



SURFACE VEHICLE INFORMATION REPORT

J3136™

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Low-Temperature Coolant Circuit Nomenclature and Applications

RATIONALE

SAE J3136 is the result of a Five-Year Review and update of the specification.

1. SCOPE

The document provides clarity related to multiple temperature coolant circuits used with on-highway and off-highway, gasoline, and light-duty to heavy-duty diesel engine cooling systems, or hybrid vehicle systems. These multiple temperature systems include engine jacket coolant plus at least one lower temperature system.

Out of scope are the low temperature systems used in electric vehicles. This subject is covered in SAE J3073. Note that some content in SAE J3073 is likely to be of interest for hybrid vehicles.

Out of scope are the terms and definitions of thermal flow control valves used in either low-temperature or high-temperature coolant circuits. This subject is covered in SAE J3142.

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 J3073 Battery Thermal Management

SAE J3142 Thermal Flow Control Valve Nomenclature and Application

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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 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 J1004 Glossary of Engine Cooling System Terms

SAE J2914 Exhaust Gas Recirculation (EGR) Cooler Nomenclature and Application

3. COOLANT CIRCUITS NOMENCLATURE

3.1 Temperature Regulation

Engines have used coolant circuits with pressure-forced coolant flow by a pump since ebullient cooling was abandoned. For many years, a single circuit was required to cool the cylinder liners, heads, and lube oil cooler, all with a desired temperature inside the engine. They were, and still are, called jacket water circuits since that was their primary purpose. When single circuit systems are used for engine jacket water cooling, these are always higher temperature circuits, with typical cylinder jacket and head temperatures in the range of 85 to 90 °C, regulated by a thermostat. Coolant temperatures above this range:

- Increase the risk of boiling at the top land of the liner and head flame deck;
- Reduce those components' material strength; and
- Increase exhaust temperatures, putting components and emissions at risk.

Colder temperatures, in a condition called overcooling:

- Cool the liner wall, and increase the risk of incomplete combustion of fuel on the wall (fuel dilution of the oil);
- Result in white smoke and/or other cold engine exhaust emissions due to incomplete combustion;
- Build up carbon behind piston rings and top land of piston;
- Overcool cylinder head exhaust port walls, with increased risk of carbon deposits on exhaust valve seat and stems; and
- Overcool the lube oil, increasing parasitic power loss.

Later engine developments added charge air coolers, fuel injectors, fuel coolers, engine control modules, turbochargers, and exhaust manifolds and were cooled by the same high-temperature coolant at available temperatures. The two major shifts over time that required a cooler temperature than the jacket water circuit were:

- a. Emissions reductions with combustion recipes that required colder intake manifold air temperatures than the existing circuit; and
- b. Electronic and electrical components (largely associated with hybrid propulsion systems), both with temperature requirements below those available in the existing circuit.

There are many system circuit designs and combinations of components capable of accomplishing the task of a second **LT** circuit. This document is intended to present them in an organized manner. It seems prudent to first define terms and provide some background on temperature regulation, whether in a low- or high-temperature (**HT**) coolant circuit, independent of the heat source or mechanism of controlling temperature. Mechanisms for controlling temperature would include wax pellet thermostats, electrically controlled flow control valves, or variable speed fan drives.

Outlet regulation is defined (illustrated in Figure 1) as controlling the temperature out of the engine or LT circuit heat source(s). The temperature-sensing element of the valve below (symbolized by a red triangle) is located at the outlet of the heat source, or radiator inlet, and some, or all, of the flow is bypassed back to the heat source inlet when the temperature is below the set point temperature of the valve. The orientation of the valve is controlling the split of one inlet flow at a desired temperature to two outlet flow streams.

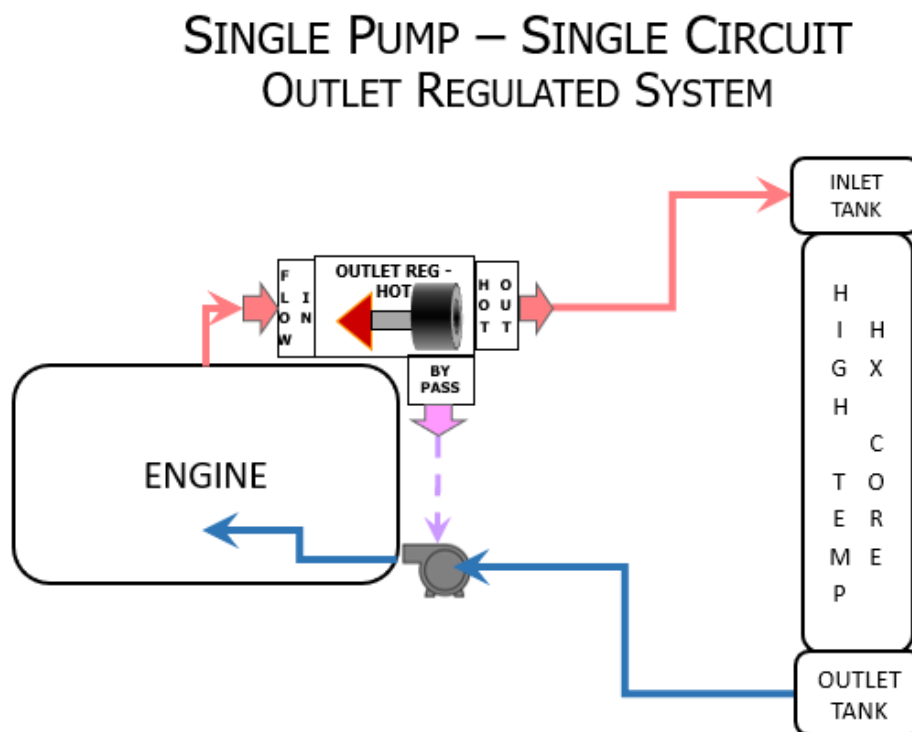


Figure 1 - Outlet temperature regulation

3.1.2 Inlet Regulation

Inlet regulation is defined (illustrated in Figure 2) as controlling the temperature into the engine or **LT** circuit sources. The control valve is placed in this location and oriented such that the temperature-sensing element is in the flow stream entering the heat source. The inlet temperature is the mixed temperature of both the heat source and radiator. The valve allows flow to pass through the radiator when the sensed temperature is above the set point. The valve is oriented to control the split of two inlet flow streams to reach a desired temperature at the single outlet.

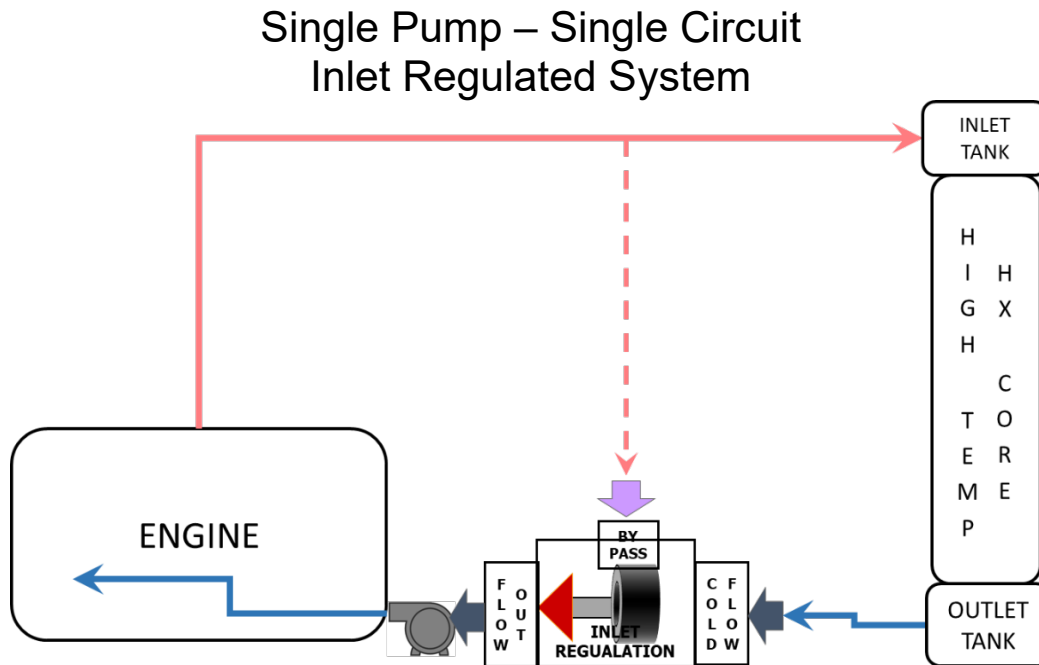


Figure 2 - Inlet temperature regulation

3.1.3 Electronic Regulation

3.1.3.1 Electrically Actuated Flow Control Valve Temperature Control

Either of the above schematics could utilize electrically actuated flow control valves instead of a wax pellet actuated valve. In an outlet regulation configuration, the position of the valve would again split a single inlet flow into two outlet flows. While the valve can be located anywhere between the engine outlet and radiator inlet, the key feature is locating the temperature sensor at the engine outlet and using that signal to control the position of the valve with an electronic control module.

In an inlet regulation configuration, the valve would control (or mix) two inlet flows into a single outlet flow. Again, the key feature is the location of the temperature sensor at the engine inlet. Sensor locations are illustrated in Figure 3.

3.1.3.2 Fan Speed Temperature Control

Figure 3 illustrates two scenarios of either inlet or outlet temperature regulation. Both scenarios assume that a variable speed fan drive is used, and the fan drive is the temperature-regulating mechanism without the presence of any flow control valve. A second point made here is that temperature regulation can be accomplished with electronic sensing and control, independent of whether the fan drive is a clutch, hydraulic motor, or electric motor.