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Test Procedure for

# MINIMUM STANDARDS FOR TESTING SOILS AND FLEXIBLE BASE MATERIALS



TxDOT Designation: Tex-198-E

**Effective Date: April 2022**

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## 1. SCOPE

- 1.1 Use this procedure to meet the requirements for the calibration and inspection of laboratory equipment used to perform testing of soils and flexible base materials. The procedures included here are those relevant to daily operations or required under Contract. This test method establishes procedures and interval requirements for all applicable equipment.
- 1.2 **The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.**
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## 2. DOCUMENTATION

- 2.1 Maintain documents and all other pertinent information using approved hard copy or electronic forms for all testing equipment calibrated. Documentation must include the following information for each piece of equipment:
- name of equipment;
  - serial number, or other identification number;
  - calibration or verification interval;
  - name of technician performing calibration or verification;
  - dates of calibration, previous calibration, and next calibration;
  - procedure used to calibrate equipment; and
  - results and all pertinent information from the calibration procedure.
- 2.2 Document information from visual inspections using [Form 2651](#), "Visual Inspection Equipment Checklist, 100-E Series Procedures."
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## 3. CALIBRATION OR VERIFICATION

- 3.1 All equipment that is required to perform each test procedure below must be available in the laboratory and in good working condition.
- 3.2 In addition to the intervals specified below, before use, calibrate or verify the calibration of scales, soil compactors, compression machines, and ovens after each time they are moved.
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3.3 Perform the calibration or verification of equipment listed in accordance with the tables below.

Table 1 — “[Tex-100-E](#), Surveying and Sampling Soils for Highways”

Equipment	Requirements	Procedure	Interval (Months)
Measuring tape, 100 ft. (30 m) long	Visual inspection	NA	12
Post hole digger, shovel, pick, other hand tools	Visual inspection	NA	12
Jack hammer and air compressor	Visual inspection	NA	12
Surveyor's level and level rod	Visual inspection	NA	12
Stakes	Visual inspection	NA	12
Ruler or tape measure, 6 ft. (2 m)	Visual inspection	NA	12
Power drill rig with core or auger attachments	Visual inspection	NA	12
Sample bags and moisture cans for disturbed samples	Visual inspection	NA	12
Materials to maintain moisture content and boxes for packing undisturbed cores	Visual inspection	NA	12
Soil auger	Visual inspection	NA	12
Sample splitter or quartering cloth	Visual inspection	NA	12

Table 2—[Tex-101-E](#), “Preparing Soils and Flexible Base Materials for Testing”

Equipment	Requirements	Procedure	Interval (Months)
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Balance, Class G20, Min. capacity of 80 lb. (36 kg).	Verify calibration record	<a href="#">Tex-901-K</a>	12
Oven, 140±9°F (60°C) and 230±9°F (110°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Crusher (optional)	Visual inspection	NA	12
Mechanical pulverizer (optional)	Visual inspection	NA	12
Mortar and pestle	Visual inspection	NA	12
Scoop	Visual inspection	NA	12
Small siphon tube (optional)	Visual inspection	NA	12
Sample containers, metal pans, cardboard cartons	Visual inspection	NA	12
Filter paper, non-fibrous	Visual inspection	NA	12
Sample splitter, quartering machine, or quartering cloth	Visual inspection	NA	12
Dispenser cup	Visual inspection	NA	12
Mechanical mixer (stirring device)	Visual inspection	NA	12
Plaster of paris molds (optional)	Visual inspection	NA	12

Table 3—[Tex-102-E](#), “Determining Slaking Time”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>

Table 4—[Tex-103-E](#), “Determining Moisture Content in Soil Materials”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Microwave oven	Visual inspection	NA	12
Balance, Class G1 for specimens with a mass of 200 g or less, Class G2 for specimens with a mass greater than 200 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Specimen containers and close fitting lids for small specimens	Visual inspection	NA	12
Specimen containers for microwave ovens	Visual inspection	NA	12
Gloves	Visual inspection	NA	12
Desiccator cabinet or jar containing indicator silica gel or anhydrous calcium sulfate	Visual inspection	NA	12
Heat sink, for microwave ovens	Visual inspection	NA	12

Table 5—[Tex-104-E](#), “Determining Liquid Limit of Soils”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G1, Min. capacity of 100 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Porcelain mixing dish, 4–6 in. diameter	Visual inspection	NA	12
Spatula	Visual inspection	NA	12
Grooving tool	Check dimensions	<a href="#">Procedure 5</a>	12
Liquid limit device	Check wear and dimensions	<a href="#">Procedure 6</a>	12
Height of drop metal gage block	Check height	NA	12
Spray bottle	Visual inspection	NA	12
Weighing dishes, non-absorbent with lids	Visual inspection	NA	12

Table 6—[Tex-105-E](#), “Determining Plastic Limit of Soils”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G1, Min. capacity of 100 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Porcelain mixing dish (4–6 in. diameter)	Visual inspection	NA	12
Spatula	Visual inspection	NA	12
Plastic limit rolling device and paper	Visual inspection	NA	12
Weighing dishes	Visual inspection	NA	12
Plaster of paris disks	Visual inspection	NA	12
Rolling surface, non-absorptive, light texture (12 × 12 in.)	Visual inspection	NA	12

Table 7—[Tex-107-E](#), “Determining the Bar Linear Shrinkage of Soils”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G1, Min. capacity of 200 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Porcelain mixing dish (4–6 in. diameter)	Visual inspection	NA	12
Spatula	Visual inspection	NA	12
Straightedge	Check planeness and length	ASTM D698 or D1557	12
Grooving tool	Check dimensions	<a href="#">Procedure 5</a>	12
Bar linear shrinkage mold	Check dimensions	<a href="#">Procedure 7</a>	12
Number 20 engineer scale or suitable ruler	Visual inspection	NA	12

Table 8—[Tex-108-E](#), “Determining the Specific Gravity of Soils”

Equipment	Requirements	Procedure	Interval (Months)
Volumetric flask, 500 mL	Visual inspection	NA	12
Balance, Class G1, Min. capacity of 800 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Hot plate or sand bath	Visual inspection	NA	12
Constant temperature water bath	Verify temperature settings	<a href="#">Procedure 2</a>	4
Thermometer, calibrated between -5°F and 110°F by 2°F intervals (-15°C and 43°C by 1°C intervals)	<ul style="list-style-type: none"> <li>▪ Visual inspection</li> <li>▪ Calibrate or verify temperature</li> </ul>	<ul style="list-style-type: none"> <li>▪ <a href="#">Tex-926-K</a></li> <li>▪ <a href="#">Procedure 4</a></li> </ul>	12
Bent wire or glass rod	Visual inspection	NA	12
Aspirator or vacuum pump	Visual inspection	NA	12
Weighing dishes	Visual inspection	NA	12

Table 9—[Tex-110-E](#), “Particle Size Analysis of Soils”

Equipment	Requirements	Procedure	Interval (Months)
<b>Part I—Sieve Analysis of Material Retained on the 425 µm (No. 40) Sieve</b>			
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G2, Min. capacity of 33 lb. (15 kg)	Verify calibration record	<a href="#">Tex-901-K</a>	12
Mechanical sieve shaker	Verify sieving duration	<a href="#">Procedure 3</a>	12
Sample splitter, quartering machine, or quartering cloth	Visual inspection	NA	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Pans	Visual inspection	NA	12
<b>Part II—Hydrometer Analysis of Soils Passing 425 µm (No. 40) Sieve</b>			
Stirring apparatus (either a mechanical stirring device or an air dispersion device)	Visual inspection	NA	12
Constant temperature water bath	Verify temperature settings	<a href="#">Procedure 2</a>	4
Thermometer, 1–220°F (0–104°C), accurate to 1°F (0.5°C)	<ul style="list-style-type: none"> <li>▪ Visual inspection</li> <li>▪ Calibrate/verify temperature</li> </ul>	<ul style="list-style-type: none"> <li>▪ <a href="#">Tex-926-K</a></li> <li>▪ <a href="#">Procedure 4</a></li> </ul>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Sedimentation cylinder	Visual inspection	NA	12
Evaporating dishes	Visual inspection	NA	12
Timing device	Verify accuracy	<a href="#">Procedure 1</a> or <a href="#">Tex-924-K</a>	12
Hydrometer, graduated in grams per liter, type 151 H or 152 H	<ul style="list-style-type: none"> <li>▪ Visual inspection</li> <li>▪ Verify dimensions and accuracy</li> </ul>	NA	12
Beaker, 7.5 oz. (250 mL)	Visual inspection	NA	12

Table 10—[Tex-111-E](#), “Determining Amount of Material in Soils Finer than the 75µm (No. 200) Sieve”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G1 for specimens with a mass of 200 g or less, Class G2 for specimens with a mass greater than 200 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Quartering machine, sample splitter, or quartering cloth	Visual inspection	NA	12

Equipment	Requirements	Procedure	Interval (Months)
Stirring device with dispersion cup or soil dispersion tube	Visual inspection	NA	12
Sample containers	Visual inspection	NA	12

Table 11—[Tex-112-E](#), “Admixing Lime to Reduce the Plasticity Index of Soils”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus as listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus as listed in <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>
Apparatus as listed in <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>

Table 12—[Tex-113-E](#), “Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Material and Cohesionless Sand”

Equipment	Requirements	Procedure	Interval (Months)
Automatic tamper	<ul style="list-style-type: none"> <li>▪ Evaluate condition</li> <li>▪ Determine compactive energy delivered</li> </ul>	<ul style="list-style-type: none"> <li>▪ <a href="#">Form 2460</a></li> <li>▪ <a href="#">Procedure 8</a></li> </ul>	12
Compaction mold	<ul style="list-style-type: none"> <li>▪ Verify dimensions</li> <li>▪ Verify volume</li> </ul>	<ul style="list-style-type: none"> <li>▪ <a href="#">Procedure 10</a></li> <li>▪ <a href="#">Tex-905-K</a></li> </ul>	12
Height measuring device (metal stand, spacer blocks, digital or dial indicator)	Verify height using spacer blocks	NA	Each use
Balance, Class G2, Min. capacity of 35 lb. (16 kg)	Verify calibration record	<a href="#">Tex-901-K</a>	12
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Extra base plate	Visual inspection	NA	12
Hydraulic extrusion press	Visual inspection	NA	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Metal pans with lids	Visual inspection	NA	12
Clean, circular porous stones	<b>Visual inspection</b>	<b>NA</b>	12
Small hand tools	Visual inspection	NA	12
Non-absorptive bowls with lids	Visual inspection	NA	12
Sprinkling jar	Visual inspection	NA	12
Non-porous paper discs, 6 in. diameter	Visual inspection	NA	Each use
Soil compactor analyzer (SCA), including sensor rod assembly, control box, and computer with system software	Sensor verification and calibration	<a href="#">SCA Reference Guide</a>	12
Slide Finishing Hammer	Verify dimensions and weights	<a href="#">Tex-113-E</a>	12
Level	Visual inspection	NA	12

Table 13—[Tex-114-E](#), “Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade and Embankment Soils”

Equipment	Requirements	Procedure	Interval (Months)
Automatic tamper	<ul style="list-style-type: none"> <li>Evaluate condition</li> <li>Determine dimensions</li> </ul>	<ul style="list-style-type: none"> <li><a href="#">Form 2460</a></li> <li><a href="#">Procedure 9</a></li> </ul>	12
Compaction mold	<ul style="list-style-type: none"> <li>Verify dimensions</li> <li>Verify volume</li> </ul>	<ul style="list-style-type: none"> <li><a href="#">Procedure 10</a></li> <li><a href="#">Tex-905-K</a></li> </ul>	12
Height measuring device (metal stand, spacer blocks, digital or dial indicator)	Verify height using spacer blocks	NA	Each use
Balance, Class G2, Min. capacity of 35 lb. (16 kg)	Verify calibration record	<a href="#">Tex-901-K</a>	12
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>Check physical condition</li> <li>Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>12</li> <li>12</li> </ul>
Extra base plate	Visual inspection	NA	12
Hydraulic extrusion press	Visual inspection	NA	12
Metal pans with lids	Visual inspection	NA	12
Clean, circular porous stones	Visual inspection	NA	12
Sprinkling jar	Visual inspection	NA	12
Small hand tools	Visual inspection	NA	12
Level	Visual inspection	NA	12
Straightedge or drawknife	Check planeness and length	ASTM D698 or D1557	12
Slide Finishing Hammer	Verify dimensions and weights	<a href="#">Tex-113-E</a>	12

Table 14—[Tex-115-E](#), “Field Method for Determining In-Place Density of Soils and Base Materials

Equipment	Requirements	Procedure	Interval (Months)
<b>Part I—Nuclear Gauge Method</b>			
Nuclear testing gauge	Verify calibration record	As specified by manufacturer	12
Scraper plate and drill rod guide	Visual inspection	NA	12
Drill rod and driver or hammer	Visual inspection	NA	12
Shovel, sieve, trowel or straightedge, and miscellaneous hand tools	Visual inspection	NA	12
Gauge log book	Visual inspection	NA	12
Portable reference standard	Visual inspection	NA	12
<b>Part II—Sand Cone Method</b>			
Buckets with lids or plastic bags	Visual inspection	NA	12
Drying pans	Visual inspection	NA	12

Equipment	Requirements	Procedure	Interval (Months)
Trowel, small hand tools	Visual inspection	NA	12
Straightedge	Check planeness and length	ASTM D698 or D1557	12
Attachable jar, or other sand container	Visual inspection	NA	12
Metal base plate or template	Visual inspection	NA	12
Detachable appliance consisting of a cylindrical valve with an orifice approximately 0.5 in. (13 mm) in diameter	Visual inspection	NA	12
Balance, Class G5, Min. capacity of 50 lb. (20 kg)	Verify calibration record	<a href="#">Tex-901-K</a>	12
Drying equipment	Same as <a href="#">Tex-103-E</a>	Same as <a href="#">Tex-103-E</a>	Same as <a href="#">Tex-103-E</a>
Calibrated sand cone and sand	Verify calibration	<a href="#">Tex-115-E</a>	Each Test
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>

Table 15—[Tex-116-E](#), “Ball Mill Method for Determining the Disintegration of Flexible Base Material”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 140±9°F (60±5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G5, Min. capacity of 33 lb. (15kg)	Verify calibration record	<a href="#">Tex-901-K</a>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Wet ball mill machine	Check RPM, dimensions, and revolution counter	<a href="#">Procedure 12</a>	12
Metal Spheres	Verify weight and dimensions	As specified in <a href="#">Tex-116-E</a>	12
Crusher (optional)	Visual inspection	NA	12
Misc. pans, wash bottles, etc.	Visual inspection	NA	12
Container (for liquid), 0.5 gal. (2 L)	Visual inspection	NA	12

Table 16—[Tex-117-E](#), “Triaxial Compression for Disturbed Soils and Base Materials”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus listed in <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>
Apparatus listed in <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-114-E</a>

Table 16—[Tex-117-E](#), “Triaxial Compression for Disturbed Soils and Base Materials”

Equipment	Requirements	Procedure	Interval (Months)
Triaxial Cells	Visual inspection	NA	12
Aspirator or vacuum pump	Visual inspection	NA	12
Air compressor	Visual inspection	NA	12
Automated load frame or screw jack press	Verify calibration	<a href="#">Tex-902-K</a>	12
Pressure regulator, gauges, and valves	Verify calibration	<a href="#">Tex-902-K</a>	12
Axial load measuring device	Verify calibration	<a href="#">Tex-902-K, Procedure 13</a>	12
10 K load cell (for use with automated load frame)	Verify calibration	<a href="#">Tex-902-K, Procedure 13</a>	12
Proving ring (for use with screw jack press)	Verify calibration	<a href="#">Tex-902-K</a>	12
Circumference measuring device	Visual inspection	NA	12
Lead weights	Visual inspection	NA	12
Curing pans	Visual inspection	NA	12
Metal pans with lids	Visual inspection	NA	12
Filter paper, medium flow porosity	Visual inspection	NA	Each use
Non-porosity paper discs, 6 in. diameter	Visual inspection	NA	Each use
Clean, circular porous stones	Verify stones are not clogged or chipped and meet specified dimensions	<a href="#">Procedure 11</a>	12
Loading end cap	Verify cap is not warped, top and bottom surfaces are level, and there is no pitting or damage to the surfaces	NA	12

Table 17—[Tex-118-E](#), “Triaxial Compression Test for Undisturbed Soils”

Equipment	Requirements	Procedure	Interval (Months)
Balance, Class G1 for soil specimens less than 100 g, or Class G2 for specimens 100 g or heavier	Verify calibration	<a href="#">Tex-901-K</a>	12
Axial load device	Verify calibration	NA	12
Axial load measuring device	Verify calibration	<a href="#">Tex-902-K</a> , <a href="#">Procedure 13</a>	12
Chamber pressure maintaining and measuring device	Verify calibration	NA	12
Devices to measure the height and diameter of the specimen	Verify calibration	NA	12
Triaxial compression chamber	Visual inspection	NA	12
Impermeable rigid specimen cap and base	Visual inspection	NA	12
Deformation indicator	Visual inspection	NA	12
Rubber membrane	Visual inspection	NA	12
Sample extruder	Visual inspection	NA	12
Timing device, to measure to the nearest 1 sec.	Verify accuracy	<a href="#">Procedure 1</a> or <a href="#">Tex-924-K</a>	12
Sample containers	Visual inspection	NA	12
Miscellaneous hand tools and equipment	Visual inspection	NA	12

Table 18—[Tex-120-E](#), “Soil-Cement Testing”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus listed in <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>
Apparatus listed in <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>
High capacity compression testing device, 60,000 lb. (267 kN)	Verify calibration	<a href="#">Tex-902-K</a>	12
Triaxial screw jack press or automated load frame [use for anticipated strengths of ≤ 400 psi (2758 kPa)]	Verify calibration	<a href="#">Tex-902-K</a>	12

Table 19—[Tex-121-E](#), “Soil-Lime Testing”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus listed in <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>
Apparatus listed in <a href="#">Tex-128-E</a>	Same as <a href="#">Tex-128-E</a>	Same as <a href="#">Tex-128-E</a>	Same as <a href="#">Tex-128-E</a>
Apparatus listed in <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>
High capacity compression testing device [60,000 lb. (267kN)] meeting the requirements of ASTM D1633	Verify calibration	<a href="#">Tex-902-K</a>	12
Triaxial screw jack press or automated load frame [use for anticipated strengths of ≤ 400 psi (2758 kPa)]	Verify calibration	<a href="#">Tex-902-K</a>	12

Table 20—[Tex-123-E](#), “Determining the Drainage Factor of Soil Materials”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus listed in <a href="#">Tex-113-E</a> or <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-113-E</a> or <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-113-E</a> or <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-113-E</a> or <a href="#">Tex-114-E</a>
Apparatus listed in <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>
Circular loading plate	Visual inspection	NA	12
Upper and lower cylindrical loading heads	Visual inspection	NA	12
Triaxial test cells	Visual inspection	NA	12
Small proving ring	Visual inspection	NA	12
Loading press assembly	Visual inspection	NA	12
Water reservoir bottle	Visual inspection	NA	12
Drilled loading plate	Visual inspection	NA	12

Table 21—[Tex-124-E](#), “Potential Vertical Rise of Natural Subgrade Soils”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus listed in <a href="#">Tex-103-E</a>	Same as <a href="#">Tex-103-E</a>	Same as <a href="#">Tex-103-E</a>	Same as <a href="#">Tex-103-E</a>
Apparatus listed in <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>
Apparatus listed in <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>
Apparatus listed in <a href="#">Tex-106-E</a>	Same as <a href="#">Tex-106-E</a>	Same as <a href="#">Tex-106-E</a>	Same as <a href="#">Tex-106-E</a>
Apparatus listed in <a href="#">Tex-207-F</a>	Same as <a href="#">Tex-207-F</a>	Same as <a href="#">Tex-207-F</a>	Same as <a href="#">Tex-207-F</a>
Supply of paraffin, cutting knives, other small hand tools	Visual inspection	NA	12
Sampling device, core drilling rig equipment to take disturbed or undisturbed core samples of the material in place	Visual inspection	NA	12

Table 22—[Tex-125-E](#), “Determining Modulus of Subgrade Reaction (K Value)”

Equipment	Requirements	Procedure	Interval (Months)
Loading device	Visual inspection	NA	12
Hydraulic jack assembly with spherical bearing attachment	Verify calibration	NA	12
Dial gauges	Verify calibration, visual inspection	NA	12
Deflection beam	Verify dimensions	NA	12
Miscellaneous hand tools	Visual inspection	NA	12
Thermometer	Verify temperature	<a href="#">Tex-926-K</a>	12
Set of circular steel bearing plates	Verify dimensions	NA	12

Table 23—[Tex-126-E](#), “Molding, Testing, and Evaluating Bituminous Black Base Materials”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Motorized gyratory press	Verify calibration	<a href="#">Tex-916-K</a>	12
Compaction mold	Verify dimensions	NA	12
Spacer block, 8 in. (200 mm) high	Check dimensions	NA	12
Press	Visual inspection	NA	12
Mechanical mixer	Visual inspection	NA	12
Oven, 290 ± 9°F (143 ± 3°C), 250 ± 9°F (121 ± 3°C), 140 ± 9°F (60 ± 3°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Electric hot plate	Visual inspection	NA	12
Dolly, caster mounted	Check dimensions	NA	12
Metal pans	Visual inspection	NA	12
Circular porous stones, slightly less than 6 in. in diameter and 2 in. high	Verify stones are not clogged or chipped and meet specified dimensions	<a href="#">Procedure 11</a>	12
Metal disks	Check dimensions	NA	12
Filter paper, 6 in. in diameter	Visual inspection	NA	12
Small tools, trowels, plastic mallet	Visual inspection	NA	12
Fine soil pans, round pans and sample pans	Visual inspection	NA	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verification of wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Screw jack press	Verify calibration	<a href="#">Tex-902-K</a>	12

Table 24—[Tex-127-E](#), “Lime-Fly Ash Compressive Strength Test Methods”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus as listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus as listed in <a href="#">Tex-113-E</a> or <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-113-E</a> or <a href="#">Tex-114-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus as listed in <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>	Same as <a href="#">Tex-117-E</a>
High capacity compression testing device [60,000 lb. (267kN)], meeting the requirements of ASTM D1633	Verify calibration	<a href="#">Tex-902-K</a>	12
Triaxial screw jack press or automated load frame, [use for anticipated strengths of ≤ 400 psi (2757 kPa)]	Verify calibration	<a href="#">Tex-902-K</a>	12

Table 25—[Tex-128-E](#), “Determining Soil pH”

Equipment	Requirements	Procedure	Interval (Months)
pH meter with glass electrode, range 0–14 ± 0.1	Check fluid level	Refer to manufacturer’s instructions	Each use
Buffer solutions	Check standard against machine	NA	Each use
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Oven, 140±9°F (60°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Balance, Class G1	Verify calibration	<a href="#">Tex-901-K</a>	12
Glass stirring rod and magnetic stir bar	Visual inspection	NA	12
Glass beaker, 250 mL	Visual inspection	NA	12
Stirring device, mechanical or magnetic	Visual inspection	NA	12
Thermometer, 32–212°F (0–100°C)	Verify temperature	<a href="#">Tex-926-K</a>	12

Table 26—[Tex-129-E](#), “Measuring the Resistivity of Soils Materials”

Equipment	Requirements	Procedure	Interval (Months)
Oven, 140 ± 9°F (60 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Splitter or quartering cloth	Visual inspection	NA	12
Portable resistivity meter	Verify calibration	NA	12
Resistivity box	Verify dimensions	NA	12
Straightedge	Check planeness and length	ASTM D698 or D1557	12
Balance, Class G2, Min. capacity of 1,500g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Graduated beaker, 200 mL	Visually inspect	NA	12
Drying pans, mixing pans, trowel, and small scoop	Visually inspect	NA	12

Table 27—[Tex-131-E](#), “Consolidated Undrained Triaxial Compression Test for Undisturbed Soils”

Equipment	Requirements	Procedure	Interval (Months)
Balance, Class G2, Min. capacity of 4,000 g	Verify calibration	<a href="#">Tex-901-K</a>	12
Axial load device	Verify calibration	NA	12
Axial load measuring device	Verify calibration	<a href="#">Tex-902-K</a> , <a href="#">Procedure 13</a>	12

Equipment	Requirements	Procedure	Interval (Months)
Chamber pressure maintaining and measuring device	Verify calibration	NA	12
Devices to measure the height and diameter of the specimen	Verify calibration	NA	12
Pore pressure measuring device	Verify calibration	NA	12
Triaxial compression chamber	Visual inspection	NA	12
Impermeable rigid specimen cap and base	Visual inspection	NA	12
Oven, 230 ± 9°F (110 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Deformation indicator	Visual inspection	NA	12
Rubber membrane	Visual inspection	NA	12
Sample extruder	Visual inspection	NA	12
Sample containers	Visual inspection	NA	12
Miscellaneous hand tool and equipment	Visual inspection	NA	12
Filter paper	Visual inspection	NA	12
Vacuum membrane expander	Visual inspection	NA	12
Sample cutter	Visual inspection	NA	12
Porous stones	Verify stones are not clogged or chipped, verify specified dimensions	<a href="#">Procedure 11</a>	12
Sample trimming equipment	Visual inspection	NA	12

Table 28—[Tex-132-E](#), “Texas Cone Penetration”

Equipment	Requirements	Procedure	Interval (Months)
Hammer	Visual inspection, verify weight and drop height	NA	12
Drill stem, sufficient to accomplish drilling to the desired depth	Visual inspection	NA	12
Anvil, threaded to fit the drill stem, slotted to accept the hammer	Visual inspection	NA	12
Conical driving point	Visual inspection, verify dimensions	NA	12

Table 29—[Tex-135-E](#), Freezing and Thawing Tests of Compacted Soil-Cement Mixture

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>	Same as <a href="#">Tex-113-E</a>
Freezing cabinet	Verify temperature	<a href="#">Procedure 14</a>	12
Moist room	Verify temperature	<a href="#">Procedure 14</a>	12
Wire scratch brush	Visual inspection	NA	12

Equipment	Requirements	Procedure	Interval (Months)
Scarifier	Visual inspection	NA	12
Carriers or trays	Visual inspection	NA	12
Mechanical mixing device	Visual inspection	NA	12
Flat pan, 2" deep	Visual inspection	NA	12
Pads (1/4" thick), felt, blotters, sheets of plastic, or similar material	Visual inspection	NA	12

Table 30—[Tex-140-E](#), “Measuring Thickness of Pavement Layer”

Equipment	Requirements	Procedure	Interval (Months)
Drill with auger bit, grubbing hoe, or other acceptable digging tool	Visual inspection	NA	12
Nail, blade, knife, or other suitable tool, not to exceed 1/8" in thickness, and about 3" long	Visual inspection	NA	12
Ruler or tape measure, 6 ft.	Visual inspection	NA	12
Depth measurement indicator, DHT#2238 (not to be used for pay purposes)	Visual inspection	NA	12

Table 31—[Tex-141-E](#), “Manual Procedure for Description and Identification of Soils”

Equipment	Requirements	Procedure	Interval (Months)
Pocket knife or small spatula	Visual inspection	NA	12
Hydrochloric acid, one part HCl (10N) to three parts water	Visual inspection	NA	Each use

Table 32—[Tex-142-E](#), “Laboratory Classification of Soils for Engineering Purposes”

Equipment	Requirements	Procedure	Interval (Months)
Apparatus listed in <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>	Same as <a href="#">Tex-101-E</a>
Apparatus listed in <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>	Same as <a href="#">Tex-104-E</a>
Apparatus listed in <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>	Same as <a href="#">Tex-105-E</a>
Apparatus listed in <a href="#">Tex-106-E</a>	Same as <a href="#">Tex-106-E</a>	Same as <a href="#">Tex-106-E</a>	Same as <a href="#">Tex-106-E</a>
Apparatus listed in <a href="#">Tex-110-E</a>	Same as <a href="#">Tex-110-E</a>	Same as <a href="#">Tex-110-E</a>	Same as <a href="#">Tex-110-E</a>

Table 33—[Tex-145-E](#), “Determining Sulfate Content in Soils – Colorimetric Method”

Equipment	Requirements	Procedure	Interval (Months)
Colorimeter and accessories	Visual inspection	NA	Each use
Auger sampler	Visual inspection	NA	12
Core sampler	Visual inspection	NA	12
Balance, Class G2, Min capacity of 3,500 g	Verify calibration	<a href="#">Tex-901-K</a>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verification of wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Mortar and pestle	Visual inspection	NA	12
Crusher	Visual inspection	NA	12
Oven, 140 ± 9°F (60 ± 5°C)	Verify temperature	<a href="#">Tex-927-K</a>	12
Miscellaneous glassware described in test procedure	Visual inspection	NA	12
HDPE bottles, 8 oz. and 16 oz.	Visual inspection	NA	12
Funnel	Visual inspection	NA	12
Filter paper, fine porosity	Visual inspection	NA	12
Disposable pipettes	Visual inspection	NA	12
Wash bottle	Visual inspection	NA	12
Desiccator, optional (not necessary if containers with close-fitting lids are used)	Visual inspection	NA	12
Sample splitter	Visual inspection	NA	12
Miscellaneous hand tools	Visual inspection	NA	12

Table 34—[Tex-146-E](#), “Conductivity Test for Field Detection of Sulfates in Soil”

Equipment	Requirements	Procedure	Interval (Months)
Portable conductivity meter	Verify electrode calibration	As described in <a href="#">Tex-145-E</a>	Each use
Conductivity standard solutions	Check expiration date	NA	Each use
HDPE bottle and wash bottle	Visual inspection	NA	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Mortar and pestle	Visual inspection	NA	12
Portable scale, Class G2, Min capacity of 400 g	Verify calibration	<a href="#">Tex-901-K</a>	12
Stopwatch	Verify accuracy	<a href="#">Procedure 1</a> or <a href="#">Tex-924-K</a>	12
Graduated cylinder	Visual inspection	NA	12
Wash bottle	Visual inspection	NA	12

Equipment	Requirements	Procedure	Interval (Months)
Weighing dishes, small spatula, and brush.	Visual inspection	NA	12
Hand auger	Visual inspection	NA	12

Table 35—[Tex-148-E](#), “Soil Organic Content Using UV-Vis Method”

Equipment	Requirements	Procedure	Interval (Months)
UV-Vis spectrometer, capable of measuring at a wavelength of 300 nm	Clean light source lenses according to manufacturer’s instructions	NA	Each use
Balance, Class G1, Min capacity of 200 g	Verify calibration record	<a href="#">Tex-901-K</a>	12
Sieves, as listed in procedure	<ul style="list-style-type: none"> <li>▪ Check physical condition</li> <li>▪ Verify wire cloth for dimensional accuracy</li> </ul>	<a href="#">Tex-907-K</a>	<ul style="list-style-type: none"> <li>▪ 12</li> <li>▪ 12</li> </ul>
Mortar and pestle	Visual inspection	NA	12
Crusher	Visual inspection	NA	12
Cuvettes (glass or quartz), 1 cm UV-Vis	Visual inspection, do not use scratched or fractured cuvettes	NA	Each use
Graduated cylinder, 10 mL	Visually inspect	NA	12
Wash bottles for DI water and solutions	Visual inspection	NA	12
Glass or polyethylene bottles, Min. capacity, 1 L	Visual inspection	NA	12
Sample splitter	Visual inspection	NA	12
Stopwatch	Verify accuracy	<a href="#">Procedure 1</a> or <a href="#">Tex-924-K</a>	12

#### 4. PROCEDURES

##### 4.1 Procedure 1—Timers:

- 4.1.1 Hold a calibrated timer in one hand and the timer to be checked in the opposite hand.
- 4.1.2 Start the timers simultaneously by pressing the start buttons at the same time.
- 4.1.3 Allow the timers to run at least 15 min., then stop the timers simultaneously. Record the time indicated by both timers. Repeat this step for a 30-min. run.
- 4.1.4 Record the difference between the two timers. Calculate and record the percent accuracy.

$$\%accuracy = \frac{(A - B)}{B} \times 100$$

Where:

A = Reading on lab timer (sec.)

B = Reading on standard timer (sec.)

**Note 1**—If no accuracy is specified in the test procedure, choose a maximum allowable error of 1 sec. per minute.

4.2 *Procedure 2—Water Bath:*

4.2.1 Place a calibrated thermometer in the center of the water bath for 1 hr. to verify temperature setting.

**Note 2**—Check setting at which the water bath is used.

4.3 *Procedure 3—Mechanical Sieve Shaker:*

4.3.1 Match the sieve and aggregate such that a minimum of 10% of the total sample weight is retained on each sieve. After sieving on the mechanical shaker for a given time, check the thoroughness of sieving by hand shaking each sieve with a lateral and vertical motion, accompanied by a jarring action, to keep the material moving continuously over the surface of the sieve. If hand shaking shows more than 1% passing any given sieve, increase the shaking time and repeat the check until all screens show less than 1% by weight passing a given sieve.

4.4 *Procedure 4—Thermometers:*

4.4.1 Examine documentation for each thermometer used. Examine documentation for the standard used.

4.4.2 The documentation on thermometers used should include:

- temperature read at each calibration point,
- true temperature read at each calibration point,
- serial or identification number of each thermometer,
- date calibrated or checked, and
- signature of the person who read calibration.

4.4.3 The documentation on standard used should include:

- serial or identification number of standard used,
- dated standard used, and
- signature of the person who ran calibration on standard.

4.5 *Procedure 5—Grooving Tool:*

4.5.1 Verify that the grooving tool meets all of the dimensions outlined in [Tex-104-E](#). Check the measurements using a calibrated caliper that will measure to the nearest 0.01 mm and a measuring magnifier.

4.6 *Procedure 6—Liquid Limit Testing Device:*

4.6.1 Verify that all of the dimensions outlined in [Tex-104-E](#) are within acceptable limits using a calibrated caliper and small ruler. A straightedge is necessary to complete some of the measurements.

4.6.2 Verify that the cam is smooth and free of any deformations that would cause jarring of the sample other than the calibrated drop at the end of the rotation.

4.6.3 Measure the contact point between the cup and the base of the liquid limit device. This wear spot should measure no more than 0.5 in. (12.7 mm) in diameter. Take this measurement at the widest point.

- 4.6.4 Calibrate the height of the drop of the cup as described in [Tex-104-E](#).
- 4.7 *Procedure 7—Bar Linear Shrinkage Mold:*
- 4.7.1 The shrinkage mold should match the dimensions outlined in [Tex-107-E](#). The dimensions listed are internal dimensions.
- 4.8 *Procedure 8—Automatic Tamper for Base Compaction:*
- 4.8.1 Evaluate condition and dimensions of automatic tamper and record on [Form 2460](#), “Soil Compactor Adjustment & Soil Compactor Analyzer Report Form.” Make adjustments necessary to comply with automatic tamper tolerances and maintenance requirements.
- 4.8.2 Mount the soil compactor analyzer (SCA) to the automatic tamper in accordance with the [Soil Compactor Analyzer Reference Guide](#).
- 4.8.3 Prepare and compact a minimum of one specimen in accordance with [Tex-113-E](#) using the SCA. The SCA will turn the compactor off when the correct energy has been delivered to the lift. The total energy delivered to each lift must equal  $750 \pm 15.0$  ft.-lb. The number of blows needed to achieve the 750 ft.-lb. must be a minimum of 50 and a maximum of 60. If the number of blows is outside the range, adjust the compactor so that the specified energy is achieved within the allowable number of blows. Some causes for not meeting the minimum compactive energy requirement include loss of compactive effort due to improper base mounting, incorrect drop height, hammer weight, a sticking grabber, incorrect tolerances, worn bushings, worn guide rods, worn or dirty hammer rod, or worn guide disc.
- 4.8.4 If the first specimen does not meet the tolerances in Section 4.8.3, make adjustments to the compactor. Prepare and compact another sample using the SCA to verify the tolerances in Section 4.8.3 are met. Continue to make adjustments to the compactor, preparing and compacting samples with the SCA until the tolerances in Section 4.8.3 are met.
- 4.9 *Procedure 9—Automatic Tamper for Soil Compaction:*
- 4.9.1 Evaluate condition and dimensions of automatic tamper and record on [Form 2460](#). Make adjustments necessary to comply with tolerances and maintenance requirements specified in the compactor manual. Verify the following:
- the base is securely mounted to a rigid foundation such as a concrete block with a mass of not less than 200 lb.;
  - rammers are within  $\pm 0.02$  lb. of the weight specified in [Tex-113-E](#) and [Tex-114-E](#);
  - striking face of the rammers conform to a  $43 \pm 2^\circ$  segment of a  $2.9 \pm 0.1$  in. ( $74 \pm 2.5$  mm) radius circle;
  - hammer drop height is 12 in. or 18 in. when set in accordance with the compactor manual;
  - grabber does operate freely;
  - bushings, guide rods, and guide disc tolerances conform to the requirements specified in the compactor manual; and
  - guide rod is clean.
- 4.10 *Procedure 10—Molds*  
**Note 3**—Also refer to [Tex-905-K](#), Part II.

4.10.1 Measure the inside diameter of the mold at four locations near the bottom, four locations near the middle, and four locations near the top, using a micrometer caliper and micrometer dial and record each reading as d1, d2, d3, etc.

4.10.2 Calculate the average inside diameter,  $d_{avg}$ , in. (mm):

$$d_{avg} = \frac{(d1+d2+d3+d4+d5+d6+d7+d8+d9+d10+d11+d12)}{12}, \text{in. (mm)}$$

The inside diameter of the mold must meet the following tolerances: 6 in., +1/16, or -1/64 in.

4.10.3 Calculate the cross-sectional area of the mold:

$$A_x = \frac{(3.1416 \times d_{avg}^2)}{4}, \text{in.}^2 \text{ (mm}^2\text{)}$$

4.10.4 Calculate the volume, in ft.<sup>3</sup> (m<sup>3</sup>) for 0.04 in. (1 mm) of height of the mold:

$$\text{Volume per in.} = \frac{A_x}{1728}, \frac{\text{ft}^3}{\text{in.}} \qquad \text{Volume per mm} = \frac{A_x}{10^9}, \frac{\text{m}^3}{\text{mm}}$$

4.10.5 Measure the height of the mold at its four quarter points and calculate the average height. The height must be  $8.5 \pm 1/16$  in.

4.11 Procedure 11—Porous Stones:

4.11.1 Wash porous stones with a plastic bristle brush after each use and dry the stones in an oven at 140°F.

4.11.2 Clean porous stones monthly in an ultrasonic cleaner, vibrating parts cleaner, or equivalent to remove particles from the pores so that water can move freely through the stones. Verify that the stones are not clogged by placing them in a pan containing 1/2 in. of water and measure the time required for water to travel through the stone to its top surface. If this takes longer than 10 min., clean the stones until water is able to reach the surface in a maximum of 10 min. If this is not achievable, discard the stone.

4.11.3 Measure dimensions with calibrated calipers. Discard stone if the diameter is less than 5-3/4 in. (146.0 mm) or the height exceeds a tolerance of 2 in.  $\pm$  1/4 in. (51  $\pm$  6.25 mm).

4.12 Procedure 12—Wet Ball Mill:

4.12.1 Verify that all of the dimensions are within tolerances listed for the wet ball mill machine as outlined in [Tex-116-E](#). Check the mill for leaks when sealed.

4.12.2 Verify that the RPM of the mill is 58–62. Inspect the apparatus for a revolution counter that will turn off the motor after the completion of 600 revolutions.

4.12.3 Verify that the size and weight of the metal spheres are within tolerances listed in [Tex-116-E](#).

4.13 Procedure 13—10 K Load Cell:

- 4.13.1 Calibrate the load cell in 100-lb. increments beginning at a load of 200 lb. Continue this frequency through a load of 1,000 lb.
- 4.13.2 Calibrate the load cell at the frequency specified in [Tex-902-K](#) for loads above 1,000 lb.
- 4.14 *Procedure 14—Temperature Dependent Apparatus – Freeze-Thaw Chamber, Refrigerators, etc.*
- 4.14.1 Using a calibrated digital thermometer graduated in 2°F (1°C), place the thermocouple probe on the shelf where the samples are normally placed.
- 4.14.2 Take the first reading at least 1 hr. after closing the apparatus. (Apparatus should remain undisturbed.) Take as many readings as necessary to determine if the temperature range is within the specified tolerance. (Three consecutive readings, taken no less than 2 hr. apart and within the tolerance allowed, are required).
- 4.14.3 Adjust the temperature of the apparatus if an observed temperature reading is outside the specified tolerance, allowing at least 2 hr. for the temperature to stabilize between each adjustment.
- 4.14.4 Repeat taking readings and adjusting the temperature as necessary.
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## 5. ARCHIVED VERSIONS

- 5.1 Archived versions are available.