



SURFACE VEHICLE RECOMMENDED PRACTICE

J1393™

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Heavy-Duty Vehicle Cooling Test Procedures

RATIONALE

Updated for content and clarity during Five-Year Review.

1. SCOPE

The purpose of this SAE Recommended Practice is to establish a testing procedure to determine the performance capability of heavy-duty vehicle cooling systems to meet Original Equipment Manufacturer or end user thermal specifications to ensure long term reliable vehicle operations. The recommendations from the present document are intended for heavy-duty vehicles including, but not limited to, on- and off-highway trucks, buses, cranes, drill rigs, construction, forestry, and agricultural machines.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J631	Radiator Nomenclature
SAE J814	Coolants for Internal Combustion Engines
SAE J1004	Glossary of Engine Cooling System Terms
SAE J1468	Oil Cooler Application Testing and Nomenclature
SAE J1726	Charge Air Cooler Internal Cleanliness, Leakage, and Nomenclature
SAE J2914	Exhaust Gas Recirculation (EGR) Cooler Nomenclature and Application

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https://www.sae.org/standards/content/J1393_202302/

Documents

Document Sharing Hub

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 7464 Earth-moving machinery - Method of test for the measurement of drawbar pull

3. DEFINITIONS

3.1 VEHICLE COOLING SYSTEM

A vehicle cooling system can consist of several heat exchangers, pumps, valves, fans, and other pertinent components. It is designed to dissipate heat generated by the operation of the powertrain to the ambient environment to ensure safe and reliable vehicle operations.

3.2 AMBIENT AIR TEMPERATURE

For lab conditions, the ambient air temperature should be measured at a specified distance, at least 2 m away from the vehicle being tested, in front of the cooling system inlet grille or screens and reported. For field conditions, the ambient air temperature should be measured near the test vehicle and its location relative to the test vehicle should be recorded.

3.3 EOTD - ENGINE OUTLET TEMPERATURE DIFFERENTIAL

The difference between the coolant temperature at the engine outlet and the ambient air temperature.

3.4 Terms Used by the Industry Related to EOTD

3.4.1 AIR-TO-BOIL (ATB)

The ambient air temperature (°C) at which the engine coolant at the radiator inlet reaches its boiling point. The coolant boiling point is a function of the absolute pressure and the characteristics of the coolant. However, this term is also commonly used without consideration for the absolute pressure or the coolant characteristics. In the case of an open radiator at sea level pressure with water as coolant, a boiling point of 100 °C is assumed.

3.4.1.1 $ATB = 100\text{ °C} - \text{engine coolant outlet temperature} + \text{ambient air temperature}.$

3.4.2 LIMITING AMBIENT TEMPERATURE (LAT)

The ambient air temperature at which the engine coolant outlet temperature reaches the maximum allowable temperature.

3.4.2.1 $LAT = \text{Maximum engine coolant outlet temperature} - \text{engine coolant outlet temperature} + \text{ambient air temperature}.$

3.4.3 AMBIENT CAPABILITY

Similar to LAT (3.4.2) but refers to an ambient air temperature at which any of the fluids being cooled exceeds its design temperature limit under a specified operating cycle.

3.4.4 AIR-TO-REDLINE (ATR)

The ambient air temperature at which the engine coolant outlet temperature reaches the coolant overheat warning temperature.

3.4.4.1 ATR = Coolant overheat activation temperature – engine coolant outlet temperature + ambient air temperature.

3.4.5 AMBIENT DESIGN TEMPERATURES (ADT)

The ambient air temperature at which each fluid being cooled in the cooling system reaches its design temperature limit under specific operating conditions related to the equipment's application.

3.4.5.1 ADT = Fluid design temperature limit – max fluid temperature in system + ambient air temperature.

3.4.6 TOP TANK TEMPERATURE DIFFERENTIAL (TTTD, also known as Top Tank Differential, TTD)

The difference between the coolant temperature at the radiator top tank and ambient air temperature. For a cross flow radiator, this would be the difference between the radiator inlet temperature and ambient air temperature.

3.4.7 AIR-TO-WATER (ATW)

The temperature differential between ambient air and engine outlet. The terminology assumes water as the coolant.

3.4.8 INTAKE MANIFOLD TEMPERATURE DIFFERENTIAL (IMTD)

The difference between the temperatures of the air in the intake manifold inlet and the ambient air. For applications with EGR, the intake manifold temperature may be specified before or after the EGR mix location.

3.4.9 CHARGE AIR COOLER (CAC) OUTLET TO AMBIENT

The difference between the CAC outlet temperature and the ambient air temperature.

3.4.10 INSTALLED CHARGE AIR COOLING SYSTEM EFFECTIVENESS

The effectiveness of the CAC system using the temperatures at the turbocharger outlet and intake manifold inlet rather than the temperatures at the CAC inlet and CAC outlet. See 3.4.10.1.

3.4.10.1 CAC System Effectiveness = (Turbocharger outlet temperature – Intake manifold temperature)/(Turbocharger outlet temperature - Ambient air temperature)

4. HEAVY-DUTY VEHICLE COOLING SYSTEM DESCRIPTION

One example of heavy-duty vehicle cooling systems is found in Figure 1. The key components may include low temperature radiators, high temperature radiators, fan assembly, pumps, CAC, surge tank, thermostat and other similar components depending on vehicles' specific requirements. The system as shown in Figure 1 comprises an engine cooling loop that circulates coolant through a high temperature radiator to dissipate heat generated in the engine, and a charge air cooling loop that circulates coolant first through a low temperature radiator and then through a coolant-to-air exchanger to cool pressurized air from the turbocharger before entering the engine combustion chamber.

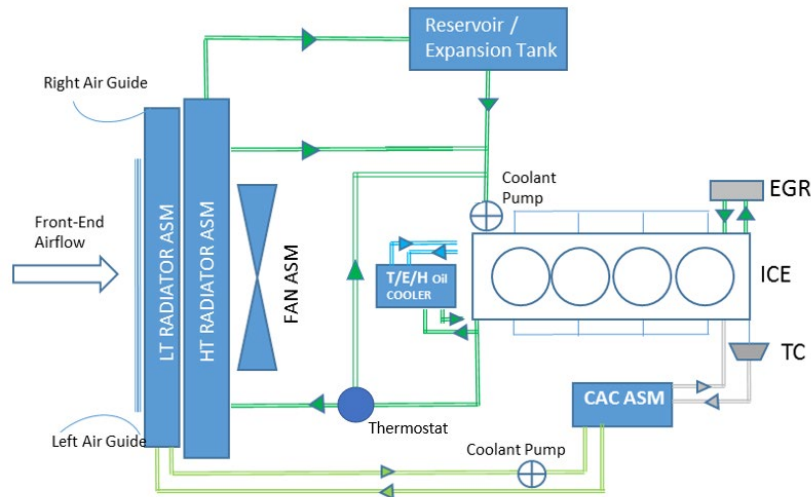


Figure 1 - Vehicle cooling system (T/E/H stands for transmission, engine, hydraulic)

4.1 Engine Cooling Module

An engine cooling module assembly is a subassembly of the vehicle cooling system designed for rapid installation in vehicle or equipment. Common heat exchangers found in cooling module assemblies include radiators, Charge Air Coolers (CACs), air conditioning condensers and transmission oil coolers. Other common cooling module assembly components include surge tanks, air shields, fan shrouds, mounting structure, hoses, and clamps. The modules are typically installed in the front or rear of vehicles and in a number of equipment orientations.

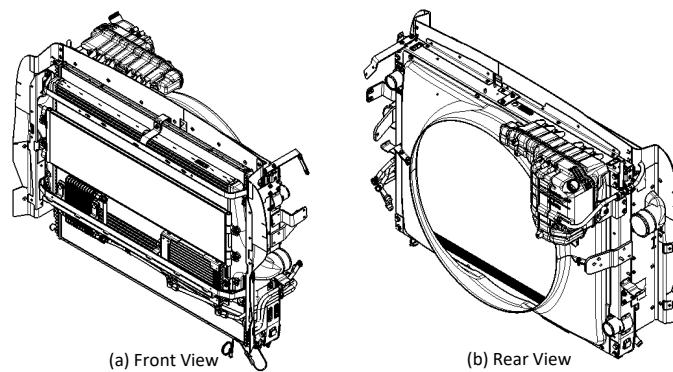


Figure 2 - Engine cooling module