

SAE Cold Start and Driveability Procedure

1. Scope

1.1 To subjectively evaluate engine starting behavior and driveability characteristics of a motor vehicle which has been soaked at ambient temperature for a given time period after attaining a stabilized engine coolant temperature. This SAE Recommended Practice also defines driveability defects and the rating system.

1.2 This evaluation may be affected by ambient temperature, altitude, fuel, and the road system.

1.2.1 The vehicle should be evaluated with all fuels recommended by the manufacturer. A partial list comprises reformulated gasoline, ethanol/gasoline and methanol/gasoline blends of various proportions, diesel #1, and diesel #2.

2. References—There are no referenced publications specified herein.

3. Test Conditions

3.1 The test road should be paved, level, smooth, and dry. If the vehicle is evaluated on a public road, traffic should be light.

3.2 Tests may be conducted at any ambient temperature, but it is recommended that average winds not exceed 25km/h (15 mph) or gusts not exceed 40 km/h (25 mph). Winds mask defects such as surge, hesitation, and bucking. Precipitation or fog may affect traction and must be avoided.

3.3 Nomenclature for transmission gear shall be as follows:

3.3.1 Automatic transmission is designated as A; the gear is represented by the first letter of the appropriate word (i.e., A-D is Drive).

3.3.2 Manual transmission is designated as M; the gear is represented by the appropriate number (i.e., M-1 is First). For idle rating purposes, the clutch is to be disengaged.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright ©2002 Society of Automotive Engineers, Inc.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER:

Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

4. Equipment

- 4.1 Stop watch
- 4.2 Engine tachometer
- 4.3 Intake manifold absolute pressure (MAP) gauge

5. Vehicle Preparation

- 5.1 The vehicle must be properly equipped, maintained, and adjusted for ambient temperature operation. This includes the use of recommended:

- 5.1.1 Fuel (at least 1/4 tank)
- 5.1.2 Weight and viscosity of engine oil
- 5.1.3 Coolant composition
- 5.1.4 Thermostat
- 5.1.5 Spark plug type and gap
- 5.1.6 Tires, at proper cold inflation pressure

- 5.1.6.1 When the ambient temperature at which the test is to be conducted differs more than 14 °C (26 °F) from that at which the vehicle is being prepared, it is recommended that the inflation pressure be altered by the following pressure increment:

$$P = k (\text{Prep Temp} - \text{Test Temp}) \quad (\text{Eq. 1})$$

where:

P = Change in pressure
 k = 1 kPa/°C or 1 psi/13 °F

- 5.1.6.2 If the ambient test temperature is higher than the preparation area temperature, then subtract the tire pressure correction factor from the specified tire pressure.
- 5.1.6.3 If the ambient test temperature is lower than the preparation area temperature, then add the tire pressure correction factor to the specified tire pressure, e.g.,
 - a. Prep Temp 21 °C (70 °F)
 - b. Test Temp 13 °C (56 °F)
 - c. (21 °C to 13 °C) 1 kPa/°C = +8 kPa or (70 °F to 56 °F) 1 psi/13 °F = +1.1 psi
- 5.1.7 Battery and battery cable sizes
- 5.1.8 Cold weather starting aids
- 5.1.9 Transmission fluid

5.1.10 Air cleaner

5.1.11 Air cleaner hot-air stove

5.2 The vehicle is to be loaded $136 \text{ kg} \pm 11.4 \text{ kg}$ ($300 \text{ lb} \pm 25 \text{ lb}$) above curb weight, inclusive of weight of driver and test equipment.

5.3 Prepare the vehicle for a cold/partial cooldown/hot start as follows:

5.3.1 If the engine coolant temperature is not at a stable value when the vehicle is delivered, then prepare the vehicle by driving at a steady state. At a time equal to the desired soak period before the start test, bring engine to stabilized coolant temperature by driving for at least 16 km (10 mile) at 70 to 90 km/h (45 to 55 mph). At temperatures lower than -18°C (0°F), drive for a minimum of 32 km (20 mile). See Table 1.

TABLE 1—LENGTH OF SOAK PERIOD

Type of Start Test	Soak Period
Cold	8 to 36 h (12 h nominal)
Partial cooldown	1.5 to 4 h
Hot	5 to 30 min

5.3.2 Record manifold absolute pressure (kPa) for stabilized engine idle (for use in 7.3) and RPM (gears A-D, A-P or M-1, M-0) at conclusion of warm-up for use with Table 2.

TABLE 2—DEFINITION OF ACCELERATION

Description	Manifold Pressure (DRIVE)	Fraction of Full Pedal Travel
Light accel	$40.4 + 0.60 * \text{Idle kPa}$	1/4
Moderate accel	$60.6 + 0.40 * \text{Idle kPa}$	$1/4 < \text{Pedal} < 1/2$
Heavy accel	$85.8 + 0.15 * \text{Idle kPa}$	$1/2 < \text{Pedal} < 7/8$
Wide Open Throttle (WOT)	101 kPa	Full

5.3.3 Place gear selector in PARK (A-P) or NEUTRAL (M-0) and turn off engine. Set the parking brake.

5.3.4 Set the heater/air conditioner controls as follows, with the blower switch in HIGH (if selectable) and the temperature set to a maximum tolerable level.

- Non A/C—Defrost, LOW fan, maximum tolerable temperature (MTT)
- Manual A/C—Defrost, LOW fan, MTT
- Semi-auto A/C—Defrost, LOW fan, MTT
- Automatic A/C—Automatic LOW fan, MTT

5.3.5 Allow the vehicle to soak at ambient temperature for the desired period.

6. Cold Start Procedure

6.1 Record all test information on the Cold Start and Driveability data sheet. See Figure 1.

6.2 For diesel engines, turn ignition key to RUN position and record "WAIT" light on-time.

- 6.3 Start engine per Owner's Manual/visor information procedure. Record start time.
- 6.4 If engine fails to start after 15 s, stop cranking. Follow Owner's Manual procedure for a no start. Begin cranking and record total cranking time until engine starts. After three failures to start, the vehicle should be withdrawn from testing for diagnosis and repair.

VEHICLE INFORMATION

Vehicle Identification _____ (VIN)
 Model Year _____ Manufacturer _____
 Model _____ Odometer _____ km
 Body Style _____ (2D, 4D, SW, TR = truck)
 Engine Displacement: _____ (Liters) Configuration _____ (L4, V6, V8)
 Induction System _____ (Normal, Turbocharged, Supercharged)
 Fuel Delivery System _____ (CARB, TBI, DIE, PFI)
 Transmission _____ (A3, A4, A5, M5, M6)
 Final Drive Ratio _____ Drive Axle _____ (Front, Rear, AWD)
 Test Weight: _____ kg Fuel Type _____
 Tire Brand & Model _____
 Tire Size _____ Cold Tire Press ____ kPa front ____ kPa rear
 Comments _____

TEST INFORMATION

Date _____ Driver _____
 Observer _____
 Soak Time _____ Soak Temperature _____ °C.
 Acceleration based on ____ Manifold Pressure ____ Throttle Pedal travel
 Manifold Pressure at Idle _____ kPa

Condition	Start Rating	Idle Rating			Drive Rating	Ambient Temp (C)	Soak Time (hr)
		Idle Neutral Reverse	Idle Drive	Idle			
Cold Drive		/	/				
Comments							
Warm Drive	-----	/	/				-----
Comments							
Hot Drive		/	/				
Comments							
Partial Cool Down		/	/				
Comments							

FIGURE 1—COLD START AND DRIVEABILITY DATA SHEET

6.5 As soon as the engine starts, turn on headlights and backlight defroster (if so equipped). The defroster is not to be reset if it shuts off automatically.

6.5.1 Fan is kept at low setting throughout test to provide a quiet ambient for assessing engine roughness, knock, and engine run-on.

6.5.2 If vehicle is tested with heated windshield activated, note this condition on the data sheet. See Figure 1.

6.6 Record the following readings (as applicable) in gear A-P or M-0 immediately after start. Do not force the idle; engine is to idle at closed throttle. For a manual transmission, record data with clutch engaged and disengaged.

6.6.1 Idle speed, RPM

6.6.2 Manifold absolute pressure, kPa

6.6.3 Idle quality (see Appendix A).

6.7 If engine stalls, repeat Steps 6.2 through 6.4. Record number of stalls and starting times. After three failures to start, the vehicle should be withdrawn from testing for diagnosis and repair.

6.8 Allow engine to idle 15 s in gear A-P or M-0. Apply brake, shift to gear A-D or M-1 (clutch disengaged) range, idle for 10 s, and record information in 6.6. If engine stalls, restart immediately. Do not record restart time. Record number of stalls.

7. *Driveability Procedure*

7.1 After the cold start evaluation, the vehicle is driven according to Cycle 1, then Cycle 2, followed by a repeat of Cycle 1 and Cycle 2.

7.2 Record the frequency and severity of the following defects:

7.2.1 Backfire (note whether induction or exhaust)

7.2.2 Bucking

7.2.3 Detonation

7.2.4 Harshness

7.2.5 Hesitation/Stumble

7.2.6 Stall

7.2.7 Surge

7.2.8 Vibration