

## Section 39 Hot Mix Asphalt

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## Section 39 Hot Mix Asphalt

### 4-3901 General

Section 39, “Hot Mix Asphalt,” of the *Standard Specifications* provides material and construction requirements for various types of hot mix asphalt (HMA) including Type A, Type B, rubberized hot mix asphalt (RHMA), open-graded friction course, and hot mix asphalt with additives such as hot mix asphalt (all types) with warm mix asphalt (WMA) technology. In this section, unless the term WMA is specified, the term hot mix asphalt refers to all mixtures of aggregate and asphalt regardless of the mixing or placing temperature.

Unless specified, all requirements of Section 39 of the *Standard Specifications* including smoothness requirements apply to all types of HMA.

*Construction of Quality Hot Mix Asphalt Pavements*, published by the Asphalt Institute, contains information on the uses of various types of asphalts and the design and production of hot mix asphalt. All personnel responsible for hot mix asphalt should familiarize themselves with this publication.

#### 4-3901A Warm Mix Asphalt

WMA technologies allow production plants to produce hot mix asphalt at temperatures of 50° to 100°F below the traditional mixing temperature. Reductions in mixing temperature have the benefits of cutting fuel consumption and decreasing the production of greenhouse gases, with engineering benefits of better compaction on the road, the ability to haul paving mix for longer distances, and extending the paving season by being able to pave at lower temperatures.

WMA technologies are divided into three categories—chemical admixture, organic admixture, and mechanical (foaming). At this time, Caltrans focuses on better handling and compaction achieved by using any of the approved technologies. Section 39-related standard special provisions mainly define WMA as hot mix asphalt produced at a temperature no greater than 275°F using one of the approved technologies. Hot mix asphalt with WMA technology is defined as hot mix asphalt produced at a temperature greater than 275°F using an approved technology. The contract will specify the approved technology used in production of hot mix asphalt.

#### 4-3901B Rubberized Hot Mix Asphalt

Rubberized hot mix asphalt (RHMA) is produced by mixing asphalt rubber and aggregate. Asphalt rubber is specified to include 18 to 22 percent crumb rubber modifier (CRM) by total mass of the asphalt rubber blend. The CRM must also include 25 percent ( $\pm 2$  percent) high natural rubber content scrap rubber by mass of the CRM that may come from scrap tires or other sources. Caltrans requires use of extender oil as an asphalt modifier in asphalt rubber. RHMA includes RHMA-G (gap graded), RHMA-O (open graded), and RHMA-O-HB (open graded high binder).

## Section 39 Hot Mix Asphalt

### 4-3901 General

#### 4-3901C Paving Personnel

Producing hot mix asphalt pavement requires a partnership among Caltrans, the plant producing the hot mix asphalt, and the contractor placing the hot mix asphalt. The resident engineer must clearly communicate assignments of responsibility and commensurate authority for all Caltrans personnel, both at the job site and at the plant.

Plant inspection and testing is essential to ensure quality hot mix asphalt. A plant inspector at the hot mix asphalt plant usually performs the inspection and testing duties for the resident engineer. However, the resident engineer is responsible for enforcing contract specifications at the plant. The resident engineer must be kept informed of test results in a timely manner so appropriate contract administration action can be taken.

The paving inspector should have completed both “Hot Mix Asphalt Basics” and “Hot Mix Asphalt Inspection” training courses before assignment as the hot mix asphalt paving inspector. In addition, the paving inspector must be qualified on California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections,” Appendix D, “Bituminous Materials.”

#### 4-3901D Hot Mix Asphalt Construction Processes

Hot mix asphalt may be placed using the standard, method, or quality control quality assurance (QCQA) process. The process is specified in the project’s special provisions. The processes are related to the level of quality control testing required for the project.

Standard process—the contractor performs quality control testing, and Caltrans performs acceptance testing.

Method process—Caltrans performs acceptance testing, and that the contractor performs process control testing for aggregate moisture content, aggregate and reclaimed asphalt pavement moisture content, reclaimed asphalt pavement aggregate gradation and asphalt content, and asphalt rubber binder viscosity.

QCQA process—the contractor is responsible for plant inspection, paving inspection, and quality control sampling and testing. Caltrans must monitor contractor inspection and quality control testing for compliance with the specifications. Caltrans must perform acceptance inspection, sampling and testing.

### **4-3902 Before Work Begins**

Section 39, “Hot Mix Asphalt,” of the *Standard Specifications* requires the contractor to submit a job mix formula for all types of hot mix asphalt except for hot mix asphalt used for minor hot mix asphalt and miscellaneous areas and dikes. For standard and QCQA processes, the contractor must have a quality control plan for hot mix asphalt production and placement.

The contractor must use accredited laboratories and qualified testers, in accordance with the *Independent Assurance Manual*, for the contractor mix design used to determine job mix formula and for QCQA process quality control testing. Hot mix asphalt plants must comply with the *Material Plant Quality Program* (MPQP).

#### 4-3902A General

Before the work begins, the resident engineer will:

- Determine the type of hot mix asphalt specified for the project and review the plans and the special provisions. The special provisions specify the type of hot mix

asphalt, aggregate size, asphalt binder grade, and construction process (standard, method, or QCQA) to be used.

- Review the project specifications' measurement and payment clauses and determine what records must be kept.

#### 4-3902B Job Mix Formula Submittal

Review the documents in the contractor's job mix formula submittal information (see below) to ensure they are complete. Notify the contractor immediately if the submittal is incomplete.

- Form CEM-3511, "Contractor Job Mix Formula Proposal," documents target values for aggregate sieves, percent of asphalt binder, and source information for all hot mix asphalt component materials. If applicable, Form CEM-3511 will also include the percentage of reclaimed asphalt pavement and antistripping treatment method.
- Form CEM-3512, "Contractor Hot Mix Asphalt Design Data," documents the testing data developed by the mix design laboratory. If Form CEM-3513, "Caltrans Hot Mix Asphalt Verification," is not attached, the completed mix design Form CEM-3512 must be dated within the last 12 months.
- Form CEM-3513, if submitted, documents Caltrans verification test results for the proposed job mix formula. Form CEM-3513 must have been signed by an engineer (preferably the district materials engineer) within 12 months of the start of planned hot mix asphalt production.
- Material Safety Data Sheets in accordance with Section 39-1.03C, "Job Mix Formula Submittal," of the *Standard Specifications*.

#### 4-3902C Job Mix Formula Review

The resident engineer's review process includes:

- Reviewing the contractor's proposed job mix formula submitted on Form CEM-3511 for compliance with Section 39, "Hot Mix Asphalt," of the *Standard Specifications* and additional requirements in the special provisions. Notify the contractor immediately if the proposed job mix formula does not comply with the specifications.
- Reviewing the contractor's proposed job mix formula submitted on Form CEM-3511 to verify the asphalt binder supplier is on Caltrans' list of approved suppliers. If the asphalt binder supplier is not on Caltrans' list of approved suppliers, notify the contractor that asphalt binder supplied for the project must comply with Section Q, "Requirements for Suppliers Supplying Asphalt Without a Certificate of Compliance," in the *Certification Program for Suppliers of Asphalt*.
- If HMA is produced using WMA technology, verify the WMA technology is approved by the Department by going to:  
[http://www.dot.ca.gov/hq/esc/approved\\_products\\_list/](http://www.dot.ca.gov/hq/esc/approved_products_list/)
- If the submitted job mix formula proposal complies with the specifications, notify the contractor within 5 days of submittal that:
  1. The job mix formula is accepted if Form CEM-3513 was issued within 12 months of proposed hot mix asphalt production. The resident engineer signs and returns Form CEM-3511.

2. The job mix formula must be verified if Form CEM-3513 was not issued within 12 months of proposed hot mix asphalt production. The resident engineer requests that the contractor give notice for when hot mix asphalt will be produced for verification and notifies the district materials engineer.
3. For open graded friction course hot mix asphalt if Form CEM-3513 was not issued within 12 months of proposed hot mix asphalt production, the resident engineer requests that the contractor give notice for sampling of aggregate, binder, and additives.

#### 4-3902D Job Mix Formula Verification

##### *4-3902D (1) General*

The contractor takes the following steps related to job mix formula verification for all types of mixes.

If the proposed job mix formula has not been verified within 12 months of production, the contractor must furnish material samples according to Section 39-1.03C, “Job Mix Formula Submittal,” of the *Standard Specifications*, including:

- Coarse, fine, and supplemental aggregate from stockpiles, cold feed belts, or hot bins. Samples must include at least 120 pounds for each course aggregate, 80 pounds for each fine aggregate, and 10 pounds for each type of supplemental fines.
- Reclaimed asphalt pavement from stockpiles or reclaimed asphalt pavement system (if used). Samples must be at least 60 pounds.
- Asphalt binder from the binder supplier. Samples must be in two 1-quart cylindrical shaped cans with open top friction lids.
- Asphalt rubber binder with the components blended in the proportions to be used. Samples must be in four 1-quart cylindrical shaped cans with open top friction lids.
- Antistrip additives if used.

The resident engineer’s verification process includes:

- Receiving notification from the contractor at least 2 business days before sampling material so that an inspector may be present during the sampling.
- Witnessing the contractor sampling hot mix asphalt and component materials.
- Shipping the samples immediately to the district materials laboratory. They will be processed according to the instructions included on Form TL-0101, “Sample Identification Card.” The TL-0101 should be marked “Priority” and include “Job Mix Formula Verification Sample” under “Remarks.”
- Providing job mix formula verification results to the contractor on Form CEM-3513 within 20 days of receiving all samples.

##### *4-3902D (2) Verification Process for Open-Graded Friction Course*

For samples of aggregate, asphalt binder, and additives, if applicable:

- Request that the district materials lab determine if the aggregates comply with the contract quality requirements.
- Request that the district materials laboratory determine asphalt binder content under California Test 368, “Method of Test for Optimum Bitumen Content (OBC) for Open Graded Friction Course.”

- Within 20 days of material sampling, Caltrans will determine asphalt binder content and provide the contractor with Form CEM-3513.
- Within 20 days of receipt of a complete job mix formula submittal and material sampling, the resident engineer signs and returns the accepted or rejected job mix formula on Form CEM-3511, with Form CEM-3513 attached, to the contractor immediately following receipt of Form CEM-3513 from the district materials laboratory.

*4-3902D (3) Verification Process for Type A, Type B, and Rubberized Hot Mix Asphalt-Gap Graded*

If the contractor's job mix formula proposal has not been verified, the contractor must provide aggregate and hot mix asphalt verification samples from the plant that will be used for the project. The contractor samples in accordance with California Test 125, "Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections."

Samples are obtained at the following locations:

- Aggregates are sampled from cold feed belts or hot bins.
- Reclaimed asphalt pavement, if used, is sampled from the reclaimed asphalt pavement system.
- Hot mix asphalt is sampled at the plant, in a truck, from a windrow, the paver hopper, or on the mat behind a paver.

Test verification samples for compliance with the specifications. Refer to Section 39-1.03E, "Job Mix Formula Verification," of the *Standard Specifications*.

If required by the special provisions, also perform California Test 371, "Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage." Use the test result for reporting only, not for specification compliance.

Ensure that the proposed job mix formula is verified by the district materials laboratory within 20 days of sampling hot mix asphalt or when requested in writing by the contractor within 3 business days for rubberized hot mix asphalt. Verification is done when the district materials engineer completes and returns Form CEM-3513 to the resident engineer. Form CEM-3511 must also be completed by the resident engineer and returned to the contractor along with Form CEM-3513 within this time frame.

For HMA using WMA technology:

- Obtain the result and a tested sample set for AASHTO T 324 from the contractor.
- Verify the HMA compliance with the mix design requirements for both AASHTO T 324 and California Test 371.
- Verify RHMA-G-WMA quality requirements within 5 business days.

*4-3902D (4) Unverified Proposed Job Mix Formula*

If the district materials laboratory does not verify the proposed job mix formula:

- The resident engineer notifies the contractor in writing on Form CEM-3511 of the rejected job mix formula, attaching Form CEM-3513, "Caltrans Hot Mix Asphalt Verification," with Caltrans verification test results.

- The contractor may submit a new job mix formula on Form CEM-3511 with a new Form CEM-3512, or the contractor may adjust the job mix formula on Form CEM-3511 with allowable adjustments specified in Section 39-1.03E, “Job Mix Formula Verification,” of the *Standard Specifications*.
- If the contractor disputes Caltrans’ verification test results, ensure that the contractor complies with Section 39-1.06, “Dispute Resolution,” of the *Standard Specifications*.

#### 4-3902D (5) *Adjusted Job Mix Formula*

The contractor may adjust the job mix formula to meet the specifications. Justification for any adjustments outside the target values shown on Form CEM-3512 must be listed on the modified Form CEM-3511.

If the adjusted job mix formula proposal complies with the specifications, arrange with the contractor a time to witness the sampling of plant produced hot mix asphalt.

Ensure that the proposed job mix formula is verified by the district materials laboratory within 20 days of sampling hot mix asphalt or when requested in writing by the contractor or within 3 days of sampling rubberized hot mix asphalt. Verification is done when the district materials engineer completes and returns Form CEM-3513 to the resident engineer. Form CEM-3511 must also be completed by the resident engineer and returned to the contractor with Form CEM-3513 within 20 days of sampling hot mix asphalt.

If the district materials laboratory does not verify the adjusted proposed job mix formula, notify the contractor in writing on Form CEM-3511 and attach Form CEM-3513 with Caltrans’ verification test results.

If the adjustment failed to resolve the job mix formula verification problem, the contractor may propose a new job mix formula or dispute Caltrans test results in accordance with Section 39-1.06, “Dispute Resolution,” of the *Standard Specifications*.

#### 4-3902E *Job Mix Formula Renewal*

A verified job mix formula is good for only 12 months so the contractor may request a job mix formula renewal if the hot mix asphalt production will be stopped for more than 30 days or the contractor wants to use the accepted job mix formula on another contract.

The contractor takes the following steps for job mix formula renewal:

- Submits the proposed job mix formula on Form CEM-3511, attaching the previously verified job mix formula on Form CEM-3513, and the mix design information for previously verified job mix formula on Form CEM-3512.
- Notifies the resident engineer prior to sampling materials.
- Samples materials at the locations and quantities shown in Section 4-3902D, “Job Mix Formula Verification,” of this manual. Hot mix asphalt must be sampled at the location approved in writing by the resident engineer.
- Submits Form CEM-3514, “Contractor Job Mix Formula Renewal.” Contractors use Form CEM-3514 to submit to the resident engineer their test results for renewal of hot mix asphalt job mix formula.

The resident engineer's job mix formula renewal process includes:

- Reviewing the proposed job mix formula on Form CEM-3511. Refer to Section 4-3902C, "Job Mix Formula Review," of this manual. If the submitted job mix formula proposal complies with the specifications, the resident engineer notifies the contractor within 5 days that split sampled hot mix asphalt and component materials must be provided.
- Witnessing the contractor sampling hot mix asphalt and component materials. Take possession of the material samples and hold until receiving contractor test results.
- Reviewing the information on Form CEM-3514 to confirm that the contractor test results comply with the specifications. When the test results indicate that the sampled and tested hot mix asphalt complies with the specification, request that the district materials laboratory perform hot mix asphalt verification testing.
- Shipping material samples to the district materials laboratory if the contractor's test results on Form CEM-3514 comply with the specifications. They will be processed according to the instructions on Form TL-0101, "Sample Identification Card." The TL-0101 should include "Job Mix Formula Renewal Verification Sample" under "Remarks."
- Providing job mix formula verification results to the contractor on Form CEM-3513 within 30 days of receiving Form CEM-3514 from the contractor.

#### 4-3902F Job Mix Formula Acceptance

Job mix formula acceptance requires the following:

- Review and acceptance of submitted Form CEM-3511, with Form CEM-3512 attached.
- Completed Form CEM-3513 within 12 months of proposed hot mix asphalt production.

#### 4-3902G Quality Control Quality Assurance Process

Contact the district QCQA coordinator for updated information and assistance.

Review the quality control plan for compliance with the requirements in the *Quality Control Manual for Hot Mix Asphalt*.

- Within 5 business days of quality control plan submittal, notify the contractor in writing of quality control plan acceptance or rejection. If the plan is rejected, provide written comments regarding deficiencies.
- The resident engineer and contractor must input the initial project information into the statistical evaluation program (HMA Pay) that will be used for the project. Contact the district QCQA coordinator for statistical evaluation program (HMA Pay) assistance or training. Contact the headquarters QCQA coordinator for additional assistance if necessary.

The QCQA statistical evaluation program (HMA Pay) is available online:

<http://www.dot.ca.gov/hq/construc/hma/>

#### 4-3902H Plant Operations

Hot mix asphalt plants, in accordance with Section 39-1.08A, “General,” of the *Standard Specifications* must be qualified under the MPQP.

Before production begins, take the following steps related to hot mix asphalt plant operations:

- Verify with the district weights and measures coordinator that the proposed hot mix asphalt plant is Caltrans-qualified under the MPQP. Batch hot mix asphalt plants must be qualified annually, and continuous hot mix asphalt plants must be qualified at least every 6 months, in accordance with Chapter 1, Section II-C, “Frequency,” of the MPQP.
- If the hot mix asphalt plant is not qualified, notify the contractor in writing and provide the contact information for the district weights and measures coordinator. The contractor must give the district weights and measures coordinator 5 business days’ notice to schedule hot mix asphalt plant qualification.
- Accept hot mix asphalt for up to 14 days from a non-qualified plant if startup approval has been granted in writing by the district weights and measures coordinator.

#### 4-3902I Antistrip Treatment of Aggregates

Hot mix asphalt may be sensitive to moisture damage and require antistrip treatments. The treatment method can be either lime treatment (by slurry application or by dry lime applied to damp aggregate) or liquid antistrip. For the standard and the method processes, the special provisions will specify the treatment method if it is required. For the QCQA process, the treatment method will be determined by the contractor based on the results of California Test 371, “Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.” For the QCQA process, the special provisions will include all three antistrip treatment methods that may be chosen by the contractor based on test results.

When California Test 371 is required and the result is less than 70, the contractor must test the proposed hot mix asphalt aggregate blend for plasticity index in accordance with California Test 204, “Method of Tests for Liquid Limit, Plastic Limit and Plasticity Index of Soils.” When California Test 204 indicates clay is present in the aggregates, the plasticity index is used to determine the type of antistrip treatment. Refer to the special provisions for the treatment method allowed.

#### *4-3902I (1) Lime Treatment of Aggregates*

There are two methods for lime treatment of aggregates:

- Hot Mix Asphalt Aggregate Lime Treatment—Slurry Method
- Hot Mix Asphalt Aggregate Lime Treatment—Dry Lime Method

Reclaimed asphalt pavement used in the production of hot mix asphalt does not need to be lime treated.

Quality characteristic acceptance test limits for aggregate properties are based on untreated aggregates. Therefore, aggregate quality control and acceptance testing must be performed on aggregate samples taken before lime treatment.

During lime treatment, the sand equivalent test is used to signal a change in the presence of clays. If sand equivalent values decrease significantly, the plasticity index

of the aggregate blend must be tested to ensure that it continues to be in the acceptable range listed in the special provisions.

If clays are present in the aggregate blend, both lime treatment methods must be followed by marination.

For lime treated aggregates, before lime treatment begins, take the following steps:

- Verify with the district weights and measures coordinator that the proposed lime treatment plant is Caltrans-qualified under the MPQP.
- Verify the lime proportions for the fine and coarse aggregate or for the combined aggregates shown on the job mix formula.

During lime treatment, take the following steps:

- Obtain aggregate samples from stockpiles in accordance with California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections,” to field test for moisture content and sand equivalent at the frequency shown in Table 6-1.12, “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual.
- Test aggregate samples for sand equivalent at the frequency shown in Table 6-1.12. Combine aggregate from individual stockpiles in the job mix formula proportions to test for sand equivalent. If the sand equivalent test result exceeds the specified limits, immediately notify the resident engineer.
- It is good practice to test aggregate samples for moisture content in accordance with California Test 226, “Method of Test for Moisture Content of Soils and Aggregates by Oven Drying,” or California Test 370, “Method of Test for Determining Moisture Content of Bituminous Mixtures or Graded Mineral Aggregates Using Microwave Ovens,” because moisture influences proportioning. The plant inspector should confirm that the contractor is performing sampling and testing for moisture content at a frequency shown in Section 39-1.04D, “Aggregate,” of the *Standard Specifications*.
- Obtain aggregate samples from stockpiles or aggregate belts before lime treatment in accordance with California Test 125. Sample aggregates at the frequency shown in Table 6-1.12, “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual for aggregate acceptance testing.

Label each aggregate sample with the contract number, date, type of mix, aggregate gradation (1/2 inch), aggregate source, hot mix asphalt producer, and producer’s mix identification number. Indicate the number of tons produced when the sample was taken.

- Test aggregate at the frequency shown in Table 6-1.12. For samples that will be shipped to the district material laboratory or field construction laboratory for testing, complete Form TL-0101, “Sample Identification Card.” Follow the instructions printed in the form booklet and the information in Section 6-103, “Field Sampled Material Identification for Testing,” of this manual. Record the type of mix, the hot mix asphalt producer, and the producer’s mix identification number. Check the acceptance tests box on the TL-0101. Under “Remarks,” identify the tests to be performed:

1. Los Angeles Rattler.
2. Percent of crushed particles course aggregate.
3. Percent of crushed particles fine aggregate.
4. Fine aggregate angularity.
5. Flat and elongated particles.
6. Other aggregate properties specified in the project special provisions, if applicable.

If any test results exceed the specified limits, the materials laboratory will immediately notify the resident engineer.

- Ensure that the aggregate treatment is adequate by witnessing contractor quality control testing, and be sure the contractor enters into a log the treatment data specified in the special provision.

For each day of aggregate lime treatment, obtain the treatment data log in electronic format for the resident engineer's project files.

#### *4-3902I (2) Marination of Lime Treated Aggregates*

Marination of the lime treated aggregates must be done when required in the special provisions or for the QCQA process if California Test 371 indicates treatment is necessary and California Test 204 indicates that the plasticity index is from 4 to 10.

Lime treated aggregate must marinate at least 1 and no more than 60 days before using it in hot mix asphalt production. If rain is anticipated during the marination period, the contractor must protect the stockpiles. If the lime treated aggregate has been exposed to rain, inspect the stockpiles. If aggregate lime coating has been damaged significantly, reject the aggregate. If only the outside surface of the stockpile has been damaged, require that the contractor remix the piles to redistribute the lime.

#### *4-3902I (3) Liquid Antistrip Treatment*

This treatment process requires the addition of the liquid antistrip to asphalt binder during hot mix asphalt production.

Before production begins, take the following steps related to liquid antistrip treatment:

- Verify with the district weights and measures coordinator that the proposed liquid antistrip metering device and storage tank are Caltrans-qualified under the MPQP.
- Verify that the liquid antistrip is the same type and brand as shown on the accepted job mix formula.

#### 4-3902J Preparing Conference

Before work begins, the resident engineer holds a preparing conference with the contractor to discuss hot mix asphalt production and placement:

- Review the accepted job mix formula and check that Form CEM-3513, "Caltrans Hot Mix Asphalt Verification," has been signed by Caltrans within the last 12 months.
- Confirm that the accepted job mix formula has not changed.

- Discuss with the contractor what atmospheric and pavement temperatures the contractor has chosen that would result in a notification to stop production of hot mix asphalt at the plant.
- Discuss method of incorporating WMA technology.
- Discuss with the contractor pavement areas to receive safety edge and construction methods to be used.
- Discuss with the contractor pavement areas to receive shoulder backing and construction methods to be used.
- Verify if the contractor intends to use a tapered notch wedge device to construct the longitudinal joint. The tapered notch wedge can be used only on a divided highway.
- Ensure that the type of spreading equipment proposed by the contractor has the necessary attributes for the project. Permit wing-type spreading equipment only for areas not requiring an asphalt paver, and then only for such widths (typically less than 5 feet) that will not adversely affect the surfacing on the traffic lane.
- Ensure that rollers have the specified attributes. For method process, ensure that the specified number of rollers will be used based on the type of hot mix asphalt being placed.
- Determine the frequency for standard and QCQA core sampling (at least once every 5 business days).
- Discuss the contractor's method (for example, ski device) to produce smooth pavement that meets the specifications. Determine how smoothness quality control will be accomplished, if a straightedge will be available, and who on the paving crew is responsible for using it.
- Determine the type of tack coat the contractor has chosen to use, based on expected atmospheric conditions, tack coat material type availability, and local experience. Also, discuss the contractor's proposed application rates and how far in advance of the paving operation the tack coat will be placed. For additional information about tack coats and the website for *Tack Coat Guidelines*, refer to Section 4-3906A, "References," of this manual.
- Emphasize that public traffic will not be allowed on pavement with tack coat and discuss how the contractor will apply additional tack coat to damaged areas immediately before placing hot mix asphalt.
- Confirm that the trucks used for tack coat application have the specified attributes. For distributor attributes, refer to Section 93, "Liquid Asphalts," of the *Standard Specifications*.

For standard and QCQA processes discuss:

- The contractor's quality control plan.
- The contractor's communication between the quality control manager and production and placement personnel.
- How the contractor will transmit required inspection and testing reports.
- How the resident engineer will transmit required test results.

With the contractor, discuss who has responsibility in the field to:

- Monitor hot mix asphalt temperatures.
- Monitor atmospheric temperatures.
- Monitor pavement temperatures.
- Direct hot mix asphalt truck drivers when loads must be tarped.
- Define the length of windrow, if applicable.
- Direct the hot mix asphalt plant to slow down or stop loading trucks because of truck queuing.
- Stop production when two consecutive quality control test results do not comply with the specifications.

Discuss the type of action that will be taken by the contractor when:

- The hot mix asphalt plant shuts down unexpectedly.
- The hot mix asphalt paver breaks down.
- The hot mix asphalt compaction equipment breaks down.
- Atmospheric or pavement temperature drops.

Ensure that the contractor has coordinated any necessary cold-planing operations; signs for construction area drop-offs, shoulder, and uneven pavement; and temporary pavement delineation, if applicable.

Review with the contractor the production startup evaluation requirements for the first 750 tons of mix. For standard and QCQA processes, the contractor must report test results within 3 business days of sampling.

#### 4-3902K Paving Operations

Before work begins, take the following steps related to hot mix asphalt paving operations:

- Review “Placing Hot-Mix Asphalt” in *Construction of Quality Hot Mix Asphalt Pavements*, published by the Asphalt Institute.
- Ensure that the subgrade has been prepared as specified. If any hot mix asphalt leveling is required to smooth out an existing irregular surface, inform the contractor and determine the method of payment.
- Determine if crack sealing or digouts (removing and replacing existing pavement) are required to repair small areas. When contract items are not included, inform the contractor of any extra work for crack sealing or digouts. Refer to *Maintenance Technical Advisory Guide* for more information about crack sealing or digouts.
- For standard and QCQA processes, review the accepted contractor’s quality control plan.
- If resurfacing under structures will result in reduced clearance, follow the procedures in Section 3-703B, “Permanent Clearance and Bridge Permit Rating Changes,” of this manual.
- Verify that personnel who will be taking mat samples and witnessing core sampling are qualified for California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections.”

## 4-3903 During the Course of Work

### 4-3903A General

Quality production and placement of hot mix asphalt requires both quality control by the contractor and quality assurance by Caltrans. While some of these functions may seem redundant, each serves a separate purpose.

#### 4-3903A (1) Quality Control

Quality control (sometimes called process control) is the inspection and testing performed by the contractor to ensure that the hot mix asphalt being produced or placed meets the requirements of the specifications. Inspection should be performed at both the production unit and at the paving site. Quality control sampling should be performed at regular intervals and at locations similar to the engineer's such as plant, windrow, or mat to ensure that quality control test results are not influenced by sampling location.

The contractor will want to know early on how closely the contractor's quality control test results replicate the quality acceptance test results. The job mix formula verification and production startup evaluation both offer early opportunities for the contractor to compare quality control test results with acceptance test results. Unlike the comparison of quality control quality acceptance test results during production and placement, these results are on the same material (split samples). Therefore, the results are a direct measure of the variation between the laboratories.

The contractor performs quality control testing for asphalt rubber binder, gradation, and fabric content of crumb rubber modifier; aggregate and reclaimed asphalt pavement moisture; and reclaimed asphalt pavement gradation. Depending on the construction process being used, the specifications require additional levels of quality control testing.

#### 4-3903A (1a) Standard Process

The contractor is required to conduct quality control inspection and testing on a regular basis. The specifications give required intervals in the quality control table of the specifications. If the total layer thickness is at least 0.15 foot, the contractor is required to conduct density testing. The contractor may choose any method for density testing including nuclear gauge, non-nuclear gauge, or cores. If the total layer thickness is less than 0.15 foot, the contractor must follow the requirements of the method process listed in Section 39-3.03, "Spreading and Compacting Equipment," and Section 39-3.04, "Transporting, Spreading, and Compacting," of the *Standard Specifications*.

#### 4-3903A (1b) Method Process

The contractor is not required to conduct quality control inspection and testing, except for tests named above in this section. In method projects, the contractor may depend on the acceptance test results for quality control. Since method projects should be small-quantity projects, the contractor will most likely depend on historical production data. The contractor has to comply with the specifications for placement such as temperature and roller requirements.

#### 4-3903A (1c) Quality Control Quality Assurance Process

The contractor is required to conduct quality control inspection and testing. For the QCQA process, the contractor must perform quality control testing at regular intervals

## 4-3903 During the Course of Work

defined by the quality control tables in the specifications. If the total layer thickness is at least 0.15 foot, the contractor is required to conduct density testing. The contractor may choose any method of density testing including nuclear gauge, non-nuclear gauge, or cores. If the total layer thickness is less than 0.15 foot, the contractor must follow the requirements in Section 39-3, “Method Construction Process,” of the *Standard Specifications*.

#### 4-3903A (2) *Quality Assurance*

Quality assurance of hot mix asphalt comprises material acceptance testing and both plant and paving inspection. The resident engineer is responsible for coordinating necessary field personnel and taking contract administration action when required. Ensure that Caltrans personnel who sample or test have met the requirements of the Caltrans Independent Assurance Program and are qualified to perform the sampling or testing.

Material acceptance sampling frequencies and material acceptance testing frequencies, shown in Table 6-1.12, “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual are not the same. Caltrans limited the risk to the contractor by specifying in Section 39, “Hot Mix Asphalt,” of the *Standard Specifications* that no single test result may represent more than the smaller of 750 tons or one day’s production. Therefore, during the course of the work it is important to split sample materials at both the plant and behind the paver every 750 tons. Obtain a split sample for every sample taken, one to test and one for dispute resolution.

Test the samples in a field construction laboratory, or ship them to a district materials laboratory to be tested at the minimum testing frequency shown in Section 6-1. Store the remaining samples in case additional acceptance testing is necessary.

The contractor may request that the resident engineer split acceptance samples. If requested, split acceptance samples into four parts: test one, provide one to the contractor, and store two for dispute resolution.

Quality assurance must be performed regularly and the material acceptance test processed in a timely fashion. The resident engineer must make every effort to conduct the necessary inspection, ensure that sampling and testing staff are available, and have samples processed as quickly as possible so acceptance decisions can be made while there is time to make corrections.

Quality pavement is obtained by strictly enforcing the specifications and notifying the contractor of failed tests as soon as possible. When a single quality assurance test for a single quality characteristic indicates that material does not comply, Section 39 of the *Standard Specifications* allows the contractor to continue producing and placing HMA. Notify the contractor of a single failed quality assurance test, and do not take further action based on a single test failure because sampling and testing variability based on statistics is extremely large.

When two consecutive quality assurance tests for a single quality characteristic do not comply with the specifications:

- Immediately notify the contractor to stop production.
- Ensure that the contractor takes corrective action.

After the corrective action has been taken and the contractor has quality control test results showing conformance, witness the contractor taking and splitting samples (into four parts) for the resident engineer's tests. The contractor must test one part for compliance with the specifications and submit three parts to the resident engineer who tests one part for compliance with the specifications and stores two parts.

#### *4-3903A (3) Quality Control Quality Assurance*

QCQA is the process normally used for large-volume hot mix asphalt projects. The contractor must perform inspection and testing at required intervals. The contractor's quality control tests for aggregate gradation and asphalt binder content are statistically compared to the engineer's acceptance testing. If the contractor's quality control tests are "verified," they are used to determine lot acceptance and payment adjustment.

The contractor will perform quality control test for compaction (if required) by any method chosen. The resident engineer will use cores to determine compaction acceptance. The contractor may compare compaction test results with the resident engineer to ensure that the testing processes are comparable.

The contractor is responsible for plant and paving inspection, and quality control testing. Caltrans monitors the contractor's inspections and testing for compliance with the specifications.

If quality control personnel are not enforcing the specifications, the resident engineer should request in writing that the contractor replace the nonperforming personnel.

#### *4-3903A (4) Dispute Process*

A dispute resolution process for acceptance tests is specified in Section 39-1.06, "Dispute Resolution," of the *Standard Specifications* and additional dispute resolution for the QCQA process in Section 39-4.04C [39-4.05C], "Dispute Resolution," of the *Standard Specifications*.

If the contractor disputes the acceptance test results, the specifications require the use of an independent third party. If you are satisfied with acceptance test results, and before using the independent third party, suggest that the contractor test one of the split samples from the material in question. If the contractor agrees to perform this test, it would be good practice to have a tester or a district independent assurance representative witness the contractor's testing.

It is preferable to use split samples of disputed material for third-party evaluation. When an independent third party is part of the dispute process, the independent third party may use any representative material available. Caltrans must retain possession of the split samples. For standard and method processes, Caltrans may discard stored split samples 5 days after the contractor has received the associated acceptance test results. For the QCQA process, Caltrans may discard the samples 5 days after determination of the quality factors for a lot.

#### 4-3903B Production Startup Evaluation

Section 39-1.07, "Production Start-Up Evaluation," of the *Standard Specifications* applies to all construction processes. The production startup evaluation allows:

- The contractor to compare quality control test results against Caltrans acceptance test results on split sample material.

- Caltrans to verify early in the project that the aggregate properties and hot mix asphalt comply with the job mix formula and specifications.
- Both parties to examine results of tests performed on split sample material.

Split samples are used only for job mix formula verification, for production start-up evaluation, and when the contractor is demonstrating compliance with the specifications because production has been stopped for out-of-specification material. In all other circumstances, acceptance samples must always be taken independently of contractor's quality control samples.

#### 4-3903C Plant Operations

Before shift production begins, the plant inspector generally takes the following steps related to hot mix asphalt plant operations:

- Verifies that the security seal has not been tampered with. If tampering is suspected, contact the district weights and measures coordinator.
- Ensures that the portioning equipment is interlocked as specified in the MPQP. Refer to the *Weights and Measures Handbook* for procedures for checking interlocks.
- Ensures that the job mix formula being used by the contractor is specific to the project and that no changes have been made to:
  1. Target asphalt binder percentage.
  2. Asphalt binder supplier.
  3. Asphalt rubber binder supplier.
  4. Component materials or percentage of any component material used in asphalt rubber binder.
  5. Combined aggregate gradation.
  6. Aggregate sources.
  7. Substitution rate for reclaimed asphalt pavement aggregate of more than 5 percent.
  8. Any material in the job mix formula.
- Notifies the resident engineer if there are changes in the job mix formula and asks if a new job mix formula will be required from the contractor before production can be started.
- Makes certain that the asphalt binder supplier is on the Caltrans approved supplier list or that asphalt binder samples have been taken from each truckload and tested in accordance with Section Q, "Requirements For Suppliers Supplying Asphalt Without a Certificate of Compliance," in the *Certificate Program for Suppliers of Asphalt*. Notifies the contractor and resident engineer if asphalt binder testing has not been completed for a supplier not on the approved supplier list.
- Ensures that aggregate is stored separately, according to proposed sizes by comparing the material from each bin with Chapter 2, Section II-E, "Aggregate Storage," of the MPQP. If any segregation, degradation, or intermingling occurs, require that the contractor empty the storage facility and waste or re-screen the material.

- Ensures that supplemental fine aggregate remains dry and is stored separately as specified in MPQP.

During production, the plant inspector generally takes the following steps related to hot mix asphalt plant operations:

- Records daily hot mix asphalt plant production information on Form CEM-3501, “Hot Mix Asphalt Production Report.”
- Documents on Form CEM-4601, “Assistant Resident Engineer’s Daily Report,” additional information about plant production, including instructions to contractor’s personnel.
- For the QCQA process, the plant inspector performs the following additional duties:
  1. Ensures that contractor personnel who sample or witness the contractor sampling at the hot mix asphalt plant are qualified to perform California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections.”
  2. Obtains samples for acceptance testing every 750 tons. Material samples must be split samples from both the plant and behind the paver.
  3. Tests for aggregate gradation at least once for every five sublots.
  4. Monitors the contractor’s hot mix asphalt plant inspection for compliance with the contractor’s quality control plan. Notifies the resident engineer of any noncompliance issues.

#### *4-3903C (1) Antistrip Treatment of Aggregates and Hot Mix Asphalt*

The hot mix asphalt may be sensitive to moisture damage and may require one of the following antistrip treatments:

- Hot Mix Asphalt Aggregate Treatment—Slurry Method
- Hot Mix Asphalt Aggregate Treatment—Dry Lime Method
- Liquid Antistrip Method

#### *4-3903C (1a) Marinated Lime Treated Aggregate*

Aggregate that has been lime treated and stockpiled for marination is handled in the hot mix asphalt production process in the same manner as untreated aggregates. Refer to Section 4-3902I (1), “Lime Treatment of Aggregates,” of this manual for lime treatment plant operation requirements.

For aggregates that have been lime treated and stockpiled:

- Verify that aggregate quality characteristic acceptance samples and tests were performed and the aggregate meets the contract specifications.
- Do not perform sampling and testing for sand equivalent or aggregate quality characteristics as shown in Section 4-3903C (3), “Hot Mix Asphalt Production,” of this manual.
- Ensure that the lime marination was performed within the past 60 days.

Reclaimed asphalt pavement used in the production of hot mix asphalt does not need to be lime treated.

#### 4-3903C (1b) Hot Mix Asphalt Aggregate Treatment—Slurry Method

If a hot mix asphalt production facility is using this process without marination, contact the Materials and Engineering Testing Services (METS) Office of Flexible Pavement for assistance.

#### 4-3903C (1c) Hot Mix Asphalt Aggregate Treatment—Dry Lime Method

The quality characteristic acceptance test limits for aggregate properties are based on untreated aggregates, so aggregate testing must be performed on aggregate samples taken before lime treatment.

During lime treatment, the plant inspector takes the following steps:

- Obtain aggregate samples from stockpiles or from the aggregate belts before lime treatment for moisture content and sand equivalent testing at the frequency shown in Table 6-1.12 “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual. Sample aggregate in accordance with California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections.”
- Test aggregate samples for sand equivalent at the frequency shown in Table 6-1.12. If the aggregates are not combined before sampling, combine aggregate from individual stockpiles or belts in the job mix formula proportions to test for sand equivalent.
- It is good practice to test aggregate samples for moisture content in accordance with California Test 226, “Method of Test for Moisture Content of Soils and Aggregates by Oven Drying,” or California Test 370, “Method of Test for Determining Moisture Content of Bituminous Mixtures or Graded Mineral Aggregates Using Microwave Ovens,” because moisture influences proportioning. The plant inspector should confirm that the contractor is performing sampling and testing for moisture content at a frequency shown in Section 39-1.04D, “Aggregate,” of the *Standard Specifications*.

Compare the contractor’s aggregate moisture quality control test results against Caltrans test results. Notify both the contractor and the resident engineer if the test results are significantly different.

Verify that the contractor is adjusting the hot mix asphalt plant controller based on the contractor’s aggregate moisture quality control test results.

- Obtain aggregate samples from stockpiles or aggregate belts before lime treatment in accordance with California Test 125. Sample aggregates at the frequency shown in Table 6-1.12, “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual for aggregate acceptance testing.
- Test aggregate for acceptance quality characteristics at the frequency shown in Table 6-1.12 for the following aggregate acceptance tests:
  1. Los Angeles Rattler.
  2. Percent of crushed particles course aggregate.
  3. Percent of crushed particles fine aggregate.
  4. Fine aggregate angularity.

5. Flat and elongated particles.
6. Other aggregate properties specified in the project special provisions if applicable.

If samples will be shipped to a district materials laboratory or to a construction laboratory, complete Form TL-0101, "Sample Identification Card," following the instructions in the book and the information in Section 6-103, "Field Sampled Material Identification for Testing," of this manual. Record the type of mix, the hot mix asphalt producer, and the producer mix identification number. Check the box on the sample TL-0101 for acceptance test. Ship the samples to the district materials laboratory or field construction laboratory for testing. If any test results exceed the specified limits, the testing laboratory will immediately notify the resident engineer.

Ensure that aggregate treatment is adequate by witnessing contractor quality control testing, and that the contractor enters the treatment data specified in the special provisions into a log. For each day of aggregate lime treatment, obtain the treatment data log electronically for the resident engineer's project file.

#### 4-3903C (1d) Liquid Antistrip Treatment

Ensure that data required in the liquid antistrip treatment section of the special provisions is entered into the production unit's treatment data log and submitted in the required format.

For each day of antistrip treatment, obtain the treatment data log electronically for the resident engineer's project files.

#### 4-3903C (2) Production Startup Evaluation

A production startup evaluation occurs within the first 750 tons produced on the first day of hot mix asphalt production. The evaluation is also required when production has stopped for more than 30 days and if a new job mix formula is being used.

The plant inspector generally takes the following steps related to a production startup evaluation:

- During the first 750 tons of production, the inspector witnesses the contractor sampling aggregate, asphalt binder, and reclaimed asphalt pavement on the first day of production in accordance with Section 39-1.07, "Production Start-Up Evaluation," of the *Standard Specifications* and California Test 125. The inspector retains three split samples for testing and dispute resolution as described earlier.
- Labels each hot mix asphalt sample with enough information to identify the exact location. Refer to the example in Section 4-3903C (3). For QCQA process projects, indicates the lot and subplot.
- Ships one sample of asphalt binder to METS for testing as detailed in Section 6-2, "Acceptance of Manufactured or Fabricated Materials and Products," of this manual, noting that it is a production startup acceptance test.
- Immediately tests one aggregate sample for aggregate gradation and sand equivalent. If reclaimed asphalt pavement is used, tests reclaimed asphalt pavement sample and determines the aggregate gradation in accordance with Lab Procedure 9, "Hot Mix Asphalt (HMA) Using Up to 15% Reclaimed Asphalt Pavement (RAP)," notifying the contractor of test results.

1. For the method process, when test results fall outside the specification limits, the inspector notifies the contractor and requires and confirms that the contractor take corrective action.
2. For the standard and QCQA processes, the inspector compares the contractor's quality control test results with Caltrans acceptance test results, notifying both the contractor and resident engineer if the test results are significantly different.

If aggregate gradation or sand equivalent test results fall outside the specification limits, notify the resident engineer immediately.

- Tests one aggregate sample for aggregate acceptance quality characteristics.

For samples that will be shipped to the district material laboratory or field construction laboratory for testing, complete Form TL-0101, "Sample Identification Card," following the instructions printed in the form booklet and the information in Section 6-103, "Field Sampled Material Identification for Testing," of this manual. Record the type of mix, the hot mix asphalt producer, the producer's mix identification number, and the production tonnage that this sample represents.

Check the box on the sample TL-0101 for acceptance test, marked "Priority," and include "Production Startup Evaluation Test" under "Remarks." Under "Remarks," identify the tests to be performed:

1. Los Angeles Rattler.
2. Percent of crushed particles course aggregate.
3. Percent of crushed particles fine aggregate.
4. Fine aggregate angularity.
5. Flat and elongated particles.
6. Other aggregate properties specified in the project special provisions, if applicable.

The specifications require 3 days for test result turnaround, so samples must be shipped immediately. If any tests results fall outside the specified limits, the testing laboratory will immediately notify the resident engineer.

#### *4-3903C (3) Hot Mix Asphalt Production*

During production, the plant inspector generally takes the following steps related to hot mix asphalt plant operations:

- Observes the overall plant operation to ensure the contractor controls dust and smoke. Requests that the contractor corrects any obvious violation and cease operation if necessary to prevent damage to hot mix asphalt mixture.
- Obtains aggregate samples and performs California Test 226, "Method of Test for Moisture Content of Soils and Aggregates by Oven Drying," or California Test 370, "Method of Test for Determining Moisture Content of Bituminous Mixtures or Graded Mineral Aggregates Using Microwave Ovens."
- Confirms that the contractor is performing sampling and testing for moisture content at the frequency shown in Section 39-1.04D, "Aggregate," of the *Standard*

*Specifications.* Because moisture influences proportioning, it is good practice to test both aggregate and reclaimed asphalt pavement for moisture content.

- Compares the contractor's quality control test results with Caltrans test results and notifies both the contractor and resident engineer if the test results are significantly different.
- Verifies that the contractor is adjusting the hot mix asphalt plant controller based on the contractor's aggregate moisture quality control testing.
- Obtains aggregate samples for field testing for aggregate gradation and sand equivalent at the frequency shown in Table 6-1.12. Tests aggregate samples before lime treatment for testing sand equivalent. (Reclaimed asphalt pavement does not need to be sampled for sand equivalent.) Do not use aggregate samplers that do not safely produce a manageable sized sample.
- Labels each aggregate sample with the contract number, date, type of mix, aggregate gradation (1/2 inch), aggregate source, hot mix asphalt producer, and producer's mix identification number. Indicates the number of tons produced when the sample was taken. For QCQA process projects, indicate the lot and subplot.

Tests aggregate samples for aggregate gradation and sand equivalent at the frequency shown in Table 6-1.12, "Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt," of this manual. If reclaimed asphalt pavement is used, determines aggregate gradation in accordance with Lab Procedure 9, "Hot Mix Asphalt (HMA) Using Up to 15% Reclaimed Asphalt Pavement (RAP)."

1. For method process, notifies the contractor of aggregate gradation and sand equivalent test results, and confirms that any required plant adjustment has been made to correct for out-of-specification aggregate gradation.
2. For standard and QCQA processes, compares the contractor's quality control test results with Caltrans acceptance test results for aggregate gradation and sand equivalent, and notifies both the contractor and resident engineer if the test results are significantly different.

If aggregate gradation or sand equivalent test results fall outside the specification limits, notify the resident engineer immediately. If the contractor makes significant or numerous adjustments in bin aggregate proportions, increase the frequency of aggregate gradation testing.

- Obtains aggregate samples for aggregate acceptance quality characteristics at the sampling frequencies shown in Table 6-1.12 of this manual and sample in accordance with California Test 125. If lime treated, aggregate samples must be taken before lime treatment for testing aggregate properties. Reclaimed asphalt pavement does not need to be sampled.

Label each aggregate sample with the contract number, date, type of mix, aggregate gradation (1/2 inch), aggregate source, hot mix asphalt producer, and producer's mix identification number. Indicate the number of tons produced when the sample was taken. Refer to the example in Section 4-3903D (5). For the QCQA process projects, indicate the lot and subplot.

- Tests aggregate at the frequency shown in Table 6-1.12. For samples that will be shipped to the district material laboratory or field construction laboratory for testing, complete Form TL-0101, "Sample Identification Card." Follows the

instructions printed in the book that contains the form and the information in Section 6-103, "Field Sampled Material Identification for Testing," of this manual. Records the type of mix, the hot mix asphalt producer, and the producer's mix identification number. Checks the acceptance tests box on the TL-0101. Under "Remarks," identifies the tests to be performed:

1. Los Angeles Rattler.
2. Percent of crushed particles course aggregate.
3. Percent of crushed particles fine aggregate.
4. Fine aggregate angularity.
5. Flat and elongated particles.
6. Other aggregate properties specified in the project special provisions, if applicable.

If any test results exceed the specified limits, the materials laboratory will immediately notify the resident engineer.

For the method and standard processes (and for the QCQA process for all requirements other than gradation, asphalt content, and compaction), if any single quality characteristic has two consecutive acceptance or quality control tests not in compliance with the specifications, ensure that before resuming production and placement of hot mix asphalt on the project, the contractor:

1. Stops production.
  2. Notifies the resident engineer.
  3. Takes corrective action.
  4. Provides a split sample for the engineer's testing.
  5. Demonstrates compliance with the specifications before resuming production and placement of hot mix asphalt on the project.
- Samples asphalt binder at the frequencies shown in Section 6-1 and in accordance with Section 6-2, "Acceptance of Manufactured or Fabricated Materials and Products," of this manual, fills out Form TL-0101, before shipping samples to METS for testing.
  - Ensures asphalt binder quality by following Section 4-92, "Asphalts," of this manual.
  - For asphalt rubber binder components:
    1. Collect certificates of compliance for each truckload of crumb rubber modifier and asphalt modifier.
    2. Collect a "Buy America" certificate for each truckload of crumb rubber modifier.
    3. Sample asphalt modifier binder at the frequencies shown in Section 6-1, of this manual. Ship to METS as detailed in Section 6-2 of this manual.
  - Ensure that the temperatures of the asphalt binder, aggregate, and hot mix asphalt do not exceed the limits specified in Section 39-1.08B, "Mixing," of the *Standard Specifications*.

- Ensure that the batch size and feed rates do not exceed the mixing capacity range used during plant dynamic testing.
- Hot mix asphalt must be tested for mix moisture content from samples taken behind the paver in accordance with California Test 370, “Method of Test for Determining Moisture Content of Bituminous Mixtures or Graded Mineral Aggregates Using Microwave Ovens.” However, the hot mix asphalt can be sampled and tested at the plant to determine if sampling and testing at the mat are necessary by performing the informal test described below. If hot mix asphalt samples taken at the plant meet the mix moisture acceptance requirements, samples taken behind the paver will also meet the specification requirement.

To perform an informal quick moisture content check at the plant, use the following procedure:

1. Have the contractor take a shovelful of aggregate from the drier’s discharge chute.
2. Notice any steaming or dark spots on the aggregate.
3. Pass a cool, shiny, clean mirror, spatula, or other similar item in a slow, deliberate motion immediately above the aggregate.
4. Observe the amount of condensed moisture on the item.
5. Advise the contractor if moisture is seen.

This informal method cannot be used for acceptance.

- Observe production to ensure the specified hot mix asphalt mixture conforms to project specifications and the MPQP.

#### 4-3903C (3a) Batch Plants

Do not approve a shorter mixing time than was used during the plant dynamic testing conducted for plant acceptance, according to Chapter 3, Section II-B, “Asphalt Binder Storage,” of the MPQP.

Ensure that the automatic batching equipment functions within the limits specified in Chapter 2, Section II-F, “Batch Mixing HMA Plants,” of the MPQP.

#### 4-3903C (3b) Continuous Mixing Plants

For continuous mixing plants (drier drum or drier drum pugmill), ensure that the following are operating:

1. Vibrating unit on the fine bins.
2. Low-level and no-flow interlock systems for aggregate and reclaimed asphalt pavement feeder bins.
3. No-flow interlock system for asphalt binder storage and feed system.
4. Automatic plant controller.
5. Dust control systems.
6. Segregation devices at hot mix asphalt storage.

The mixing time depends on the length of the mixing area and the rate of drop in the drier drum during mixing. The most efficient pugmill mixing occurs when the material level remains at the top of the paddles along the length of the mixer. For best results,

feeding must be continuous and uniform. Do not approve a production rate less or greater than the range of production used during the plant dynamic testing conducted for plant acceptance according to Chapter 3, Section II-B of the MPQP.

#### *4-3903C (4) Plant Weighing Systems*

Observe the operation of all weighing systems. Whenever scales and meters seem inaccurate, contact the district weights and measures coordinator for further assistance. Be aware of scale and meter security seals and set points.

For batch plants:

- Ensure that the weigh box containing the total batch does not come in contact with anything that prevents a true indication of the batch weight.
- When intermediate storage, such as a silo, is used for hot mix asphalt, periodically check the batching by comparing the total weight of the batches in a truckload with the platform scale weight for the same load.
- Check the asphalt binder scales frequently to ensure that they return to within zero tolerance limits and that the scale lever systems or load cells move freely.

When plants are used for only one project, the accuracy of meter-driven devices that proportion asphalt binder can be checked. To do so, compare meter totalizer readings with asphalt binder tank stabbings and, in conjunction with an onsite vehicle scale, with the combined aggregate totalizer readings. Take into account any wasted mix or individual ingredients wasted after proportioning.

#### *4-3903C (5) Hot Mix Asphalt Storage*

Ensure that hot mix asphalt storage silos are in accordance with Chapter 2, Section II-J, “Hot Mix Asphalt Storage,” of the MPQP.

#### *4-3903C (6) Hot Mix Asphalt Transporting*

Before the trucks are loaded, ensure the absence of an excessive amount of parting agent or other contaminating material. Such material is excessive when it forms pools. Diesel or other petroleum-based products are prohibited from being used as parting agents.

After the trucks are loaded, be sure the hot mix asphalt mixture is uniform (that is, aggregate is coated with asphalt binder and load is not segregated). Notify the resident engineer if loads need to be rejected based on non-uniformity of hot mix asphalt mixture.

For the method process and when standard and QCQA processes are required to use Section 39-3.04, “Transporting, Spreading, and Compacting,” of the *Standard Specifications*, ensure that rubberized hot mix asphalt gap-graded and open-graded friction course loads are covered with tarpaulins when the atmospheric temperature is below 70°F. Tarps are not required if the time from discharge to truck until transfer to the paver’s hopper or to the pavement surface is less than 30 minutes. If the trucks are tarped, record that information on Form CEM-3501, “Hot Mix Asphalt Production Report.”

#### 4-3903D Paving Operations

During hot mix asphalt placement, the paving inspector generally takes the following related steps:

- Record daily hot mix asphalt placement information on Form CEM-3502, “Hot Mix Asphalt Placement Report,” and additional information, including instructions to contractor’s personnel, on Form CEM-4601, “Assistant Resident Engineer’s Daily Report.”
- Refer to “Placing Hot-Mix Asphalt” in *Construction of Quality Hot Mix Asphalt Pavements*, published by the Asphalt Institute, as guidance for best practices during hot mix asphalt placement.

##### 4-3903D (1) *Atmospheric and Pavement Temperature*

- Ensure that placement occurs within the specified temperature ranges by taking sufficient measurements of the atmosphere, pavement, and hot mix asphalt. Refer to Sections 39-1.11, “Transporting, Spreading, and Compacting,” and 39-3.04, “Transporting, Spreading, and Compacting,” of the *Standard Specifications* for atmospheric and surface temperature minimum requirements.
- Record temperatures and the time taken on Form CEM-3502. Notify the contractor to stop hot mix asphalt placement when temperatures are below specified limits.

##### 4-3903D (2) *Tack Coat*

- Ensure that tack coat is applied to surfaces to be paved. The contractor may request and the paving inspector authorize that the application of tack coat is waived between layers when both of the following conditions apply:
  1. The surface to be paved does not have a film of dust or clay.
  2. The temperature of the surface to be paved is  $\geq 140^{\circ}\text{F}$ .

For information on inspecting tack coat, refer to Section 4-3906A, “References,” of this manual for the *Tack Coat Guidelines* website.

##### 4-3903D (3) *Transporting and Spreading*

- Ensure that hot mix asphalt delivery trucks have load slips, and collect the load slips from the arriving trucks. If inspection resources are limited, collect load slips on a daily basis. If hot mix asphalt loads are rejected before placement, note on the back of the load slip and Form CEM-4601, why the hot mix asphalt was rejected, such as cold mix, segregated mix, or contaminated mix.
- Watch for queuing of trucks to avoid excessive cooling of hot mix asphalt mixture.
- If windrowing is used, prevent overcooling of the hot mix asphalt by not allowing excessive windrowing.
  1. Windrow temperatures can be monitored with an infrared heat gun, and hot mix asphalt may be rejected for not meeting minimum first coverage of breakdown temperature shown in Section 39-3.04, “Transporting, Spreading, and Compacting,” of the *Standard Specifications*.
  2. Be aware when using a heat gun that the instrument measures surface temperature only and that the interior of the windrow is hotter. When the hot mix asphalt is run through the paver, the mat temperature may be above the minimum specified.

3. If windrow temperatures are inadequate or visual inspection of the material in the windrow identifies segregation, poor mixing, or an over-rich mix, notify the contractor. If this material is incorporated into the paving, additional inspection and testing may be necessary to determine if the mix is acceptable.
- When hot mix asphalt is placed against the edge of a longitudinal or transverse construction joint damaged or not placed to a neat line, ensure the contractor saw cuts or grinds the pavement straight and vertically along the joint and removes the extraneous material.
  - Ensure that longitudinal joints between layers are offset 0.5 foot and that longitudinal joints on the finished surface correspond to the edge of traffic lanes.
  - Ensure that the paver spreads the hot mix asphalt at the required thickness and that layer thickness does not exceed 0.25 foot.
  - Ensure pavement thickness by comparing the hot mix asphalt spread rate with the theoretical rate and, if necessary, order the contractor to make adjustments.

Below is an example spread-rate calculation assuming 12 feet wide, 0.15-foot thickness, mix 150 pounds per cubic foot, and 16 tons shown on truckload slip.

1. Calculate the weight of hot mix asphalt 0.15-foot thick required for 1 square foot:  $150 \times 0.15 = 22.5$  pounds persquare foot
2. Calculate the weight of hot mix asphalt for 1 linear foot:  
 $22.5 \times 12 = 270$  pounds per linear foot
3. Calculate the linear feet that can be covered by one truckload:  
 $(16 \text{ tons} \times 2000 \text{ pounds per ton}) \div 270 \text{ pounds per linear foot} = 118.5$  linear feet
4. Calculate the linear feet covered by 1 ton of hot mix asphalt:  $2000 \text{ pounds per ton} \div 270 \text{ pounds per linear foot} = 7.40$  feet
5. Calculate the linear feet the paver will travel to spread the load:  
 $11.0 \text{ tons} \times 7.40 \text{ feet per ton} = 81.4$  feet

Check layer thickness and spread rate during placement, and check daily theoretical spread rate against the distance actually paved for the day. Note these on Form CEM-3502, "Hot Mix Asphalt Placement Report."

Payment for hot mix asphalt is based on the weight shown on the load slips. Because of the high cost of hot mix asphalt, it is important to monitor the spread rate so an excess of hot mix asphalt is not placed and project funding is not exceeded.

#### 4-3903D (4) *Production Startup Evaluation Samples*

Section 39-1.07, "Production Start-Up Evaluation," of the *Standard Specifications* requires samples of hot mix asphalt within the first 750 tons of production on the first day of production.

- Observe the contractor sampling from the mat behind the paver or other location approved by the resident engineer. The contractor must sample in accordance with California Test 125, "Methods of Test for Sampling Highway Materials and

Products Used in the Roadway Structural Sections,” and give the resident engineer three of the four split samples.

- Test the hot mix asphalt production startup evaluation sample for quality characteristics shown in Section 4-3903D (5), “Sampling and Testing Hot Mix Asphalt,” of this manual.
- Test aggregate at the frequency shown in Table 6-1.12. For samples that will be shipped to the district material laboratory or field construction laboratory for testing, complete Form TL-0101, “Sample Identification Card.” Follow the instructions printed in the form booklet and the information in Section 6-103, “Field Sampled Material Identification for Testing,” of this manual. Record the type of mix, the hot mix asphalt producer, and the producer’s mix identification number. Check the acceptance tests box on the TL-0101. Under “Remarks,” identify the tests to be performed.

Label each hot mix asphalt sample with enough information to identify the exact location. For QCQA process projects, indicate the lot and subplot. Refer to the example below in Section 4-3903D (5).

Check the box on TL-0101 for acceptance test marked “Priority,” and include “Production Startup Evaluation Test” under “Remarks.” Also under “Remarks,” list all required acceptance tests. The resident engineer must report the test results to the contractor within 3 business days of sampling, so samples must be shipped immediately.

#### *4-3903D (5) Sampling and Testing Hot Mix Asphalt*

- Obtain split samples of hot mix asphalt from the mat behind the paver or other location approved by the resident engineer, in accordance with California Test 125, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections.” Table 6-1.12, “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual provides the frequency for sampling hot mix asphalt mix.

Label each hot mix asphalt sample aggregate grading (for example, “1/2 inch”), asphalt binder target value, producer, and producer’s mix identification number. Indicate both the stationing where the sample was taken and the area represented (for example, STA 100+50, NB, Lane 1, first layer). The label must have enough information to identify the exact location if the hot mix asphalt is rejected and must be removed. For QCQA process projects, indicate the lot and subplot.

- Test aggregate at the frequency shown in Table 6-1.12 of this manual. For samples that will be shipped to the district material laboratory or field construction laboratory for testing, complete Form TL-0101, “Sample Identification Card.” Follow the instructions printed in the form booklet and the information in Section 6-103, “Field Sampled Material Identification for Testing,” of this manual. Record the type of mix, the hot mix asphalt producer, and the producer’s mix identification number. Check the acceptance tests box on the TL-0101, and identify the tests to be performed under “Remarks”:
  1. Asphalt binder content.
  2. Stability.

3. Voids in mineral aggregate (report only if an adjustment for asphalt binder content target value is less than  $\pm 0.3$  percent from optimum binder content).
4. Voids filled with asphalt (report only if an adjustment for asphalt binder content target value is less than  $\pm 0.3$  percent from optimum binder content).
5. Dust proportion (report only if an adjustment for asphalt binder content target value is less than  $\pm 0.3$  percent from optimum binder content).
6. Maximum theoretical density (California Test 309, “Method of Test for Determining Theoretical Maximum Specific Gravity of Hot Mix Asphalt”), if applicable.
7. California Test 371, “Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage,” if applicable.

For the method and standard processes (and for the QCQA process for all requirements other than gradation, asphalt content, and compaction), if any single quality characteristic has two consecutive acceptance or quality control tests not in compliance with the specifications, ensure that before resuming production and placement of hot mix asphalt on the project, the contractor:

1. Stops production.
  2. Notifies the resident engineer.
  3. Takes corrective action.
  4. Provides a split sample for the engineer’s testing.
  5. Demonstrates compliance with the specifications.
- For the QCQA process, in addition to the sampling and testing requirements described above, perform the following:
    1. Test the asphalt binder content of the hot mix asphalt mixture for verification testing at least once every five sublots. Contractor quality control test results are used in the QCQA process for acceptance test results if the quality control test results are verified.
    2. Ensure that the contractor is complying with the minimum quality control testing frequencies in Section 39-4.02C [39-4.03C], “Quality Control Inspection, Sampling, and Testing,” of the *Standard Specifications*.
    3. Ensure that, when any quality characteristic is beyond the action limits shown in the quality control plan, the contractor is taking corrective action. The contractor must document the corrective action in accordance with Section 39-4.02E [39-4.03E], “Records of Inspection and Testing,” of the *Standard Specifications*.

The contractor must stop production, notify the resident engineer, take corrective action, and demonstrate compliance with the specifications before resuming production and placement of hot mix asphalt on the project if any of the following occurs:

1. A lot’s composite quality factor or individual quality factor (QFQC<sub>i</sub> when  $i = 3, 4, \text{ or } 5$ ) is below 0.90, determined under Section 39-4.02F [39-4.03F], “Statistical Evaluation,” of the *Standard Specifications*.
2. A QFQC<sub>i</sub> for  $i = 1 \text{ or } 2$  is below 0.75.

3. Quality characteristics with an undetermined quality factor have two consecutive acceptance or quality control tests not in compliance with the specifications.

Daily, ensure that the contractor is submitting Form CEM-3502, "Hot Mix Asphalt Placement Report," and Form CEM-3804, "Hot Mix Asphalt Inspection and Testing Summary," in accordance with Section 39-4.02E [39-4.03E], "Records of Inspection and Testing," of the *Standard Specifications*.

#### 4-3903D (6) *Compaction*

For standard and QCQA processes, the contractor must comply with the method process in Section 39-3.03, "Spreading and Compacting Equipment," and in Section 39-3.04, "Transporting, Spreading and Compacting," of the *Standard Specifications* if:

- The total paved thickness is less than 0.15 foot.
- The total paved thickness is less than 0.20 foot and a ¾-inch aggregate grading is specified and used.
- The hot mix asphalt is used in:
  1. Asphalt concrete remove-and-replace areas (digout).
  2. Leveling courses.
  3. Detours not included in final roadway prism.
  4. Areas the resident engineer determines that conventional compaction and compaction measurement methods are impeded.

#### 4-3903D (6a) *Method Process Compaction*

For the method process hot mix asphalt compaction:

- Use the MultiCool 3 program as a guide for determining the length of time available for achieving compaction, based on layer thickness, hot mix asphalt temperature, existing pavement temperature, and atmospheric temperature. The MultiCool 3 program is available at:  
<http://www.dot.ca.gov/hq/construc/hma/>
- Ensure that:
  1. Specified equipment performs the compaction in the specified order.
  2. A required number of coverages are made for each compaction type (first coverage, breakdown, and finish).
  3. The hot mix asphalt compaction is completed above the specified minimum temperature for each compaction type (first coverage, breakdown, and finish).
  4. The speed of the vibratory roller in miles per hour does not exceed the vibrations per minute divided by 1,000 when a vibratory roller is specified for compaction. When the hot mix asphalt layer thickness is less than 0.08 foot, the vibratory must be in the off mode.
  5. The speed does not exceed 5 miles per hour when a pneumatic-tired roller is specified for compaction.

Refer to Section 39-3.03 of the *Standard Specifications* for additional compaction equipment requirements and to Section 39-3.04 of the *Standard Specifications* for detailed compaction temperature and coverage requirements.

- Visually inspect the finished hot mix asphalt surface for marks, tearing, and irregular texture that may be caused by segregated mix. Notify the contractor of defective areas.

#### 4-3903D (6b) Compaction Determination by Cores—Standard and Quality Control Quality Assurance Processes

For standard and QCQA processes, when the total paved thickness is at least 0.15 foot:

- The contractor will determine the number of rollers and sequence necessary to meet the compaction requirements of the specifications.
- The contractor can use any method for quality control testing such as nuclear gauge, non-nuclear gauge, or cores to determine the relative compaction.
- The contractor will obtain the cores for the resident engineer within 5 days of hot mix asphalt placement. The resident engineer will use the cores to determine relative compaction.
  1. Randomly select core locations for every 250 tons of hot mix asphalt placed according to Part 3, “Section B, “Test Site Location,” of California Test 375, “Determining the In-Place Density and Relative Compaction of Hot Mix Asphalt Pavement Using Nuclear Gages.”
  2. Witness the contractor taking the cores, mark each core, and place the cores in a protective container before taking possession of the cores.
  3. Complete Form TL-0101, “Sample Identification Card,” following the instructions printed in the form’s book and the information in Section 6-103, “Field Sampled Material Identification for Testing,” of this manual. Identify the stationing where they were taken and the area they represent (for example, “lane #1, first layer”). Label the samples with enough information that the exact location where hot mix asphalt was placed can be identified if it is rejected and has to be removed. On Form TL-0101, check the box for acceptance test.
  4. Transport the cores to the district materials laboratory or construction field laboratory where they will be tested for in-place density (California Test 308, Method A). The percentage of maximum theoretical density (compaction) will be determined from hot mix asphalt samples using California Test 309.

#### 4-3903D (7) Smoothness

The paving inspector checks pavement smoothness for acceptance by daily use of a straightedge to determine whether the finished surface complies with the tolerances specified in Section 39-1.12B, “Straightedge,” of the *Standard Specifications*.

The paving inspector records straightedge measurements on Form CEM-4601, “Assistant Resident Engineer’s Daily Report,” and notifies the contractor of all out-of-specification areas.

For smoothness, the contractor must profilograph the top layer of hot mix asphalt. Refer to Section 39-1.12C, “Profilograph,” of the *Standard Specifications* for additional information about smoothness requirements.

- Witness the contractor profilograph the pavement in accordance with California Test 526, “Method of Test for Operation of California Profilograph and Evaluation of Profiles.”
- The contractor must meet zero (null) blanking band profile index and must-grinds on the top layer of hot mix asphalt Type A, Type B, and RHMA-G when the total thickness is greater than 0.25 foot.
- The pavement surface must meet smoothness requirements for must-grinds for Type A, Type B, and RHMA-G when total thickness is less than or equal to 0.25 foot.
- The pavement surface for open graded friction course must meet the must-grind requirement if the open graded friction course is placed over hot mix asphalt constructed under the same project.
- Retain one copy of profile information in Microsoft Excel and one electronic copy of longitudinal pavement profiles in “.erd” or other ProVAL format.

#### 4-3903D (8) *Miscellaneous Areas and Dikes*

The contractor must place hot mix asphalt at miscellaneous areas and place dikes where shown on the plans and in accordance with Section 39-1.14 [39-1.13], “Miscellaneous Areas and Dikes,” of the *Standard Specifications*.

#### 4-3903D (9) *Fog Seal Coat*

The contractor applies fog seal coat to rumble strip ground areas and ground areas caused by smoothness correction grinding. If smoothness correction grinding is excessive, contact the METS Office of Flexible Pavement before allowing the contractor to fog seal within the traveled way.

The contract item for “fog seal coat” is used when fog seal must be applied to shoulders, miscellaneous areas, and dikes. Prohibit the contractor from applying fog seal coat to the traveled way.

Fog seal coat applied to ground in rumble strips and smoothness correction areas is not paid separately. Refer to Section 4-37, “Bituminous Seals,” of this manual for additional information.

#### 4-3903D (10) *Open to Traffic*

Do not allow traffic on new hot mix asphalt until its mid-depth temperature is below 160°F. The contractor may request in writing and the resident engineer authorize cooling of hot mix asphalt Type A and Type B with water when rolling is complete.

For rubberized hot mix asphalt, the contractor must spread sand at a rate between 1 and 2 pounds per square yard before opening to public traffic.

Temporary construction signing and temporary pavement delineation must be in place before opening to public traffic.

### **4-3904 Contract Administration**

The resident engineer must review the notice of materials to be used, review and accept the job mix formula for hot mix asphalt, review and accept the contractor’s quality control plan when applicable, and verify inspection reports and acceptance testing results for contract compliance. The resident engineer makes decisions regarding non-

### **4-3904 Contract Administration**

compliant materials and placement, administers the HMA Pay program for QCQA process, and ensures that pay adjustments are made when required.

The Federal Highway Administration requires Caltrans to have a quality assurance program. As part of that program, this chapter defines quality assurance and contract administration requirements for hot mix asphalt. Caltrans requires that these same quality assurance standards be met for state-funded projects. If the requirements are not met, there is a risk that federal funds will be withheld or withdrawn. The resident engineer takes the following steps for hot mix asphalt contract administration:

- Verifying that Form CEM-3101, “Notice of Materials to Be Used,” includes all component materials and materials sources used in hot mix asphalt. Refer to Section 6-202, “Responsibilities for Acceptance of Manufactured or Fabricated Materials and Products,” of this manual for details.
- Ensuring that the job mix formula for the project is verified and accepted before placement of hot mix asphalt.
- Ensuring that the contractor’s quality control plan and its supplements for standard and QCQA processes are submitted and comply with the requirements of the specifications. The quality control plan must describe the organization and procedures used by the contractor to:
  1. Control the quality characteristics.
  2. Determine when corrective actions are needed, based on the contractor’s action limit.
  3. Implement corrective actions.

For standard process, a formal acceptance of the quality control plan is not required. The submitted quality control plan must address the following elements affecting hot mix asphalt quality: aggregate, asphalt binder, additives, and production paving.

For the QCQA process, refer to Section 4-3902G, “Quality Control Quality Assurance Process,” of this manual for review and acceptance of the contractor’s quality control plan.

#### 4-3904A Acceptance Testing and Evaluation

The resident engineer ensures that acceptance testing is performed at least at the minimum frequency shown in Table 6-1.12, “Materials Acceptance Sampling and Testing Requirements: Hot Mix Asphalt,” in Section 6-1, “Sample Types and Frequencies,” of this manual. Record test results on Form CEM-3701, “Test Result Summary,” so that minimum acceptance testing frequency is easily verified and documented.

The resident engineer ensures that production startup evaluation testing is completed and recorded on Form CEM-3703, “Caltrans Production Startup Evaluation,” and that the contractor is provided with a copy of the completed form.

#### *4-3904A (1) Acceptance Test Results Outside Specified Limits*

If any acceptance test result is outside the limits specified, notify the contractor in writing that the material may be defective. Attach a copy of the acceptance test result.

For the standard and QCQA processes, ask the contractor if any corrective action has been taken based on quality control test data for the period when the acceptance sample was taken.

If acceptance test results are disputed within the period specified in Section 39-1.06, “Dispute Resolution,” of the *Standard Specifications*, try to resolve these issues at the project level before involving the independent third party.

If an acceptance test is outside the acceptance specification limits, direct the field construction lab, district materials lab, or METS to test the most recent acceptance sample for compliance with the specifications. Designate this sample for priority testing.

#### 4-3904A (2) Two Consecutive Acceptance Test Results Outside Specification Limits

If two consecutive acceptance test results do not comply with the specifications:

- Inform the contractor in writing that the material represented by the two out-of-specification acceptance tests is defective, and include a statement that the defective material is rejected and must be removed or remedied in accordance with Section 5-1.30 [6-1.04], “Noncompliant and Unauthorized Work,” of the *Standard Specifications*.
- Attach copies of both test results that indicate the material is outside specification limits.
- Submit any samples taken between the two failed tests to the appropriate lab for priority testing to define the amount of material not in compliance with the specifications.
  1. Notify the appropriate lab that two consecutive acceptance tests are outside the acceptance specification limits.
  2. Direct the testing labs to test all samples between the first and second out-of-specification acceptance tests. Use their test results to define the quantity of hot mix asphalt that will be rejected.
- Notify the contractor in writing of results of all additional acceptance tests conducted to determine the extent of the out-of-specification material. In the notice, include language that the material represented by out-of-specification material is defective and rejected and must be removed or remedied to comply with Section 5-1.30 [5-1.09], “Noncompliant and Unauthorized Work,” of the *Standard Specifications*.
- Require the contractor to:
  1. Take corrective action to remedy the cause of out-of-specification material.
  2. Provide written documentation of corrective action taken.
  3. Demonstrate compliance by providing quality control testing of material produced but not delivered to the project.
  4. Provide samples of hot mix asphalt for both the resident engineer and contractor to test. The contractor samples this material in the engineer’s presence and splits the samples into four parts.
  5. Test one part of the split sample to verify that the corrective action taken by the contractor was successful.

If both Caltrans' and the contractor's test results are within specifications, the contractor has demonstrated compliance with the specifications and may resume production.

Since the samples tested by the contractor and resident engineer are from a split sample, the test results should not be significantly different. If there is a significant difference, the resident engineer and the contractor should investigate the reason for the discrepancy. Contractors can choose to begin production during this investigation but proceed at their own risk.

- The contractor may dispute any out-of-specification acceptance test result within the specified number of days of receiving the test result by notifying the resident engineer in writing in accordance with Section 39-1.06 of the *Standard Specifications*. Try to resolve testing or sampling issues at the project level before involving the independent third party.
- If the contractor agrees that the hot mix asphalt placed is defective, the contractor may propose to the resident engineer in writing that the defective material will be remedied or that the defective material will be left in place for reduced compensation. Consult with district materials engineer and either the METS Office of Flexible Pavement, or the district's construction field coordinator, or both, about acceptance of the contractor's proposal. Document material remediation or reduced pay by issuing a contractor-requested change order. Document all non-compliant materials test results including the action taken on the final Project Materials Certification. Refer to Section 6-106, "Project Materials Certification," of this manual for documentation requirements.

#### 4-3904B Testing for Significant Difference

The resident engineer should compare the contractor's test results against Caltrans' test results to determine if they are significantly different. Compare the test results in one of three ways:

1. A one-to-one comparison of the test results of a single split sample (job mix formula verification and production startup).
2. The comparison of groups of test results (that is, the average of all acceptance tests compared to the average of all quality control tests).
3. The QCQA verification process.

The resident engineer should always examine the differences between contractor and Caltrans test results for job mix formula verification, production startup, and dispute resolution based on a one-to-one comparison of the test results. For job mix formula verification and production startup evaluation, the test result comparison will show whether the contractor and Caltrans can test properly sampled and split samples for aggregate and hot mix asphalt and get reasonably close test results. If a significant difference exists, the resident engineer should notify the contractor. Then both the resident engineer and contractor should examine what is causing the difference and try to find a way to bring their results closer.

The resident engineer should never consider a one-to-one comparison of two test results from different samples—that is, Caltrans' acceptance result of a sample taken in the morning compared to a contractor's quality control test result of a sample taken in the afternoon. If examination of the contractor's and Caltrans' test results shows large differences, compare the test result groups to determine if the results are significantly

different. Compare the average of all acceptance test results to the average of the contractor's quality control test results, and use the table below to determine if the difference between the test results is reasonable or significantly different. If the comparison between the test results indicates a significant difference, notify the contractor. Then both the resident engineer and contractor should examine and investigate the cause of test result differences.

In QCQA, the verification process using the t-value is a means of comparing groups of test results. While only the asphalt binder content and individual gradations are subjected to verification, it is reasonable to assume that the same process (equations and  $t_{crit}$  values) can be used to compare the contractor's quality control compaction results to Caltrans' density core results or for other test comparisons. Although this process is somewhat cumbersome, it is statistically sound. However, a drawback with this process is that the statistics might define the two populations (quality control results compared to acceptance results) as unverified; yet both groups might be within the specification boundaries. Therefore, some other measure of comparison to "fall back on" is necessary. The specifications for QCQA allow the contractor to continue to produce and place hot mix asphalt if the average of the quality control and acceptance test results are in specification and if the difference between these averages is less than or equal to 1.0 percent for any grading or 0.1 percent for asphalt binder content.

The resident engineer may use the QCQA t-test statistical verification equations and  $t_{crit}$  values to compare the contractor quality control test results and acceptance test results. The t-test is shown in Section 39-4.03B [39-4.04B], "Verification Sampling and Testing," of the *Standard Specifications*. If the results of the statistical verification show that the contractor's test results are unverified, use the averages column in the table below as the measure of comparison to fall back on. If the test results are significant different, notify the contractor. Then both the resident engineer and contractor should examine and investigate what is causing the test result differences.

For QCQA, standard, or disputes in method projects, use the reasonable testing difference values in Table 4-39.1, "Precision Index," to evaluate whether a significant testing difference exists.

**Table 4-39.1. Precision Index**

Quality Characteristic	California Test	Reasonable Testing Differences	
		Single Results	Averages
Sand equivalent	217	6	2
Stabilometer value	366	10	4
Theoretical maximum specific gravity (see Note 1)	309	0.05	0.02
Percentage of maximum specific gravity (see Note 1)		3% (see Note 2)	1% (see Note 3)
		2% (see Note 4)	
Design air voids content (see Note 1)	367	2.8%	4.5
Asphalt binder content	379	0.3%	0.1%
	382	0.5%	0.2%
Aggregate gradation	202		
3/4" or 1/2"		3%	1%
3/8"		3%	1%
No. 4		3%	1%
No. 8		3%	1%
No. 30		3%	1%
No. 200		3%	1%

NOTES:

1. Examine the CT 309 values also. Determine whether resolution of CT 309 is necessary and sufficient to resolve issues with % MTD or design air void content.
2. Comparing one core to the average of QC test results within the same 250 tons.
3. Comparing the average of Caltrans' cores to the average of QC test results for the same volume of hot mix asphalt or the same area.
4. Comparing the average of three of Caltrans' cores in 750 tons to the average of QC test results for the same 750 tons of hot mix asphalt.

4-3904C Certificates of Compliance

The resident engineer obtains certificates of compliance for each delivery of asphalt binder (attach bill of lading), crumb rubber modifier, tack coat, and fog seal.

Keep track of total quantity of material delivered and ensure that inspectors have obtained an adequate number of certificates of compliance to cover the quantity of material received.

In addition, perform the following contract administration reviews for certificates of compliance:

- Refer to the *Certification Program for Suppliers of Asphalt* to determine what information must be shown on the certificate of compliance for asphalt binders.
- Obtain "Buy America" certification for each shipment of crumb rubber modifier.

Ensure that asphalt binder contract administration requirements are met by following Section 4-92, "Asphalts," of this manual.

4-3904D Quality Control Quality Assurance Process

For the QCQA process, follow these additional contract administration requirements:

- Ensure the contractor is complying with the accepted quality control plan.

- Ensure contractor’s compliance with the quality control testing requirements by reviewing the daily submittal of Forms CEM-3501, “Hot Mix Asphalt Production Report”; CEM-3502, “Hot Mix Asphalt Placement Report”; and CEM-3804, “Hot Mix Asphalt Inspection and Testing Summary,” for each day of paving.
- Use the statistical evaluation program, “HMA Pay,” to verify that the contractor’s quality control tests for aggregate gradation and asphalt binder content can be used as acceptance tests.
- Ensure quality hot mix asphalt by determining that:
  1. A lot’s composite quality factor is greater than or equal to 0.90. Refer to Section 39-404B [39-4.05B], “Statistical Evaluation, Determination of Quality Factors and Acceptance,” of the *Standard Specifications*.
  2. The individual quality factors for gradations for the number 200 sieve, asphalt content, and compaction are greater than or equal to 0.90.
  3. The individual quality factors for the largest sieve and the number 8 sieve are greater than or equal to 0.75.
  4. The individual quality factor for percent of maximum theoretical density, using the test results from the cores taken by the engineer, is greater than or equal to 0.90.

If any of these conditions is not met, terminate the lot and adjust payment.

#### **4-3905 Measurement and Payment**

For details of measurement and payment, review Section 39-6 [39-5], “Payment,” of the *Standard Specifications*.

For guidelines on how to weigh hot mix asphalt, refer to Section 3-902E, “Weighing Equipment and Procedures,” of this manual.

For measuring asphalts, liquid asphalts, and asphaltic emulsions used as tack coat, refer to Section 4-92, “Asphalts”; Section 4-93, “Liquid Asphalts”; and Section 4-94, “Asphaltic Emulsions,” of this manual.

##### 4-3905A Quality Control Quality Assurance Process Payment Adjustment

Process a change order to allow for payment increase or decrease based on monthly calculated payment adjustment.

Make QCQA payment adjustments on the next monthly estimate when a lot (20 sublots) is accepted. If the next lot consists of fewer than eight sublots, these sublots must be added to the previous lot for QCQA payment adjustment.

##### 4-3905B Standard Process Payment Adjustment for Core Density

Determine if a deduction is required for cores outside specification limits for the percent of maximum theoretical density. Use the table, “Reduced Payment Factors for Percent of Maximum Theoretical Density,” in Section 39-2.03, “Acceptance Criteria,” of the *Standard Specifications*.” The core density (compaction) deduction should be taken on the next monthly estimate as an administrative deduction.

#### **4-3905 Measurement and Payment**

#### 4-3905C Compensation Adjustment for Price Index Fluctuation

For compensation adjustments for price index fluctuation for asphalt binder, perform the following:

- Process a change order to allow for payment increases or decreases.
- Calculate the amount of asphalt used monthly in hot mix asphalt and tack coat.
- Calculate a paving asphalt adjustment if the California Statewide Paving Asphalt Price Index for the current month has fluctuated by more than the specified amount in the same index for the month in which the bid opening for the project occurred. Include the asphalt payment adjustment on the monthly estimate.

#### 4-3905D Payment After Dispute Resolution for Independent Third Parties

If applicable, when the dispute resolution process determines the contractor's test results are correct, Caltrans pays the independent third party testing costs and adjusts the contract time. The resident engineer adjusts payment and contract time according to Section 8-1.07 [8-1.09], "Delays," of the *Standard Specifications* and processes a change order to allow for payment and adjustment.

#### 4-3905E Compensation and Contract Time for Delays

When failing to comply with the specified times to return test results to the contractor, the resident engineer must adjust payment and contract time under Section 8-1.07 [8-1.09] of the *Standard Specifications*:

- Within 20 days of sampling for job mix formula verification.
- Within 3 days of rubberized hot mix asphalt production sampling for job mix formula verification.
- Within 3 days of sampling for production startup evaluation.

Make compensation and contract time adjustments only when work completion is delayed.

### **4-3906 References and Resources**

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The following lists of references and resources provide construction personnel with additional sources of information.

##### 4-3906A References

- California Test Methods, METS:  
<http://www.dot.ca.gov/hq/esc/ctms/index.html>
- Certification Program for Suppliers of Asphalt, METS:  
[http://www.dot.ca.gov/hq/esc/Translab/ofpm/pdf/COC\\_Guidelines.pdf](http://www.dot.ca.gov/hq/esc/Translab/ofpm/pdf/COC_Guidelines.pdf)
- CEM forms, Division of Construction:  
<http://www.dot.ca.gov/hq/construc/forms.htm>
- Independent Assurance Manual, Procedures for Accreditation of Laboratories and Qualification of Testers, METS:  
[http://www.dot.ca.gov/hq/esc/Translab/ofpm/IA\\_reports/IAP.htm](http://www.dot.ca.gov/hq/esc/Translab/ofpm/IA_reports/IAP.htm)
- Lab Procedures and Engineering Testing Services, Department of Transportation:

<http://www.dot.ca.gov/hq/esc/ctms/index.html>

- *Maintenance Technical Advisory Guide* (MTAG), Office of Pavement Preservation, Division of Maintenance:

[http://www.dot.ca.gov/hq/maint/MTA\\_Guide.htm](http://www.dot.ca.gov/hq/maint/MTA_Guide.htm)

- Materials Plant Quality Program, Division of Construction:

<http://www.dot.ca.gov/hq/construc/hma/>

[http://www.dot.ca.gov/hq/maint/MTA\\_Guide.htm](http://www.dot.ca.gov/hq/maint/MTA_Guide.htm)

- Construction of Quality Hot Mix Asphalt Pavements, Asphalt Institute.
- Quality Control Manual for Hot Mix Asphalt, Division of Construction:

<http://www.dot.ca.gov/hq/construc/publications/qcqaman1.pdf>

- *Standard Specifications*, Department of Transportation:

[http://www.dot.ca.gov/hq/esc/oe/construction\\_standards.html](http://www.dot.ca.gov/hq/esc/oe/construction_standards.html)

- *Tack Coat Guidelines*, Division of Construction:

<http://www.dot.ca.gov/hq/construc/publications/tackcoatguidelines.pdf>

#### 4-3906B Resources

Use available experts within your district or region to resolve issues and obtain additional information about hot mix asphalt production and placement. Contact the construction engineer and Division of Construction coordinator for issues about contract administration related to hot mix asphalt specifications. Contact the district materials engineer for issues about materials and the district independent assurance coordinator for issues concerning testing.

When questions about Section 39, “Hot Mix Asphalt,” of the *Standard Specifications* or related special provisions cannot be addressed by district or region experts, or the construction engineer refers the resident engineer to the Division of Construction or Engineering Services for assistance, contact the following:

For materials or testing issues:

Chief, Office of Roadway Materials Testing  
Materials Engineering & Testing Services and Geotechnical Services  
State of California, Department of Transportation

For quality control quality assurance issues:

District QCQA Coordinator

For contract administration, measurement or payment issues:

Chief, Office of Construction Engineering  
Division of Construction  
State of California, Department of Transportation