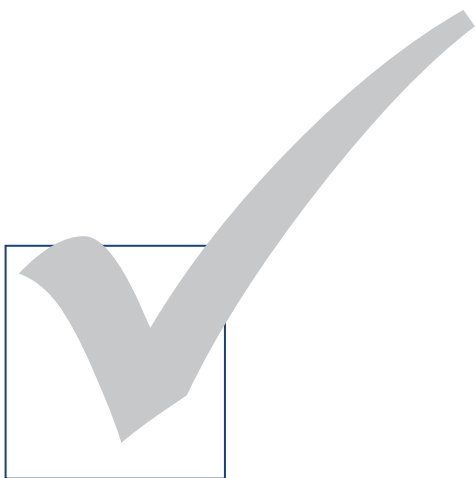


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Cold In-Place Recycling



Cold In-Place Recycling (CIR) Checklist

This checklist is one in a series created to guide State and local highway preservation/maintenance and inspection staff on the use of innovative pavement preservation techniques.

FHWA uses its partnerships with different pavement preservation organizations including American Association of State Highway and Transportation Officials, and State and local transportation agencies to promote pavement preservation.

To obtain other checklists or to find out more about pavement preservation, contact your local FHWA division office or check the following FHWA Web page:

www.fhwa.dot.gov/pavement/preservation/resources.cfm

Other valuable resources on pavement preservation:

- www.roadresource.org
- www.fp2.org
- www.tsp2pavement.pavementpreservation.org

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Preliminary Responsibilities

Document Review

- Project specifications
- As built plans, if available
- Mix design
- Structural pavement design
- Construction manual
- Traffic control plan
- Agency requirements
- Additive manufacturer's instructions
- Safety data sheets
- Health and safety plan and job hazard analysis
- Applicable Occupational Safety and Health Administration (OSHA) safety requirements
- Contractor quality control (QC) plan

Project Review

- Confirm that all necessary contractor and agency personnel attend the pre-construction meeting.
- Verify that the project is a good candidate for cold in-place recycling (CIR).
 - Identify if there are any weak or unstable mixes in the existing cross section.
 - Previous on-site testing has not detected the presence of base or subgrade failures underlying the pavement within the project limits.
 - Examine the current surface and subsurface drainage conditions and confirm they are sufficient to prevent surface deterioration and softening of the subgrade and will enable long-term performance of the pavement after CIR treatment.
 - Existing appurtenance structures including guardrails, curbs, and bridge clearances do not impose limitations or potential variations to the existing pavement geometry.
- Note the types and causes of existing pavement distresses.
- Cores from both center and edge of pavement have been obtained at various locations along the project length that confirm the thickness of the bituminous layers.

- Verify from the cores that there is sufficient thickness of the existing pavement to perform the CIR process.
- Determine whether paving fabric is present within any of the layers to be recycled and if it could affect construction operations.
- Determine if excessive crack sealant is in the pavement to be recycled and whether it could affect CIR operation.
- Based on the forensic data verify that the project is a good candidate for CIR.

Materials Checks

- A sufficient number of cores and samples are obtained for mix design.
- Samples are evaluated for consistency over the length of the project.
- The recycling agent is compatible with the materials and processes. The recycling agent may be
 - Emulsified asphalt
 - Foamed (expanded) asphalt
- Recycling additives can be added in small amounts to improve mix properties, if indicated by the mix design. Recycling additives may be lime, hydraulic cement, or new aggregates.

Pre-Construction Inspection Responsibilities

Pavement Preparation

- Confirm that all necessary contractor and agency personnel attend the pre-construction meeting.
- Ensure that severe structural pavement distresses have been repaired.
- Areas with existing drainage issues from stormwater or subsurface aquifers (springs) have been corrected.
- Ensure that pre-milling, if required for grade control, cross-slope, or profile correction, was performed satisfactorily.
- Utilities have been lowered and back filled with reclaimed asphalt pavement (RAP), aggregate, or an approved cold mix.
- Ensure that all grass and soil are removed from the pavement surface, especially along the edges of the pavement, prior to recycling.
- Combustible materials, oils, or raised roadway markings are removed by sweeping, blading, or other approved method.
- Dirt deposits should be scrubbed from the pavement surface.

Equipment Inspections

Multi-Unit Trains:

MILLING MACHINE

- Confirm that the milling drum is the correct width.
- Verify that the milling machine has sufficient weight and horsepower to cut to the depth and tolerances required in the project specifications.
- Check that the cutting teeth are all in place and not broken or badly worn.
- Visually confirm that the spray bar and nozzles are working properly and not clogged.

SCREENING AND CRUSHING UNITS

- Examine the opening size and condition of the screen deck and determine whether it meets the project specifications.
- Verify that all oversize material will be routed through the crusher and rescreened.
- Visually confirm that the crushing unit is working properly.

PUGMILL

- Check that all paddles within the pugmill are in good condition and not broken or missing.
- Verify that the clearance between the paddles and the wall of the pugmill does not exceed that manufacturer's tolerances.

- Visually inspect the pugmill wall for holes or significant wear that adversely affects its operation.
- Confirm that the spray bars and recycling agent supply lines are not clogged and working properly.

**RECYCLING AGENT AND ADDITIVE SYSTEMS
(WATER, FOAMED ASPHALT/EMULSIFIED
ASPHALT, OTHER)**

- Verify that the mixing unit is properly calibrated and is capable of accurately dispensing the required quantity of recycling agent and additives.
- Verify that the on-board recycling agent/additive system is equipped with a meter capable of recording the rate of flow and total amount of each liquid being added to the recycled material.
- Verify that the on-board foam generating system includes a foamed asphalt sampling valve when foamed asphalt is being used as the recycling agent.
- Verify that the binder injection system contains two independent pumping systems and spray bars to regulate the application of foamed asphalt.

- Confirm that the on-board recycling agent system has a positive interlock system linked to the forward speed of the train so that the amount of liquid recycling agent being added will change according to the operational speed of the train.
- Routinely monitor that the correct amount of water is being added to achieve a homogenous mixture and achieve the specified density.
- Verify that the bulk spreader is properly calibrated and is capable of accurately dispensing the required quantity of additive such as cement or aggregate.

Single-Unit Trains:

- Verify that the cutting drum is the correct width.
- Confirm that the single-unit train has sufficient weight and horsepower to cut to the depth and tolerances required in the specifications.
- Check that the cutting teeth are all in place and not broken or badly worn.
- Visually confirm that the spray bar and nozzles are working properly and not clogged.
- Verify that the on-board recycling agent system is equipped with a meter capable of recording the rate of flow and total amount of each liquid being added to the recycled material.

- Verify that the unit is equipped with an on-board foam generating system that includes a foamed asphalt sampling valve when foamed asphalt is being used as the recycling agent.
- Confirm that the on-board liquid recycling agent system has a positive interlock system linked to the forward speed of the train so that the amount of recycling agent being added will change as the train speed changes.
- Check that the correct amount of water is being added to achieve a homogenous mixture and achieve the specified density.

All Trains:

NURSE TRAILER

- Confirm that the tank is dedicated to transporting only the material specified and has not been contaminated.
- Verify that the flexible hose used to flow material from the nurse trailer to the recycling unit is clean and not contaminated.

PAVER AND PICKUP MACHINE

- Verify that the paver and pickup machine, if required, have sufficient horsepower for the required operation.
- Ensure the paver hopper is adequately sized to prevent material spillover.
- Confirm that the automatic grade and cross-slope controls are functioning properly.

COMPACTION ROLLERS

- Determine the type(s) of rollers that will be used for breakdown, intermediate, and finish rolling. Typically, a minimum of one pneumatic-tired roller and one vibratory, double-steel drum roller are required.
- Confirm that the rollers meet the size, width, and weight requirements of the specification.
- Verify that the number of rollers necessary for the compaction effort can keep pace with the rate of material being processed and placed.
- Water spray bars, wetting pads, and scraping bars are working on all rollers to avoid material buildup.
- Approved asphalt release agents are available. Note: Do NOT use diesel fuel to clean roller drums or tires.
- Steel drums are free of grooves and dents and not warped.
- Pneumatic-tired rollers comply with the manufacturer's recommendation for tire pressure.
- Pneumatic-tired roller tires do not vary more than 5 psi from the prescribed pressure.

Weather Requirements

- Confirm that the ambient air temperature meets the project specification.
- Verify that the RAP temperature meets project specification requirement, typically a minimum of 50°F.
- Consider that variations in temperature, humidity, and wind conditions will all affect breaking and curing times.
- Verify that no heavy precipitation is predicted, although light rain is not typically a problem.

Mix Design

- Confirm that a mix design has been performed and that the resulting mixture meets the project specifications.
- Verify that any special instructions included with the mix design are incorporated into the contractor's preparations for construction operations.
- Confirm that the contractor has submitted the final mix design for review and acceptance prior to initiation of construction operations.
- In areas where in-place material properties change significantly, additional mix designs should be performed to establish representative mixtures.

Traffic Control

- Verify that traffic control conforms to plans and specifications and complies with the *Manual on Uniform Traffic Control Devices* (MUTCD).
- Verify that traffic control personnel are trained and qualified in accordance with agency requirements.
- Any unsafe conditions are reported to a supervisor.
- Determine whether conditions warrant use of a pilot vehicle. The pilot car leads traffic slowly, 25 mph or less, through the work zone.
- Ensure that flaggers do not hold traffic for extended periods of time. Long work zones need two-way communication between flaggers.
- Ensure that flaggers do not hold traffic stopped on freshly treated material.
- Ensure that signs are removed or covered when they no longer apply.

Project Inspection Responsibilities

Milling, Crushing, and Mixing

- Ensure that all grass and soil are removed from the pavement surface, especially along the edges of the pavement, prior to recycling.
- Ensure that the depth and width being milled are in accordance with project specifications.
- Verify that the width of milling overlaps with the previous pass by at least 4 in.
- Verify that the maximum size of the RAP is less than or equal to the maximum permitted by the mix design, typically 1 in. to 1.5 in.
- Treatment depth should extend through or remain 1 in. above any paving fabric to prevent pullout or delamination of the mixture.
- Verify that paving fabric incorporated into the recycled mix has a maximum dimension requirement in the project specifications. Typically, the maximum dimension is not greater than 2 in. Oversized material should be removed from the recycled mixture.
- Verify that dry additives, such as cement, are applied by spreading on the pavement ahead of the milling operation.
- Additives in slurry form, such as lime, are added either to the mixing chamber or sprayed over the cutting teeth of the milling machine.

- Small adjustments to the recycling agent content (less than 0.2%) should be allowed to ensure optimum performance.
- Asphalt binder for foamed asphalt should be the same performance grade (PG) from the same source as the mix design.

Single-Unit Trains

- Construction personnel must constantly assess profile changes of the existing pavement to ensure the correct rate of recycling agent is being applied.

Pickup Machine and Paver

- When processed material is being windrowed, ensure that the pickup machine is the correct distance behind the pugmill. (The project specification may specify a maximum separation, either in units of distance or time.)
- Ensure the screed on the paver is not heated.
- Ensure that the paving machine places processed material to grade and slope or crown in accordance with project specifications.
- Ensure that both the transverse and longitudinal joints are constructed in accordance with project specifications.

- Ensure that a continuous flow of material is deposited into the paver hopper. Material should not overflow the hopper and spill over the sidewalls, nor should the hopper be underfilled such that the drag slats in the bottom of the hopper are exposed.

Rolling Procedure

- Develop a rolling pattern at the beginning of construction so that the number of passes required using the specified rollers will result in the maximum achievable density (using a nuclear density gauge) in accordance with project specifications.
- Ensure that there is no damage from potential over rolling.
- Communicate daily with the roller operators to review the developed rolling pattern.
- Ensure that compaction tests are performed as required by the project specifications and that the test results meet the density requirements.
- Ensure that stops, starts, and turns are gradual.
- Ensure that finish rolling is completed within the time frame designated in the project specifications.
- Ensure that water is lightly sprayed onto the roller drums and tires to prevent pickup. Under no circumstances should diesel or other solvents be used to prevent pickup.
- If a wetting agent is utilized, verify compatibility with the recycling agent.

Acceptance

- Verify that recycling agent, water, and additives are added at the rates specified by the mix design in accordance with project specifications.
- Visually inspect the mixture for uniformity and homogeneity as it is discharged, whether onto the pavement and windrowed or directly into the paver hopper.
- Obtain samples of the mixture and component recycling agents and additives in accordance with the acceptance requirements of the project specifications.
- Verify that the mixture and component recycling agents and additives comply with the project specifications.
- Ensure the recycled pavement density is achieved according to the project specification.

Opening to Traffic

- Ensure that the material in the recently completed mat meets the specification requirements for compaction density and length of initial cure time.
- If required, apply a fog seal to minimize potential raveling. The fog seal application rate is typically 0.05 to 0.15 gal/yd² prior to opening to traffic. If necessary to absorb excess fog seal and to prevent pickup by traffic, apply blotter sand, typically at a rate of 2 to 3 lb/yd². Take extra care to not over sand the pavement surface.
- Ensure that temporary pavement markings required by the project specifications are in place prior to opening the surface to traffic.

Curing

- Allow the completed CIR to cure in accordance with the project specifications.
- If required, perform secondary compaction (for only emulsified asphalt CIR mixes) to remove minor consolidation in the wheel paths at the end of the curing period and prior to placing the surface course.

Surface Course

- ❑ After curing and secondary compaction if required, apply a surface course as required in the project specifications.
- ❑ Sweep the pavement immediately prior to placing the surface course.
- ❑ Apply a tack coat for a hot mix asphalt overlay in accordance with the project specifications to promote a good bond between the CIR layer and the overlay.

Common Problems and Solutions

(Problem: Solution)

Base Layer Aggregate or Subgrade Soils in the Recycled Mixture:

- ❑ Inspect milling depth.
- ❑ Ensure sufficient asphalt pavement thickness.

Oversize Material or Chunks in the Recycled Mat:

- ❑ Check the screen deck for correct size or holes (multi-unit train).
- ❑ Check for chunks in the pugmill: ensure paddle clearance; remove chunks before compaction.
- ❑ Check forward speed of the CIR machine and breaker bar (single-unit train).

Nonhomogeneous Mixture:

- Check for sufficient moisture content.
- Check for sufficient recycling agent.
- Check recycling agent temperature for extremes.
- Check correct operation of the pugmill/mixing chamber.

Segregation:

- Inspect the top size versus the depth being placed.
- If the wings of the hopper are being used, make sure segregated material is not being introduced.
- Identify systematic segregation areas and make corrections, such as around a gear box.
- If the screed is extended, look for segregation in the extensions.

Drag Marks in Uncompacted Mixture:

- Ensure that the screed is clean.
- Ensure that the screed is not heated.

Insufficient Compaction:

- Ensure rolling is started at the correct time.
- Ensure the proper rates of recycling agents, water, and additives are being introduced to the mix.
- Ensure roller patterns have been adequately established, are understood, and are being followed.
- Ensure the correct type, number, and size of rollers are being used.
- Ensure rollers are not operating too fast.
- Reestablish the rolling pattern as necessary.

Raveling:

- Ensure the water system is working on the rollers.
- Check if traffic may be on the compacted CIR too soon.
- Check for sufficient recycling agent content.
- Ensure ambient conditions are not too cool.

Flushing:

- Ensure there is not too much pre-wet water or recycling agent being added (total fluids).

Sources

Information in this checklist is based on or refers to the following sources:

Basic Asphalt Recycling Manual, Second Edition. Pub. No. FHWA-HIF-14-001. 2014. Glen Ellyn, IL: Asphalt Recycling and Reclaiming Association. Available at www.arra.org.

Manual on Uniform Traffic Control Devices. 2009, Revised May 2012. Washington, DC: Federal Highway Administration. Available at <http://mutcd.fhwa.dot.gov>.

For more information on the Pavement Preservation Checklist Series, contact:

Construction Management Team, HICP-30
Office of Preconstruction, Construction,
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