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Sequence IVA Information Letter 14-1
Sequence Number 24
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ASTM consensus has not been obtained on this information letter. An appropriate ASTM ballot will be issued in order to achieve such consensus.

TO: Sequence IVA Mailing List

SUBJECT: Standardized wording describing the role of the TMC

At a June 23, 2014 meeting, ASTM Section D02.B0.10 on Standards Acceleration approved standardized wording describing the role of the Test Monitoring Center. Subcommittee B has requested that the TMC incorporate this wording into all test methods through the information letter system.

These changes are effective with the issuance of this letter.

William A. Buscher III
Chairman
Sequence IVA Surveillance Panel

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ASTM Test Monitoring Center

Attachment

c: ftp://ftp.astmtmc.cmu.edu/docs/gas/sequenceiv/procedure_and_ils/il14-1.pdf

Distribution: Email

Revises Test Method D 6891-14

The following Table summarizes the renumbering of Annexes.

Current Annex Description	Current Annex Number	New Annex Number
Operational Conditions	Annex A1	Annex A5
Parts List	Annex A2	Annex A6
Figures and Drawings	Annex A3	Annex A7
Fuels Specification Information	Annex A4	Annex A8
Safety Precautions	Annex A5	Annex A9
The ASTM Test Monitoring Center Calibration Program	Annex A6	Deleted Replaced with Annexes A1 – A4

Revised introduction section to address additional TMC description items

INTRODUCTION

This test method is written for use by laboratories that utilize the portions of the test method that refer to ASTM Test Monitoring Center (TMC) services (see Annex A1). Laboratories that choose not to use the TMC services may simply disregard these portions.

The TMC provides reference oils, and engineering and statistical services to laboratories that desire to produce test results that are statistically similar to those produced by laboratories previously calibrated by the TMC.

In general, the Test Purchaser decides if a calibrated test stand is to be used. An organization such as the American Chemistry Council require that a laboratory use the TMC services as part of their test registration process. In addition, the American Petroleum Institute requires that a laboratory utilize the TMC services in seeking qualification of oil against its specifications.

This section required Annex reference update

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* See Annex A9 for specific safety precautions.

Added new note one

Note 1--The advantage of using the TMC services to calibrate test stands is that the test laboratory (and hence the Test Purchaser) has an assurance that the test stand was operating at the proper level of test severity. It should also be borne in mind that results obtained in a non calibrated test stand may not be the same as those obtained in a test stand participating in the ASTM TMC services process.

The following Sections have been revised to update references to Annexes, NOTEs or Figures in Annexes whose designation has changed.

4.3 *Test Stand*—Couple the test engine (devoid of alternator, cooling fan, water pump, clutch and transmission) to an eddy-current dynamometer for precise control of engine speed and torque. Specify the combined inertia of the driveline and dynamometer to ensure reproducible transient ramping of engine speed and torque. Control the intake air, provided to the engine air filter housing, for temperature, pressure, and humidity. Mount the engine similar to its vehicle orientation (tilted up 5.5° in front; sideways 10° up on intake manifold side; bottom of oil sump horizontal). Modify the engine ECM wiring harness, sensors, and actuators. The test stand plumbing shall conform to the diagrams shown in Annex A7. Install the engine on a test stand equipped with computer control of engine speed, torque, various temperatures, pressures, flows, and other parameters outlined in the test procedure (see Section 11).

NOTE 2—This test method may be used for engine oil specifications, such as Specification D4485, API 1509, SAE J183, and ILSC GF 3.

NOTE 3—Coordination with the ASTM Committee D02, Subcommittee B, Sequence IVA Surveillance Panel is a prerequisite to the use of any equivalent apparatus. However, the intent is to permit reasonable adaptation of existing laboratory facilities and equipment. Figures are provided throughout the test method to suggest appropriate design details and depict some of the required apparatus.

6.1 *Test Engine*—This test method uses a fired 1994 model Nissan KA24E, in-line 4-cylinder, 4-cycle, water-cooled, port fuel-injected gasoline engine with a displacement of 2.389 L.[11,12] See Annex A6 for a parts lists. Nominal oil sump volume is 3.5 L. The cylinder block is constructed of cast iron, while the cylinder head is aluminum. The engine features a single overhead camshaft with sliding follower rocker arms, with two intake valves and one exhaust valve per cylinder, and hydraulic lash adjusters. The camshaft is not phosphate-coated or lubrited. The rocker arm contact pad material is powdered metal. The engine compression ratio is 8.6 to 1. Rate the engine at 198 N·m torque at 4400 r/min. The ignition timing and multi-port fuel injection system is ECM. Fuel the engine with a specially blended, non-detergent unleaded reference gasoline. Make the EGR non-operable.

6.2 *External Engine Modifications*—Modify the test engine for the valve-train wear test. Make the exhaust gas recirculation non-operable. Disable the swirl control actuator. Disable the fast idle system and the auxiliary air control (AAC) valve. Replace the engine coolant temperature sensor by a fixed resistor. Modify the engine water-pump to incorporate an external electric-driven water-pump. Do not use the water-pump fan blade and cooling radiator. Remove the alternator. Install an oil cooler (water-to-oil heat exchanger) at the oil filter housing, as shown in Annex A7. Modify the engine wiring harness. Install fittings for various temperature and pressure measurements as required by the test method. Place the Nissan production rocker cover with a specially manufactured aluminum jacketed rocker cover. Route the engine coolant through this jacket. Install a fitting in the front engine cover to allow a portion of the crankcase ventilation air to bypass the rocker cover.

6.2.1 *Non-Operable EGR*—This test method does not use an EGR valve. Cover the EGR port with the supplied 3 mm thickness block-off (blind) plate (see Annex A7). Remove the hose from the exhaust manifold to the EGR. Plug the EGR supply port in the rear of the exhaust manifold with a pipe fitting.

6.2.5.7 Fabricate a water pump bore plug (see Annex A7) starting at the neck of the aluminum alloy pump body towards the internal cavity. In some instances, due to manufacturing tolerances, the pump body may need to be heated to approximately 200 °C and the fabricated bore plug cooled to approximately 0 °C. This will allow easy installation of the bore plug.

6.2.7 *Oil Cooler*—Insert a water-to-oil heat exchanger (see Annex A7) between the engine oil filter adapter block and the oil filter, using a gasket as shown in Annex A7. See Annex A7 for installation details. Plumb the water outlet to the cooler fitting and orient to the same axis as the oil filter. Orient the cooler for both water fittings to face the rear of the engine. To connect process water to the oil cooler, use flexible hoses (16 mm diameter) of approximately 500 mm length to connect process water to the oil cooler. Control the oil temperature by metering the flow of the process water outlet. A control system valve with Flow Coefficient (Cv) of 0.32 produces satisfactory control. Replace the oil cooler when it no longer remains serviceable.

TABLE 1 ECM Wiring Harness Modifications[A]

Connector Description	Connector Number(s)
Camshaft Position Sensor	30M
Power Transistor	44M
Distributor	46M
Ignition Coil	47M, 97M
Oxygen Sensor	59M
Mass Air Flow Sensor	63M
Engine Coolant Temperature Sensor	65M (Install 300Ω resistor)
Throttle Position Sensor	66M
Injectors 1–4	72M, 73M, 74M, 75M
Intake Air Temperature Sensor	18M
Body Ground	275M
Engine Ground	60M, 61M
Connector Description	Connector Number(s)
Fuel Pump Relay[B]	5M
ECCS Relay[C]	6M
Resistor and Condenser	40M
Check Connector	208M
Joint Connector A	259M
ECM (ECCS Control Module)	262M
Fuel Pump	2C
Joint Connector C	212M (jumper hardwired)
Connector	260M (jumper hardwired)
EGR Temperature sensor	17M (retain, do not connect)
EGRC solenoid valve	88M (retain, do not connect)
IACV-AAC Valve and	64M (retain, do not connect)
IACV-FICD Solenoid Valve	
Ground Connector	(retain, do not connect)
Check Engine Light	add and utilize
30 A fuse holder	add and utilize
Ground[D]	add and utilize
Keep-Alive wire	add and utilize
Ignition wire	add and utilize
Ground wire[D]	add and utilize

[A] See modified wiring diagram in Annex A7.
[B] Modify the fuel pump relay connector (5M) to provide a nominal 13 V to the fuel pump only when turning on the ignition power switch. See Annex A7 for the wiring details.
[C] The ECCS relay uses the 6M connector. Connect it to the battery through a fusible link.
[D] Attach the wiring harness grounds to the front engine-lifting bracket.

6.3.2 *Test Stand Configuration*—Mount the engine on the test stand similar to its vehicle orientation (tilted up 5.5° in front; sideways 10° up on intake manifold side; bottom of oil sump horizontal). This orientation is important to the return flow of oil in the cylinder head, and ensures reproducible oil levels. Directly couple the engine flywheel to an eddy-current dynamometer through a driveshaft. The driveshaft design shall minimize vibration at the test operating conditions. The dynamometer system shall have inertia of (0.75 ± 0.15) $kg \cdot m^2$ to ensure satisfactory control of engine speed at 800 r/min, stable air-to-fuel ratio control, and enable reproducible transient control of engine speed and torque during stage changes. Do not use hydraulic type dynamometers, as they exhibit residual torques at low speed operation. Do not use the engine to drive any external engine accessory. Recommend the area above and to the left of the rocker arm cover be left unobstructed to allow for easier on-site replacement of valve-train wear parts while the engine rests on the test stand. See Annex A9 for Safety Precautions.

NOTE 4—The dynamometer speed and torque control systems shall be capable of maintaining the steady state operating set points within the performance envelope (that is, quality index established by the industry matrix testing program).

NOTE 5—Two types of full closed-loop speed and torque control systems have been successfully utilized. One typical closed-loop system maintains speed by varying dynamometer excitation and maintains torque by varying the engine throttle. This arrangement may provide satisfactory steady-state control. Another closed-loop speed and torque control system maintains torque by varying dynamometer excitation and controls speed using the engine throttle. This arrangement may provide satisfactory transient control during stage changes.

6.3.4 *Intake-air Supply System*—The supply system shall be capable of delivering a minimum of 600 L/min (2000 L/min preferred) of conditioned and filtered air to the test engine during the 100 h test, while maintaining the intake-air parameters detailed in Annex A5. A humidifying chamber controls the specific humidity and provides a positive air pressure to an intake air supply duct. Annex A7 shows a general schematic of the intake air system.

6.3.4.2 *Intake Air Filtering*—Use the production intake air cleaner assembly (Annex A6), with filter, at the engine. Use a snorkel adapter, functionally equivalent to that shown in Annex A7, to connect the controlled air duct to the air cleaner. Modify the top of the air cleaner assembly for the installation of the intake temperature sensor and for the intake pressure sensor line. Refer to 6.3.4.5.

6.3.4.4 *Intake Air Temperature*—For final control of the inlet air temperature, install an electric air heater strip within the air supply duct. The duct material and heater elements design shall not generate corrosion debris that could be ingested by the engine. To provide sufficient duct flow for adequate air temperature control, it is recommended that excess air be dumped just prior to the air cleaner snorkel. An air dump area of approximately 60 mm^2 will provide sufficient flow without stagnation. If additional airflow is required to stabilize air temperature, it is permissible to install a nominal 10 mm bleed hole in the air filter housing. Install the inlet temperature sensor in the air cleaner, centered at the inlet to the air cleaner (see Annex A7). Attach a support brace to the air cleaner assembly mounting stud and wing nut, if vibration of the temperature sensor is a problem.

6.3.5 *Fuel Supply System*—This test method requires approximately 200 L of unleaded Haltermann KA24E Green test fuel[114 ,12] per test (100 cycles). Ensure a sufficient fuel supply at the start of test to conduct the test without a shutdown. Use the production port fuel injection system, including fuel pump (see Annex A7), fuel injector rail, and fuel pressure regulator. Use recirculated fuel within the system using a non-production heat exchanger to maintain fuel temperature ranging from (15 to 30) °C. Measure fuel consumption using a mass flow meter (MicroMotion[125 ,12] model D-6 is suitable). Install a fuel filter assembly (see Annex A7) upsteam of the fuel pump. Ensure proper fuel filtration to maintain precise air-fuel ratio control during the test.

6.3.6.3 Mount an industrial cooling blower with a nominal air flow rating within 10 000 L/min to 14 000 L/min to blow air vertically over the cast iron exhaust manifold and the manifold exhaust gas oxygen (EGO) sensor. This cooling air is essential to proper EGO operation. Ensure this cooling air is not directed to the engine oil pan or rocker arm cover. Use a deflector shield to prevent air currents at the oil pan. See Annex A9 for Safety Precautions.

6.3.6.4 Use the production exhaust pipe front length (minimum 500 mm), including tube collector with shield, leading from the manifold. Route the exhaust from the test cell using accepted laboratory practices. Install an exhaust pressure control valve at any point after the production exhaust pipe to enable the exhaust to be controlled to an absolute pressure. Use of a catalytic converter, or exhaust attenuator, or

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[2] The sole source of supply of the apparatus known to the committee at this time is Micromotion, 7070 Winchester Circle, Boulder, CO 80301.

pipe cooling is optional, provided these devices are installed after the production exhaust pipe front length and specified absolute pressure is maintained. Remove the unused exhaust pipe production fitting, and weld a plate over the opening (see Annex A7).

6.3.6.7 *Exhaust Gas Temperature*—Measure the exhaust gas temperature using a 6 mm diameter thermocouple. Install the thermocouple in a welded fitting attached to the exhaust pipe at a location (50 ± 10) mm downstream from the end of the collector. Insert the sensor tip to the center of the exhaust pipe (see Annex A7).

6.3.9 *Engine Coolant System*—A schematic diagram of the external coolant system is shown in Annex A7. Use a 50 % deionized water and antifreeze solution, using an extended life ethylene glycol based engine coolant. Texaco Havoline Dex-Cool[138 ,12] has been found to meet this requirement (see Annex A8). Configure the plumbing such that the total coolant system capacity, including engine and normal reservoir capacity, is (25 to 30) L. Regulate the system pressure by a 100 kPa radiator-type pressure cap onto the reservoir tank. Plumb the coolant to enter the engine at the thermostat housing (remove the thermostat). Coolant exits the engine at the front of the intake manifold. Circulate a portion of the engine coolant through the specially manufactured jacketed rocker cover (see Annex A7).

6.3.9.6 *Jacketed Rocker Cover Coolant System*—Route a portion of total coolant system flow through the jacketed rocker cover. Install a tee fitting at the exit of the coolant heat exchanger to allow the coolant flow to split into two circuits (main circuit to the engine thermostat housing and secondary circuit to the jacketed rocker cover (see Fig. 2). The secondary circuit enters the front of the jacketed cover and exits the rear of the cover. Install an automatic air bleed vent near the front of the rocker cover. Limit the secondary circuit flow rate at the exit by installing a two-way control valve, 13 mm nominal internal diameter size, with a flow coefficient rating (Cv) of 1.25. Configure the control valve in the fail-safe open position. The secondary flow joins the primary flow at the suction of the coolant system-circulating pump. Refer to the schematic of the cooling system located in Annex A7.

6.3.10.1 Draw the crankcase off-gas from the engine at the production breather and oil separator. From the breather, the crankcase gas flows through the Positive Crankcase Ventilation (PCV) valve to the bottom plenum of the intake manifold (see Annex A7) for a drawing of the ventilation system plumbing.

6.3.13.3 *Blowby Flow Rate Measurement System*—Use the apparatus shown in Annex A7 for measurement of the blowby flow rate. The measurement system routes the blowby through an external, sharp-edge orifice and into the engine intake manifold by way of an auxiliary PCV valve. Maintain the crankcase gage pressure at (0.0 to 0.025) kPa during system operation to minimize crankcase leakage. Determine the blowby flow rate by measuring the differential pressure drop across the sharp-edge orifice. Use an inclined manometer or differential pressure sensor for the orifice differential pressure measurement. The crankcase pressure sensor shall have a (0 to 1) kPa range and be adequately damped to indicate a zero gage pressure. The sharp-edge orifice is specifically designed for blowby flow rate measurement and shall be fabricated in strict compliance with the specifications available from the TMC. The assembly contains five orifices. Use a 3.175 mm orifice for the blowby flow rate range of (5 to 12 L/min). The flow rate measurement orifice fabrication location and the blowby flow rate measurement can be obtained from the TMC.

6.4.1 *Nissan Supplied Component Kits*—Obtain the test parts and engines for this test method from Nissan North America[11 ,12] (see Annex A6).

6.4.1.1 *Test Engine Long-Block*—Order the test engine long-block assembly (also called bare engine assembly) as shown in Annex A6. The test engine includes the block, pistons, rods, crankshaft, oil pan, front cover, cylinder head, and rocker arm cover final assembly. Use the camshaft and rocker arms during engine break-in only; but they are not official test parts. Annex A2 contains information regarding the number of test the short-block may be used. Use the original cylinder head for the number of test listed in Annex A6.

6.4.1.2 *Stand Set-Up Kit*—There are four component kit parts that comprise the stand setup kit (see Annex A6). These four component kits include crankshaft pulleys, flywheel, intake and exhaust manifolds, air cleaner, fuel injection system, EGR block-off plate, ignition distributor, wiring, starter motor, fuel pump, exhaust pipe, and oil cooler. Use one of each of the four component kit parts to configure one test installation.

6.4.1.4 *Cylinder Head Replacement Kit*—Every engine short-block is used for the number of tests listed in Annex A6. Use the original cylinder head for the number of tests listed in Annex A6. After that number of tests, install a replacement cylinder head for the number of runs listed in Annex A6. To assemble and install the bare cylinder head, use 1 gasket and seal kit. Install new calibrated valve springs, intake and exhaust valves with the replacement head (see Annex A6). When the replacement head is installed onto the engine, use the original supplied camshaft and rocker arms for conducting another break-in prior to the next test.

6.4.3 *Required New Engine Parts*—This test method is a flush-and-run type test. For each test, the camshaft and rocker arms are replaced. Use all the parts in test kit number 13000-40F85 as shown in Annex A6.

6.4.4 *Reusable Engine Parts*—Replace the engine short-block and the cylinder head as specified in Annex A6. If the engine demonstrates deterioration (excessive blowby or oil consumption or fuel dilution, poor compression, low oil pressure, clearances beyond service limits, or stripped fasteners) prior to this expected life (see Annex A6), replace the engine and follow the break-in procedure prior to resuming non-reference oil testing. Do not exceed the number of tests on the short-block or cylinder heads listed in Annex A6.

TABLE 5 Test Tools

Item
$^{3}/_{8}$-in. Drive Impact Gun
$^{3}/_{8}$-in. Drive Speed Handle
$^{3}/_{8}$-in. Drive Rachet
$^{3}/_{8}$-in. Drive 4-in. Extension
$^{3}/_{8}$-in. Drive Rachet
Medium Flat Head Screwdriver
Large Flat Head Screwdriver
$^{5}/_{8}$-in. Wrench, Combination
$^{5}/_{8}$-in. Spark Plug Socket, $^{3}/_{8}$ in. Drive
27 mm Deep Socket, $^{3}/_{8}$-in. Drive
24 mm Impact Deep Socket, $^{3}/_{8}$-in. Drive
12 mm Deep Socket, $^{3}/_{8}$-in. Drive
10 mm Deep Socket, $^{3}/_{8}$-in. Drive
Digital Bore Gage with Metric Head
Dial Indicator Set with Magnetic Base
Mounting Plate for Dial Indicator
1-2 in. Digital Micrometer
Spark Plug Gapping Tool
Suction Device (Syringe and Tubing)
Wooden Wedge Tool (see Annex A8)
Utility Rocker Shafts

Item
Pin Vise and 1.17 mm Diameter Drill Bit

6.5.1.3 The nominal traversing speed is (0.50 to 0.75) mm/s. A computer interface is recommended. The Precision Devices, Inc. MicroAnalyzer 2000 system,[243,12] see Fig. 9, a computer-driven profilometer, may be used. Equip the profilometer with custom V-blocks (see Annex A6) for holding the work-piece (the camshaft on its journals), and an optical angle encoder for determining the cam shaft angular position (see Annex A6).

7. Reagents and Materials

NOTE 6—Use 13 L of the non-reference test oil sample to perform the 100 h Valve-train Wear test.

7.2 *Fuel*—Use Haltermann KA24E Green test fuel for this test method as shown in Annex A8. (**Warning—**Flammable. Health hazard.) It is dyed green to preclude unintentional contamination with other test fuels. Use approximately 200 L of fuel for each test (100 cycles). This fuel has a hydrogen-to-carbon ratio of 1.80 to 1.

7.2.1 *Fuel Approval Requirements*—The fuel is blended as needed by the fuel supplier. Base the fuel batch acceptance upon the physical and chemical specifications given in Annex A8. Engine validation tests are not necessary for fuel batch acceptance.

7.4.2 *Sealing Compounds*—Use a silicone based gasketing compound during engine assembly (for example, oil pan). Use only the silicone gasket shown in Annex A6.

8.1 *Sample Selection and Inspection*—The non-reference oil sample shall be uncontaminated and representative of the lubricant formulation being evaluated.

NOTE 7—If the test is registered using the American Chemistry Council[255] protocols, the assigned oil container formulation number shall match the registration form.

9. Preparation of Apparatus

NOTE 8—This section details those recurring preparations necessary for test operation. This section assumes the engine test stand facilities and other hardware described in Section 6 are in place.

9.3.6.1 *Assembled Force Calibration*—Measure and record the assembled valve spring loading with the valve springhead calibration fixture shown in Fig. 10 and the part number in Annex A6.

9.3.6.2 The procedure detailed below includes measuring each installed valve spring at two deflection points (see Table 8).

TABLE 8 Spring Specifications

Intake Valve Spring		Exhaust Valve Spring	
Force	Deflection	Force	Deflection
(889 ± 35) N	9.86 mm	(969 ± 35) N	9.86 mm
(438 ± 35) N	1.27 mm	(447 ± 35) N	12.7 mm

(1) Check the apparatus load cell calibration for accuracy.
(2) Install the cylinder head holding fixtures (see Annex A7) for the test cylinder head.

9.6.1 *Cylinder Head Installation*—The parts kit (see Annex A6) include the assembled new cylinder head. The valve seats and valve faces are machined to Nissan production specifications. Laboratory inspection may reveal the need to lap the valve seat and valve faces. Perform the following before assembling the cylinder head:

9.6.1.6 Measure and adjust installed valve spring force to test specifications (see9.3.5). Install the modified and measured cylinder head on the short-block using a new cylinder head gasket (see Annex A2). Torque the head bolts in proper sequence, and in five stages according to the Nissan Service Manual. Use an angle-meter torque wrench to properly torque the cylinder head bolts.

NOTE-9—At Southwest Research Institute (SwRI), client test oil is poured over valve-train parts at test start before Flush 1, NOT during parts installation.

9.7.2.1 Obtain the new test parts, including the pre-measured test camshaft. See Annex A6 for a new parts listing with their corresponding part numbers for each turnaround.

9.7.2.27 Install new spark plugs (see Annex A6). Gap the plugs to 0.99 mm and torque to 14 N·m.

NOTE10—10.2.6 and 10.2.7 and Annexes A1 – A4 describe the involvement of the TMC in respect to calibration procedures and acceptance criteria for a testing laboratory and a test stand, and the issuance of Information Letters and memoranda affecting the test method.

NOTE 11—Internal leakage within the 3-way valve may cause some of the blowby gas to pass directly to the intake manifold from the test PCV valve and result in erroneous blowby flow rate measurements.

10.4.3 *Oil Cooler Replacement*—Replace the oil cooler (see Annex A6) when replacing the short-block assembly.

11. Procedure

NOTE 12—When installing a new engine and cylinder head or both, conduct a break-in procedure, see 11.1.3, before running official 100 h tests. After completing the break-in, install the official test valve-train parts as shown in 9.7. Then conduct a double oil-flush procedure as shown in11.2.2. After performing the double oil-flush, conduct the 100 h test as shown in11.2.3. Use Annex A5 for operational conditions.

11.1.3 *Engine Break-in Procedure*—Conduct the break-in procedure prior to lubricant evaluation testing when installing a new engine short-block, new long-block, or new cylinder head on the test stand. The break-in allows for setting the ignition timing, purging air from the coolant system, checking for leaks in the various systems, and monitoring engine performance and test stand instrumentation. Follow the prescribed break-in conditions in Table A6.1. Use the engine short-block assembly for 20 tests and the cylinder head assembly for 10 tests. Perform new engine break-in once every 10 tests. Use the following break-in steps:

11.2 *Engine Operating Procedure*—The Valve-train Wear test is a double-flush and run test. Conduct the oil flush and test operations as shown in 11.2.2 – 11.2.3, and in Annex A5.

11.2.2.2 Install a new oil filter onto the engine (see Annex A6). Perform the following steps to help the oil pressure build quicker during initial start-up. Do not install a dry oil filter on the test engine.

11.2.2.6 Once the oil temperature has reached 50 °C run Flush 1 according to the prescribed flush conditions Table A5.2. Flush 1 is a 20 min flush operating the engine at 800 r/min and 10 N·m of torque.

11.2.2.10 Install a new oil filter onto the engine (see Annex A6). Perform the following steps to help the oil pressure build quicker during initial start-up. Do not install a dry oil filter on the test engine.

11.2.2.13 Once the oil temperature has reached 60 °C run Flush 2 according to the prescribed flush conditions (Annex A5). Flush 2 is a 20 min flush operating the engine at 1500 r/min and 10 N·m of torque.

11.2.3.4 Obtain a new test oil filter (see Annex A6), weigh it dry, and record for use in calculating oil consumption in11.5.1.

11.2.3.9 Once the oil temperature has reached 50 °C, initiate the 100 h test. Follow the prescribed test conditions (Annex A5).

11.2.5 *Cyclic Schedule, General Description*—See Annex A5 for the steady-state operating test conditions (specification targets). The actual test operational conditions are summarized on the appropriate report

11.3.5.1 *Spark Plug Replacement*—Replace the spark plugs (see Annex A6) before conducting the oil flushing procedure in 9.7.2.

NOTE 13—High fuel consumption rate can promote excessive cylinder bore, camshaft, and rocker arm wear.

11.5.3.3 The Precision Devices Inc. MicroAnalyzer 2000 system is recommended as the computer-driven profilometer. Equip it with custom V-blocks (see Annex A6) for holding the work-piece (the camshaft on its journals). Use a diamond stylus that does not skid and that features a 0.005 mm stylus radius and a 6.5 mm stylus height. Take a trace across the lobe from front-to-rear of the lobe, at a traversing speed of (0.50 to 0.75) mm/s. Slightly extend (drop) the stylus off the lobe edges to ensure a full trace. View the data from the trace in the profile mode, allowing an analysis of the texture and waviness of the trace. Configure the instrument software for a two-point line texture leveling at the average value of the unworn edges of the cam lobe. Display the waviness of the profile using the Gaussian smoothing filter set at a cutoff length of 0.25 mm and with the filter set (nonstandard setting) to extend to the ends of the texture. Typically, the leveling line coincides with (contracts or is very close to) the highest peak of the waviness profile that exists at each unworn end. To obtain the wear measurement, the waviness evaluation length encompasses the whole lobe width. The Wt parameter (waviness total) yields the value of the height from the maximum peak to the lowest valley of the waviness profile. Record the wear measurement as the Wt measurement.

11.3.1 *Blowby Flow Rate Measurement*—Measure and record the blowby flow rate during the middle of Stage I of cycle 5 and cycle 100. Stabilize and operate the engine at normal Stage I operating conditions. Use a 3.175 mm diameter blowby orifice size for the normal blowby flow range of (5 to 12) L/min. An apparatus similar to those shown in schematics in Fig. A7.17 and Fig. A7.18 may be used. The design of the apparatus is left up to the discretion of the laboratory. Perform steps 11.3.1.1 through 11.3.1.8 when using a device similar to the schematic in Fig. A7.17 or perform steps 11.3.1.9 through 11.3.1.15 when using a device similar to the schematic in Fig. A7.18.

NOTE 14—The summary of results and calculations are recorded on the appropriate report form.

13. Test Report

13.1 For reference oil results, use the standardized report form set available from the ASTM TMC and data dictionary for reporting test results and for summarizing operational data.

NOTE 15 Report the non-reference oil test results on these same forms if the results are intended to be submitted as candidate oil results against a specification.

13.1.1 Fill out the report forms according to the formats shown in the data dictionary.

XY.1.2 Transmit results to the TMC within 5 working days of test completion.

13.1.3 Transmit the results electronically as described in the ASTM Data Communications Committee Test Report Transmission Model (Section 2 — Flat File Transmission Format) available from the ASTM TMC. Upload files via the TMC's website.

13.2 Report all reference oil test results, whether aborted, invalidated, or successfully completed, to the TMC.

13.3 *Deviations from Test Operational Limits*—Report all deviations from specified test operational limits.

13.4 *Precision of Reported Units*—Use the Practice E29 rounding-off method for critical pass/fail test result data. Report the data to the same precision as indicated in data dictionary.

13.5 In the space provided, note the time, date, test hour, and duration of any shutdown or off-test condition. Document the outcome of all prior reference oil tests from the current calibration sequence that were operationally or statistically invalid.

13.6 If a calibration period is extended beyond the normal calibration period length, make a note in the comment section and attach a written confirmation of the granted extension from the TMC to the test report. List the outcomes of previous runs that may need to be considered as part of the extension in the comment section.

13.7 *Photographs*—The final test report does not require photographs.

NOTE 16—"Intermediate precision" is the appropriate term for this test method, rather than "repeatability," which defines more rigorous within-laboratory conditions.

ANNEXES
(Mandatory Information)

A1.1 *Nature and Functions of the ASTM Test Monitoring Center (TMC)*—The TMC is a non-profit organization located in Pittsburgh, Pennsylvania and is staffed to: administer engineering studies; conduct laboratory inspections; perform statistical analyses of reference oil test data; blend, store, and ship reference oils; and provide the associated administrative functions to maintain the referencing calibration program for various lubricant tests as directed by ASTM Subcommittee D02.B0 and the ASTM Executive Committee. The TMC coordinates its activities with the test sponsors, the test developers, the surveillance panels, and the testing laboratories. Contact TMC through the TMC Director at:

ASTM Test Monitoring Center
6555 Penn Avenue
Pittsburgh, PA 15206-4489
www.astmtmc.cmu.edu

A1.2 *Rules of Operation of the ASTM TMC*—The TMC operates in accordance with the ASTM Charter, the ASTM Bylaws, the Regulations Governing ASTM Technical Committees, the Bylaws Governing ASTM Committee D02, and the Rules and Regulations Governing the ASTM Test Monitoring System.

A1.3 *Management of the ASTM TMC*—The management of the Test Monitoring System is vested in the Executive Committee elected by Subcommittee D02.B0. The Executive Committee selects the TMC Director who is responsible for directing the activities of the TMC.

A1.4 *Operating Income of the ASTM TMC*—The TMC operating income is obtained from fees levied on the reference oils supplied and on the calibration tests conducted. Fee schedules are established by the Executive Committee and reviewed by Subcommittee D02.B0.

A2. ASTM TEST MONITORING CENTER: CALIBRATION PROCEDURES

A2.1 *Reference Oils*—These oils are formulated or selected to represent specific chemical, or performance levels, or both. They are usually supplied directly to a testing laboratory under code numbers to ensure that the laboratory is not influenced by prior knowledge of acceptable results in assessing test results. The TMC determines the specific reference oil the laboratory shall test.

A2.1.1 *Reference Oil Data Reporting* – Test laboratories that receive reference oils for stand calibration shall submit data to the TMC on every sample of reference oil they receive. If a shipment contains any missing or damaged samples, the laboratory shall notify the TMC immediately.

A2.2 *Calibration Testing:*

A2.2.1 Full-scale calibration testing shall be conducted at regular intervals. These full-scale tests are conducted using coded reference oils supplied by the TMC. It is a laboratory's responsibility to keep the on-site reference oil inventory at or above the minimum level specified by the TMC test engineers.

A2.2.2 *Test Stands Used for Non-Standard Tests*—If a non-standard test is conducted on a previously calibrated test stand, the laboratory shall conduct a reference oil test on that stand to demonstrate that it continues to be calibrated, prior to running standard tests.

A2.3 *Reference Oil Storage*—Store reference oils under cover in locations where the ambient temperature is between -10 °C and +50 °C.

A2.4 *Analysis of Reference Oil*—Unless specifically authorized by the TMC, do not analyze TMC reference oils, either physically or chemically. Do not resell ASTM reference oils or supply them to other laboratories without the approval of the TMC. The reference oils are supplied only for the intended purpose of obtaining calibration under the ASTM Test Monitoring System. Any unauthorized use is strictly forbidden. The testing laboratory tacitly agrees to use the TMC reference oils exclusively in accordance with the TMC's published Policies for Use and Analysis of ASTM Reference Oils, and to run and report the reference oil test results according to TMC guidelines. Additional policies for the use and analysis of ASTM Reference Oils are available from the TMC.

A2.5 *Conducting a Reference Oil Test*—When laboratory personnel are ready to run a reference calibration test, they shall request an oil code via the TMC website.

A2.6 *Reporting Reference Oil Test Results*—Upon completion of the reference oil test, the test laboratory transmits the data electronically to the TMC, as described in Section 15. The TMC reviews the data and contacts the laboratory engineer to report the laboratory's calibration status. All reference oil test results, whether aborted, invalidated, or successfully completed, shall be reported to the TMC.

A2.6.1 All deviations from the specified test method shall be reported.

A3. ASTM TEST MONITORING CENTER: MAINTENANCE ACTIVITIES

A3.1 *Special Reference Oil Tests*—To ensure continuous severity and precision monitoring, calibration tests are conducted periodically throughout the year. Occasionally, the majority or even all of the industry's test stands will conduct calibration tests at roughly the same time. This could result in an unacceptably large time frame when very few calibration tests are conducted. The TMC can shorten or extend calibration periods as needed to provide a consistent flow of reference oil test data. Adjustments to calibration periods are made such that laboratories incur no net loss or gain in calibration status.

A3.2 *Special Use of the Reference Oil Calibration System*—The surveillance panel has the option to use the reference oil system to evaluate changes that have potential impact on test severity and precision. This option is only taken when a program of donated tests is not feasible. The surveillance panel and the TMC shall develop a detailed plan for the test program. This plan requires all reference oil tests in the program to be completed as close to the same time as possible, so that no laboratory/stand calibration status is left pending for an excessive length of time. In order to maintain the integrity of the reference oil monitoring system, each reference oil test is conducted so as to be interpretable for stand calibration. To facilitate the required test scheduling, the surveillance panel may direct the TMC to lengthen and shorten reference oil calibration periods within laboratories such that the laboratories incur no net loss or gain in calibration status. To ensure accurate stand, or laboratory, or both severity assessments, conduct non-reference oil tests the same as reference oil tests.

A3.3 *Donated Reference Oil Test Programs*—The surveillance panel is charged with maintaining effective reference oil test severity and precision monitoring. During times of new parts introductions, new or re-blended reference oil additions, and procedural revisions, it may be necessary to evaluate the possible effects on severity and precision levels. The surveillance panel may choose to conduct a program of donated reference oil tests in those laboratories participating in the monitoring system, in order to quantify the effect of a particular change on severity and precision. Typically, the surveillance panel requests its panel members to volunteer enough reference oil test results to create a robust data set. Broad laboratory participation is needed to provide a representative sampling of the industry. To ensure the quality of the data obtained, donated tests are conducted on calibrated test stands. The surveillance panel shall arrange an appropriate number of donated tests and ensure completion of the test program in a timely manner.

A3.4 *Intervals Between Reference Oil Tests*—Under special circumstances, such as extended downtime caused by industry-wide parts or fuel shortages, the TMC may extend the intervals between reference oil tests.

A3.5 *Introducing New Reference Oils*—Reference oils produce various results. When new reference oils are selected, participating laboratories will be requested to conduct their share of tests to enable the TMC to recommend industry test targets. ASTM surveillance panels require a minimum number of tests to establish the industry test targets for new reference oils.

A3.6 *TMC Information Letters*—Occasionally it is necessary to revise the test method, and notify the test laboratories of the change, prior to consideration of the revision by Subcommittee D02.B0. In such a case, the TMC issues an Information Letter. Information Letters are balloted semi-annually by Subcommittee D02.B0, and subsequently by D02. By this means, the Society due process procedures are applied to these Information Letters.

A3.6.1 *Issuing Authority*—The authority to issue an Information Letter differs according to its nature. In the case of an Information Letter concerning a part number change which does not affect test results, the TMC is authorized to issue such a letter. Long-term studies by the surveillance panel to improve the test procedure through improved operation and hardware control may result in the issuance of an Information Letter. If obvious procedural items affecting test results need immediate attention, the test sponsor and the TMC issue an Information Letter and present the background and data supporting that action to the surveillance panel for approval prior to the semiannual Subcommittee D02.B0 meeting.

A3.7 *TMC Memoranda*—In addition to the Information Letters, supplementary memoranda are issued. These are developed by the TMC and distributed to the appropriate surveillance panel and participating laboratories. They convey such information as batch approvals for test parts or materials, clarification of the test procedure, notes and suggestions of the collection and analysis of special data that the TMC may request, or for any other pertinent matters having no direct effect on the test performance, results, or precision and bias.

A4. ASTM TEST MONITORING CENTER: RELATED INFORMATION

A4.1 *New Laboratories*—Laboratories wishing to become part of the ASTM Test Monitoring System will be requested to conduct reference oil tests to ensure that the laboratory is using the proper testing techniques. Information concerning fees, laboratory inspection, reagents, testing practices, appropriate committee membership, and rater training can be obtained by contacting the TMC Director.

A4.2 *Information Letters: COTCO Approval*—Authority for the issuance of Information Letters was given by the committee on Technical Committee Operations in 1984, as follows: "COTCO recognizes that D02 has a unique and complex situation. The use of Information Letters is approved providing each letter contains a disclaimer to the affect that such has not obtained ASTM consensus. These Information Letters should be moved to such consensus as rapidly as possible."

A4.3 *Precision Data*—The TMC determines the precision of test methods by analyzing results of calibration tests conducted on reference oils. Precision data are updated regularly. Current precision data can be obtained from the TMC

CURRENT ANNEXES A1 THROUGH A5 HAVE BEEN RENUMBERED A5 THROUGH A9.
REVISE NUMBERING ACCORDINGLY.
DELETE CURRENT ANNEX A6.