DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
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METHOD FOR TESTING OF MATERIAL PRODUCTION PLANTS

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this test method, testers are required to read Section F, "**SAFETY AND HEALTH**" in Parts 2, 3, 4, 5A, 5B and Part 6 "Material Plant Safety Inspection" of this test method and Part 11 of California Test 125. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

The procedures used for testing and approving material production plants and the proportioning devices used in the plants are described in this method. This method is divided into the following parts:

1. General Procedure for Testing and Approving Weighing and Measuring Devices
2. Test Procedure for Hopper Scales
3. Test Procedure for Liquid Metering
4. Test Procedure for Conveyor Scales
5. Test Procedure for Volumetric Proportioning Plants
6. Material Plant Safety Inspection

PART 1 - GENERAL PROCEDURE FOR TESTING AND APPROVING WEIGHING AND MEASURING DEVICES

A. GENERAL

The purpose of this test method is the approval by Caltrans personnel of material plants supplying construction materials to Caltrans projects. The duty of the Caltrans Weights and Measures Coordinator (WMC), within the context of this test method, is to oversee the implementation of the testing and inspection of material production plants. It is not the responsibility of the Caltrans person to direct the contractor's operation or to operate any of the controllers or proportioning devices connected with material production.

The inspection of the plant for conformance with the requirements of the contract specifications may be performed concurrently with the calibration of installed proportioning devices and, ultimately, the approval of the material plant. This work may proceed in any order, but it is envisioned that initial plant inspection and device calibration will be conducted on the first plant visit and subsequent visits may be needed to finalize the approval of those items found deficient initially.

B. PLANT INSPECTION

Perform a complete inspection of the plant. All devices and procedures required by Caltrans specifications, for the production of the material in question, shall be in place and in full working condition before the completion of this California Test (CT) 109.

Testing for CT 109 shall not be complete until all material plant equipment and devices have met the requirements of the Standard Specifications, Contract Special Provisions, and CT 125. Attention is also directed to Section 7-1.06, "Safety and Health Provisions" of the Standard Specifications.

If the dynamic testing of the material plant is not completed on the initial plant site visit, the contractor shall notify the WMC, no less than 10 calendar days in advance of production startup, for the completion of the dynamic testing of plant facilities. If the dynamic testing has not been completed before the as-notified plant start up time, the WMC may issue a "Start-up Approval" letter to allow the beginning of material production until such time as the dynamic testing can be completed. The time between actual production start up and completion of dynamic plant testing shall not exceed 14 calendar days. The WMC will extend the time for dynamic testing when the delay is due to Caltrans scheduling. The test acceptance sticker CP-CEM-0017, or equivalent, shall only be issued upon the satisfactory completion of the plant dynamic testing, proportioning device testing, and the plant inspection.

A dynamic test shall be performed before acceptance of the equipment's accuracy.

1. Dynamic testing of batch type plant proportioning devices shall include the following:

    a. Interlocks - Review individual batch masses to ascertain the performance of the batch controller in regards to interlock tolerances. The controller must batch within the tolerances allowed by the specifications for zero tolerances and draft cutoff tolerances for the product being produced. For more information on the procedure of checking the viability of batch controller interlock functions, refer to the Weights and Measures Handbook.

    b. Material Leakage - No ingredient leakage shall occur that would alter the accuracy at the point of measurement. Material leakage is determined by visual inspection by holding a batch mass for a short time and see if the indicated mass is changing. The "weight inspect" feature of the batch controller will stop the batch process long enough to see if material is leaking from the gates.

    c. Ingredient Ratio - For asphalt concrete (AC), batch masses are to produce a mixture where the binder content is a percent of the dry aggregate not a percent of the total mix. The batch controller shall be programmed to deliver the correct binder ratio.

    d. Batch Lockout - During an extended interval, 45 min or more, observe and note the percent of batches in which one or more drafts are outside of the specified zero or cutoff tolerances. Specifications do not allow the acceptance of any batched ingredient draft that is out of tolerance unless corrected by removing or adding material. A well-adjusted batch plant should have no more than 5 % of the drafts in an out-of-tolerance condition.

    e. Device Functionality - During mix production, note the functionality of thermometers, silo cutoffs, load ticket generation, surge batchers, wasted mix handling, moisture meters and cold feed control.

f. Delivery Tickets - Review the printing of ingredient batch masses on the portland cement concrete (PCC) delivery ticket. The actual, as batched, PCC masses are to be printed on the delivery ticket as required by specification. Where AC delivery tickets are generated from batch masses, refer to Section 39-8.01, "Measurement," of the Standard Specifications for a list of requirements for this type of operation. Refer to the Weights and Measures Handbook for more data on delivery tickets.

2. Dynamic testing of continuous mixing type plant proportioning devices shall include the following:

   a. Ingredient Ratio - While the plant is operating at the planned production rates, see that the plant controller is maintaining 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 (asphalt, lime, cement, etc). The length of time used to check the functionality of plant controller will differ depending on the production rate of the plant in question, but a timed test of at least 10 min will be needed. A significant difference here would indicate a need for recalibration of individual proportioning devices or a problem with the blending capabilities of the plant controller. Resettable totalizers for individual ingredients are required by the specifications for the material being produced.

   b. Specific Gravity - Where applicable, ensure that the correct specific gravity for the binder being used has been input into the plant controller. The specific gravity reported by the refinery will have to be verified by the Transportation Laboratory (TransLab) testing.

   c. Moisture Correction - Ascertain whether the aggregate moisture system is functioning properly. Where there is a separate indication of wet aggregate delivery, compare this to the dry aggregate delivery as displayed on the plant controller. Where there is no separate display of wet aggregate usage during an aggregate only check-run, change the input aggregate moisture by a nominal amount (say 3 %) and note the appropriate change to the indicated aggregate delivery rate. Moisture is computed as a percent of the dry aggregate, refer to CT 226 or CT 370, and Standard Specifications Section 39-3.02, "Drying."

   d. Multiple Indication - Where there are multiple indicators for like ingredients see that the multiple indications are within specifications. Refer to specifications for continuous mixing material production for the maximum allowable difference for like indicators. Errors displayed on like indicators, multiple indication for the same material delivery, is an indication of mismanagement of the proportioning process.

   e. Material leakage – No ingredient leakage shall occur after the point of measurement. Material leakage is determined by visual inspection. Material leakage and, conversely, material storage after the point of measurement are detrimental to continuous proportioning accuracy.

   f. Device Functionality - During mix production note the functionality of all required devices and procedures. These items include, but are not limited to, the following: thermometers, silo cutoffs, load ticket generation, surge batchers, wasted mix handling, low-flow and no-flow interlocks, material mixing, mix handling, moisture control and cold feed control.

3. Dynamic Testing of Volumetric Proportioning Systems

   a. Observe the production process while using the as calibrated ingredient delivery rates.

   b. The required follow-up and spot testing is adequate for the dynamic testing of the rapid strength concrete. (See Part 5A, Section C2 of this test method.)

4. Review all items used for material production, as identified in the specifications that may affect mix quality. This will include all areas where Caltrans specifications require a device or procedure. Areas of the plant site where Caltrans personnel frequent shall be inspected for adherence to CAL-OSHA requirements. Use a plant checklist for the specific plant type in question. Check with the WMC at the Caltrans Headquarter Division of Construction (HQ Construction) for checklist availability.

C. PROPORTIONING SYSTEMS CALIBRATION AND APPROVAL

Perform a pre-test inspection of the weighing and measuring system and controls.

1. Identification: Note and record manufacturer's name, model number and serial number.

2. Approval: Determine whether the device, system or control has been either type-approved for commercial use in the State of California in accordance with the requirements of the California Department of Agriculture, Division of Measurement Standards (DMS), or has been tested and approved previously by Caltrans HQ Construction. An approved list of weighing and measuring devices, system and controls, including AC continuous mixing plants, will be maintained by HQ Construction.

   If the device, system or control is not included in the current list, CT 109 should not be performed. The manufacturer of the device must request either type-approval by the DMS if a commercial use is intended, or set a date for a Caltrans inspection for approval through HQ Construction if the device, system, or control is to be used non-commercially.

   NOTE 1: Refer to the Weights and Measures Handbook for a discussion of commercial/non-commercial devices and the role of the DMS.

3. Ascertain whether the indicating and recording elements are compatible with their intended use and are located properly.

4. Make a visual inspection of the device's details; i.e., levers horizontal and free from binds, linkages and connectors hanging plumb, counter-masses free from other moving parts and secured from random movement, knife edges and pivot points clean and free from binds, badly worn or otherwise defective parts. Any faulty condition affecting the plant functionality that can be detected visually shall be corrected before continuing with CT 109.

D. DEVICE TESTING

A test shall be performed upon each newly installed, repaired or relocated weighing or measuring device, or when any elements of the device have been adjusted. All weighing, measuring and plant-control systems used on batch type plants must be tested for accuracy at least once a year or upon each repair or moving of the plant to a new location. Continuous mixing plants, including AC, liquid antistrip and lime treatment, must be tested for accuracy at least once every six months or upon each repair or moving of the plant to a new location. Volumetric proportioning plants shall be tested at an interval as required by the appropriate project special provision. In any case, any device shall be tested as often as deemed necessary by the Engineer.

The test is completed by checking other fixed points, such as intermediate points during a build-up test or corner loading on a batch weigh hopper. At the option of the Engineer, certain of the above steps may be eliminated. The total test load shall be at least equal to the intended operating capacity.

If an automatic batching system with remote indicators is used, these remote indicators become the primary indicators.

Commercial class test masses shall be compared to California State Standards and certified by an authorized representative of the DMS. These standards shall conform to the specifications and tolerances for commercial standards as established by National Institute of Standards and Technology (NIST). The frequency of comparison shall conform to the current DMS field reference manual.

The contractor shall be responsible for providing access, all modifications, special equipment and labor necessary to perform the inspection and testing. The contractor shall notify the Engineer at least 24 hrs in advance of testing the device, system or controls. The Engineer or WMC will witness the testing, including witness scale error testing, and record the necessary information on Form CEM-0014, or equivalent. A copy of the CEM-0014, or equivalent, is to be sent to HQ Construction immediately. Another copy is to be furnished to the contractor and Resident Engineer. The Engineer will affix a CEM-0017, or equivalent, (departmental sticker) on each proportioning device found to be accurate by the testing and after successfully completing the dynamic testing and plant inspections. The CEM-0014, or equivalent, record sheet should contain the time required to perform the testing.

The Engineer will seal all adjusting elements that change the measuring device's accuracy upon witnessing acceptable accuracy of the device. Any time these seals are broken, without the Engineer's witnessing that there has been no change in the adjusting elements, the measuring device shall be retested for accuracy and resealed after being found accurate. Refer to Standard Specifications Section 9-1.01, paragraph 4, "Measurement of Quantities." The owner of the device is responsible for providing the means to seal the device.

All interlock settings shall be tested for accuracy. Refer to the Weights and Measures Handbook for more information on the testing of interlock tolerances. There shall be a manufacturer's manual of operating instructions available at the control panel of each automatic batching or continuous mixing control system. This manual shall contain the procedure for checking interlock-tolerance settings and means of determining span-adjustment settings for computerized controls. Where automatic controllers are used, the manual shall contain a detailed procedure of how to set controller parameters that meet Caltrans specifications. A detailed listing of items to be included in the manufacturer's operating manual is in the Weights and Measures Handbook.

A build-up test may be used in conjunction with test masses to check a weigh batcher or vehicle scale's high range. When a buildup test is required to complete the check, the contractor shall notify the Engineer sufficiently in advance to obtain approval of the build-up method intended to be used.

NOTE 2: See Build-up Test, Part 3.

All attachments to the scale that are necessary for material production shall be attached during the test of the weighing system's accuracy.

PART 2 - TEST PROCEDURE FOR HOPPER SCALES

A. GENERAL

Scale mounted tanks used to weigh liquid products shall be tested and calibrated as required for scale mounted hoppers in this CT 109.

B. INSPECTION

1. Inspect the scale in accordance with the requirements of Part 1. Beam scales shall not be used for batch operations.

2. Inspect the load cells installed in the weigh system. In multiple load cell applications, the load cells shall be of the same value on the same device. Load cell values shall be of appropriate value for the intended use.

C. TESTING EQUIPMENT AND PROVISIONS

1. Test masses, certified as per this CT 109, in an amount needed to satisfy the scale capacity shall be available.

2. An electronic load cell simulator, where automatic batch controllers are in use, shall be supplied by the contractor. This device facilitates the rapid inspection and testing of the zero and cutoff tolerances required of these controllers. The load cell simulator shall have the range and sensitivity to suit the parameters of the device being tested.

D. DEVICE TESTING AND CALIBRATION

1. Check oscillations of indicator (where applicable). Oscillations in the indication shall not exceed two scale graduations.

2. Set the zero-load balance after all equipment needed for the scale testing has been installed on the scale.

3. At dial type mechanical indicators:

   a. Lock the dial. Release locking mechanism; indicator should return to zero. Repeat procedure several times.

   b. Lock the dial and shake the hopper or tank.

   c. Release locking mechanism; indicator should return to the starting point.

4. Corner and section test. Inspect the scale system, including levers, load cells, bearing points and hoppers. Correct any adverse condition that could affect the device's accuracy (such as damaged or altered parts or altered factory adjusted settings). Where the hopper or tank can be loaded off center a corner and section test shall be made.

   To accomplish a corner or section test, a test load equal to 25 % of the scale's capacity shall be concentrated at each of the main bearing points and 50 % of the scale's capacity on a main section.

5. Apply test loads at 25 %, 50 %, 75 % and full capacity.

   a. Record the mass indicated at each loading and note the amount of error in mass and graduations. The maximum allowable error shall be two scale graduations.

b. When applicable, lock the dial and release locking mechanism. The scale shall repeat indicated mass within one minimum graduation.

c. Remove load and indicator should return to zero. If the scale does not return to zero look to problems such as sluggish bearing points, dead loadcells, or leaking material gates. In dealing with the error in returning to zero, keep in mind the maximum allowable error in this scale test is two graduations.

NOTE 3: The Engineer may require other intermediate loads.

NOTE 4: The Build-Up Test - When there are not sufficient known masses available to test the weighing system to full capacity or means to hang all such masses, the Contractor must provide an acceptable means of building up or substituting other mass in place of the known masses. The build-up method is as stated below.

The build-up method for hopper scales is to replace a portion of the known mass with material (aggregate or other product used during production). This is done by first hanging available known masses (test masses) to at least 1/4 of scale's capacity and calibrate the scale system to this known mass. Remove the known mass and replace it by placing an equal mass of material in the hopper (equal to but not in excess of test load of known mass applied above), then add the known mass again to the built-up mass. This procedure is repeated as necessary to attain capacity, but the total build-up mass may not exceed three times the known mass.

An example of an acceptable build-up test follows:

Condition: 10,000 kg aggregate weigh hopper – scale agency has only 2500 kg of certified test masses. All recording is to be done on Form CEM-0014, or equivalent.

1. Apply the 2500 kg of certified test masses. Record indicated mass. Record plus or minus error (indicated mass relative to known mass applied, 2490 kg indicated = - 10 kg error; 2510 kg indicated = + 10 kg error); and remove known masses.

2. Place 2500 kg of substituted mass (aggregate) into the weigh hopper being careful that it is applied evenly to all corners of scale. Do not exceed the mass indicated in step 1. Record the true mass. Indicated mass minus error recorded in step 1. (A minus error in step 1 is added to indicated mass for true built-up mass and a plus error in step 1 is subtracted from indicated mass for true built-up mass.) In other words, 2490 kg indicated is equal to 2500 kg actual mass in the first instance and 2510 kg indicated is equal to 2500 kg actual mass in the second instance.

3. Reapply the 2500 kg of test masses to the partially loaded hopper. Record applied known mass equal to 2500 kg plus recorded true built-up mass of 2500 kg = 5000 kg. Record mass indicated and plus or minus error, as in step 1, and remove test masses.

4. Add more material in weigh hopper equal to the test masses removed. Do not exceed previous indicated mass. Record the true built-up mass using same procedure as given in step 2.

5. Reapply the 2500 kg of test masses and add the true built-up mass from

step 4; record the newly applied test load, 7500 kg. Record the indicated mass and the algebraic difference from the applied test loads, as in step 1, and remove the known test masses.

6. Add more material in weigh hopper equal to the test masses removed. Do not exceed the previously indicated mass in step 5. Record the true built-up mass using the same procedure given in step 2.

7. Reapply the 2500 kg of certified test masses and add the true built-up mass from step 6; record the newly applied test load, 10,000 kg. This completes the application of test load to full capacity of scale. Record the mass indicated and the algebraic difference on Form CEM-0014, or equivalent. Any procedure of building-up mass that doesn't follow the aforementioned methods is not acceptable.

E. REPORT AND SECURITY SEAL

At the conclusion of a successful test of proportioning devices, record the span-adjustment settings and make them available to the plant inspector. Where the device does not produce a record of adjustment, span number or other indication of adjustment, the device shall be left in a secure condition by the placing of a physical security seal. Refer to Section 9-1.01, paragraph 4, "Measurement of Quantities," of the current Standard Specifications. (See Note 10.)

F. SAFETY

Test masses are heavy and unforgiving. Do not place yourself in danger by being too close to the activities during the act of lifting and lowering of test masses. Lifting chains and come-alongs can and do break under the load of the test masses.

PART 3 - TEST PROCEDURE FOR LIQUID METERING

A. GENERAL

When the liquid meter system includes a separate stand-alone controller, this independent controller shall be the only controller used for the testing and calibration of the liquid meter. The calibration procedure shall be separate from and not used with the main plant controller. After the successful testing of the separate, stand-alone device, the main plant controller shall be adjusted to track the calibrated proportioning device, exactly.

NOTE 5: An example of this would be the Micro Motion mass-flow meter. The meter is supplied with its own transmitter. This separate, stand-alone metering device is calibrated and then the controller that handles the combined plant function is adjusted to track the meter transmitter. The same could be true of a Ramsey weighbelt controller.

Where the meter is not supplied with the means of self-calibration, the main plant controller will have to be used for the liquid meter testing and calibration.

The meter manufacturer’s name and model number shall be identified on the device identification plates. This identification shall be on the meter proper and the meter transmitter on multiple part meters. A copy of the DMS approved type-approval shall be supplied with the meter.

The liquid meter shall meet the requirements of Part 1 of this CT 109.

Meter by Mass - The device that allows the measurement of the flow of liquids by mass (weight) is called a mass-flow or coriolis effect meter. This device records and indicates the measured amount of liquid passing through it in mass units without the need for input of temperature or specific gravity of the measured product. Refer to the Weights and Measures Handbook for more information on mass flow meters.

Meter by Volume - This type of device measures the liquid product volumetrically. The device records and indicates the measured amount of liquid passing through it in volume (gallons or liters). In some applications this measurement will have to be manually converted to mass and may require the input of temperature and unit mass (specific gravity) of the liquid. Volumetric meters installed at continuous mixing AC plants are required to have automatic temperature compensation (ATC).

B. INSPECTION

1. All meter installations shall be inspected visually for proper connections and conditions before tests for accuracy are performed. The meter installation shall be in accordance with the meter manufacturer's instructions, a copy of which shall be furnished to the Engineer. All meters shall have been type-approved by the DMS prior to use. Inspect for leakage.

2. Indicators for all proportioning devices shall be in the plant control room. Indications shall be clear, definite, accurate and legible under normal conditions of operation of the system. Where there is no control room associated with the material plant, the proportioning device displays shall be grouped to facilitate their reading from one location. Deliveries shall be indicated and recorded in kilograms, tonnes, pounds, tons, liters, gallons and decimal subdivisions thereof. The indication shall display a rate meter and a resettable totalizer. The indication for the mass-flow meter shall be in mass, volume shall not be acceptable as a unit of measurement.

3. Mass-flow type meters are required by Caltrans specifications for the measurement of lime slurry and rubber-modified asphalt binder and are acceptable for all other liquid measurements.

C. TESTING EQUIPMENT AND PROVISIONS

1. The liquid meter shall be tested in the operating location in which it is to be used with all operating conditions prevailing. The meter system shall be tested under normally expected environmental conditions. The testing shall be rescheduled when weather conditions are such that the witness scale indicator fluctuates by more than two graduations.

   The metering at AC plants system shall be operated in the circulate mode for at least 15 min just prior to testing to heat and thoroughly fill the system before the start of calibration.

2. Test drafts shall be weighed on a platform scale located at the proportioning plant. The under support for the platform scale used for the test standard shall conform to the requirements of the Standard Specifications, Section 9-1.01, “Measurement and Payment.” Witness scales shall have been type approved by the DMS prior to use for device calibration. The platform scale shall be error tested within 8 hrs of the calibration. Error testing shall be performed with test masses conforming to this CT 109 and shall produce a witness scale that is within two graduations of the test mass load. Refer to the Weights and Measures Handbook for a description of platform scale error testing.

3. The contractor shall provide a suitable container capable of receiving the full flow of material being delivered from the meter for

the calibration procedure. The meter installation shall be plumbed to facilitate the diversion of the test draft to a container suitable for the size of the required test draft. All parts of the meter system shall be free of leaks of calibration liquid or air. Leaking or loss of testing material during the calibration run at any place between the liquid storage and test mass determination on the witness scale shall cancel the testing until the malfunction can be corrected. Any physical change of the meter system shall require a restart of the calibration procedures.

4. Product flow rates used during device testing shall be commensurate with anticipated production flow rates. Requirements for minimum test draft size, witness scale capacity and witness scale graduations shall comply with Table A, "Meter Testing Extremes." (Table A attached.) (See Note 6.)

5. Device plumbing shall be such that the Engineer can clearly ascertain that none of the liquid passing through the meter during calibration is being diverted before entering the test draft container.

6. Tank Scales - Some plant configurations may include a scale-mounted tank for calibration use. This tank may be used as the witness scale provided it meets the requirements of Table A, "Meter Testing Extremes," and all other requirements for witness scales and calibration containers in this CT 109.

7. Provers - A prover is a calibrated vessel with a capacity suitable to the test draft as per Table A.

   a. A prover may be used to calibrate water meters provided the calibration draft size adheres to the requirements of Table A, "Meter Testing Extremes."

   b. Provers shall meet the requirements of the DMS.

   c. The prover shall be maintained in a level position throughout the test run.

8. A standardized thermometer must be available to check the temperature of the liquid at the time of testing where volumetric metering is being utilized without automatic temperature compensation. A stopwatch will also be needed.

D. DEVICE TESTING AND CALIBRATION

1. Where the test draft used for calibration is 1150 liters or less, the testing parameters shall conform the requirements of Table A, "Meter Testing Extremes," for limitations to test drafts and witness scales.

   Large Draft Option - At the option of the contractor, a large-draft calibration test may be used. When the Contractor chooses to use a test draft that does not comply with Table A, "Meter Testing Extremes," the minimum test draft shall be 4 tonnes. This large draft option shall require a vehicle scale, located at the proportioning plant, as the calibration witness scale. Error-test the required vehicle scale with test loads of known mass. Error testing must be completed no more than 8 hrs prior to testing the accuracy of the proportioning devices. A build-up method may be used to error-test that portion of the scale capacity in excess of 25 % of its operational limit. The minimum graduation of the vehicle scale's indicator shall not be greater than 0.01 tonne. Error testing shall produce a witness scale that is accurate to within two graduations of the test mass load. When the newly error-tested witness scale is isolated from uses outside of the device calibration, it will not have to be retested for a period of 7 days provided it remains undisturbed and free of errors. Refer to the Weights and Measures Handbook for details on error testing scales.

2. Immediately before starting the series of test runs for the meter calibration, it will be necessary to send calibration liquid through the system to "dirty the system," or bring the calibration path to an as-used condition, being careful to leave the system at the same degree of "empty" for all test runs. This exercise is to have the meter system in the same condition for all of the test runs, including the first one of the series. Always reset the totalizer to zero and re-tare the calibration container before starting the calibration procedure before each test run.

   When weighing the test draft on the witness scale, be aware that hoses, ropes and other paraphernalia hanging from or on the calibration container may have an effect on the accurate weighing of the test draft. If fill hoses are left attached to the calibration container during the weighing process, the witness scale may have to be error tested again after the hoses have been softened by the hot asphalt.

3. Record the position of the meter's span number (calibration constant) for each test in the series. Each series of tests shall consist of at least three runs of a minimum quantity, as required by Table A, "Meter Testing Extremes" or the Large Draft Option, each at rates of flow commensurate with rates of flow anticipated during production.

   NOTE 6: Commensurate Rate Example - Where the liquid is to be used in a asphalt concrete mixture, apply the bitumen ratio from the proposed job-mix formula to the aggregates flow rate to determine asphalt binder flow rate, or in the case of lime slurry treatment of AC aggregates, the ratio of lime slurry to aggregate. The three calibration rates should be at 100 %, 65 % and 30 % of the maximum flow anticipated during production.

4. The meter totalizer must be read with the indicator at rest. Totalizer readings shall not be made on the fly. The meter totalizer indicator shall start from, or return to, zero and shall not advance its indications before delivery of material. No zero creep shall be allowed.

5. At the end of the individual test run, log the amount measured by the liquid meter, the value from the meter totalizer, or the mass delivered as indicated by the process controller. The meter indication for the measured liquid for any individual test run shall be compared with the mass determined by weighing the measured liquid on the previously error tested witness scale. All determinations of accuracy shall be made by comparing metered results with actual results from the witness scale.

   Error calculation is $E = A - M$, where E is error for the run, A is the actual mass of the liquid as determined on the witness scale, and M is the mass of the liquid as determined by the proportioning device, the meter.

   Percent error calculation is: $\%E = (E/A)x100$. Average error for the device is the combined percent error for runs a, b and c divided by 3. If the metering device is adjusted before completion of the three calibration runs, the test is aborted and a new series must be initiated. Error limits shall be as per the requirements of Table A, "Meter Testing Extremes."

6. Always check the rate indicator against the totalizer's indicator for

at least a 1-min interval. Time the interval with a stopwatch. The indicated rate should track the rate determined from the totalizer. A rate meter is a digital display of the speed of the operation - tonnes per hour, liters per minute, etc. A totalizer is a digital display of the mass delivered in tonnes, liters, etc.

7. Volumetric Conversions - Where the meter is of the volumetric type, a conversion for temperature and/or unit mass may have to be made.

   a. Unit Mass - The initial specific gravity for product to be metered must be obtained from the material source (the refinery in the case of asphalts) and verified. The specific gravity shall be determined for the specific lot of asphalt to be used in the calibration process. If at the initial determination of specific gravity there is some doubt as to the specific gravity value, the contractor will have to decide whether to use the available number or wait until a value can be produced by the TransLab before calibrating the device. If the contractor chooses to wait, the sampled product will have to be kept in storage until the calibration is completed. At the time of testing the meter, take a sample of the asphalt and immediately send it to the TransLab for determination of its actual specific gravity. Request results for specific gravity only with an e-mailed answer.

   NOTE 7: If the confirmed specific gravity is such that the previously tested meter's accuracy is within 0.5 %, the meter may be adjusted without running subsequent accuracy tests. If the adjustment requires more than a 0.5 % change, a new series of tests of the asphalt meter shall be run.

   b. Temperature Correction - Hot ingredients must be reduced to a baseline temperature of 15°C (60°F) for the purpose of converting to mass. The conversion factors for asphalts can be found in Section 93, "Liquid Asphalts" of the Standard Specifications. The temperature of the liquid shall be constant during individual test runs in order to permit converting the baseline temperature. When a mass-flow coriolis effect meter is used, no specific gravity will be needed as no conversion will have to be done.

8. Method used to calculate the percent of error for the test run where no automatic temperature compensation is present:

   a. Reduce the metered hot volume to baseline (15°C or 60°F) metered volume by multiplying the indicated volume from the meter totalizer by the multiplier shown in Conversion Table 1 of Section 93 of the Standard Specifications.

   b. Convert the baseline temperature metered volume to metered mass by using the specific gravity of the calibration liquid.

   c. The differential between the metered mass and the actual mass equals the test run error.

   NOTE 8: When meter indication has been compensated for thermal change by an automatic temperature compensator (to 15°C or 60°F baseline) or when a mass-flow meter is used, it is not necessary to make a hot-liters calculation.

   d. Determine the percent of meter error thus: The test run error divided by the actual mass equals the test run percent error times 100. [100 times (calculated metered mass minus actual mass) divided by the actual mass.]

EXAMPLE: 2176.6 L of asphalt metered at 135°C weighs 2041 kg. The specific gravity of the asphalt at 15°C is 1.020. Determine the percent of meter error using the mass of asphalt as the measuring standard.

Step a. 2176.6 x 0.9266 = 2016.84
Step b. 1.00 x 1.020 = 1.020 kg per L @ 15°C x 2016.84 = 2057.17
Step c. 2057.17 - 2041 = 16.17
Step d. 16.17 / 2041 = 0.8 %

NOTE 9: The specific gravity at varying temperatures may have to be furnished by the manufacturer of the product in conjunction with TransLab.

E. REPORT AND SECURITY SEAL

At the conclusion of a successful test of proportioning devices, record the span-adjustment settings and make them available to the plant inspector. Where the device does not produce a record of adjustment, span number or other indication of adjustment, the device shall be left in a secure condition by the placing of a physical security seal. Refer to Section 9-1.01, paragraph 4, "Measurement of Quantities," of the current Standard Specifications.

NOTE 10: When testing continuous mixing AC plants with computer control systems, the means of observing the input settings for span adjustment will be a digital display. The manufacturer shall supply the instructions indicating the procedure for displaying, setting and securing device adjustments and security seals. The HQ Construction will be responsible for reviewing all new proportioning systems for acceptability and supplying the instructions for inspection of each system accepted for use in producing material for Caltrans projects.

F. SAFETY

1. The test draft container shall be sized to absolutely prevent overflow during testing.

2. Extreme attention must be directed to the high temperature liquids that may be used during these calibration attempts. These liquids may be at temperatures in excess of 220°C.

3. Do not loiter in the area of the meter and its plumbing while the test is being ran. The inspection of this area should be completed before the start of calibration or between test runs for subsequent inspections. The liquid being used for testing of the proportioning devices is often at high temperature and/or high pressure.

4. Be alert to the movement of vehicles during the testing operation. Numerous tests may be running simultaneously with multiple vehicles moving about.

PART 4 - TEST PROCEDURE FOR CONVEYOR SCALES

A. GENERAL

Part 4 applies to all conveyor scale applications. The continuous conveyor scale (weighbelt) shall meet the requirements of Part 1 and Part 5 of this CT 109.

B. INSPECTION

1. The manufacturer's name and model number shall be identified on the model identification plate.

2. The scale and the conveyor at the scale shall be protected from the wind and weather.

3. The installation shall be in accordance with the scale manufacturer's instructions and a copy of

the instructions shall be furnished to the Engineer.

4. The incline of conveyor must be positioned such that there is no slippage of material along the conveyor.

5. Footings for weighbelt must be PCC and shall conform to the requirements of Section 9-1.01, "Measurement of Quantities," of the Standard Specifications.

6. Indicators for all proportioning devices shall be in the plant control room. Indications shall be clear, definite, accurate and legible under normal conditions of operation of the system. Where there is no control room associated with the material plant, the proportioning device displays shall be grouped to facilitate their reading from one location. Deliveries shall be indicated and recorded in kilograms, tonnes, pounds, tons, liters, gallons and decimal subdivisions.

C. TEST EQUIPMENT AND PROVISIONS

1. The weighbelt shall be tested in its operating location with all operating conditions prevailing. The scale shall be tested after it is installed on the conveyor with which it is to be used. The conveyor shall be tested under normally expected environmental conditions. The testing shall be rescheduled when weather conditions are such that the witness scale indicator fluctuates by more than three graduations.

2. Any physical change of the belt scale shall require a restart of the calibration procedures. Changes that may trigger retesting the device include, but are not limited to: a component of the conveyor or belt scale is changed, adjusted, or altered; the conveyor incline angle is changed; the physical location of the belt scale is changed. If the conveyor has been idle for a period of 2 hrs or more, the empty conveyor shall be run for not less than 25 min before the start of the testing.

3. The contractor shall provide a suitable container capable of receiving the full flow of material being delivered from the weighbelt for the calibration procedure. This calibration container shall be readily portable.

4. Leaking or loss of testing material during the calibration run at any place between the weighbridge and determining the test mass on the witness scale shall cancel the testing until the malfunction can be corrected. The testing procedure shall not lose excess product into the atmosphere.

5. The contractor shall designate the maximum production speed for the device being tested. The successfully tested calibration speeds become the production speed limits. Intermediate testing ranges shall be as required in Table B, “Conveyor Scale Testing Extremes” as applied to the maximum production speed. (Table B attached.)

D. DEVICE TESTING AND CALIBRATION

1. The calibration procedure may be by pre-weighing or post-weighing the testing material on the witness scale. When a preweighed test load is passed over the weighbelt, the conveyor-loading hopper must be examined before and after the test to assure that all the material used for the calibration check actually passed over the weighbelt. In either type of operation, it may be necessary to run calibration material through the system to “dirty the system,” or bring the calibration path to an as-used condition, being careful to run the system to the same degree of “empty” for each test run.

2. Before the start of the calibration procedure, a zero-load test shall be conducted and the device shall be calibrated to manufacturer's recommendations. Set the zero-load condition with the conveyor in motion and with all necessary attachments for normal operation in place. If zero creep is present, it must be self-compensating positive readings compensating for negative readings.

3. The calibration medium shall be the same type of material that will be used in production.

4. Witness Scale - The witness scale shall meet the requirements in Table B, "Conveyor Scale Testing Extremes." Error-test the required scale to be used as the test standard with test loads of known mass. (Refer to Part 1, Section D.) This must be done within 8 hrs prior to the beginning of testing the accuracy of the proportioning devices. A build-up method may be used to check that portion of the scale capacity in excess of 25 % of its operational limit. Error testing shall produce a witness scale that is accurate to within two graduations of its calibration test mass (known test mass and build-up mass if used). When the newly error-tested witness scale is isolated from uses outside of the device calibration, it will not have to be retested for a period of 7 days provided it remains undisturbed and free of errors. Refer to the Weights and Measures Handbook for details on error testing of witness scales.

NOTE 11: When testing production plants with computer-control systems, the means of observing the input settings for the numerical security seal (span number) is normally a digital display. The manufacturer must supply the instructions on how the span numbers for the adjusting elements are displayed and calibrated. The HQ Construction will be responsible for reviewing all new proportioning systems for acceptability and supplying the instructions for inspection of each system accepted for use in producing material for Caltrans projects. Where the adjusting elements do not produce a numerical security seal, the device shall be left in a secure condition by the placing of a physical security seal by the District WMC. Refer to Section 9-1.01, paragraph 4, "Measurement of Quantities," of the Standard Specifications.

5. Always check the rate indicator against the totalizer indicator for several intervals of 1-min or more. Time the interval with a stopwatch. The indicated rate should be within 1 % of the rate determined by the totalizer. Check the current specifications for the product being produced to determine the maximum allowable error for like indicators.

6. When the weighbelt system includes a separate stand-alone controller, this independent controller shall be the only controller used for the testing and calibration of the weighbelt. The calibration procedure shall be separate from and not used with the main plant controller. After the successful testing of the separate, stand-alone device, the main plant controller shall be adjusted to track the calibrated proportioning device, exactly. (See Note 5.)

   Where the weighbelt is not supplied with the means of self-calibration, the main plant controller will have to be used for the weighbelt testing and calibration. Refer to the Weights and Measures Handbook for more information about plant controller interface with individual proportioning controllers.

7. In the event the material production rate is to exceed 365 metric tonnes per hour (MTH) (402 tonnes per

hour), the high speed calibration attempt may be a set of two runs of 2 min each for each calibration rate greater than 365 MTH. The average error for each pair of runs shall not exceed 1.0 %. This average high-speed error shall be used as the high-speed result.

8. Record span-adjustment setting and reading of the weighbelt's totalizer before each test run. Divert the test flow of calibration material into the calibration container directly from the feeder belt at each of the designated rates. Each series of tests shall consist of at least three runs of at least the minimum quantity stated in Table B, "Conveyor Scale Testing Extremes." The empty mass (tare) of the calibration container shall be determined at the beginning of each test run. Any loss of material during the test run shall be cause for starting the test run over.

9. The difference between the mass accumulated on the weighbelt totalizer (metered) and the mass indicated on the witness scale when the calibration container is weighed (actual) is divided by the actual mass to determine the percent error for the calibration run. The average percent error for the three test runs is the sum of the deviations of the three individual test runs divided by 3. If the device is adjusted before completion of the three calibration runs, the test is aborted and a new series must be initiated. Device error shall be within the limits expressed in Table B, "Conveyor Scale Testing Extremes."

E. REPORT AND SECURITY SEAL

At the conclusion of a successful test of proportioning devices, record the span-adjustment settings and make them available to the plant inspector. Where the device does not produce a record of adjustment, span number or other indication of adjustment, the device shall be left in a secure condition by the placing of a physical security seal. Refer to Section 9-1.01, paragraph 4, "Measurement of Quantities," of the current Standard Specifications.

F. SAFETY

1. Be alert to the movement of vehicles during the testing operation. Numerous tests may be running simultaneously with multiple trucks moving about.

2. Place yourself in an area that is completely free of the cold feed bins, feeder conveyor, weighbelt and truck loading areas during the time of testing.

PART 5 - TEST PROCEDURE FOR VOLUMETRIC PROPORTIONING PLANTS

Part 5A - Volumetric RSC (Rapid Strength Concrete) Proportioning

A. GENERAL

The delivery rate of aggregate and cement per revolution of the aggregate feeder shall be calibrated at appropriate gate settings for each batch-mixer truck used on the project and for each aggregate source.

B. INSPECTION

Inspect the batch-mixer trucks for compliance with the contract special provisions.

C. TESTING EQUIPMENT AND PROVISIONS

1. Calibration tests for aggregate, cement and water proportioning devices shall be conducted with a platform scale located at the calibration site. This platform scale shall have a maximum capacity not exceeding 2.5 tonnes with maximum graduations of 0.5-kg. The platform scale shall be error tested within 8 hrs of calibration of batch-mixer

truck proportioning devices. Error testing shall be performed with test masses conforming to this CT 109 and shall produce a witness scale that is within two graduations of the test mass load. The scale and all other equipment needed for the calibration of proportioning systems shall be available for use at the production site throughout the production period.

2. The batch-mixer truck shall be equipped so that an accuracy check can be made prior to the first operation for the project and at any other time as directed by the Engineer. Further calibration of proportioning devices shall be required every 30 days after production begins or when the source or type of any ingredient is changed. A spot calibration shall consist of calibration of the cement proportioning system only. A two run spot recalibration of the cement proportioning system shall be performed each time 50 tonnes of cement has passed through the batch-mixer truck. Should the spot recalibration of the cement proportioning system fall outside the limitations specified herein, a full calibration of the cement proportioning system shall be completed before production resumes.

   Ingredient indicators shall be in working order prior to commencing proportioning and mixing operations, and shall be visible when standing near the batch-mixer truck.

D. DEVICE TESTING AND CALIBRATION

1. Aggregate Proportioning - Batch-mixer trucks shall be calibrated at three different aggregate gate settings that are commensurate with production needs. Two or more calibration runs shall be required at each of the different aggregate gate openings. Aggregate belt feeder shall deliver aggregate to the mixer with such volumetric consistency that deviation for any individual aggregate delivery rate check-run shall not exceed 1.0 % of the mathematical average of all runs for the same gate opening and aggregate type. Each test run shall be at least 500 kg. Fine aggregate used for calibration shall not be reused for device calibration.

2. Cement Proportioning - The cement proportioning system shall deliver cement to the mixer with such volumetric consistency that the deviation for any individual delivery rate check-run shall not exceed 1.0 % of the mathematical average of three runs of at least 500 kg each. Cement used for calibration shall not be reused for device calibration.

3. Water Proportioning - Refer to Part 3, Test Procedure for Liquid Metering. The water meter shall be equipped with rate-of-flow indicators to show the rate of delivery and a resettable totalizer so that the total water introduced into the mixture can be determined. The totalizer shall not register when the water metering system is not delivering water to the mix.

4. Liquid admixtures shall be proportioned by a meter. This meter shall be tested as per Part 3 of this CT 109.

E. REPORT AND SECURITY SEAL

1. A Certificate of Compliance in conformance with the provisions in Standard Specifications, Section 6-1.07, "Certificates of Compliance," shall be furnished with each delivery of aggregate, cement, and admixtures used for calibration tests, and shall be submitted to the Engineer with a certified copy of the mass of each delivery. The

Certificate of Compliance shall state that the source of materials used for the calibration tests is from the same source as to be used for the planned work. The Certificate of Compliance shall state that the material supplied conforms to the Standard Specifications and the Special Provisions, and shall be signed by an authorized representative who shall have the authority to represent and act for the contractor.

2. At the conclusion of a successful test of proportioning devices, record the span-adjustment settings and make them available to the plant inspector. Where the device does not produce a record of adjustment, span number or other indication of adjustment, the device shall be left in a secure condition by the placing of a physical security seal. Refer to Section 9-1.01, paragraph 4, "Measurement of Quantities," of the current Standard Specifications.

F. SAFETY

Rotating and reciprocating equipment on batch-mixer trucks shall be covered with metal guards. Be very careful around these trucks when they are mobile.

Part 5B - Test Procedure for Volumetric Pavement Seal Production Equipment

A. GENERAL

1. Slurry seal mixer-spreader trucks proportion aggregate and emulsion by volume. Due to possible changes in aggregate obtained from different sources, each truck must be calibrated for each source at least once every six months. A greater frequency may be necessary, especially with equipment changes.

2. Inspect the mixer-spreader trucks to ensure compliance with the requirements of Section 37 of the Standard Specifications, this CT 109, and all applicable Standard Special Provisions.

B. INSPECTION

Inspect the batch-mixer trucks for compliance with the contract special provisions.

C. TESTING EQUIPMENT AND PROVISIONS

1. For the test standard, error-test a section of a vehicle scale located within 3 miles of the aggregate stockpile.(Refer to Part 4, Section D-4.)

2. The mixer-spreader truck shall be equipped so that an accuracy check can be made prior to the first operation for the project and at any other time as directed by the Engineer.

3. Ingredient indicators shall be in working order prior to commencing proportioning and mixing operations and shall be visible when standing near the batch-mixer truck.

D. DEVICE TESTING AND CALIBRATION

1. Aggregate Belt Rate Determinations

   a. Preweigh a loaded truck and run at least 3 tonnes of aggregate from the truck mounted hopper, over the belt, and through the pugmill. Register the number of counts on the aggregate belt-feeder revolution counter.

      Reweigh the truck after the test run, divide the net mass change by the revolutions counted and reduce the results by the moisture content of the aggregate being used for the calibration to obtain a dry kilogram of aggregate per revolution.

   Note 12: What you have after here is the number of dry kilograms of aggregate delivered to the pugmill per unit of the aggregate belt-feeder revolution counter. The type of count does not matter as long as it relates to aggregate belt-feeder movement – it may be different for each truck. The important final product of this calibration is the ability to determine the ratio of kilograms of dry aggregate to the kilograms of emulsion, corrected for temperature, while operational.

b. Continue this operation for a total of three runs at the approximate gate setting to be used during the production of slurry seal. None of these three runs should deviate from their combined mathematical average by more than 1.0 %.

   After using the above procedure to establish belt-feeder delivery consistency, do two more runs that bracket the initial delivery rate. These two runs and the average of the first three runs should produce a straightline plot.

NOTE 13: An alternate aggregate calibration option is to capture the material leaving the mixer-spreader truck, without loss, and deposit it into a container. The procedure then shall be as for volumetric PCC equipment as in Part 5A, Volumetric RSC Proportioning.

2. Emulsion Pump Rate Determination. Use the test standard, vehicle scale, as set up for the aggregate test.

   a. Preweigh a mixer-spreader truck, empty of aggregate, loaded with emulsion to be used for the contract. Run at least 1200 L from the truck mounted emulsion storage through the emulsion pump and into a separate tank. The aggregate belt-feeder must run in an empty mode in order to make the aggregate belt-feeder revolution counter functional. Register the number of counts on the counter.

      Reweigh the mixer-spreader truck after the test run, divide the net mass change by the revolutions counted, and reduce the results for any major temperature correction to obtain a corrected kilograms of emulsion per unit of the aggregate belt-feeder revolution counter.

   b. Continue this operation for a total of three runs at the approximate emulsion rate to be used during the production of slurry seal. None of these three runs should deviate from their combined mathematical average by more than 2.0 %. The average of the results produced by these three test runs shall be used for the emulsion pump rate determination for use in operational calculations.

      If the contractor elects to use a variable rate emulsion pump, continue the test with the following procedure. After using the initial three test runs to establish the emulsion pump delivery consistency, do two more runs that bracket the initial delivery rate. The results of these two runs and the average of the first three runs should produce a straightline plot.

   c. Check that the emulsion pump and all plumbing are free of leaks. Check the thermometer in the emulsion storage tank with a standardized thermometer.

3. Water Meter - Refer to Part 3, Test Procedure for Liquid Metering.

E. REPORT AND SECURITY SEAL

At the conclusion of a successful test of proportioning devices, record the span-adjustment settings and make them available to the plant inspector. Where the device does not produce a record of adjustment, span number or other indication of adjustment, the device shall be left in a secure condition by the placing of a physical security seal. Refer to Section 9-1.01, paragraph 4, "Measurement of Quantities," of the current Standard Specifications.

F. SAFETY

Rotating and reciprocating equipment on mixer-spreader trucks shall be covered with metal guards. Be very careful around these trucks when they are moving.

PART 6 - MATERIAL PLANT SAFETY INSPECTION

A. GENERAL

Test all plants producing material for Caltrans projects for departures from the regulations administered by the California Division of Occupational Safety and Health, U. S. Department of Labor - Occupational Safety and Health Administration, and California Department of Transportation. Only those areas frequented by Caltrans plant inspectors need be inspected. Refer to Section 7-1.06 “Safety and Health Provisions” of the Standard Specifications.

Report all safety deficiencies on Form HC-0012, “Material Plant Safety Checklist,” or equivalent. This is a checklist type form to help with the safety regulations. The completed copy of this report must be passed on to the Resident Engineer, HQ Construction, the plant inspector, and the contractor, before the start of production possible.

REFERENCE

California Standard Specifications
Caltrans Standard Special Provisions
California Test 125
Caltrans Weight and Measures Handbook

End of Text
(California Test 109 contains 21 pages)

Attachment

TABLE A - METER TESTING EXTREMES

meter size		size	minimum test draft	witness scale maximums		maximum individual error			
inch	mm	designation	liters/kg	capacity	graduation	asphalt*	water	lime slurry*	epoxy
< 0.76	< 19	small	100	250 kg	0.10 kg	± 0.5%	± 1.5%	± 0.5%	± 0.5%
0.76 - 1.49	19 - 38	medium	600	1000 kg	0.50 kg	± 0.5%	± 1.5%	± 0.5%	± 0.5%
> 1.49	> 38	large	1150	2500 kg	0.50 kg	± 0.5%	± 1.5%	± 0.5%	± 0.5%

* Meters used for proportioning at continuous mixing AC plants and lime slurry treatment plants shall be accurate to within 0.5 % of the test load for an average of three test runs and no individual test run error shall exceed 1.0 %

TABLE B - CONVEYOR SCALE TESTING EXTREMES

		maximum error		test size	witness scale		testing range
		average	individual	minimum	scale, max	grad, max	
Agg, AC							
	agg	1.0%	2.0%	3 min.*	40 tonnes	10 kg	30%, 65%, 100%
	dust	1.0%	2.0%	15 min.	2.5 tonnes **	0.5 kg	30%, 65%, 100%
Agg, Antistrip		1.0%	2.0%	3 min.*	40 tonnes	10 kg	30%, 65%, 100%
Lime, Marinate							
	agg	1.0%	2.0%	3 min.*	40 tonnes	10 kg	30%, 65%, 100%
	lime	0.5%	1.0%	0.5 tonne	2.5 tonnes	0.5 kg	30%, 65%, 100%
Lime, Dry							
	agg	1.0%	2.0%	3 min.*	40 tonnes	10 kg	30%, 65%, 100%
	lime	0.7%	1.0%	0.5 tonne	2.5 tonnes	0.5 kg	30%, 65%, 100%
All Other							
	> 100 tph	1.0%	2.0%	3 min.*	40 tonnes	10 kg	30%, 65%, 100%
	< 100 tph	1.0%	2.0%	0.5 tonne	2.5 tonnes	0.5 kg	30%, 65%, 100%

* Use a 3 minute or longer calibration run unless the calibration rate exceeds 365 tonnes per hour.
** The witness scale size for baghouse dust will depend on the amount of material delivered during the 15 minute test run.