR shall be milled in accordance with 306 to the specified cross-slope in preparation for the overlay. Construction engineering in accordance with 105.08(b) shall be provided.*

#### **416.14 CIR Surface Course**

*The CIR shall be swept with a rotary power broom in accordance with 409 immediately prior to placing the overlay. The CIR shall be swept lightly to avoid damage to the CIR.*

*A tack coat shall be required only for the HMA overlay and shall be applied to the CIR in accordance with 406 immediately following sweeping operations.*

*The surface course atop the CIR shall be as shown on the plans.*

*Monuments shall be reestablished in accordance with 615.10*

**416.15 Method of Measurement**

*The CIR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the ton in accordance with 109.05(b). Subgrade treatment will be measured in accordance with 207.05. Corrective aggregate, when used to correct the CIR gradation, will be measured by the ton of material used. Stabilizing material, Portland cement, used as a recycling additive will be measured by the ton in accordance with 109.05(b). Asphalt milling will be measured in accordance with 306.09. HMA Patching will be measured in accordance with 304.06. Re-established monuments will be measured by the number of units installed in accordance with 615.13. Grade adjustment of existing structures will be measured in accordance with 720.06. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12.*

**416.16 Basis of Payment**

*The CIR will be paid for at the contract unit price per square yard, complete in place. The accepted quantities of additional stabilizing material will be paid for at the contract unit price per ton for the type specified, complete in place. Subgrade treatment will be paid for in accordance with 207.06. Asphalt milling will be paid for in accordance with 306.10. HMA patching will be paid for in accordance with 304.07, of the thickness specified on the plans. Re-established monuments will be paid for at the contract unit price per each complete in place in accordance with 615.14. Grade adjustment of existing structures will be paid for at the contract unit price in accordance with 720.07. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.*

*Payment will be made under:*

| <b><i>Pay Item</i></b>                             | <b><i>Pay Unit Symbol</i></b> |
|--|-------------------------------|
| <i>Cold In-place Recycling.....</i>                | <i>SYS</i>                    |
| <i>Corrective Aggregate.....</i>                   | <i>TON</i>                    |
| <i>Stabilizing Material, Asphalt Emulsion.....</i> | <i>TON</i>                    |
| <i>Stabilizing Material, Portland Cement.....</i>  | <i>TON</i>                    |

*The costs associated with the CIR mix design and quality control testing shall be included in the cost of the CIR.*

*The costs associated with removal of grass and vegetation, pulverizing, stabilizing, compacting, curing and maintenance of the CIR not related to failing subgrade shall be included in the cost of the CIR.*

*The costs associated with the asphalt emulsion shall be included in the cost of the stabilizing material pay item.*

*The costs associated with removing existing material to maintain profile shall be included in the cost of the asphalt milling.*

*In the locations of failing subgrade, removal of the CIR shall be included in the cost of subgrade treatment.*

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