# GREENBOOK SEMINAR October 30, 2024 PART 10 ASPHALT CONCRETE RECYCLING





Erik Updyke, P.E.

Marco Estrada

**Michael Concannon** 

SECTION 1000 – COLD-IN-PLACE RECYCLING USING EMULSIFIED RECYCLING AGENT (CIR-ERA)

## **1000-1 GENERAL.**

1) "CIR-ERA shall consist of crushed and screened 100 percent reclaimed asphalt pavement (RAP), emulsified recycling agent, and additive(s) mixed in a <u>traveling cold</u> <u>recycling plant</u>, ..."





#### **1000-3 MATERIALS.**

#### 1000-3.3 Emulsified Recycling Agent (ERA).

1000-3.5 Additives.



1) ERA: Specially formulated emulsion (203-4)

2) Effects of Portland Cement vs. Lime

#### **1000-4 MIX DESIGNS.**

- 1) "<u>Unless otherwise specified</u>, the Contractor shall prepare and submit the mix design(s)." (1000-4.1)
- 2) "Cores shall be considered as part of the mix design process <u>unless otherwise specified</u>." (1000-4.1)
- 3) "<u>Unless otherwise specified</u>, the Contractor shall perform the coring necessary for preparation of the mix design." (1000-4.2.1)
- 4) "<u>If specified</u>, the Agency will collect the core samples and furnish to the Contractor for use in preparing the mix design." (1000-4.2.3)

### **1000-4 MIX DESIGNS.**

- 5) "Based on the characteristics of the RAP taken from the Work site, <u>more than one mix design may be required</u>." (1000-4.3)
- 6) "<u>If specified</u>, the Agency will prepare the mix design(s)." (1000-4.4)
- Comments:
- 1) Cores: No. and Location
- 2) Mix Designs



- **1000-5.2 Cold Milling Machines.**
- 1000-5.3 Crushing and Screening Equipment.
- 1000-5.4 Mixing and Proportioning Unit.
- **1000-5.5 Water Storage and Supply Equipment.**
- 1000-5.7 Paving Machine. "... track paver ..."
- **1000-5.8 Rollers.** "... pneumatic-tired ... weighing 25 tons ... double-drum vibratory ..."







## **1000-6 QUALITY CONTROL PROGRAM.**

- 1) "The Contractor shall implement a quality control program <u>throughout the production and placement of CIR-ERA.</u>)." (1000-6.1)
- 2) "The Contractor shall prepare and submit ... a QCP which includes the following:" (1000-6.2)
- 3) "The Contractor shall be responsible for <u>quality control</u> <u>inspection, sampling, testing, and reporting</u> as part of its Quality Control Program." (1000-6.3.1)
- 4) "<u>The basis of reporting shall be a Lot</u>... 3,000 square yards or fraction thereof of CIR-ERA constructed during the same day." (1000-6.3.2)

## **1000-7 JUST-IN-TIME TRAINING (JITT).**

- 1) "JITT is a formal joint training class on materials, equipment, placement, compaction methods and quality control." (1000-7.1)
- **1000-8 PRODUCTION AND PLACEMENT.**
- 1000-8.2 Sequence of Work.
- 1000-8.4 Roadway Surface Preparation.

# 1000-8.5 Cold Milling, Crushing, and Screening.

- 1) "The existing asphalt concrete pavement shall be cold milled to the depth shown on the Plans [Pre-Mill]."
- 2) "Paving fabric, if present in the crushed and screened RAP, shall not exceed 2 inches (50 mm) in any dimension."
- 3) "Inductive loop detector wires, ... and other incompatible materials shall be removed from the RAP."

# 1000-8.5 Cold Milling, Crushing, and Screening.







#### **1000-8.6 Mixing and Proportioning.**







# 1000-8.7 Mixing and Spreading of Cement and Lime.

- 1) "Dry Portland cement shall be <u>spread upon the existing</u> <u>asphalt concrete surface</u> ahead of the recycling train at the rate specified in the approved mix design." (1000-8.7.1)
- 2) "Lime, <u>if approved</u>, shall be added in the form of lime slurry only." (1000-8.7.2.1)
- 3) "Lime slurry shall be introduced directly into the pugmill <u>or</u> sprayed over the cutting teeth of the cold milling machine at the rate specified in the approved mix design." (1000-8.7.2.1)

# 1000-8.7 Mixing and Spreading of Cement and Lime.



#### **1000-8.8 Mixture Placement.**

- 1) "... the mixture shall be placed in one continuous pass and conform to the lines, grades, and cross sections <u>shown on</u> <u>the Plans</u>."
- 2) "A single lift thickness shall be a <u>minimum</u> compacted depth of 3 inches (75 mm) and not exceed a <u>maximum</u> compacted depth of 4.5 inches (113 mm)."



#### **1000-8.9 Initial Compaction.**

- 1000-8.9.1 General.
- 1000-8.9.2 Rolling Pattern.
- 1000-8.10 Smoothness.





### **1000-9 TEST STRIP.**

- 1) "The Contractor shall construct a test strip a single lane in width and a minimum of 1,500 feet in length located within the limits of the CIR-ERA work on the first Working Day of CIRERA operations." (1000-9.1)
- 2) "CIR operations shall not proceed further until the test strip has been approved by the Engineer." (1000-9.2)
- 3) "A new rolling pattern and a new maximum obtainable density shall be established if any of the following occurs:" (1000-9.3)

#### **1000-9 TEST STRIP.**



## 1000-10 FOG SEAL COAT AND SAND COVER.



#### 1000-11 CURING.

- 1) "CIR-ERA shall cure in-place <u>until the start of supplemental</u> <u>compaction</u>."
- 2) "The start of supplemental compaction shall be determined in accordance with the following:"

### **1000-12 SUPPLEMENTAL COMPACTION.**

- 1) "... shall be performed after the CIR-ERA has cured in accordance with 1000-11 and prior to any smoothness testing or placement of a new asphalt concrete surface course."
- 2) "For each Lot, the Contractor shall measure or calculate and record the following information:"

## **1000-12 SUPPLEMENTAL COMPACTION.**

3) "The final compacted surface shall be free of ruts, bumps, indentations, raveling, irregularities, or segregation and conform to the smoothness requirements specified in <u>1000-8.5</u> [1000-8.10]."



## 1000-13 PROTECTION AND MAINTENANCE.

- **1000-14 MEASUREMENT.**
- 1) "Cores will be measured by <u>each</u> or by lump sum as shown in the Bid." (1000-14.1)
- "CIR will be measured by the <u>square yard</u> of finished surface for <u>each thickness shown on the Plans</u>." (1000-14.2)

### **1000-14 MEASUREMENT.**

- 3) "ERA will be measured by the ton." (1000-14.3)
- 4) *"Portland cement and lime will be measured by the <u>ton</u>." (1000-14.4)*

## **1000-15 PAYMENT.**

- 1) "Payment for cores will be made at the <u>Contract Unit Price</u> <u>for each core</u> or the lump sum price in the Bid." (1000-15.1)
- 2) "Payment for sampling, testing, and mix design(s), if performed by the Contractor, will be made at the <u>lump sum</u> <u>price</u> in the Bid. (1000-15.2)

## **1000-15 PAYMENT.**

- 3) "Payment for CIR will be made at the <u>Contract Unit</u> <u>Price per square yard for each thickness shown on the</u> <u>Plans</u>." (1000-15.3)
- 4) *"Payment for ERA will be made at the <u>Contract Unit Price</u> <u>per ton</u>." (1000-15.4)*
- 5) *"Payment for Portland cement and lime will be made at the Contract Unit Price per ton."*

SECTION 1001 – COLD CENTRAL PLANT RECYCLING USING EMULSIFIED RECYCLING AGENT (CCPR-ERA)

#### **1001-1 GENERAL.**

1) "CCPR-ERA shall consist of crushed and screened 100 percent reclaimed asphalt pavement (RAP), emulsified recycling agent, and additive(s) mixed at a <u>mobile cold</u> <u>recycling plant or stationary batch plant</u>, ..."

#### **1001-1 GENERAL.**



#### 1001-1 Comments:

- Similar to CIR, except produced at a mobile or stationary facility.
- 2) 1001 specifications refer to 1000 or specify the requirements if different than for CIR.

#### **1001-8 PRODUCTION.**

#### 1001-8.2 Sequence.





#### **1001-8 PRODUCTION.**

#### 1000-8.2 Sequence.





#### **1001-9 PLACEMENT.**

#### 1001-9.2 Sequence.





#### **1001-10 TEST STRIP.**

## 1001-11 FOG SEAL COAT AND SAND COVER.

1001-12 CURING.

**1001-13 SUPPLEMENTAL COMPACTION.** 

1001-14 PROTECTION AND MAINTENANCE.

## **1001-15 MEASUREMENT.**

Same as 1000-14 except:

- 1) "CCPR will be measured by the <u>square yard</u> of finished surface for <u>each thickness shown on the Plans</u>, <u>or</u> by the <u>ton</u> of CCPR-ERA mixture placed.." (1001-14.3)
- **1001-16 PAYMENT.**
- Same as 1000-15 except:
- 1) "Payment for CCPR will be made at the <u>Contract Unit Price</u> <u>per square yard for each thickness shown on the Plans</u> or by the <u>ton</u>." (1001-16.3)

## **Sample CIR/CCP Calculations**

**Emulsified Recycling Agent (ERA):** 

- L = 10,560'
- W = 40'
- T = 3" = 0.25'
- Density (dry) = 138 pcf (assumed)
- ERA content: 3% (assumed)
- ERA (tons) = 10,560' x 40' x 0.25' x 138 lbs./cf x 0.03 x 1 ton/2000 lbs. = 218.6 > <u>220 tons</u>

## City and County Pavement Improvement Center

**References and Links** 



#### References

- Guide for Partial and Full-Depth Recycling in California, UCPRC-GL-2020-01, ("Recycling Guide"), Caltrans:
  - <u>https://dot.ca.gov//media/dotmedia/programs/maint</u> <u>enance/documents/office-of-asphalt-</u> <u>pavements/469fdrpdr-guidestg6ada.pdf</u>
- Basic Asphalt Recycling Manual, American Recycling and Reclaiming Association, ("ARRA Manual"):

www.arra.org/store/ListProducts.aspx?catid=595203



## **Questions?**

## eupdyke@ucdavis.edu