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SAE J819 MAR87

**Engine Cooling
System Field Test
(Air-to-Boil)**

**SAE Standard
Revised March 1987**

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SAE 87-0102
SAE 87-0103
SAE 87-0104
SAE 87-0105
SAE 87-0106
SAE 87-0107
SAE 87-0108
SAE 87-0109
SAE 87-0110
SAE 87-0111
SAE 87-0112
SAE 87-0113
SAE 87-0114
SAE 87-0115
SAE 87-0116
SAE 87-0117
SAE 87-0118
SAE 87-0119
SAE 87-0120
SAE 87-0121
SAE 87-0122
SAE 87-0123
SAE 87-0124
SAE 87-0125
SAE 87-0126
SAE 87-0127
SAE 87-0128
SAE 87-0129
SAE 87-0130
SAE 87-0131
SAE 87-0132
SAE 87-0133
SAE 87-0134
SAE 87-0135
SAE 87-0136
SAE 87-0137
SAE 87-0138
SAE 87-0139
SAE 87-0140
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SAE 87-0142
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SAE 87-0186
SAE 87-0187
SAE 87-0188
SAE 87-0189
SAE 87-0190
SAE 87-0191
SAE 87-0192
SAE 87-0193
SAE 87-0194
SAE 87-0195
SAE 87-0196
SAE 87-0197
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ENGINE COOLING SYSTEM FIELD TEST (AIR-TO-BOIL)

1. PURPOSE: The purpose of this code is to provide a procedure to determine the cooling system reserve capacity under the conditions existing when tested.
2. SCOPE: This code applies to all self-propelled construction and industrial machines using liquid-cooled internal combustion engines.
3. DEFINITIONS:
 - 3.1 Air-to-boil (ATB) temperature is the ambient air temperature that will cause the cooling system to boil when the machine is operated under specified conditions and modes of operation, usually at maximum productivity.
 - 3.2 Theoretical coolant boiling temperature is the temperature at which the coolant will boil at sea level, including any system pressurization allowed by the radiator cap. (For further information, see SAE J814.)
 - 3.3 ΔT is the temperature differential between radiator top tank and ambient air.
 - 3.4 Coolant - Water.
4. FACILITIES AND APPARATUS:
 - 4.1 Facilities: The test course shall be level within 2% grade where data is recorded. The remainder of the course to be such as to cause minimum deviation of engine load.
 - 4.2 Apparatus:
 - 4.2.1 Means for measuring temperature, accuracy $\pm 1^{\circ}\text{C}$ (2°F).
 - 4.2.2 Means to measure engine speed, accuracy $\pm 2\%$.

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- 4.2.3 Means to establish output shaft speed, accuracy $\pm 2\%$, if data is to be recorded.
- 4.2.4 Means to measure machine speed, accuracy $\pm 2\%$, if data is to be recorded.
- 4.2.5 Means to measure time, accuracy ± 1 s.
- 4.2.6 Means to provide a controllable holdback (towed load) for drawbar type tests.
- 4.2.7 Means to measure average fuel consumption within 1% total fuel consumed during test period, if data is to be recorded.

5. PROCEDURE:

- 5.1 If the machine has not recently been used, it should be limbered up in a manner recommended by the manufacturer. Any malfunction or maladjustment noted during this limbering-up period must be corrected.
- 5.2 Do not run a cooling test if the ambient temperature is below 24°C (75°F) because the large changes in air density and radiation from non-cooling system parts give false results.
- 5.3 Do not test if wind velocity exceeds 10 km/h (6 mph) unless wind is at 90 deg to the test course.
- 5.4 Prior to start of the test, the machine shall be inspected to assure that:
 - 5.4.1 It is serviced as specified.
 - 5.4.2 It delivers specified power. This may be checked by application of the Drawbar Test Procedure for Construction, Forestry and Industrial Machines or other suitable means.
 - 5.4.3 All items directly related to the cooling system, such as: Fan speed, fan belt adjustment, fan to core spacing, baffling, coolant and other fluid levels, radiator pressure cap ratings, etc., are properly adjusted and the core is clean inside and out, and the fins are straight and in good condition.
 - 5.4.4 Test apparatus is installed and checked for proper function.
- 5.5 Block the thermostat(s) open to assure full water flow throughout the test.
- 5.6 Install temperature measuring equipment in radiator top tank or engine coolant out line.
- 5.7 Shade thermometers and thermocouples from sun or other sources of non-pertinent radiated heat.

- 5.8 Operate machine under steady load and speed conditions, which must be proper for any converter in the driveline. Record data in two opposing directions of the course with readings at the same point on the test sections being taken at intervals of at least 15 min. Continue operating and recording data until stabilization of the cooling system is achieved. Stabilization shall be considered achieved when the variation in ΔT between two consecutive laps is within 1°C (2°F), or as specified in any one direction of travel and within 2°C (4°F), or as specified for opposing directions.
- 5.9 The coolant must not boil during the test.
- 5.10 The interpolation of system performance at different ambients may be made on the basis a degree change in ambient will cause a degree change in coolant temperature, under conditions of paragraphs 5.2 and 5.3.
- 5.11 (Optional): Additional test information for the analysis of the cooling system may be obtained by measuring the following:
- 5.11.1 Radiator bottom tank temperature.
 - 5.11.2 Average temperature of air entering the radiator.
 - 5.11.3 Average temperature of air leaving the radiator.
 - 5.11.4 Engine air intake temperature.
 - 5.11.5 Air flow rate through radiator.
 - 5.11.6 Coolant flow rate.
 - 5.11.7 De-aeration ability of the cooling system.
 - 5.11.8 Top tank pressure.
 - 5.11.9 Engine oil temperature.
 - 5.11.10 Engine compartment temperature.

6. REPORTING OF RESULTS:

- 6.1 Air-to-Boil Temperature: Subtract top tank or engine coolant out line temperature from theoretical coolant boiling temperature (corrected for any pressurization) and then add the result to actual ambient temperature recorded during test.

(Example: $ATB = (100 - 80) + 30 = 50$ where 100 is theoretical coolant boiling temperature, 80 is top tank temperature, and 30 is ambient temperature. All temperatures are degrees Centigrade.)

- 6.2 (Optional) Percent Engine Power Utilization: Rate of fuel used during test divided by rate of fuel consumed if engine were operated at maximum rated power.

ENGINE COOLING TEST SUMMARY

GENERAL DATA

OBSERVERS _____ TESTING AGENCY _____
 ALTITUDE FEET _____ HOUR METER READING _____
 MACHINE MAKE _____ MODEL _____ SERIAL NO. _____
 ENGINE MAKE AND HP _____ MODEL _____ SERIAL NO. _____
 TRANSMISSION MAKE _____ MODEL _____ SERIAL NO. _____
 CONVERTER MAKE _____ MODEL _____ SERIAL NO. _____
 RADIATOR MAKE _____ MODEL _____ PART NO. _____
 RADIATOR PRESSURE CAP RATING _____
 FAN SIZE _____ NO. BLADES _____ PART NO. _____
 FAN PULLEY RATIO _____ TYPE _____ ANGLE _____
 AVERAGE WIND VELOCITY AND DIRECTION _____ COOLANT _____
 TRUE BAROMETER PRESSURE _____ HUMIDITY _____
 TEST TRACK DESCRIPTION _____ LOCATION _____
 TOTAL GEAR REDUCTION _____ OPERATING GEAR _____
 TYPE FUEL USED _____ SPECIFIC GRAVITY _____
 COOLANT _____

NOTE ANY AIR FLOW OBSTRUCTION OR UNUSUAL CONDITIONS.
 DESCRIPTION OF TEST: NATURE AND VALUES OF MACHINE LOAD, AND SO FORTH.

TEST RESULTS

TEST NO.	1	2	3	4	5	6	7	8	9	10
DIRECTION										
TIME										
TERMOCOUPLE POSITION										
(1) TOP TANK										
(2) AMBIENT AIR										
(3)										
(4)										
(5)										
(6)										
(7)										
(8)										
(9)										
(10)										
Δ T TEMPERATURE DIFFERENCE										
MACHINE SPEED										
ENGINE RPM										
OUTPUT SHAFT SPEED										
AIR-TO-BOIL _____ °C _____ °F										
POWER LEVEL _____ PERCENT										
REMARKS										
DATE _____ 19 _____ SIGNED _____										

FIG. 1 - TEST DATA SUMMARY SHEET

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J819 MAR87

RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

Not applicable.

APPLICATION:

This code applies to all self-propelled construction and industrial machines using liquid-cooled internal combustion engines.

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