

## **30-6 COLD IN-PLACE RECYCLING USING FOAMED ASPHALT (CIR – FA)**

### **30-6.01 GENERAL**

#### **Submittals:**

The Contractor shall furnish the following information regarding the Cold In-Place Recycling (CIPR) to the Engineer. Approval of the Contractor or Subcontractor performing the CIPR is at the discretion of the Engineer.

- 1) Description and specification of the proposed CIR recycling unit and support equipment, construction method, expected production rates, and planned sequence of construction.
- 2) The Contractor (or Subcontractor) shall have completed a minimum of three (3) CIR projects in the last three (3) years. Submit project name, agency/owner, project engineer, and construction dates.
- 3) Verification the CIR recycling unit meets the proportioning requirements of California Department of Transportation Material and Plant Quality Program (MPQP) and the applicable Air Quality Control District permits.

#### **30-6.01A Summary**

Section 30-6 includes specifications for constructing the pavement using cold in-place recycling using foamed asphalt (CIR-FA).

CIR-FA consists of:

1. Cold planning the existing asphalt concrete pavement to the depth shown
2. Mixing the cold-planed material with foamed asphalt, cement, and water
3. Spreading and compacting the mixture
4. Applying asphaltic emulsion and sand cover

#### **30-6.01B Definitions**

expansion ratio: a measure of the viscosity of the foamed asphalt, calculated as the ratio of the maximum volume of the foam relative to the original volume of asphalt  
half life: a measure of the stability of the foamed bitumen, calculated as the time taken in seconds for the foam to collapse to half of its maximum volume  
ITS : indirect tensile strength  
lot : 3,000 square yards (2,250 linear feet of a 12-foot wide lane)  
RAP: reclaimed asphalt pavement

#### **30-6.01C**

#### **Submittals 30-**

#### **6.01C(1)**

#### **General**

At least 20 days before starting CIR work, submit the following:

1. QC Plan
2. Mix Design
3. Contingency Plan

#### **30-6.01C(2) Quality Control Plan**

Provide a quality control plan (QCP) that describes the organization, responsible parties, and procedures the Contractor will use to:

1. Control quality
2. Determine when corrective actions are needed (action limits)

3. Implement corrective actions

The QCP must contain copies of the forms that will be used to provide all required inspection records and sampling and testing results. On the form used to record and report the quality control measurements, also show the job mix formula information.

**30-6.01C(3) Mix Design**

The Contractor will take samples of the existing pavement, prepare, and submit a mix design for the Engineer’s approval. Laboratories preparing the mix design must be accredited through the AASHTO re:source program, and/or Caltrans’ Independent Assurance Program, or be approved by the Engineer. The mix design submittal must be signed and sealed by an Engineer who is registered as a Civil Engineer in the State of California.

The mix design must comply with **2012 1<sup>st</sup> Edition of Wirtgen Cold Recycling Technology (Wirtgen Manual)** with the following specific requirements:

1. Representative field samples used for the mix design shall be pulverized to the following gradation requirements excluding the addition of mineral filler (cement):

SIEVE SIZE		GRADATION RANGE, % PASSING
2”	50 mm	100
1.5”	37.5 mm	87-100
¾”	19 mm	65-100
3/8”	9.5 mm	48-80
#4	4.75 mm	35-62
#8	2.36 mm	25-47
#16	1.18 mm	18-36
#30	0.60 mm	13-28
#50	0.30 mm	9-22
#100	0.15 mm	6-17
#200	0.075 mm	4-12

2. Moisture-density relationship for the RAP material shall be determined per CTM 216. RAP materials shall be adjusted to optimum moisture content prior to compaction.
3. Foaming properties of bitumen shall conform to Section A1.2.3 of the Wirtgen Manual. Minimum expansion ratio and half-life shall be 10 times and 8 seconds, respectively, for RAP material temperatures between 10°C (50°F) and 15°C (59°F). For RAP material temperatures greater than 15°C (59°F), the absolute minimum expansion ratio and half-life shall be 8 times and 6 seconds, respectively.
4. After mixing in accordance with Section A1.2.4 of the Wirtgen Manual, foamed asphalt treated material must be sealed immediately in air-tight containers and allowed to sit for 30 minutes. After the 30-minute sit time, the foamed asphalt treated material must be compacted no later than 90 minutes after mixing (includes the 30-minute sit time).
5. Specimens must be compacted in accordance with Section A1.2.5.1 of the Wirtgen Manual (Modified Marshall method).
6. Design specimens are cured following the “Curing Dry” method as specified in Section A1.2.6.1 (specimens are placed in a forced-draft oven at 40°C (104°F) and cured to constant mass (normally 72 hours)) of the Wirtgen Manual.

7. The indirect tensile strength (ITS) of specimens shall be determined in accordance with ASTM D6931 with the following modifications:
  - a. specimen temperature must be  $25\pm 2^{\circ}\text{C}$  ( $77\pm 3.6^{\circ}\text{F}$ ) prior to testing for both soaked and dry subsets.
  - b. conditioning time for dry subsets should be either Procedure A or Procedure B in Sections 7.3.1 and 7.3.2, respectively of ASTM D6931.
  - c. additional conditioning time for wet subsets is not required if it has already been soaked for 24 hours in a water bath at  $25\pm 2^{\circ}\text{C}$  ( $77\pm 3.6^{\circ}\text{F}$ ). Remove wet subsets from the water bath, surface dried, and test immediately per Section A1.2.7 of the Wirtgen Manual.

At a minimum, the design submittal for each pavement section (street) must provide the following information:

- Cold in-place recycling equipment and method proposed
- RAP gradation
- Moisture-density relationship per CTM 216 of RAP materials
- Asphalt Binder Grade
- Asphalt Binder Content
- Asphalt Binder Source
- Foaming profile data (expansion ratio/ half life) and proposed foaming settings (temperature / water content)
- Temperature of RAP materials prior to foaming process
- Cement Content
- Cement Source
- Cement Grade
- Any other additives or emulsifiers
- Bulk density of test specimens
- Indirect tensile strength of dry and soaked specimens at various asphalt binder contents
- Recommended asphalt binder content, cement content, optimal water content for foaming asphalt binder, and foaming temperature
- Time stamps for: mixing CIR-FA material, start/end time for sit period (30 minutes), start/end time for compacting each briquette

Minimum criteria used for acceptance of the proposed mix design shall be:

- Soaked Indirect Tensile Strength **250 kPa minimum**

### **30-6.01C(4) Contingency Plan**

The contingency plan must include any corrective actions including repairing and reopening the roadway to traffic using hot mix asphalt in compliance with Section 39 of the Standard Specifications or temporary bituminous surfacing in compliance with these special provisions.

Hot mix asphalt must:

1. Be Type F or Type H as approved by the Engineer
2. Use ½-inch nominal maximum aggregate size gradation
3. Use asphalt binder grade PG 64-10 or PG 64-16

Temporary bituminous surfacing must:

1. Be commercial quality bituminous material
2. Contain using 1/2 -inch nominal maximum aggregate size gradation in compliance with

Section 39 Aggregate of the Standard Specifications.

3. Use liquid asphalt SC-800 in compliance with Section 94, "Asphaltic Emulsions"

Meet with the Engineer at least 7 days before starting CIR work to review the QCP and contingency plan.

### **30-6.01D Quality Control and**

#### **Assurance 30-6.01D(1) QC**

##### **Laboratory**

The contractor shall provide a certified testing laboratory and personnel to perform quality control inspection, sampling, and testing. Provide the Engineer or Engineer's authorized representative with unrestricted access to the laboratory, sampling, and testing sites, and all information resulting from job mix formula and quality control inspection and testing activities.

Proficiency of testing laboratories and sampling and testing personnel must be reviewed, qualified, and accredited by AASHTO re:source, and/or Caltrans' Independent Assurance Program, or approved by the Engineer before starting cold-in-place recycling work.

Perform inspection, sampling and testing at a rate sufficient to ensure that cold in-place recycling mixture, placement, compaction and finishing complies with the specifications.

##### **30-6.01D(2) Production**

Once daily the contractor shall sample RAP behind the recycling equipment or the processed RAP before the addition of the foaming agent. The contractor shall report the test results immediately to the Engineer. Reprocess the RAP or take other corrective action to attain compliance.

Divide the project into 3,000 square yard lots. For each lot:

1. Determine the actual recycle depth at each end of the milling drum at least once every 300 feet along the cut length
2. Determine the amount of recycling agent
3. On every third sample taken, perform a wet field gradation for material passing the 1-inch through No. 4 sieves. Compare the sieved sample to the gradation band determined from the job mix formula and adjust the emulsified recycling agent if necessary.
4. Determine in place density and relative compaction of 10 random locations.

For each lot, measure or calculate and record the following information:

1. Length, width, depth of cut and calculated weight in tons of material processed
2. Weight of recycling agent added in tons
3. Percentage of added recycling agent in the lot's CIR mixture by weight
4. Weight of recycling additive used in tons (if used)
5. Percentage of recycling additive in the lot's CIR mixture by weight (if used)
6. Maximum particle size of the RAP
7. Maximum obtainable density used for relative compaction calculation
8. Nuclear gauge in-place density and relative compaction at 10 random locations
9. Ambient and compacted recycled pavement surface temperatures
10. Maximum theoretical density under California Test 309 and void ratio (Report only)
11. Rate of fog seal coat application
12. Rate of sand cover application

On the form used to record and report the quality control measurements, also show the job mix formula information. Make adjustments during CIR operations for optimum quality. If adjustments are made,

document the reason for the change and identify on the daily quality control inspection records and sampling and test results.

The Contractor shall perform all Quality Control testing and sampling for the project. The Contractor shall furnish copies of all test results to the Engineer or the Engineer's authorized representative within 24 hours of completing the test of the acquired sample or the next business day.

**30-6.01D(3) Placement**

CIR shall be to a depth specified within the lines and grades of the project plans and specifications or as directed by the Engineer. The CIR material shall be capable of holding traffic at the end of each day's production without deformation or damage occurring to the surface. No rutting or raveling shall be tolerated and corrective action as specified in the Quality Control Plan shall be applied when either occurs.

**30-6.01D(3)(a) Fog Seal and Sand Spreading**

At the end of each day's production the contractor shall apply a fog seal to the surface at a rate of 0.12 gal/sy. Fog seal shall meet Section 37 of City Standard Specifications. Sand shall be spread at a rate of 1.0 to 2.0 pounds per square yard at the areas fog seal is placed or as determined by the Engineer. The contractor shall protect drainage inlets and remove excess sand from the CIR surface by sweeping. Sand cover shall be spread by means of a self-propelled spreader equipped with a mechanical device that will spread the sand at a uniform rate over the CIR surface. The area treated shall be capable of holding traffic at the end of each day's production without any deformation or damage to the surface.

**30-6.01D(3)(b) Measurement**

Quantities of seal coat to be paid for will be measured by the ton in accordance with the provisions in Section 94, "Asphaltic Emulsions" of the Standard Specifications.

**30-6.01D(3)(c) Payment**

Reserved

**30-6.01D(4) Acceptance**

The project shall be divided into lots of 3,000 square yards. If one day's production will be less than 3,000 square yards, that day's production shall be a lot. If one day's production is one lot plus an additional amount, the additional work shall be a separate lot.

For each lot, the Engineer or Engineer's authorized representative shall sample a minimum of 80 lbs. of CIR material per CTM 125. Samples shall be collected in tightly sealed containers to prevent moisture loss during transport. The CIR material shall be transported to the acceptance testing lab as quickly as possible. A portion of the sampled material shall be used to determine the moisture-density relationship per CTM 216. The remaining portion shall be compacted in the "as is" condition per Section A1.2.5.1 of the Wirtgen Manual (Modified Marshall method). Two sets of compacted CIR samples shall be prepared with 3 briquettes tested in the dry condition, and 3 briquettes tested in the soaked condition.

Compacted specimens shall be cured in accordance with "Curing Dry" method as specified in Section A1.2.6.1 of the Wirtgen Manual. Specimens are placed in a forced-draft oven at 40°C (104°F) and cured to constant mass (normally 72 hours).

After curing and before testing for indirect tensile strength (ITS), the bulk density of each specimen shall be determined per Section A1.2.7 of the Wirtgen Manual.

The ITS of specimens shall be determined per ASTM D6931 with the following modifications:

- specimen temperature must be 25±2°C (77±3.6°F) prior to testing for both soaked and dry subsets.
- conditioning time for dry subsets shall be either Procedure A or Procedure B in Sections 7.3.1 and 7.3.2, respectively of ASTMD6931.
- additional conditioning time for wet subsets is not required if it has already been soaked for 24 hours in a water bath at 25±2°C (77±3.6°F). Remove wet subsets from the water, surface dried,

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and test immediately per Section A1.2.7 of the Wirtgen Manual.

CIR material sampled for acceptance during production shall be compacted **within 3 hours** of sampling. Acceptance during production will be based on the following criteria:

- A. Soaked ITS test results shall be no less than 95% of the minimum design strength (95% x 300 kPa = 285 kPa).
- B. The average Relative Compaction of a lot (average of 10 gauge readings within the lot) shall be a minimum of 98% of the maximum wet density as measured by CTM 216. No single test reading shall be less than 94% relative compaction.

For a lot outside of the acceptance criteria, the Engineer determines a deduction for each test result representing a lot outside the specifications using the reduced payment factors shown in the following tables:

Table 1: Reduced Payment Factors for CIR Soaked ITS

% of Minimum Design Strength 250 kPa	Pay Factor	% of Minimum Design Strength 250 kPa	Pay Factor
95.0	100%	92.0	85.0%
94.9	99.5%	91.9	84.5%
94.8	99.0%	91.8	84.0%
94.7	98.5%	91.7	83.5%
94.6	98.0%	91.6	83.0%
94.5	97.5%	91.5	82.5%
94.4	97.0%	91.4	82.0%
94.3	96.5%	91.3	81.5%
94.2	96.0%	91.2	81.0%
94.1	95.5%	91.1	80.5%
94.0	95.0%	91.0	80.0%
93.9	94.5%	90.9	79.5%
93.8	94.0%	90.8	79.0%
93.7	93.5%	90.7	78.5%
93.6	93.0%	90.6	78.0%
93.5	92.5%	90.5	77.5%
93.4	92.0%	90.4	77.0%
93.3	91.5%	90.3	76.5%
93.2	91.0%	90.2	76.0%
93.1	90.5%	90.1	75.5%
93.0	90.0%	90.0	75.0%
92.9	89.5%		
92.8	89.0%	≤ 89.9	Remove at Engineer's sole discretion
92.7	88.5%		
92.6	88.0%		
92.5	87.5%		
92.4	87.0%		
92.3	86.5%		
92.2	86.0%		
92.1	85.5%		

Table 2: Reduced Payment Factors for Relative Compaction

Average Compaction per Lot as % of Measured Maximum Wet Density per CTM 216	Relative Maximum Pay Factor	Average Compaction per Lot as % of Measured Maximum Wet Density per CTM 216	Relative Maximum Pay Factor
98.0	100%	95.0	70%
97.9	99%	94.9	69%
97.8	98%	94.8	68%
97.7	97%	94.7	67%
97.6	96%	94.6	66%
97.5	95%	94.5	65%
97.4	94%	94.4	64%
97.3	93%	94.3	63%
97.2	92%	94.2	62%
97.1	91%	94.1	61%
97.0	90%	94.0	60%
96.9	89%		
96.8	88%		
96.7	87%		
96.6	86%		
96.5	85%		
96.4	84%		
96.3	83%		
96.2	82%		
96.1	81%		
96.0	80%		
95.9	79%		
95.8	78%		
95.7	77%		
95.6	76%		
95.5	75%		
95.4	74%		
95.3	73%		
95.2	72%		
95.1	71%		
		≤ 93.9	Remove at Engineer's sole discretion

In the event a lot is subject to both pay factors, they will be cumulative (i.e., an 80% pay factor for Marshall and a 70% pay factor for Compaction equals a 56% cumulative pay factor.  $0.80 \times 0.70 = 0.56$ ).

**30-6.01D(5) Dispute Resolution**

You and the Engineer must work together to avoid potential conflicts and to resolve disputes regarding test result and visual inspection discrepancies. You and the Engineer may only dispute each other’s test results if one party’s test results pass and the other party’s test results fail.



You must notify the Engineer within 3 business days of receiving the Engineer’s test results. Submit your test results and copies of paperwork including worksheets used to determine the disputed test results within 3 business days of notifying the Engineer of your plan to dispute test results.

You and the Engineer shall mutually agree on an independent third party (ITP) to perform referee testing. Before the ITP participates in a dispute resolution, it must be qualified under the AASHTO re:source program and/or Caltrans Independent Assurance Program, or approved by the Engineer. The ITP personnel performing the tests shall be competent and possess the necessary training and experience including certifications to provide referee testing. The ITP must have no prior direct involvement with this Contract. If the Engineer’s portion of acceptance samples are not available, the ITP shall propose means and methods to be used for the disputed material for evaluation. The proposal must be in writing and mutually agreed by you and the Engineer.

If you or the Engineer dispute each other’s visual inspection findings, submit copies of your visual inspection findings. An ITP consisting of a CIR industry or Academia expert will perform a visual inspection. The ITP must have no prior direct involvement with this Contract. The ITP is chosen by mutual agreement between you and the Engineer.

The entire dispute resolution process shall not exceed 20 business days from the day you notified your plan to dispute the test results (includes ITP selection for referee testing).

If the ITP determines the Engineer’s test results or visual inspection findings are valid, the Engineer deducts the ITP’s testing and service costs from payments. If the ITP determines your test results or visual inspection findings are valid, the Engineer pays the ITP’s testing and service costs.

**30-6.01D(6) Method of Measurement**

The unit of measurement for Cold In-Place Pavement Recycling shall be per square yard for the depth specified in the contract. The area to be paid shall be the length measure along the centerline of the roadway multiplied by the average perpendicular width. Additional excavation/recycling performed by the Contractor outside the lines provided in the Plans shall not be measured and compensated by the Department without approval by the Engineer.

**30-6.01D(7) Basis of Payment**

Cold In-Place Pavement Recycling shall be paid for at the contract unit price per square yard adjusted by the pay factor. This amount shall be full compensation for all work necessary within the dimensions shown on the plans or specified herein, including but not limited to pulverizing existing pavements, additional materials, stabilizing agent(s), mineral filler, water, grading, compaction, sampling, testing and for all materials, labor, tools, equipment, hauling permits, mobilization, and any incidentals necessary to complete the work.

Payment shall be made under:

<b>Item Description</b>	<b>Unit</b>
Cold In-Place Recycling	Per Square Yard