WSDOT

Standardization and Check Procedures for Region Laboratory Equipment

2017

The procedures in this document meet the standardization and check requirement of AASHTO R 18 and/or the procedure standards referenced for each piece of equipment.

Introduction

Verification Procedures (VP's) are in-house written procedures for performing standardization or check of laboratory equipment. The procedures are uniquely identified, describe the equipment required to perform, designates the frequency to occur and includes a step-by-step procedure for performing the activity.

All Verification Procedures (VP's) consist of two parts:

Procedure: The procedure portion covers:

- What test procedure(s) the equipment is used in
- What measurement standard is required to perform the standardization/check
- The required accuracy of the measurement standards
- Whether the procedure is a check or a standardization
- The tolerances for the equipment
- A step by step explanation of how to standardize or check the equipment.

Worksheet: The Worksheet is used to document the following:

- unique identification of the equipment
- Frequency of standardization/check
- name of the person performing the standardization/check
- Date the equipment was standardized/checked
- Date of the previous standardization/check.
- Date of the next standardization/check, SML or Region.
- Measurement standards used to perform the standardization/check
- Specification and tolerances for the equipment being standardized/checked
- Actual measurement(s) of the equipment
- Whether the equipment is satisfactory or unsatisfactory for use
- Whether the equipment requires a correction factor to be applied.
- What steps were taken (replace, repair, dispose, removed from service, apply correction, none).
- Additional comments

Table of Contents

Standards/ Measurement Standards

A Standard or Measurement Standard is equipment used to calibrate/standardize/check other equipment. This equipment must be calibrated by an accredited calibration laboratory, traceable to N.I.S.T. (National Institute of Standards and Technology), and **cannot be used in daily work**.

All equipment used to perform the standardization/check must be recorded on the verification worksheet and identified with a unique ID number. All Certificates of Calibration for Standards should be kept in a separate file to make it easy to verify the calibration of the Standard.

Correction of Standard Measurements

If the calibration company notes a required correction on the Certificate of Calibration this correction must be noted on all worksheets that reference the Standard.

Example: The Certificate of Calibration for Standard thermometer shows the thermometer requires a correction of -1˚F. When using the Standard for standardization of an oven the correction of -1˚F must be noted on the worksheet to indicate the Standard requires a correction factor.

The correction information can be a simple statement in the comments section of the worksheet as shown below:

Standard thermometer 93410034 requires a -1˚F correction, recorded readings include this correction.

Entering Data

All entries must be made in permanent ink or can be typed on the computer and a .pdf printed or stored electronically.

If a correction must be made, the verification technician must put one straight line through the incorrect data, initial it and write the corrected data underneath the old lined out data. If there is not enough room for the correction a new worksheet may be created and the original sheet may be attached to the new worksheet if required.

Units of measure must be recorded on individual measurements if the worksheet does not specify the unit of measure (i.e. kg, ˚ F, mmHg, etc.). If the worksheet does not state units of measure but you are using only one unit of measure you may define the unit of measure in the comments section like this:

Unit of measure for all measurements above is ˚F

All measurements must be entered individually. Do not use repeat signs or down arrows to indicate repeated measurements.

Make sure all required data is entered into the header of the worksheet. You may leave the Time Charged blank if your laboratory is not using this information. If the piece of equipment being standardized or checked has not been previously standardized or checked, enter "New" as the Previous Verification Date. Indicate the due date and frequency for the Next Verification.

If a piece of equipment was standardized/checked but was not used, and the laboratory has stored it in such a manner that the standardization/check has not changed, the laboratory may roll the previous standardization when the equipment is put into service like this:

Equipment used and stored in a protected environment until ___date_____.

Make sure the Next Verification Date is revised to the in-service date + the frequency of verification (apply a new verification sticker if applicable).

As Found/As Left

As found/Set Temp are notations that provide information on the reliability of the equipment. If a piece of equipment requires adjustment each time it is standardized or checked the frequency of standardization/check should be increased or the equipment may be in need of repair.

Example: Ovens - enter the target temperature and indicator setting in the "as found" column. If no adjustment is needed enter the same temperature in the "set temp" column for reading one, then continue entering the time and temperature reading in the "set temp" column, unless something changes.

CHECK PROCEDURE: VP-1 (Sieves)

Equipment Verified: SIEVES

Standard References: AASHTO M 92

Purpose

This method provides instructions for checking the physical condition of laboratory test sieves ranging in size from 75mm (3 inches) to 0.075mm (No. 200).

Standard Equipment Required:

1. An eyepiece with a scale readable to 0.1mm (for use when checking sieves finer than No. 4).

2. A caliper readable to 0.01mm

3. A set of gauge blocks with one side equal to ½ the sieve opening and the other side stepped having a minimum dimension equal to the minimum specified opening, and a maximum dimension equal to the maximum specified size of the opening as stated in the applicable tolerances from AASHTO M-92. As a minimum, the gauge block shall have the following sizes 1-1/2", 1- 1/4", 1", 3/4", 5/8", 1/2", 3/8", #4.

Tolerance

Sieves shall meet the physical requirements specified in AASHTO M - 92 (ASTM E -11).

Procedure

General inspection of all sizes of sieves

1. Check the frame and solder joints for cracks or holes (check for pin holes in the finer sieves).

2. Make sure the sieve has an appropriate label, i.e. the ID # and sieve size.

3. Check the sieve mesh for excessive bowing by pressing the mesh from either side, it should not flex the more than 1/8".

4. Mark sieves acceptable by placing a signed and dated sticker on the frame of the sieve.

5. Discard unacceptable sieves

Inspection of sieves having openings equal to or greater than 4.75 mm

1. Select and measure the dimensions of at least 4 or 5 sieve openings in each sieve to ensure that the openings in the wire cloth conform to the requirements in Table 1.

    a. If a sieve has less than five full openings, measure all full openings.

    b. Include, in the selection, any openings that appear distorted or unusual in size

2. Measure each opening in both the x (horizontal) and y (vertical) directions with calipers or a set of standard gauge blocks.

    a. **Calipers**- measure each of the openings as the distance between parallel wires measured at the center of each opening. Record the measurements for each of the selected openings.

    b. **Gauge blocks**- measure and record the minimum and maximum dimension of each step for each block prior to use. The block is inserted into each opening to be measured in the horizontal and vertical directions.

        i. If the opening is undersized, the block will not pass the minimum step

        ii. if the opening is oversized, then the block will pass the maximum step.

3. Record measurements or pass/fail for each sieve.

Inspection of sieves smaller than No. 4,

1. Inspect the sieve cloth against a uniformly illuminated background.
2. Use the eye comparator or magnifier to examine any suspicious areas of the cloth.
3. The wire cloth is unacceptable if there are obvious deviations, such as weaving defects, creases, wrinkles, or foreign matter in the cloth.

Size (in) or #	Metric (mm)	Hole Size English		Hole Size Metric	
		Max. (in)	Min. (in)	Max. (mm)	Min. (mm)
4”	100	4.051	3.823	102.9	97.1
3"	75	3.039	2.866	77.2	72.8
2-1/2"	63	2.555	2.406	64.9	61.1
2"	50	2.028	1.909	51.5	48.5
1-1/2"	37.5	1.520	1.433	38.6	36.4
1-1/4"	31.5	1.280	1.201	32.5	30.5
1"	25	1.016	0.953	25.8	24.2
3/4"	19	0.772	0.724	19.6	18.4
5/8"	16	0.650	0.610	16.5	15.5
1/2"	12.5	0.507	0.477	12.89	12.11
3/8"	9.5	0.386	0.362	9.8	9.2
5/16"	8	0.325	0.305	8.25	7.75
¼’	6.3	0.256	0.240	6.50	6.10
#4	4.75	0.193	0.181	4.9	4.6

Table 1 Sieve Sizes and Permissible Deviations

Worksheet: VP-1

Sieves (Regions) Frequency: 12 months Standard References: ASTM E 11

Equipment ID:		Verifying Technician:	
Date Verified		Next Verification Date:	
Previous Verification Date:		Time Charged:	
Standard	**ID#**	**Standard**	**ID#**
Eye Piece		Calipers	
Gauge Blocks			

Size (in) or #	Metric (mm)	Hole Size		Number Inspected	Number OK	Remarks
		Max.(mm)	Min. (mm)			
4”	100	102.9	97.1			
3"	75	77.2	72.8			
2-1/2"	63	64.9	61.1			
2"	50	51.5	48.5			
1-1/2"	37.5	38.6	36.4			
1-1/4"	31.5	32.5	30.5			
1"	25	25.8	24.2			
3/4"	19	19.6	18.4			
5/8"	16	16.5	15.5			
1/2"	12.5	12.89	12.11			
3/8"	9.5	9.8	9.2			
5/16"	8	8.25	7.75			
¼”	6.3	6.50	6.10			
#4	4.75	4.9	4.6			
Sieve cloth of sieves smaller than #4 are visually inspected for weaving defects, creases, wrinkles, etc.						
#6						
#8						
#10						
#12						
#16						
#20						
#30						
#40						
#50						
#60						
#80						
#100						
#200						
Total Number of Sieves						
Pans & Covers : ❑ Satisfactory ❑ Unsatisfactory						

CHECK PROCEDURE: VP-02 (Single Use Mold)

Equipment Verified: SINGLE USE CONCRETE CYLINDER MOLDS

Standard References: AASHTO M-205

Purpose

This procedure provides instructions for verifying compliance of single use plastic cylinder molds.

Standard Equipment Required

Inside Caliper reading to 1/16" (1 mm)

18- inch Scale reading to 1/16" (1 mm)

Tolerance

Single use molds shall meet criteria described in sections 3 and 6 of AASHTO M-205.

Procedure

1. Inspect three molds from each shipment delivered to the Materials Laboratory as follows:
2. Measure the inside diameter of the mold and record on the worksheet.
3. Measure the inside height of the mold at two locations and record on the worksheet.
4. Check the resistance of the mold to damage under use by filling it in three lifts with a 1"-#4 crushed aggregate. Rod each lift 25 times. After filling the mold, empty it, wipe lightly with a clean cloth and examine for damage.
5. Check mold for water tightness by filling it with room temperature water and allowing it to stand for three (3) hours, then note any visible leakage.
6. When the inspection is complete, report the following:
7. Brand of molds;
8. Shipment or lot samples taken from;
9. Date sampled, date tested;
10. Brief description, type of mold, nominal dimensions, type of material;
11. Water tightness (complies or fails); and
12. If sample fails, record average diameter or height and maximum and minimum diameter or height.
13. Mark the boxes of molds that have been inspected with the inspection date, pass or fail, and the inspector's name.

Worksheet: VP-02

Single Use Plastic Concrete Cylinder Molds **Frequency: Per shipment**

Standard References: AASHTO T 23

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper		18 inch ruler	

	Single Use Plastic	Single Use Plastic	Single Use Plastic
BRAND			
LOT #			
DATE SAMPLED			
DATE TESTED			

	SAMPLE #1	SAMPLE #2	SAMPLE #3
HEIGHT +/- 2%			
DIAMETER +/- 1%			
WALL THICKNESS			
WATER TIGHTNESS (Leak Test)	❑ Pass ❑ Fail	❑ Pass ❑ Fail	❑ Pass ❑ Fail

Comments:

STANDARDIZATION PROCEDURE: VP-4 (Concrete Pressure Meter)

Equipment Verified: CONCRETE AIR METER PRESSURE GAUGE

Standard References: AASHTO T 152, Annex A 1.9, Manufacturer's Instructions

Purpose

To perform a Calibration test to check the Air Content Graduations on the Pressure Gauge, Type B Meter.

Standard Equipment Required

Calibration tubes and measures: as provided by the gauge manufacturer.

Tolerance

Adjust gauge hand if two readings at 5% are in error by more than 0.2%.

Procedure

Note: - The procedure described below generally follows the written instructions for Type B meters manufactured by Forney or Watts. Consult the manufactures instruction for meters manufactured by other manufacturers.

1. Fill the base full of water
2. Screw the short piece of straight tubing into the threaded petcock hole on the underside of the cover. Clamp the cover on the base with the tube extending down into the water.
3. With both petcocks open, add water with the syringe through the petcock having the pipe extension below, until all air is forced out opposite petcock. Leave both petcocks open.
4. Pump up air pressure to a little beyond the pre-determined initial pressure line. Wait a few seconds for compressed air to cool to normal temperature and then stabilize the gauge hand at the proper initial pressure by pumping or bleeding off as needed.
5. Close both petcocks and immediately press down on the thumb lever exhausting air into the base. Wait a few seconds until the needle stabilizes. If all the air was eliminated and the initial pressure line was correctly selected, the gage should read 0%. If two or more tests show a consistent variation from zero% in the result, then change the initial pressure line to compensate for the variation. Use the newly established "initial pressure" line for subsequent tests.
6. Screw curved tube into the outer end of the petcock and by pressing on thumb lever end controlling flow with petcock lever, fills the 5% calibrating vessel (345 ml) level full of water from the base.

7. Release the air at the free petcock. Open the other petcock and let the water in the curved pipe run back into the base. There is now 5% air in the base.
8. With petcocks open, pump air pressure in exact manner outlined in paragraph 4. Close petcocks and immediately press thumb lever. Wait a few seconds for the exhaust air to warm to normal temperature, and for the needle to stabilize. The dial should now read 5%.
9. If two or more consistent tests show that gage reads incorrectly at 5% air in excess of 0.2%, then remove gauge glass and reset the dial hand to 5% by turning the recalibrating screw.
10. When gauge needle reads correctly at 5%, additional water may be withdrawn in the same manner to check results at 10%, 15%, 20%, etc.

Worksheet: VP-04

Air Content Meter (Pressure)

Frequency: **Region – Yearly**
PEO–Weekly when in use

Standard References: AASHTO T 152

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Calibrated 5% tube			

Beginning Initial Pressure _____	**Final Initial Pressure** _____

Equipment found to be:	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-5 (Unit Weight)

Equipment Verified: UNIT WEIGHT MEASURES

Standard References: AASHTO T 19, T 121, T 152

Purpose

This method provides instructions for the standardization of unit weight measures used in the Materials Laboratory.

Standard Equipment Required

1. Calipers having a range sufficient to measure the diameter of the measure being checked and readable to at least 0.001 inch (0.025 mm)
2. Feeler gauge; 0.01 inch (0.25mm)
3. Ruler or scale, readable to at least 1/16 inch 1(mm)
4. Inside diameter calipers, 12 inch (300mm) range
5. Diameter tape, readable to 0.01 inch (1 mm)
6. A plate, either of glass at least ¼ inch (6 mm) thick or acrylic at least (1/2 inch (12mm) thick, and at least 1 inch (25 mm) larger than the diameter of the measure to be calibrated.
7. Place a supply of water pump or chassis grease, or similar substance on the rim of the container to prevent leakage.
8. Balance conforming to the requirements of AASHTO M231 for the class of general purpose balance required for the principal weight of the measure filled with water and the plate for calibration.
9. Thermometer, calibrated and readable to 0.2F (0.1C) having a range sufficient to determine the temperature of the water in the measure at approximately room temperature.

Tolerance

Unit weight measures shall meet all appropriate specifications described in AASHTO T-19.

Procedure

1. Measure the height and insure that it is approximately equal to the diameter. In no case shall the height be less than 80% or greater than 150% of the diameter.

2. Check to see that the top is smooth and plane by placing the plate on the top and insure that the 0.01 in. feeler gage cannot be inserted between the plate and the top of the measure.

3. Check to see that the top and bottom are parallel by measuring the distance from the plate to table on each side, divide the shorter distance by the longer distance for each two opposite sides, neither result shall exceed 0.5 degrees (0.87%).

4. Determine the thickness of metal of the upper 1 1/2 inches (38 mm) of the wall with the calipers in two locations, 90 degrees apart. Compare the average of the two measurements with the standards of T 19.

5. Measure the inside diameter with the inside calipers and scale. Determine the outside diameter by means of the diameter tape. Determine the wall thickness as one half the differences in diameters and compare with the standards of T 19.

6. Measure and record the external height of the measure at two places 90 degrees apart. Determine the inside height of the measure by measuring from the plate across the measure to the bottom of the measure. Determine the bottom thickness as the difference between the two heights

7. Record the empty weight of the measure with the plate.

8. Fill the measure with water (approx. room temperature)

9. Cover the measure with the plate to eliminate bubbles or excess water (use grease if necessary).

10. Record the weight of the measure, plate, and water. .

11. Measure the water temperature and determine the density of water using the table on the worksheet.

12. Calculate the weight of the water.

13. Calculate the volume of the measure

14. Calculate the calibration factor.

Worksheet: VP- 05

Unit Weight Measure — Frequency: **Region-Yearly**
Standard References: AASHTO T 121, T 19

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Caliper		Glass Plate	
Straightedge		Feeler Gauge	
Steel Ruler			

Planeness	
Top rim is smooth?	❑ Yes ❑ No
Top rim is plane, within 0.01 in.?	❑ Yes ❑ No
Top and bottom are parallel within 0.5 degrees?	❑ Yes ❑ No

Weights and factors	
Record empty weight of measure with plate (lb.(kg)): [1]	
Record weight of measure, plate and water (lb.(kg)): [2]	
Record temperature of water: °F(°C)	_____ °F _____ °C

Measurements	**Reading 1**	**Reading 2**	**Average**
Diameter (in)			
Height (in) tolerance 80% - 150% of diameter: % $=\frac{Dia}{h}$ x 100			
Thickness of metal in upper 1-1/2" of wall (in): *See Table1 on page 2 of worksheet,*			
Thickness of metal in remainder of wall (in): *See Table1 on page 2 of worksheet,*			
Thickness of metal at bottom(in): *See Table1 on page 2 of worksheet* , _____			
Determine density of water. *See Table 2 on page 3 of worksheet* **[4]** lb/f^3 (kg/m^3)			
Calculate the mass of the water. **[3]= [2]-[1]** lb.(kg)			
Calculate volume of measure. **[V= [3]/ [4]** cf (cm)			
Calculate the calibration factor. 1/**[V]**			

Capacity **Cubic feet**	**Bottom**	Upper 1-1/2" **of Wall**	Remainder **of Wall**
<0.4	0.2 in.	0.10 in.	0.10 in.
0.4 to 1.5	0.2 in.	0.20in.	0.12 in.

Table 1 Thickness of Metal (minimum)

□F	**□C**	**lb./ft.³**	**kg/m ³**		**□F**	**□C**	**lb./ft.³**	**kg/m³**
59.0	15	62.372	999.10		73.4	23	62.274	997.54
60.0	15.6	62.366	999.01		75.0	23.9	62.261	997.32
60.8	16	62.361	998.94		75.2	24	62.259	997.29
62.6	17	62.350	998.77		77.0	25	62.243	997.03
64.4	18	62.340	998.60		78.8	26	62.227	996.77
65.0	18.3	62.336	998.54		80.0	26.7	62.216	996.59
66.2	19	62.328	998.40		80.6	27	62.209	996.50
68.0	20	62.315	998.20		82.4	28	62.192	996.23
69.8	21	62.302	997.99		84.2	29	62.175	995.95
70.0	21.1	62.301	997.97		85.0	29.4	62.166	995.83
71.6	22	62.288	997.77		86.0	30	62.156	995.65

Table 2 **Unit Mass of Water** (FOP for AASHTO T121)

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-10 (Ovens W/O Openings)

Equipment Verified: General Purpose oven without opening

Standard References: AASHTO R 18

Purpose

This method provides instructions for checking the temperature indicator on general-purpose drying ovens.

Standard Equipment Required:

1. A calibrated temperature measuring device capable of reading in 1° increments and having a range that includes the temperature range to be checked.

2. A brass thermometer well to retain heat while the oven door is open. This is essential for a constant temperature reading. If a thermocouple is used the brass well is not required.

3. A clothespin to hold the thermometric device in such a manner as to enable the operator to read the scale easily from outside or inside the oven. (Not required for thermocouples)

Tolerance:

Drying ovens shall be capable of maintaining the constant temperature range stated in each test method performed in the oven.

Procedure:

1. Position the thermometer or thermocouple probe in the area of the oven that best represents the overall temperature of the oven.

   Note: If using a thermometer, place the thermometer inside the brass well with the clothespin attached to the thermometer.

2. Set the oven's temperature indictor device to the mid-temperature of the temperature range required by the test procedure performed in the oven. Example: 230 ± 9 º F set temperature indicating device to 230 º F

3. Take the first reading at least 1 hour after closing the oven (oven should remain undisturbed).

4. Take as many readings as necessary to determine if the setting on the temperature indicating device accurately represents the internal temperature of the oven (three consecutive readings, taken no less than 1/2 hour apart if using a liquid-in-glass thermometer and no less than 15 minutes apart if using a thermocouple, are adequate.)

5. If the internal temperature measured in the oven does not agree with the setting on the temperature indicating device, adjust the temperature indicating device to the measured internal temperature. Allow at least 1/2 hour for the temperature to stabilize and repeat step 3. Continue until the setting on the temperature indicating device and the internal temperature are the same.

6. Repeat the procedure from step 2 until temperature ranges are checked for all test procedures which require the oven.

7. If the oven does not have a means of adjusting the temperature indicator. Record the setting of the temperature indicating device where you achieve the target temperature. Record this setting in the "As Left" line of the worksheet and set it equal to the target temperature.

   Example: Temperature indicating device is set at 231 º F to reach target temperature of 230 º F. "As Left" is 231 º F = 230 º F.

Example 1: No correction required

Standardization Worksheet: VP-10
Drying Ovens Without Opening

Frequency: **Yearly**
Standard References: AASHTO R 18

Equipment ID: 43L23009	**Verifying Technician:** A. Technician
Date Verified 3/11/2015	**Next Verification Date:** April 2016
Previous Verification Date: April 2014	**Time Charged:** 1 1/2 hrs (optional)

Standard	ID#	Adjustment factor (if required)	Standard	ID#	Adjustment factor (if required)
Thermometer	200387				

Record temperatures to the nearest whole degree. Include standard adjustment in reading if an adjustment is required.

Condition of Equipment	Target Temp	Indicator Setting	Time * 1ST Reading	Time * 2nd Reading	Time * 3rd Reading
As Found	325 ˚F	325 ˚F	7:20 AM / 325 ˚F	7:35 AM / 325 ˚F	7:50 AM / 325 ˚F
Set Temp	325 ˚F	325 ˚F			
As Found	350 ˚F	350 ˚F	8:50 AM / 350 ˚F	9:05 AM / 350 ˚F	9:20 AM / 350 ˚F
Set Temp	350 ˚F	350 ˚F			
As Found	300 ˚F	300 ˚F	1:00 pm / 300 ˚F	1:15 PM / 300 ˚F	1:30 PM / 300 ˚F
Set Temp	300 ˚F	300 ˚F			
As Found					
Set Temp					

Equipment found to be :	[X] Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	[X] None
Comments:			

*Time may be noted in minutes also

Example: Oven with no adjustment-Set temp correction

Standardization Worksheet: VP-10 Frequency: **Yearly**
Drying Ovens Without Opening Standard References: AASHTO R 18

Equipment ID: 43L23009	**Verifying Technician:** A. Technician
Date Verified 3/11/2015	**Next Verification Date:** April 2016
Previous Verification Date: April 2014	**Time Charged:** 1 1/2 hrs (optional)

Standard	ID#	Adjustment factor (if required)	Standard	ID#	Adjustment factor (if required)
Thermometer	200387				

Record temperatures to the nearest whole degree; include standard adjustment in reading if an adjustment is required.

Condition of Equipment	Target Temp	Indicator Setting	Time * 1st Reading	Time * 2nd Reading	Time * 3rd Reading
As Found	300 ˚F	300 ˚F	0 min 293 ˚F	30 min 295 ˚F	50 min
Set Temp		Adjustment required			
As Found	300 ˚F	305 ˚F	0 min 300 ˚F	25 min 301 ˚F	52 min 300 ˚F
Set Temp	300 ˚F	305 ˚F			
As Found	325 ˚F	325 ˚F	0 min 325 ˚F	30 min 324 ˚F	50 min 325 ˚F
Set Temp	325 ˚F	325 ˚F			
As Found	350 ˚F	350 ˚F	0 min 360 ˚F	35 min 359 ˚F	54 min 361 ˚F
Set Temp		Adjustment required			
As Found	350 ˚F	340 ˚F	0 min 350 ˚F	30 min 350 ˚F	55 min 350 ˚F
Set Temp	350 ˚F	340 ˚F			

Equipment found to be :	[X] Satisfactory	☐ Unsatisfactory	
Action Taken:	☐ Replace	☐ Repair	[X] None
Comments:			

*Time may be noted as a bracket of times (i.e. 8:00 am – 8:30 am)

Worksheet: VP-10

Drying Ovens Without Opening — Frequency: Region-Yearly
Standard References: AASHTO R 18

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)	Standard	ID#	Adjustment (if required)
Thermometer					

Record temperatures to the nearest whole degree

Condition of Equipment	Target Temp	Indicator Setting	Time 1ST Reading	Time 2nd Reading	Time 3rd Reading
As Found					
Set Temp					
As Found					
Set Temp					
As Found					
Set Temp					
As Found					
Set Temp					

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-11(Oven with Opening)

Equipment Verified: GENERAL PURPOSE DRYING OVEN with Access Opening

Standard References: AASHTO R 18

Purpose

This method provides instructions for checking the temperature settings on general-purpose drying ovens having a thermometer access opening.

Standard Equipment Required

1. A calibrated thermometer capable of reading in 1° increments and having a range that includes the temperature range checked.

2. A clothespin to hold the thermometer for the operator to read the scale easily from outside the oven.

Tolerance

Drying ovens shall be capable of maintaining the constant temperature range stated in the test methods.

Procedure

1. Set the oven for the desired temperature.

   Note: If the oven is used at more than one temperature, verify the oven for each range of temperatures.

2. Place the thermometer through cork or thermometer holder. Insert the thermometer through the hole in the top of the oven. Position thermometers so the appropriate portion of thermometer scale is readable from outside the oven, but the thermometer is as far inside the oven as possible

3. Take the first reading at least 1 hour after closing the oven (oven should remain undisturbed).

4. Take as many readings as necessary to determine if the setting on the temperature indicating device accurately represents the internal temperature of the oven (three consecutive readings, taken no less than 1/2 hour apart if using a liquid-in-glass thermometer and no less than 15 minutes apart if using a thermocouple, are adequate.)

5. If the internal temperature measured in the oven does not agree with the setting on the temperature-indicating device, adjust the temperature-indicating device to the measured internal temperature. Allow at least 1/2 hour for the temperature to stabilize and repeat step 3. Continue until the setting on the temperature-indicating device and the internal temperature are the same.
6. Repeat the procedure from step 2 until all temperature ranges for the oven are checked.
7. If the oven does not have a means of adjusting the temperature indicator, record the setting of the temperature-indicating device and mark this on the oven as the set temperature (234˚ F = 230˚F. Also, record this setting in the "As Left" line of the worksheet and set it equal to the target temperature.

   Example: Temperature indicating device is set at 234 º F to reach target temperature of 230 º F. "As Left" is 234 º F = 230 º F.

Worksheet: VP-11

Drying Ovens with opening
Standard References: AASHTO R 18

Frequency: Yearly- Region

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)	Standard	ID#	Adjustment (if required)
Thermometer					

Record temperatures to the nearest whole degree

Condition of Equipment	Target Temp	Indicator Setting	Time 1ST Reading	Time 2nd Reading	Time 3rd Reading
As Found					
Set Temp					
As Found					
Set Temp					
As Found					
Set Temp					
As Found					
Set Temp					

Equipment found to be:	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-12 (Thermometer-Ice Point)

Equipment: Thermometers (Ice point)

Standard References: ASTM E 77

Purpose
This method provides instructions for the standardization of accuracy of high-quality thermometric device at the ice point.

Standard Equipment Required
1. Dewar Flask (to prevent excessive melting of ice during process)
2. Appropriate stand
3. Thermometer retention clip
4. 10x power telescope
5. Siphon tube (to remove excess water from flask)
6. Ice (made from distilled water)
7. Ice Shaving Machine
8. Protective gloves (surgical or equivalent)
9. Worksheet for VP-12, VP-13 and VP-75.

Tolerance N/A

Procedure

1. Surgical or plastic gloves free of foreign particles shall be worn by the operator.
2. Ice is shaved to the consistency of a “snow-cone” with particles 2 to 5 mm diameter.
3. Place ice in the Dewar flask with distilled water and pack firmly. After approximately 15 to 30 minutes, siphon excess water, resulting from melting of the ice from the flask and add ice to replace that, which has melted. The ice bath is ready to use

when it has set for 15 to 30 minutes, no ice is floating in the flask, and there is no excess water on the surface of the ice. Put as much ice in the flask as possible and fill the crevices with distilled water. Throughout the procedure, replace excess water with ice.

4. Clean the thermometer with distilled water at or below room temperature.

5. Loosen the ice at the center of the bath with an object such as a clean glass rod to a depth approximately equal to the thermometer's immersion depth. Gently place the thermometer though the holder into the region of the loosened ice.

6. Immerse the thermometer in the ice to the immersion line or 0˚ C mark.

    a. If the thermometer touches a firm surface before reaching the immersion line or 0˚ C mark, then remove it and loosen the ice to a greater depth.

    b. If the thermometer passes the immersion line or 0˚ C mark before resting on a firm foundation, remove the thermometer, repack the ice, and loosen the ice to the correct depth.

7. Firmly pack the ice around the thermometer so it is perpendicular to the telescope

8. Once the thermometer is stable, leave it in the ice bath for approximately one to two minutes. Read the thermometer and record the reading.

    a. Organic liquid thermometers will require approximately 15 minutes to stabilize.

    b. Liquid in Glass -When the mercury is stable, (i.e.: the meniscus stops moving), gently tap the thermometer to free the mercury meniscus and record the ice point reading on the worksheet.

    c. Metal Probe Digital Display- When the digital reading stops fluctuating record the ice point reading on the worksheet.

Worksheet: VP-12

Thermometers (Ice Point) Frequency: Yearly- Region
Standard References: AASHTO R 18

Date Verified :	Verifying Technician:
Previous Verification Date:	Next Verification Date:

Standard	ID#
Dewar Flask	
Water bath	

Therm. ID	Desired Temp	Temp of Standard (w/adjustment if required)	Reading	Meets Spec:	Action Taken:
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
				❑ Yes ❑No	❑ Disposed ❑ Adjusted
Comments:					

STANDARDIZATION PROCEDURE: VP-13 (Thermometer Working Range)

Equipment: WORKING RANGE THERMOMETER

Standard References: ASTM E 77, AASHTO procedures as noted

Purpose

This method provides instructions for the standardization of thermometers using an oil bath oven, or thermostatically or non-thermostatically controlled water bath,

Standard Equipment Required

1. NIST calibrated thermometer(s) appropriate to the test temperature(s).
2. A thermostatically controlled water or oil bath, oven, or non-thermostatically controlled water bath
3. Sand-filled container for use in oven
1. Corks or thermometer holders as necessary.

Tolerance

Thermometers shall be accurate to one degree within their accuracy range.

Specifications

1. T-48 - Cleveland Open Cup - 11°F or 11°C.
2. T-49 - Penetration - for warm bath 17°F or 17°C, for cold bath 63°C or 63°F - must be calibrated at 25.0°C (±0.1°C) (77.0°F (± 0.2°F)) for warm bath and 4.0°C(± 0.1°C) (39.2°F(± 0.2°F)) for cold bath.
3. T-50 - Float Test - 15°F or 15°C - must be calibrated at 60.0°C(± 0.5°C) (140°F(± 1°F)).
4. T-51 - Ductility - for warm bath 17°F or 17°C, for cold bath 63°C or 63°F - must be calibrated at 25.0°C(± 0.1°C) (77.0°F (± 0.2°F)) for warm bath and 7.2°C(± 0.1°C) (45.0°F(± 0.2°F)) for cold bath.
5. T-53 - Ring and Ball Softening Point - 113°F or 113°C.

6. T-78 - Cutback - 8°F or 8°C.

7. T-201 - Kinematic Viscosity - 110°C or 110°F - must be calibrated at 135.0°C (± 0.02°C), (275°F (± 0.04°F).

8. T-202 - Absolute Viscosity - 47°F or 47°C - must be calibrated at 60.0°C(± 0.1°C) (140.0°F (± 0.2°F).

9. T-228 - 63°F or 63°C - must be calibrated at 25.0°C(± 0.1°C) (77.0°F (± 0.2°F)).

10. T-240 - Rolling Thin Film Oven - 13°C.-must be calibrated at 163°C (± 0.5°C) (325°F ± 1.0°F).

11. T-59 - (Distillation) - 7°C or 7°F.

12. T-59 - (Saybolt) - 17°C or 17°F for tests at 25°C (± 0.05°C) (77°F(± 0.1°F), 19°C or 19°F for tests at 50°C(± 0.05°C) (122°F ± 0.1°F).

13. Other thermometers at the temperature defined by their intended use.

Procedure

4. Set the bath at the appropriate temperature (thermostatically controlled bath); or place a standard thermometer into the bath to continually monitor the temperature of the water in the bath. When using an oven, set the oven at the desired temperature

5. Adjust water temperature, for a non-thermostatically controlled bath, or oven temperature to test temperature according to standard thermometer.

6. Place the working thermometers to be standardized into the water or oven and allow them to stabilize. Multiple thermometers may be standardized at one time in this process.

7. After 1/2 hour record the temperature of the standard thermometer and working thermometers.

8. Record two more readings not less than 1/2 hour apart.

9. Determine the average correction between the working thermometers and the standard thermometer and record on the worksheet.

10. Indicate the temperature correction on the working thermometer or adjust the working thermometer to agree with the temperature of the Standard thermometer.

Worksheet: VP 13

Thermometers (Working Range) Frequency: Yearly- Region

Standard References: AASHTO R 18

Date Verified :	Verifying Technician:
Previous Verification Date:	Next Verification Date:

Standard	**ID#**	**Adjustment (if required)**	**Standard**	**ID#**	**Adjustment (if required)**
Thermometer			Dewar Flask		
Oven					
Water bath					

Therm. ID	**Desired Temp**	**Temp of Standard (w/adjustment if required)**	**Time / Reading (1)**	**Time / Reading (2)**	**Time / Reading (3)**	**Ave. Correct.**
	Meets Spec: ❑ **Yes** ❑ **No**	**Action Taken:** ❑ Disposed ❑ Adjusted				
	Meets Spec: ❑ **Yes** ❑ **No**	**Action Taken:** ❑ Disposed ❑ Adjusted				
	Meets Spec: ❑ **Yes** ❑ **No**	**Action Taken:** ❑ Disposed ❑ Adjusted				
	Meets Spec: ❑ **Yes** ❑ **No**	**Action Taken:** ❑ Disposed ❑ Adjusted				
	Meets Spec: ❑ **Yes** ❑ **No**	**Action Taken:** ❑ Disposed ❑ Adjusted				
	Meets Spec: ❑ **Yes** ❑ **No**	**Action Taken:** ❑ Disposed ❑ Adjusted				
Comments:						

CHECK PROCEDURE: VP-14 (Using Internal Bore Gauge)

Equipment Checked: 150mm GYRATORY SPECIMEN MOLD and TOP/BOTTOM PLATES

Standard References: WSDOT T 312, WSDOT SOP 731, AASHTO T 312-11

Purpose

This procedure provides instructions for checking the critical dimension of gyratory specimen molds and bottom/top plates.

Standard Equipment Required

1. Length Measuring Instrument (Outside Calipers or Micrometer) – With appropriate range and a minimum resolution of 0.01mm (0.0005 in.).

2. Calibrated Master Ring – A calibrated master ring of the same nominal size as the mold diameter shall be used to set the measuring instrument reference for each series of measurements. A 150mm ANSI/ASME B89.1.6 Class Z standard is acceptable for 150mm sized molds.

3. Three-Point Bore Gauge – Minimum resolution shall be 0.001mm (0.00005 in.).

4. Verified straight edge.

5. Verified feeler Gauge, 0.025mm (0.001 in.).

Frequency of Check

Minimum frequency of this evaluation is 12 months or 80 hours of operation.

Tolerance

The gyratory specimen molds and bottom/top plates checked at a temperature of 64° F to 82° F (18° C to 28° C) shall meet the dimensional tolerances specified in the applicable test method listed above.

Note 1: *May confirm this temperature range with an infrared thermometer.*

Procedure

Molds:

1. Confirm the molds are clean and identified with a unique serial number or other unique identifier.

2. Allow the mold to achieve a temperature of 64° F to 82° F (18° C to 28° C). The mold bore shall be free of residue and deep gouges. Mold bores without gouges typically have acceptable surface finish. Identify any wear area that may be visible in the mold.

3. Standardize the bore gauge with the master ring at a temperature of 64° F to 82° F (18° C to 28° C) prior to each use. Place the master ring on a flat surface. Position the gauge inside the ring without contacting the surface. Engage the contact points with the ring internal diameter. To eliminate errors from misalignment while extending the gauge contacts, use a small circular motion at the top of the gauge to align the contact tips with the master ring bore. This engagement should be firm but not overly tight.

4. Reset (zero) the bore gauge. On mechanical gauges without an electronic reset, confirm the gauge reads within 0.0025 mm (0.0001 in.) of the master ring. Release the gauge from the ring by retracting the contact points.

   Note2: Reference AASHTO T312 Annex A for techniques on using the three-point bore gauge with calibrated master ring and identifying gage position for measurement within the mold.

5. Place a removable mark at the top of the mold to identify orientation of measurements to be taken.

6. The inside diameter of the mold shall be measured at three locations (elevations) along its axis. Designate these elevations as: 1, 2, and 3. Record each measurement to at least the nearest 0.001mm (0.00005 in.) on the verification worksheet. For best accuracy and consistency, each bore measurement should use the same firmness and technique applied for gauge standardization

7. Measure the internal diameter of the mold approximately 50mm from the top of the mold (elevation 1). Three measurements, 90º apart starting at the removable mark, will be taken at this elevation and labeled as 1A, 1B, and 1C.

8. Measure the internal diameter of the mold in the visible wear area approximately 100mm (elevation 2) from an end of the mold (top or bottom) as determined by the wear area. Three measurements, 90º apart, will be taken at this elevation and labeled as 2A, 2B, and 2C.

9. Measure the internal diameter of the mold at 50mm from the bottom of the mold (elevation 3). Three measurements, 90º apart, will be taken at this elevation and labeled as 3A, 3B, and 3C.

10. Each individual bore measurement shall be compared to the specified range of 149.90mm – 150.20mm (new molds at 149.90mm – 150.00mm) and given a pass/fail rating.

11. Verify height of mold and record on worksheet.

Mold Plates:

1. Confirm the mold plates are clean and properly identified. Allow the end plates to achieve a temperature of 64° F to 82° F (18° C to 28° C). The plates shall be free of residue and deep gouges. Surfaces in contact with the asphalt mixture shall be flat. Minor abrasion marks from aggregates are acceptable. Surfaces in contact with the SGC frame or compaction ram shall be free of raised burrs that may cause the plate to wobble during gyration. Small recesses on the side of the plate interfacing the SGC (opposite the asphalt mixture) can reduce rocking and are acceptable.

2. Determine the maximum diameter of the end plate by measuring in several locations. Place a removable mark at this position. Record the maximum plate diameter to the nearest 0.01mm (0.0005 in.). Designate this as measurement “A”.

3. Measure the diameter at a 90º orientation to the maximum diameter. Record this diameter as measurement “B”.

4. Each individual measurement reading shall be compared to the specified range (149.50mm - 149.75mm) and given a pass/fail rating.

5. Using a verified straight-edge and feeler gauge, ensure that the plate is flat by taking two observations 90º apart while trying to insert the feeler gauge between the plate and straight-edge. Record the results as measurement A and B on the verification worksheet.

Worksheet: VP-14

150 mm Gyratory Specimen Mold, Top/Bottom Plates Frequency: Yearly-Region or 80 hrs. of operation

Standard References: AASHTO T 312-11

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:
Visual inspection of equipment ❑ Satisfactory ❑ Unsatisfactory	

Standard	ID#	Adjustment (if required)	Standard	ID#	Adjustment (if required)
Caliper			Steel Ruler		
Straightedge			Feeler Gauge		
Bore Gauge			Master Ring		

MOLD MEASUREMENTS

Elevation	Tolerance	Measurement A	Measurement B	Measurement C	Pass / Fail Measurements A	B	C
(1) 50 mm from Top	149.90 to 150.20mm				❑ Pass ❑ Fail	❑ Pass ❑ Fail	❑ Pass ❑ Fail
(2) 100mm from Top/Bottom (depending on area of wear)	149.90 to 150.20mm				❑ Pass ❑ Fail	❑ Pass ❑ Fail	❑ Pass ❑ Fail
(3) 50mm from Bottom	149.90 to 150.20mm				❑ Pass ❑ Fail	❑ Pass ❑ Fail	❑ Pass ❑ Fail
Height	≥ 250mm				❑ Pass ❑ Fail		

BOTTOM PLATE MEASUREMENTS

Dimension	Tolerance	Measurement A	Measurement B	Pass / Fail Measurements A	B
Outside Dia.	149.50 to 149.75mm			❑ Pass ❑ Fail	❑ Pass ❑ Fail
Surface	Flat	❑ Pass ❑ Fail	❑ Pass ❑ Fail		

TOP PLATE (IF APPLICABLE) MEASUREMENTS

Dimension	Tolerance	Measurement A	Measurement B	Pass / Fail Measurements A	B
Outside Dia.	149.50 to 149.75mm			❑ Pass ❑ Fail	❑ Pass ❑ Fail
Surface	Flat	❑ Pass ❑ Fail	❑ Pass ❑ Fail		

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory
Action Taken: ❑ Replace ❑ Repair ❑ None	
Comments:	

STANDARDIZATION PROCEDURE: VP-17 (Mechanical Sieving Device)

Equipment Verified: MECHANICAL SIEVING DEVICE

Standard References: AASHTO T 27

Purpose

This procedure provides instructions on testing for sieving thoroughness. Separate instructions are provided for round sieves, 12 inches (300 mm) in diameter or less and for rectangular screens and round screens exceeding 12 inches (300 mm) in diameter.

Standard Equipment Required

1. A set of sieves with standard or non-standard frames as appropriate for the sieving device being checked.

2. Balance, with a capacity required for the principal weight of the sample and readable to at least 0.1 g.

3. Pans, weighing pans, and other appropriate sieve cleaning tools as required.

Tolerance

As specified in AASHTO T 27, sieving action and time shall be sufficient to assure that, after completion, not more than 0.5 percent by weight of the total sample passes any sieve during one minute of continuous hand sieving. (For rectangular sieves or others exceeding 12 inch (300 mm) diameter, one minute of additional mechanical sieving shall be used in the evaluation.)

Procedure

Check the mechanical shaker using a normal set of sieves (coarse and fine) and a material sample of sufficient size and particle distribution for the required sieves. In no case shall the amount of material on any one sieve smaller than 4.74 mm (No. 4) exceed 4 g per square inch of sieving surface. For sieves larger than 4.74 mm, (No. 4), limit the amount of material to one particle deep.)

1. Weigh and record the total weight of the sample.

2. Set the sieve shaker timer for the time normally required to separate the material being sieved. Record the time

3. Remove the sample from the shaker and check thoroughness of sieving as follows:

   Round sieves, 12 inches (300 mm) in diameter or less:

   a. Remove the sample from the shaker and, beginning with the largest sieve, hand sieve the material retained on the sieve for one minute as specified in AASHTO T 27 and record the weight of material passing the sieve.

Note: To prevent hand injury WSDOT allows a rubber mallet to be used in lieu of the palm of the hand for the one-minute check. The force of the blow delivered by the rubber mallet should not exceed the force of a blow delivered by the palm of the hand.

   b. Determine and record the percent passing the sieve based on the total weight of the sample before sieving.

   c. Repeat steps a and b for all sieves used.

   d. If the percent passing any of the sieves exceeds 0.5 percent by weight of the total sample, increase sieving time and sieve the material again using steps 3.1.1 thru 3.1.4 until the above criteria is met.

   e. Record the extended sieving time, if any, as the minimum time for the shaker in question.

3.2. Rectangular sieves, or round sieves exceeding 12 inches (300 mm) diameter:

   a. Remove the sample from the shaker and, beginning with the largest sieve, record the weight of the sieve and retained material after the initial shaking.

   b. Then, starting with the largest screen, return the screen to the shaker, placing it over a pan. Agitate for one additional minute.

   c. Remove and weigh the screen again and determine if less than 0.5% of the original sample passes the screen Repeat this process for all screens

   d. If any screens show an increase of more than 0.5% passing, increase the base shaking time for the machine by one minute, and repeat steps 3.2.1 thru 3.2.4.

   e. When no screens show an increase exceeding 0.5%, record the new shake time as minimum for the device.

Worksheet: VP-17

Mechanical Sieving Device Frequency: **Region- Yearly**

Standard References: AASHTO T 27, T 11

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)
Balance		

Initial weight of sample: _____ (Total Weight)			Sieving time: _____ min.
Sieve Size	**Additional Grams Passing**	**Additional % Passing**	**Allowable Additional % Passing**
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5
			0.5

Calculations:

Additional % Passing = $\frac{\text{Additional grams passing}}{\text{Total Sample Weight}} * 100$

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-19 (Mechanical SE Shaker)

Equipment Verified: MECHANICAL SAND EQUIVALENT TEST SHAKER

Standard References: AASHTO T 176

Purpose

This method provides instruction for checking the mechanical shaker to insure operation at the specified amplitude and number of cycles per minute.

Standard Equipment Required

1. A measuring device capable of measuring the specified throw of 8 ± 0.04 inches
2. Handheld mechanical counting device capable of reading to 500 counts, minimum.
3. A noncontact tachometer readable to 500 units per minute may also be used. (A Mitutoyo Non-contact Digital Tachometer, Model 982-522, has been found to be satisfactory for this purpose.)
4. A timer, readable to 1 second.

Tolerance

175 ± 2 cycles per minute (2.92 ±0.03 Hz)

8 ± 0.04 inches (203.3 ±1.02 mm) throw

Procedure

1. Measure the cycles per minute:
    a. Using a mechanical counting device
    Operate the shaker for 60 + 1 seconds and record the number of cycles in one direction as cycles per minute.
    b. Using a non-contact tachometer
        i. Start the shaker and hold the tachometer in such a manner as to cause the beam of light emitted from the lens to be broken by one edge of the moving part of the shaker, and record the reading displayed on the tachometer as cycles per minute.

2. Measure throw

    a. Having first taken the proper steps to insure personal safety, manually operate the mechanism to one extreme of its throw.

    b. Measure the distance along a straight line, parallel to the movement of the shaker, from a stationary point on the frame to a fixed point on the part that holds the graduated plastic cylinder.

    c. Slowly, manually operate the shaker in such a way as to cause the movable part of the shaker to move to its extreme position and record the difference between the first measurement and the second. This value equals the throw of the shaker.

3. Record the results and insure that the values obtained meet the tolerances referenced above.

4. If the cycles per minute or throw does not meet the tolerances, take the shaker out of service and either replaced or repair it to conform to the referenced tolerances.

Worksheet: VP-19

Mechanical Sand Equivalent (SE) Shaker Frequency: Region-Yearly

Standard References: AASHTO T 176

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)
Caliper		
Ruler		
Tachometer readable to 500 units per minute		
Timer readable to 1 second		

Cycles per minute		Throw	
Measured	Specified	Measured	Specified
	175 ± 2 cycles per min. (2.92 ± 0.03 Hz)		8 ± 0.04 in (203.3 ±1.02 mm)

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-20 (S.E. Weighted Foot)

Equipment Verified: SAND EQUIVALENT WEIGHTED FOOT ASSEMBLY

Standard References: AASHTO T 176

Purpose

This method provides instructions for checking the condition and mass of the weighted foot assembly

Standard Equipment Required

1. Calipers, readable to 0.001 inch

2. Balance, 5 kg capacity, readable to 1 g

Tolerance

The mass of the weighted foot assembly shall be 1000 grams ± 5 grams.

The distance from the bottom of the foot to the top of the sand indicator shall be 256.5 mm ± 0.40 mm.

Procedure

1. Determine and record the weight of the weighted foot assembly to the nearest 1 g.

2. Measure the distance from the bottom of the weighted foot to the top of the sand indicator to the nearest 0.01 mm.

Worksheet: VP-20

Sand Equivalent Weighted Foot Assembly Frequency: **Region – Yearly**

Standard References: AASHTO T 176

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if necessary)
Caliper		
Balance		

Weighted Foot Assembly	Tolerance	Measurement	Acceptable
Mass of assembly	1000 grams +/- 5 grams	**grams**	❑ Yes ❑ No
Distance from bottom of foot to top of indicator	256.5 mm +/- 0.40 mm	**mm**	❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZE PROCEDURE: VP-23 (Water Bath)

Equipment Verified: Water Bath

Standard References: AASHTO T 202, T 50, T 49, T 50, T 59

Purpose

This method provides instructions for standardizing the temperature settings on water baths.

Note: Water baths for AASHTO T 209 do not require standardization if the temperature of the water in the bath is monitored using a standardized thermometer.

Standard Equipment Required

Thermometer, calibrated and readable to 0.03C (± 0.05F)

Cork of appropriate size or thermometer holder

Tolerance

Absolute Bath - AASHTO T-202 - Range of 60 (± .03 C)

Float Bath - AASHTO T-50 - 60 C.

Warm Penetration Bath - AASHTO T-49 - Range 25.0 (± 0.1 C)

Cold Penetration Bath - AASHTO T-49, 50 - Range 4.0 (± 0.1 C)

Emulsion Bath - AASHTO T-59 - 71 C

Saybolt Bath - AASHTO T-59 (Saybolt Viscosity) – 71 (± 3 C)

Other Baths at the temperature defined by their intended use

Procedure

1. Refer to appropriate test procedure for water bath specifications.

2. Place the thermometer through cork or thermometer holder. Position the thermometer in the water bath so that the appropriate portion of thermometer scale is readable.

3. Take the first reading at least one hour after the thermometer and bath have come to temperature.

4. Take two more readings a minimum of 30 minutes apart and record. If any reading is not within the range allowed for the type of bath, adjust temperature indicator and start readings over.

Worksheet: VP-23

Water Bath Frequency: Region- Yearly

Standard References: AASHTO T 202, T 50, T 49, T 50, T 59

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)
Thermometer		

Target Temperature	After 1 Hour	After ½ Hour	After ½ Hour	Acceptable
				❑ Yes ❑ No
				❑ Yes ❑ No
				❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-31(Vacuum System)

Equipment Verified: **Vacuum System**

Standard Reference: AASHTO T 209, WSDOT W 718, T 100, WSDOT T 606

Purpose

This method provides instructions to verify that minimum vacuum is achieved and to correct readings on the vacuum gauge.

Standard Equipment Required

1. Absolute pressure gauge.
2. Water trap.
3. Hoses, connectors, and any other miscellaneous fittings.
4. Pycnometer (metal or glass)

Tolerance

When all pycnometer(s) are connected to the vacuum system with the valve(s) fully open, a maximum of 30mm Hg will be measured.

Note: If an adjustment is shown on the Certificate of Calibration for the absolute pressure gauge, make sure the reading is adjusted accordingly. Example: If the absolute pressure gauge has a correction of +3.3 mmHg then a gauge reading of 30 mmHg it is actually 33.3 mmHg.

Procedure

1. Connect the absolute pressure gauge to the system with the water trap in line between the system and the gauge. A hose tees off the main line to the bench mounted valve, which can be used for the connection.
2. Check all connections for air tightness.
3. Fill all pycnometers one-half full of water and connect to the system.
4. Open the vacuum line fully and allow the system to stabilize.

5. Record the vacuum achieved.

6. Close vacuum line and bleed vacuum system slowly to atmospheric pressure.

7. Repeat steps 4 and 5. If both checks meet tolerance, stop.

    a. Mark the appropriate vacuum level on the gauge for reference. For WSDOT FOP for AASHTO T-209 bleed the vacuum slowly to 30mm Hg (4.0kPa) and mark the gauge for reference.

    b. If either test fails to meet tolerance, repeat steps 4 and 5 until two consecutive tests meet tolerance. If two consecutive tests do not meet tolerance, discontinue use of the vacuum system until repairs can be made.

Worksheet: VP-31

Vacuum System Frequency: **Region – Yearly**

Standard References: AASHTO T 209, WSDOT T 718, WSDOT T 606

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)
Absolute Pressure Gauge		

Vacuum Pressure		Air Tightness
First Reading	**Second Reading**	
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-32 (Slump Cone)

Equipment Verified: SLUMP CONE

Standard References: AASHTO T 119

Purpose

This method provides instructions for checking the critical dimensions of the slump cone used in the above test method.

Standard Equipment Required

1. Calipers or ruler readable to 1/16 inch (1mm)
2. Ruler readable to 1/16 inch (1 mm)

Tolerance

1. Metal thickness shall be not less than BWG 16 gage (0.065 inches).
2. If produced by a spinning process the min. thickness shall not be less than 0.045 inch (1.14 mm).
3. Base shall be 8 ± 1/8 inch (203 ± 3 mm).
4. Top shall be 4 ± 1/8 inch (102 ± 3 mm)
5. Height shall be 12 ± 1/8 inch (305 ± 3 mm)

Procedure

1. Measure the inside diameter at the top of the cone to the nearest 1mm by taking two readings 90° apart using the calipers and record the results.
2. Invert the cone and repeat Step 1 using a ruler.
3. Place the cone on a flat glass surface. Measure the height of the cone by using the ruler and record the results.
4. Measure the thickness of the cone to the nearest 1mm by taking two (2) readings 90° apart at the top of the cone and two (2) readings 90° apart at the bottom of the cone and record the results.
5. Examine the interior to determine that it is relatively smooth, free of projections and free of dents.

Worksheet: VP-32

Slump Mold Frequency: **Region – Yearly**

Standard References: AASHTO T 119

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#
Caliper	
Scale (18 inches)	

Slump Mold	Tolerance	Measurement	Acceptable
Inside of mold smooth and free of projections?			❑ Yes ❑ No
Metal Thickness -Top	See procedure for tolerance		❑ Yes ❑ No
Metal Thickness-Base	See procedure for tolerance		❑ Yes ❑ No
Diameter - Top	4.0 ± 1/8 inch (102 mm ± 3.2 mm)		❑ Yes ❑ No
Diameter - Base	8.0 ± 1/8 inch (203 mm ± 3.2 mm)		❑ Yes ❑ No
Height	12.0 ± 1/8 inch (305 mm ± 3.2 mm)		❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP- 41 (Soil Molds)

Equipment Verified: SOIL TEST MOLDS

Standard References: AASHTO T 99, T 180, T 190, T 193

Purpose

This procedure provides instructions for checking the critical dimensions of the 4, 6, and 8-inch molds used in soil testing.

Standard Equipment Required

1. Calipers capable of measuring the height and inside diameter of the molds and readable to 0.001 inch.

2. Feeler Gauge, readable to 0.127 mm (0.005 inch).

3. Verified straight edge or mechanic square.

Tolerance

The height and diameter of the molds checked shall meet the dimensional tolerances specified in the applicable test method listed above.

The base plate shall be flat within 0.127 mm (0.005 inch)

Check Mold Procedure

1. Measure and record the inside diameter of the mold, determined by taking two readings 90 degrees apart, to the nearest 0.001 inch.

2. Turn the mold over and repeat step 1.

3. Measure and record the height of the mold, determined by taking two readings 90 degrees apart, to the nearest 0.001 inch. Note: When measuring the large mold, the height measurement will be the inside height of the mold.

Check Base Plate Procedure

1. Place the edge of the straightedge or mechanic's square into the recessed area of the base plate.

2. Attempt to slide the feeler gauge between the base plate and the level. If the feeler gauge fits between the base plate and the level, the base plate is not plane.

3. Record results.

Worksheet A: VP-41 (4 Inch Mold)

Soil Mold (4 inch) and Base Plate Frequency: Region – Yearly

Standard References: AASHTO T 99

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper		4 inch Straightedge	
Steel Ruler		Feeler gauge 0.005 inch (0.127 mm)	

Dimension	Required	Tolerance	Measurement		Average	Meets Requirement
Inside Diameter	4.000 in. 101.60 mm	3.984 - 4.016 in 101.19 - 102.01 mm				❑ Yes ❑ No
Height	4.584 in. 116.43 mm	4.579 - 4.589 in 116.30 - 116.56 mm				❑ Yes ❑ No

Dimension	Acceptable
Base Plate Plane to within 0.005 inch (0.127 mm)	❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Worksheet B: VP-41 (6” Mold)

Soil Mold (6 inch) Frequency: Region – Yearly

Standard References: AASHTO T 180

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper		4 inch Straightedge	
Steel Ruler		Feeler gauge 0.005 inch (0.127 mm)	

Dimension	Required	Tolerance	Measurement		Average	Meets Requirement
Inside Diameter	6.000 in 152.40 mm	5.974 – 6.026 in 151.74 – 153.06 mm				❑ Yes ❑ No
Height	4.584 in 116.43 mm	4.579 - 4.589 in 116.30 - 116.56 mm				❑ Yes ❑ No

Dimension	Acceptable
Base Plate Plane to within 0.005 inch (0.127 mm)	❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP – 42 (Grooving Tool)

Equipment Verified: GROOVING TOOL

Standard References: AASHTO T 89

Purpose

This method provides instructions for the verification of critical dimensions of the Liquid Limit Grooving Tool.

Standard Equipment Required

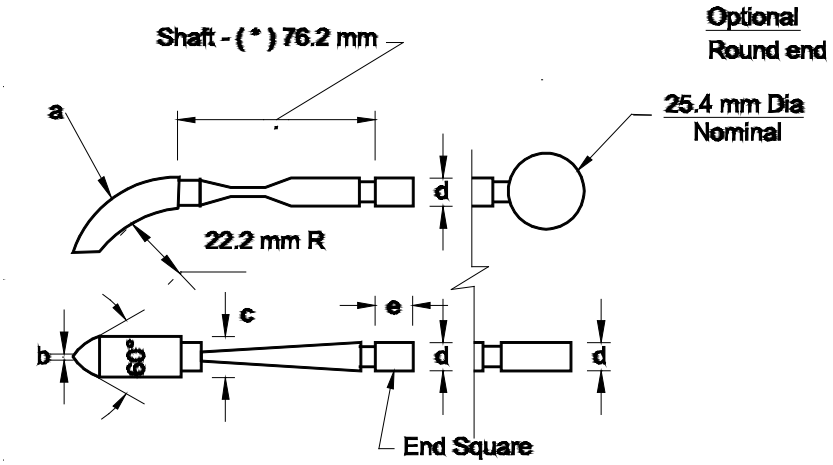
1. Caliper readable to 0.1 mm.

Tolerance

Equipment shall meet the dimensional tolerances specified in the applicable test method as extracted and shown on the attached worksheet.

Procedure

Using a caliper, measure and record the critical dimensions as indicated on the worksheet. Record the dimensions as indicated.



Grooving Tool

Worksheet: VP-42

Grooving Tool Frequency: **Region Yearly**

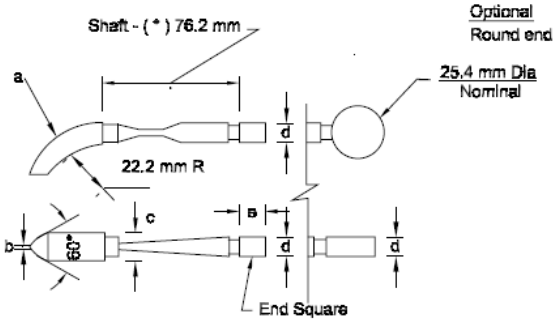
Standard References: AASHTO T 89

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#
Caliper	

Grooving tool	Tolerance	Measurement (mm)	Acceptable
Curved end Thickness (a)	10.0 ± 0.1 mm		❑ Yes ❑ No
Curved end cutting edge (b)	2.0 ± 0.1* mm		❑ Yes ❑ No
Curved end width (c)	13.5 ± 0.1 mm		❑ Yes ❑ No
Gauge depth (d)	10.0 ± 0.2 mm		❑ Yes ❑ No

* An additional wear tolerance of +0.1 mm shall be allowed for dimension "b" for used grooving tools



Grooving Tool

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP – 43 (Liquid Limit Device)

Equipment Verified: LIQUID LIMIT DEVICE

Standard References: AASHTO T 89, Fig 1, Section 4.1

Purpose

This method provides instructions for checking critical dimensions and calibration of the liquid limit device used in the above test procedure.

Standard Equipment Required

1. Calipers readable to 0.1 mm

2. Height gauge 10 mm + 0.2 mm (Square end of the grooving tool may be used if verified)

3. Worksheet VP-43 (attached)

Tolerance

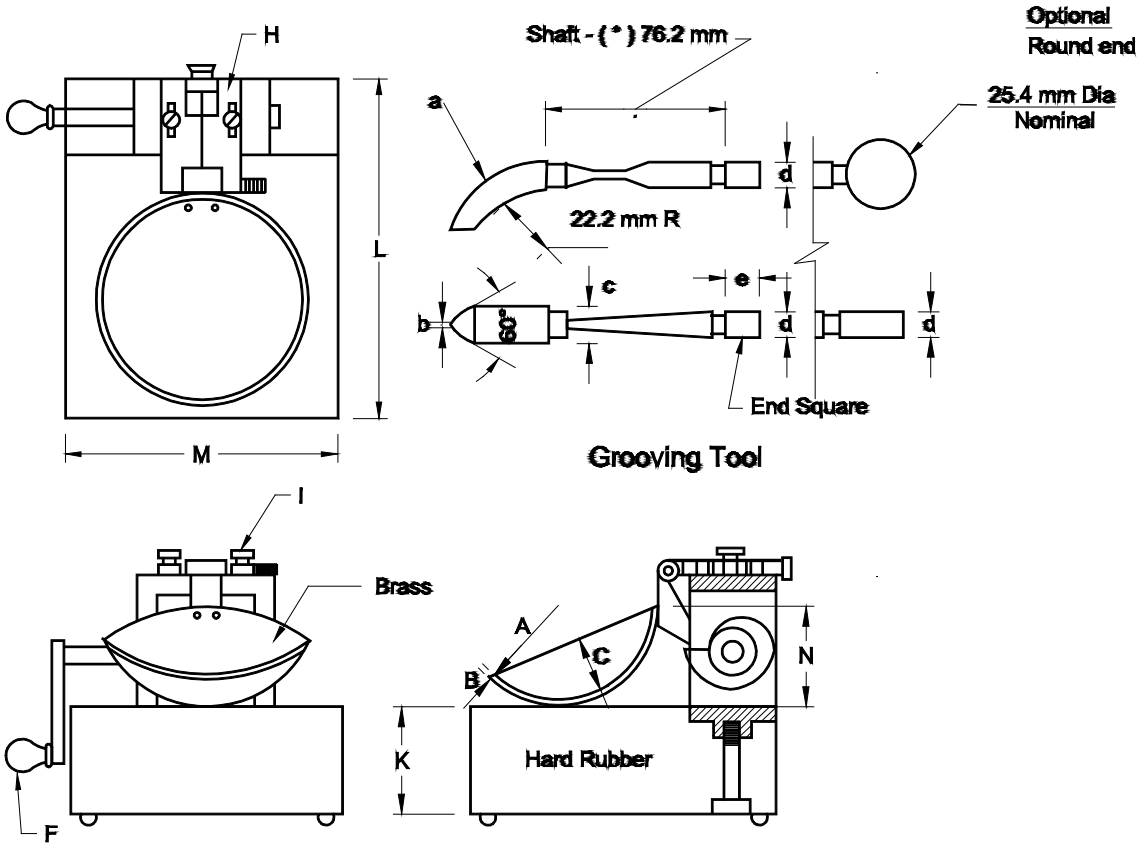
Equipment shall meet the dimensional tolerances specified in the applicable test method as extracted and shown on the worksheet.

Procedure

1. Measure the dimensions described in AASHTO T 89 with caliper and record results on the work sheet.

2. Check for wobble on the rise of the cup as an indication of wear on the pin.

3. Check for wear as described in AASHTO T 89, section 4.1 and record observations on the worksheet.


H
L
M
Shaft - (*) 76.2 mm
Optional
Round end
25.4 mm Dia
Nominal
a
d
22.2 mm R
c
e
b
d
d
End Square
Grooving Tool
I
Brass
A
B
C
N
K
Hard Rubber
F

Worksheet: VP-43

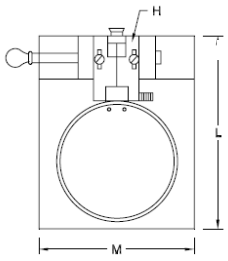
Liquid Limit Device
Standard References: AASHTO T 89

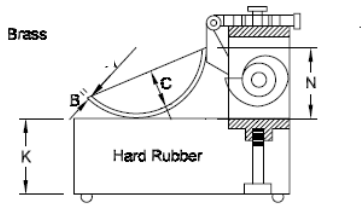
Frequency: **Region-Yearly**

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#
Caliper (readable to 0.1 mm)	

Liquid Limit Apparatus	Tolerance	Measurement (mm)	Acceptable
Cup Assembly			
Radius (A)	54 ± 2 mm		❑ Yes ❑ No
Thickness (B)	2.0 ± 0.1 mm		❑ Yes ❑ No
Depth (C)	27 ± 1 mm		❑ Yes ❑ No
Cup @ Cam follower to base (N)	47 ± 1.5 mm		❑ Yes ❑ No
Base			
Thickness (K)	50 ± 5 mm		❑ Yes ❑ No
Length (L)	150 ± 5 mm		❑ Yes ❑ No
Width (M)	125 ± 5 mm		❑ Yes ❑ No





Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP – 44 (Manual Rammer)

Equipment Verified 5.5 lb MANUAL RAMMER T 99
10.0 lb MANUAL RAMMER T 180

Standard References: AASHTO T 99, T 180, WSDOT T 606

Purpose

This procedure provides instructions for the verification of the weight and critical dimensions of the manual rammer.

Standard Equipment Required

1. Balance, capacity 5 kg (10 lb), readable to 1 g (0.01 lb)
2. Tape measure, readable to 0.20 mm (1/16 inch)
3. Calipers, readable to 0.025 mm (0.001 inch)

Tolerance

Manual Rammers shall meet all applicable tolerance described in AASHTO T 99, AASHTO T 180 and WSDOT T 606.

Procedure

1. Measure and record the diameter of the rammer face determined by taking two readings 90 degrees apart using the calipers.
2. Measure and record the drop height by pulling the handle out and measuring the distance from the bottom edge of the tube to the rammer face using the tape measure inserted inside the tube.
3. Record the weight of the rammer:
   a. Remove the rammer handle knob;
   b. Slide the rammer out of the tube;
   c. Replace the knob and nuts into the rammer;
   d. Weigh the rammer; and
   e. Adjust the weight if necessary by removing the rammer head from the handle shaft and adding or removing shot.
4. Measure and record the diameter of the vent holes near the end of the rammer.

Worksheet: VP-44

Manual Rammer/Tamper Frequency: Region-Yearly

Standard References: AASHTO T 99, WSDOT T 606 or T 180

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper/micrometer		Steel Ruler	
Balance		Straightedge	
Feeler gauge			

Type of Rammer	❑ **T 99** ❑ **T606** ❑ **T 180**			
Dimension	**Required**	**Tolerance**	**Measurement**	
Rammer Face Diameter	2.000 in (50.80 mm)	1.985 - 2.010 in (50.42 – 51.05 mm)		
Rammer Weight T99/ T606	5.50 lb (2.495 kg)	5.48 - 5.52 lb (2.486 - 2.504 kg)		
Rammer Weight T180	10.00 lb (4.536 kg)	9.98-10.02 lb (4.527 - 4.545 kg)		
Drop Height T99/ T606	12.00 in (305 mm)	11.94 - 12.06 in (303 - 307 mm)		
Drop Height T180	18.00 in (457 mm)	17.94 - 18.06 in (455 - 459 mm)		
Diameter of Vent Holes	≥ 0.375 in (≥ 9.5 mm)		**Meets Specification**	
			❑ Yes ❑ No	❑ Yes ❑ No
			❑ Yes ❑ No	❑ Yes ❑ No
Vent Hole Location from End	≈0.75 in (≈19 mm)		❑ Yes ❑ No	❑ Yes ❑ No
			❑ Yes ❑ No	
Is the rammer face flat?			❑ Yes ❑ No	

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP – 45 (Mechanical Compactor)

Equipment Verified: MECHANICAL COMPACTOR

Standard References: AASHTO T 99, T 180, ASTM D2168

Purpose

This method provides instructions for checking critical dimensions of the mechanical compactor used in the above test procedures (manual verses mechanical comparison only).

Standard Equipment Required

1. Balance, capacity 5 kg (10 lb) readable to 1 g (0.01 lb)
2. Tape Measure, readable to 0.20 mm (1/16 inch).
3. Calipers, readable to 0.025 mm (0.001 inch).
4. Soil Sample for calibration

Tolerance

Mechanical compactors shall meet all applicable tolerances described in AASHTO T 99 and AASHTO T 180

Procedure

1. Measure the specified parameters indicated in the above test procedure for the mechanical compactor.
2. The mechanical compactor shall be calibrated by ASTM D 2168.
    a. Inspect the mechanical compactor for wear and malfunction
    b. Operate for a minimum of 25 drops, allowing the rammer to fall on the soil
    c. Obtain approximately 50 pounds of required material for calibration. Allow the sample to air dry, sieve and retain material passing the #4 sieve.

d. Prepare two samples, one using the mechanical compactor and one using the manual rammer and determine the optimum moisture and maximum density for each sample.

e. Determine the percent difference in the maximum density.
f. If the two samples are within 2 percent, the mechanical compactor is within specifications. If not, prepare two additional samples using the soil prepared in step c, and repeat steps d and e. If the average of the three samples are within 2 percent, the mechanical compactor is within specification. If not adjust the rammer mass and repeat steps c through e. Repeat until the average difference in maximum density between the mechanical compactor and manual rammer is within 2 percent.

Note: If a larger than permitted change in rammer mass is necessary, improper operation of the mechanical compactor is indicated inspect and adjust to discover the problem and eliminate the cause of the malfunction and repeat the calibration.

Do not make makeshift modifications that could affect the operation of the mechanical compactor. If results indicate that the mass needs to be reduced, carefully recheck all the equipment and the calibrations. If removal of mass is still indicated the drop height should be adjusted. Do not add more than 10 percent to the original mass. If more than 10 percent is required, the mechanical compactor should be rebuilt or repaired.

Do not use the mechanical compactor if the indicated mass change is still larger than allowed.

Calculations

Determine W, the percentage difference of maximum dry unit weight values for a single set of data. If the absolute value of W is equal to or less than 2.0, the mechanical compactor is satisfactory for immediate use. If the absolute value of W is greater than 2.0, then obtain two additional sets of data. Use the same soil sample, prepared in accordance with 5.2, that was used previously. Determine W, the average percentage difference of maximum dry unit mass values for three sets of data. If the absolute value of W is equal to or less than 2.0, the mechanical compactor is satisfactory for immediate use. If the absolute value of W is greater than 2.0, then adjust the rammer mass of the mechanical compactor in accordance with the method stated below. Then secure three new values of γ' max and compute a new value of W. Repeat this procedure until the absolute value of W is equal to or less than 2.0.

Make changes in the weight of the mechanical hammer with due consideration to good workmanship. Makeshift modifications that could affect the operation of the mechanical compactor are not permitted. The maximum permissible variation in the weight of the mechanical hammer as the result of calibration is as follows: The total mass added to the original mass of the hammer as received from the manufacturer must not exceed ten percent of its original mass. If it is necessary to add more than ten percent, the mechanical compactor is to be rebuilt or repaired. If the calibration indicates that the mass of the original rammer needs

to be reduced to less than 5.5 lbf (2.49 kg) or 10 lbf (4.54 kg) depending on the test method rammer standard, carefully recheck all equipment and calibrations and report the procedure. If removal of mass is still indicated, the height-of-drop should be adjusted.

If a larger change than that permitted is found to be necessary, then improper operation of the mechanical compactor is indicated. Evaluate and adjust the mechanical compactor in order to determine and eliminate the cause of the malfunction and repeat the calibration procedure.

Weight values as follows:

$$W = \left[\left(\gamma'_{\max} - \gamma_{max}\right)\right]/\gamma_{max}] \times 100$$
$$\overline{W} = \left[\left(\overline{\gamma}'_{\max} - \overline{\gamma}_{max}\right)\right]/\overline{\gamma}_{max}] \times 100$$

W = percentage difference of maximum unit weight values for a single set of data,
$\overline{W}$ = average percentage difference of maximum unit weight values for three sets of data,
γ_{max} = maximum unit weight value obtained by the manual method,
$\overline{\gamma}_{max}$ = average of three maximum unit weight values obtained by the manual method,
γ'_{max} = maximum unit weight value obtained by the mechanical method, and
$\overline{\gamma}'_{max}$ = average of three maximum unit weight values obtained by the mechanical method.

Worksheet: VP-45

Mechanical Compactor Frequency: Region-Yearly

Standard References: AASHTO T 99 & WSDOT T 606

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper readable to 0.001 in		Feeler gauge	
Balance readable to 0.01 lb. 10 lb. capacity		Measuring device readable to 1/16 inch	
Straightedge			

Dimension	Required	Tolerance	Measurement
Rammer Face Diameter	2.000 in (50.80 mm)	1.985 - 2.010 in (50.42 – 51.05 mm)	
Rammer Weight	5.50 lb. (2.495 kg)	5.48 - 5.52 lb. (2.486 - 2.504 kg)	
Drop Height	12.00 in (457 mm)	11.94 - 12.06 in (455 - 459 mm)	
Is the rammer face flat?			❑ Yes ❑ No

Manual Rammer				Mechanical Compactor			
	γ_{max}	$\bar{\gamma}_{max}$	W		γ'_{max}	$\bar{\gamma}'_{max}$	$\bar{W}$
1.				1.			
2.		Average of three maximum unit weight values	Percentage of difference	2.		Average of three maximum unit weight values	Percentage of difference
3.				3.			

Equations

$$W = [(\gamma'_{max} - \gamma_{max})]/\gamma_{max}] \times 100$$
$$\bar{W} = [(\bar{\gamma}'_{max} - \bar{\gamma}_{max})]/\bar{\gamma}_{max}] \times 100$$

W = percentage difference of maximum unit weight values for a single set of data,
$\bar{W}$ = average percentage difference of maximum unit weight values for three sets of data,
γ_{max} = maximum unit weight value obtained by the manual method,
$\bar{\gamma}_{max}$ = average of three maximum unit weight values obtained by the manual method,
γ'_{max} = maximum unit weight value obtained by the mechanical method, and
$\bar{\gamma}'_{max}$ = average of three maximum unit weight values obtained by the mechanical method.

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP – 46 (Straight Edge)

Equipment Verified: STRAIGHT EDGE

Standard References: AASHTO T 99, T 180

Purpose

This method provides instruction for the verification of the planeness of the straight edge.

Standard Equipment Required

1. Measurement standard Feeler gage: 0.25 mm (0.01 inch)

2. Measurement standard Carpenter's level, or Straightedge, equal to or longer than the checked straight edge.

Tolerance

The straight edge shall meet the tolerance specified in AASHTO T 99 and T 180.

Procedure

1. Measure and record the length of the straightedge.

2. Place the carpenter's level or verified straightedge on its edge on a counter. Hold the straightedge on its edge against the edge of the carpenters level and attempt to slide the feeler gage between the straightedge and the level. If the feeler gauge fits between the straight edge and the level, the straight edge is not plane.

3. Record results

Worksheet: VP-46

Straight edge Frequency: Region Yearly

Standard References: AASHTO T 99 & T 180

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Straightedge		Glass plate	
Feeler gauge			

Straightedge	Tolerance	Measurement	
Length	> 10 in (> 254 mm)		
Base plate	4 in maximum		
Plane of longitudinal edge	0.01 in 10 in 0.250 mm in 250 mm	❑ Yes ❑ No	
One beveled edge?		❑ Yes ❑ No	
Condition of beveled edge		❑ Satisfactory ❑ Unsatisfactory	

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: *VP- 51*

Equipment Verified: SAMPLE PREPARATION & CURING CONDITIONS
(Moist Room, Moist Cabinet & Water Storage Tank)

Standard References: AASHTO M 201, T 106, T 22

Purpose:

This procedure provides instructions on verifying compliance of the moist room, moist cabinet and water curing tanks to ensure conformance with the referenced standards.

Standard Equipment Required

1. Verified thermometer, readable to 0.5°F (1°C), having a range of 68 to 81°F (20 to 27.5°C)
2. Verified Humidity sensing device (Sling Psycrometer)

Tolerance

1. Temperature in moist cabinets and rooms shall be 73.4 ± 3°F (23 ± 2°C).

2. Humidity in moist cabinets and rooms shall be not less than 95 percent.

3. Water temperature of water storage (curing) tanks shall be 73.4 ± 3°F (23 ± 2°C)

Procedure

1. Record the reading(s) indicated on the recording thermometer(s) for the moist room, moist cabinet and water curing tanks.

2. Place the reference thermometer as close to the recording sensor as possible, keep the door to the moist room or cabinet closed for a minimum of 5 minutes before taking a reading. If a discrepancy more than 2° F (1.0° C) exists, adjust the recording thermometer to within 1° F (0.5° C).

3. If the water storage tank is not in a temperature-controlled room, it must have a temperature-recording device. That device will be verified by placing the reference thermometer as close to the recording sensor as possible. If a discrepancy more than 2° F (1.0° C) exists, adjust the recording thermometer to within 1° F (0.5° C).

4. Measure and record the humidity in the moist room and moist cabinet.

5. Observe that there is free-lime present in the bottom of the sample curing tanks. Stir the water in the tank if the saturated water is less than 24 months old, otherwise clean and refill the tank with water containing 3 g/L of calcium hydroxide.

6. If actual temperature is not 73.4 ± 3°F (23 ± 2°C) or the humidity is less than 95 percent, make adjustments as necessary.

Worksheet: VP-51

Moist Room, Moist Cabinet & Water Storage Tank Frequency: 6 months

Standard References: AASHTO M 201, T 22, T 106

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#
Thermometer	
Humidity sensing device	

Temperature Check

Environment	Tolerance	Reference Thermometer Reading	Recording Thermometer Reading	Difference	Adjustment required
Moist Cabinet	73.4 ± 3°F (23 ± 2°C)				❑ Yes ❑ No
Moist Room	73.4 ± 3°F (23 ± 2°C)				❑ Yes ❑ No
Water Tank	73.4 ± 3°F (23 ± 2°C)				❑ Yes ❑ No

Humidity Check

Environment	Tolerance	Humidity sensing device (Reference)	Humidity sensing device	Difference	Adjustment required
Moist Cabinet	>95%				❑ Yes ❑ No
Moist Room	>95%				❑ Yes ❑ No

Water Storage Tank Condition	Date	Acceptable	If "No" Action taken to correct
Free Lime checked		❑ Yes ❑ No	
Stirred, cleaned or refilled		❑ Yes ❑ No	

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-53 (Bearing Blocks)

Equipment Verified: BEARING BLOCKS

Standard References: AASHTO T 22 and AASHTO T 106

Purpose:

This procedure provides instructions for checking the diameter, planeness, and the spherical seating of the bearing blocks for determining the compressive strength of concrete cylinders or mortar grout cubes.

Standard Equipment Required

1. Calipers capable of reading to 0.001 in
2. Verified Straightedge
3. Feeler gauges: 0.013 mm (0.0005 in) for new blocks 0.025mm (0.001 in) for blocks in-service

Tolerance

See worksheets for tolerances

Procedure

1. Measure the diameter of the upper and lower blocks.
2. Check bearing surface by attempting to insert a thickness gauge between the straightedge and the block surface.
3. Rotate the straight edge, 90 degrees in the plane of the surface and repeat the check.
4. Check that the upper block seat is spherical and moves freely.
5. Record as acceptable blocks, which meet the planeness, diameter, and spherical criteria above.
6. Remove from service and machine or replace blocks that exceed the allowable values.

Worksheet: VP- 53a (Grout Blocks)

Grout Cube Bearing Blocks Frequency: 12 months

Standard References: T 106

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Caliper		Ruler	
Straightedge		Feeler gauge	

General Requirements for Upper and Lower Blocks	
Plane within 0.001 inch (NEW blocks plane within 0.0005 inch)	❑ Yes ❑ No
Rockwell hardness not less than 60 HRC	❑ Yes ❑ No

Specific Requirements for Lower Bearing Block:	
Bearing face diameter between 71.6mm (2.82 in.) and 73.7mm (2.9 in.)	❑ Yes ❑ No

Specific Requirements for Top Spherically Seated Bearing Block	
Spherically seated face properly lubricated and free to move in any direction	❑ Yes ❑ No
Bearing face diameter between 71.6mm (2.82 in.) and 79.5mm (3.13 in.)	❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Worksheet: VP- 53b (Cylinder Blocks)

Concrete Cylinder Bearing Blocks Frequency: 12 months
Standard References: T 22

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Caliper		Ruler	
Straightedge		Feeler gauge	

General Requirements Bearing Blocks	
Plane within 0.001 inch (New blocks plane within 0.0005 inch)	❑ Yes ❑ No
Thickness - minimum 1 inch, see T-22 for exceptions	❑ Yes ❑ No
Horizontal dimension 3% greater than diameter of specimens	❑ Yes ❑ No
Rockwell hardness not less than 55	❑ Yes ❑ No
Concentric Rings - required if block is 0.5 inch larger than cylinder	
Lower Bearing Blocks	
Thickness - minimum 1 inch new, 0.9 inch after resurfacing	❑ Yes ❑ No
Provision for centering specimens on lower block	❑ Yes ❑ No
Specific Requirements for Top Spherically Seated Bearing Block	
Size of spherical face: Max. 6.5 inch dia. for 4 inch cylinders Max. 10 inch dia. for 6 inch cylinders	❑ Yes ❑ No
Spherical block held close in the spherical seat	❑ Yes ❑ No
Free to move 4° minimum in any direction	❑ Yes ❑ No
Ball and socket cleaned and lubricated periodically (Lubricant a petroleum type oil - not a pressure grease)	❑ Yes ❑ No
If radius of sphere is less than radius of largest specimen tested: Is thickness of face at edge as great as difference in radii	❑ Yes ❑ No
Center of sphere at center of bearing plate	❑ Yes ❑ No
Is Spherical portion & socket free from deformation	❑ Yes ❑ No
Radius of bearing face equal to or greater than the radius of sphere	❑ Yes ❑ No
Diameter of the sphere at least 75% of diameter of specimen	❑ Yes ❑ No

	Diameter	**Radius**
Bearing Face		
Sphere		

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP- 58 (Gyratory Compactor)

Equipment Verified: GYRATORY COMPACTOR

Standard References: AASHTO T 312, AASHTO T 344

Purpose

This procedure identifies the equipment needed to standardize the Superpave Gyratory Compactor (SGC) in accordance with the manufacturer's calibration manual. The SGC requires yearly standardization unless moved. If the SGC or the testing facility housing the SGC is moved, the SGC will be standardized prior to use.

Standard Equipment Required

All measuring equipment, devices, or spacers used to standardize the SGC must be calibrated/standardized/checked on a yearly basis. An accredited calibration company, in accordance with AASHTO R 18, shall perform all calibration of equipment.

Hydraulic oil filter kit; Pine Instruments Part No AFGBA10 (Pine SGC AFGB1A Only).

Load Cell

Standard Height Block.

Timer, readable to 0.1 seconds.

Straight edge.

Feeler Gauge, 0.001 inch (0.025 mm).

Dynamic Internal Angle Measuring Device w/HMS (Hot Mix Simulator) with manual.

Manufacturer's Calibration Manual for SGC.

Tolerance

Measurements determined shall conform to the requirements defined in AASHTO T 312 and AASHTO T 344.

Procedure

1. The hydraulic system shall be serviced by filtering the entire volume of the fluid reservoir according to the manufacturer's procedure (Pine AFGB1A only; Manual Sec 5.3, Pg V-8), prior to verifying the ram pressure.

2. Standardize the ram pressure using the calibrated load cell provided for the machine and the manufacturer's calibration procedure.

3. The standardization process shall be repeated until measurements are within the allowable tolerance of 600 KPa ± 18 KPa per the manufacturer's instructions.

4. Record the load cell pressure on the work sheet.

5. Standardize the height LVDT using the standard height block and the manufacturer's calibration procedure. Repeat this process until the measured results are within the allowable tolerances.

6. Using a verified timer, count the number of rotations in one minute. Repeat this process two times. Average the results and compare them to the allowable tolerance of 30.0 gyrations/min. ± 0.5 gyrations/min. Make necessary adjustments per manufacturer's instructions. Repeat until the measured results are within the allowable tolerances.

7. Verify Dwell Setting:
   Troxler – dwell set at 0
   Interlaken – dwell set at 0
   Pine (AFGC125X) – dwell set at 0
   Portable Pine (AFGB1A) – dwell set at 2
   Pine (AFG1A) – dwell set at 0

8. Measure the internal angle of gyration per the Dynamic Internal Angle Measuring Device w/HMS procedure and AASHTO T 344 Standard Method of Test for Evaluation of Superpave Gyratory Compactor (SGC) Internal Angle of Gyration Using Simulated Loading. If necessary, make adjustments according to the compactor manufacturer instructions and measure the angle again. This process shall be repeated until two consecutive effective internal angle measurements are obtained that are within the allowable tolerance of 1.16º ± 0.02º. Attach a printout of the internal angle calibration consisting of the last set of four angle measurements to the SGC worksheet.

9. If available through any particular brand and model of SGC, obtain a printout of the calibration from the SGC internal computer and attach it to the worksheet.

Ram Head or End Plate (If Applicable)

1. Confirm the ram head/end plate is clean and at a temperature of 64°F to 82°F (18° C to 28° C). Ram head/end plate shall be free of residue and deep gouges. Surfaces in contact with the asphalt mixture shall be flat. Minor abrasion marks from aggregates are acceptable. Surfaces in contact with the SGC frame shall be free of raised burrs that may cause the ram head/end plate to wobble during gyration. Small recesses on the side of the ram head/end plate interfacing the SGC (opposite the asphalt mixture) can reduce rocking and are acceptable.

2. Determine the maximum diameter of the ram head/end plate by measuring in several locations. Place a removable mark at this position. Record the maximum plate diameter to the nearest 0.025 mm (0.001 in.). Designate this as measurement “A”.

3. Measure the diameter at a 90º orientation to the maximum diameter. Record this diameter as measurement “B”.

4. Each individual measurement reading shall be compared to the specified range (149.50mm - 149.75mm) and given a pass/fail rating.

5. Using a verified straight-edge and feeler gauge, ensure that the ram head/end plate is flat by taking two observations 90º apart while trying to insert the feeler gauge between the ram head/end plate and straight-edge. Record the results as a pass/fail rating for A and B on the verification worksheet.

Worksheet: VP-58

Gyratory Compactor

Frequency: Yearly or after move

Standard References: AASHTO T 312

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Thermometer		Standard Height block	
Feeler Gauge		Caliper	
Load Cell		Timer	
DAV w/HMS			

	Required	Tolerance	Measurements	
Frequency	30.0 rev./min.	30.0 ± 0.5/1 min.		
Internal Angle	1.16 degrees	1.16 ± 0.02 degrees		
Height	Manufacturer's measured height	± 0.05 mm		
Ram Pressure	600 kPa	600 ± 18 kPa		

RAM HEAD/END PLATE MEASUREMENTS (IF APPLICABLE)					
Dimension	Tolerance	Measurement A	Measurement B	Pass / Fail Measurements	
Outside Dia.	149.50 to 149.75mm			A ❑ Pass ❑ Fail	B ❑ Pass ❑ Fail
Surface	Flat	❑ Pass ❑ Fail	❑ Pass ❑ Fail		

Dwell Setting _____

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Note: Attach print out of readings

STANDARDIZATION PROCEDURE: VP- 59 (GC Standard Block)

Equipment Verified: GYRATORY COMPACTOR STANDARD BLOCK

Standard References: AASHTO T 312

Purpose:

This procedure identifies the equipment needed to calibrate the gyratory compactor in accordance with the manufacturer's manual.

Standard Equipment Required

1. Caliper, readable to 0.01 mm

Tolerance

Measurements shall conform to the requirements defined in AASHTO T 312.

Procedure

1. Measure and record the block height at 90° intervals around its perimeter.
2. Average the 4 measurements
3. Determine if they are within the required tolerance.

Worksheet: VP-59

Gyratory Standard Block Frequency: Yearly- Region or after move

Standard References: AASHTO T 312, Manufacturer's Recommendation

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#
Caliper readable to 0.01 mm	

Dimension	A Required	B 1st	C 2nd	D 3rd	E 4th	F Average*	Difference A-F
Height (measured to nearest 0.01 mm)							

Average* = $\frac{B+C+D+E}{4}$

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZE PROCEDURE: VP- 67 (Pycnometer)

Equipment Verified: PYCNOMETER

Standard References: AASHTO T 209/ WSDOT T 606

Purpose:

This method provides instructions for verifying the mass of each pycnometer used in the determination of the maximum specific gravity. The procedure applies to either flask type: Glass Jars or Metal Vessels.

Standard Equipment Required

1. Balance- 11,000 gram capacity and readable to 0.1 gram.

2. Vacuum pump or water aspirator capable of 30 mm Hg or less absolute pressure, for evacuating air from the flask.

3. Standardized thermometric device of suitable range and readable to $1^{o}F$ ($0.5^{o}C$)

4. Water bath large enough to accommodate up to six 2000 ml flasks and capable of maintaining a temperature of 77 ± $1^{o}F$ (25 ± $5^{o}C$) for rice specific gravity and 68 ° ± $1^{o}F$ (20° ± $0.5^{o}C$) for T606 specific gravity.

Tolerance

The weight of the pycnometer, cover plate, and the enclosed water at 77 ^{o}F ($25^{o}C$) for rice specific gravity and 68 ^{o}F (20^{o} C) for T606 specific gravity shall not vary more than 0.1 gram after weighing three times.

Procedure

1. Glass Jars shall be inspected prior to use to ensure they are suitable for use. Glass jars may require grinding with silicon carbide powder to assure the openings are smooth.

2. Fill the jars or vessels approximately 3/4 full with water at 77 ^{o}F ($25^{o}C$) for rice specific gravity and 68 ^{o}F (20^{o} C) for T606 specific gravity.

3. Connect the jars (vessels) to the vacuum system; apply a partial vacuum of 30 ml Hg or less absolute pressure for a period of 15+ 2 minutes. Agitate container either continuously by mechanical device or manually by vigorous shaking at 2 minute intervals.

4. Release vacuum and disconnect the hoses, fill each pycnometer with water and bring contents to a temperature of:

    a. 77 ^{o}F (25^{o}C) for rice specific gravity in a constant temperature water bath of 77 ^{o}F (25^{o}C) for 10 minutes

    b. 68 ^{o}F (20^{o} C) for T606 specific gravity in a constant temperature water bath of 68 ^{o}F (20^{o} C) for 10 minutes.

Filling Pycnometer:

For glass vessels: Completely fill pycnometer with water, slide glass cover plate over opening, remove from water bath, wipe all moisture off of pycnometer and plate or cover, then weigh and record.

For metal vessels: Place the cover and fill the unit completely with water, wipe all moisture off of pycnometer and plate or cover, then weigh and record.

5. Repeat steps 3 - 6 until each pycnometer has at least three readings that are within 0.1 gram of each other.

6. Record the average of the three readings in step 6 as the calibration weight.

Worksheet: VP-67

Pycnometer Frequency: Regions yearly

Standard References: AASHTO T 209 & WSDOT T 606

Verifying Technician:	Date Verified
Next Verification Date:	Previous Verification Date:

Standard	ID#	Adjustment (if required)	Standard	ID#	Adjustment (if required)
Balance			Vacuum System		
Thermometer					

Note: Equipment used to standardize must be calibrated, standardized or checked by an accredited calibration company.

Equipment ID	First Reading	Second Reading	Third Reading	Add'l Reading	Add'l Reading	New Calibration

Equipment found to be :		❑ Satisfactory	❑ Unsatisfactory
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP- 73 (Volumetric Air Meter)

Equipment Verified: VOLUMETRIC AIR METER

Standard References: AASHTO T 196

Purpose:

This method provides instructions for calibrating the volume of Volumetric Air Meter and associated cup.

Standard Equipment Required

1. A plate, either of Glass at least 6 mm (1/4 inch) thick or acrylic at least 12 mm (1/2 inch) thick and at least 25 mm (one inch) larger than the diameter of the measure to be calibrated.

2. A supply of water pump, chassis grease, or similar substance to prevent leakage from the rim of the container.

3. A balance 10 kg (25 lb) capacity, readable to 0.01 gm (0.01 lb)

4. Thermometer, Range 0 to 50C, (66 to 80F) readable to 0.1C (0.2F).

Tolerance

Equipment shall meet the tolerances required by the referenced standard.

Procedure

A. VOLUME CALIBRATION OF BOWL

1. Measure the inside height and the inside diameter of the bowl.

2. Weigh and record to nearest 0.01 lb the weight of the bowl & glass plate.

3. Fill the bowl with water.

4. Weigh and record to nearest 0.01 lb the weight of the bowl and glass plate & water (use grease if necessary).

5. Determine, by subtraction, the weight of water required to fill the bowl.
6. Determine and record the temperature, to 0.1C, (0.2F) of the water in the bowl.
7. Determine, from the table, the density of the water.
8. Divide the weight of water determined in step 5 by the density of water determined in step 7 to determine the volume of the bowl to 0.001 cf.

B. VOLUME CALIBRATION OF THE TOP SECTION

1. Verify the graduated scale starts at no more than 0.5 and ends at no less than 9.0.
2. Weigh and record to nearest 0.01 lb the weight of the bowl, top section and amount of water determined to fill the bowl in step 5 above.
3. Fill the bowl and top section to the 0.0 mark with water.
4. Weigh and record to nearest 0.01 lb the weight of the bowl, top section and water.
5. Fill the bowl and top section to the 0.1 mark with water.
6. Weigh and record to nearest 0.01 lb the weight of the bowl, top section and water to the 1.0 mark.
7. Observe the junction between bowl and top section for leakage.
8. Determine and record the temperature, to 0.1C, (0.2F) of the water.
9. Determine, from the table, the density of the water.
10. Determine, by subtraction, the weight of water required to fill the top section to the 0.0 mark.
11. Divide the weight of water determined in step 10 by the density of water determined in step 8 to determine the volume of the top section to 0.001 cf.
12. Determine if the top section is at least 20% larger than the bowl.
13. Determine, by subtraction, the weight of water required to fill the top section from the 1.0 mark to the 0.0 mark.
14. Divide the weight of water determined in step 13 by the density of water determined in step 8 to determine the volume from 1.0 to 0.0 to 0.001 cf.

15. Determine if the volume from step 14 is 1 +/- 0.1 percent of the bowl.

C. VOLUME CALIBRATION OF CUP

1. Weigh and record to nearest 0.01 lb the weight of the cup and glass plate.
2. Fill the cup with water using the glass plate to insure the cup is full.
3. Weigh and record to nearest 0.01 lb the weight of the cup and glass plate and water (use grease if necessary).
4. Determine, by subtraction, the weight of water required to fill the cup.
5. Determine and record the temperature, to 0.1C, (0.2F) of the water in the cup.
6. Determine, from the table, the density of the water.
7. Divide the weight of water determined in step 4 by the unit weight of water determined in step 6 to determine the volume of the cup to 0.001 cf.
8. Determine if the volume from step 7 is 1.03 +/- 0.04 percent of the bowl.

Worksheet: VP-73

Air Meter (Volumetric) **Frequency:** 36 months

Standard References: AASHTO T 198

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID	Standard	ID
Balance		Steel Ruler	
Thermometer			

Bowl	Measurement/ Calculation	Tolerance	Acceptable
Height: (in.)			
Diameter (in)			
Diameter to height ratio (D/H)		1 – 1.25 times height	❑ Yes ❑ No
Empty weight of bowl and plate: **[1]**= lb(kg)			
Weight of bowl, plate and water: **[2]** = lb. (kg)			
Calculate the weight of the water = **[2]** - **[1]=** lb. (kg)			
Record temperature of water: °F (°C)			
Determine density of water. *See Table 2 on page 2 of worksheet* **[4]=** lb/f^3			
Calculate volume of bowl. **[V_b]= [3]/[4]** = cf (cm)		0.075 cf or more	❑ Yes ❑ No

Top Section	Measurement/Calculation	Tolerance	Acceptable
Transparent Scale graduated		0.5 max to 9.0 min	❑ Yes ❑ No
weight of bowl with top section filled with **[3]** lbs. water **[5]**			
weight of bowl with top section filled with water to the 0.0 mark **[6]**			
weight of bowl with top section filled with water to the 1.0 mark **[6a]**			
Is the bowl / top section junction watertight?			
Calculate the weight of the water in top section = **[6]** - **[5]=[7]**			
Record temperature of water: °F			
Determine density of water. *See Table 2 on page 2 of worksheet* **[4]=** lb/f^3 (kg/m^3)			
Calculate volume of the top section **[V_t]= [7]/[8]** = cf (cm)		0.075 cf or more	❑ Yes ❑ No
Volume of top section **[V_t] > 1.2[V_b]**		at least 20% larger than bowl?	❑ Yes ❑ No
Calculate volume from 0.0 to 1.0 **[V_g]= [6]- [6a]/[8]** = cf (cm)		+/-0.1% of bowl	❑ Yes ❑ No

Cup	Measurement/Calculation	Tolerance	Acceptable
Empty weight of cup and plate **[9]**			
weight of cup, plate and water **[10]**			
Calculate the weight of the water = **[10]** - **[9]=** lb (kg)			
Record temperature of water: °F (°C)			
Determine density of water. *See Table 1* **[12]=** lb/f^3 (kg/m^3)			
Calculate volume of cup **[V_C]= [11]/[12]=** cf (cm)			
Volume of cup		1.03 +/- 0.04% volume of bowl	❑ Yes ❑ No

°F	°C	lb./ft.^{3}	kg/m ^{3}		°F	°C	lb./ft.^{3}	kg/m ^{3}
59.0	15	62.372	999.10		73.4	23	62.274	997.54
60.0	15.6	62.366	999.01		75.0	23.9	62.261	997.32
60.8	16	62.361	998.94		75.2	24	62.259	997.29
62.6	17	62.350	998.77		77.0	25	62.243	997.03
64.4	18	62.340	998.60		78.8	26	62.227	996.77
65.0	18.3	62.336	998.54		80.0	26.7	62.216	996.59
66.2	19	62.328	998.40		80.6	27	62.209	996.50
68.0	20	62.315	998.20		82.4	28	62.192	996.23
69.8	21	62.302	997.99		84.2	29	62.175	995.95
70.0	21.1	62.301	997.97		85.0	29.4	62.166	995.83
71.6	22	62.288	997.77		86.0	30	62.156	995.65

Unit Weight of Water

Table 1

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-74 (Cube Molds)

Equipment Verified: CUBE MOLDS AND TAMPERS

Standard References: WSDOT T 813

Purpose

This method provides instructions for checking the critical dimensions of the cube mold and tamper used in the above test method.

Standard Equipment Required

1. Ruler readable to 1 mm (0.01 in.)
2. Straight-edge or ruler.
3. Machinist square

Tolerance

Equipment shall meet the dimensional tolerances specified on the VP Checklist.

Procedure

Cube Mold

1. Visually inspect all surfaces that will come into contact with the grout to ensure they are essentially plane. A straightedge may be used if necessary.

2. Measure the length, width, and height using the ruler to verify the distances.

    a. Distance between opposite sides:
        i. New: 2 in. ± 0.005 in.;
        ii. Used: 2 in. ± 0.02 in.

    b. Height:
        i. New:2 in. +0.01 in. to –0.005 in.
        ii. Used: 2 in. + 0.01 in. to – 0.015 in.

3. Visually inspect all angles to ensure that they are approx. 90 degrees.

4. Visually inspect the overall condition of the cube mold.

Tamper

1. Measure dimensions of the tamper face.
2. Visually inspect the overall condition of the tamper.

Worksheet: VP-74R

Cube Mold and Tamper (Region) Frequency: Yearly

Standard References: AASHTO T 106

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Check Equipment Type	ID#	Check Equipment Type	ID#
Steel Rule		Machinist Square	
Caliper		Feeler gauge	
Straightedge			

Mold & Tamper	Tolerance		Measurement	Acceptance
	New	Used		
Mold	❑New	❑ Used	**N/A**	❑ Yes ❑ No
Mold condition acceptable?	**N/A**	**N/A**	**N/A**	❑ Yes ❑ No
Tamper condition acceptable?	**N/A**	**N/A**	**N/A**	❑ Yes ❑ No
Planeness of sides	<0.001 in.	<0.002 in.	**N/A**	❑ Yes ❑ No
Cube dimension (distance from opposite side)	2 in. ± 0.005	2 in. ± 0.02		❑ Yes ❑ No
				❑ Yes ❑ No
				❑ Yes ❑ No
				❑ Yes ❑ No
				❑ Yes ❑ No
				❑ Yes ❑ No
Height of each compartment	2 in. + 0.01 to –0.005 in.	2 in. + 0.01 to -0.015 in		❑ Yes ❑ No
				❑ Yes ❑ No
				❑ Yes ❑ No
Angles of mold	90 ± 0.5°	90 ± 0.5°	**N/A**	❑ Yes ❑ No
Tamping block end area	½ x 1 inch			❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE : VP-76 (Manual SE Shaker)

Equipment Verified: MANUAL SAND EQUIVALENT TEST SHAKER

Standard References: AASHTO T 176

Purpose

This method provides instruction for checking the manual shaker to insure operation at the specified amplitude and that the counter is functioning properly.

Standard Equipment Required

1. A measuring device capable of measuring the specified throw of 5 inches and accurate to at least 1/16 inch. (2 mm)

2. Handheld mechanical counting device capable of reading to 500 counts, minimum.

3. Verified timer, readable to 1 second.

Tolerance

Manual shakers shall be capable of operation at 100 cycles in 45 + 5 seconds have a hand assisted half stroke of 5 + 0.2 inches (127 + 5.08 mm).

Procedure

1. With manual shaker in the center position, check that the half stroke indicator is aligned with the center mark on the back of the shaker box or the wall. The half stroke indicator is usually an arrow shaped pointer located in the middle of the upper platform.. If the half stroke indicator is not proper aligned with the center mark the back of the shaker box or the wall mark a new center mark opposite the half stroke indicator at the proper position.

2. Measure the half stroke distance along a straight line parallel to the movement of the shaker, from the center mark. Mark offsets of 0.1 inch from the half stroke distance. Repeat this for the half stroke distance on either side of the center mark.

3. While holding one of the spring steel uprights apply enough force in the direction of the counter to move the half stroke indicator to the stroke limit mark. See 2 above.

4. If needed adjust the counter so it will advance one digit each time the half stroke indicator is within the range of stroke limit mark.

5. Operate the shaker through three complete test cycles to determine if the counter is functioning properly.

Worksheet: VP-76

Manual SE Shaker Frequency: Regions-Yearly

Standard References: AASHTO T 176

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
18” steel ruler		Timer	
Counting device			

Half Stroke Indicator Aligned with Center Mark		❑ Yes ❑ No	
Measure Half Stroke Distance		Left _____ Right_____	
0.1 inch marks made		❑ Yes ❑ No	
Cycles per 45 seconds		Throw (nearest 0.1”)	
Measured	Specified	Measured	Specified
	100 complete cycles in 45 ± 5 seconds		10 +/- 0.4 in (254 +/- 10 mm)
	100 complete cycles in 45 ± 5 seconds		10 +/- 0.4 in (254 +/- 10 mm)
	100 complete cycles in 45 ± 5 seconds		10 +/- 0.4 in (254 +/- 10 mm)

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP- 77 (SE Irrigation Tubes)

Equipment Verified: Sand Equivalent Irrigation Tubes

Standard References: AASHTO T 176

Purpose:

To ensure the proper control of the hydraulic force and amount of solution is used in irrigating (i.e. flushing) the fines from the sand particles.

Standard Equipment Required

No. 60 drill bit or wire gauge.

Procedure

1. Inspect the tube to insure that it is reasonably straight.

2. Measure the tube must be a minimum of 510 mm.

3. Inspect the soldered joint at the end of the tube. Joint at end of tube must have 100 percent seal.
    a. The integrity of the soldered end may be tested by allowing water or working solution to flow freely from the tube. If any fluid flows from the tube except from the two drilled holes the tube is defective and must be replaced.

4. Check the drilled holes using either a No. 60 wire gauge or No. 60 wire drill.
    a. Insert the wire gauge or drill in each hole, do not force the wire gauge or drill into the hole.
        i. If the wire gauge or drill does not fit in the hole use a No. 60 wire drill to carefully enlarge the hole to the proper size.
        ii. If the hole is too large the irrigation tube must be replaced.

Worksheet: VP-77

SE Irrigation Tube Frequency: 12 months

Standard References: AASHTO T 176

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
500 mm or larger Steel Ruler		No. 60 drill bit or wire gauge	

SE Tube Straight	❑ Yes ❑ No
SE Tube Length (min 510 mm)	❑ Yes ❑ No
No Leaks Through Soldered End	❑ Yes ❑ No
2 Holes Open and Free Flowing	❑ Yes ❑ No
Diameter of Holes Satisfactory	❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP- 81 (Retaining Rings)

Equipment Verified: RETAINING RINGS

Standard References: AASHTO T 22, ASTM C1231

Purpose:

This method provides instruction for checking the retaining rings used in conjunction with neoprene inserts for testing cylinders.

Equipment Required

- Calipers
- Straightedge
- Feeler Gauge
- Machinist's Square
- Ruler

Tolerance:

Item	Measurement	Tolerance
Retaining ring	Height	1.0 ±.1 in. [25 ± 3 mm]
Retaining ring	Inside diameter	Not less than 102 % or greater than 107 % of the diameter of the cylinder.
Retaining ring	Thickness	At least 0.47 in. [12 mm] for 6 in [150 mm] diameter retainers and at least 0.35 in. [9 mm] for 4 in. [100 mm] diameter retainers.
Base plate	Thickness	At least 0.47 in. [12 mm] for 6 in. [150 mm] retainers and at least 0.3 in. [8 mm] for 4 in. [100 mm] retainers.
Contact surface of base plate	Planeness	Plane to within 0.002 in. [0.05 mm]
Contact surface of base plate	Surface condition	No gouges, grooves, protrusions, or indentations greater than 0.010 in. [0.25 mm] deep or greater than 0.05 in.^{2} [32 mm^2] in surface area

Procedure:

1. Using the straightedge, machinist's square, and feeler gauge, determine if the bearing faces are plain and that outside dents or gouges do not exceed specifications.
2. Measure the inside diameter.
3. Measure the thickness of the bearing surface.

Worksheet: VP-81a (4 inch)

4 in Diameter Retaining Rings Frequency: Region – Yearly

Standard References: AASHTO T 22

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper		Feeler Gauge	
Steel Ruler		Machinist Square	
Straight edge			

Requirement	Acceptable
Bearing surfaces plane within 0.002 inch inside and out	❑ Yes ❑ No
Outside bearing surface free of gouges and dents larger than 0.010 inch in depth or 0.05 in^2 surface area	❑ Yes ❑ No

Requirement	Tolerance	Measurement	Acceptable
Average inside diameter	4.08- 4.28 inches		❑ Yes ❑ No
Base Plate Thickness	>0.3 in		❑ Yes ❑ No
Retainer depth	0.9 -1.1 inches		❑ Yes ❑ No
Neoprene Pads thickness	0.5 ± 0.063 in		❑ Yes ❑ No
Neoprene Pads. diameter	0.063 smaller than inside diameter		❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Worksheet: VP-81b (6 inch)

6 in Diameter Retaining Rings Frequency: Region – Yearly

Standard References: AASHTO T 22

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper		Feeler Gauge	
Steel Ruler		Machinist Square	
Straight edge			

Requirement	Acceptable
Bearing surfaces plane within 0.002 inch inside and out	❑ Yes ❑ No
Outside bearing surface free of gouges and dents larger than 0.010 inch in depth or 0.05 in^2 surface area	❑ Yes ❑ No

Requirement	Tolerance	Measurement	Acceptable
Average inside diameter	6.12 - 6.42 inches		❑ Yes ❑ No
Thickness of base plate	>0.47 in. [12 mm]		❑ Yes ❑ No
Retainer depth	0.9 - 1.1 inches		❑ Yes ❑ No
Neoprene Pads thickness	0.5 ± 0.063 in		❑ Yes ❑ No
Neoprene Pads. diameter	0.063 smaller than inside diameter		❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-84 (Uncompacted Void Apparatus)

Equipment Verified: UNCOMPACTED VOID APPARATUS

Standard References: AASHTO T-304

Purpose:

This method provides instruction for checking the acceptability of the Uncompacted Void Apparatus.

STANDARD EQUIPMENT REQUIRED:

- Calipers having a range sufficient for the measurements needed and being calibrated and readable to at least 0.1 mm.
- A glass plate at least 4 mm thick, and approximately 60 mm square.
- A supply of grease to be used when calibrating the cylindrical measure.
- Scale or balance accurate and readable to +/-0.1 g within the range of use, capable of weighing the cylindrical measure and its contents.
- Thermometer, calibrated and readable to 0.1 C (0.2F) having a range sufficient to determine the temperature of the water between 18 and 24 C.
- A supply of freshly boiled deionized water for calibrating the measure

TOLERANCE:

Cylinder- Diameter = approx. 39 mm, Height= approx. 86mm, round with no dents

Metal spatula- length =100mm, width minimum 20mm

Glass plate- 60 mm x 60 mm, min of 4 mm thick

Distance from bottom of cone to top of cylinder = 115 ± 2 mm

PROCEDURE:

1. Measure the inside diameter of the cylinder

2. Measure the inside height of the cylinder
3. Measure the glass plate, Length, Width, & Thickness
4. Measure from the top of the cylinder to the bottom of the cone
5. Measure the spatula, Length & Width
6. Check the angles at the spatula's end with a carpenter square to make sure they are at right angle to the blade.
7. Calibrate the cylinder
    a. Apply a light coating of grease to top edge of empty cylinder
    b. Weight the cylinder, grease, and glass plate
    c. Fill the cylinder with freshly boiled deionized water
    d. Place glass plate on top of measure, ensuring no trapped air bubbles
    e. Dry the outer surface of the measure
    f. Weight the cylinder, grease, glass plate, and water
    g. Remove the grease and reweigh the empty cylinder
    h. Density of water determined using table 1
    i. Calculate the volume of the measure to 0.1 mL

CALCULATIONS

$$V = 1000 * \left[\frac{(M - E)}{D} \right]$$

Where:

E= Mass of cylinder, grease, and top plate in grams
M= Mass of cylinder, grease, top plate, and deionized water in grams
D=Density of water from table 1 Kg/m^3
V= Calibration value nearest 0.1 mL

Worksheet: VP-84

Uncompacted Voids Apparatus Frequency: Region-Yearly

Standard References: AASHTO T 304

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Caliper		Balance	
Thermometric Device			

Cylinder	Measurement	Tolerance	Equipment Meets Specification
Inside Diameter		Approx. 39 mm	❑ Yes ❑ No
Inside Height		Approx. 86 mm	**Action Taken**
Cylinder	Round & Not Dented		❑ Replace ❑ Repair ❑ None

Glass Plate	Measurement		Tolerance	Equipment Meets Specification
	Length	Width		
Plate			Approx. 60 mm x 60 mm	❑ Yes ❑ No
Plate Thickness			4 mm min.	**Action Taken**
				❑ Replace ❑ Repair ❑ None

	Measurement	Tolerance	Equipment Meets Specification
Funnel Opening to Top of Cylinder		115 ± 2 mm	❑ Yes ❑ No
			Action Taken
			❑ Replace ❑ Repair ❑ None

Spatula	Measurement		Tolerance	Equipment Meets Specification
	Length	Width		
Length			Approx. 100mm x 20 mm	❑ Yes ❑ No
Sides	Straight			❑ Yes ❑ No
End Angle	Right Angles			❑ Yes ❑ No
				Action Taken
				❑ Replace ❑ Repair ❑ None

Calibration of Cylinder	Measurement
Mass of cylinder, grease, and top plate in grams (E)	grams
Mass of cylinder, grease, top plate, and deionized water in grams (M)	grams
Temperature of water °C	C
Density of water from table 1 Kg/m^3 (D)	
Empty mass of cylinder in grams	grams
Calibration value nearest 0.1 mL (V)	mL

Comments:

Calculations

$$V = 1000 * \left[\frac{(M - E)}{D} \right]$$

°C	(°F)	kg/m³	(lb/ft³)	°C	(°F)	kg/m³	(lb/ft³)
15	(59.0)	999.10	(62.372)	23	(73.4)	997.54	(62.274)
15.6	(60.0)	999.01	(62.366)	23.9	(75.0)	997.32	(62.261)
16	(60.8)	998.94	(62.361)	24	(75.2)	997.29	(62.259)
17	(62.6)	998.77	(62.350)	25	(77.0)	997.03	(62.243)
18	(64.4)	998.60	(62.340)	26	(78.8)	996.77	(62.227)
18.3	(65.0)	998.54	(62.336)	26.7	(80.0)	996.59	(62.216)
19	(66.2)	998.40	(62.328)	27	(80.6)	996.50	(62.209)
20	(68.0)	998.20	(62.315)	28	(82.4)	996.23	(62.192)
21	(69.8)	997.99	(62.302)	29	(84.2)	995.95	(62.175)
21.1	(70.0)	997.97	(62.301)	29.4	(85.0)	995.83	(62.166)
22	(71.6)	997.77	(62.288)	30	(86.0)	995.65	(62.156)

Table 1
Density of Water

CHECK PROCEDURE: VP- 85 (Flat and Elongated Device)

Equipment Verified: FLAT and ELONGATED DEVICE

Standard References: ASTM D4791

Purpose:

This method provides instruction for checking the flat and elongated measuring device

STANDARD EQUIPMENT REQUIRED:

Calipers or other adequate measuring device.

TOLERANCE:

The device shall be capable of determining the ratios required.

PROCEDURE:

1. Set the device at a random opening.
2. Measure the smaller opening with the calipers.
3. Measure the larger opening with the calipers.
4. Repeat for ratios required.
5. Calculate the ratios from opening sizes measured.

Worksheet: VP-85

Flat & Elongated Device Frequency: Region Yearly

Standard References: ASTM D 4791

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper			

Desired Ratio	Smaller Measurement	Larger Measurement	Calculated Ratio

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-86 (Capping Compound)

Equipment Verified: CAPPING COMPOUND

Standard References: AASHTO T 231

Purpose

This procedure provides instruction for determining the compressive strength of the capping compound.

Standard Equipment Required

1. Calibrated set of Grout Cube Molds
2. Cover Plate meeting the requirements AASHTO T 231
3. Verified Compressive Strength Press
4. Straight Edge

Tolerance

The capping material shall have compressive strength as defined in Section 6.2.2 of AASHTO T 231.

Procedure

1. Fabricate the cubes according to Section 5.2.2.1 of AASHTO T 231
2. Check for planeness according the Section 10.6.2 of AASHTO T 106
3. Test the cubes according to AASHTO T 106.

Worksheet: VP-86

Capping Compound

Frequency: On receipt of a new lot and at 3 month intervals

Standard References: AASHTO T 231

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Straightedge		Compression tester	

Cube Number	Planeness Checked ✓	Load (lbf)	Compressive Strength (5000 psi required)
1			
2			
3			
		Average	

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP- 88 (Internal Calibration Vessel)

Equipment Verified: Type B Air Meter Internal Calibration Vessel

Standard Reference: AASHTO T 152

Purpose:

This method provides instructions for verifying the volume of metal or plastic internal calibration vessels used to verify a type B Portland cement concrete air meter.

Standard Equipment Required

Calibrated Type B Portland cement concrete air meter.

Tolerance

Although no specific tolerances exist for internal calibration vessels it is the intent of the verification process to ensure that these devices provide accurate, repeatable results. There are several factors, including altitude, manufacturing variance, and air meter base dimensions that will slightly affect the *apparent* volume of an internal calibration canister. This procedure will determine the apparent volume of the vessels when they are utilized in verification of the air meter.

Procedure

1. Calibrate the air meter to be used in verification of the vessel in accordance with VP-4. Verify that the indicated air content is 5.0 +/- 0.1% when 5% of the water is removed from the base to ensure that the meter is functioning properly. Adjust the gauge of the air meter that is being used to verify internal calibration vessels so that it indicates exactly 5.0% air content when 5% of the water has been removed from the base of the air meter. Repeat this process if necessary to ensure consistent operation of the meter.

2. Inspect the internal calibration vessel for any signs of damage that would prevent it from operating properly.

3. Fill the base of the air meter full with water and place the internal vessel to be verified in an upright position in the base.

4. Clamp the top of the air meter to the base then remove any remaining air in the base by adding water through one of the petcocks. Gently rock the meter to assist in removing any trapped air being careful not to topple the calibration vessel in the air meter base.

5. Pump up the air meter to the initial pressure point determined in step #1. Wait a moment for the air temperature in the chamber to reach equilibrium then re-verify that the air meter is at the correct initial pressure. Adjust if necessary.

6. Close the petcocks and immediately depress the lever to release the compressed air from the chamber into the air meter base. Hold the lever down while waiting a moment for the air temperature in the chamber and base to reach equilibrium. Tap the back of the gauge gently while it is stabilizing.

7. Record the air content indicated on the gauge on the worksheet.

8. Gently release the pressure in the air meter base through the petcocks then repeat steps 3 through 7 until a uniform (within 0.1% consistently) reading is achieved. Record at least two trials on the worksheet.

9. Place a permanent label indicating the average apparent volume of the internal calibration vessel to the nearest 0.1%.

Worksheet: VP-88

PCC Air Meter Internal Calibration Vessel Frequency: Yearly

Standard References: WSDOT T 152

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Air meter			

Calibration of Internal Vessel			Acceptable		
Condition of Vessel			❑ Satisfactory ❑ Unsatisfactory		
First reading (%)	Second reading (%)	Additional reading if necessary (%)	Tolerance	Average (%)	Acceptable
			(5.0 +/- 0.2%)		❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory
Action Taken: ❑ Replace ❑ Repair ❑ None	
Comments:	

STANDARDIZATION PROCEDURE: VP- 89 (External Calibration Vessel)

Equipment Verified: Type B Air Meter External Calibration Vessel

Standard Reference: AASHTO T 152

Purpose:

This method provides instructions for verifying the volume of the metal or plastic external calibration vessels used to calibrate a type B Portland cement concrete air meter.

Standard Equipment Required

1. Balance with a minimum 1000 gram capacity, readable to 0.1 gram.
2. Glass cover plate. (The glass plate used in VP-84 is satisfactory.)
3. Calibrated liquid in glass thermometer of suitable range and readable to $0.2^{o}F$ ($0.1^{o}C$)

Tolerance

The theoretical interior volume of most of these vessels is 0.0125 $ft.^3$ for air meters with a volume of 0.25 $ft.^3$. This corresponds to an equivalent mass of 353.3 grams of water @ $68.0^{o}F$. Correspondingly, a 7.1 gram mass of water @ $68.0^{o}F$ represents 0.1% of the volume of the air meter base. Therefore, a tolerance of +/-3.0 grams of water @ $68.0^{o}F$ applied to the mass of water contained in the calibration vessel represents less than 0.05% error in volume of the air meter base.

Procedure

1. Clean any debris or adherent particles from both the interior and exterior or the vessel and inspect for damage that would change the interior volume of the vessel.
2. Obtain and record the mass of the empty vessel and glass cover plate.
3. Fill the vessel completely full with water that is as close to $68\ ^{o}F$ as possible. Use the glass cover plate (and if necessary to seal the top of the vessel a small amount of light grease). Be certain all air bubbles are removed from the vessel. Record the temperature of the water.

4. Remove any water from the exterior surface of the vessel and glass cover plate then obtain and record the mass of the vessel, water and glass cover plate.

5. Calculate the mass of the water by subtracting the mass of the empty vessel and glass cover plate from the mass of the filled vessel and glass cover plate.

6. If the mass of the water contained in the vessel is 353.3 +/- 3.0 grams the vessel is satisfactory for use.

7. If the water's mass is outside of this tolerance, machine the top rim of the vessel to achieve the desired tolerance or replace the vessel.

Worksheet: VP-89

PCC Air Meter External Calibration Vessel Frequency: Regions-Yearly

Standard References: WSDOT T 152

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Balance		Thermometer	

Calibration of External Vessel	Measurement
Condition of Vessel	❑ Satisfactory ❑ Unsatisfactory
Mass of vessel, grease, and cover plate	**grams**
Mass of vessel, grease, cover plate, and water	**grams**
Mass of water	**grams**
Water Temperature*	**°F**
Mass 353.3 ± 3.0 grams?	❑ Yes ❑ No
Vessel Volume Satisfactory?	❑ Yes ❑ No

***** (The temperature of the water used for calibration should be maintained as close to 68^{O} F as possible.)

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-90 (Thermometers-Dry Well)

Equipment Verified: Standardization of Thermometer using Dry Well Calibrator

Standard References: ASTM E 77

Purpose

This method provides instructions for the standardization of thermometers in a Dry-well Calibrator.

Standard Equipment Required

NIST traceable Dry-well Calibrator appropriate to the thermometer working range.

Specifications

Procedure	Working Range	Accuracy
T 309 *	0 ºF - 120 ºF	1 ºF (0.5 ºC)
T 312	250 ºF to 350 ºF	1 ºF
R 30	50 ºC to176 ºC	1 ºC (1 ºF)

* Requires the thermometer be checked at ice point or water baths at lower temperatures.

Tolerance

Thermometers shall be accurate to one degree within their accuracy range.

Procedure

1. Set the Calibrator at the lowest setting to be checked for the thermometer's working range and allow the calibrator to heat for 20 minutes

2. Insert the probe or stem of the thermometer into the dry well and let sit for 10 minutes. Choose a well that allows probe or stem to slip in easily while maintaining contact with all sides of the well.

3. Record the temperature of the display and the thermometer being standardized.

4. With the thermometer still in the Dry-well, change the set point of the Calibrator to the middle temperature of the thermometer's working range.

5. Note: It is acceptable to check multiple thermometers at each setting before moving to the next setting rather than one thermometer per setting.

6. Allow the well to reach the desired temperature and then wait 5 minutes for the

7. Dry-well to stabilize.

8. Record the temperature of the display and the thermometer being standardized.

9. With the thermometer still in the Dry-well, change the set point of the Calibrator to the high temperature (not to exceed Calibrator's capacity) of the thermometer's working range.

10. Allow the well to reach the desired temperature and then wait 5 minutes for the

11. Dry-well to stabilize

12. Record the temperature of the display and the thermometer being standardized.

13. Determine the average correction between the working thermometers and the calibrated thermometer.

14. Indicate the temperature correction on the thermometer and record data on VP-90 form. For adjustable thermometers, adjust the reading to agree with the verified thermometer reading.

15. After last reading, "cool" the Calibrator per the manufacturer's recommendation before turning power off.

Worksheet: VP-90

Thermometer Standardization Using Dry Well   Frequency: **Region-Yearly**

Standard References: AASHTO R 18

Verifying Technician:	Date Verified
Next Verification Date:	Previous Verification Date:

Standard	ID#	Adjustment (if required)
Dry Well		

Record temperatures to the nearest whole degree

Thermometer ID	**Temp. Working Range**	**Desired Temp**	**Dry Well Reading (w/adjust if required)**	**Thermometer Reading**	**Average Correction**	**Meets Spec**	**Action Taken**
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None
	Low					❑ **Yes**	❑ Replace
	Middle					❑ **No**	❑ Repair
	High						❑ None

Comments:

CHECK PROCEDURE: VP-91 (Infrared Gun or Camera)

Equipment Verified: Infrared Gun or Camera

Standard References: SOP 733

Purpose

This method provides instructions for the standardization of Infrared guns and cameras.

Standard Equipment Required

NIST traceable Infrared Calibrator

Tolerance

Accuracy per manufacturer's statement for device

Procedure

1. Set the IR Calibrator to 50 ºC and allow it to heat for 20 minutes.
2. Set the IR device to .95 emissivity.
3. Hold the IR device at a 90º angle to the center of the calibrator and close enough so the target area of the device is completely contained within IR target of the calibrator. Do not touch the surface of the IR calibrator!
4. Record the temperature of the display and the reading of the IR device.
5. Set the IR Calibrator to 100 ºC and wait for it to achieve the required temperature and stabilize.
6. Repeat steps 3 & 4
7. Set the IR Calibrator to 150 ºC and wait for it to achieve the required temperature and stabilize.
8. Repeat steps 3 & 4
9. Calculate the difference between the IR calibrator and the temperature reading of the IR device.

10. Indicate the temperature correction on the IR device and record data on VP-91W form. For adjustable IR devices, adjust the IR device reading to agree with the verified reading.

Worksheet: VP-91

Infrared Gun and Camera Frequency: SML-12 months

Standard References: ASTM E 77

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
IR Calibrator			

Calibrator Reading °C	IR device Reading °C	Difference °C	Adjusted IR device
50			❑ Yes ❑ No
100			
150			

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-92 (Rebound Hammer)

Equipment Verified: REBOUND HAMMER

Standard References: ASTM C 805M

Purpose

This method provides instruction for verifying a rebound hammer using a calibration anvil.

Standard Equipment Required

1. Rebound Hammer, consisting of a spring-loaded steel hammer that when released strikes a steel plunger in contact with the concrete surface. The spring-loaded hammer must travel with a consistent and reproducible velocity. The rebound distance of the steel hammer from the steel plunger is measured on a linear scale attached to the frame of the instrument.

2. Calibration Anvil- approximately 150-mm [6-in.] diameter by 150-mm [6-in.] high cylinder made of tool steel with an impact area hardened to 66 ± 2 HRC as measured by Test Methods E 18. An instrument guide is provided to center the rebound hammer over the impact area and keep the instrument perpendicular to the surface.

Tolerance

Average of 10 readings must be within ±2 of the manufacturer's hardness value of the calibration anvil

Procedure

1. Place calibration anvil on a concrete floor or slab
2. Place the rebound hammer in the instrument guide and take a series of ten readings
3. Average the ten readings
4. If the average of the ten readings is outside of the tolerance, clean and lubricate the rebound hammer per the manufacturer's recommendation and repeat steps 1-4.
5. If after cleaning the rebound hammer is still not within the tolerance limit the hammer must be sent in to the manufacturer or an accredited repair facility for correction.

Worksheet: VP-92

Rebound Hammer Frequency: Yearly or 2,000 blows

Standard References: ASTM C 805

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Anvil 66 ± 2 HRC			

Calibration Anvil Hardness Value: _____

Reading #	Result
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Average	

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP – 93 (Metal Ruler or Tape)

Equipment Verified: Metal Ruler or Metal Measuring Tape

Standard References: AASHTO T19, T119, T121, T702, T721

Purpose

This method provides instruction for the verification of a metal ruler or metal measuring tape.

Standard Equipment Required

24" Standardized Steel Rule

Tolerance

Within ± 1/32 of the standard rule

Procedure

1. Visually inspect the ruler for defects (ie bends, breaks and readability of graduations).
2. Divide the rule into six even increments (i.e. 12" rule = 2", 4", 6", 8", 10", 12")
3. Compare the incremental readings of the reference ruler to the ruler being standardized.
4. Record the measurements.

Worksheet: VP-93

Metal Ruler/Tape Measure Frequency: Regions- Yearly

Standard References: AASHTO T 119, T 720, T 702

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Steel Ruler			

Length of ruler being verified: _____		
Reference Measurement	**Length Measured**	**Difference**

(Note: for metal tape measure only the length required for the test will be verified)

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-94 (Sieve Gauge Blocks)

Equipment Verified: SIEVE GAUGE BLOCKS

Standard References: AASHTO M 92

Purpose

This method provides instructions for checking the physical condition of sieve gauge blocks for sieves ranging in size from 1½" to No. 4. Check blocks before each use. This procedure is only used in the Region.

Standard Equipment Required

1. A caliper readable to 0.01mm

Procedure

1. Using the caliper take a measurement of the maximum dimension and minimum dimension for each step of the each gauge block. Record the measurements of the gauge block worksheet.

2. Replace gauge blocks that do not meet the required dimensions.

3. Store gauge blocks in a manner that prevents damage.

	Required Dimensions	
Nominal Size (inch)	**Maximum** (mm)	**Minimum** (mm)
1 ½	38.6	36.4
1 ¼	32.5	30.5
1	25.8	24.2
¾	19.6	18.4
5/8	16.5	15.5
½	12.9	12.1
3/8	9.8	9.2
¼	6.5	6.1
No. 4	4.9	4.6

Gauge Block Dimensions
Table 1

Worksheet: VP-94

Sieves Gauge

Frequency: Yearly

Standard References: AASHTO M 92

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper 0.01 mm			

	Measures		Required Dimensions	
Nominal Size (inch)	**Maximum** (mm)	**Minimum** (mm)	**Maximum** (mm)	**Minimum** (mm)
1 ½			38.6	36.4
1 ¼			32.5	30.5
1			25.8	24.2
¾			19.6	18.4
5/8			16.5	15.5
½			12.9	12.1
3/8			9.8	9.2
¼			6.5	6.1
No. 4			4.9	4.6

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

CHECK PROCEDURE: VP-97 (Field Probe Thermometers)

Equipment Verified: FIELD PROBE THERMOMETER (Non-laboratory use only)

Standard References: AASHTO T 309

Purpose

This method provides instructions for the verification of thermometers used for determining the temperature of concrete in the field and field inspection of HMA.

Standard Equipment Required

- NIST traceable Dry-well Calibrator appropriate to the thermometer working range or a thermostatically controlled water or oil bath at the appropriate test temperature
- Calibrated reference thermometer

Tolerance

Thermometers shall be accurate to one degree within their accuracy range.

Specifications

Procedure	Working Range	Accuracy
T 309	0 ºF - 120 ºF	1 ºF (0.5 ºC)
HMA Inspection	250 ºF to 350 ºF	1 ºF (0.5 ºC)

Procedure for verifying concrete field thermometers with a dry well calibrator block

1. For concrete thermometers set the dry well calibrator block at 100 ºF allow the calibrator to heat for 20 minutes
2. Insert the probe or stem of the thermometric device into the dry well and let sit for 5 minutes or until reading stabilizes. Choose a well that allows probe or stem to slip in easily while maintaining contact with all sides of the well.
3. Record the temperature of the display and the thermometer being standardized.
4. Wait 2 minutes and take another reading and record the reading.
5. Determine the average correction between the working thermometers and the calibrated thermometer.

6. Indicate the temperature correction on the thermometer and record data on VP-97 form. For adjustable thermometers, adjust the reading to agree with the verified thermometer reading.

Procedure for verifying concrete field thermometers with a water bath

1. Set the water bath at 77 ºF.

2. Place a calibrated thermometer and thermometer(s) to be verified in the bath.

3. Adjust bath temperature to 77 ºF according to calibrated thermometer, if necessary.

4. After 1/2 hour record the temperature of the calibrated and working thermometers.

5. Record one more reading not less than 1/2 hour after the previous reading.

6. Determine the average correction between the working thermometers and the calibrated thermometer.

7. Indicate the temperature correction on the thermometer and record data on VP-97 form. For dial thermometers, adjust the dial reading to agree with the verified thermometer reading if possible

Procedure for HMA Inspection thermometers with a dry well calibrator block

1. For HMA inspection thermometers set the Calibrator at 275 ºF allow the calibrator to heat for 20 minutes

2. Insert the probe or stem of the thermometric device into the dry well and let sit for 5 minutes or until reading stabilizes. Choose a well that allows probe or stem to slip in easily while maintaining contact with all sides of the well.

3. Record the temperature of the display and the thermometer being standardized.

4. Wait 2 minutes and take another reading and record the reading.

5. Determine the average correction between the working thermometers and the calibrated thermometer.

6. Indicate the temperature correction on the thermometer and record data on VP-97 form. For adjustable thermometric devices, adjust the reading to agree with the verified thermometer reading.

Worksheet: VP-97

Field Probe Thermometer (non-laboratory use) Frequency: Region-Yearly

Standard References: AASHTO T 309, TM 8

Verifying Technician:	Date Verified
Next Verification Date:	Previous Verification Date:

Standard	ID	Adjustment (If required)	Standard	ID	Adjustment (If required)
Dry well calibrator			Water Bath		
DeWar Flask					

Record temperatures to the whole degree

Thermometer ID	Dry Well Reading or water bath (w/adjustment if required)	Time 1st Reading	Time 2nd Reading (For water bath only)	Average Difference	Correction	Meets Specs	Action (if did not meet specification)
						❑ Yes ❑ No	❑ Adjust ❑ Dispose
						❑ Yes ❑ No	❑ Adjust ❑ Dispose
						❑ Yes ❑ No	❑ Adjust ❑ Dispose
						❑ Yes ❑ No	❑ Adjust ❑ Dispose
						❑ Yes ❑ No	❑ Adjust ❑ Dispose

Comments:

CHECK PROCEDURE: VP-98 (T 606 Mold)

Equipment Verified: T 606 Molds

Standard References: T 606

Purpose

This procedure provides instructions for checking the critical dimensions, determining volume and height constant of the T 606 small and large molds

Standard Equipment Required

1. Calipers having a range sufficient to measure the diameter of the measure being checked and readable to at least 0.001 inch (0.025 mm)
2. Feeler gauge; 0.01 inch (0.25mm).
3. Ruler or scale, readable to at least 1/16 inch (1 mm).
4. Inside diameter calipers, 12 inch (300mm) range.
5. Diameter tape, readable to 0.01 inch (1 mm).
6. Straightedge at least 1 inch larger than the diameter of the mold

Additional equipment required for wet method

1. A plate, either of glass at least ¼ inch (6 mm) thick or acrylic at least (1/2 inch (12mm) thick, and at least 1 inch (25 mm) larger than the diameter of the measure to be calibrated.

2. A supply of water pump or chassis grease, or similar substance, that can be placed on the rim of the container to prevent leakage.

3. Balance conforming to the requirements of AASHTO M231 for the class of general purpose balance required for the principal weight of the measure filled with water and the plate for calibration.

4. Thermometer, calibrated and readable to 0.2F (0.1C) having a range sufficient to determine the temperature of the water in the measure at approximately room temperature.

Tolerance

Wall thickness tolerance

Capacity Cubic feet	Bottom	Upper 1-1/2" of Wall	Remainder of Wall
<0.4	0.2 in.	0.10 in.	0.10 in.
0.4 to 1.5	0.2 in.	0.20in.	0.12 in.

Height must be 80 – 150 % of the diameter
Top rim is plane, within 0.01 in.

The base plate shall be flat within 0.005 inch (0.127 mm)

Procedure

Mold Dry Method (removable base only)

1. Measure and record the inside diameter of the mold, determined by taking two readings 90 degrees apart, to the nearest 0.001 inch.

2. Turn the mold over and repeat step 1.

3. Measure and record the inside height of the mold, determined by taking two readings 90 degrees apart, to the nearest 0.001 inch.

4. Calculate the volume of the measure
   Volume = $(\pi r^2)h$

   Where:
   r= radius of the inside of the mold
   h= inside height of mold

Calculate the mold constant

Mold constant = V/h
Where:
V= the volume of the mold
h= inside height of mold

Height Correction Constant

1. Place the lid in the bottom of the mold, piston area facing up.

2. Place the T bar on the top of the mold (if spacers are used they must also be included in the height correction).
3. Measure down from the top of the T bar to the center of the lid.
4. Record the measurement.
5. Turn T bar 90˚ and measure again.
6. Average the two readings and record as the height correction constant.

Mold Wet Method

1. Measure the height and insure that it is approximately equal to the diameter. In no case shall the height be less than 80% or greater than 150% of the diameter.

2. Check to see that the top is smooth and plane by placing the plate on the top and insure that the 0.01 in. feeler gage cannot be inserted between the plate and the top of the measure.

3. Check to see that the top and bottom are parallel by measuring the distance from the plate to table on each side, divide the shorter distance by the longer distance for each two opposite sides, neither result shall exceed 0.5 degrees (0.87%).

4. Determine the thickness of metal of the upper 1 1/2 inches (38 mm) of the wall with the calipers in two locations, 90 degrees apart. Compare the average of the two measurements with the standards of T 19.

5. Measure the inside diameter with the inside calipers and scale. Determine the outside diameter by means of the diameter tape. Determine the wall thickness as one half the differences in diameters and compare with the standards of T 19.

6. Measure and record the external height of the measure at two places 90 degrees apart. Determine the inside height of the measure by measuring from the plate across the measure to the bottom of the measure. Determine the bottom thickness as the difference between the two heights

7. Record the empty weight of the measure with the plate.

8. Fill the measure with water (approx. room temperature)

9. Cover the measure with the plate to eliminate bubbles or excess water (use grease if necessary).

10. Record the weight of the measure, plate, and water.

11. Measure the water temperature and determine the density of water using the table on the worksheet.

12. Calculate the weight of the water

    Mass of Water lb(kg)= $M_2 - M_1$

    Where:
    M_1= mass of empty mold including plate lb(kg)

    M_2= mass of mold including plate and water lb(kg)

    Calculate the volume of the measure
    Volume = Mass of water (lbs (kg))/ Density of water (AASHTO T 19)

    Calculate the mold constant
    Mold Constant = Volume (ft^3)/h (in)

Height Correction Constant

1. Place the lid in the bottom of the mold piston area facing up.
2. Place the T bar on the top of the mold (if spacers are used they must also be included in the height correction).
3. Measure down from the top of the T bar to the center of the lid.
4. Record the measurement.
5. Turn T bar 90˚ and measure again.
6. Average the two readings and record as the height correction constant.

T-bar and spacers

1. Using a caliper measure the thickness of the T-bar at the three points of intersect with the mold
2. All depths must be equal
3. Check the bar with a straightedge and feeler gauge to make sure the bar is straight.
4. Check to spacers to make sure all spacers are the same thickness.

5. Place the piston inside an empty mold, place the T bar and spacers (if needed) on top of the mold and measure down to the center of the mold.
6. Take two measurements and average
7. Record this measurement as the height correction constant.

Worksheet: VP-98a

T 606 Small Mold (wet) Frequency: Region-Yearly

Standard References: WSDOT T 606

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Caliper		Glass Plate	
Straightedge			
Steel Ruler			
Feeler Gauge			

MOLD				
Dimension	**Tolerance**	**1st Reading**	**2nd Reading**	**Average**
Inside Dia.	5.85 – 6.15 in			
Height	7.9 -8.1 in			

CALCULATIONS		
1. Inside Height Mold		In
2. Tare of Mold		lbs
3. Tare of glass plate		lbs
4. Mass of mold and glass plate (2 + 3)		lbs
5. Mass of mold + glass plate + water		lbs
6. Mass of water (5-4)		lbs
7. Temp of water		F/C
8. Unit Mass of Water @ temp (See Table 1)		lbs/ft^3
9. Volume $\left(\frac{6}{8}\right)$		ft^3
10. Mold Constant (V/h)		ft^3/ in
11. Height Correction Constant		in

T bar #	Depth 1	Depth 2	Depth 3	Depth same for all legs	Plane on face 0.01 in 10 in
				□ Yes □ No	□ Yes □ No
				□ Yes □ No	□ Yes □ No

Space bar #	Depth 1	Depth 2 @ 90˚	Depth same for both ends	Plane on face 0.01 in 10 in
			□ Yes □ No	□ Yes □ No
			□ Yes □ No	□ Yes □ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory
Action Taken: ❑ Replace ❑ Repair ❑ None	
Comments:	

Table 1
Unit Mass of Water

°F	°C	lb./ft.³	kg/m³		°F	°C	lb./ft.³	kg/m³
59.0	15	62.372	999.10		73.4	23	62.274	997.54
60.0	15.6	62.366	999.01		75.0	23.9	62.261	997.32
60.8	16	62.361	998.94		75.2	24	62.259	997.29
62.6	17	62.350	998.77		77.0	25	62.243	997.03
64.4	18	62.340	998.60		78.8	26	62.227	996.77
65.0	18.3	62.336	998.54		80.0	26.7	62.216	996.59
66.2	19	62.328	998.40		80.6	27	62.209	996.50
68.0	20	62.315	998.20		82.4	28	62.192	996.23
69.8	21	62.302	997.99		84.2	29	62.175	995.95
70.0	21.1	62.301	997.97		85.0	29.4	62.166	995.83
71.6	22	62.288	997.77		86.0	30	62.156	995.65

Worksheet: VP-98b

Small Mold-Dry

Frequency: **Region – Yearly**

Standard References: WSDOT T 606

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper			

Dimension	Required	Tolerance	Measurements		Average	Meets Requirements
Inside Diameter (d)	6.000 in.	5.85 – 6.15 in				❑ Yes ❑ No
Height (h)	8.000 in	7.9 -8.1 in				❑ Yes ❑ No

Calculations		
Volume	$\frac{3.14159\,x\left(\frac{d}{2}\right)^2\,x\;h}{1728\frac{in}{ft^3}}$	(ft^3)
Mold Constant	V/h	ft^3/in
	Height Correction Constant	(in)

T bar #	Depth 1	Depth 2	Depth 3	Depth same for all legs	Plane on face
				□ Yes □ No	0.02 in 10 in
				□ Yes □ No	0.01 in 10 in

Space bar #	Depth 1	Depth 2 @ 90˚	Depth same for both ends	Plane on face 0.01 in 10 in
			□ Yes □ No	□ Yes □ No
			□ Yes □ No	□ Yes □ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Worksheet: VP-98c

T 606 Large Mold (wet) Frequency: Region-Yearly

Standard References: WSDOT T 606

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	Equipment ID	Standard	Equipment ID
Caliper		Glass Plate	
Straightedge			
Steel Ruler			
Feeler Gauge			

MOLD (capacity=approximately 0.5000 ft^3)					
Dimension	**Tolerance**	**1st Reading**	**2nd Reading**	**Average**	
Inside Dia.	**-**				
Height (internal)	**85-150% of dia**				
Top rim is smooth?				❑ Yes	❑No
Top rim is plane, within 0.01 in.?				❑ Yes	❑No
Thickness of metal in upper 1-1/2" of wall: *See Table 1 on page 2 of worksheet*					in.
Thickness of metal in remainder of wall: *See Table 1 on page 2 of worksheet*					in.
Thickness of metal at bottom: *See Table 1 on page 2 of worksheet*					in.

CALCULATIONS		
1. Inside Height Mold		In
2. Tare of Mold		lbs
3. Tare of glass plate		lbs
4. Mass of mold and glass plate (2 + 3)		lbs
5. Mass of mold + glass plate + water		lbs
6. Mass of water (5-4)		lbs
7. Temp of water		F/C
8. Unit Mass of Water @ temp (See Table 2)		lbs/ft^3

9.	Volume $\left(\frac{6}{8}\right)$		ft^3
10.	Mold Constant $\left(\frac{9}{1}\right)$		$\frac{ft^3}{in}$
11.	Height Correction Constant		in

T bar #	Depth 1	Depth 2	Depth 3	Depth same for all legs	Plane on face 0.01 in 10 in
				□ Yes □ No	□ Yes □ No
				□ Yes □ No	□ Yes □ No
				□ Yes □ No	□ Yes □ No

Space bar #	Depth 1	Depth 2 @ 90˚	Depth same for both ends	Plane on face 0.01 in 10 in
			□ Yes □ No	□ Yes □ No
			□ Yes □ No	□ Yes □ No

Table 1
Thickness of Metal
(Minimum)

Capacity Cubic feet	Bottom	Upper 1-1/2" of Wall	Remainder of Wall
<0.4	0.2 in.	0.10 in.	0.10 in.
0.4 to 1.5	0.2 in.	0.20in.	0.12 in.

Table 2
Unit Mass of Water

?F	?C	lb./ft.³	kg/m ³		?F	?C	lb./ft.³	kg/m³
59.0	15	62.372	999.10		73.4	23	62.274	997.54
60.0	15.6	62.366	999.01		75.0	23.9	62.261	997.32
60.8	16	62.361	998.94		75.2	24	62.259	997.29
62.6	17	62.350	998.77		77.0	25	62.243	997.03
64.4	18	62.340	998.60		78.8	26	62.227	996.77
65.0	18.3	62.336	998.54		80.0	26.7	62.216	996.59
66.2	19	62.328	998.40		80.6	27	62.209	996.50
68.0	20	62.315	998.20		82.4	28	62.192	996.23
69.8	21	62.302	997.99		84.2	29	62.175	995.95
70.0	21.1	62.301	997.97		85.0	29.4	62.166	995.83
71.6	22	62.288	997.77		86.0	30	62.156	995.65

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Worksheet: VP-98d

Large Mold-Dry

Frequency: **Region – Yearly**

Standard References: WSDOT T 606

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Standard	ID#
Caliper		Feeler gauge	
Straightedge		Glass plate	
Steel Ruler			

MOLD (capacity=approximately 0.5000 ft^3)				
Dimension	**Tolerance**	**1st Reading**	**2nd Reading**	**Average**
Inside Dia. (Top)	-			
Height (internal)	85-150% of dia			
Top rim is smooth?				❑ Yes ❑No
Top rim is plane, within 0.01 in.?				❑ Yes ❑No
Thickness of metal in upper 1-1/2" of wall: *See Table 1 on page 2 of worksheet*				in.
Thickness of metal in remainder of wall: *See Table 1 on page 2 of worksheet*				in.
Thickness of metal at bottom: *See Table 1 on page 2 of worksheet*				in.

Calculations		
Volume	$\frac{3.14159\, x \left(\frac{d}{2}\right)^2 x\ h}{1728 \frac{in}{ft^3}}$	ft^3
Mold Constant	V/h	ft^3/in
	Height Correction Constant	in

T bar #	Depth 1	Depth 2	Depth 3	Depth same for all legs	Plane on face 0.01 in 10 in
				□ Yes □ No	□ Yes □ No
				□ Yes □ No	□ Yes □ No
				□ Yes □ No	□ Yes □ No

Space bar #	Depth 1	Depth 2 @ 90˚	Depth same for both ends	Plane on face 0.01 in 10 in
			□ Yes □ No	□ Yes □ No
			□ Yes □ No	□ Yes □ No

Equipment found to be :	❑ Satisfactory ❑ Unsatisfactory		
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

Table 1
Thickness of Metal
(Minimum)

Capacity Cubic feet	Bottom	Upper 1-1/2" of Wall	Remainder of Wall
<0.4	0.2 in.	0.10 in.	0.10 in.
0.4 to 1.5	0.2 in.	0.20in.	0.12 in.

STANDARDIZATION PROCEDURE: VP-103 (VACUUM SYSTEM)

Equipment Verified: CoreLok Vacuum System

Standard Reference: AASHTO T 331, WSDOT SOP 731

Purpose

This method provides instructions to verify that minimum vacuum is achieved.

Inspection Equipment Required

1. Absolute pressure gauge

Tolerance

The CoreLok sample chamber shall reach a vacuum of 4mmHg or lower when measured.

Note: If an adjustment is shown on the Certificate of Calibration for the absolute pressure gauge, make sure the reading is adjusted accordingly. Example: If the absolute pressure gauge has a correction of +3.3mmHg then a gauge reading of 30mmHg is actually 33.3mmHg.

Procedure

1. If the CoreLok pump is cold. Turn the CoreLok unit on. Make sure it is set on Program 1. Close the lid and run Program 1 a total of 4 times.
2. After the 4th run, place the absolute vacuum gauge in the sample chamber and start the unit again.
3. While the unit is running, verify that the vacuum gauge reaches a vacuum of 4mmHg or lower.
4. Repeat steps 2 and 3.
5. If both readings on the gauge are ≤ 4mmHg, your CoreLok system is working correctly. If the vacuum gauge reads > 4mmHg, call the InstroTek office at (919) 975-8371 for troubleshooting options.

Worksheet: VP-103

CoreLok Vacuum System Frequency: 6 months

Standard References: AASHTO T 331, WSDOT SOP 731

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)
Absolute Pressure Gauge		

Vacuum Pressure	
First Reading	**Second Reading**

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			

STANDARDIZATION PROCEDURE: VP-104 (VACUUM SYSTEM)

Equipment Verified: CoreDry Vacuum System

Standard Reference: AASHTO PP 75, WSDOT SOP 731

Purpose

This method provides instructions to verify that minimum vacuum is achieved and to correct readings on the vacuum gauge.

Inspection Equipment Required

2. Absolute pressure gauge

Tolerance

The CoreDry sample chamber shall reach a maximum of 6mmHg when measured.

Note: If an adjustment is shown on the Certificate of Calibration for the absolute pressure gauge, make sure the reading is adjusted accordingly. Example: If the absolute pressure gauge has a correction of +3.3mmHg then a gauge reading of 30mmHg is actually 33.3mmHg.

Procedure

1. Dry the cold trap and remove samples and/or debris from the sample chamber. Turn the unit on. Press the start button and allow the unit to run a total of 7 cycles. This may require starting the unit multiple times based on the settings of your CoreDry.
2. After the 7^{th} cycle, place the absolute pressure gauge in the sample tank and start the unit again.
3. While the unit is running, verify that the vacuum gauge reaches a vacuum of 6mmHg or lower and the gauge readout matches the digital readout on your CoreDry.
4. Repeat steps 2 and 3.
5. If both readings on the gauge are ≤ 6mmHg **and** the absolute pressure gauge readout matches the CoreDry digital readout, your CoreDry system is working correctly. If the absolute pressure gauge reads > 6mmHg **or** does not match the CoreDry digital readout, call the InstroTek office at (919) 975-8371 for troubleshooting options.

Worksheet: VP-104

CoreDry Vacuum System Frequency: 6 months

Standard References: WSDOT SOP 731

Equipment ID:	Verifying Technician:
Date Verified	Next Verification Date:
Previous Verification Date:	Time Charged:

Standard	ID#	Adjustment (if required)
Absolute Pressure Gauge		

Vacuum Pressure		CoreDry Digital Readout Correct
First Reading	Second Reading	
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No
		❑ Yes ❑ No

Equipment found to be :	❑ Satisfactory	❑ Unsatisfactory	
Action Taken:	❑ Replace	❑ Repair	❑ None
Comments:			