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## Test Procedure for

# MINIMUM STANDARDS FOR ACCEPTANCE OF A LABORATORY FOR SOILS AND FLEXIBLE BASE TESTING



TxDOT Designation: **Tex-198-E**

**Effective Date: March 2011**

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## 1. SCOPE

- 1.1 Use this procedure to determine if a laboratory meets the minimum standards for soils and flexible base testing. The scope of a laboratory's qualification may include only those test procedures relevant to its operations or which may be required under contract. All applicable equipment should be calibrated or verified in accordance with Tables 1–32. In addition to requirements shown below, each piece of apparatus required to perform each test method must be available in the laboratory.
- 1.2 The values stated in U.S. customary units are standard, except for units of weight, where metric is considered the standard.
- 1.3 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 Laboratories must maintain records for all calibrated or verified equipment. Miscellaneous items such as trowels, pans, scoops, spatulas, straightedges, funnels, brushes, containers, etc. are excluded. Such records should include the following information for each piece of equipment:
- description of equipment
  - serial number, or other ID
  - frequency of calibration
  - calibrating technician
  - date of calibration
  - date of last calibration
  - date of next calibration
  - procedure used to calibrate equipment
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- detailed results of calibration work.

2.2 See [Form 2461](#), “Calibration/Verification of Grooving Tools,” for an example of a typical worksheet used to document calibration and verification of equipment.

### 3. REQUIREMENTS

#### 3.1 *Moved Equipment:*

3.1.1 In addition to the intervals specified below, the following equipment must be re-calibrated or verified each time it is moved prior to being used again: balances/scales, compression machines, thermometers (check for broken mercury column), and ovens.

#### 3.2 *Sieves:*

3.2.1 In addition to the noted six-month visual inspections, results from annual soils and aggregates proficiency samples can be used to verify the accuracy of sieves.

**Table 1—Tex-100-E, Surveying and Sampling Soils for Highways**

| Equipment  | Requirements      | Procedure | Interval (Months) |
|--|-------------------|-----------|-------------------|
| Metallic tape, 100 ft (30 m) long  | Visual inspection | NA        | 12                |
| Post hole digger, shovel, prospector’s pick, other hand tools                  | Visual inspection | NA        | 12                |
| Jack hammer and air compressor   | Visual inspection | NA        | 12                |
| Engineer’s level and level rod   | Visual inspection | NA        | 12                |
| Stakes   | Visual inspection | NA        | 12                |
| Gasoline burner and pan  | Visual inspection | NA        | 12                |
| Ruler, 6 ft (2 m)  | Visual inspection | NA        | 12                |
| Power drill rig with core and/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**

| <b>Equipment</b>   | <b>Requirements</b>   | <b>Procedure</b>               | <b>Interval<br/>(Months)</b> |
|--|---|--------------------------------|------------------------------|
| Sieves, as listed in procedure   | Check physical condition<br>Verify wire cloth for<br>dimensional accuracy | Tex-907-K                      | 6<br>6                       |
| Balance, minimum capacity of 80 lb. (36 kg), with a minimum accuracy and readability of 5 g or 0.1% of the test load, whichever is greater | Verify calibration record   | Tex-901-K                      | 12                           |
| Drying oven, maintained at 140°F (60°C)  | Verify temperature  | Procedure 2<br>or<br>Tex-927-K | 12                           |
| Crusher (optional)   | Visual inspection   | NA                             | 12                           |
| Mechanical pulverizer (optional)   | Visual inspection   | NA                             | 12                           |
| Wedgewood 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   | 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**

| <b>Equipment</b>                 | <b>Requirements</b> | <b>Procedure</b>  | <b>Interval<br/>(Months)</b> |
|----------------------------------|---------------------|-------------------|------------------------------|
| Apparatus as listed in Tex-101-E | Same as Tex-101-E   | Same as Tex-101-E | Same as Tex-101-E            |

**Table 4—Tex-103-E, Determining Moisture Content in Soil Materials**

| <b>Equipment</b>  | <b>Requirements</b>       | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|---|---------------------------|--------------------------|------------------------------|
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)  | Verify temperature        | Procedure 2 or Tex-927-K | 12                           |
| Microwave oven  | Visual inspection         | NA                       | 12                           |
| Balance, having a precision (repeatability) of ± 0.01 g for specimens having a mass of 200g or less, ± 0.1 g for specimens having a mass between 200 g and 1000 g, or ± 0.5g for specimens having a mass greater than 1000 g or 0.1% of the test load, whichever is greater | Verify calibration record | Tex-901-K                | 12                           |
| Specimen containers and close fitting lids for small specimens  | Visual inspection         | NA                       | 12                           |
| Specimen containers for microwave ovens   | Visual inspection         | NA                       | 12                           |
| Container handling apparatus  | Visual inspection         | NA                       | 12                           |
| Dessicator 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 Limits of Soils**

| <b>Equipment</b>   | <b>Requirements</b>       | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|--|---------------------------|--------------------------|------------------------------|
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)   | Verify temperature        | Procedure 2 or Tex-927-K | 12                           |
| Balance, minimum capacity of 100 g, accurate and readable to 0.01 g or 0.1% of the test load, whichever is greater | Verify calibration record | Tex-901-K                | 12                           |
| Porcelain mixing dish, 4 to 5 in. in diameter  | Visual inspection         | NA                       | 12                           |
| Spatula  | Visual inspection         | NA                       | 12                           |
| Grooving tool  | Check dimensions          | Procedure 6              | 12                           |
| Liquid limit device  | Check wear and dimensions | Procedure 7              | 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**

| <b>Equipment</b>   | <b>Requirements</b>       | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|--|---------------------------|--------------------------|------------------------------|
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)   | Verify temperature        | Procedure 2 or Tex-927-K | 12                           |
| Balance, minimum capacity of 100 g, accurate and readable to 0.01 g or 0.1% of the test load, whichever is greater | Verify calibration record | Tex-901-K                | 12                           |
| Porcelain mixing dish (4 to 5 in. 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 in. x 12 in.)   | Visual inspection         | NA                       | 12                           |

**Table 7—Tex-107-E, Determining the Bar Linear Shrinkage of Soils**

| <b>Equipment</b>   | <b>Requirements</b>        | <b>Procedure</b>                   | <b>Interval<br/>(Months)</b> |
|--|----------------------------|------------------------------------|------------------------------|
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)   | Verify temperature         | Procedure 2 or Tex-927-K           | 12                           |
| Balance, minimum capacity of 200 g, accurate and readable to 0.01 g or 0.1% of the test load, whichever is greater | Verify calibration record  | Tex-901-K                          | 12                           |
| Porcelain mixing dish (4.5 in - 5.5 in) in diameter  | Visual inspection          | NA                                 | 12                           |
| Spatula  | Visual inspection          | NA                                 | 12                           |
| Straight edge  | Check planeness and length | As described in ASTM D698 or D1557 | 12                           |
| Grooving tool  | Check dimensions           | Procedure 6                        | 12                           |
| Bar linear shrinkage mold  | Check dimensions           | Procedure 8                        | 12                           |
| Number 20 engineer scale or other suitable rule  | Visual inspection          | NA                                 | 12                           |

**Table 8—Tex-108-E, Determining the Specific Gravity of Soils**

| <b>Equipment</b>   | <b>Requirements</b>                             | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|--|---|--------------------------|------------------------------|
| Volumetric flask, 500ml  | Visual inspection                               | NA                       | 12                           |
| Balance, minimum capacity of 800 g, accurate and readable to 0.05 g or 0.1% of the test load, whichever is greater | Verify calibration record                       | Tex-901-K                | 12                           |
| Hot plate or sand bath   | Visual inspection                               | NA                       | 12                           |
| Constant temperature water bath  | Verify temperature settings                     | Procedure 3              | 4                            |
| Thermometer, calibrated between -5°F to 110°F by 2°F intervals (-15°C and 43°C by 1°C intervals)                   | Visual inspection and<br>Calibrate/verify temp. | Procedure 5<br>Tex-926-K | 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**

| <b>Part I—Sieve Analysis of Material Retained on the 425µm (No. 40) sieve</b>   |   |                              |                              |
|---|---|------------------------------|------------------------------|
| <b>Equipment</b>  | <b>Requirements</b>   | <b>Procedure</b>             | <b>Interval<br/>(Months)</b> |
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)  | Verify temperature  | Procedure 2 or<br>Tex-927-K, | 12                           |
| Balance, minimum capacity of 33 lb (15 kg), accurate and readable to 0.5 g or 0.1% of the test load, whichever is greater | Verify calibration record   | Tex-901-K                    | 12                           |
| Mechanical sieve shaker   | Visual inspection   | NA                           | 12                           |
| Sample splitter, quartering machine, or quartering cloth  | Visual inspection   | NA                           | 12                           |
| Standard U.S. sieves, as listed in procedure  | Check physical condition<br>Verify wire cloth for<br>dimensional accuracy | Tex-907-K,                   | 6<br>6                       |
| Pans  | Visual inspection   | NA                           | 12                           |

**Table 9—Tex-110-E, Particle Size Analysis of Soils**

| <b>Part II—Hydrometer Analysis of Soils Passing 425µm (No. 40) Sieve</b>                 |  |                          |                          |
|--|--|--------------------------|--------------------------|
| <b>Equipment</b>   | <b>Requirements</b>  | <b>Procedure</b>         | <b>Interval (Months)</b> |
| Stirring apparatus (either a “mechanical stirring device” or an “air dispersion device”) | Visual inspection  | NA                       | 12                       |
| Constant temperature water bath  | Verify temperature settings  | Procedure 3              | 4                        |
| Thermometer, range of 1°F to 220°F (0°C to 104°C), accurate to 1°F (0.5°C)               | Visual inspection and Calibrate/verify temp.                           | Procedure 5 , Tex-926-K  | 12                       |
| Sieves, as listed in procedure   | Check physical condition<br>Verify wire cloth for dimensional accuracy | Tex-907-K                | 6<br>6                   |
| Sedimentation cylinder, as described in “Apparatus” portion of procedure                 | Visual inspection  | NA                       | 12                       |
| Evaporating dishes   | Visual inspection  | NA                       | 12                       |
| Timing device w/second hand  | Verify accuracy  | Procedure 1 or Tex-924-K | 6                        |
| Hydrometer, graduated in grams per liter, type 151 H or 152 H                            | Visual inspection<br>Verify dimensions and accuracy                    | 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**

| <b>Equipment</b>   | <b>Requirements</b>  | <b>Procedure</b>         | <b>Interval (Months)</b> |
|--|--|--------------------------|--------------------------|
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)   | Verify temperature   | Procedure 2 or Tex-927-K | 12                       |
| Balance, accurate and readable to 0.01 g for specimens having a mass of 200 g or less, 0.1 g for specimens having a mass between 200 g and 1000 g, or 0.5 g for specimens having a mass greater than 1000 g or 0.1% of the test load, whichever is greater | Verify calibration record  | Tex-901-K                | 12                       |
| Sieves, as listed in procedure   | Check physical condition<br>Verify wire cloth for dimensional accuracy | Tex-907-K,               | 6<br>6                   |

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

| Equipment   | Requirements      | Procedure | Interval (Months) |
|---|-------------------|-----------|-------------------|
| Quartering machine, sample splitter, or quartering cloth    | Visual inspection | NA        | 12                |
| 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 Tex-101-E | Same as Tex-101-E | Same as Tex-101-E | Same as Tex-101-E |
| Apparatus as listed in Tex-104-E | Same as Tex-104-E | Same as Tex-104-E | Same as Tex-104-E |
| Apparatus as listed in Tex-105-E | Same as Tex-105-E | Same as Tex-105-E | Same as Tex-105-E |

**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   | Evaluate condition of automatic tamper using “Tex-113/114 Soil Compactor Adjustment & Soil Compactor Analyzer” Report Form. Determine compactive energy delivered. | Procedure 9                | 12                |
| Compaction mold  | Verify dimensions and volume of molds  | Tex-905-K and Procedure 11 | 12                |
| Height measuring device (metal stand, spacer blocks, dial indicator)   | Verify dimensions meet requirements in Tex-113-E   | Tex-113-E                  | 12                |
| Balance, minimum capacity of 35 lb (16 kg), accurate and readable to 0.001 lb (0.5 g) or 0.1% of the test load, whichever is greater | Verify calibration record  | Tex-901-K                  | 12                |
| Drying oven, maintained at 230± 9°F (110 ± 5°C)  | Verify temperature   | Procedure 2                | 12                |

**Table 12—Tex-113-E, Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Material and Cohesionless Sand**

| Equipment                 | Requirements   | Procedure       | Interval (Months) |
|---------------------------|--|-----------------|-------------------|
|                           |  | or<br>Tex-927-K |                   |
| Extra base plate          | Visual inspection  | NA              | 12                |
| Hydraulic extrusion press | Visual inspection  | NA              | 12                |
| Metal pans                | Visual inspection  | NA              | 12                |
| Circular porous stones    | Verify stones are not clogged or chipped and meet specified dimensions | Procedure 12    | 12                |
| Small hand tools          | Visual inspection  | NA              | 12                |
| Slide Finishing Hammer    | Verify dimensions and weights meet requirements in Tex-113-E           | Tex-113-E       | 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   | Evaluate condition of automatic tamper using “Tex-113/114 Soil Compactor Adjustment & Soil Compactor Analyzer” Report Form. | Procedure 10               | 12                |
| Compaction mold  | Verify dimension and volume of molds  | Tex-905-K and Procedure 11 | 12                |
| Height measuring device (metal stand, spacer blocks, dial indicator)   | Verify requirements specified in Tex-114-E are met.   | Tex-113-E                  | 12                |
| Balance, minimum capacity of 35 lb. (16 kg), accurate and readable to 0.001 lb. (0.5 g) or 0.1% of the test load, whichever is greater | Verify calibration record   | Tex-901-K                  | 12                |
| Drying oven, maintained at 230 ± 9°F (110 ± 5°C)   | Verify temperature  | Procedure 2 or Tex-927-K   | 12                |
| Sieves, as listed in procedure   | Check physical condition  | Tex-907-K                  | 6                 |

**Table 13—Tex-114-E, Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade and Embankment Soils**

| Equipment                 | Requirements   | Procedure    | Interval (Months) |
|---------------------------|--|--------------|-------------------|
|                           | Verify wire cloth for dimensional accuracy.                            |              | 6                 |
| Extra base plate          | Visual inspection  | NA           | 12                |
| Hydraulic extrusion press | Visual inspection  | NA           | 12                |
| Metal pans                | Visual inspection  | NA           | 12                |
| Circular porous stones    | Verify stones are not clogged or chipped and meet specified dimensions | Procedure 12 | 12                |
| Small hand tools          | Visual inspection  | NA           | 12                |
| Level                     | Visual inspection  | NA           | 12                |
| Slide Finishing Hammer    | Verify dimensions and weights meet requirements in Tex-113-E           | Tex-113-E    | 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                |
| Calibration curves for nuclear gauge                               | Visual inspection         | NA                           | 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                |
| Standardizing block  | 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                |

**Table 14—Tex-115-E, Field Method for Determining In-Place Density of Soils and Base Materials**

| <b>Equipment</b>  | <b>Requirements</b>  | <b>Procedure</b>                         | <b>Interval (Months)</b> |
|---|--|--|--------------------------|
| Trowel, straight edge, small hand tools   | Visual inspection<br>Check planeness and length for straight edge      | NA<br>As described in 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, with a minimum capacity of 50 lb (20 Kg.) and a readability of 1 g, accurate to 5 g or 1% of the test load, whichever is greater | Verify calibration record  | Tex-901-K                                | 12                       |
| Drying equipment  | Same as Tex-103-E  | Same as Tex-103-E                        | Same as Tex-103-E        |
| Calibrated sand cone and sand   | Verify calibration   | In accordance with Tex-115-E             | Each Test                |
| Sieves, as listed in procedure  | Check physical condition<br>Verify wire cloth for dimensional accuracy | Tex-907-K                                | 6<br>12                  |

**Table 15—Tex-116-E, Ball Mill Method for Determining the Disintegration of Flexible Base Material**

| <b>Equipment</b>  | <b>Requirements</b>  | <b>Procedure</b>         | <b>Interval (Months)</b> |
|---|--|--------------------------|--------------------------|
| Oven, Air-dryer maintained at 140 ± 9°F (60 ± 5°C)  | Verify temperature   | Procedure 2 or Tex-927-K | 12                       |
| Balance, minimum capacity of 33lb (15kg), with a readability of no greater than 1 g and accuracy of at least 1 g or 0.1% of the test load, whichever is greater | Verify calibration record  | Tex-901-K                | 12                       |
| Sieves, as listed in procedure  | Check physical condition<br>Verify wire cloth for dimensional accuracy | Tex-907-K                | 6<br>6                   |
| Wet ball mill machine   | Check RPM, dimensions and revolution counter                           | Procedure 13             | 12                       |
| Metal Spheres   | Check weight and dimensions as per                                     | As specified in          | 12                       |

**Table 15—Tex-116-E, Ball Mill Method for Determining the Disintegration of Flexible Base Material**

| Equipment                           | Requirements                     | Procedure | Interval (Months) |
|-------------------------------------|----------------------------------|-----------|-------------------|
|                                     | “Apparatus” section of procedure | Tex-116-E |                   |
| Crusher (optional)                  | Visual inspection                | NA        | 12                |
| Misc. pans, wash bottles, etc.      | Visual inspection                | NA        | 12                |
| Container (for liquid), 0.5gal (2L) | Visual inspection                | NA        | 12                |

**Table 16—Tex-117-E, Triaxial Compression for Disturbed Soils and Base Materials**

| Equipment                              | Requirements   | Procedure                  | Interval (Months) |
|--|--|----------------------------|-------------------|
| Apparatus as listed in Tex-101-E       | Same as Tex-101-E  | Same as Tex-101-E          | Same as Tex-101-E |
| Apparatus as listed in Tex-113-E       | Same as Tex-113-E  | Same as Tex-113-E          | Same as Tex-113-E |
| Apparatus as listed in Tex-114-E       | Same as Tex-114-E  | Same as Tex-114-E          | Same as Tex-114-E |
| Triaxial Cells                         | Visual inspection  | NA                         | 12                |
| Aspirator or other vacuum pump         | Visual inspection  | NA                         | 12                |
| Air compressor                         | Visual inspection  | NA                         | 12                |
| Automated load frame                   | Verify calibration   | Tex-902-K                  | 12                |
| Screw jack press                       | Verify calibration   | Tex-902-K                  | 12                |
| Pressure regulator, gauges, and valves | Verify calibration   | Tex-902-K                  | 12                |
| Axial load measuring device            | Verify calibration   | Tex-902-K                  | 12                |
| 10 K load cell                         | Verify calibration   | Tex-902-K and Procedure 14 | 12                |
| Proving ring                           | Verify calibration   | Tex-902-K                  | 12                |
| Circumference measuring device         | Visual inspection  | Tex-905-K                  | 12                |
| Lead weights                           | Visual inspection  | NA                         | 12                |
| Pans and porous stones                 | Verify stones are not clogged or chipped and meet specified dimensions | Procedure 12               | 12                |
| Cover for top of sample                | Visual inspection  | NA                         | 12                |

**Table 17—Tex-118-E, Triaxial Compression Test for Undisturbed Soils**

| Equipment  | Requirements               | Procedure                  | Interval (Months) |
|--|----------------------------|----------------------------|-------------------|
| Balance, able to weigh soil specimens of less than 100g to the nearest 0.01g, and specimens of 100g or heavier to the nearest 0.1g | Verify calibration records | Tex-901-K                  | 12                |
| Axial load device, as described in “Apparatus”   | Verify calibration records | Tex-902-K and Procedure 14 | 12                |
| Axial load measuring device, as described in “Apparatus”   | Verify calibration records | NA                         | 12                |
| Chamber pressure maintaining and measuring device, as described in “Apparatus”   | Verify calibration records | NA                         | 12                |
| Devices to measure the height and diameter of the specimen, as described in “Apparatus”  | Verify calibration records | NA                         | 12                |
| Triaxial compression chamber, as described in “Apparatus”  | Visual inspection          | NA                         | 12                |
| Impermeable rigid specimen cap and base  | Visual inspection          | NA                         | 12                |
| Deformation indicator, as described in “Apparatus”   | Visual inspection          | NA                         | 12                |
| Rubber membrane, as described in “Apparatus”   | Visual inspection          | NA                         | 12                |
| Sample extruder  | Visual inspection          | NA                         | 12                |
| Timing device, to measure to the nearest 1 sec.  | Calibrate                  | Procedure 1                | 12                |
| Sample containers  | Visual inspection          | NA                         | 12                |
| Miscellaneous hand tool and equipment  | Visual inspection          | NA                         | 12                |

**Table 18—Tex-120-E, Soil-Cement Testing**

| Equipment  | Requirements               | Procedure         | Interval (Months) |
|--|----------------------------|-------------------|-------------------|
| Apparatus as listed in Tex-101-E   | Same as Tex-101-E          | Same as Tex-101-E | Same as Tex-101-E |
| Apparatus as listed in Tex-113-E   | Same as Tex-113-E          | Same as Tex-113-E | Same as Tex-113-E |
| Apparatus as listed in Tex-117-E   | Same as Tex-117-E          | Same as Tex-117-E | Same as Tex-117-E |
| High capacity compression testing device 60,000 lb (267 kN)                          | Verify calibration records | Tex-902-K         | 12                |
| Triaxial screw jack press (use when anticipated strengths $\leq$ 400 psi [2758 KPa]) | Verify calibration records | Tex-902-K         | 12                |

**Table 19—Tex-121-E, Soil-Lime Testing**

| <b>Equipment</b>   | <b>Requirements</b>        | <b>Procedure</b>  | <b>Interval<br/>(Months)</b> |
|--|----------------------------|-------------------|------------------------------|
| Apparatus as listed in Tex-101-E   | Same as Tex-101-E          | Same as Tex-101-E | Same as Tex-101-E            |
| Apparatus as listed in Tex-113-E   | Same as Tex-113-E          | Same as Tex-113-E | Same as Tex-113-E            |
| Apparatus as listed in Tex-128-E   | Same as Tex-128-E          | Same as Tex-128-E | Same as Tex-128-E            |
| Apparatus as listed in Tex-117-E   | Same as Tex-117-E          | Same as Tex-117-E | Same as Tex-117-E            |
| High capacity compression testing device (60,000lb) (267kN), meeting the requirements of ASTM D 1633 | Verify calibration records | Tex-902-K         | 12                           |
| Triaxial screw jack press [use if anticipated strengths $\leq$ 400psi (2758 Kpa)]                    | Verify calibration records | Tex-902-K         | 12                           |

**Table 20—Tex-123-E, Determining the Drainage Factor of Soil Materials**

| <b>Equipment</b>  | <b>Requirements</b>            | <b>Procedure</b>               | <b>Interval<br/>(Months)</b>   |
|---|--------------------------------|--------------------------------|--------------------------------|
| Apparatus as listed in Tex-101-E                                      | Same as Tex-101-E              | Same as Tex-101-E              | Same as Tex-101-E              |
| Apparatus as listed in Tex-113-E or Tex-114-E                         | Same as Tex-113-E or Tex-114-E | Same as Tex-113-E or Tex-114-E | Same as Tex-113-E or Tex-114-E |
| Apparatus as listed in Tex-117-E                                      | Same as Tex-117-E              | Same as Tex-117-E              | Same as Tex-117-E              |
| Circular loading plate, as described in “Apparatus”                   | Visual inspection              | NA                             | 12                             |
| Upper and lower cylindrical loading heads as described in “Apparatus” | 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 as described in “Apparatus”                    | Visual inspection              | NA                             | 12                             |
| Drilled loading plate as described in “Apparatus”                     | Visual inspection              | NA                             | 12                             |

**Table 21—Tex-124-E, Determining Potential Vertical Rise**

| <b>Equipment</b>  | <b>Requirements</b> | <b>Procedure</b>  | <b>Interval<br/>(Months)</b> |
|---|---------------------|-------------------|------------------------------|
| Apparatus as listed in Tex-101-E  | Same as Tex-101-E   | Same as Tex-101-E | Same as Tex-101-E            |
| Apparatus as listed in Tex-103-E  | Same as Tex-103-E   | Same as Tex-103-E | Same as Tex-103-E            |
| Apparatus as listed in Tex-104-E  | Same as Tex-104-E   | Same as Tex-104-E | Same as Tex-104-E            |
| Apparatus as listed in Tex-105-E  | Same as Tex-105-E   | Same as Tex-105-E | Same as Tex-105-E            |
| Apparatus as listed in Tex-106-E  | Same as Tex-106-E   | Same as Tex-106-E | Same as Tex-106-E            |
| Apparatus as listed in Tex-207-F  | Same as Tex-207-F   | Same as Tex-207-F | Same as Tex-207-F            |
| 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)**

| <b>Equipment</b>  | <b>Requirements</b>                           | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|---|---|--------------------------|------------------------------|
| Loading device, as described in “Apparatus”                       | Visual inspection                             | NA                       | 12                           |
| Hydraulic jack assembly with spherical bearing attachment         | Verify calibration records                    | NA                       | 12                           |
| Dial gauges, as described in “Apparatus”                          | Verify calibration records, visual inspection | NA                       | 12                           |
| Deflection beam, as described in “Apparatus”                      | Verify dimensions                             | NA                       | 12                           |
| Miscellaneous hand tools  | Visual inspection                             | NA                       | 12                           |
| Thermometer   | Calibrate/verify temp.                        | Procedure 5<br>Tex-926-K | 12                           |
| Set of circular steel bearing plates, as described in “Apparatus” | Verify dimensions                             | NA                       | 12                           |

**Table 23—Tex-126-E, Molding, Testing, and Evaluating Bituminous Black Base Materials**

| <b>Equipment</b>  | <b>Requirements</b>   | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|---|---|--------------------------|------------------------------|
| Apparatus as listed in Tex-101-E  | Same as Tex-101-E   | Same as Tex-101-E        | Same as Tex-101-E            |
| Motorized gyratory press  | Verify calibration records  | Tex-916-K                | 12                           |
| Compaction mold, as described in “Apparatus”  | 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                           |
| Ovens, able to heat to 290 ± 5°F (143 ± 3°C), 250 ± 5°F (121 ± 3°C), 140 ± 5°F (60 ± 3°C) | Calibrate/verify temp.  | Procedure 2 or Tex-927-K | 12                           |
| Electric hot plate  | Visual inspection   | NA                       | 12                           |
| Dolly, caster mounted,  | Check dimensions  | NA                       | 12                           |
| Metal pans, as described in “Apparatus”   | Visual inspection   | NA                       | 12                           |
| Circular porous stones, slightly less than 6in. in diameter and 2in. high                 | Verify stones are not clogged or chipped and meet specified dimensions          | Procedure 12             | 12                           |
| Metal disks, as described in “Apparatus”  | Check dimensions  | NA                       | 12                           |
| Filter paper, 6in. 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  | Check physical condition<br>Verification of wire cloth for dimensional accuracy | Tex-907-K                | 6<br>6                       |
| Screw jack press  | Verify calibration records  | Tex-902-K                | 12                           |

**Table 24—Tex-127-E, Lime-Fly Ash Compressive Strength Test Methods**

| <b>Equipment</b>   | <b>Requirements</b>            | <b>Procedure</b>  | <b>Interval<br/>(Months)</b> |
|--|--------------------------------|-------------------|------------------------------|
| Apparatus as listed in Tex-101-E   | Same as Tex-101-E              | Same as Tex-101-E | Same as Tex-101-E            |
| Apparatus as listed in Tex-113-E or Tex-114-E  | Same as Tex-113-E or Tex-114-E | Same as Tex-101-E | Same as Tex-101-E            |
| Apparatus as listed in Tex-117-E   | Same as Tex-117-E              | Same as Tex-117-E | Same as Tex-117-E            |
| High capacity compression testing device (60,000lb (267kN)), meeting the requirements of ASTM D 1633 | Verify calibration records     | Tex-902-K         | 12                           |
| Triaxial screw jack press, (use if anticipated strengths $\leq$ 400psi (2757 Kpa) )                  | Verify calibration records     | Tex-902-K         | 12                           |

**Table 25—Tex-128-E, Determining Soil pH**

| <b>Equipment</b>   | <b>Requirements</b>                          | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|--|--|--------------------------|------------------------------|
| pH meter with glass electrode, pH range 0-14 $\pm$ 0.1   | Check fluid level                            | NA                       | Each use                     |
| Buffer solutions, such as pH 4.0, 7.0, and 9.0   | Check standard against machine               | NA                       | Each use                     |
| Apparatus as listed in Tex-101-E   | Same as Tex-101-E                            | Same as Tex-101-E        | Same as Tex-101-E            |
| Drying oven, maintained at 140°F (60°C)  | Verify temperature                           | Procedure 2 or Tex-927-K | 12                           |
| Balance, accurate within 0.1% of the test load at any point within the range of use, graduated to at least 0.01g | Verify calibration records                   | Tex-901-K                | 12                           |
| Glass stirring rod   | Visual inspection                            | NA                       | 12                           |
| Glass beaker, 250ml  | Visual inspection                            | NA                       | 12                           |
| Stirring device, mechanical or magnetic  | Visual inspection                            | NA                       | 12                           |
| Thermometer, 32-212°F (0-100°C)  | Visual inspection and Calibrate/verify temp. | Procedure 5 Tex-926-K    | 12                           |

**Table 26—Tex-129-E, Measuring the Resistivity of Soils Materials**

| <b>Equipment</b>  | <b>Requirements</b>   | <b>Procedure</b>                         | <b>Interval<br/>(Months)</b> |
|---|---|--|------------------------------|
| Drying oven, maintained at 140 ± 9°F<br>(60 ± 5°C)  | Verify temperature  | Procedure 2 or<br>Tex-927-K              | 12                           |
| Splitter or quartering cloth  | Visual inspection   | NA                                       | 12                           |
| Portable resistivity meter, Vibroground<br>Model 293 or equal   | Verify calibration records  | NA                                       | 12                           |
| Resistivity box   | Verify dimensions as per<br>“Apparatus”                                   | NA                                       | 12                           |
| Straight edge   | Check planeness and<br>length   | As described in<br>ASTM D698 or<br>D1557 | 12                           |
| Balance, minimum capacity of 1500g,<br>accurate and readable to 0.5g, or 0.1% of the<br>test load, whichever is greater | Verify calibration records  | Tex-901-K                                | 12                           |
| Sieves, as listed in procedure  | Check physical condition<br>Verify wire cloth for<br>dimensional accuracy | Tex-907-K                                | 6<br>6                       |
| Graduated beaker, 200ml   | Visually inspect  | NA                                       | 12                           |
| Drying pans, mixing pans, trowel, and small<br>scoop  | Visually inspect  | NA                                       | 12                           |

**Table 27—Tex-131-E, Consolidated Undrained Triaxial Compression Test for Undisturbed Soils**

| <b>Equipment</b>   | <b>Requirements</b>        | <b>Procedure</b> | <b>Interval<br/>(Months)</b> |
|--|----------------------------|------------------|------------------------------|
| Balance, with a minimum capacity of 4000g,<br>accurate and readable to least 0.1g          | Verify calibration records | Tex-901-K        | 12                           |
| Axial load device, as described in<br>“Apparatus”  | Verify calibration records | NA               | 12                           |
| Axial load measuring device, as described in<br>“Apparatus”                                | Verify calibration records | NA               | 12                           |
| Chamber pressure maintaining and measuring<br>device, as described in “Apparatus”          | Verify calibration records | NA               | 12                           |
| Devices to measure the height and diameter of<br>the specimen, as described in “Apparatus” | Verify calibration records | NA               | 12                           |

**Table 27—Tex-131-E, Consolidated Undrained Triaxial Compression Test for Undisturbed Soils**

| <b>Equipment</b>  | <b>Requirements</b>  | <b>Procedure</b>         | <b>Interval<br/>(Months)</b> |
|---|--|--------------------------|------------------------------|
| Pore pressure measuring device  | Verify calibration records   | NA                       | 12                           |
| Triaxial compression chamber, as described in “Apparatus”   | Visual inspection  | NA                       | 12                           |
| Impermeable rigid specimen cap and base, as described in “Apparatus”                                    | Visual inspection  | NA                       | 12                           |
| Drying oven, thermostatically controlled, capable of maintaining a temperature of 230 ± 9°F (110 ± 5°C) | Verify temperature   | Procedure 2 or Tex-927-K | 12                           |
| Deformation indicator, as described in “Apparatus”  | Visual inspection  | NA                       | 12                           |
| Rubber membrane, as described in “Apparatus”  | 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 and meet specified dimensions | Procedure 12             | 12                           |
| Sample trimming equipment   | Visual inspection  | NA                       | 12                           |

**Table 28—Tex-132-E, Texas Cone Penetration**

| <b>Equipment</b>  | <b>Requirements</b>                              | <b>Procedure</b> | <b>Interval<br/>(Months)</b> |
|---|--|------------------|------------------------------|
| Hammer, as described in “Apparatus”                                 | 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, as described in “Apparatus”                  | 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 as listed in Tex-113-E  | Same as Tex-113-E  | Same as Tex-113-E | Same as Tex-113-E |
| Freezing cabinet, as described in “Apparatus”                                 | Verify temperature | Procedure 2       | 12                |
| Moist room, as described in “Apparatus”                                       | Verify temperature | Procedure 2       | 12                |
| Wire scratch brush, as described in “Apparatus”                               | Visual inspection  | NA                | 12                |
| 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 inch 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                |
| Folding ruler (6 ft.), or other scale with 1/8” or smaller divisions                           | 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        | NA                |

**Table 32—Tex-142-E, Laboratory Classification of Soils for Engineering Purposes**

| Equipment                                    | Requirements      | Procedure         | Interval (Months) |
|--|-------------------|-------------------|-------------------|
| Apparatus as listed in Test Method Tex-101-E | Same as Tex-101-E | Same as Tex-101-E | Same as Tex-101-E |
| Apparatus as listed in Test Method Tex-104-E | Same as Tex-104-E | Same as Tex-104-E | Same as Tex-104-E |
| Apparatus as listed in Test Method Tex-105-E | Same as Tex-105-E | Same as Tex-105-E | Same as Tex-105-E |
| Apparatus as listed in Test Method Tex-106-E | Same as Tex-106-E | Same as Tex-106-E | Same as Tex-106-E |
| Apparatus as listed in Test Method Tex-110-E | Same as Tex-110-E | Same as Tex-110-E | Same as Tex-110-E |

#### 4. PROCEDURES

##### 4.1 Procedure 1—Timers:

##### 4.1.1 Apparatus:

##### 4.1.1.1 Calibrated timer.

##### 4.1.2 Procedure:

4.1.2.1 Hold the calibrated timer in one hand and the timer to be checked in the opposite hand.

4.1.2.2 Start the timers simultaneously by pressing the start buttons at the same time.

4.1.2.3 Allow the timers to run at least 15 min., then stop the timers simultaneously. Record the time indicated by both timers.

4.1.2.4 Record the difference between the two timers. Calculate and record the percent accuracy.

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

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 one second per minute.

- 4.2            *Procedure 2—Oven:*
- 4.2.1        *Apparatus:*
- 4.2.1.1      *Calibrated digital thermometer, graduated in 2°F (1°C), having a range including the temperature range to be checked.*
- 4.2.1.1.1    When using the calibrated digital thermometer, place the thermocouple probe on the shelf where the samples are normally placed.
- 4.2.1.1.2    Take the first reading at least 1 hour after closing the oven (oven 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 hours apart and within the tolerance allowed, are required).
- 4.2.1.1.3    Adjust the temperature of the oven if an observed temperature reading is outside the specified tolerance (allow at least 2 hours for the temperature to stabilize between each adjustment).
- 4.2.1.1.4    Repeat taking readings and adjusting the temperature as necessary.
- OR-
- 4.2.1.2      *Calibrated thermometer, graduated in 2°F (1.0°C) increments, having a range including the temperature range to be checked.*
- 4.2.1.2.1    When using the calibrated thermometer, place it inside the brass well with the clothespin attached to the thermometer. Position the thermometer on the shelf where the samples are normally placed.
- 4.2.1.2.2    Take the first reading at least 1 hour after closing the oven (oven 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 hours apart and within the tolerance allowed, are required).
- 4.2.1.2.3    Adjust the temperature of the oven if an observed temperature reading is outside the specified tolerance (allow at least 2 hours for the temperature to stabilize between each adjustment).
- 4.2.1.2.4    Repeat taking readings and adjusting the temperature as necessary.
- 4.2.1.3      A brass thermometer well to retain heat while the oven door is open. This is essential for a constant temperature reading.
- 4.2.1.4      A clothespin to hold the thermometer in such a manner as to enable the operator to read the scale easily from outside or inside the oven.

4.3 *Procedure 3—Water Bath:*

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

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

4.4 *Procedure 4—Mechanical Shaker:*

4.4.1 Match the sieve and aggregate such that a minimum of ten percent of the total sample weight is retained on each sieve. After sieving on the mechanical shaker for a given time, the thoroughness of sieving should be checked 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, then shaking time should be increased and the check repeated until all screens show less than 1% by weight passing a given sieve.

4.5 *Procedure 5—Thermometers:*

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

4.5.2 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
- signature of person who read calibration.

4.5.3 The documentation on standard used should include:

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

4.6 *Procedure 6—Grooving Tool:*

4.6.1 Verify that the grooving tool meets all of the dimensions outlined in Tex-104-E. The measurements should be checked using a calibrated caliper that will measure to the nearest 0.01 mm and a measuring magnifier.

4.7 *Procedure 7—Liquid Limit Testing Device:*

4.7.1 Verify that all of the dimensions outlined in Tex-104-E are within acceptable limits using a calibrated caliper and small ruler. A straight edge is necessary to complete some of the measurements.

- 4.7.2 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.
- 4.7.3 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. This measurement should be taken at the widest point.
- 4.7.4 Calibrate the height of the drop of the cup as described in Tex-104-E.
- 4.8 *Procedure 8—Bar Linear Shrinkage Mold:*
- 4.8.1 The shrinkage mold should match the dimensions outlined in Tex-107-E. The dimensions listed are internal dimensions.
- 4.9 *Procedure 9—Automatic Tamper for Base Compaction:*
- 4.9.1 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.
- 4.9.2 Mount the soil compactor analyzer (SCA) to the automatic tamper in accordance with the Soil Compactor Analyzer Reference Guide.
- 4.9.3 Prepare and compact a minimum of one specimen in accordance with Tex-113-E using the SCA in machine control mode. 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 are: 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
- 4.9.4 Prepare and compact another sample using machine control to verify the tolerances in Section 4.9.3 are met.
- 4.10 *Procedure 10—Automatic Tamper for Soil Compaction:*
- 4.10.1 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 tolerances and maintenance requirements specified in the 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 2,000 lb.;
  - rammers are within  $\pm 0.02$  lb. of the weight specified in 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. when set in accordance with the manual;
- grabber does operate freely;
- bushings, guide rods, and guide disc tolerances conform to the requirements specified in the manual; and
- guide rod is clean.

4.11 *Procedure 11—Molds:*

4.11.1 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.

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

$$d_{avg} = (d1 + d2 + d3 + d4 + d5 + d6 + d7 + d8 + d9 + d10 + d11 + d12) / 12$$

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

4.11.3 Calculate the cross sectional area of the mold:

$$A_x = (3.1416 \bullet d_{avg}^2) / 4, mm^2 (in^2)$$

4.11.4 Calculate the volume, in  $ft^3$  ( $m^3$ ) for 0.04 in. (1 mm) of height of the mold:

$$Volume \text{ per } mm = A_x / 10^9, m^3 / mm$$

$$(Volume \text{ per } in. = A_x / 1728, ft^3 / in. )$$

4.11.5 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.

4.12 *Procedure 12—Porous Stones:*

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

4.12.2 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 minutes, clean the stones until water is able to reach the surface in a maximum of 10 minutes. If this is not achievable, discard the stone.

4.12.3 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).

4.13 *Procedure 13—Wet Ball Mill:*

4.13.1 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.

4.13.2 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.

4.13.3 Verify that the size and weight of the metal spheres are within tolerances listed in Tex-116-E.

4.14 *Procedure 14—10K Load Cell:*

4.14.1 Calibrate the load cell in 100 lb increments beginning at a load of 200 lb. Continue this frequency through a load of 1000 lb.

4.14.2 Calibrate the load cell at the frequency specified in Tex-902-K for loads above 1000 lb.

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**5. ARCHIVED VERSIONS**

5.1 Archived versions are available.