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| REVIEW OF NEW SPECIFICATION OR SPECIFICATION CHANGE  | 307-4 |
| **Specification Section No.:** 307, 406 and 702 | **Item:** Cold Asphalt Pavement (Recycle) |
| **Originating Office:** MAC | **By:** Stanford |
| **Date Sent For Review:** 11/28/17 | **Date Comments Due: 12/26/17** |
| Submit response to: STANDARDS AND SPECIFICATIONS UNIT, DIVISION OF PROJECT SUPPORT 4TH FLOOR, CDOT HEADQUARTERS |
| **Vote****/N** | **Concurrent Reviews – Others Commenting** | The attached Draft Specification is submitted for your review and comments. If not returned by Date Comments Due, the draft specification will be considered to be approved unless the Standards and Specifications Unit of the Project Development Branch [(303) 757-9474, (303) 757-9402] is advised otherwise.**REMARKS:** If these proposed modifications are approved, our unit will issue these in a new sample project special provision, and will eliminate all other sample project special provisions related to Cold In Place Recycling. |
|  | **Spec Committee Members:** |  **✓** |
|  | Co-Chairman: Lacey |  |
|  | Region 1: Quirk |  |
|  | Region 1: Lucerna |  |
|  | Region 2: Pieper |  |
|  | Region 3: Jean |  |
|  | Region 4: Boespflug |  |
|  | Region 5: Valentinelli |  |
|  | Project Development: Lacey |  |
|  | Specifications: Brinck |  |
|  | Bridge: Pott |  |
|  | Contracts & Market Analysis: Atamo |  |
|  | Materials: Schiebel |  |
|  | Traffic Engineering: Matthews |  | REVIEWER COMMENTS:( ) Approved ( ) Disapproved ( ) ModifiedIf disapproved or modified, give reason why and show any modifications on the attached draft copy: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ Name/Signature Date |
|  | Maintenance: Weldon |  |
|  | FHWA: Larson |  |
|  | Attorney General: Milan |  |
|  |  |  |
|  | **Others:** |  |
|  | Colorado Contractors Assoc.: Moody |  |
|  |  |  |
|  | **Technical Committees:** |  |
|  | PDAC |  |
|  | Drainage Advisory Committee (DAC) |  |
|  | Water Quality Advisory Committee (WQAC) |  |

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| **COLORADO DEPARTMENT OF TRANSPORTATION****SUBMITTAL OF NEW SPECIFICATION OR SPECIFICATION CHANGE** | Log No. (Assigned by Standards and Specifications Unit)307-4 |
| TO: Standards and Specifications Unit, Project Development, Suite 290 | FROM:Michael Stanford, MAC(Region, Branch or Technical Committee) |
| SPECIFICATION SECTION NO.307 406 and 702 | ITEM307 406 and 702 | Priority Routine[x]  Fast[ ]  |
| Reason for this new or changed specification:This revision is needed to bring all of the Special Provisions associated with a Cold In Place Recycling Projects, into one document.The Specification was reviewed by the Asphalt Industry in November 2017 (without comment) and approved by the Materials Advisory Committee in November 2017 |
| New or Revised Specification:See Attached |
| Note: See Procedural Directive 513.1 for a description of appropriate specification development procedures. |

 **CDOT Form 1215 10/01**

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 REVISION OF SECTIONS 307, 406 AND 702

COLD ASPHALT PAVEMENT (RECYCLE)

Sections 307, 406 and 702 of the Standard Specifications are hereby revised for this project as follows:

Subsection 307.01 shall include the following:

Lime for Cold Asphalt Pavement (Recycle). This work consists of producing and furnishing lime slurry for incorporation into the Section 406 item Cold Asphalt Pavement (Recycle). The Region Materials Engineer may elect to eliminate the requirement for lime. This decision will be made after the mix design is established and submitted, and may involve the deletion of the item.

Subsection 307.02 shall include the following:

Materials for lime slurry for use in Cold Asphalt Pavement (Recycle) shall conform to the following:

 **Lime:** The lime shall conform to the requirements of ASTM C 977 for quicklime, and shall be the product of a high-calcium limestone as defined by ASTM C 51. Certificates of Compliance (COC) for the lime shall be submitted to the Engineer. The lime will be sampled and if required, tested in accordance with the CDOT Field Materials Manual.

 **Slurry:** The lime slurry shall be a uniform and pumpable suspension of solids in water.

 **Water:** Water used for the lime slurry shall conform to the requirements of subsection 712.01.

Subsection 307.04 shall include the following:

Production and transportation of the lime slurry for Cold Asphalt Pavement (Recycle) shall conform to the following:

 **Slurry Production Equipment:** The lime slurry shall be produced with a batching tank. The batching tank shall have mechanical agitation to thoroughly mix and react the quicklime with water and to keep the slurry homogeneous and prevent settlement. The tank shall have a calibrated water meter for proper control of the amount of water. The tank shall be vented for steam to escape and shall have a thermometer to determine the temperature of the slurry. The tank shall have a manhole at the top for observation and monitoring of the slurry production process.

 **Slurry Production:** Quicklime shall be added to the required amount of water to provide a uniform lime slurry having a "dry solids content" of not less than 30% by weight. Prior to loading of the tank truck or trailer, the lime slurry in the batch or holding tank shall be thoroughly mixed. The time of mixing shall be sufficient to assure good slaking of the quicklime. For each batch of slurry, the date and time of production, amount of both quicklime and water used, and lime solids content shall be recorded by the Contractor and reported to the Engineer.

 **Slurry Transport:** The lime slurry shall be transported to the cold recycle operation in a tank truck or trailer having mechanical agitation to maintain a homogeneous slurry and prevent settlement. While transporting or transferring the slurry to the cold in‑place recycling equipment, the slurry shall be continuously mixed.

Delete subsection 307.13 and replace with the following:

**307.13** Hydrated lime will be measured by the ton. If quicklime is used the pay quantity will be determined using the certified lime purity for each truckload as follows:

 Pure quicklime (CaO) • 1.32 = Hydrated Lime (Ca(OH)2)

 Quicklime delivered • % purity • 1.32 = A

 Quicklime delivered • % inert material = B

 A + B = total hydrated lime produced = pay quantity

Quicklime incorporated into the Section 406 item, Cold Asphalt Pavement (Recycle), will be measured by the equivalent number of tons of Hydrated Lime, dry basis, to the nearest 0.01 ton, as calculated within this subsection.

 An invoice for each load of quicklime delivered to the project shall be provided to the Engineer.

Payment for lime used in the Cold Asphalt Pavement (Recycle) operation will be full compensation for all work and materials required to complete the item, including mobilization of all processing and mixing equipment required in the paving train.

Section 406 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 406.02 and replace with the following:

* 1. The finished bituminous pavement shall be a homogeneous layer composed of in place bituminous pavement, 1.5 percent lime slurry, and asphalt recycling agent as determined by the mix design. The application rates of the additives shall be synchronized with the machine to provide uniform application.
1. **Mix Design.** Prior to starting Cold In-place Recycling (CIR) operations, the Contractor shall furnish the Engineer with a proposed mix design and target values following the procedures of CPL 5111 with the project specific modifications and requirements as outlined within this revision.

The Contractor shall contact the CDOT Region Materials Engineer for cold recycle testing, preliminary field materials data, or existing pavement materials that may be available to the Contractor. The Contractor shall base the mix design on samples obtained by the Contractor in the presence of the Engineer, and shall include all elements listed in Table 406-1. The Region Materials Engineer will provide a Form #43 that sets the production targets based on the Contractor’s mix design. The Contractor shall submit any proposed changes to the mix design in writing, and a new Form #43 will be provided.

If after work has begun, the mixture properties do not correlate with the plan mix design, work shall be suspended until proper corrective actions or adjustments can be made. This may include but not be limited to changing the production rates, amount or type of recycling agent, or other additives. The Contractor shall submit proposed corrective actions or adjustments in writing for approval by the Engineer. The Contractor shall allow a minimum of two working days for the Engineer to approve the changes. The Contractor shall not resume work without the approval of the Engineer.

Note that a minimum of 54 lab design gyratory specimens will be required - 9 specimens (61.0mm to 66.0mm tall) at each of three emulsion contents for both coarse and fine gradation mix designs. Each emulsion content requires six specimens for Moisture Susceptibility Testing (Lottman) and three specimens for Hveem Stability Testing. This does not include specimens needed for Raveling, Indirect Tensile and other tests required.

If required on the project per Table 406-1, for each mix design also prepare four 6” diameter Hamburg Wheel test samples for each emulsion optimum content.

When required by Table 406-1, for each mix design also prepare two 6-inch diameter disk shape compact test specimens (130 mm to 160 mm tall) for each emulsion optimum content. Each specimen will be cut to generate 2 specimens with a height of 50 mm.

Approximately 250 pounds of additional pavement material will be required for Hamburg and Fracture Energy testing, if required.

(a*) Sampling and Processing for Mix Design*

The Contractor shall obtain random core samples as required by CPL 5111. If cores show significant differences in various areas within the length of the project, such as different type or thickness of layers between cores, then separate mix designs shall be performed for each of these pavement segments. The gradation shall be determined by CP 31 (dried at no greater than 40 degrees C). The Contractor’s mix design shall be based on a blend of the crushed material using the medium gradation and either the fine or coarse gradations established in CPL 5111. Traffic control and all other work necessary for mix design sampling will not be paid separately. The Contractor shall provide traffic control in accordance with Section 630 of the Standard Specifications.

(b) *Recycling Agent*

The recycling agent shall meet the requirements of the Revision of Section 702, Recycling Agents, Asphalt Emulsion, CSS (Special).

(c*) Lime Slurry*

This project will require the addition of 1.5 percent Hydrated Lime for all mix designs. The Lime shall be quicklime slurry and be added in to the mix design in accordance with CPL 5111.

(d) *Thermal Cracking*

Indirect Tensile Testing (IDT) specification temperature shall be determined using latest FHWA LTPPBind software using the weather stations most representative to the project. The required temperature for the specification is the coldest temperature at the depth of the top of the cold recycled pavement layer in the finished pavement structure. Use 98 percent reliability. Mix design IDT temperature requirement for each project location shall be approved by the Region Materials Engineer prior to mix design testing. The Contractor shall perform Indirect Tensile Testing (IDT) as follows:

The Contractor shall perform IDT according to AASHTO T322 for CIR Design Specimens, with the following exceptions:

1. Specimens using the medium gradation shall be 6 inches (150 mm) in diameter and at least 5.5 inches (115 mm) in height and compacted to air voids +/- 1 percent of design air voids at the design emulsion content. A trial specimen is suggested for this. Test specimens shall be cured at 60ºC no less than 48 hours and no more than 72 hours. Check specimen mass every 2 hours after 48-hour cure to verify compliance of no more than 0.05% change in mass in 2 hours. After curing, two specimens shall be cut from each compacted specimen to 2 inches (50 mm) in height. Perform bulk specific gravity after cutting.
2. A minimum of two specimens at each temperature are required to be tested at the specified temperature, 10 ºC above the specified temperature, and 10 ºC below the specified temperature.
3. The tensile strength test shall be performed on each specimen directly after the tensile creep test and at the same temperature as the creep test.
4. The environmental chamber must be capable of maintaining a temperatures down to –40 ºC.
5. The critical cracking temperature is defined as the intersection of the calculated pavement thermal stress curve (derived from the creep data) and the tensile strength line (the line connecting the results of the average tensile strength at the two temperatures).

(e*) Raveling.*

Raveling Test (Standard Test Method for Raveling Test of Cold Mixed Bituminous Emulsion Samples ASTM D7196-06) will be a requirement of this mix design.

*(f) Emulsion Content Selection*

 The properties of the specimens at design emulsion content shall be consistent with guidelines in CPL 5111 and shall meet the properties in Table 406-1. Target emulsion content may be adjusted by the Region Materials Engineer to optimize workability and design performance.

*(g) Report*

 The report shall contain the following minimum information: Asphalt Content of the recycled pavement, target gradation of the recycled pavement, recommended water content range as a percentage of dry recycled pavement, optimum emulsion content as a percentage of dry recycled pavement, density corresponding to optimum emulsion content, air void level, absorbed water, Hveem stability, TSR with 1.5 percent lime at recommended moisture and emulsion contents, and thermal cracking initiation temperature and percent raveling. Include the emulsion designation and weight per gallon, company name, plant location, residue content, and residue penetration.

*(h) Mixture Design Criteria*

The proposed mix design, conforming to CDOT Procedures, shall be submitted to the Engineer for approval, and the Contractor shall allow 14 working days for approval prior to scheduling work on the recycling operation.

**Table 406-1
MIX DESIGN CRITERIA**

|  |  |  |
| --- | --- | --- |
| **TEST** | **TEST PROCEDURE** | MIX DESIGN**REQUIREMENTS** |
| Asphalt Content | CPL 5120 | Report for Existing RAP at design. |
| Sieve Analysis | CP 31 | 100% Passing 1.5” Sieve – Report Target Gradations in Mix design. |
| Max. Sp. Gr. of Mix | CP 51 | Report |
| Hveem Stability | CPL 5106 (25°C) as modified in CPL 5111 | Report |
| Bulk Specific Gravity | CP 44 (AASHTO T‑166) | Report |
| Air Voids | CPL 5115 (30 Gyrations) | 8%-16% - Report Mix design target |
| Lottman Test | CPL 5109 as modified in CPL 5111 (30 Gyrations) | 60% TSR for mix design with 1.5% Lime |
| Indirect Tensile Test | Modified Procedure Item (d) Above | –ºC as determined for project location. See (d) above |
| Raveling Test  | ASTM D7196-06 (10°C and 50% humidity) | 2% max. |
| Fracture Energy | ASTM D 7313 | As required by the Regional Materials Engineer \* |
| \* When required by the Engineer, the Contractor shall:1. Use a gyratory compactor (AASHTO T 312) to fabricate specimens 150 mm in diameter and 130 to 160 mm in height and 30 gyrations.
2. Dry specimens to constant weight at 60° C from 48 to 72 hours.
3. Cut two 50 mm specimens from each compacted specimen.
4. Determine bulk specific gravity of 50 mm specimens (AASHTO T 166).
5. Measure the fracture energy at Tc in degrees C which is the temperature determined using LTPPBind 3.1 for the single station closest to the project location for the CIR Mid Layer Depth and 98% Reliability
6. Report the CIR mixture fracture energy according to ASTM D7313 based on the average of at least 4 replicates.
 |

Delete subsection 406.03 and replace with the following:

* 1. **Weather Limitations**. Daily recycling operations shall not begin until the atmospheric temperature is 55ºF and rising. Recycling operations shall be discontinued when the temperature is 60 ºF and falling. Recycling operations shall not be performed when the weather is foggy or rainy, or when weather conditions are such that the proper mixing, spreading, compacting, and curing of the recycled material cannot be accomplished. Cold recycled pavement damaged by precipitation shall be reprocessed or repaired by methods approved by the Engineer, at the Contractor’s expense.

The construction of cold recycled pavement will not be allowed from September 16 through May 14 unless otherwise approved. The Contractor’s Progress Schedule shall show the methods to be used to comply with this requirement.

Delete subsection 406.04 and replace with the following:

* 1. **Milling.** The existing asphalt surfacing shall be cold recycled in a manner that does not disturb the underlying material in the existing roadway.

Adjacent recycling passes shall overlap at the longitudinal joint a minimum of 4 inches.

The beginning of each day’s recycling operation shall overlap the end of the preceding recycling operation a minimum of 100 feet unless otherwise directed.

Any fillet of fine, pulverized material which forms adjacent to a vertical face shall be removed prior to spreading the mixed material, except that such fillet adjacent to existing pavement which will be removed by a subsequent overlapping milling operation need not be removed. Vertical cuts in the roadway shall not be left overnight.

Delete subsection 406.05 and replace with the following:

* 1. **Mixing.** The Contractor shall ensure there is a representative experienced in cold bituminous recycling with solventless emulsion present on the project for the first three days of cold recycle work at a minimum and during recycling operations until an acceptable production sequence is established, or as determined by the Engineer. This individual may be a representative of the emulsion supplier, the cold recycle mixture designer, a private consultant or recycling contractor’s staff as necessary to ensure for documented experience with solventless emulsion cold bituminous recycling. This individual shall have past experience with cold bituminous recycle with solventless emulsion on the basis of the support of at least three projects previously constructed in the United States. Representative name, qualifications, and previous experience, shall be provided to the Engineer for approval 5 working days before the recycle work commences. Any changes to the chemistry or blend of the recycling agent or to mixture proportions beyond the allowed tolerances during production shall be disclosed by this representative and submitted in writing by the Contractor as a change in mix design.

When commencing recycling operations, the recycling agent shall be applied to the pulverized material at the initial rate as established by Form 43 from the approved mix design submitted by the Contractor. The application rate of the recycling agent shall be guided by the mix design and may be varied as required by existing pavement conditions. An allowable tolerance of plus or minus 0.2 percent of the emulsion design target rate shall be maintained at all times. The emulsion target will be documented by the Department on a Form #43 for each design that is accepted. Changes in amount of water, emulsion or other additives will be considered a change to the mix design. Changes in emulsion formulation will be considered a change in mix design.

An amount of lime slurry equivalent to a minimum of 1.5 percent hydrated lime, based on the weight of the dry Cold Asphalt Pavement (Recycle) shall be added to the pulverized mixture for the limits indicated on the plans. The slurry shall be added to the pulverized material by use of a metering device which is capable of accurately measuring the amount of slurry being added to within + 0.2 percent by weight. This metering device shall be calibrated to and controlled by the weigh belt for the pulverized material being recycled. The slurry shall be added to the milled material by a spray bar located within the milling chamber of the milling equipment.

The Contractor shall:

1. Arrange for supervisory personnel of the contractor crew, testing laboratory, Contractors Quality Control representative, emulsion supplier and Engineer, to meet a minimum of two weeks prior to beginning the CIR process to discuss methods of accomplishing all phases of the work.
2. Be prepared to discuss with the Department, the following:
3. Provide the department with a list of all equipment to be used in the CIR process, for their approval.
4. Names of the contractor’s CIR personnel on the project.
5. Names and experience of the contractor’s representative who will perform the field QC tests for the Department’s approval.
6. Step-by-step CIR process
7. Prepare contingency plans based on weather related issues.
8. Compaction and establishment of target density.
9. Field emulsion adjustments.
10. Release to traffic considerations.
11. Provide the names of their CIR construction management team, who will act for them during the CIR portion of the project and monitor the Contractors Quality Control.
12. Provide a copy of the medium/coarse or fine gradation table as part of the Contractors furnished CIR mix design for use in directing field adjustments during production.

The Contractor may add water to the pulverized material to facilitate uniform mixing with the recycling agent. Water may be added prior to or concurrently with the recycling agent, provided that this water does not adversely affect the recycling agent. The amount of water added in production should be identified as part of the initial design rate. The exact application rate of water added will be determined and may be varied as required by existing pavement conditions. The amount of water added in the recycle process shall be documented daily and deviations of greater than plus or minus 1 percent from the initial design target shall be submitted to the Engineer.

The Contractor shall, on a daily basis, provide to the Engineer the following information:

1. Date and production day number.
2. Direction of operation, location of start and finish for the production day.
3. Start time of work and finish time of work.
4. Air temperature at start of production and every two hours thereafter.
5. Gradation of material before addition of recycling agent, note location.
6. Depth of recycling (check and record at least every two hours)
7. Rolling pattern and maximum wet density achieved for every rolling pattern throughout the day, note locations for each rolling pattern
8. Production of the following mid-day and end of day at a minimum:
	1. Tons of recycled asphalt pavement processed
	2. Quantity of emulsion used in process (calculate percentage)
	3. Quantity of lime used in process (calculate percentage)
	4. Quantity of additional water used in process (if any) (calculate percentage)
9. Any challenges encountered and breakdowns of equipment.
10. Windrow and finished mat moisture report
11. Delivery tickets for Lime and Emulsion

The Contractor shall calibrate the equipment after mobilization to the project site and before beginning the recycling process. The Contractor shall provide certified platform scales at the calibration site. A copy of the certification shall be provided to the Engineer prior to calibration. The Department will observe the calibration and will approve if the calibration standards are met. The Contractor shall record the results of the calibration and provide it to the Engineer prior to beginning recycling operations. The calibration shall include the following items:

1. Aggregate Weigh Belt
	* + - 1. Calibrate the aggregate weight belt at 3 different speeds (lowest, medium and highest speeds of anticipated operation).
				2. At least 10 tons shall be used for the aggregate tests.
				3. Calibrate the aggregate feed so the masses shown on the console indicators are within 1% of the actual mass as weighed on the certified platform scales.
				4. Verify the difference in the 3 runs is within 1% of each other.
				5. Display must have readings showing the speed of the belt and the tons per hour of the

material.

1. Emulsion Metering Device

Introduce the emulsion into the mixer through a positive displacement metering device.

Equip the metering device with a ready means of varying the emulsion delivery rate.

Calibrate the feed at 3 different speeds using the percentage set in the approved mix design so the masses or gallons shown on the indicators are within 0.5% of the actual mass as weighed on the certified platform scales.

1. Lime Slurry Metering Device
	* + - 1. Introduce the lime slurry into the mill head using a Mas Flow Coriolis effect type meter.
				2. Equip the metering device with a ready means of varying the lime slurry delivery rate.
				3. Calibrate the lime slurry feed at 3 different speeds using the percentage set in the approved mix design so the masses or gallons shown on the indicators are within 5% of the actual mass as weighed on the certified platform scales.

Any changes in recycling equipment will require re-calibration.

Delete Subsection 406.06 and replace with the following:

* 1. **Spreading and Placement.** Recycling and placing recycled material shall be at a rate sufficient to provide continuous operation of the paving machine. If paving operations result in being excessively behind or in excessive stopping of the paving machine, as determined by the Engineer, recycling operations shall be suspended. Recycling may resume when the Contractor can synchronize the rate of recycling with the capacity of the paving machine.

If segregation occurs during or after placement with a paving machine, the Contractor shall make changes in methods, equipment, or operations to eliminate the segregation. Segregated areas may require rework, as determined by the Engineer. Rework shall be at the expense of the Contractor.

Delete Subsection 406.07 and replace with the following:

**406.07 Compacting and Finishing.** After the recycled material has been spread, traffic, including Contractor’s equipment, shall not be allowed on the recycled material until it starts its initial break as determined by the Engineer. However, if precipitation is imminent, compaction may proceed to seal the surface from additional moisture.

Initial or intermediate rolling shall be performed with pneumatic tire rollers, each with 30 ton minimum weight. Initial rolling shall begin no more than 30 minutes after material placement and shall be continued until no additional displacement is observed. Final rolling to eliminate pneumatic tire marks shall be performed by steel wheel rollers. Static mode shall be used unless vibratory mode is approved by the Engineer. If vibratory mode is used, vibration shall be at low amplitudes to prevent transverse cracking. Final rolling shall be completed no more than two hours after paving is completed, unless otherwise approved by the Engineer.

Subject to the above requirements, the Contractor shall determine what methods and procedures are to be used for the compaction operation to achieve the required density. The Contractor shall document these procedures on the first day of production in a Roller Pass Study. The Contractor shall record the following information and a copy of this data shall be furnished to the Engineer.

1. Type, size, amplitude, frequency, and speed of each roller.
2. Tire pressure for rubber tire rollers, and if the pass for vibratory rollers is vibratory or static.
3. Ambient and Surface temperature that rolling is being started and completed.
4. Production rates of the recycle train at time of compaction.
5. Sequence and distance from recycle train for each roller, and number of passes of each roller to obtain specified density.
6. Quality Control Testing for Density shall be at a minimum of 1 test per 1000 feet in this initial roller pass study section.

The recycled material shall be compacted to a minimum of 100 percent of the density of a laboratory specimen compacted in accordance with CP 53. The sample of material for testing shall be taken immediately prior to breakdown compaction, in accordance with CP41 Method C. Samples to be used for acceptance testing shall be taken by the Contractor or his representative. An authorized representative of the CDOT shall be present during the sampling and will take immediate possession of all samples obtained. CDOT will determine the sampling method and locations of the samples per CP 75. Acceptance testing will be conducted in accordance with the CDOT Field Materials Manual. The area shall meet the required density prior to being opened to traffic. If the area tested fails to meet the required density and must be opened to traffic to comply with working time or maximum delay time requirements, the area shall be reworked the following working day, until it attains 100 percent compaction. The Contractor shall not be allowed to proceed with additional recycling the following working day until the previous day’s recycled material meets density requirements. Rework shall include full four inch recycling. Re-rolling is not an acceptable alternative. For areas of retest, the initial target density will be determined by the original data established with CP 53 for the material taken immediately prior to breakdown compaction. Rework, including traffic control and all other equipment, materials, and labor necessary to complete the work, shall be at the expense of the Contractor.

Rollers shall not be started or stopped on uncompacted recycled material. Rolling shall be accomplished so that starting and stopping will be on previously compacted cold recycled pavement or existing pavement.

Any type of rolling that results in cracking, movement, or other types of pavement distress shall be discontinued until the problem is resolved.

After the recycled material has been compacted, traffic, including the Contractor’s equipment, shall not be permitted on the cold recycled pavement for at least two hours, unless otherwise approved.

Before placing the sealing emulsion or hot mix asphalt overlay, the cold recycled pavement shall be allowed to cure until the free moisture is reduced to 1 percent free moisture or less, by total weight of mix. Free moisture will be measured according to CP 57. After the free moisture content of the cold recycled pavement has reached the acceptable level, the hot mix asphalt overlay or sealing emulsion, if required, shall be placed. However, unless otherwise approved by the Engineer, the cold recycled pavement shall be covered with a minimum thickness of 2 inches of hot mix asphalt within ten calendar days after it is laid and compacted. The sealing emulsion, if required, shall be applied to the surface at an approximate rate of 0.025 to 0.10 gallons per square yard. The sealing emulsion shall be applied when the Engineer determines that it is necessary to prevent raveling (progressive separation of aggregate particles).

Damage caused by the Contractor to the cold recycled pavement shall be repaired at Contractor’s expense, as directed, prior to placing any hot asphalt surfacing. Soft areas that are not caused by the Contractor or weather shall also be repaired prior to placing the hot mix asphalt.

Delete subsection 406.08 and replace with the following:

* 1. **Recycling Train.** The Contractor shall furnish a self-propelled machine capable of pulverizing the existing asphalt surfacing to the depth shown on the plans, in one pass. The machine shall have a minimum rotor cutting width of 12 feet. The rotor cutting width selected for the project shall allow for the longitudinal joint to be offset from the longitudinal joint of the layer placed above by at least 6 inches. The longitudinal joint shall not fall in the wheel path. The machine shall have standard automatic depth controls, and maintain a constant cutting depth. The machine shall also have screening and crushing capabilities to reduce or remove oversize particles prior to mixing with recycling agent. Oversize particles shall be reduced to size by crushing.

	The machine shall perform continuous weight measurement of the pulverized material interlocked with the recycling agent metering device so the required recycling agent content will be maintained. Positive means shall be provided for calibrating the weight measurement device and the recycling agent metering device.

	A positive displacement pump, capable of accurately metering the required quantity of recycling agent at rates as low as 4 gallons per minute, shall be used to apply the recycling agent. The interlock system shall allow addition of the recycling agent only when pulverized material is present in the mixing chamber. Each mixing machine shall be equipped with a meter capable of registering the rate of flow and the total amount of recycling agent introduced into the mixed material.

The recycle train shall have an independent source of water to properly disperse emulsion in accordance with manufacturer’s recommendations. This source of water shall be independent of the lime slurry. This source of water will require a positive displacement pump with a flow capacity of up to 5% that is interlocked with the weight of measurement of the pulverized material. All water sources shall be equipped with calibrated flow meters. The Contractor shall supply positive means for calibrating the weight measurement and water-metering device.

The recycling agent shall be applied through a separate mixing machine capable of mixing the pulverized material and the recycling agent to a homogeneous mixture, and placing the mixture in a windrow. The mixture shall be placed in a windrow in a manner that prevents segregation.

**406.09 Paver.** The recycled material shall be placed with a self-propelled asphalt paver meeting the requirements of subsection 401.10, except that the screed shall not be heated. The mixed material shall be spread in one continuous pass, without segregation, to the lines and grades established on the plans.

When a pick‑up machine is used to feed the windrow into the paver hopper, the pick‑up machine shall be capable of picking up the entire windrow to the underlying materials.

Subsection 406.13 shall include the following:

Asphalt Recycling Agent will be measured and paid for in accordance with Section 411.

Lime Slurry will be measured and paid for in accordance with Section 307.

Section 702 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 702.02 (e) and replace with the following:

**702.02 (e) Recycling Agent.** Recycling agent for Item 406, Cold Asphalt Pavement (Recycle) shall conform to physical and chemical requirements of Table 702-7:

**Table 702-7**

**ASPHALT EMULSION (CSS) (SPECIAL)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test on Emulsion** | **Test Method** | **Minimum** | **Maximum** |
| Residue from distillation, % | ASTM D2441 | 63.0 |  |
| Oil distillate by distillation, % | ASTM D2441 |  | 1.0 |
| Sieve Test, % | ASTM D2441 |  | 0.3 |
| Penetration (TBD2), 25°C, dmm | ASTM D53 | -25% | +25% |
|  |  |  |  |
| 1 Modified ASTM D244 procedure – distillation temperature of 177°C with a 20 minute hold. The ASTM D244 vacuum distillation procedure may be substituted once the maximum oil distillate is satisfied.2 TBD – to be determined by the Contractor’s 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 Region Materials Engineer for approval prior to project start.3 Modified ASTM D5 Procedure – The Penetration test for this material will be conducted under a dry condition with no water used on the surface of the emulsion residue.  |

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INSTRUCTION TO DESIGNERS (delete before including in the project):

\* When specified by the Region Materials Engineer for high volume traffic locations or when required to direct-load the recycled material from the recycling train into the laydown paver hopper, include the following mix design test requirements in Table 406-1:

|  |  |  |
| --- | --- | --- |
| Hamburg Wheel test on Medium and Coarse gradation | CPL 5112 (test at 50°C using 6” diameter 30-gyration compacted samples cured for 48 hours at 60°C) | 5,000 passes min. with rut depth less than 12.5 mm |
| Tc, ºC, LTPPBind 3.1 for the single station closest to the project location | Report Tc, ºC | Determine Tc for the CIR Mid Layer Depth and 98% Reliability |
| Fracture Energy, J/m2, ASTM D 7313, at Tc, Medium Gradation and Corresponding Optimum Emulsion Content | CIR Mixture Design Requirement For Cracking Resistance (test 6” diameter 30-gyration compacted samples cured for 48 hours at 60°C) | 125 Minimum |
| Fracture Energy, J/m2, ASTM D 7313, at Tc, Coarse Gradation and Corresponding Optimum Emulsion Content |