



Description

This work shall consist of pulverizing, crushing, and screening the in situ bituminous materials to the depth and width shown on the plans; CIR-EE emulsified asphalt binder agent, water, and other additives, if required, will then be incorporated into the pulverized material. This material will then be spread and compacted in accordance with the plans and specifications or as directed by the Engineer.

Materials

Asphalt Emulsion

The type of asphalt emulsion to be used shall be determined by the mix design. A representative from the Contractor’s asphalt emulsion supplier will be at the job site at the beginning of the project to monitor the characteristics and performance of the asphalt emulsion. Throughout the job, a representative will be available to check on the project and make adjustments to the asphalt emulsion formulation as required.

The CIR-EE asphalt emulsion material properties shall meet the requirements shown in Table 1.

Table 1			
Test ¹	Method	Minimum	Maximum
Residue from distillation, % by mass	AASHTO T59 ²	63	
Oil distillate by distillation, % by volume	AASHTO T59 ²		1
Sieve Test, %	AASHTO T59 ²		0.3
Penetration (TBD ³), 25°C, dmm	ASTM D5 ⁴	-25%	+25%
1. Tests must be completed within 14 days from date sampled			
2. Modified AASHTO T59 procedure - distillation temperature of 350°F with a 20 minute hold. The AASHTO T59 vacuum distillation procedure may be substituted once the maximum oil distillate is satisfied.			
3. TBD - to be determined by the CIR design prior to emulsion manufacture for project. Penetration range will be determined on the design requirements for the project and will be submitted to the Engineer for approval prior to project start.			
4. To make each of the three required determinations, the sample shall be removed from the bath, shaken gently to remove free water from the surface of the specimen, tested in a dry surface state, and then immediately replaced in the water bath. The total time between removal from the bath and testing shall be less than 60 seconds for each determination. Artificially high penetration results are possible if this procedure is not followed and are indicative of the emulsifier and not representative of field performance. In the event that abnormally high results are obtained, retest the sample using the aforementioned procedure.			

Sampling and Acceptance of the asphalt emulsion shall be in accordance with Section 9-02.2 of the Standard Specification, Sampling and Acceptance.

Cold Pulverized Material

The cold pulverized material shall meet the gradation requirement shown in Table 2 prior to the addition of the asphalt emulsion.

Table 2	
Sieve Size	%Passing
2.0 inch	100
1.5 inch	80 - 100

Water

Water shall be free from an excessive amount of acids, alkali, oil, and other substances, which will cause damage to the materials used.

Other Additives

If necessary, additives may be used to meet the requirements in Table 5. In the case that an additive is used, the type and allowable usage percentage must be described in the submitted mix design recommendation for approval.

Additional Reclaimed Asphalt Pavement (RAP) Material

If available, crushed RAP may be added at the discretion of the Engineer if the RAP meets the requirements in Table 3.

The crushed RAP shall be free from vegetation and all other deleterious materials. In addition no silt, clay balls, excessive amounts of portland cement concrete chunks, or non-asphaltic aggregate shall be permitted. When blended with the design millings it shall produce a product that meets the specification requirements given in Table 5.

Table 3 Additional Crushed RAP		
Tests	Method	Limit
Deleterious Materials: Clay Lumps and Friable Particles in Aggregate, % max	ASTM C 142 or AASHTO T112	0.2

Additional Non-Asphaltic Aggregate

Based on the results of the mix design or other requirements, the contractor shall determine if additional aggregate is required. Any additional aggregate shall meet the requirements in Table 4, and it shall be graded to produce a product that meets the specification in Table 5.

Table 4 Additional Aggregate		
Tests	Method	Limit
Los Angeles abrasion value, % loss	AASHTO T 96	40 max
Sand Equivalent,%	ASTM D-2419	60 minimum
Maximum size, 100% Passing, Sieve Size	ASTM C 136 or AASHTO T 27	Table 2
Water absorption %	AASHTO T 85	5 max

Asphaltic Emulsion Fog Seal and Sand Seal

The contractor shall include in the bid price for CIR the full cost of applying a fog seal to all areas as directed by the Engineer prior to opening the lane to uncontrolled public traffic. Asphaltic emulsion (fog seal coat) shall be applied to the surface of the CIR material and shall be grade CSS-1 or CSS-1h or CIR-EE asphalt emulsion unless otherwise ordered by the Engineer. All asphaltic emulsion materials shall be diluted 50/50 with water before application. The application rate of the fog seal coat (asphalt emulsion and equal amounts of water) shall be such that the diluted asphaltic emulsion will be spread at a rate of .08 gallons per yds² minimum to 0.12 gallons per yds². The exact rate of application will be determined by the Engineer. Following the application of the fog seal, sand will be spread over the entire fog sealed area at a rate of 2 lbs ± 0.5 lbs per syd.

Construction Requirements

Mix Design

The Contractor shall submit a mix design tested in accordance with Mix Design Procedures of this Special Provision using materials obtained directly from the project site from cores. More than one mix design may be required. The mix design shall meet the criteria outlined in Table 5. The Contractor shall submit the mix design for approval by the Engineer at least three weeks prior to CIR construction. The Contractor shall submit with the mix design the supporting data and test results used to produce the mix design.

Table 5		
4 inch specimens shall be prepared in a Superpave Gyratory compactor. The mixture should meet the following criteria at the selected design asphalt emulsion content:		
Property	Criteria	Purpose
Compaction effort, Superpave Gyratory Compactor	1.25° angle, 12,500 lbs/ft ² stress, 30 gyrations	Density Indicator
Density, ASTM D 2726 or equivalent	Report	Compaction Indicator
Gradation for Design Millings, ASTM C117	Report	
Marshall stability*, ASTM D 1559 Part 5, 40°C	1,250 lb min	Stability Indicator
Retained stability based on cured stability **	70 % min	Ability to withstand moisture damage
Raveling Test, ASTM D 7196-06, 4 hour cure time @ 50°F, @ 50% humidity, for 15 minute test time	2% max	Raveling Resistance
* Cured stability tested on compacted specimens after 140°F curing to constant weight.		
**Vacuum saturation of 55 to 75 percent, water bath 77°F 23 hours, last hour at 104°F water bath		

Mix Design Procedures for CIR Material

Sampling and Processing

The contractor shall obtain cores from the areas to be recycled. The contractor shall provide at a minimum, one core for each lane mile and additional cores at each location where visual differences in the pavement are noticed. If cores show significant differences in material type or thickness of layers, then separate mix designs shall be performed for each area. Cores shall be cut and crushed in the laboratory to the depth specified in the plans. Approximately 150 lbs. of cut and crushed material is required for each mix design. Using the recycled asphalt

millings criteria in Table 6, the Contractor shall perform a mix design on these crushed millings for the medium and coarse gradation.

Table 6		
Sieve Size	Medium	Coarse
1.25inch	100	100
1.0inch	100	85-100
¾inch	85-96	75-92
No. 4	40-55	30-45
No. 30	4-14	1-7
No. 200	0.1-3	0.1-3

The gradation of the millings after crushing shall be determined by ASTM C117 and C136 (dried at no greater than 104°F).

Samples shall be prepared with a sample splitter.

Mixing

Specimen size: the specimen shall be 4 inches in diameter and 2.4 to 2.6 inches tall; use ASTM D2041 to determine the size for Rice specific gravity.

Number of specimens: Specimens shall be taken for three (3) emulsion contents. Each selected emulsion content shall consist of four (4) specimens, of which two (2) specimens shall be for long-term stability and two (2) specimens shall be for moisture testing. Two (2) additional specimens are required for Rice specific gravity; test at the highest emulsion content in the design and back calculate for the lower emulsion contents.

Recommended emulsion contents: 1.5%, 2.0%, 2.5%, 3.0%, 3.5%, 4.0%. Choose three emulsion contents that bracket the estimated emulsion content.

Add moisture that is expected to be added at the milling head, typically 1.5 to 2.5 percent.

If any additives are in the mixture, introduce the additives in a similar manner that they will be added during field production.

Mixing of test specimens shall be performed with a mechanical bucket mixer. Mix the CIR RAP millings thoroughly with water first, then mix with emulsion. Mixing shall occur at ambient temperature. Only one specimen of specific emulsion content shall be mixed at a time. Mixing time with emulsion should not exceed 60 seconds.

Compaction

Specimens shall be compacted immediately after mixing. Place paper disks on the top and bottom of the specimen before compaction.

Specimens shall be compacted with a Superpave gyratory compactor (SGC) in a 4 inch mold at 1.25° angle, 12,500 lbs/ft² ram pressure, and 30 gyrations. The mold shall not be heated.

Curing after compaction

Extrude specimens from molds immediately after compaction. Carefully remove paper disks.

Place specimens in 140°F forced draft oven with ventilation on sides and top. Place each

specimen in a small container to account for material loss from the specimens.

Specimens for Rice specific gravity should be dried to constant weight (less than 0.05% weight loss in 2 hours). Care should be taken not to over-dry the specimens.

Cure compacted specimens to constant weight but no more than 48 hours and no less than 16 hours. Constant weight is defined here as 0.05% change in weight in 2 hours. After curing, cool specimens at ambient temperature a minimum of 12 hours and a maximum of 24 hours.

Measurements

Determine bulk specific gravity (density) of each compacted (cured and cooled) specimen according to ASTM D2726 or equivalent; however, the mass of the specimen in water (measurement C) can be recorded after one-minute submersion.

Determine specimen heights according to ASTM D3549 or equivalent. Alternatively, the height can be obtained from the SGC readout.

Determine Rice (maximum theoretical) specific gravity using ASTM D2041, except as noted in the Curing and Compaction sections of this Special Provision, and do not break any agglomerates which will not easily reduce with a flexible spatula. It is normally necessary to perform the supplemental dryback procedure to adjust for uncoated particles.

Determine air voids at each emulsion content.

Determine corrected Marshall stability by ASTM D1559 at 104°F after 2 hour temperature conditioning in a forced draft oven. This testing shall be performed at the same time that the moisture conditioned specimens are tested.

Moisture Susceptibility

Perform the same conditioning and volumetric measurements on moisture conditioned specimens as on other specimens. Vacuum saturate to 55 to 75 percent, soak in a 77°F water bath for 23 hours, followed by a one hour soak at 104°F. Determine corrected Marshall stability. The average moisture conditioned specimen strength divided by the average dry specimen strength is referred to as retained stability.

Emulsion Content Selection

The properties of the specimens at design emulsion content shall meet the properties in Table 5.

Report

The report shall contain the following minimum information: Gradation of RAP; amount and gradation of virgin aggregate or additional RAP, if any; recommended water content range as a percentage of dry RAP; optimum emulsion content as a percentage of dry RAP and corresponding density, air void level, and absorbed water; Marshall stability and retained stability at recommended moisture and emulsion contents, and raveling %. Include the emulsion designation, company name, plant location, and residue content.

Equipment

All equipment for cold in place recycle described below used on the project shall be in proper working condition.

A self-propelled reclaimer shall be capable of fully pulverizing the existing road to the depth required, incorporate the asphalt emulsion and water, and mix the materials to produce a homogeneous material. The milling drum shall have:

- Drum diameter at cutting bit, tip-to-tip 45.0" (min)
- Cutting width of 86.5" (min)
- Cut depth range, single pass (for recycling) 0"-4" (min)

The recommended minimum power of the recycling unit is 800 hp. The machine shall be capable of pulverizing up to 4-inches deep in each pass. Non contact flow meters shall be employed to measure liquid volumes and the control systems shall be proportional to the machines advance speed and shall be capable of maintaining accurate mixing regardless of changes in the machines working speed. The pump shall be a positive displacement, eccentric shaft style with a minimum capacity of 210 gallons per minute, and shall be resistant to damage from contaminants in the water or emulsion. The pump shall spray liquid into the mixing chamber through a single spray bar with twelve spray nozzles. The nozzles shall be self-cleaning and the operator shall be able to switch off any number of individual nozzles, for working at reduced widths, from the control console in the operators cabin. The spray bar shall be separate from any other spray system on the recycler. A hydraulically extendable screed shall be located at the rear of the recycler to precompact and place the treated material to grade.

The screed shall have a basic width of 6' 6" and extend to a maximum width of 12' 0". The variable width screed shall be of a tamper bar design to ensure initial compaction on cold mixed materials. Tamper bars shall be included on the main screed as well as the extensions to ensure even compaction across the entire width of the recycled area.

Individual valves on the spray bar shall be capable of being turned off as necessary to minimize emulsion overlap on subsequent passes. The distance between the center of the mixing drum and leading edge of the screed shall not exceed 15ft .

All rollers shall be self-propelled. The number, weight and types of rollers shall be as necessary to obtain the required compaction, however at least two pneumatic rollers and one vibratory steel roller are required on the project. The pneumatic rollers shall have a minimum gross operating weight of not less than 50,000 lbs. each. Pneumatic rollers must have properly working scrapers and water spraying systems. At least one double drum vibratory roller shall have a gross operating weight of not less than 20,000 lbs. and a width of 78 inches. Double drum vibratory rollers must have properly working scrapers and water spraying systems.

A self-propelled power broom for removal of loose particles and other materials from the CIR surface. The broom shall have positive control on the downward pressure applied to the surface.

Processing, Placing, Compacting, and Finishing

Arrange for supervisory personnel of the contractor crew, testing laboratory, mix design laboratory, emulsion supplier and Engineer, to meet within two weeks of the start of the CIR process to discuss methods of accomplishing all phases of the work.

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

The existing pavement shall be pulverized to the required depth and width as indicated on the plans. Recycling shall be in a manner that does not disturb the underlying material in the

existing roadway. The milling operation shall be conducted so that the amount of fines occurring along the vertical faces of the cut will not prevent bonding of the cold recycled materials. The pulverized bituminous material shall be processed by screening and crushing to the required gradation as specified in Cold Pulverized Material.

The recycled material shall be produced through a mixing unit or chamber capable of processing the pulverized material, asphalt emulsion, and water to a homogeneous mixture. The asphalt emulsion and water shall be incorporated into the pulverized bituminous material at the initial rate determined by the mix design(s) and approved by the Engineer. Sampling and mix design may determine different amounts of asphalt emulsion are required at various portions of the project.

The cold in-place recycled asphalt treated base shall be compacted to a density approved by the Engineer. The Contractor shall prepare a 1000' test section. A combination of steel wheeled, under static or vibratory mode, and pneumatic rollers will be used to establish what combination will yield the maximum density. Rolling or roller patterns shall be established at the beginning of each day's work, or a change when major displacement and/or cracking of the recycled material occurs, or a change in mix design. Rolling shall start no more than 15 minutes behind the screed. Vibratory mode shall only be used if it is shown to not damage the pavement. When possible, rolling shall not be started or stopped on uncompacted material but with rolling patterns established so that they begin or end on previously compacted material or the existing pavement. Rolling shall be longitudinal and commence at the outer edges of the road and progress toward the centerline. In superelevated curves, the rolling shall begin at the low side and progress to the high side. Where paving is abutting a previously placed lane, compaction shall begin with the roller entirely on the new mat and the edge approximately 6 inches from the joint. Both passes (forward and backward) shall be made in vibratory mode with the second pass overlapping the cold lane by 6 inches. Final rolling, to eliminate pneumatic tire marks and to achieve density shall be done by double drum steel roller(s), either operating in a static or vibratory mode. Finish rolling shall be completed no more than two hours after milling is completed.

After the completion of compaction of the recycled material, no traffic, including that of the Contractor, shall be permitted on the completed recycled material for at least two (2) hours. After two hours rolling traffic may be permitted on the recycled material. This time may be adjusted by the Engineer to allow establishment of sufficient cure so traffic will not initiate raveling. After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic. All loose particles that may develop on the pavement surface shall be removed by power brooming.

The Cold In-Place Recycled bituminous material will be accepted visually on the roadway after compaction. The Contractor shall repair any damage as directed by the Engineer prior to the placement of the hot mix asphalt concrete surface course or other applicable surface treatment. Any areas showing an excess or deficiency of CIR-EE, not acceptably mixed, or that ravels shall be reprocessed. If raveling occurs, additional rolling shall be provided. If the Engineer determines that the unacceptable material is due to the Contractor's operations, the corrective work shall be performed at the Contractor's expense.

Placing of the recycled asphalt treated base shall be done by such methods and such equipment that the final surface, including the shoulders, shall not deviate at any point more than 0.03' from the bottom of a 10' straightedge laid in any direction on the surface on either side of the roadway crown. When tests show that the pavement is not within the specified

tolerance, the Contractor shall take immediate action to correct equipment or procedures in the paving operation to eliminate the unacceptable pavement irregularities. Any surface deviations from the specified tolerances shall be corrected within 24 hours by reprocessing the surface. The cost of all corrective work, including traffic control, shall be performed at the Contractor's expense.

Before placing the hot mix asphalt concrete surface course, or other applicable surface treatment, the Cold In Place Recycled bituminous material shall be allowed to cure until the moisture of the material is reduced to 2.0 percent or less, or approval of the project Engineer. Under dry conditions the Cold In-Place Recycling should meet the moisture requirements within 48 hours.

Quality Control

The Contractor shall be responsible for quality control of the materials and cold recycling process. Two weeks prior to the CIR construction the Contractor shall submit for approval by the Engineer a Quality Control Plan addressing Pulverized Bituminous Material, Asphalt Emulsion Content, Water Content, and Mixture Testing. The Contractor shall make available at any time quality control data as requested by the Engineer. The quality control requirements are as follows:

Pulverized Bituminous Material Sizing

A sample shall be obtained each ½ mile behind the recycling unit using a 2.0 inch sieve (or smaller sieve if required) to determine if meeting the maximum particle size requirement. Additionally, two gradations shall be performed each day on the oven air dried recycled mixture using the following sieves: 2.0 inch, 1.5 inch, 1.0 inch, ¾ inch, ½ inch, 3/8 inch, No.4, No.8, No.16, and No.30. The resulting gradation shall be compared to the mix design gradations to determine any necessary changes to emulsion content. Sampling procedures shall generally be in accordance with ASTM D979 or AASHTO T168.

Asphalt Emulsion Content

Emulsion content shall be checked and recorded for each segment in which the percentage is changed. Emulsion content changes shall be made based upon mix design recommendations, which are based upon different mix designs for road segments of varying construction. Asphalt emulsion content can be checked from the asphalt pump totalizer. If no percentage changes are made, the Emulsion content shall be checked a minimum of once per day.

Water Content

Water content used in the recycling process shall be checked and recorded for each segment in which the percentage is changed. This information shall be gathered from the water metering device. Water content changes shall be made based on mixture consistency, coating, and handling of the recycled materials. If no percentage changes are made, the Water content shall be checked a minimum of once per day.

Mixture Testing

Samples will be gathered for testing mixture results from the design given as described in Table 5. The frequency of testing shall be one test per day or change in mix design. The samples should be taken following ASTM D3665 and D979. If samples of the emulsion/recycled asphalt pavement mixture are taken, the specimens must be compacted within 15 minutes of sampling and tested as required in Table 5. The samples must be screened through a 1 inch screen if 4 inch specimens are to be compacted.

Weather Limitations

Begin recycling if the anticipated atmospheric temperature is 60°F and rising at the project site by 10 00 am when starting recycling operations prior to 10 00 am. Cease recycling operations if the air or pavement temperatures drop below 60F after 10 00 am. Do not begin in-place recycling if it is anticipated the atmospheric temperature will drop below 40°F within 48 hours of mixing at the project site, or during stormy weather

Measurement

Measurement of the Cold In-Place Recycle will be by the square yard of completed surface.

The CIR-EE Asphalt Emulsion for Cold In-place Recycle will be measured by the ton in accordance with Section 1-09.

Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items that are included in the proposal:

“Cold In-Place Recycle” per square yard.

The unit contract price per square yard for “Cold In-Place Recycle” shall be full pay to complete the work as specified.

“Asphalt CIR-EE”, per ton.

The unit contract price per ton for “Asphalt CIR-EE” shall be full pay to complete the work as specified, including all cost to provide and add water to the Asphalt Emulsion for Cold In-place Recycled with CIR-EE

“Asphalt Emulsion Fog Seal”, per ton.

The unit contract price per ton for “Asphalt Emulsion Fog Seal” shall be full pay to complete the work as specified, including all cost to provide and add water to the Asphalt Emulsion for Fog Seal.