MATERIAL PLANT QUALITY PROGRAM

MPQP Manual

October 2022

California Department of Transportation

Division of Construction

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October 2022

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Introduction

The *Material Plant Quality Program (MPQP) Manual* is intended for use by material producers and California Department of Transportation (Caltrans) personnel. The *MPQP Manual* provides procedures to approve proportioning material plants that produce material for Caltrans construction projects. Caltrans district weights and measures coordinators (WMC) oversee the implementation of the MPQP and inspection of material plants to verify compliance with this manual and Caltrans specifications. It is not the responsibility of any Caltrans employee to direct the producer's operation or to operate any controller or proportioning device connected with material production. Once the plant is approved, the WMC will issue an approval of certification letter and provide a sticker for each piece of equipment. To obtain plant certification, the plant operator must submit a certification request to the Caltrans district WMC and schedule an inspection at least 14 days before the desired date of producing material. Material producers may request MPQP certification of plants that are not associated with an active Caltrans project. However, plants producing materials for an active Caltrans project will have priority.

The material producer is responsible for all expenses associated with MPQP certification, including testing and approving devices.

The *MPQP Manual* is written to help Caltrans staff assure that projects meet requirements of the Caltrans *Standard Specifications*, Revised *Standard Specifications*, contract special provisions, and Non-Standard Special Provisions. If a discrepancy exists between the *MPQP Manual* and contract documents, the contract documents will govern.

The *MPQP Manual* is divided into three sections:

Section 1 "Overview," includes requirements that apply to all types of proportioning.

Section 2, "Equipment, Requirements for Material Plants," includes equipment requirements for different types of material plants.

Section 3, "Material Plant Calibration and Dynamic Testing," defines the procedure for verification of calibration and approval of plant proportioning systems.

Section 1—Overview

Proportioning plants producing construction materials for Caltrans projects must be certified in accordance with the MPQP requirements and contract documents. The *MPQP Manual* covers weighing and measuring device inspection, calibration, dynamic testing, and approval requirements for material plants.

1-1. Equipment

1-1.01. General

The material plant must:

1. Be designed and constructed in accordance with general practice for the equipment.
2. Be of adequate capacity to allow completion of the project within the time limit.
3. Be suitable for the purpose intended.
4. Meet the requirements of the contract documents and this manual.

If asked by the district weights and measures coordinator (WMC), the material producer must discontinue the use of out-of-specification plant equipment until the district WMC verifies that specifications are met.

When requested by the district WMC, a statement by the manufacturer must be furnished designating sectional and weighbridge capacities of portable vehicle scales.

1-1.02. Approval

The WMC has responsibility for material plant approval within the limits of this manual when:

1. Required plant equipment is in place and functional.
2. All material plant equipment and devices have met the requirements of the *Standard Specifications*, contract special provisions, and California Test 125, “Method of Test for Sampling Highway Materials and Products Used in the Roadway Pavement Structure Sections.”
3. Proportioning devices are calibrated to required tolerances.
4. Dynamic testing is complete.

The WMC issues a Material Plant Quality Program sticker, and an approval of certification letter when the following are complete:

1. Plant equipment safety inspection, including Form CEM-4202, “Material Plant Safety Checklist.” Form CEM-4202 is used by Caltrans employees to assess the safety of areas accessed by Caltrans plant inspectors.
2. Type approval of measurement elements, except for continuous conveyor scales and loss-in-weight meters.

3. Type approval of continuous conveyor scales and loss-in-weight meters by the California Department of Agriculture's Division of Measurement Standards (DMS).
4. Type approval of measurement elements outside the DMS area of responsibility by the MPQP coordinator, Caltrans Division of Construction.
5. Device calibration.
6. Dynamic testing of the plant during operation.

The initial approval for continuous and batch-type material production operations of plant process controllers (PPC), weighing and metering systems, and all specialized plant types is provided by the MPQP coordinator from the Caltrans Division of Construction at headquarters.

All site-based equipment testing must be witnessed and approved by the district WMC. Material producers must not produce material for Caltrans projects until they receive an MPQP sticker for the equipment and an approval letter. The letter should be posted in a conspicuous place.

1-1.03. Material Plant Safety

Plant areas accessed by Caltrans material plant inspectors must comply with the applicable safety requirements and regulations administered by these agencies:

1. California Division of Occupational Safety and Health (Cal/OSHA)
2. U.S. Department of Labor Occupational Safety and Health Administration (OSHA)
3. Caltrans

Safety is the responsibility of the material producer. The material producer must verify that hazardous conditions are corrected. Caltrans employees may notify Cal/OSHA if the material producer fails to establish or maintain a safe and healthful workplace.

1-1.04. Frequency

The MPQP plant approval process must be performed when weighing or measuring devices are newly installed, repaired, adjusted, or when the plant is relocated. A resident engineer may request a re-certification or approval at any time on any type of plant.

Batch-type plants must receive approval at least once every 12 months.

Continuous mixing plants, including hot mix asphalt (HMA) plants, HMA plants that incorporate HMA additives or lime treatment, and stand-alone lime treatment plants, must receive approval at least once every 6 months.

Volumetric proportioning plants must be calibrated and tested at an interval specified in contract special provisions, and when ordered by the resident engineer. All plants must be equipped to allow accuracy testing at any time, including before a project's first operation.

1-1.05. Timeline

When possible, the WMC performs plant inspection concurrently with calibration of installed proportioning devices and approval of the material plant. Inspection, device calibration, and plant approval may proceed in any order, but Caltrans intends that initial plant inspection and device calibration be conducted on the first plant visit. Subsequent visits may be needed to verify that deficiencies are corrected.

The material producer must notify the WMC at least 14 days before testing the material plant system or plant controls.

If the dynamic plant testing is not completed before the plant start-up time, the WMC may issue a start-up approval letter that allows material production until dynamic plant testing is completed. The time between the beginning of material production and completion of dynamic plant testing must not exceed 14 days.

1-1.06. Electronic Data

If electronic data is allowed or required, data must be presented in a format specified in the *Standard Specifications*. Captured data for the ingredients represented by each production snapshot must have sufficient fields to satisfy the data requirements. Each data set must be a separate record presenting the specified data on a single line and include data titles at least once in each report. Collected data must be stored by the PPC for the duration of the contract.

Continuous recording occurs when production data is collected electronically at intervals of 1 minute or less.

1-2. Measurement of Quantities

1-2.01. Weighmaster Certificates

1-2.01.01. General

Weighmaster certificates must comply with DMS requirements.

Weighmaster certificates must be provided in printed form with each delivered load. This data may also be submitted as electronic media in accordance with Section 1-1.06, “Electronic Data,” of this manual. Collected data must be stored by the PPC for the duration of the contract.

The weighmaster certificate must show the actual scale weights in pounds or tons for the material loaded. Theoretical or target weights are not allowed and must not be used as a substitute for actual scale weights.

1-2.01.02. Hot Mix Asphalt Weighmaster Certificates

Each load of HMA delivered to the job site must be accompanied by a weighmaster certificate showing:

1. Mix identification number
2. Non-repeating load number
3. Date and time of loading on the hauling vehicle
4. Scale location
5. Weighmaster's name and signature
6. Vehicle identification number

When HMA weighmaster certificates are generated directly from batch weights, these weights must be used for determining pay quantities, provided:

1. Total aggregate, baghouse collected fine aggregate (BCFA), and supplemental fine aggregate weight for each batch is printed. If supplemental fine aggregate is weighed cumulatively with the aggregate, the total batch weight of aggregate must include the supplemental fine aggregate.
2. Total bitumen weight in each batch is printed.
3. Zero tolerance weight, the allowable variation in the weight value of a scale or weighing hopper in an empty condition, is printed before weighing the first batch and after weighing the last batch of each truckload.
4. Each weighmaster certificate is correlated with time, date, mix number, load number, and truck identification.
5. A copy of the recorded batch weights is certified by a licensed weighmaster and submitted to the resident engineer.

1-2.01.03. Concrete Weighmaster Certificates

Each load of concrete delivered to the job site must be accompanied by a weighmaster certificate showing:

1. Mix identification number
2. Non-repeating load number
3. Date and time at which materials were batched
4. Total amount of water added to the load
5. For transit-mixed concrete, the reading of the revolution counter at the time the truck mixer is filled with cement
6. Actual batch weights or measurements for the ingredients batched

The material producer may furnish a weighmaster certificate accompanied by a separate certificate that lists actual batch weights or measurements for a load of concrete. Both certificates must be imprinted with the same non-repeating load number unique to the contract that is delivered to the job site with the load.

Each load of returned plastic concrete (RPC) delivered to the job site must be accompanied by a weighmaster certificate showing:

1. Weight or volume of RPC
2. Type, brand, and dosage of hydration stabilizing admixture
3. Time of adding hydration stabilizing admixture
4. Copy of the original weighmaster certificate for the RPC
5. Temperature of RPC

When requested, submit the hydration stabilizing admixture manufacturer's instructions, including dosage tables.

Theoretical or target batch measurements must not be used as a substitute for actual measurements.

1-2.02. Scales

1-2.02.01. General

Each scale used to determine material payment quantities must be operated by a licensed weighmaster.

Each scale gradation must be no more than 0.001 of the total scale capacity. For each material, use a scale with single gradations not exceeding the maximum permissible weight variation for the given material being weighed.

1-2.02.02. Scale Undersupports

When ingredient scales are an integral part of a material plant, that is, essential or critical to the operation of the plant, the plant proper must meet the requirements for scale undersupports.

Scales used to determine payment or material proportioning must be supported as follows:

1. Small scales: If the total weight of the live and dead weight of the scale structure is 15 tons or less, the undersupports for scale-bearing points must be constructed of structural grade steel with a minimum width of 20 inches and a minimum thickness of 1.5 inches. The total pressure on any one support leg must not exceed 2,000 pounds per square foot (psf) to bearing surfaces. The scale foundation must have a minimum allowable bearing capacity of 2,000 psf at each undersupport. The requirements for large scales may be used for small scales.
2. Large scales: If the total weight of the live and dead weight of the scale is more than 15 tons, the undersupports for scale-bearing points must be constructed of portland cement concrete (PCC) produced from commercial quality aggregates and cementitious material. The portland cement concrete must contain not less than 470 pounds of cementitious material for each cubic yard. The undersupport’s bearing surface must

have a minimum width of 30 inches and a minimum thickness of 16 inches. The total pressure on any undersupport must produce no more than 4,000 psf pressure to bearing surfaces. The scale foundation must have a minimum allowable bearing capacity of 4,000 psf at each undersupport.

3. Drainage: Provide adequate drainage to prevent saturation of scale foundation.
4. Leveling. The scale structure including undersupports must remain level during device calibration and material production. Shimming, if necessary, must be securely attached using metal shims and must not exceed 2 inches.
5. Rigidity: The scale structure including undersupports must not move or deflect during production operations.
6. Wood: The scale structure including undersupports must not include wood.

1-2.02.03. Vehicle Scales

1-2.02.03.01. General

Vehicle scales must permit the entire vehicle, or combination of vehicles, to rest on the scale deck while being weighed. Combination vehicles may be weighed as separate units if they are disconnected while being weighed.

The maximum concentrated load must not exceed the manufacturer's designated section capacity of the scale.

Mechanical indicating elements must be rigidly mounted, level, and plumb on a concrete foundation.

1-2.02.03.02. Tare Weights

Vehicles used to haul material being paid for by weight must be weighed empty. They must be weighed daily or more often as requested by the resident engineer. Each vehicle must bear an identification number. Engineers may request that loaded and unloaded vehicles are to be weighed on other designated scales.

1-2.02.04. Commercial Devices

Weighing, measuring, or metering devices used for determining the quantity of materials to be paid for are "commercial devices." All commercial devices must be sealed by DMS or its designated representative. Commercial devices that are not type-approved by the DMS must be type-approved by the MPQP coordinator from Caltrans' Division of Construction headquarters for non-commercial devices in accordance with this manual using a method suitable to DMS. Contractors or material producers may furnish a commercial device at their own expense or use another sealed scale regularly inspected by the DMS or its designated representative. Volumetric measuring systems may not be used to generate delivery tickets for pay.

Commercial devices must be suitable for the purpose intended and comply with:

1. California Code of Regulations, Title 4, Division 9, “Registration of Service Agencies for Commercial Weighing and Measuring Devices”
2. California Business and Professions Code, Division 5, “Weights and Measures”
3. This manual

1-2.02.05. Non-commercial Devices

Weighing, measuring, or metering devices required by the contract specifications for proportioning materials or products are “non-commercial devices.” Non-commercial devices must be tested and approved in compliance with this manual in the presence of a WMC.

Section 2 —Equipment Requirements for Material Plants

2-1. General

Section 2 specifies equipment requirements for material plants.

2-1.01. Security Seal

Elements of the plant process controller (PPC) that affect accuracy or delivery of data must be available for the application of physical security seals. If the device produces a secure digital record of an adjustment, such as a span number or calibration factor, and this number is recorded in the device controller, the device is considered as being in a sealed condition.

Controllers are inspected, and adjusting elements are sealed before the first production of materials for the contract. The weights and measures coordinator (WMC) furnishes security seals. The resident engineer may order a halt of material production when alteration, disconnection, or manipulation of the security seals occurs. Production must not resume until the device is inspected and resealed by the WMC.

2-1.02. Ingredient Indicators

Indicators for proportioning devices must be in the plant control room. The displayed indications must be clear, definite, accurate, and legible under normal operating conditions. If there is no plant control room, proportioning device displays must be grouped and readable from where proportion operations are controlled.

Ingredient deliveries must be indicated and recorded in pounds, tons, or gallons with decimal subdivisions. The indicator must display rate of flow to show the rate of ingredient delivery. The indicator must be equipped with a resettable totalizer to display ingredient quantity delivered.

The indication for the mass flow, a Coriolis-effect type meter, must be in weight. Volume is not acceptable as measurement for these meters.

Indicators must be fully functional at all production rates. Multiple indicators for the same ingredient must agree to within 0.1 percent when compared directly.

During production, the asphalt binder totalizer must not register when the asphalt metering system is not delivering asphalt to the mixer.

2-1.03. Liquid Ingredient Measurement

A meter is an electromechanical device designed to measure liquid ingredients.

Meters must comply with production proportioning limits and calibration limits of Table A, “Meter Testing Extremes,” in the appendix of this manual.

Meters for determining the quantity of water for concrete batch production, liquid ingredients for volumetrically proportioned materials, and liquid admixture for concrete

mixtures must be either volumetric or mass flow type. Meters for determining the quantities of other liquids and slurries must be of the mass flow, Coriolis-effect type.

The mass flow meter must be of the appropriate size for the intended flow. The transmitter and the indicator for the meter should be located where the proportioning operations are controlled, with a display that indicates the meter set points.

2-1.04. Dry Ingredient Proportioning

Dry ingredients must be proportioned by weight. Ingredients for slurry seal, rapid set concrete, polyester concrete, and cold in-place recycling material may be proportioned by volume. Devices used for measuring dry ingredients by weight must comply with the limits for production, proportioning, and calibration specified in Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes,” in the appendix of this manual.

The conveyor scale must remain in its as-tested location during material production, excluding scales used in cold in-place recycling material plants.

Batch plant proportioning of dry ingredients must use hopper scales. Scale size must be appropriate for the draft amount being used.

Beam scales must not be used for proportioning dry ingredients.

Weighing equipment must be insulated against vibration or movement of other plant equipment.

Material delivery for the refill cycle on loss-in-weight meters must be automatic and an integral part of its control system.

2-1.05. Ingredient Cutoffs

Continuous mixing plants must be equipped with cutoff devices that stop production when any ingredient flow is detected to be outside specified limits.

2-1.06. Operational Tolerances

HMA batch plant operational tolerances for individual ingredient proportioning must comply with Section 2-2.08.02, “Hot Mix Asphalt Batch Tolerances,” of this manual.

Concrete batch plant operational tolerances for individual ingredient proportioning must comply with Section 2-9.03.05, “Concrete Batch Tolerances,” of this manual, and Section 90-1.02F(3), “Proportioning Devices,” of the *Standard Specifications*.

Continuous mixing plant operational tolerances for individual ingredient proportioning are as follows:

1. Conveyor scales must comply with Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes,” in the appendix of this manual.
2. Liquid meters must comply with Table A, “Meter Testing Extremes,” in the appendix.

Refer to Section 39, "Asphalt Concrete," of the *Standard Specifications* for operational tolerances of the HMA aggregate to binder ratio.

2-1.07. Reference Documents

1. Caltrans *Standard Specifications,* edition specified in project special provisions
2. Project special provisions
3. California Test 125, “Method of Test for Sampling Highway Materials and Products Used in the Roadway Pavement Structure Sections”

2-2. Hot Mix Asphalt Plant Equipment

2-2.01. General

HMA must be produced in either a batch plant or a continuous mixing plant. Batch plants must be hot-feed controlled. Continuous mixing plants must be cold-feed controlled. Hot-feed control and cold-feed control indicate the location of aggregate proportioning devices or process control.

Continuous mixing plants may mix ingredients in the dryer drum or by continuous pugmill mixing. Ingredients must be proportioned before mixing them.

HMA ingredients must be proportioned by weight. At the plant, the material producer must provide a separate vehicle scale to verify the weight of the various proportioned amounts.

The plant must have facilities and equipment to monitor or determine moisture content in aggregate, recycled asphalt pavement and HMA in accordance with Section 39-2.02A, “General,” of the *Standard Specifications*.

During production, do not allow use of petroleum-based products, such as diesel fuel or kerosene, to release HMA from plant or hauling equipment.

2-2.02. Ingredient Temperatures

During production, automatic continuous temperature sensing and recording devices must be used to accurately record HMA ingredient temperatures in an electronic format. Continuous recording occurs when production temperature data is collected electronically at a maximum 5-minute intervals.

Temperature sensing devices must be accurate to 5 degrees Fahrenheit increments.

One temperature sensing device must be installed in the asphalt binder feed line. One temperature sensing device must be installed to measure the temperature of material leaving the dryer. Temperature indicators must be installed and maintained at the point where proportioning operations are controlled.

Captured temperature data must include the production location, date, and time of capture, ingredient, or mix temperature and description.

2-2.03. Sampling

The material producer must provide samples of HMA ingredients and HMA mixture, and the samples must represent actual production. Each sampling device and the sampling area must be safe and convenient. If a sample is taken from above ground level, the material plant producer must provide a means for lowering the sample to ground level.

Material sampling must comply with California Test 125 and Section 92-1.01D(3), "Sampling," of the *Standard Specifications*. The material producer must have an inspection dock that allows sampling from the hauling vehicle before it leaves the plant site. When a hauling vehicle is pulled up alongside the dock, the loaded HMA must be accessible. The material producer must instruct hauling vehicle drivers to stop at the dock when inspection personnel are on the dock and to remain there until directed by the person taking the sample.

2-2.04. Asphalt Binder Storage

Asphalt binder for HMA must be stored in tanks that maintain material at the specified temperature. Heating must be effective and controlled. The material producer must not allow the flame used to heat the tank to make contact with the asphalt in the storage tank.

Different grades of asphalt binder must be prevented from mixing while in storage.

2-2.05. Aggregate Drying

Aggregate must be fed directly to a dryer at a uniform rate.

Without exceeding specified maximum HMA temperatures, continue drying until the time of placement so the moisture content of HMA does not exceed 1 percent. Moisture content is determined under AASHTO T 329, "Standard Method of Test for Moisture Content of Asphalt Mixtures by Oven Method."

The plant must have facilities and equipment to monitor moisture in aggregate and HMA. Control moisture content in all dry ingredients not dried before proportioning.

Aggregate moisture content is determined at least once every 2 hours of production. The HMA PPC must adjust for aggregate moisture content in accordance with Section 39-2.02, "Type A Hot Mix Asphalt," of the *Standard Specifications*.

2-2.06. Aggregate Storage

Fine material collected in skimmers, knock-out boxes, and centrifugal collectors may be returned without being measured, or stored separately if all of the following are met:

1. Material is used in its entirety
2. Material is returned at a rate commensurate with the plant's production rate
3. Material is returned at a point preceding the sampling device in batch plants or before mixing in continuous plants

Fine material collected in dust control systems, except centrifugal collectors or knock-out boxes, is supplemental fine aggregate.

Each type of supplemental fine aggregate must be stored, if allowed, separately and kept thoroughly dry.

During storage, the material producer must prevent each size aggregate from intermingling.

If at least 20 percent of aggregate passes the No. 8 sieve, the material producer must feed that portion from storage with a mechanical feeder.

For plants using cold-feed control, each nominal aggregate gradation must be separated into sizes and stored as follows before being fed to the dryer:

1. Aggregate for 1-inch open graded friction course must be separated into at least two sizes and stored separately.
2. Aggregate for 3/4-inch and 1/2-inch HMA Type A, and rubberized hot mix asphalt—gap-graded must be separated into at least three sizes and stored separately.
3. Aggregate for 3/8-inch and 1/4-inch HMA Type A and for 1/2-inch and 3/8-inch open graded friction course must be separated into at least three sizes and stored separately.
4. After aggregate separation, each size must be stored in a separate bin and recombined in compliance with the grading specified in the authorized job mix formula (JMF).
5. The minimum feed rate for each aggregate size must not be less than the aggregate feeder manufacturer's suggested minimum operating rate for equipment being used.

For plants using hot-feed control, dried aggregate must be separated into the same sizes as for cold-feed control and:

1. After hot aggregate is separated, each size must be stored in a separate bin and recombined in compliance with Section 2-2.08, "Batch Mixing Hot Mix Asphalt Plants," of this manual, and the grading specified in the accepted JMF
2. Hot storage bins must prevent overflow into adjacent bins

2-2.07. Baghouse Collected Fine Aggregate

Baghouse collected fine aggregate (BCFA), if returned at a rate other than specified in Section 2-2.06, "Aggregate Storage," of this manual, must be metered into the HMA by weight.

Batch type proportioning must proportion BCFA in a hopper scale that is separate and distinct from scales for other aggregate sizes. The batch scale system must meet the error limits under 2-2.08.02, "Hot Mix Asphalt Batch Tolerances," of this manual.

Continuous type proportioning must meter BCFA by use of a conveyor scale or loss-weight meter. The meter must operate to within the error limits required under Table B, "Conveyor Scale and Loss-in-Weight Meter Testing Extremes," in the appendix of this manual, regardless of meter type chosen.

Fine aggregate used as mix supplement and dry HMA additives must be proportioned in accordance with BCFA.

Any BCFA storage reservoir installed in the dust return system must be located before the meter in the feeder stream. BCFA storage reservoir capacity must not exceed 2 hours of the HMA plant runtime.

The metering device must be mounted in accordance with Section 1-2.02.02, “Scale Undersupports," of this manual.

The material producer must provide sampling equipment in each feed line preceding the metering device to safely sample BCFA in accordance with California Test 125, Appendix A.

2-2.08. Batch Mixing Hot Mix Asphalt Plants

2-2.08.01. General

Batch proportioning must use an automatic plant process controller (PPC). The batch operation must be automatic: The only manual input for a complete batch of HMA is a single switch or starter on the PPC.

Proportioning devices must discharge materials from bins controlled by gates or mechanical conveyors.

Batching devices must be interlocked to prevent a new batch from starting until weigh hoppers are empty, scales are within zero tolerances, and discharge gates are closed. Zero tolerance is defined as the allowable variation in the weight value of a scale or weighing hopper in an empty condition.

Bin withdrawal and weigh hopper discharge must be interlocked to prevent more than one bin from discharging onto the same scale at the same time. The weigh hopper must not trip until the required quantity from each required bin has been deposited.

Automatic proportioning devices must be interlocked to interrupt the weighing cycle when amount of material drawn from storage varies from the preselected amount by more than tolerances specified in Section 2-2.08.02, “Hot Mix Asphalt Batch Tolerances,” of this manual.

Automatic proportioning devices must not use net weighing. The material producer may not use material from another bin to compensate for an out-of-tolerance bin.

When partial batches are proportioned, interlock tolerances must apply to the total aggregate weight in the partial batch. Exception would be for zero tolerance where it applies to the empty condition.

Proportioning device controls for weight increments must be preset at the same time for the batch, before proportioning starts. The controls must be able to change settings without delay and to change the order of discharge from the bins.

Proportioning device controls must be equipped with a means to inspect interlock tolerance settings. Inspection equipment and instructions must be available at the proportioning controller location.

Asphalt binder must be measured by a tank scale.

2-2.08.02. Hot Mix Asphalt Batch Tolerances

Ingredients must be proportioned by weight as follows:

1. The zero tolerance for aggregate scales must be within 0.05 percent of the total batch weight of the aggregate.
2. The zero tolerance for scales weighing supplemental fine aggregate or asphalt binder must be 0.05 percent of the total batch weight of the aggregate.
3. The indicated weight of material drawn from storage must not vary from the preselected scale setting by more than the following percentages of the total draft target:
   a. For aggregate, plus or minus 1.0 percent except if supplemental fine aggregate is used and weighed cumulatively with the aggregate, then the aggregate drawn immediately before the addition of supplemental fine aggregate must not vary more than plus or minus 0.5 percent.
   b. For supplemental fine aggregate weighed separately, plus or minus 0.5 percent
   c. For asphalt binder, plus or minus 0.1 percent

2-2.09. Continuous Mixing Hot Mix Asphalt Plants

All ingredient proportioning must be fully automatic and free of manual intervention.

Continuous mixing plants must use pugmill or dryer-drum mixers. The mixer must discharge into a storage silo that complies with Section 2-2.11, “Hot Mix Asphalt Storage,” of this manual. The material producer must provide a means for diverting HMA away from the silo to prevent poorly mixed HMA from entering the silo.

For continuous mixing plant proportioning:

1. Asphalt binder must enter the mixer through a liquid meter complying with Section 2-1.03, “Liquid Ingredient Measurement,” of this manual.
2. PPC and ingredient metering systems must be capable of varying the binder delivery rate proportionate to delivery of aggregate at all production rates and rate changes.
3. Asphalt binder storage must be equipped with an automatic plant cut-off device that activates when the binder level exposes the pump suction line.
4. BCFA or supplemental fine aggregate must be proportioned by uniformly feeding the material within 1 percent of the specified rate and discharging directly into the mixer.

5. Fine material, collected in the dust control system or added as a supplement, must be proportioned into the mix at a rate complying with the authorized JMF. This fine material must be returned at or before the point at which the asphalt binder is added.
6. Conveyor scales must be used for weighing combined aggregate and recycled asphalt pavement and must comply with Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes,” in the appendix of this manual.
7. Dry ingredient scales, the PPC, and liquid ingredient meters must be interlocked and automatically adjust feed rates for aggregates and binders to maintain the bitumen ratio in the accepted JMF. The plant must not be operated unless this automatic system is operating and in good working condition.
8. The proportioning system must indicate each dry and liquid ingredient’s flow rate and be equipped with a resettable totalizer to determine the total amount of each ingredient in the mixture.
9. Dry ingredient bins, including aggregate, BCFA, HMA additives, and supplemental fine aggregate, must be equipped to prevent material jamming during plant operation.
10. Each belt feeder must have equipment to monitor aggregate depth on the belt. Feeder equipment must automatically shut down the plant when aggregate depth is less than 70 percent of target depth. There may be a delay between the sensing of less than 70 percent of target depth and plant shutdown. Any delay in plant shutdown must be determined at the time of initial MPQP testing.
11. Each belt feeder must have equipment to monitor its aggregate stream beyond the belt or where it will detect revolutions of the idler pulley on the belt feeder. Feeder equipment must automatically stop the plant when ingredient flow has stopped.
12. When continuous mixing plants are in full operation, they must have equipment to sample aggregate in compliance with California Test 125.
13. For BCFA or supplemental fine aggregate metering, the plant must have equipment in each feed line preceding the proportioning device to safely sample fine aggregate.

2-2.10. Hot Mix Asphalt Mixing

The material in a batch mixer, or the feed rate to a continuous mixer must not exceed the amount that permits complete mixing. The material producer must correct areas in the mixer where material does not move or is not sufficiently agitated by making adjustments such as reducing the volume of material. The material discharged must be a homogeneous mix of thoroughly and uniformly coated aggregates. The completed mix must be visible for inspection at the discharge point.

If the material producer uses a batch mixer with hot-feed control, mixing must be in a twin-shaft pugmill. Material in a batch mixer must be mixed for at least 30 seconds in addition to any required dry mixing time.

2-2.11. Hot Mix Asphalt Storage

The material producer may store HMA.

Closed silos must be used if HMA is stored.

During production, the quantity of HMA stored in each silo must be at least 20 tons. The material producer may store less after a plant has been shut down for at least 2 hours.

Each silo must have a visual indicator of quantity stored.

Each silo must be equipped with a surge batcher. Surge batcher must:

1. Be equipment placed at the top of the silo that catches the continuous delivery of HMA, converts the HMA to individual batches, and places these batches into storage.
2. Prevent segregation of the HMA as it is placed into storage.
3. Be independent from conveyors and chutes that collect HMA for discharge into silos.
4. Be the last device to handle HMA before it enters the silo.
5. Be center loading.
6. Prevent material buildup.

The material producer must not use rotary chutes as surge batchers.

For multiple storage silos, each silo must be served by an individual surge batcher.

Material between the highest elevation and subsequent placement in the silo must drop straight down to prevent segregation issues.

The discharge gate on each surge batcher must operate automatically and discharge after no less than 2 tons of HMA is collected. The surge batcher gate must close before the last collected HMA leaves the device. HMA must not deflect during gate opening and closing.

The material producer must not use open graded friction course stored longer than 2 hours or any other HMA stored longer than 18 hours.

The material producer must not use HMA with hardened lumps. If HMA has hardened lumps, the material producer must stop storing in silos that held that material until the cause is corrected.

2-3. Lime-Slurry Treatment of Hot Mix Asphalt Aggregates

2-3.01. General

Lime-slurry treatment of HMA aggregates consists of proportioning water and hydrated dry lime to produce a slurry and then treating HMA aggregates with the slurry in a continuous operation.

2-3.02. Lime Slurry Production

Lime slurry must be produced by either a batch or continuous method.

For the batch method, the material producer must:

1. Proportion dry lime by weight. Weigh dry lime at the slurry production site using a scale appropriate for the lime draft amount used. If the dry lime draft is less than 9 tons, use an automatic batch controller. Automatic batch controllers used for lime-slurry aggregate treatment must comply with Section 2-2.08, “Batch Mixing Hot Mix Asphalt Plants,” of this manual.
2. Use a water meter equipped with a resettable totalizer to measure water that will be used in the slurry.
3. If an automatic controller is used to batch the dry lime, use the automatic controller to also control the water proportioning. The indicated water draft must be within 1.5 percent of its total draft weight.

For the continuous method, the material producer must:

1. Proportion dry lime with a conveyor scale.
2. Use a meter to measure water to be used in the slurry.
3. Interlock the dry lime conveyor scale and the water meter so that dry lime and water feed rates are adjusted automatically at each production rate to maintain the lime-to-water ratio in the authorized JMF. Meters and scales must be equipped with rate-of-flow indicators showing delivery rates of dry lime and water, and with resettable totalizers determining total amounts of dry lime and water introduced into slurry storage tank.

2-3.03. Lime Slurry Storage

Lime slurry must be stored in a central mixing tank equipped with an agitator that both mixes and keeps lime in suspension until it is applied to the aggregate. Agitation must be continuous while the slurry is in storage. Storage must not exceed 24 hours. Agitation must prevent a consolidated lime buildup on the storage tank’s bottom or sides. The storage tank for slurry must be equipped with an automatic level-sensing device that immediately stops slurry and aggregate proportioning when the slurry pump suction line is exposed.

2-3.04. Hot Mix Asphalt Aggregate Treatment

The material producer must use continuous proportioning and mixing for producing lime slurry-treated aggregate. Slurry must be introduced into the mixer with a mass flow, Coriolis-effect type meter. A conveyor scale must be used to proportion aggregate. The proportioning system must be capable of varying the slurry delivery rate proportional to aggregate delivery rate.

The conveyor scale for aggregate and the slurry meter must be interlocked so that feed rates of aggregate and slurry are adjusted automatically at all production rates and rate

changes to maintain the approved lime ratio. The plant must not be operated unless this automatic system operates in good working condition.

The slurry meter and the aggregate feeder must be equipped with devices that determine feed rates while the plant operates. Meters and conveyor scales used for proportioning aggregates and slurry must be equipped with rate-of-flow indicators that show delivery rates of slurry and aggregate. Meters and scales must also have resettable totalizers that determine total amounts of slurry and aggregate introduced into the mixer. The slurry totalizer must not register when the slurry metering system is not delivering material to the mixer.

Lime slurry and aggregate must be mixed in a twin shaft, pugmill type mixer. The mixer must produce a homogeneous mixture of coated aggregates at mixer discharge. When aggregate treatment operation stops for more than one hour, the material producer must clean the treatment operation of partially treated aggregates and lime.

2-3.05. Lime Slurry Treatment Data Log

The aggregate treatment plant PPC must produce an unfiltered electronic log of raw production data consisting of a series of snapshots captured at a maximum of 1-minute intervals throughout the period of daily production. Each snapshot of production data must be a register of production activity at that specific time and not a summation of data over the preceding interval to the previous snapshot. The amount of material represented by each snapshot is the amount produced during the 0.5-minute interval before and the 0.5-minute interval after the capture time. The snapshot must include the following in the order specified:

1. Treatment date
2. Time of day the data is captured
3. Aggregate size being treated
4. Wet aggregate flow rate collected directly from the aggregate conveyor scale
5. Moisture content of the aggregate just before treatment, expressed as a percent of the dry aggregate weight
6. Dry aggregate flow rate calculated from the wet aggregate flow rate
7. Lime slurry flow rate measured by the slurry meter
8. Dry lime flow rate calculated from the slurry meter output
9. Authorized lime ratio for the aggregate size being treated
10. Actual lime ratio calculated from the aggregate conveyor scale and the slurry meter output, expressed as a percent of the dry aggregate weight
11. Calculated difference between the authorized lime ratio and the actual lime ratio
12. Dry lime and water proportions at the slurry treatment time

2-4. Dry Lime Treatment of Hot Mix Asphalt Aggregates

2-4.01. General

Dry lime treatment of HMA aggregates consists of treating aggregates with hydrated lime. Lime may be added to aggregate as a dry ingredient. After treating with lime, the material producer must mix aggregate in a batch plant or a continuous mixing plant.

The dry lime totalizer must not register when the dry lime proportioning device is not delivering material to the mixer.

2-4.02. Dry Lime Treatment with Marination

If treating aggregate with marination is required, the material producer must treat aggregate by individual sizes and transfer them directly from treatment mixer to marination stockpiles.

2-4.03. Continuous Mixing Plants

Before treating, the material producer must combine aggregate in compliance with the accepted JMF. Treated material mixed in continuous mixing plants must meet the following:

1. Hydrated lime must be proportioned by weight. Weight is determined with a conveyor scale.
2. At the time of mixing dry lime and aggregate, aggregate moisture content must be sufficient to assure the complete coating of aggregate with lime. The aggregate moisture content must not cause loss of aggregate between the point of weighing the continuous stream of combined aggregate and the dryer. Add the water needed for mixing and coating aggregate before the point of aggregate weight determination at the conveyor scale.
3. The production controller must capture the weight of blended aggregates after all water has been added to the mixture. Data from the following must be used by the production controller to determine amount of dry lime to be added to the treatment process:
   a. Output from the aggregate conveyor scale
   b. Input from the target dry lime content
   c. Input from the aggregate moisture content
   d. Output from the dry lime conveyor scale
4. Determine aggregate moisture content when aggregate is weighed on the aggregate conveyor scale. This determination must be frequent enough to control the ratio of dry lime to aggregate.
5. If lime-treated aggregate is used in an HMA plant, the plant must be equipped with a baghouse dust system.

6. The conveyor scale for combined aggregate and the dry lime conveyor scales must be interlocked so that feed rates of aggregates and dry lime are adjusted automatically at all production rates and production rate changes to maintain the target lime ratio. The plant must not be operated unless this automatic system is in good working condition.
7. Mix dry lime, aggregates, and water with a twin-shaft, pugmill type continuous mixer. The mixer must produce homogeneous, thoroughly, and uniformly coated aggregates at the mixer discharge. When the aggregate treatment operation stops for more than 1 hour, clean the treatment operation of partially treated aggregates and lime.

2-4.04. Batch Mixing

Lime-treating HMA aggregates at a batch mixing plant must be a continuous operation separate from the HMA plant. The material producer must use a separate controller, a conveyor scale for lime, and a conveyor scale for aggregate.

Lime, moisture control, and proportioning control must be as specified in Section 2-4.03, “Continuous Mixing Plants,” of this manual. When the aggregate treatment operation stops for more than 1 hour, clean the treatment equipment of partially treated aggregates and lime.

The material producer must mix aggregate, lime, and water as specified in Section 2-4.03.

2-4.05. Dry Lime Treatment Data Log

2-4.05.01. Dry Lime On Wet Aggregate Without Marination

During lime proportioning at the HMA plant, the HMA PPC must produce an electronic log of raw production data consisting of a series of snapshots captured at a maximum of 1-minute intervals throughout daily production. Each snapshot of production data must be a register of production activity at that time and not a summation of data over the preceding interval to the previous snapshot. The amount of material represented by each snapshot is the amount produced during the 0.5-minute interval before and the 0.5-minute interval after the capture time. The snapshot must include the following in the order specified:

1. Treatment date
2. Time of day the data is captured
3. Aggregate size being treated
4. HMA type and mix aggregate size
5. Wet aggregate flow rate collected directly from the aggregate conveyor scale
6. Aggregate moisture content expressed as a percent of the dry aggregate weight
7. Dry aggregate flow rate calculated from the wet aggregate flow rate
8. Dry lime flow rate

9. Lime ratio from the authorized JMF for each aggregate size being treated
10. Lime ratio from the authorized JMF for the combined aggregate
11. Actual lime ratio calculated from the aggregate conveyor scale output, the aggregate moisture input, and the dry lime meter output, expressed as a percent of the dry aggregate weight
12. Calculated difference between the authorized lime ratio and the actual lime ratio

2-4.05.02. Dry Lime on Wet Aggregate with Marination

When HMA aggregate is pre-treated at a plant that is separate from the HMA plant, that plant PPC must produce an electronic log of raw production data consisting of a series of snapshots captured at a maximum of 1-minute intervals throughout the period of daily production. Each snapshot of production data must be a register of production activity at that time and not a summation of data over the preceding interval to the previous snapshot. The amount of material represented by each snapshot is the amount produced during the 0.5-minute interval before and the 0.5-minute interval after the capture time. The snapshot must include the following in the order specified:

1. Treatment date
2. Time of day the data is captured
3. Aggregate size being treated
4. Wet aggregate flow rate collected directly from the aggregate conveyor scale
5. Aggregate moisture content expressed as a percentage of the dry aggregate weight
6. Dry aggregate flow rate calculated from the wet aggregate flow rate
7. Dry lime flow rate
8. Lime ratio from the authorized JMF for the aggregate size being treated
9. Lime ratio from the authorized JMF for the combined aggregate
10. Actual lime ratio calculated from the aggregate conveyor scale output, the aggregate moisture input, and the dry lime meter output, expressed as a percentage of the dry aggregate weight
11. Calculated difference between the authorized lime ratio and the actual lime ratio

2-5. Hot Mix Asphalt Additives

2-5.01. General

HMA additives used for antistrip treatment and warm mix asphalt may be either in a liquid or dry state.

The HMA plant must have a sampling device in the feed line connecting the additive storage to the additive metering system. The sampling equipment must comply with Section 2-2.03, “Sampling,” of this manual.

2-5.02. Hot Mix Asphalt Additive Proportioning

All ingredients must be proportioned by weight. The HMA PPC must be the sole source of ingredient proportioning control and must fully monitor all scale and meter measurements in the production process. The material producer must make sure that the HMA PPC uses the HMA additive as an integral ingredient of the HMA mix.

Additive-enhanced HMA must be produced by using either a continuous mixing or a batch type HMA plant.

Liquid ingredient additive, including a normally dry ingredient made liquid, must be proportioned with a mass flow meter at continuous mixing plants. A mass flow meter or a container scale must be used to proportion liquid additives at batch mixing plants.

For a continuous mixing plant:

1. Dry ingredient additives for continuous production must be proportioned with a conveyor scale or a loss-in-weight meter.
2. The HMA PPC, in conjunction with additive ingredient measuring systems, must be capable of varying all ingredient feed rates proportionate with dry aggregate delivery, at all production rates and rate changes.
3. Liquid HMA additive must enter the production stream with the binder. Dry HMA additive must enter the production stream at or before the mixing area.
4. HMA additive must be proportioned to within 0.3 percent of the target additive rate.

For a batch mixing plant:

1. Metered liquid HMA additive must be placed in an intermediate holding vessel before being added to the stream of asphalt binder as it enters the pugmill.
2. When a container scale is used, weigh the additive before combining with asphalt binder. Keep the container scale separate from other ingredient proportioning. The container scale capacity must be no more than twice the volume of the maximum additive batch size. The container scale’s gradations must be smaller than proportioning tolerances or 0.001 times container scale capacity.
3. Dry HMA additive proportioning devices must be separate from metering devices for aggregates and asphalt binder. Proportion dry HMA additive directly into the pugmill or place in an intermediate holding vessel to be added to the pugmill at the appropriate time in the batch cycle. Dry ingredients for batch production must be proportioned with a hopper scale.

4. Zero tolerance for the HMA additive batch scale is plus or minus 0.5 percent of target additive weight. The indicated HMA additive batch scale weight may vary from the preselected weight setting by as much as 1.0 percent of target additive weight.

2-5.03. Hot Mix Asphalt Additive Data Collection

The HMA PPC must produce an unfiltered electronic log of raw production data consisting of a series of snapshots captured at a maximum of 1-minute intervals throughout the period of daily production. Each snapshot of production data must be a register of production activity at that time and not a summation of data over the preceding interval to the previous snapshot. The amount of material represented by each snapshot is the amount produced during the 0.5-minute interval before and the 0.5-minute interval after the capture time. The snapshot must meet data requirements of the *Standard Specifications* as follows:

- Section 39-2.01A(3)(f), “Liquid Antistrip Treatment”
- Section 39-2.01A(3)(g), “Lime Treatment”
- Section 39-2.01A(3)(h), “Warm Mix Asphalt Technology”

Production data must be presented in accordance with Section 1-1.06, “Electronic Data,” of this manual. All collected data must be submitted as electronic media. No handwritten reports or data will be accepted.

2-6. Asphalt Rubber Binder

2-6.01. General

Asphalt rubber binder (ARB) ingredients—asphalt binder, asphalt binder modifier, scrap tire crumb rubber, and high natural rubber—constitute 100 percent of the ARB mixture. The addition of any other ingredients will not be calculated in the mix formula.

2-6.02. Asphalt Rubber Binder Production

The ARB production plant is a stand-alone unit, independent of HMA production plants. HMA mixtures, pavement seals, and other mixtures use the completed ARB mixture as the binder. Perform all ARB proportioning at the ARB production site.

ARB production consists of proportioning:

- Asphalt modifier with paving grade asphalt.
- Scrap tire crumb rubber and high natural crumb rubber.
- The preblended liquids. Combine with the proportioned scrap tire rubber and high natural rubber simultaneously and mix for the specified time at specified temperatures.

When asphalt and asphalt modifier are preblended, the material producer must provide an asphalt heating tank equipped to maintain the blended ingredients at the necessary temperature before blending with dry ingredients.

The method and equipment for combining liquid and dry ingredients must enable the resident engineer to readily determine compliance with proportioning requirements for each material and the completed ARB. The district weights and measures coordinator (WMC) must approve all required equipment before use.

The PPC must assure that combined liquids and combined dry ingredients have been proportioned to within their own ratio limits before proportioning final liquid and dry mixtures for ARB.

The PPC assigns a lot number to each volume of ARB moved from the initial mixing chamber to reaction storage. The product volume represented by each lot must be that amount set aside for the reaction period. Leftovers and portions of lots may be combined and assigned a new non-repeating lot number. Reassigned lots must include all electronic data captured for the previous original lots used to generate the new lot.

Liquid and dry ingredients must be fed directly into the mixer at a uniform rate. ARB must be mechanically mixed to provide for complete blending of liquid and dry ingredients.

ARB must be produced by either a batch or continuous method. Regardless of production method, all ingredients must be proportioned by weight. Liquid ingredients must be proportioned with a meter complying with Section 2-1.03, “Liquid Ingredient Measurement,” of this manual.

For the batch method:

1. The hopper scale system used must include interlocks that prevent filling the hopper while drawing ingredients from the same hopper.
2. The PPC must comply with Section 2-2.08, “Batch Mixing Hot Mix Asphalt Plants,” of this manual. The PPC must proportion all ingredients used in the production of the ARB.
3. The zero tolerance for dry ingredient scales must be 0.5 percent of the total draft being weighed.
4. The indicated weight of material drawn from storage must not vary from the preselected target weight setting by more than 1.0 percent of the total draft target.

For the continuous method:

1. Dry ingredients must be proportioned with a conveyor scale or a loss-weight meter.
2. Continuous proportioning must be fully automatic.
3. An automatic system must proportion total asphalt binder to total rubber to within 0.5 percent of the target rate.

2-6.03. Asphalt Rubber Binder Transportation

During transportation between the ARB production location and the end-use facility, the mixture must comply with all requirements for agitation, temperature control, and data log.

2-6.04. Asphalt Rubber Binder Storage

During the proportioning and blending of liquid ingredients, maintain temperatures of asphalt and asphalt modifier to within 25 degrees Fahrenheit of specified temperature. ARB mixing and temperature control must be continuous from initial ingredient blending until the product end use.

When ARB is produced at a site remote from the end-use plant site, the receiving tank at end-use site must be compliant with all agitation, heating, temperature, and data-reporting requirements.

The material producer must provide a safe sampling device capable of delivering a representative sample of the completed ARB. The device must meet the requirements of California Test 125, “Method of Test for Sampling Highway Materials and Products Used in the Roadway Pavement Structure Sections,” and Section 92-1.01D(3), “Sampling,” of the *Standard Specifications*.

2-6.05. Ingredient and Asphalt Rubber Binder Temperatures

During production, the material producer must use automatic and continuous temperature sensing and recording equipment to control and document ARB and liquid ARB ingredient temperatures accurately. Temperature-sensing devices must be accurate to within 5 degrees Fahrenheit.

Temperature-sensing points must be placed at each liquid feed line where the reaction occurs and at each storage tank for completed ARB.

Temperature indicators must be installed and maintained at the point where the ARB proportioning operation is controlled.

2-6.06. Asphalt Rubber Binder Production Data Log

After lot number designation, correlate all captured data to the lot number. The PPC for ARB production must produce an electronic log of raw production data consisting of a series of snapshots captured at a maximum of 1-minute intervals throughout the period of daily production. Each snapshot of production data must be a register of production activity at the time and not a summation of data over the preceding interval to the previous snapshot. The amount of material represented by each snapshot is the amount produced during the 0.5-minute interval before and the 0.5-minute interval after the capture time.

ARB temperature need not be captured when the product temperature is lower than 370 degrees Fahrenheit.

When ARB proportioning is used, the following data must be captured:

1. Date of production.
2. Production location.
3. Time of day the data is captured.

4. The assigned, non-repeating lot number.
5. The certificate of compliance numbers for dry and liquid ingredients currently used in the production process. Input liquid ingredients' certificate numbers to the nearest 25-ton increment.
6. Viscosity test results including sampling time. Test viscosity in accordance with Section 39-2.03A(4)(e)(ii)(D), "Asphalt Rubber Binder," of the *Standard Specifications*.
7. ARB temperature at each required sensing point.
8. Ratio A—The high natural rubber to scrap tire crumb rubber ratio calculated from metered ingredient output.
9. Ratio B—The asphalt modifier to asphalt ratio calculated from metered ingredient output.
10. Ratio C—The total dry ingredient to total liquid ingredient ratio calculated from metered ingredient output.
11. Total reaction time and the ending reaction time.
12. The HMA additive type and target ARB to HMA additive target ratio.
13. The ARB to HMA additive ratio calculated from individual metered output.

In addition, when a batch type proportioning system is used, capture the following data:

1. Batch weight for each dry ingredient as determined by its scale system
2. Batch weight for each liquid ingredient as determined by its meter

Also, when a continuous-type proportioning system is used, the material producer must capture the rate of flow for each dry and liquid ingredient as determined by its metering system.

2-6.07. Asphalt Rubber Binder Production Data Reports

Make as-collected raw data available to the engineer at all times during production and end use.

The production data report generated from data collected at remote end-use sites must be submitted to the engineer at a maximum interval of once each work week. A remote end-use site is more than 5 miles from the ARB production location.

For production and non-remote end-use sites, the report generated from the production data must be submitted to the engineer daily.

The electronic media must be presented in a comma-separated values format. Captured data for the ingredients represented by production snapshots must have sufficient fields to satisfy the amount of data required and include data titles at least once in each report.

The material producer must collect and hold data for the duration of the contract. All collected data must be submitted as electronic media. No handwritten reports or data will be accepted. See Section 1-1.06, “Electronic Data,” of this manual, for further details.

2-7. Crumb Rubber Modifier for Asphalt Rubber Binder–High Viscosity

2-7.01. General

This section covers all crumb rubber modifier for asphalt rubber binder (CRMB) products while excluding ARBs, which are covered in Section 2-6, “Asphalt Rubber Binder,” of this manual. CRMB ingredients must include asphalt binder and scrap tire crumb rubber, and may include asphalt binder modifier, polymers, and other additives during binder production. All the previously listed ingredients constitute 100 percent of the CRMB blend. The addition of any other ingredient, such as warm mix additive, or antistrip, is considered mathematically outside the CRMB formula.

2-7.02. Crumb Rubber Modifier for Asphalt Rubber Binder Production

The method and equipment for combining all ingredients must enable the resident engineer to readily determine compliance with proportioning requirements for the final product. The WMC must approve all required equipment before use. All proportioning must be performed at a CRMB production site.

The PPC monitors that combined liquids and combined dry ingredients have been proportioned to the requirements of the final product. The PPC must proportion all ingredients used in the production of the CRMB.

The PPC assigns a lot number to each volume of CRMB before it is moved from the processing tank. Multiple lots combined for storage must be assigned a new lot number. Leftovers, portions of lots, or concentrates may be combined and assigned a new non-repeating lot number. Reassigned lots must include all electronic data captured for the previous original lots used to generate the new lot.

CRMB must be mechanically mixed to provide for the complete blending of liquid and dry ingredients.

CRMB must be produced by the batch method. All ingredients must be proportioned by weight. Liquid ingredients must be proportioned with a meter complying with Section 2-1.03, “Liquid Ingredient Measurement,” of this manual.

The hopper scale systems must include interlocks that prevent filling the hoppers while drawing ingredients from the same hoppers.

The material producer’s PPC must comply with Section 2-2.08, “Batch Mixing Hot Mix Asphalt Plants,” of this manual.

Antistrip and warm mix additives cannot be added during the production of CRMB.

2-7.03. Batch Tolerances

1. The zero tolerance for dry ingredient scales must be 0.5 percent of the total draft being weighed.
2. The indicated weight of material drawn from storage must not vary from the preselected target weight setting by more than 1.0 percent of the total draft target.

2-7.04. Crumb Rubber Modifier for Asphalt Rubber Binder Storage

The material producer must provide a safe sampling device capable of delivering a representative sample of the completed CRMB. The device must meet the requirements of California Test 125, “Method of Test for Sampling Highway Materials and Products Used in the Roadway Pavement Structure Sections,” and section 92-1.01D(3), “Sampling,” of the *Standard Specifications*.

2-7.05. Crumb Rubber Modifier for Asphalt Rubber Binder Ingredients

During production, the PPC automatically controls and documents CRMB and CRMB ingredients. Recordings of production data are collected electronically at intervals of 1 minute or less.

2-7.06. Crumb Rubber Modifier for Asphalt Rubber Binder Production Data Log and Report

2-7.06.01. General

After a lot number is designated, all captured data must correlate to the lot number. The PPC for production of CRMB must produce a log of production data consisting of a series of snapshots captured at a maximum of 1-minute intervals throughout the period of daily production. Batch data must be captured at the time of batching. Each snapshot of production data must be a register of production activity at the time and not a summation of the data over the preceding interval to the previous snapshot. The amount of material represented by each snapshot is the amount produced during the 0.5-minute interval before and the 0.5-minute interval after the capture time.

During CRMB production, the following data must be captured:

1. Date of production
2. Production location
3. Time of day the data is captured
4. The assigned, non-repeating lot number
5. The certificate of compliance numbers for crumb rubber used in the production process
6. The total crumb rubber ingredient to the remaining dry and liquid ingredients ratio calculated from metered ingredient output

7. Batch weight for each dry ingredient as determined by its scale system
8. Batch weight for each liquid ingredient as determined by its meter

The material producer must provide the production report to the resident engineer. For each bill of lading, the production report must be submitted on the day of shipment. The production report must include the Caltrans expenditure authorization number, data log, bill of lading number, and lot number.

2-7.06.02. Electronic media

Production data must be presented in accordance with Section 1-1.06, “Electronic Data,” of this manual. All collected data must be submitted as electronic media. No handwritten reports or data will be accepted.

2-8. Volumetric Pavement Seal Plant

2-8.01. General

Bituminous based, volumetrically proportioned materials must comply with Section 37, “Bituminous Seals,” of the *Standard Specifications*, and Section 3-6.02, “Volumetrically Proportioned Pavement Seal Procedures,” of this manual.

The equipment for production and placement of slurry seal and micro-surfacing must proportion asphaltic emulsion, water, aggregate, and any set-control additives by volume and mix them in continuous pugmill mixers. Continuous pugmill mixers must be of adequate size and power for the type of materials to be mixed. The plant must be truck mounted.

2-8.02. Volumetric Pavement Seal Plant

Volumetric pavement seal plants must have:

1. Covered rotating and reciprocating equipment with metal guards.
2. A belt feeder with an adjustable cutoff gate to proportion aggregate. The engineer verifies the height of the gate opening.
3. A belt feeder with a depth monitor device. The depth monitor device must automatically stop the belt feeder when the aggregate depth is less than 70 percent of the target depth.
4. A separate no-flow monitoring device that detects the revolutions of the belt feeder. This device must automatically stop the belt feeder when revolution detection is lost. If the belt feeder is an integral part of the equipment's drive chain, the no-flow monitor device is not required.
5. An aggregate belt feeder that is connected directly to the drive on the emulsion pump. The aggregate feeder drive shaft must have a revolution counter reading to the nearest 0.10 revolution.

6. Emulsion storage that is equipped with a device that automatically stops the emulsion pump and aggregate belt feeder when the level of stored emulsion is lowered to the suction level. To allow for normal fluctuations, there may be a delay of 1 second between detection of low emulsion storage levels or low aggregate depths and automatic power shut down.
7. Emulsion stored immediately before the emulsion pump.
8. An emulsion storage tank with a temperature indicator at the pump suction level. The indicator must be accurate to plus or minus 5 degrees Fahrenheit.

2-8.03. Continuous Self-Loading Plant

Continuous self-loading plants must be automatically sequenced and self-propelled. The mixing machine must deliver each material to a double shafted mixer and discharge the mixed material on a continuous flow basis. The plant must have sufficient storage capacity to maintain a continuous supply of material to the proportioning controls. The plant operator must have full control of forward and reverse speeds during placement independent of material delivery vehicles.

2-9. Concrete Plant Equipment

2-9.01. General

Concrete must be produced in either a batch plant or a volumetric mixing plant.

Concrete must comply with Section 90, “Concrete” of the *Standard Specifications*.

2-9.02. Storage of Aggregates

Aggregates must be stored or stockpiled in accordance with Section 90-1.02F(2), “Storage of Aggregates,” of the *Standard Specifications*.

Store or stockpile aggregates separately to prevent the coarse and fine particles of each size from mixing before proportioning.

Prevent intermingling of different aggregate sizes by using measures such as physical separation of stockpiles or construction of bulkheads of adequate length and height. Prevent contamination of the aggregates by contact with the ground through measures such as placing aggregates on wooden platforms or on concrete, asphalt concrete, or cement-treated material.

When placing the aggregates in storage or moving the aggregates from storage to the weigh hopper of the batching plant, do not use methods that cause segregation, degradation, or mixing of materials of different gradations, or excessive particle breakage.

Material must not be reintroduced from plant dust collectors into cementitious material storage.

2-9.03. Proportioning

Proportioning of concrete must meet requirements of 90-1.02F(4), “Proportioning,” of the *Standard Specifications*.

2-9.03.01. General

Proportioning consists of combining measured aggregates, cementitious material, admixtures, returned plastic concrete (RPC) if used, and water.

Dry ingredients must be proportioned by weight.

RPC must be proportioned by weight or by volume.

Liquid ingredients must be proportioned by weight or by volume.

2-9.03.02. Ingredient Flow

At the time of batching:

1. Aggregates must be dried and drained to a stable moisture content to prevent visible separation of water from aggregate during transportation from the proportioning plant to point of mixing.
2. Free moisture content of fine aggregate must not exceed 8 percent of its saturated, surface-dry weight.

If the proportioning plant has separate supplies of the same size group of aggregate with different moisture content, specific gravity, or surface characteristics affecting workability, one supply must be exhausted before using a different supply.

Bulk type portland-pozzolana cement or portland-slag cement with moderate sulphate resistance must be weighed in an individual hopper.

Bulk cement and supplemental cementitious materials (SCM) may be weighed in separate weigh hoppers or in the same weigh hopper. Cement and SCM must be kept separate from aggregates until the ingredients are released for discharge into the mixer. Cement and SCM must be discharged into the mixer simultaneously with the aggregate.

If cement and SCM are weighed in the same weigh hopper, the cement must be weighed first. If cement and SCM are weighed in separate weigh hoppers, the weigh systems for proportioning aggregate, cement, and SCM must be separate from all other weigh systems.

To constitute a separate material-weighing device, each weigh system must have a hopper, a lever or load cell system, and an indicator.

If concrete is mixed completely in a stationary mixer, SCM must be weighed in a separate weigh hopper and introduced with cement simultaneously into the mixer proportionately with aggregate. If the material producer submits certification that the stationary mixer is capable of mixing cement, SCM, aggregates, and water uniformly before discharge, the material producer may weigh SCM cumulatively with cement. Certification must include:

1. Test results for 2 compressive strength test cylinders taken within the first 1/3, and 2 compressive strength test cylinders taken within the last 1/3, of a single batch of concrete discharged from the stationary mixer. Compressive strength tests and cylinder preparation must comply with Section 90-1.01D(5), “Compressive Strength,” of the *Standard Specifications*.
2. Calculations demonstrating that the average of the 2 compressive strengths taken within the first 1/3 of the batch do not differ by more than 7.5 percent from the average of the 2 compressive strengths taken within the last 1/3 of the batch.
3. Mixer rotation speed and time of mixing before discharge that are required to produce a mix that complies with the preceding requirements.

Discharge gates on the cement and SCM weigh hoppers or the cement plus SCM weigh hopper must allow the regulation of the flow of cement, SCM, or cement plus SCM into the aggregate.

If separate weigh hoppers are used for each aggregate size, discharge gates must allow regulation of the flow of each aggregate size. If a separate weigh hopper is used for each aggregate size, all weigh hoppers may be operated and discharged simultaneously.

Gates or mechanical conveyors must control the discharge of the material from each storage bin.

For batches of 1 cubic yard or more, aggregate batching equipment must comply with one of the following combinations:

1. Separate hopper, separate scale and indicator for weighing each aggregate size
2. Single hopper and scale indicator for weighing all aggregates
3. Single hopper scale or separate hopper scales and automatic weighing mechanism for all aggregates

If the material producer is asked to check the accuracy of batch weights, determine gross weight and tare weight of batch trucks, truck mixers, truck agitators, and non-agitating hauling equipment. This equipment must be weighed using scales designated by the engineer.

2-9.03.03. Proportioning Devices

Proportioning devices must discharge materials from storage bins controlled by gates or mechanical conveyors.

The material producer may not use material from another bin to compensate for an out-of-tolerance bin.

When partial batches are proportioned, interlock tolerances, except the zero tolerance, must apply to the total weight in the partial batch.

Weighing equipment must be insulated against vibration or movement from other plant equipment.

2-9.03.04. Automatic Proportioning

Proportioning for concrete must use a PPC. The PPC must be automatic to the extent that the only manual input for a complete batch is a single switch or starter.

Any PPC used must be compliant with requirements for an automatic PPC.

Automatic proportioning devices must not use net weighing.

The PPC must allow all required proportions to be input into the device at the same time before proportioning starts. The PPC must change settings without delay and change the order of discharge from storage bins.

The storage bin withdrawal and weigh hopper discharge must be interlocked to prevent more than one storage bin from discharging onto the same scale at the same time. The weigh hopper must not be tripped until the required quantity from each required bin has been deposited.

The PPC must be interlocked to interrupt the weighing cycle when the amount of material drawn from storage varies from the preselected amount by more than tolerances specified in Section 2-9.03.05, “Concrete Batch Tolerances,” of this manual. If the weighing cycle is interrupted, do not use that batch unless it can be manually adjusted to comply with specified tolerances.

Proportioning device controls must be equipped with a means to inspect the interlock tolerance settings. Inspection equipment and instructions must be available at the PPC location.

The process of batching all ingredients if the volume of the batch is greater than 1 cubic yard must be interlocked so that:

1. A new batch cannot start until all weigh hoppers are empty
2. Proportioning devices are within zero tolerance
3. Discharge gates are closed

When ingredients are weighed cumulatively, their charging mechanisms must be interlocked to prevent introduction of the next ingredient until the weight of the initial ingredient in the weigh hopper is within tolerances specified in Section 2-9.03.05, “Concrete Batch Tolerances,” of this manual.

Plants must have facilities and equipment to monitor moisture in aggregates. Moisture content must be controlled in all aggregates before and during proportioning.

For proportioning pavement concrete, an electronically actuated moisture meter that detects moisture content of fine aggregate as it is batched to within a sensitivity of 0.5 percent by weight of fine aggregate must be installed and maintained in good operating

condition. The PPC must adjust aggregate target batch weights to reflect moisture meter determinations.

2-9.03.05. Concrete Batch Tolerances

Concrete proportioning tolerances are described in Section 90-1.02F(3), “Proportioning Devices,” of the *Standard Specifications*.

The weighing and measuring equipment must have the following zero tolerances:

1. For cumulative weighing of aggregates, plus or minus 0.5 percent of the designated total aggregate batch weight
2. For weighing each aggregate size separately, plus or minus 0.5 percent of the designated batch weight for each aggregate size
3. For cumulative weighing of cement and supplemental cementitious materials (SCM), plus or minus 0.5 percent of the designated total batch weight of the cement and SCM
4. For weighing cement and SCM separately, plus or minus 0.5 percent of their designated individual batch weights
5. For measuring water, plus or minus 0.5 percent of its designated weight or volume

The indicated weight of material drawn from storage must not vary from the weight designated by the engineer by more than:

1. Aggregate weighed cumulatively must be within plus or minus 1.0 percent of the designated total aggregate batch weight.
2. Aggregates weighed separately must be within plus or minus 1.5 percent of the designated batch weight of each aggregate.
3. Cement and SCM weighed cumulatively or separately must be no more than 2 percent and no less than 1 percent of their designated individual or combined batch weights.
4. Water must be within plus or minus 1.5 percent of the designated weight or volume of water.
5. Liquid admixtures must be within plus or minus 5 percent of the designated weight or volume of the individual admixture batch.

2-9.03.06. Proportioning and Dispensing Liquid Admixtures

Proportioning and dispensing liquid admixtures must meet requirements of Section 90-1.02F(4)(b), “Proportioning and Dispensing Liquid Admixtures,” of the *Standard Specifications*. Equipment must include:

1. Capacity sufficient to measure at one time the total quantity of admixture required for each batch of concrete.

2. A scaled measuring unit that is accurate to within plus or minus 5 percent of the required quantity for each batch of concrete.
3. Locations that allow for accurate reading from proportioning operation controls and a visual check of batching accuracy before discharge.
4. Measuring units that are clearly marked for the type and quantity of admixture.

Each liquid admixture dispensing system must be equipped with a sampling device consisting of a valve in a safe and readily accessible position to enable the engineer to slowly withdraw a test sample.

If more than one liquid admixture is used in the concrete mix, each admixture must have a separate measuring unit and must be dispensed by injecting equipment placed so that admixtures are not combined in high concentrations and do not interfere with the effectiveness of each other.

Air-entraining admixtures must be dispensed before other liquid admixtures, unless the material producer demonstrates that a different sequence improves performance.

If a PPC is used, liquid admixture dispensers must operate automatically with the batching control equipment.

If the quantity of admixture measured varies from the preselected dosage by more than 5 percent or if the entire contents of the measuring unit are not emptied into the mix, the concrete batch operation must be stopped until corrections can be made.

Liquid admixtures must be added to premeasured batch water or discharged into the stream of water to assure that they are well dispersed throughout the batch.

The material producer may dispense air-entraining admixtures directly into moist sand in the batching bins if the material producer maintains adequate control of the concrete air content.

2-9.03.07. Precast Proportioning Systems

Precast concrete plants are considered non-commercial. Precast proportioning systems must be in accordance with Section 2-9.03, “Proportioning,” and 3-2.03, “Proportioning System Calibration and Approval,” of this manual, except:

- A decumulative weighing scale system may be used for precast proportioning operations if the total volume of the batch is 2.0 cubic yards or less. This proportioning operation must produce a net weight that is a true measure of the start-stop weight differential in this type of scale system.
- The decumulative weighing operation must include a PPC. The decumulative weighing system does not use a zero-load indication and is not subject to zero interlock tolerance requirements.

- Cementitious material must not be proportioned with a decumulative weighing scale system.
- Ingredient storage in any individual decumulative weighing system must not exceed 64,000 pounds.

2-9.04. Returned Plastic Concrete Proportioning

Proportioning concrete containing RPC consists of combining measured aggregates, cementitious materials, admixtures, RPC, and water.

Dry ingredients must be proportioned by weight.

RPC must be proportioned by weight or by volume.

Liquid ingredients must be proportioned by weight or by volume.

For volumetric proportioning:

1. The volumetric container must be imprinted with manufacturer's name, model number, serial number, the as-calibrated volume, and date of the last calibration. Cross-sectional dimensions of the container must remain the same as those during its calibration.
2. The device must be re-calibrated at least every 6 months, or if the container shape has been deformed from its as-calibrated condition, or there is evidence of material buildup inside the device.
3. The device must remain level during filling. Fill the device to the measure or strike-off line. Each measurement must be filled to within 1.0 percent of the device's as-calibrated volume.
4. The device's interior must be cleaned after each measurement to maintain a zero tolerance.

For weight proportioning:

1. RPC must be proportioned with a weigh hopper or vehicle scale.
2. The weigh hopper must be attached to the plant at a position that allows the addition of the RPC to the mixer with the conventional concrete ingredients. The PPC must control the proportioning of RPC to within 1.0 percent of its target weight.
3. If a vehicle scale is used to weigh RPC, transit mixers must have a daily tare weight. Tare weight is taken when transit mixer fuel and water tanks are full, and the driver and all items that are not a part of the vehicle are unloaded. The whole vehicle must be on the vehicle scale. Axle weights are not allowed. Transit mixer returning with RPC must be topped off with fuel and water before reweigh. Net weight of RPC is captured and added to new batch to get the new total weight of concrete containing RPC.
4. Transit mixers must be equipped with sight glass or gauges that show the level of liquid reservoirs. Accuracy of these devices must be within 1.0 percent.

2-9.05. Volumetrically Proportioned Concrete

Volumetric proportioning of concrete must meet requirements of Section 90-3.02B, "Volumetric Proportioning," of the *Standard Specifications*.

2-9.05.01. General

Rapid strength concrete may be produced using volumetric proportioning.

Equipment for production of volumetrically proportioned concrete (VPC) must proportion cementitious material, water, aggregate, and any admixture used and mix them in a continuous auger mixer. This combination of components is the production plant and will be truck- or trailer-mounted.

2-9.05.02. Proportioning

The PPC must proportion cement and aggregate by volume. Water and additives may be proportioned by volume or weight.

Aggregate must be proportioned using a belt feeder that is operated with an adjustable cutoff gate calibrated to the nearest quarter increment. The gate opening height must be readily determinable. Aggregates must be proportioned at rate accuracies in accordance with Section 3-6.01, "Volumetrically Proportioned Concrete Procedures," of this manual.

The PPC used for VPC production must comply with the following:

1. The aggregate feed conveyor must be interlocked with the cement vane feeder. The cement feed rate must be tied directly to the feed rate for aggregate, water, and additives.
2. The ratio of cement to aggregate must only be changed by adjusting the gate opening for each aggregate feed.
3. The aggregate feeder drive shaft with a revolution counter reading must be equipped to the nearest 0.1 revolution of the aggregate delivery belt.
4. The PPC indicators must be in working order before starting proportioning or mixing and must be visible to a person standing near the volumetric mixer.

Cement must be proportioned by use of a vane feeder at rate accuracies in accordance with Section 3-6.01. of this manual.

Water must be proportioned with a meter in accordance with Section 2-1.03, "Liquid Ingredient Measurement," of this manual. The water meter with rate-of-flow indicators must be equipped to show delivery rate and a resettable totalizer to determine the total water introduced into the mixture. The totalizer must not register when the water metering system is not delivering water to the mix.

Liquid admixtures must be proportioned in accordance with Section 2-9.03.06, "Proportioning and Dispensing Liquid Admixtures," of this manual.

2-9.05.03. Volumetrically Proportioned Concrete Data Collection

The PPC used for rapid strength concrete production must produce a log of raw production data consisting of a series of snapshots captured at a maximum of 15-minute intervals throughout the period of daily production. Each snapshot of production data must be a register of production activity at the time and not a summation of the data over the preceding interval to previous snapshot. The amount of material represented by each snapshot is the amount produced during the 7.5-minute interval before and the 7.5-minute interval after the capture time. The snapshot must include the following in the order specified:

1. Date of production
2. Production location
3. Time of day the data is captured
4. Name of producer
5. Specific type of concrete being produced
6. Source of the individual aggregate sizes
7. Source, brand, and type of cement
8. Source, brand, and type of individual admixtures
9. Volumetric mixer identification
10. Production start and stop times
11. Weight of cement per revolution count
12. Weight of each aggregate size per revolution count
13. Gate openings for each aggregate size
14. Weight of water added to the concrete per revolution count
15. Moisture content of each aggregate size
16. Individual volume of admixtures per revolution count

Production data must be presented in accordance with Section 1-1.06, “Electronic Data,” of this manual. All collected data must be submitted as electronic media. No handwritten reports or data will be accepted.

2-9.05.04. Volumetrically Proportioned Concrete Equipment

VPC must be mixed in a mechanically operated mixer. The material producer may use an auger-type mixer. The mixer must be of adequate size and power for the materials being mixed. The mixer must be operated uniformly at the mixing speed recommended by the manufacturer. The material producer must not use a mixer that has an accumulation of hard concrete or mortar.

The material producer must not use equipment with components made of aluminum or magnesium alloys that could have contact with plastic concrete during mixing or transporting of RSC.

Rotating and reciprocating equipment must be covered on volumetric mixers with metal guards.

Identifying numbers of VPC plants must be at least 3 inches in height and must be located on the front and rear of the vehicle.

Each mixer must have metal plates that state designed usage, manufacturer's guaranteed mixed concrete volumetric capacity, and recommended rotation speed.

Cement storage must be located immediately before the cement vane feeder. The PPC must be equipped to automatically shut down power to cement feeder and aggregate belt feeder if either cement or aggregate storage level is less than 10 percent of its total volume.

2-9.06. Volumetric Polyester Concrete

Polyester concrete consists of polyester resin binder and aggregate.

A continuous mixer must be used to mix polyester concrete. The continuous mixer must:

1. Employ an auger screw device with a discharge chute
2. Be equipped with an automatic metering device that measures and records aggregate and resin volumes
3. Have a visible readout gauge that displays volumes of aggregate and resin being recorded
4. Produce a satisfactory mix consistently
5. Be able to record polyester concrete volume at least every 5 minutes, including time and date

The weight of the resin must be approximately 12 percent of the weight of the aggregate.

2-10. Cement Treated Bases

Cement treated bases must comply with Section 27, “Cement Treated Bases,” of the *Standard Specifications*.

2-11. Concrete Bases

Concrete bases must comply with Section 28, “Concrete Bases,” of the *Standard Specifications*.

Section 3 — Material Plant Calibration and Dynamic Testing

3-1. Scope

This section consists of procedures to test, calibrate, and approve proportioning devices, including material plant scales and meters, used in the material plants.

3-2. Testing and Approving Weighing and Measuring Devices

3-2.01. General

Inspect each device or procedure specified for material production that may affect mix quality. Use a plant checklist for the plant type in question. The MPQP coordinator at the Division of Construction provides standardized inspection checklists.

Multiple calibration-set failures must be limited. Three calibration-set failures, on the same device, during the same shift is an indication that the equipment is not ready. Testing may be rescheduled to when the plant or equipment is fully functional.

3-2.02. Dynamic Testing

3-2.02.01. General

Dynamic testing evaluates plant functionality during production and is an integral part of the MPQP. Dynamic testing must be performed before approval of the equipment's accuracy.

3-2.02.02. Dynamic Testing of Batch Plants

Dynamic testing of batch plant proportioning devices includes:

1. Interlocks—Review individual batch weights to ascertain batch controller performance for interlock tolerances. The controller must batch within specified zero tolerances and draft cutoff tolerances for the product being produced. Zero tolerance is defined as the allowable variation in the weight value of a scale or weighing hopper in an empty condition.
2. Material Leakage—Material leakage that would alter measurement accuracy must not occur. The "weight inspect" feature of the batch controller must stop the batch process long enough to see if material is leaking from gates.
3. Batch Ingredient Ratio, Hot Mix Asphalt (HMA)—Actual batch weights are used to calculate ingredient ratios. The batch controller must be programmed to deliver the correct binder ratio.
4. Batch Ingredient Ratio, Concrete—Recorded batch data are used to calculate the ingredient ratios. These ingredient ratios must be within specified tolerances.
5. Batch Lockout—During an interval of 30 minutes or more, observe and note the percentage of batches in which one or more drafts are outside the specified zero or

cutoff tolerances. Specifications do not allow the approval of a batched ingredient draft that is out of tolerance. It may be corrected by removing or adding material.

6. Device Functionality—During mix production, note the functionality of the following:
   - Temperature-sensing devices
   - Silo cutoffs
   - Weighmaster-certificate generation
   - Surge batchers
   - Waste-mix handling
   - Moisture meters
   - Cold-feed control
7. Weighmaster Certificates—Review the printing of ingredient batch weights on the mix weighmaster certificates. The actual as-batched ingredient weights must be printed on the weighmaster certificates as specified. Design or theoretical weights are not acceptable as batch weights.
8. Aggregate Moistures—Check that aggregate moistures are being calculated as a percentage of the dry aggregate.

3-2.02.03. Dynamic Testing of Continuous Mixing Plants

Dynamic testing of continuous mixing plant proportioning devices includes:

1. Continuous Ingredient Ratio—During plant operation at the planned production rates, the plant process controller (PPC) must maintain the correct ingredient ratios. Observe the rate and total for the aggregate being used, and compare it with the rate and total for the binder. The time needed to check the PPC functionality differs depending on the plant production rate, but the minimum timed test must be 10 minutes. Incorrect ingredient ratios indicate a need for a recalibration of individual proportioning devices or a problem with PPC blending capabilities.
2. Moisture Correction—Determine whether the aggregate moisture system is functioning properly. If there is a separate indication of wet aggregate delivery, compare it to dry aggregate delivery displayed on the PPC. Discrepancies on multiple moisture systems must be corrected.
3. Multiple Indication—If similar ingredients have multiple indicators, verify that multiple indicators are within specifications. Discrepancies on multiple indicators for the same material delivery must be corrected.
4. Material Leakage—Ingredient leakage must not occur during measurement. Material leakage is determined by visual inspection. Material leakage is detrimental to continuous proportioning accuracy.

5. Device Functionality—During mix production, note the functionality of the following:
   - Temperature sensing device
   - Silo cutoffs
   - Weighmaster-certificate generation
   - Surge batchers
   - Waste-mix handling
   - Low-flow and no-flow interlocks
   - Material mixing
   - Mix handling
   - Moisture control
   - Cold-feed control

3-2.03. Proportioning System Calibration and Approval

Perform a pre-test inspection of weighing and measuring system and controls as follows:

1. Note and record model number, serial number, and manufacturer's name.
2. Determine whether device, system, or control has been either type-approved for commercial use in California in accordance with the requirements of the Division of Measurement Standards (DMS) or tested and type-approved previously by the Caltrans Division of Construction for non-commercial use.
3. Do not perform the MPQP certification inspection if the device, system, or control is not currently type-approved.
4. Ascertain whether the indicating and recording elements are compatible with their intended use and are located appropriately.
5. Make a visual inspection of the device's details. Any faulty condition affecting the plant functionality that can be detected visually must be corrected before continuing with the MPQP inspection.

3-2.04. General Device Testing

The MPQP inspection is completed by checking fixed points such as intermediate points during a buildup test or corner loading on a batch weigh hopper. The total test load or throughput must be at least equal to the intended operating capacity.

If a PPC batching system with remote indicators is used, these remote indicators become the primary indicators.

Commercial class test weights and volumetric liquid provers must comply with California state standards and be certified by an authorized representative of the DMS. These

standards must comply with the specifications and tolerances for commercial standards established by the National Institute of Standards and Technology.

The material producer must provide the access, modifications, special equipment, and labor necessary to perform the inspection and testing. The material producer must submit an MPQP certification request to the district weights and measures coordinator (WMC). This request is filed in the district that performs the MPQP certification. The WMC will complete Form CEM-4202, “Material Plant Safety Checklist,” and notify the material producer of any deficiencies. The WMC witnesses the testing, including scale error testing, before issuing a certification.

Upon witnessing acceptable accuracy of the device, the WMC seals adjusting elements to assure accuracy of the measuring device.

Interlock settings must be tested for accuracy.

Written manufacturer’s operating instructions must be available at the control panel of each automatic batching or use automatic and continuous mixing control system. These instructions must contain the procedure for checking interlock tolerance settings and a means for determining span-adjustment settings for computerized controls. If automatic controllers are used, instructions must contain a detailed procedure for setting controller parameters that comply with Caltrans specifications.

A build-up test complying with Section 3-3.04, “Device Testing and Calibration,” of this manual, may be used in conjunction with test weights to check a hopper scale or vehicle scale’s high range. When a build-up test is required, the material producer must obtain the WMC’s approval before testing of the intended build-up test method to be used.

Attachments to the scale or meter that are necessary for material production must be attached during weighing system accuracy testing.

Once the WMC determines that the system is in compliance with requirements and after successful completion of dynamic testing, an MPQP approval sticker will be affixed to each proportioning device found to be accurate.

3-3. Procedure for Hopper Scales

3-3.01. General

Observe the testing and calibration of the scale-mounted tanks used to weigh liquids in compliance with specifications for scale-mounted hoppers used to weigh dry ingredients.

3-3.02. Inspection

Inspect scale for compliance with Section 3-2, “Testing and Approving Weighing and Measuring Devices,” of this manual.

Inspect the weigh system load cells. In multiple load-cell applications, load cells must be of the same capacity on the same device. Load-cell capacities must be appropriate for their intended use.

3-3.03. Testing Equipment

At least 25 percent of the scale capacity must be supplied in DMS-certified test weights.

If automatic batch controllers are used, the material producer must provide an electronic load-cell simulator for controller interlock testing. The load-cell simulator must have a range and sensitivity compatible with the device being tested.

3-3.04. Device Testing and Calibration

3-3.04.01. General

Check indication oscillations. The maximum oscillation is plus or minus two scale gradations.

The zero-load balance is set after the scale testing equipment is installed.

For dial mechanical indicators:

1. Observe that the dial is locked and the locking mechanism is released. The indicator must return to zero, even if the action is repeated.
2. Observe that the dial is locked and the hopper or tank is shaken. After releasing the locking mechanism, the indicator must return to zero.

3-3.04.02. Buildup Test

The material producer must provide an acceptable means of a build-up test or substituting other weight if there are not enough test weights available to hang the required test amount.

For hopper scales, the build-up method replaces a portion of the test weight with aggregate, substituted weights, or another product used during production. The build-up method consists of:

1. Hanging available test weights to at least one-fourth of the scale's operational capacity and calibrating the scale system to this known weight.
2. Removing the known weight and replacing it with a weight of material in the hopper equal to but not in excess of test load of known weight.
3. Adding the known weight again to the built-up weight. Repeat as necessary to attain capacity. The total build-up weight may not exceed three times the known weight.

3-3.05. Report and Security Seal

After a successful test of proportioning devices, the recorded span adjustment settings will be made available to the contractor, plant inspector, and the resident engineer. The WMC applies security seals in accordance with Section 2-1.01, “Security Seal,” of this manual.

3-4. Procedures for Liquid Metering

3-4.01. General

If the liquid meter system includes a separate, stand-alone controller, this controller must be the only controller used for liquid meter testing and calibration. The calibration procedure must be separate from the main PPC’s calibration procedure. After the successful testing of the separate, stand-alone controller, the main PPC must be adjusted to exactly track the calibrated, stand-alone controller.

If the meter does not self-calibrate, the main PPC must be used for liquid meter testing and calibration.

The meter manufacturer’s name and model number must be on the device identification plates. For multiple-part meters, this identification must be on the meter proper and the meter transmitter. A copy of the DMS-type approval must be submitted to the WMC with the meter.

The liquid meter must comply with Section 2-1.03, “Liquid Ingredient Measurement,” and Section 3-2, “Testing and Approving Weighing and Measuring Devices,” of this manual.

A mass flow meter is a device that measures the flow of liquids by weight. This device records and indicates the weight of liquid passing through it without input of the liquid’s temperature or specific gravity.

A volume meter measures liquid volumetrically. The device records and indicates the volume of liquid throughput. This measurement must be manually converted to weight and may require the input of the liquid’s temperature and specific gravity.

3-4.02. Inspection

Inspect the meter installations for proper connections and conditions before the accuracy tests are performed. The meter installation must comply with meter manufacturer’s instructions, a copy of which must be furnished to the WMC.

3-4.03. Testing Equipment and Provisions

3-4.03.01. General

Liquid meters are tested at the material production site under normal operating and environmental conditions. Reschedule the testing if weather conditions cause the witness scale indicator to fluctuate more than three gradations.

The metering systems at HMA plants must be operated in the circulate mode for at least 15 minutes just before testing and calibration to heat and fill the system.

Test drafts must be weighed on a witness scale at the proportioning plant. Witness scale error testing must be performed with test weights complying with Section 3-2.04, “General Device Testing,” of this manual and must produce a witness scale within two gradations of the test weight load.

For the calibration procedure, the material producer must provide a suitable container capable of receiving the full flow of material delivered from the meter for the size of required test draft. Meter installation must be plumbed to allow diversion of the test draft to a container. The meter system must not leak calibration liquid or air. If testing material is lost during the calibration run between the liquid storage and test weight determination on the witness scale, cancel testing until the leak is corrected. Any physical or electronic change of the meter system requires a restart of the calibration procedures.

Product flow rates used during device testing must be commensurate with anticipated production flow rates. Specifications for minimum test draft size, witness scale capacity, and witness scale gradations must comply with Table A, “Meter Testing Extremes” in the appendix.

The device plumbing must allow the WMC to clearly ascertain that none of the liquid passing through the meter during calibration is diverted before entering the test draft container.

3-4.03.02. Tank Scales

Some plant configurations include a scale-mounted tank for calibration. This tank may be used as the witness scale if it meets the specifications in Table A, “Meter Testing Extremes,” in the appendix, and specifications for witness scales and calibration containers in this manual.

3-4.03.03. Provers

A prover is a calibrated vessel with test draft capacity as specified in Table A, “Meter Testing Extremes,” in the appendix. Provers must comply with DMS specifications. The prover must remain level throughout the test run.

3-4.03.04. Volumetric Container for Returned Plastic Concrete

Observe the calibration of the container used for volumetric measurements with water. The water temperature must be in the range of 40 to 80 degrees Fahrenheit, with a target temperature of 60 degrees Fahrenheit during container calibration. The container must be free of leaks. One cubic foot of water weighs 62.4 pounds. The material producer must:

1. Furnish a witness scale with a capacity of 110 to 150 percent of the combined weight of the container and the water. Witness scale gradation must be no more than 0.001 of the total scale capacity.

2. Keep the container level during testing.
3. Zero the witness scale. Tare the container on the witness scale, fill with water, and reweigh.

The as-calibrated volume of the container will be the average result of 3 calibration runs. Individual calibration results that exceed the average by 1 percent are not acceptable.

3-4.04. Device Testing and Calibration

3-4.04.01. General

A rate meter is a digital display of the speed of operation in units such as tons per hour or gallons per minute. A totalizer is a digital display of the amount in units such as tons or gallons delivered at any time. Compare the rate indication with totalizer's indication for an interval of at least one minute. Time the interval with a stopwatch.

Before starting meter calibration, calibration liquid is sent through the system to bring the calibration path to an as-used condition. The system is left at the same degree of "empty" for all test runs. This exercise will make sure the meter system is in the same condition for all test runs. The totalizer is reset to zero and calibration container is re-tared before the start of each calibration test run.

Hoses, ropes, and other paraphernalia on or hanging from the calibration container may affect weighing accuracy of the test draft. If fill hoses are left attached to the calibration container during weighing process, the witness scale may require error testing again after hoses have been softened by hot asphalt.

Record the meter's span number for each test in the series. A span number is a number assigned to the measure of adjustment of the control device. Each series of tests consists of at least three runs. Each calibration run size must comply with Table A, "Meter Testing Extremes," in the appendix. Calibration flow rates must be commensurate with flow rates anticipated during production.

If the liquid is used in an HMA mixture, calculate the asphalt binder flow rate as the ratio of asphalt binder content from the proposed job-mix formula to the aggregates flow rate. In the case of lime-slurry treatment of HMA aggregates, ratio of lime slurry to aggregate is calculated. Read the meter totalizer with the indicator at rest. Totalizer readings must not be made while the meter is operating. The meter totalizer indicator must start from or return to zero and must not advance its indications before material delivery.

At the individual test run's end, as indicated by the process controller, log amount measured by the meter, value from meter totalizer, or weight delivered. Compare meter indication for the measured liquid for any individual test run with the weight determined by weighing the measured liquid on the witness scale. Make determinations of accuracy by comparing metered results with actual results from the witness scale.

Calculate error with the formula E equals A minus M, where E is the error for the run, A is the actual weight of liquid as determined on the witness scale, and M is the weight of the liquid as determined by the meter.

Determine the percentage error with the formula: The error percent equals E divided by A, times 100.

Average error for the device is the combined percentage error for three sequential runs divided by three. If the metering device is adjusted before completion of three calibration runs, the test must be started over. Error limits must comply with Table A, “Meter Testing Extremes,” in the appendix.

3-4.04.02. Large Draft Option

The material producer may use a large draft calibration test. The minimum test draft must be 8,500 pounds, or 1,000 gallons. The large draft option requires a vehicle scale located at the proportioning plant as the calibration witness scale. Error-test the vehicle scale with test weights in accordance with Table A of the appendix. The smallest gradation of the vehicle scale’s indicator must not be greater than 0.01 tons.

3-4.04.03. Medium Draft Option

If the witness scale has a maximum capacity of 5,000 pounds and a maximum gradation of 1 pound, the material producer may choose to use a 2,500-pound, or 300-gallon, test draft instead of the 8,500-pound, or 1,000-gallon, test draft required in Table A of the appendix.

3-4.04.04. Buildup Method

A buildup method may be used to error-test the witness scale capacity in excess of 25 percent of its operational limit. Error testing must produce a witness scale that is accurate to within two gradations of test weight load. A newly error-tested witness scale does not have to be re-tested for 7 days if it remains isolated from uses outside of the device calibration.

3-5. Procedure for Conveyor Scales or Loss-in-Weight Meters

3-5.01. General

Type approval by DMS is not required for conveyor scales.

This procedure applies to all conveyor scale installations.

3-5.02. Inspection

Identify the manufacturer’s name and model number on the model identification plate.

Weighbridge and conveyor must be protected at the weighbridge from wind and weather.

Scale manufacturer's instructions must be used during installation. The material producer must submit a copy of the instructions to the WMC.

The conveyor's incline must be positioned to prevent material slippage along the conveyor during operation.

Undersupports for conveyor scale-bearing points or loss-in-weight meters must comply with Section 1-2.02.02, "Scale Undersupports," of this manual

3-5.03. Test Equipment and Provisions

The conveyor scale is tested at the material production site under normal operating and environmental conditions. Reschedule testing if weather conditions cause the witness scale indicator to fluctuate more than three gradations.

Calibration procedures are restarted for any physical change of conveyor scale. Changes that trigger retesting the device include any of the following:

- Conveyor component or conveyor scale component is changed, adjusted, or altered
- Conveyor incline angle is changed
- Physical location of the conveyor scale is changed

If the conveyor has been idle for 2 hours or longer, the conveyor must be run in an empty mode for not less than 25 minutes before the start of testing.

For the calibration procedure, the material producer must provide a suitable container capable of receiving the full flow of material being delivered from the conveyor scale. This calibration container must be readily portable.

If testing material leaks or is lost during calibration run at any place between the weighbridge and determining the test weight on the witness scale, cancel testing until any leaks are corrected. Material must not be lost to the atmosphere during the testing procedure.

The material producer must designate a maximum production speed for the device being tested. The successfully tested calibration speeds become the production speed limits. The low and intermediate testing ranges, as applied to the maximum production speed, must comply with Table B, "Conveyor Scale and Loss-in-Weight Meter Testing Extremes," in the appendix.

3-5.04. Device Testing and Calibration

For calibration, either pre-weighing or post-weighing of testing material is used on the witness scale. When a pre-weighed test load is passed over the conveyor scale, examine the conveyor-loading hopper before and after the test to verify that all the material used for calibration check actually passed over the conveyor scale. It may be necessary to process calibration material through the system to bring the calibration path to an as-used condition.

When bringing the path to an as-used condition, the system must be run to the same degree of “empty” for each test run.

Before starting the calibration procedure, the material producer must conduct a zero-load test and calibrate conveyor scale to manufacturer’s recommendations. The material producer must set a zero-load condition with the conveyor in motion and with all necessary attachments for normal operation in place. If creep is present, the scale must be self-compensating with positive and negative adjustments within the timeframe of the test run.

The calibration medium must be the same type of material to be used in production.

The plant must be equipped to make an accuracy check before a project’s first operation and when the resident engineer directs. The witness scale must be located at the plant and must comply with Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes,” in the appendix. The witness scale must be error-tested with test loads of known weight. The material producer may use a buildup method to check scale capacity in excess of 25 percent of its operational limit. Error testing must produce a witness scale accurate to within two gradations of its calibration test weight including any buildup weight. A newly error-tested witness scale does not have to be re-tested for a period of seven days if it remains isolated from uses outside device calibration.

A PPC-controlled production plant normally displays digitally the input settings for the numerical security seal, or span number. The plant manufacturer must supply instructions for how to display and calibrate the adjusting element span numbers. The Division of Construction is responsible for accepting each proportioning system and supplying inspection instructions. If adjusting elements do not produce a span number, the device must be secured by the WMC, who places a physical security seal on the device. Refer to Section 2-1.01, “Security Seal,” of this manual.

If the conveyor scale system includes a separate, stand-alone controller, it must be the only controller used for conveyor scale’s testing and calibration. The calibration procedure must be separate from the main PPC. After successful testing of the separate, stand-alone device, the main PPC must be adjusted to exactly track the calibrated proportioning device. If conveyor scale is not supplied with means of self-calibration, the main PPC is used for conveyor scale testing and calibration.

If material-production rate exceeds 400 tons per hour, the material producer may perform a high-speed calibration consisting of two, 2-minute runs for each calibration rate greater than 400 tons per hour. If the average error for each pair of runs exceeds 1.0 percent, a slower calibration test should be run. Use the average high-speed error as the high-speed result.

Record the span-adjustment setting. Note that the conveyor scale’s totalizer must be zeroed before each test run. The test flow of calibration material is diverted into the calibration container at each of the designated rates. Each series of tests must consist of at least three runs using the rates required in Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes” in the appendix. Determine the tare weight of the calibration

container at the start of each test run. If any material is lost during the test run, start the test run over.

Divide the difference between the metered weight accumulated on the conveyor scale totalizer and the actual weight indicated on witness scale when calibration container is weighed by actual weight to determine the percentage error for the calibration run. The average percentage error for the three test runs is the sum of deviations of the three individual test runs divided by three. If the device is adjusted before completion of three sequential calibration runs, the test must be restarted. Device error must be within the limits expressed in Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes” in the appendix.

3-5.05. Loss-in-Weight Metering Systems

The loss-in-weight meter testing must also comply with requirements of Table B, “Conveyor Scale and Loss-in-Weight Meter Testing Extremes,” in the appendix and must:

1. Include at least one complete system re-fill cycle during each calibration test run.
2. Operate the device in a normal run mode for 10 minutes immediately before starting calibration process.
3. Isolate the scale-system, within the loss-in-weight meter feeder, from surrounding vibration.
4. Check the scale-system, within the loss-in-weight meter feeder, for accuracy before and after the calibration process and daily during mix production.

3-6. Procedures for Volumetric Proportioning Plants

3-6.01. Volumetrically Proportioned Concrete Procedures

3-6.01.01. General

Volumetrically proportioned concrete (VPC) plants proportion aggregate and cement by volume. The VPC plant is mobile and placed at the job site. The delivery rates of aggregate and cement per revolution of the aggregate feeder must be calibrated at appropriate gate settings for each batch mixer truck used and for each ingredient source. Calibration results are adjusted for the aggregate moisture content.

Determine that VPC equipment complies with applicable specifications before calibrations are started.

3-6.01.02. Testing Equipment and Provisions

The cutoff gate must be calibrated for each volumetric mixer used and for each aggregate source. Each aggregate feeder must be calibrated at 3 aggregate gate settings that

correspond to production needs. At least 2 calibration runs are performed for each aggregate feeder gate setting.

Individual aggregate delivery rate check runs must not vary by more than 1.0 percent from the mathematical average of sequential runs for the same gate and aggregate type. Each test run must be at least 1,000 pounds.

Individual cement delivery rate test results must not vary by more than 1.0 percent from the mathematical average of 3 sequential runs of at least 1,000 pounds each.

The procedure in Section 3-4., “Procedures for Liquid Metering,” of this manual, is used for water meter accuracy test runs. Table A, “Meter Testing Extremes,” in the appendix is used for testing limitations. The water meter must be equipped with a resettable totalizer and must display the operating rate.

Calibration tests must be conducted for aggregate, cement, and water proportioning devices using a platform scale at the calibration site. Platform scales for weighing test-run calibration material must have a maximum capacity of 5,000 pounds with maximum gradations of 1 pound. The material producer must furnish a witness scale that is accurate to within 2 gradations of test weight load. The witness scale and equipment needed for calibration of proportioning systems must remain available at the production site throughout production period.

The VPC plant must be equipped so that accuracy checks may be made. After production starts, the proportioning devices must be recalibrated at least every 90 calendar days for pavement work, 90 calendar days for structure work, or when the material plant producer changes the source or type of any ingredient. Refer to the contract special provisions for possible variation in calibration frequency.

3-6.02. Volumetrically Proportioned Pavement Seal Procedures

3-6.02.01. General

Slurry seal mixer-spreader trucks proportion aggregate and emulsion by volume. The delivery rates of aggregate and emulsion per revolution of the aggregate feeder must be calibrated at appropriate gate settings for each mixer-spreader truck used and for each aggregate source before the first slurry seal production and at least once every six months during production.

Verify that mixer-spreader trucks comply with requirements of Section 37, “Bituminous Seals,” of the *Standard Specifications*, this manual, and all applicable special provisions. Rotating and reciprocating equipment on mixer-spreader trucks must be covered with metal guards. Be very careful around mixer spreader trucks, which are constantly moving.

3-6.02.02. Testing Equipment and Provisions

Calibration tests for ingredient proportioning devices must be conducted with an error-tested vehicle scale. This witness scale must be within 3 miles of the aggregate stockpile.

The material producer must equip the mixer-spreader truck for the accuracy check.

Ingredient indicators must be in working order before beginning proportioning and mixing operations, and they must be visible to someone standing near the mixer-spreader truck.

3-6.02.03. Device Testing and Calibration

For aggregate conveyor rate determinations:

1. A loaded truck is pre-weighed, and at least 3 tons of aggregate from truck mounted hopper is run over the belt and through pugmill. Register the number of counts on the aggregate belt-feeder revolution counter. Determine number of dry pounds of aggregate delivered to pugmill per unit of the aggregate belt-feeder revolution counter.
2. The truck is re-weighed after the test run. Divide net weight change by the revolutions counted and reduce the results by the moisture content of the aggregate to obtain a dry pound of aggregate per revolution.
3. Continue this operation for three sequential runs at the approximate gate setting to be used during the production of slurry seal. These three test runs must not deviate from their combined mathematical average by more than 2.0 percent.
4. After using the previous procedure to establish belt-feeder delivery rate consistency, the material producer must run two more runs.
5. An alternate aggregate calibration option is to capture material leaving the mixer-spreader truck, without loss, and deposit it into a container.

For emulsion pump rate determination:

1. The witness scale is used as setup for an aggregate test.
2. A mixer-spreader truck is weighed, emptied of aggregate, and loaded with emulsion. At least 500 gallons from the truck-mounted emulsion storage are run through the emulsion pump, and into a separate tank. The aggregate belt-feeder must run in an empty mode to make the aggregate belt-feeder revolution counter functional. Register the number of counts on the counter.
3. The mixer-spreader truck is re-weighed after a test run. Divide net weight change by revolutions counted, and adjust results for temperature correction to obtain a corrected pounds of emulsion per unit of the aggregate belt-feeder revolution counter. Hot ingredients must be reduced to a baseline temperature of 60 degrees Fahrenheit for the purpose of converting to mass. The conversion factors for asphalts can be found in Section 94, “Asphaltic Emulsions” of the *Standard Specifications*. The temperature of the liquid must be constant during individual test runs in order to permit conversion of the baseline temperature. When a mass-flow, Coriolis-effect meter is used, no specific gravity and no conversion will be needed.
4. Complete three sequential runs at the approximate emulsion rate to be used during the production of slurry seal. None of these three runs must deviate from their combined

mathematical average by more than 2.0 percent. The average of the results produced by these three test drafts will be used for the emulsion pump rate determination for use in operational calculations.

5. If the material producer elects to use a variable rate emulsion pump, the test is continued with the following procedure: After using the initial three test drafts to establish emulsion pump delivery consistency, the material producer must run two more runs.
6. The emulsion pump and all plumbing must be free of leaks.

Appendix

Calibration and Production Error Limits

Table A—Meter Testing Extremes

Meter Size	Size Designation	Minimum Test Draft, lbs	Witness Scale Maximums, lbs		Maximum Individual Error (See Note 1), %	
			Capacity	Gradation	Asphalt, Liquid Antistrip Lime Slurry, Epoxy, HMA & Concrete Admixtures	Water
< 0.50 inches	Very Small	50	100	0.1	±0.5	±1.5
0.51 - 0.99 inches	Small	200	500	0.5	±0.5	±1.5
> 1 inch	Medium	2,500	5,000	1.0	±0.5	±1.5
> 1.50 inches	Large (See Note 2)	8,500	80,000	20.0	±0.5	±1.5

Note 1: Meters used for proportioning at continuous mixing HMA plants and lime-slurry treatment plants must be accurate to within 0.5 percent of the test load for an average of three test runs, and no individual test run error may exceed 1.0 percent of the test load.

Note 2: Refer to Large Draft Option and Medium Draft Option of Section 3-4.04. “Device Testing and Calibration,” of this manual.

Table B—Conveyor Scale and Loss-in-Weight Meter Testing Extremes

Product	Item (See Note 6)	Maximum Error, %		Test Size Minimum	Witness Scale Maximums		
		Avg.	Indiv.		Capacity	Gradation, lbs	Approx. Operational Testing Range
Aggregate, HMA	agg, dust	1.00 1.00	2.00 2.00	3 min. (See Note 1) 15 min.	40 tons 5,000 lbs. (See Note 2)	20 1.0	(See Note 3)
Lime, Marinate	agg	1.00	2.00	3 min. (See Note 1)	40 tons	20	(See Note 5)
	lime	1.00	2.00	1,000 lbs.	5,000 lbs. (See Note 2)	1.0	(See Note 3)
Lime, Dry	agg	1.00	2.00	3 min. (See Note 1)	40 tons	20	(See Note 5)
	lime	1.00	2.00	1,000 lbs.	5,000 lbs. (See Note 2)	1.0	(See Note 3)
All Other	less than 100 tph	1.00	2.00	3 min. (See Note 1)	40 tons	20	(See Note 3)
	5-100 tph	1.00	2.00	1,000 lbs.	5,000 lbs. (See Note 2)	1.0	(See Note 3)
	Greater than 5 tph	1.00	2.00	(See Note 4)	500 lbs. (See Note 2)	0.1	(See Note 3)

Note 1: Use a 3-minute or longer calibration run unless calibration rate exceeds 400 tons per hour (tph).

Note 2: The witness scale size for baghouse collected fine aggregate will depend on the amount of material delivered during the 15-minute test run.

Note 3: Material producer designates the maximum rate in accordance with Section 3-5.03., “Test Equipment and Provisions,” of this manual. The low rate must be less than or equal to 30 percent of the maximum rate. The mid-rate must be approximately 60 percent of the maximum rate.

Note 4: 15-minute or 250-pound minimum test run size.

Note 5: Material producer designates the maximum rate in accordance with Section 3-5.03. The low rate must be less than or equal to 40 percent of the maximum rate. The mid-rate must be approximately 70 percent of the maximum rate.

Note 6: agg is aggregate and tph is tons per hour abbreviated.