EQUIPMENT

1. TEST PLATES: smooth polished surface stainless steel or aluminum test plates ***(records)*** ____
   a) plate diameter 8.00 ± 0.02 mm or 25.00 ± 0.05 mm dia. ..... ____
      i) with raised portion of minimum 1.50 mm ..... ____
   b) top and bottom plates have same diameter with minimum thickness ≥ 1.50 mm ..... ____
2. ENVIRONMENTAL CHAMBER:
   a) controlled temperature test chamber (by liquid or gas to 0.1°C) ..... ____
   b) if cooled by air of gas a suitable drier is used to prevent condensation or ice formation .. ____
   c) if cooled by liquid circulating bath used ..... ____
   d) chamber completely encloses the top and bottom plates ..... ____
3. TEMPERATURE CONTROLLER: maintains specimen temperature from 3 to 88°C within 0.1°C ..... ____
4 INTERNAL TEMPERATURE DETECTOR: platinum resistance thermometer (PRT) in intimate contact with fixed plate, controls temperature in range of 3 to 88°C to 0.1°C and provides continuous readout ***(records)*** ..... ____
5 THERMOMETERS:
   a) reference thermometer NIST traceable liquid in glass or NIST traceable electronic thermometric device and maintained as the laboratory standard – shall be used to standardize portable thermometer ***(records)*** ..... ____
      i) liquid-in-glass within an ice point and standardized according to ASTM E563 ..... ____
      ii) portable thermometer having a with accuracy of ± 0.05°C and resolution of 0.01°C, calibrated at least yearly using NIST-traceable reference standard in accordance with ASTM E77 ..... ____
   b) electronic thermometer with resistive detector and digital readout (may be the reference thermometer if it fits within dummy specimen) calibrated at lest yearly ***(records)*** ..... ____
6. LOADING DEVICE: applies sinusoidal oscillatory load at frequency of 10.0 ± 0.1 rad/sec .. ____
   a) if strain controlled, shall apply a cyclic torque sufficient to cause an angular rotation strain to within 100 µ rad of the strain specified ..... ____
   b) if stress controlled, shall apply a cyclic torque accurate to within 10 mN.m of the torque specified ..... ____
   c) total system compliance at 100 N.m torque shall be < 2 mrad/N.m ..... ____
6. TEMPERATURE CORRECTION: must be traceable to NIST standards ***(records)***
   a) silicone wafer of thickness or dia. < 2.0 mm used for dummy specimen ..... ____
   b) dummy test specimen used ..... ____
7. DATA ACQUISITION SYSTEM: ***(demo)***
   a) provides a record of
      i) temperature to 0.1°C ..... ____
      ii) frequency to 1 % ..... ____
      iii) torque to 10 mN.m ..... ____
      iv) deflection angle to 100 µrad ..... ____
   b) measures and records
      i) complex shear modulus (G*) in range of 100Pa to 10MPa with accuracy of 1.0% or less ..... ____

ii) phase angle (D) in range of 0 to 90° (with accuracy of 0.1°) ..... ____
iii) calculates shear stress, shear strain, complex shear modulus and phase angle ..... ____

9. SPECIMEN MOLD: silicone mold of defined dimensions (optional) ..... ____
10. CLEANING SOLVENTS: mineral oil, toluene, citrus-based, mineral spirits; acetone to remove solvent residue ..... ____
11. WIPING MATERIAL: clean cloth, paper towel, cotton swabs ..... ____
12. SPECIMEN TRIMMER: metal spatula or similar with straight edge 4 mm wide ..... ____

VERIFICATION AND CALIBRATION

1. TEMPERATURE: dummy asphalt binder prepared or silicone wafer used ..... ____
2. TEMPERATURE CORRECTION: ***(demo – records)***
   a) temperature measured using dummy sample or silicone wafer with the reference thermal detector and compared to DSR RTD temperature ..... ____
   b) temperature at equilibrium (difference between reference detector and DSR RDT over a five min. period) ..... ____
   c) reference detector temperature vs DSR temperature plotted at 6 °C intervals over range of test temperatures ..... ____
   d) appropriate correction applied to DSR RDT if not in agreement within ± 0.1°C ..... ____
      i) does softwear incorporate temperature corrections ..... ____
3. DSR TORQUE TRANSDUCER:using
   a) standard viscosity with DSR complex viscosity (G*/(rad/s) within 3.0 % of capillary viscosity of the liquid standard ..... ____
   b) using supplied fixtures if available ..... ____
4. ANGULAR DISPLACEMENT TRANSDUCER: calibrated as per directions and fixtures supplied with apparatus (if available – otherwise not required) ..... ____
5. TEST PLATE DIAMETERS:
   a) 8.00 ± 0.02 mm and 25.0 ± 0.05 ..... ____
   b) if in range of 7.9 to 8.1 mm and 24.5 to 25.5 mm diameters measured and maintained in log ..... ____
6. OVERALL CALIBRATION: verified using reference viscosity fluids ***(demo – records)*** ..... ____
7. VERIFICATION: is carried out every 6 months or when DSR is
   a) newly installed ..... ____
   b) relocated ..... ____
   c) accuracy suspected ..... ____

PREPARATION OF APPARATUS ***(demo)***

1. APPARATUS: set up as per manufacturer recommendation ..... ____
2. TEST PLATES: checked for damage, cleaned and mounted on test fixtures and tightened firmly ..... ____
3. TEST TEMPERATURE: selected according to grade of asphalt binder(M320) and equipment temperature stabilized to within 0.1 °C of target temperature ..... ____

4. GAP SETTINGS: ..... ____
   a) zero gap set (at temperature) by:
      i) manually by spinning moveable plate while closing the gap until the moveable plate touches the fixed plate ..... ____
      ii) automatically closing the gap while watching the normal force, after contact set zero gap approx. to zero force ..... ____
   b) plates moved apart to approximate test gap settings..... ____
   c) plates preheated to:
      i) test temperature for 25 mm plates (or lowest temperature if testing at more than one temperature) ..... ____
      ii) to 34 to 46°C range for 8 mm plates ..... ____

PREPARATION OF SAMPLES AND TEST SPECIMEN ***(demo)***

1. TEST SPECIMENS:
   a) binder heated until just fluid enough to be transferred (> 135°C to be avoided if possible)..... ____
      i) to removable plate removed, sample poured continuously approximately 15 mm above plate until plate covered to within approximately 2 mm of the perimeter, allowed to stiffen and plate placed in the DSR ..... ____
      ii) to one of the plates using a rod or spatula..... ____
      iii) by pouring the binder into a silicone rubber mold, cooled, demolded and centered on plate..... ____
   b) immediately after samples placed on the plates, the plates are moved together to:
      i) 1 mm plus 0.05 mm for 25 mm plate ..... ____
      ii) 2 mm plus 0.10 mm for 8 mm plate ..... ____
   c) gap decreased to produce bulge, typically:
      i) 0,05 mm for 25 mm plate..... ____
      ii) 0.10 mm for 8 mm plate..... ____
   d) excess binder trimmed flush to plates..... ____

PROCEDURE

1. TEMPERATURE:
   a) test temperature set to ± 0.1°C, including any offset..... ____
   b) desired temperature (including any offset) is maintained at the test temperature ± 0.1°C for at least 10 min before start..... ____
2. STRAIN CONTROL MODE: controlled to within 20 % of target value as per table below ... ____
3. STRESS CONTROL MODE: controlled to within 20 % of target value as per table below .. ____

WHEN TESTING FOR COMPLIANCE WITH M320G					
Target strain Values			Target Stress Values		
Material	Target, %	Range, %	Material	Target, %	Range, %
Original	12	9 to 15	Original	0.12	0.09 to 0.15
RTFO Residue	10	8 to 12	RTFO Residue	0.22	0.18 to 0.26
PAV Residue	1	0.8 to 1.2	PAV Residue	50.0	40.0 to 60.0

4. TEST MEASUREMENT:
   a) test initiated immediately after preparing and trimming sample ..... ____
   b) sample conditioned by applying
      i) a recommended 10 cycles at 10 rad/s ..... ____
      ii) a required strain 8 to 16 cycles at 10 rad/s ..... ____
   c) test measurement acquired by repeating the:
      i) recommemded strain for 10 more cycles ..... ____
      ii) required strain for 8 to 16 more cycles ..... ____
   c) data obtained for a second of cycles reduced to produce a value for complex modulus and phase angle ..... ____
   d) when testing at more than one frequency testing started at the lowest temperature ..... ____
   e) all testing completed within 4 hours ..... ____

REPORT

1. SAMPLE IDENTIFICATION: sample name, type, code number, source etc. ..... ____
2. INSTRUMENT USED:
   a) whether at constant stress or strain rheometer ..... ____
   b) type of environmental chamber ..... ____
   c) report observed modulus and whether or not strain levels were outside the linear range ..... ____
   d) report modulus at recommended stress or strain levels ..... ____
   e) report if data was obtained oudside the linear region ..... ____
4. TEST PLATE DIAMETER: to nearest 0.1 mm ..... ____
5. TEST GAP: to nearest 1 µm ..... ____
6. TEST TEMPERATURE: to nearest 0.1°C ..... ____
7. TEST FREQUENCY: to nearest 0.1 rad/s ..... ____
8. STRAIN AMPLITUDE OR TORQUE: to nearest 0.01 % or nearest mN.m respectively ..... ____
9. COMPLEX MODULUS: (G*) for 10 measurements, kPa to three significant figures ..... ____
10. PHASE ANGLE: phase angle (δ) for second 10 cycles, report to nearest 0.1°C ..... ____
11 QUIPMENT MANUFACTURER: _____
12 MODEL: _____

REMARKS: