

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

(Revised 09-20-18)

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 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 Just in Time Training, JITT***

*The Engineer and Contractor are required to attend a JITT course regarding CIR and both shall mutually agree on the course instructor, course content and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for CIR operations and inspection to attend.*

*The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of CIR operations.*

*The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with asphalt emulsion stabilized CIR. A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.*

***416.03 Quality Control***

*A quality control plan, QCP, shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. 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 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.*

<u>QC TESTING</u>	
Test	Frequency <sup>1,2</sup>
Depth of Pulverization	1 per 500 ft
Pulverized Material Gradation	1 per 0.5 day of processing
Asphalt Emulsion Content	1 per 500 ft
Water Content	1 per 500 ft
Compacted In-Place Field Density	1 per 1000 ft
Field Moisture Content for Curing	1 per each day of production
Note 1: The Contractor shall perform all quality control tests within the first 500 ft after startup and after any change in the mix design.	

*Note 2: Testing frequency is based upon linear feet of CIR processing.*

## **MATERIALS**

### **416.04 Materials**

*CIR shall consist of a homogenous blend of reclaimed asphalt pavement, RAP, combined with asphalt emulsion, water, and when required, recycling additives such as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized CIR may be dry powder or slurry with a minimum dry solids content of 60%. 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:*

<i>Asphalt Emulsion .....</i>	<i>902.01(b)3</i>
<i>Corrective aggregate to adjust gradation or supplement material volume:</i>	
1. <i>Coarse or Dense Graded Aggregate, Class C or Higher .....</i>	<i>904.03</i>
2. <i>Fine Aggregate.....</i>	<i>904.02</i>
3. <i>RAP shall be the product resulting from the cold milling or crushing of an existing asphalt pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.</i>	
<i>Portland Cement, Type I .....</i>	<i>901.01(b)</i>
<i>Water .....</i>	<i>913.01</i>

*Acceptance of the RBC will be in accordance with the Frequency Manual on the basis of a type D certification in accordance with ITM 804.*

### **416.05 Mix Design**

*The CIR mix design shall be in accordance with ITM 592 and comprised of existing RAP, asphalt emulsion and if necessary, recycling additives. 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 emulsion. 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.*

*The Contractor shall provide a mix design or designs for approval at least five calendar days prior to the JITT. 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**

### **416.06 Roadway Preparation**

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

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

*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 shown on the plans, shall be corrected prior to CIR operations.*

#### **416.07 Equipment**

*The recycling equipment shall be capable of milling the existing asphalt pavement, 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 the depth specified, incorporate the asphalt emulsion and water and mix the materials to produce a homogenous mixture. The machine shall have two systems for adding asphalt emulsion 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 asphalt emulsion 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 asphalt 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 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 asphalt 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 asphalt 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 asphalt 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) Additive Slurry Storage and Supply Equipment***

*Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.*

***(d) Spreading of Corrective Aggregate***

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

***(e) 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.*

***(f) Laydown Equipment***

*The processed CIR mixture shall be spread uniformly across the recycling width using either a self-propelled paver in accordance with 409.03(c) 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.*

***(g) Compaction Equipment***

*Compaction equipment shall be in accordance with 409.03(d). 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 in accordance with 409.03(d)3 with a minimum weight of not less than 20 tons.*
- 2. At least one double drum vibratory roller in accordance with 409.03(d)4 with a minimum weight of not less than 10 tons.*

***416.08 Weather Limitations***

*CIR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50°F with ambient temperatures above 35°F for seven days. The Engineer may restrict work when the heat index is greater than 100°F. The CIR shall not be performed before May 1 or after October 1.*

***416.09 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.*

*An additive used in asphalt emulsion stabilized CIR may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.*

*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 injected into the pulverized asphalt 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. 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 requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.*

#### **416.10 Control Strip and Compaction**

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

- (a) Demonstrate the proposed equipment, materials and processes can produce a CIR layer in accordance with specification requirements.*
- (b) Determine the optimal rates for the asphalt emulsion, water and any additives recommended for the reclaimed material.*

- (c) *Determine the sequence and manner of rolling necessary to obtain specified density requirements.*

*The CIR density shall be achieved with the same equipment, materials, construction methods and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside of the tolerances of the original mix design, equipment or construction methods.*

*A rolling pattern that produces the maximum obtainable density, or optimum field density, shall be determined during the control strip. The Contractor shall provide a sequence and manner of rolling by establishing a roller pass versus density chart that shows the progress of densification from initial lay down through optimum field density using a properly calibrated nuclear gauge in accordance to AASHTO T 310. Production may continue after approval of the control strip.*

*The Contractor shall perform compaction testing in accordance with AASHTO T 310 during production to ensure compaction is between 97% and 102% of the optimum field density established during the control strip. If two successive tests indicate compaction is over 102% or below 97% of the optimum field density, a new rolling pattern and roller pass versus density chart shall be established.*

*The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.*

*Any type of rolling effort that causes cracking, displacement or other type of pavement distress shall be discontinued until such time as the problem can be resolved and approved by the Engineer.*

*Rollers shall not be started or stopped on recycled material except when changing direction during the compaction process.*

*All tests shall be conducted at the stated QC testing frequencies throughout CIR operations.*

#### **416.11 Opening to Traffic**

*Opening to traffic shall occur after sufficient cure time has been applied to the CIR so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.*

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

#### **416.12 Maintenance**

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

*Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or CIR material as directed by the Engineer. No direct payment will be made for damage or repair unless approved by the Engineer.*

#### **416.13 Curing**

*Before placing the final surfacing, the recycled surface shall remain in-place for a minimum of three days and meet one of the following conditions:*

- (a) there is less than 3.0% moisture remaining in the mixture, or*
- (b) The material has remained in-place for a minimum of 10 days without rainfall.*

*The planned method and duration of curing for CIR shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the CIR final cure, but no later than November 1.*

#### **416.14 Milling**

*The entire surface of the CIR shall be scarified 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.*

#### **416.15 CIR Surface Course**

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

*The CIR shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the surface. 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.*

*Monuments shall be reestablished in accordance with 615.10*

#### **416.16 Method of Measurement**

*The CIR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the ton. Aggregate to adjust the CIR gradation will be measured by the ton of material used. HMA Patching will be measured in accordance with 304.06. Milling will be measured in accordance with 306.10. Re-established monuments will be measured 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.*

#### **416.17 Basis of Payment**

*The CIR will be paid for at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per ton, complete in*



place. Aggregate used to adjust the CIR gradation will be paid for at the contract unit price per ton, complete in place. HMA patching will be paid for in accordance with 304.07, of the thickness specified on the plans. Milling will be paid for in accordance with 306. 11. Re-established monuments will be paid for in accordance with 615.14. Grade adjustment of existing structures will be paid for 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, CIR.....</i>	<i>TON</i>
<i>Stabilizing Material, Asphalt Emulsion .....</i>	<i>TON</i>

*The costs of the CIR mix design and QC testing shall be included in the cost of the CIR.*

*The costs associated with removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the CIR.*

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

*The cost associated with mixing water shall be included in the cost of the CIR.*

*The cost associated with aggregate when used to supplement material volume shall be included in the cost of the CIR.*

*The cost associated with portland cement when used as an additive shall be included in the cost of the CIR.*

*The cost associated with aggregate when used to adjust the CIR gradation shall be included in the cost of the corrective aggregate pay item.*

*The cost of milling the asphalt emulsion stabilized CIR to maintain profile shall be included in the cost of the milling.*

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