SCOPE:
The purpose of this Materials Method is to describe Department practices involved in the inspection of the plant equipment associated with the production of Hot Mix Asphalt and Portland Cement Concrete. Included in the manual are check procedures for scales, meters and automated proportioning equipment.

Strict adherence to this manual may not be possible at all times. If it becomes necessary to deviate from the listed procedures, contact the Materials Bureau. There are many equipment manufacturers involved in the automation process and they all use different controls to obtain the same result.

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I. HOPPER SCALE TEST METHOD

A. GENERAL

This section describes the test procedures for determining the accuracy of aggregate, cement and asphalt hopper scales. It also includes a guide for visual inspection of the scale components.

Most hopper scales are tested by the substitution method using standard 25 kg or equivalent test weights which are supplied by the producer. Scales that have the capability of switching units using an external switch on the digital indicators can be checked in either unit (Kilograms or pounds). Do not break or authorize the breaking of any seals which have been placed on the scale system by a Sealer of Weights and Measures.

The accuracy tolerance for a hopper scale is determined in accordance with the requirements of the National Institute of Standards and Technology Handbook 44 (NIST HB44), Automatic Bulk Weighing Systems. These tolerances are as follows:

- The minimum maintenance and acceptance tolerance shall be 0.1% of the weighing capacity of the system, or the value of the scale division, whichever is less.
- Acceptance Tolerance shall be 0.1% of the test load.
- Maintenance Tolerance shall be 0.2% of the test load.

In addition to the above tolerances, to tests involving digital indications, there shall be an added amount equal to one-half (½) the value of the scale division.

These tolerances requirements are listed on the reverse side of Form BR 191b.

Acceptance tolerance is only required on hopper scales when:

- Equipment is put into use for the first time.
- Equipment is being put into service following a rejection.
- Equipment has been relocated or reconditioned.

If at any time during this test the scale accuracy falls outside of the allowable tolerance, stop the test, have a competent scale technician correct the inaccurate scale component, and restart the test from the beginning.

B. VISUAL

The indicating elements, load cells, and the load receiving element shall be adequately protected from environmental factors such as wind, weather and radio frequency interference (RFI) that may adversely affect the operation or performance of the system.

C. ACCURACY TEST- ASPHALT SCALE
Check the accuracy of the asphalt scale using form BR 191 as follows:
1. Record the zero scale reading in Column 1. If necessary, add a cradle from which to suspend weights and either tare the scale to zero or record the tare weight and treat this as the “new zero”. Generally, weights can be placed directly on the asphalt weigh bucket.

2. Add one 25 kg test weight then calculate (if necessary) and record the scale target weight in Column 2.

3. Record the scale reading (test weights plus material, if any) in Column 3.

4. Compute the scale error (if any) by determining the difference, in scale divisions, between the target weight (Column 2) and the scale reading (Column 3) and record in Column 4. Record whether this error is (+) or (-) and combine with previous cumulative errors (+) or (-) and record the new cumulative error in Column 5.

**Note:** Errors are only considered cumulative when material is used as a substitution for known weight. When using test weights exclusively, the error does not accumulate, but is recorded as the actual variation from target value for that test point.

5. Repeat steps 2-4 by adding test weights one at a time, uniformly distributing the weights around the top of the asphalt weigh bucket, until the upper limit of the asphalt batching range is reached (not necessarily the full capacity of the scale). If sufficient test weights are not available to reach the upper limit of the batching range, add asphalt in increments approximately equal to the highest verified point reached using the known test weights and continue the check using the substitution method.

**D. ACCURACY TEST- ALL OTHER HOPPER SCALES**

Check the accuracy of hopper scales using form BR 191 as follows: (see figure 1 for an example of this procedure)

1. Record the zero scale reading in Column 1. If necessary, add a cradle from which to suspend weights and either tare the scale to zero or record the tare weight and treat this as the “new zero”.

2. Suspend a minimum of ten standard test weights for HMA plants or twenty standard test weights for PCC plants from the weigh hopper then calculate (if necessary) and enter the scale target weight in Column 2.

3. Record the scale reading (test weights plus material, if any) in Column 3.

4. Compute the scale error (if any) by determining the difference, in scale divisions, between the target weight (Column 2) and the scale reading (Column 3) and record in Column 4. Record whether this error is (+) or (-) and combine with previous cumulative errors (+) or (-) and record the new cumulative error in Column 5.

5. Remove the test weights from the weigh hopper.
6. Add material to the weigh hopper until the scale reading equals the approximate weight of the test weights. Record the scale reading in Column 1.

7. Add the material weight from Column 1 to the amount of standard test weights being used. This is the scale target weight. Record the scale target weight in Column 2.

8. Record the scale reading of material and standard test weights in Column 3 and compute the scale error, in graduations, as a (+) or (-) in Column 4.

9. Combine the error (if any) in Step 8 with the previous cumulative errors and record in Column 5. This cumulative error must stay within the allowable tolerance throughout the scale check.

**Note:** Errors are only considered cumulative when material is used as a substitution for weight. When using test weights exclusively, the error does not accumulate.

There may be situations where one or two large substitutions can be made, rather than a substitution for each draw. Errors will not be considered cumulative when adding test weights “in-between” these large substitutions.

10. Repeat Steps 5-9 until the upper limit of the material batching limit is reached.
At this point the scale is out of tolerance. Scale technician should make adjustment, dump cement and start over

In this example, test weights totaling 240 kg were used. The minimum allowed tolerance is 0.1% of the scale capacity, or 1 scale grad.

Allowable error is calculated based on 0.2% of the test load, plus ½ scale grad.

Example: At 1670 kg, the allowable tolerance =

\[(1670 \text{ kg}) \times (0.002) = 3.34 \text{ kg} + 1 \text{ kg} = 4.34 \text{ kg (± 2 grads)}\]

Scale is Accepted after adjustment.

**FIGURE 1**
II. VEHICLE SCALE TEST METHODS

A. GENERAL

Vehicle scales are tested throughout the working range using either the substitution method or strain method. The accuracy tolerance for a vehicle scale is determined in accordance with the requirements of the NIST HB 44. The tolerances are as follows:

Maintenance Tolerance – 1 scale division (1d) for each 500 scale divisions (500d)
Acceptance Tolerance - ½ of Maintenance Tolerance

These tolerances are listed on the reverse side of BR 191b.

The substitution method is used (at the acceptance tolerance) for all new scale installations and anytime scales have been reconditioned and placed back into service. The substitution method is used (at the maintenance tolerance) for all annual scale inspections. The strain method (at maintenance tolerance) may be used at any other time.

If at any time during this test the scale accuracy falls outside of the allowable tolerance, stop the test, have a competent scale technician correct the inaccurate scale component, and restart the test from the beginning.

B. GLOSSARY

1. Certified Test Weights- Certified by New York State Weights and Measures (or equivalent State agencies) within the past 5 years. Weights equal to a minimum of 12.5% of the capacity of the scale will be available to perform the scale check.

2. Calibration Points- areas of the scale range that will be checked during the accuracy test. Generally these points are a maximum of every 500 scale divisions.

C. ACCURACY TEST- SUBSTITUTION METHOD

The test begins at zero using the substitution method. All of the load on the platform is “known weight”, making this an “absolute” test. This is accomplished by using the certified weights to calibrate a given range of the scale (at least 12.5% of capacity) then removing the weights and substituting a test load. The test load or loads substituted may take any form (dump truck, payloader, etc.) as long as the test load falls within the previously verified range of the scale. (See figure 2 for an example of this procedure).

**Note:** A maximum of three substitutions may be used.

1. Starting at zero, add certified test weights up to the predetermined calibration point and record this known weight in Column 2.

2. Record the actual scale reading in Column 3.
3. Compute the scale error (if any) by determining the difference, in scale divisions, between the target weight (Column 2) and the scale reading (Column 3) and record in Column 4. Record whether this error is (+) or (-) and combine with previous cumulative errors (+) or (-) and record the new cumulative error in Column 5.

4. Either add certified weights to reach the next calibration point or substitute a test load that does not exceed the previous calibration point by more than 200 divisions. Record this weight in Column 1.

5. Add certified weights (in addition to the test load) and record this weight in Column 2.

6. Compute the scale error (if any) by determining the difference, in scale divisions, between the target weight (Column 2) and the scale reading (Column 3) and record in Column 4. Record whether this error is (+) or (-) and combine with previous cumulative errors (+) or (-) and record the new cumulative error in Column 5. The error will only accumulate if there is a scale error prior to substitution and then a subsequent error after substitution.

7. Repeat steps 3-6 until the scale is checked to its maximum anticipated working range. If at any point during the test, a scale technician makes adjustments to the scale, then the scale check must be started over from the beginning.

D. SECTION OR SHIFT TEST

A “section test” or “shift test” must also be performed on the scale as a part of the substitution accuracy test. Large capacity scales are usually made up of pairs of load sensing elements which are summed to produce the scale reading. The section test attempts to isolate each pair of sensors to assure that each pair is performing properly. Accuracy tolerances on the shift test are determined in accordance NIST HB 44 and are applied in two ways. First, all section test results must be within the tolerance applied (acceptance or maintenance). Second, the readings must agree with each other within the absolute value of the maintenance tolerance (the difference between the highest value and the lowest value must be less than or equal to the maintenance tolerance.)

1. The tests are performed by placing a test load of the same magnitude on each individual section of the scale.

2. Record each section’s load reading and apply applicable tolerances.

3. Minimum of one shift test shall be conducted with a minimum test load of 12.5% of the scale capacity. Do not allow the weight of the test load to exceed the capacity of any individual scale section.

E. ACCURACY TEST - STRAIN METHOD

The strain load test is a “relative” test of scale performance, as opposed to an “absolute” test as described in the substitution method. The test is performed by the addition of a known test load to an arbitrary strain load starting point and checking to see that the scale advances by the amount of the test load. Tolerance is applied only to the known test weights in accordance with NIST HB 44.
1. Strain load test begins at zero and an “unknown” strain load is added to the platform scale.

2. Certified test weights meeting the requirements outlined in the glossary of this section are then applied to this “unknown” load. Record the scale reading on form BR 191b.

3. If at any time during this test the scale accuracy falls outside of the allowable tolerance, stop the test, and have a qualified scale technician correct the inaccurate scale component. Restart the test from the beginning using the substitution method.
**Materials Method 27**

**DEPARTMENT OF TRANSPORTATION**

**MATERIALS BUREAU**

**HOPPER/VEHICLE SCALE TEST**

**REGION: 09**  **FACILITY NO. 10997**  **DATE: 03/13/2005**

**PLANT/LOCATION:**  **ALL STAR PAVING, INC. ONEONTA, NY**

**SCALE MAKE:**  **METTLER TOLEDO**  **TYPE: AGG, CEM, ASP.**  **X VEHICLE**

**CAPACITY:** 120000 LB  **SCALE DIV. SIZE:** 20 lb

**ALLOWABLE TOLERANCE:** Maintenance Check  **CHECKED BY:**  **JOHN JACOBS – NYSDOT**

(see reverse for tolerances)

<table>
<thead>
<tr>
<th>COLUMN 1</th>
<th>COLUMN 2</th>
<th>COLUMN 3</th>
<th>COLUMN 4</th>
<th>COLUMN 5</th>
</tr>
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<tbody>
<tr>
<td>Scale Reading</td>
<td>Target WT.</td>
<td>Scale Reading</td>
<td>Material + Test WT.</td>
<td>Material + Test WT.</td>
</tr>
<tr>
<td><strong>Material Only</strong></td>
<td><strong>Material + Test wt.</strong></td>
<td><strong>Material + Test wt.</strong></td>
<td><strong>High</strong></td>
<td><strong>Low</strong></td>
</tr>
<tr>
<td>0</td>
<td>4000 LB</td>
<td>4000 LB</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0</td>
<td>8000 LB</td>
<td>8000 LB</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0</td>
<td>12000 LB</td>
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<td>-</td>
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<td>16000 LB</td>
<td>-</td>
<td>-</td>
</tr>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22800 LB</td>
<td>22800+4000=26800 LB</td>
<td>26820 LB</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>22800+8000=30800 LB</td>
<td>30820 LB</td>
<td>+1</td>
<td>+1</td>
<td>3</td>
</tr>
<tr>
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<td>+2</td>
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<td>+2</td>
<td>+2</td>
<td>4</td>
</tr>
<tr>
<td>22800+24000=46800 LB</td>
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<td>+2</td>
<td>+2</td>
<td>4</td>
</tr>
<tr>
<td>44720 LB</td>
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<td>48740 LB</td>
<td>+1</td>
<td>+3</td>
</tr>
<tr>
<td>44720+8000=52720 LB</td>
<td>52740 LB</td>
<td>+1</td>
<td>+3</td>
<td>5</td>
</tr>
<tr>
<td>44720+12000=56720 LB</td>
<td>56740 LB</td>
<td>+1</td>
<td>+3</td>
<td>5</td>
</tr>
<tr>
<td>44720+16000=60720 LB</td>
<td>60760 LB</td>
<td>+2</td>
<td>+4</td>
<td>6</td>
</tr>
<tr>
<td>44720+2000=64720 LB</td>
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<td>6</td>
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<td>7</td>
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<td>+5</td>
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<td>67520+20000=87520 LB</td>
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<td>+6</td>
<td>8</td>
</tr>
<tr>
<td>67520+24000=91520 LB</td>
<td>91560 LB</td>
<td>+2</td>
<td>+6</td>
<td>9</td>
</tr>
</tbody>
</table>

For vehicle scales, the maximum number of substitutions is three. In this example, known test weights of 24000 pounds are used.

Note that errors only accumulate after a substitution (“unknown” weight) is added to the scale at a point where the known weights have verified the scale.

**FIGURE 2**
III. BELT CONVEYER SCALES

A. GENERAL

This section describes the test procedures for determining the accuracy of belt-conveyer scales used at Hot Mix Asphalt drum mix plants. Belt scales are tested by running material over the belt for a predetermined interval of time. The indicated weight is then compared to the actual weight on a previously calibrated and approved truck scale. The tolerances are as follows:

- Acceptance Tolerance – 0.5% of the test load and applies to initial installation of the weigh system, annual approval prior to production and whenever the equipment fails to meet maintenance tolerance during production.
- Maintenance Tolerance – 1.0% of the test load and applies all other times

The allowable tolerances are stated in Section 401 of the Standard Specifications.

B. ACCURACY TEST - BELT SCALES

The test is conducted at full and half plant capacity. If these two accuracy checks fall within the allowable tolerance, the Producer may request that the belt scale be checked at one-third of the plant capacity. This is the lowest capacity at which the belt scale is allowed to run.

The producer is responsible for supplying a sufficient number of trucks of adequate size to permit testing of the belt scale in a timely manner. The belt scale is tested as follows (See figure 3 for an example of this procedure):

1. Moisture compensation must be set to zero percent.
2. Set the aggregate feed rate to the maximum capacity for which the test will be run. Record this number on the BR-112.
3. Establish a run time for the test based on the production rate being tested. Obtain a sufficient quantity of material to provide a representative sample. The full sample must fit into one truck.
4. Obtain a tare weight on the truck and an initial reading from the belt totalizer as a starting point. The totalizer is defined as the aggregate weighbridge indicator or the automation display. Record these weights on the BR-112.

*Note: In test mode, the belt totalizer must be readable to the nearest 0.01 Mg.*

5. Ensure that the truck is in place and that the belt is clear of material before starting the test. It is suggested that the material used for the test be #1 or #1A size aggregate. At the high production rate, it may be necessary to feed material from more than one bin.
6. Activate the bin feeder(s) for the predetermined time established in step # 3. Stop the feeder(s) and clear the belt of any material. Record the belt totalizer reading on the BR-112.
7. Weigh the truck on the vehicle scale and record the scale reading on the BR-112.
8. Use the vehicle scale weight as an accurate weight and determine the allowable tolerance and acceptable range.

9. Compare the net belt weight to the acceptable range and note the result (pass/fail) on the BR-112.

10. Repeat steps 4-9 until three consecutive passing tests have been performed.

11. Change the production range to one-half (½) the maximum plant capacity and repeat steps 3-10. Should the Producer wish to calibrate the belt scale to one-third (1/3) the capacity, repeat steps 3-10 once again.

12. Once the belt scale accuracy is found acceptable, record the span setting for the scale and place the manufacturer’s test weight on the unloaded belt and allow the reading to stabilize. The rate should be recorded in the plant diary and can be used in the future to spot check the scale accuracy.

13. The above steps apply to the initial and the annual inspection (Acceptance Tolerance). Intermediate scale checks require only one high and one low rate test be done (Maintenance Tolerance). Should either of these rates fail, it is necessary to retest the scale at the acceptance tolerance (three high and three low).
## Belt Scale and Asphalt Meter Checks

### BELT SCALE ACCURACY TEST

**Producer**: All Star Paving Inc.  
**Inspector**: John Jacobs - NYSDOT  
**Location**: Oneonta, NY  
**Date Tested**: 03/13/2005

<table>
<thead>
<tr>
<th>Span Setting</th>
<th>102550</th>
<th>Setting</th>
<th>102550</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPH w/test Weights</td>
<td>passed</td>
<td>or</td>
<td>failed</td>
</tr>
</tbody>
</table>

**Aggregates**
- Size of aggregate: #1 Stone
- Aggregate Feeder(s) used: #4 & #5
- Aggregate Feed Rate: 350 MgPH TPH
- Test time: 3 minutes

### TEST # 1

<table>
<thead>
<tr>
<th>Belt Scale Finish</th>
<th>21.57 Ton</th>
<th>Truck Gross</th>
<th>24540 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belt Scale Start</td>
<td>4.24 Ton</td>
<td>Truck Tare</td>
<td>7260 kg</td>
</tr>
<tr>
<td>Belt Scale Net</td>
<td>17.33 Ton</td>
<td>Truck Net</td>
<td>17280 kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17330 kg</td>
</tr>
</tbody>
</table>

Allowable tolerance = truck Net x 0.005 = ± 86.4 kg

Acceptable Range: 17194 to 17366

### FIGURE 3

**Two additional acceptable tests required at this range.**
IV. METERS

A. GENERAL

This method describes specific procedures for testing the calibration and accuracy of metering devices.

B. METER TEST

1. Meters in approved facilities are equipped with bypass valves and lines which enable samples to be obtained for calibrating the meter. The location of the lines and the point at which the sample is taken will vary from plant to plant. The point at which the sample is taken, specifically with an asphalt meter, is an important factor considering the amount of material that can adhere to the inside of the sample lines.

2. Sample Size

   A. Asphalt Meters- For batch plants, minimum sample size will be 4.0% of the minimum plant capacity and maximum sample size will be 8.0% of the maximum plant capacity. For drum mix plants, asphalt sample set points will be 2.5% of the minimum capacity and 7.0% of the maximum capacity.

   B. Water Meters- Minimum and maximum sample size will be based on 125 L/m³ (25 gallons/yd³) at the minimum and maximum plant capacity.

   C. Mineral Filler- The minimum and maximum sample size will be based on 1.0% of the minimum plant capacity and 4.0% of the maximum plant capacity.

3. Obtain the weight of the empty container or zero any inline calibration tanks. For an asphalt test, heat the valves and lines by wasting several liters of material through the system.

4. Drain the lines for one minute before starting to draw the test sample.

5. Draw the sample, either automatically or manually, into the sample container and allow the lines to drain for one minute.

6. Record the final meter reading and the weight of the sample.

7. Determine the meter accuracy according to §401 or §501 of the Standard Specifications. This tolerance is applied to the actual volume (liters or gallons) of material.

C. METER ACCURACY TOLERANCES

1. Asphalt Meter - ± 0.1 % based on the total theoretical batch size.

2. Water Meter - ± 1.0 % by mass or volume.
3. Mineral Filler Meter - ± 0.25 % based on the total theoretical batch size.
D. DRUM MIXER ASPHALT TEST

1. The asphalt meter is checked at the probable minimum and maximum asphalt output. For the basis of the test it is assumed that the maximum asphalt content will be 7.0 % and the minimum asphalt content will be 2.5 % of the total theoretical weight of material produced (in Mg). Therefore, the test will encompass the maximum percentage at the maximum rated plant output capacity and the minimum asphalt percentage at either a rate of ½ the maximum plant capacity (if approved at this rate) or a rate of ½ the maximum plant capacity.

2. Prior to starting the test, determine the time necessary to run the meter to ensure that a reasonable amount of asphalt is run through the meter and that the sampling receptacle will be large enough to accommodate the entire sample. For the purpose of the following examples, it will be assumed that the sample receptacle is a tanker truck, although an “in line” sampling container is acceptable providing that the capacity is sufficient to obtain a representative sample.

3. The meter accuracy is applied to a theoretical total mix produced. This is determined by weighing the actual amount of asphalt delivered and dividing by the theoretical asphalt percentage. Allowable variation is 0.1% of this theoretical total mix produced.

4. For initial and annual testing of the meter, a total of three high and three low tests are conducted to ensure repeatability. For tests conducted during the construction season, one high and one low test will be sufficient. However, should either of the intermediate tests fail, it will be necessary to re-evaluate the meter using the initial acceptance procedure of three high and three low tests.

5. The following example illustrates the procedure: (See figure 4 for an example of this procedure)

   Maximum plant rate - 450 MgPH
   Asphalt content (theoretical) - 7.0 %
   Length of test (minutes)- 10

   Asphalt Accumulator Finish - 123.68 Mg
   Asphalt Accumulator Start - 118.49 Mg
   Delivered Quantity = 5.19 Mg (From recordation)

   Vehicle Scale Gross - 18020 kg
   Vehicle Scale Tare - 12780 kg
   Net Test Weight - 5240 kg or 5.24 Mg (Actual material)

   Theoretical Total Mix = 5240 kg \div 0.07 \% = 74857 kg or 74.86 Mg

   Meter Accuracy Tolerance = 74.86 Mg \times 0.1 \% = \pm 0.07 Mg
   Acceptable Range = 5.17 Mg - 5.31 Mg (5.24 Mg \pm 0.07 Mg)

6. These readings are recorded on BR 112. In this example, the meter is within the acceptable allowed tolerance range. Two more tests at this range, and three acceptable tests at the low range would complete the annual acceptance of this meter.
Drum Mix Asphalt Meter Example

**APOL F Region**

Inspector: Jon Jacobs - NYSDOT

Date Tested: 03/13/2005

### Asphalt Meter Accuracy Test

Asphalt Flow Rate: 450 MgPH, T.P.H. Plant Production x 7.0% Asphalt = 31.5MgPH T.P.H. Asphalt

### Test #1

<table>
<thead>
<tr>
<th>Meter or Accumulator</th>
<th>Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish 123.68 L @ 16°C or Tons</td>
<td>Gross 18020 kg or Tons</td>
</tr>
<tr>
<td>Start 118.49 L @ 16°C or Tons</td>
<td>Tare 12780 kg or Tons</td>
</tr>
<tr>
<td>Net 5.19 L @ 16°C or Tons</td>
<td>Net 5240 kg or Tons</td>
</tr>
</tbody>
</table>

Meter Net L @ 16°C or Tons = \( \frac{\text{Net} \times \text{kg/L}}{\text{T.P.H. Asphalt}} \) = \( \frac{5.19 \times 7.0}{31.5} \) kg

Tank Net 5240 kg or Tons ÷ 7.0% A.C. = 74857 kg or 74.86 Mg kg or Tons Theor. Batch

Theor. Batch 74.86 kg or Tons x 0.001 = ± 0.07 Mg kg or Tons Allow. Tol.

Acceptable Range = 5.17 Mg to 5.31 Mg

### Test #2

<table>
<thead>
<tr>
<th>Meter or Accumulator</th>
<th>Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish _____________ L @ 16°C or Tons</td>
<td>Gross ___</td>
</tr>
<tr>
<td>Start _____________ L @ 16°C or Tons</td>
<td>Tare ___</td>
</tr>
<tr>
<td>Net _____________ L @ 16°C or Tons</td>
<td>Net ___</td>
</tr>
</tbody>
</table>

Meter Net L @ 16°C or Tons = \( \frac{\text{Net} \times \text{kg/L}}{\text{T.P.H. Asphalt}} \) = \( \frac{\text{Net} \times \text{kg/L}}{\text{T.P.H. Asphalt}} \) kg

Tank Net ___ kg or Tons ÷ ___ % A.C. = ___ kg or Tons Theor. Batch

Theor. Batch ___ kg or Tons x 0.001 = ± ___ kg or Tons Allow. Tol.

Acceptable Range = ___ to ___

---

**FIGURE 4**

Asphalt Meter proved accurate in Test #1 – Three acceptable high and low range asphalt meter tests are required during the initial and subsequent annual testing of the meter. 90 day meter checks during the construction season require one high and one low range meter test.
V. HOT BITUMINOUS HOLDING BINS AND LOAD-OUT SYSTEMS

A. HOLDING BINS

Holding bins or silos shall meet the requirements of §401-3.09 Hot Mix Asphalt Holding Bins. Standard holding times of 6 and 12 hours will be granted, without testing, for silos and bins from manufacturers that have previously been approved by NYSDOT. Extended holding times of 24 or 48 hours may be approved through additional testing as per NYSDOT procedures.

B. LOAD-OUT SYSTEMS

The quantity of the mixture drawn from holding bins and delivered to State projects shall be measured and recorded by one of the following:

1. A truck scale conforming to §401-3.08A.10. Truck Scales

2. A weigh box or hopper suspended beneath the holding bin. The scale shall measure the actual weight to within an accuracy of 0.1 percent of full scale capacity or one graduation, whichever is less. There must be an interlock to prevent the commencement operation if the scale is outside the zero return tolerance. The zero return tolerance will be from 0 to a maximum of plus 70 kilograms or 0.07 metric tons, whichever is applicable. Each weighing cycle must be visually displayed and recorded.

C. DELIVERY TICKET REQUIREMENTS

1. Ticket number
2. Plant Identification
3. Contract number
4. Mix Codes
5. Quantity of material in vehicle (2 of 3- Gross, Net, Tare)
6. Date and Time
VI. PLANT AUTOMATION INSPECTIONS - DRUM MIXER

A. GENERAL

These procedures are a general guide for checking drum mix plants and shall be used in conjunction with the Standard Specifications §401 governing drum mix plants. As this is a general guide, some variations from this procedure may be necessary on different automation manufacturer’s software as well as the physical capabilities of the facility itself.

The following items shall be checked to determine conformance of the drum mixer automation and controls to the Standard Specifications:

B. MOISTURE COMPENSATION

1. Moisture Compensation shall be checked by placing the test weight(s) on the operating belt scale with the moisture content set at zero. The belt should be warmed up for approximately 15 minutes and the value of the test weight should be in the working range of the scale. Activate the recorder to produce prints at five minute intervals. Record the difference in aggregate totals at five minute intervals and use this number as the “Wet Weight”. It may be necessary to obtain more than one set of numbers to ensure that the zero is accurate, as all other calculations are based on this number.

2. Once a stable 0% moisture reading has been obtained, input an artificially high moisture content (greater than 20%) and again record the difference between aggregate totals at five minute intervals. Record this number as the “Dry Weight”. A high percentage will exaggerate the calculation, making any error in calculating moisture compensation obvious.

3. The correct method for determining moisture compensation is:

\[
\frac{\text{Wet Weight - Dry Weight}}{\text{Dry Weight}} \times 100 = \% \text{ Moisture}
\]

The incorrect method for determining moisture compensation is:

\[
\frac{\text{Wet Weight - Dry Weight}}{\text{Wet Weight}} \times 100 = \% \text{ Moisture}
\]

Refer to the following examples:
### Materials Method 27

<table>
<thead>
<tr>
<th>Time of Print</th>
<th>Agg. weight</th>
<th>Difference</th>
<th>Rate (MgPH)</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture @ 0 % ↓</td>
<td></td>
<td></td>
<td>223.1</td>
<td></td>
</tr>
<tr>
<td>10:15:32</td>
<td>119.04 Mg</td>
<td>N/A</td>
<td>222.9</td>
<td></td>
</tr>
<tr>
<td>10:20:32</td>
<td>137.61 Mg</td>
<td>18.57 Mg</td>
<td>223.0</td>
<td>137.61 – 119.04 = 18.57 Mg</td>
</tr>
<tr>
<td>Moisture @ 21.7 % ↓</td>
<td></td>
<td></td>
<td>183.1</td>
<td></td>
</tr>
<tr>
<td>10:50:32</td>
<td>169.89 Mg</td>
<td>N/A</td>
<td>183.1</td>
<td></td>
</tr>
<tr>
<td>10:55:32</td>
<td>185.16 Mg</td>
<td>15.27 Mg</td>
<td>183.0</td>
<td>18.57-15.27 × 100 = 21.6 % (OK) 15.27 (not 18.57)</td>
</tr>
<tr>
<td>Moisture @ 26.8 % ↓</td>
<td></td>
<td></td>
<td>175.5</td>
<td></td>
</tr>
<tr>
<td>11:20:32</td>
<td>215.42 Mg</td>
<td>N/A</td>
<td>175.7</td>
<td></td>
</tr>
<tr>
<td>11:25:32</td>
<td>230.06 Mg</td>
<td>14.64 Mg</td>
<td>175.6</td>
<td>18.57-14.64 × 100 = 26.8 % (OK) 14.64 (not 18.57)</td>
</tr>
</tbody>
</table>

4. The allowable variation for moisture compensation shall be ± 0.5% from the set point quantity. By calculating the moisture compensation both ways (correct and incorrect) it should be obvious as to which way the automation system is working.

C. ASPHALT INPUT CONTROL

1. The asphalt content shall be checked by placing the test weight(s) on the operating belt scale with the asphalt pump running in the circulate mode. Activate the recorder to produce prints at five minute intervals.

2. Input an artificially high (10-15 %) asphalt content, once again to exaggerate any error in the calculation involved.

*Note: Make sure not to exceed the capacity of the asphalt pump by inputting these artificially high percentages.*

3. Once the system has stabilized, record the differences of quantities of aggregate and asphalt during the 5 minute interval.
Determine the actual asphalt content using the following equations:

Asphalt content (%) without Recycled material =

\[
\text{Asphalt content} = \frac{\text{Asphalt from pump}}{\text{Dry Aggregate} + \text{Asphalt from pump}}
\]

Asphalt content (%) using Recycled material =

\[
\text{Asphalt content} = \frac{\text{Asphalt from pump} + \text{asphalt from recycle}}{\text{Dry aggregate} + \text{Dry recycle} + \text{asphalt from pump}}
\]

*Note: “Dry Recycle” normally still includes the recycled asphalt cement, therefore it is usually not necessary to include the recycle AC in the denominator of this equation.*

5. The allowable variation from the set point for asphalt input shall be 0.1%.

**D. INTERLOCKS**

1. Aggregate interlocks (normally called no-flows) are required to prevent the plant from producing material should one or more bins become empty. These interlocks are checked by running the plant with no material in the bins and activating the interlocks, one at a time, to shut the plant down within 5 seconds. Plant shut down is defined as the initiation of the stop sequence. Positive mechanical devices must be incorporated for this requirement, the use of tolerance deviation is not acceptable.

2. Asphalt interlocks are required to prevent the plant from producing material should the flow from the asphalt tank become restricted or cease. Mass flow meters (or equivalent) and float switches for the asphalt tank are acceptable and should shut the plant down within 5 seconds. Inline mechanical devices are not acceptable for this interlock.

**E. DISPLAYS AND RECORDATION**

1. Resolution of readouts:

   - **Plant Flow:**
     - Aggregate and RAP - nearest 1 Mg/hr.
     - Mineral Filler (if added separately) - nearest 0.1 Mg/hr.
     - Asphalt - nearest 0.1 Mg/hr.

   - **Resolution of Accumulators:**
     - Dry aggregate and RAP - 0.1 Mg
     - Mineral filler (if added separately) - 0.01 Mg
     - Asphalt - 0.01 Mg

   Resolution of Recordation: same as accumulators.

2. Recordation shall also include the date (day, month and year), time (nearest minute) and the actual asphalt content (nearest 0.1%).
3. Check to ensure that the totals during production agree between the recordation and the accumulators within one graduation. This test is done by simulating production using the test weight on the belt scale and recirculating the asphalt through the meter. Print intervals may be shortened for this test, but obtain enough readings to provide a good comparison.

F. MISCELLANEOUS

1. Check to ensure that the aggregate sampling device interrupts the full aggregate flow prior to being mixed with asphalt.

2. Check to see that all controls on the manual panel are properly identified (i.e. interlock bypass, auto/manual, no-flow bypass) and that any change of these controls which could affect proportioning are indicated on the recordation.

3. Check the variation of aggregate and mineral filler flow rate (automation display or recordation) from the target setpoint (±1.5% for aggregate and ± 0.5% for mineral filler, based on the total mix).

4. Check the variation of asphalt flow rate from the target setpoint (± 0.1% based on the total mix).
VII. PLANT AUTOMATION INSPECTIONS - ASPHALT BATCH PLANTS

A. GENERAL

1. The intent of the automation-recordation inspection is to verify that the equipment being checked is in compliance with the intent of NYSDOT specifications. The purpose of these tests is to verify that the automation system, operating in fully automatic mode, draws aggregates and asphalt to the pre-programmed weights without the interference of the operator.

2. The testing includes checking to see that an interruption to the batching cycle takes place whenever the batching tolerances for any material are not met and/or the automation system is taken out of the fully automatic mode. Depending on the automation system, a permanent record of the batch is made either during the process or immediately upon completion. A legible copy of this permanent record is supplied to the Department.

3. It is the responsibility of the Producer to have on site for this inspection, qualified personnel who are knowledgeable of the automation equipment and the facilities batching processes such that they can demonstrate that the automation system and facility meet applicable Department Specifications. An electronic simulator for each scale involved in the batching process is required unless the automation system has a different means of simulating batching without actually drawing material.

Note: This test is normally performed with the plant hot bins empty and asphalt valve closed so that no material is actually batched. The pugmill normally needs to “cycle” to produce the required recordation.

B. CHECK PROCEDURES - AUTOMATION

1. Determine the minimum and maximum batch size. The maximum batch size is determined from the Producer. The minimum batch size shall be no less than 50 % of the maximum batch size.

2. Determine zero return tolerance. This is the amount of acceptable weight which can be on the scale to initiate or discharge a batch. Zero return tolerance is equal to 0.5 % of the minimum batch size for aggregate and 0.1 % of the minimum batch size for asphalt.

3. Determine aggregate (and RAP, if applicable) batching tolerance. This is equal to ±1.5 % of the total batch size (asphalt included) for that specific batch.

4. Determine asphalt batching tolerance. This is equal to ±0.1 % of the total batch size.

5. Determine mineral filler batching tolerances (if applicable). This is equal to ±0.5 % of the total batch size. In addition, the aggregate which draws immediately prior to the mineral filler must be batched to the same tolerance as the mineral filler.

Note: Normally the tolerances will increase and decrease proportionally with the batch size. Should this not be the case, then the tolerances are fixed at the smallest approved batch size.
6. Set up a test formula to draw the maximum number of aggregates and asphalt that are expected to be used at one time.

7. Set the automation to operate in a test mode or weight check mode. This allows the operator to simulate the batching of material and to check to see that the automation is attempting to draw all of the preprogrammed weights and applying the correct tolerances. Test several different batch sizes. Remember to apply the tolerance to the particular batch size. The batching cycle must be interrupted and a definite indication must show up on the automation system to indicate when an out of tolerance condition is reached. Check to make sure that the batching tolerances cannot be changed during the batching cycle for the mixture being produced.

**Note:** *The purpose of the tolerance range is to accommodate occasional minor variations from the design value median zone, not to allow the production of material of borderline quality.*

8. Test to see that when the automation is in the fully automatic mode, no material can be drawn from any bin other than the bin being called for. This is done during the simulation of batching by simultaneously pressing the feed buttons for the bin being called for and any other bin. Only the bin being called for by the automation should be active. Check to see that no other manual controls are active. Evidence that the gates are active can be determined by bin indicator lights illuminating or actually hearing the aggregate feed gate open or the solenoid “click”, attempting to open the gate.

9. Check to see that all controls on the manual panel are properly identified (i.e. interlock bypass, auto/manual, no-flow bypass) and that any change of these controls which could affect proportioning are indicated on the recordation.

10. Check zero interlock (see step 2 for tolerance) by using the scale simulator to leave an “out of tolerance” value on the scale. In the fully automatic mode, this interlock should prevent the automation from either initiating or discharging the batch.

11. Check the batching interlocks to see that weigh hopper discharge gates (aggregate and asphalt) will not open until the material being batched is completely weighed up. Also check to see that no material inlet gates can be opened while the discharge gates are open.

12. Check dry and wet mix timers (15 seconds and 45 seconds respectively). The dry mix timer can start either on the opening of the aggregate weigh hopper discharge gate (after all aggregates are weighed) or when the pre-weighed aggregate discharges to within the zero return tolerance. In either case, the wet mix timer is not allowed to start prior to the completion of the dry mix timer. The wet mix timer is allowed to start either with the opening of the asphalt discharge valve (once the asphalt weigh-up is completed) or when the pre-weighed asphalt discharges to within the zero return tolerance. In either case, verify that the pugmill discharge gate will not open until the completion of the wet mix timer. Check the timers to ensure that they cannot be changed during the progress of the batch.
C. RECORDATION REQUIREMENTS

1. The recordation provides the Department with a permanent record of the quantities of material that went into each batch of asphalt mix. It also documents that all batching and mixing was done in the fully automatic mode. The printed weights shall reflect the actual quantities as indicated on the plant batching scales within one graduation.

2. The following is information required to be printed on the batch recordation (See figure 5 for a typical batch plant ticket):
   a. Aggregate identification and amount of each aggregate batched (in kg).
   b. Asphalt quantity (in kg).
   c. Total batch weight (in kg or Mg).
   d. Time (nearest minute) and date (day-month-year) of the load or batch.
   e. Serial or ticket number (permanent identification).
   f. A clear and identifiable indication whenever a batch is initiated without all conditions being satisfied for fully automated production or a system is taken out of the fully automatic mode during the batching or mixing sequence.
   g. In addition to the above information, if the automation is capable of making batches other than standard sizes (full, ½ or ¼ Mg increments) the recordation must show for each aggregate (mineral filler and RAP if used) and asphalt material, the target weight and the calculated over and under weights, or, the calculated over and under weights and the theoretical batch total. The Department requires this heading to be printed once for each load, regardless of the number of batches per load. If loading storage silos, each full ticket will be considered as a load.
   h. A clear indication whenever the system produces a “simulation” or “demonstration” batch.
   i. A clear indication whenever the system reprints a ticket.
ALWAYS HOT MIX, INC.  
P. O. BOX 1118 – EAST EDEN, NY

PLANT # 4

WEIGH MASTER:

<table>
<thead>
<tr>
<th>SHIP TO</th>
<th>FORMULA #</th>
<th>MIX CODE</th>
<th>JMF #</th>
<th>JOB NAME</th>
</tr>
</thead>
</table>
| TOWN MAINTENANCE GARAGE  
ERIE RESIDENCY | AHM-44 | 25F94NC | 211-34Y | ROUTE 66 REPAVING |

| | MIN | 476 | 986 | 1496 | 2029 | 2142 | 111.1 |
| | TARGET | 510 | 1020 | 1530 | 2030 | 2153 | 113.4 |
| | MAX | 76 | 1054 | 1564 | 2051 | 2164 | 115.7 |

<table>
<thead>
<tr>
<th>Batch#</th>
<th>TARE</th>
<th>FINES</th>
<th>1A’S</th>
<th>1’S</th>
<th>2’S</th>
<th>MF</th>
<th>TARE</th>
<th>%AC</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>15*</td>
<td>510</td>
<td>1020</td>
<td>1530</td>
<td>2040</td>
<td>2150</td>
<td>2.5*</td>
<td>113.5</td>
<td>(5.01)</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>505</td>
<td>1015</td>
<td>1535</td>
<td>2030</td>
<td>2150</td>
<td>0</td>
<td>112.0</td>
<td>(4.95)</td>
</tr>
</tbody>
</table>

ALL VALUES IN KG

<table>
<thead>
<tr>
<th>REQUESTED</th>
<th>TRUCK LOADS</th>
<th>LOAD TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.536 Mg</td>
<td>2</td>
<td>4.526 Mg</td>
</tr>
<tr>
<td>5.00 TONS</td>
<td>2</td>
<td>4.99 TONS</td>
</tr>
</tbody>
</table>

FIGURE 5
D. METHODS AND EXAMPLES FOR DETERMINING TOLERANCES

1. **Zero return tolerance:**
   
   Typical plant: 4.5 Mg maximum capacity - 2.25 Mg minimum capacity, with the capability of the separate addition of mineral filler.

   Aggregate scale: 5000 kg maximum capacity x 5 kg increments.
   Asphalt scale: 500 kg maximum capacity x 0.5 kg increments.

   Zero return tolerance - aggregate: \((2250 \text{ kg}) \times (0.5 \%) = 11.25 \text{ kg}\)

   Zero return tolerance - asphalt: \((2250 \text{ kg}) \times (0.1 \%) = 2.25 \text{ kg}\)

   In this example, the aggregate would have 2 graduations of tolerance and the asphalt would have 4 graduations of tolerance.

2. **Aggregate batching tolerance:**

   Assume batch size of 4.5 Mg (which is equal to 4500 kg).

   Aggregate batching tolerance = \((4500 \text{ kg}) \times (1.5 \%) = 67.5 \text{ kg}\)

   For each aggregate batched in this example, (excluding mineral filler), the tolerance is ± 67.5 kg

3. **Mineral Filler batching tolerance:**

   Assume batch size of 4.5 Mg

   Mineral filler batching tolerance = \((4500 \text{ kg}) \times (0.5 \%) = \pm 22.5 \text{ kg}\)

4. **Methods and examples for determining tolerances - Asphalt batching tolerance:**

   Assume batch size of 4.5 Mg

   Asphalt batching tolerance = \((4500 \text{ kg}) \times (0.1 \%) = \pm 4.5 \text{ kg}\)

   Typical example of 4.5 Mg batch:
<table>
<thead>
<tr>
<th>Material</th>
<th>Cumulative Target Weight</th>
<th>Tolerance</th>
<th>Acceptable Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agg. # 1</td>
<td>1250</td>
<td>±67.5</td>
<td>1182.5 - 1317.5</td>
</tr>
<tr>
<td>Agg. # 2</td>
<td>2650</td>
<td>±67.5</td>
<td>2582.5 – 2717.5</td>
</tr>
<tr>
<td>Agg. # 3</td>
<td>3850</td>
<td>±22.5</td>
<td>3827.5 - 3872.5</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>4245</td>
<td>±22.5</td>
<td>4222.5 - 4267.5</td>
</tr>
<tr>
<td>Asphalt @ 5.6 %</td>
<td>252.0</td>
<td>±4.5</td>
<td>247.5 - 256.5</td>
</tr>
</tbody>
</table>

5. Documentation - After satisfactory completion of the inspection, record the positions and functions of the various automation switches and/or controls that can affect proportioning or automated batching. This information should be included in the original automation approval and subsequent regional approvals. The information should be prominently displayed at the facility for the plant inspector’s reference.
VIII. RECLAIMED ASPHALT PAVEMENT (RAP) ADDITIONS AT ASPHALT BATCH PLANTS

A. GENERAL

1. In batch plants, regardless of the technique used to incorporate RAP into the HMA mixture, hot virgin aggregates are used to heat the cold, wet RAP. The most popular ways to produce recycled asphalt mixtures at batch plants are:

- Aggregate weigh hopper method
- Pugmill method utilizing separate weigh hopper
- Bucket elevator method

All methods require the automation perform additional calculations based on RAP properties.

B. AGGREGATE WEIGH HOPPER METHOD

1. Utilizing this method, the RAP is weighed last in the sequence and deposited into the aggregate weigh hopper along with the heated virgin aggregate. During this heat transfer, a significant amount of steam is released.

2. Settle time on the aggregate scale normally needs to be increased to ensure accurate batching of the RAP during the heat transfer process.

3. Asphalt binder content in the RAP needs to be proportionately added to the virgin asphalt content and displayed on the recordation as total AC content.

4. Wet mix time normally needs to be increased 15 seconds to ensure that the mix moisture is within Department limits as outlined in §401 of Standard Specifications.

C. PUGMILL METHOD-SEPARATE WEIGH HOPPER

1. Cold, wet RAP is batched into a separate weigh hopper while virgin aggregate and virgin asphalt are being batched.

2. RAP moisture content needs to be determined as outlined in Department Procedures, and compensated for during the weigh up process.

3. When weigh-up is complete, virgin aggregate is discharged into the pugmill, followed by the RAP. Heat transfer takes place in the pugmill during the dry mix time, creating a significant amount of steam. Extended dry mix time is required to ensure RAP dries sufficiently. Virgin asphalt is then discharged into the pugmill.

4. Asphalt binder content in the RAP needs to be proportionately added to the virgin asphalt content and displayed on the recordation as total AC content.
5. Wet mix time normally needs to be increased 15 seconds to ensure that the mix moisture is within Department limits as outlined in §401 of Standard Specifications.

D. BUCKET ELEVATOR METHOD

1. This method requires that the cold, wet RAP be proportioned on a belt scale and deposited onto the hot virgin aggregate as it enters the bucket elevator. Heat transfer and steam release happens on a continuous basis as the aggregates travel to the screen deck.

2. Because the RAP is blended with the virgin aggregate on a continuous basis, the virgin aggregate is also proportioned on a belt scale to ensure that the proper ratio of RAP to virgin aggregate is maintained.

3. Both feed belts need to compensate for aggregate moisture to accurately proportion RAP to the desired percentage.

4. The RAP feed bin must be equipped with a no-flow device that initiates a plant shut down within 5 seconds should the RAP bin become empty. Positive mechanical devices must be incorporated for this requirement, the use of tolerance deviation is not acceptable.

5. Once the RAP and virgin aggregate composite mixture reach the screen deck, one of two methods can be employed to control gradation.
   - In the first method, RAP and virgin aggregate are both screened together over the screen deck, and the composite mixture is separated into the different hot bins in the tower. Each hot bin is then sampled for asphalt content and gradation. Extractions must be done to determine the asphalt content in each bin. Gradations and asphalt content from the hot bin samples are then evaluated to determine mix design criteria, including virgin asphalt requirement. Alternate sampling and testing methods may be employed at the discretion of the Regional Materials Engineer.
   - The second method incorporates a “screen by-pass” system, where the composite mixture (RAP and virgin aggregate) is stored in a single hot bin in the batching tower and then weighed up as one in the aggregate weigh hopper. All gradation is controlled at the cold feed bins. Because of this, the aggregate feed bins need to incorporate no-flow device that initiates a plant shut down within 5 seconds should any of the cold feeds become empty.

6. Asphalt binder content in the RAP needs to be proportionately added to the virgin asphalt content and displayed on the recordation as total AC content.

E. RAP RECORDATION REQUIREMENTS

1. RAP Asphalt binder content
2. RAP Moisture content (if batching by method C or D as outlined above)
3. RAP Percentage of mixture (if batching by method D as outlined above)
IX. PLANT AUTOMATION INSPECTIONS- PORTLAND CEMENT CONCRETE PLANTS.

A. GENERAL

1. The intent of the automation-recordation inspection is to verify that the equipment being checked is in compliance with the intent of NYSDOT specifications. The purpose of these tests is to verify that the automation system, operating in fully automatic mode, draws aggregates and cement to the pre-programmed weights without the interference of the operator.

2. The testing includes checking to see that an interruption to the batching cycle takes place whenever the batching tolerances for any material are not met and/or the automation system is taken out of the fully automatic mode. Depending on the automation system, a permanent record of the batch is made either during the process or immediately upon completion. A legible copy of this permanent record must be supplied to the Department.

3. It is the responsibility of the Producer to have on site for this inspection, qualified personnel who are knowledgeable of the automation equipment and the facilities batching processes such that they can demonstrate that the automation system and facility meet applicable Department Specifications. An electronic simulator for each scale involved in the batching process is required unless the automation system has a different means of simulating batching without actually drawing material.

   Note: *This test is normally performed with the “air” to plant and any augers that feed material shut off, or all plant bins empty, so that no material is actually batched.*

B. CHECK PROCEDURES FOR AUTOMATION

1. Determine minimum batch weights. This is done by dividing two scale graduations by the tolerance applied to the specific material which will be weighed on that scale.

2. Determine the minimum and maximum batch sizes. The minimum batch size is calculated using the minimum batch weights determined in step one. See example in section F. Tolerances.

3. Determine zero return tolerance. This is the amount of acceptable weight which can be on the scale to initiate or discharge a batch. See example in section F. Tolerances.

4. Determine aggregate, cement and water, (water if central mix plant only), batching tolerances as per §501 of the Standard Specifications.

5. Set up a test formula to draw all aggregates and cements that are expected to be used at one time. Usually 3 aggregate draws and 3 cement draws (cement, flyash and microsilica). Admixes and water may not be required to be input at this time.
6. Set the automation to operate in a test mode or weight check mode. This allows the operator to simulate the batching of material and to check to see that the automation is attempting to draw all of the preprogrammed weights and applying the correct tolerances. Test several different batch sizes, remember to apply the tolerance to the particular batch size. The batching cycle must be interrupted and a definite indication must show up on the automation system to indicate when an out of tolerance condition is reached.

Note: The purpose of the tolerance range is to accommodate occasional minor variations from the design value median zone, not to allow the production of material of borderline quality.

7. Repeat steps 5 and 6, but this time input a moisture factor into the first or second aggregate draw. Check to see that all aggregate target weights after the draw with the moisture are recalculated to reflect the moisture input. See example in section F. Tolerances.

8. Test to see that when the automation is in the fully automatic mode that no material can be drawn from any bin other than the bin being called for. This is done during the simulation of batching by simultaneously pressing the feed buttons for the bin being called for and any other bin. Only the bin being called for by the automation should be active. Check to see that no other manual controls are active.

9. Check zero interlock (see step 2 for tolerance) by using the scale simulator to leave an out of tolerance value on the scale. In the fully automatic mode, this interlock should prevent the automation from either initiating or discharging the batch.

10. Test the batching interlocks to see that the weigh hopper discharge gates will not open until the material being batched is completely weighed up. This applies to both aggregate and cement. Also test to see that no materials inlet gates can be opened while the discharge gates are open. Relays, solenoids or indicator lights should either give an audible sound or light up to indicate whether gates are trying to open or not.
C. ADMIXTURES

1. Admix systems must be calibrated to meet a delivery tolerance of ± 3% or 1 count, whichever is greater, of the quantity called for in the system. Standard Specifications require that all admixtures to be in a liquid form. Normally, they are volumetrically measured by a meter. Verify the admixture meter at the lowest recommended dose at the minimum batch size, and the highest recommended dose at the maximum batch size. Draw the required sample of admixture, either through the automation, by inputting a mix design that includes only the admixture under test, or manually batching the admixture under test. The admixture must be dispensed through the meter and (if equipped) a vial, then completely emptied into a graduated cylinder. Determine whether the quantity drawn through the meter is within the specified tolerance. See section F. Tolerances.

2. Test the admixture system interlocks. Normally there are two types of systems, “meter to vial” or “meter direct”. In the “meter to vial” system there are three interlocks to check.

   - The batch should not initiate unless the vial is empty, or if it does, an indication should show up on the recordation. To check for this, either manually put material into the vial to cover the zero probes or use a jumper wire to simulate material in the vial.
   - The second interlock requires that, if the programmed amount of admix is not reached, the aggregate and cement discharge gates cannot open. To check for this, batch complete the aggregate and cement then slowly simulate the batching of the required amount of admixture stopping at least 2 counts short of target. The batch should not complete until the target amount of admixture is reached.
   - The final interlock requires that the admixture completely discharge to the zero point. If the admixture does not completely discharge into the batch, the recordation must not print (which is usually the last thing to happen). The interlock must not allow a new batch to be initiated.

3. In a meter direct system, there are no holding vials. The programmed amount of admixture is pumped through the meter continuously until the quantity called for is batched. The only interlock required in this system is to check that if the quantity called for is not reached, then the batch will not complete. This can be checked much the same way as when using the vials.

4. In addition to the above interlocks, an interlock is required at the storage point of the admixture. If the admixture supply is exhausted, this interlock prevents the meter from “counting” air as it is pushed through by the pumps. There are several methods to used to activate this interlock. The type of pump or pump configuration being employed, air operated flexible bladder tanks and actual floats in the admixture storage tanks are all viable methods. Check this interlock by removing the admixture intake line from the pump. This is necessary rather than just turning off the valve from the storage tank. Have the automation call for the admixture. If the system is interlocked correctly, no counts will appear on the meter.

   Note: This final admixture interlock should be performed by the Producer or the admixture representative.
D. RECORRATION REQUIREMENTS

1. The recordation provides the Department with a permanent record of the quantities of material that went into each batch of concrete. It also documents that all batching was done in the fully automatic mode. The printed weights shall reflect the actual quantities as indicated on the plant batching scales within one \( \pm \) graduation.

2. The following information is required to be printed on the batch recordation: (see figure 6 for a typical concrete batch ticket).
   a) Individual aggregate identification and quantity
   b) Individual cement and pozzolan (if used) identification and quantity
   c) Water quantity (central mix plants only)
   d) Quantity and type of admixtures
   e) Time (to the nearest minute) of batch completion and date (day-month-year)
   f) Mix identification (concrete class)
   g) Individual batch number (preprinted ticket serial numbers are acceptable)
   h) A clear and identifiable indication whenever a batch is initiated without all conditions being satisfied for fully automated production or a system is taken out of the fully automatic mode during the batching or mixing sequence.
   i) In addition to the above information, if the automation is capable of producing batches other than standard sizes (standard sizes is defined as ¼, ½ or full cubic meter increments), the recordation must show for each aggregate, cementitious and water (central mix only) the target weight and the calculated over and under weights, or the target weight and percent variation from target.
   j) A clear indication whenever the system produces a “demonstration” or “simulation” batch.
   k) A clear indication whenever the system reprints a ticket.

E. CENTRAL MIX PLANTS

1. Central mix plants require a mix time interlock. The timer must be readily visible such that the preset mix times can be verified. The two interlocks required are:
   a) The timer does not start until all scales reach an empty condition, and the mixer is fully charged, including all metered material.
   b) The mixer will not start to discharge until the full mix time has elapsed.

If either interlock can be bypassed, a clear indication must show on the recordation.
F. METHODS AND EXAMPLES FOR DETERMINING TOLERANCES

1. **Minimum Batch Weights.**

   Typical plant: 7.5 Cubic Meter batch plant.

   Aggregate Scale: 20000 kg using 20 kg increments.
   Cement Scale: 5000 kg using 5 kg increments.

   Minimum Batch weights are determined by allowing 2 graduations for each specific scale, divided by the materials batching tolerance.

   \[
   \text{AGGREGATE MINIMUM BATCH WEIGHT} = \frac{(\text{Scale grad. } \times 2)}{0.02} \\
   \text{Example: (scale grad = 20 kg)} \quad \frac{20(2)}{0.02} = 2000 \text{ kg} \\
   \text{CEMENT MINIMUM BATCH WEIGHT} = \frac{(\text{Scale grad. } \times 2)}{0.01} \\
   \text{Example: (scale grad = 5 kg)} \quad \frac{5(2)}{0.01} = 1000 \text{ kg}
   \]

2. **Minimum Batch Size.**

   Minimum batch size is determined by using the calculated minimum batch weight and dividing by an assumed concrete batch of 1800 kg of aggregate and 360 kg of cement per cubic meter respectively.

   Aggregate: \[2000 \text{ kg (minimum calculated batch weight)} = 1.11 \text{ m}^3\] \[1800 \text{ kg (average mass of aggregate per m}^3)\]
   Cement: \[1000 \text{ kg (minimum calculated batch weight)} = 2.81 \text{ m}^3\] \[360 \text{ kg (average mass of cement per m}^3)\]

   In this case the minimum batch size is determined by the cement and would be rounded to the nearest acceptable nominal size (i.e. 3.0 m³).

3. **Zero Start/Return.**

   Zero start/return tolerances are the values determined for each scale to which the load can begin or finish. This is determined by using the calculated minimum batch weight and multiplying by the materials batching tolerance.

   Aggregate: \[2000 \text{ kg (minimum calculated batch weight)} \times 0.02 \% = 40 \text{ kg}\]
   Cement: \[1000 \text{ kg (minimum calculated batch weight)} \times 0.01 \% = 10 \text{ kg}\]

4. **Aggregate Batching Tolerances**

   If the facility is using a single weigh hopper/scale for aggregate, batching tolerances are based on the **cumulative** total of the aggregate requested for the specific batch size.
Example: Assume that the plant is batching 6.0 m³ with 1800 kg of aggregate per cubic meter.

Aggregate tolerance: \( (6.0 \text{ m}^3 \times 1800\text{ kg}) = 10800 \text{ kg} \times 0.02 = 216 \text{ kg} \)

For each aggregate batched in this example, the tolerance is ± 216 kg

Some facilities use separate weigh hoppers/scales for each aggregate. Should this be the case, the tolerance would be applied to the cumulative total of aggregate for each scale for that specific batch size.

Example: Assume that the plant is batching 6.0 m³ with three draws of aggregate of 600 kg each.

Aggregate tolerance: \( (6.0 \text{ m}^3 \times 600 \text{ kg}) = 3600 \text{ kg} \times 0.02 = 72 \text{ kg} \)

For each aggregate batched in each scale in this example, the tolerance is ± 72 kg

5. Cement Batching Tolerances

If the facility is using a single weigh hopper/scale for the cementitious materials, batching tolerances are based on the cumulative total of the cementitious materials requested for the specific batch size.

Example: Assume that the plant is batching 6.0 m³ with three cementitious draws totaling 405 kg per cubic meter.

Cementitious tolerance: \( (6.0 \text{ m}^3 \times 405 \text{ kg }) = 2430 \text{ kg} \times 0.005 = \pm 12.15 \text{ kg} \)

For each cement batched in this example, the tolerance is ± 12.15 kg

6. Water Batching Tolerances

This tolerance applies to Central Mix Plants only. Water can either be weighed or metered.

Example: Assume that the plant is batching 6.0 m³ with 150 Liters of water per cubic meter.

Water tolerance: \( (150 \text{ liters} \times 6.0 \text{ m}^3 \) = 900 liters (or kg) \times 0.01 = \pm 9 \text{ liters} \)

7. Moisture Compensation Calculation: The amount of moisture in the aggregate must be compensated for by the automation system. Perform the aggregate free moisture test based on Department written instructions. A moisture sensing device, once deemed accurate by the Regional Materials Engineer or his representative, may be used to adjust the free moisture content of the fine aggregate between batches. No adjustment for free moisture will be allowed for an individual batch after batching starts.
Example: Assume that the plant is batching 6.0 m³ with 4.3% moisture content inputted in a bin that is calling for 600 kg/m³.

Moisture calculation = 6.0 m³ x 600 kg = 3600 kg of aggregate with 4.3% moisture.

3600 kg x (.043) = 154.8 kg. The target weight of this specific aggregate will have to be increased this amount to compensate for the free moisture.

Note: Some automation systems will “carry-out” this calculation two or three times (i.e. 154.8 kg (.043) = 6.66 kg; 6.66 kg (.043) = .29 kg for a total moisture compensated additional mass of 161.75 kg.)

8. Admixture Tolerance

When testing the admixture dispensing system two separate checks are performed, delivery tolerance and accuracy tolerance. Delivery tolerance is a check to see that the automation system attempts to batch to the preprogrammed target value of admixture. Accuracy tolerance is a comparison of the meter reading to the actual volume of admixture dispensed. In each case, the tolerance values are the same, and can be found in §501 of the Standard Specifications. The tolerance is ± 3% or 1 count of the meter, whichever is greater.

Accuracy tolerance is applied to the known volume of admixture as measured.

Check the production facility at the minimum and maximum approved batch sizes using the minimum and maximum recommended admixture dosage rates, respectively.

Example, maximum range:

Assume: Facility production range - 3.0 - 7.5 m³
         Admixture dosage rate - 30 - 250 ml / 100 kg

High range check: 7.5 m³ x 360 kg = 2700 kg of cement.
2700 kg / 100 = (27 cwt) x (250 ml) = 6750 ml (Target value)

Have the plant operator request this amount from the system, either by manually batching admixture or by setting up a mix design isolating the admixture under test and batching automatically. If batching manually, do not interrupt the flow of the admixture by “pulsing” the meter.

Target value = 6750 ml
Amount delivered (according to automation display) = 6808 ml
Amount measured (graduated cylinder) = 6700 ml
Delivery tolerance = ± 3% or 1 count (1 count = 30 ml) = (6700) x (0.03) = ± 201 ml
In this case, the tolerance range would be 6499 ml - 6901 ml
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<th>MATERIAL</th>
<th>ACTUAL</th>
<th>TARGET</th>
<th>% TOL</th>
<th>% MOIST</th>
<th>START TARE</th>
<th>END TARE</th>
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<td>4600 KG</td>
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<td>0.00</td>
<td>AGG 30 **</td>
<td>0 KG</td>
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<td>9380 KG</td>
<td>1.5</td>
<td>4.30</td>
<td>CEM 15 **</td>
<td>0 KG</td>
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<td>1665 ML</td>
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</table>

BOTTLE 1 NOT EMPTY

FINISHED TIME 02:21 PM

FIGURE 6
G. DOCUMENTATION

After satisfactory completion of the inspection, record the positions and functions of the various automation switches and/or controls that can effect proportioning or automated batching. This information will be used for processing the Main Office Automation Approvals and the Regional Office Annual Approvals.