

5.1.1.1.1.1 Engine Cooling

The engine shall be cooled by a water-based, pressure type, cooling system that does not permit boiling or coolant loss during the operations described above. Engine thermostats shall be easily accessible for replacement. Shutoff valves shall allow filter replacement without coolant loss. Valves shall permit complete shutoff of lines for the heating and defroster units, and water booster pumps. The water boost pump shall be a long life brushless design. All low points in the water-based cooling system shall be equipped with drain cocks. Air vent valves shall be fitted at high points in the cooling system unless it can be demonstrated that the system is self-purging.

EMP electric fan cooling system is required. Electric fans shall be brushless, variable speed, reversible and have a corrosion resistant metal shroud with finger guards. The fans should provide electronic feedback control and have diagnostics capability through the standard SAE J1939 diagnostics port. The cooling system shall consist of multiple electric DC brushless pusher type variable speed fans with electronic feedback controls. Electric fan motor speeds shall have a minimum operating range of 0-5500 rpm with capability of manual or automatic reverse operation in order to assist in debris removal. The cooling system shall be equipped with a master controller with the following capabilities; automatically reduce fan speed when the vehicle stops to minimize noise at the curbside, communicate on the J1939 CAN data link with system diagnostic reporting via DM1 messaging, review and download data via a laptop with service tool software, capable of software and calibration up-dates, receive commands from the engine or transmission ECM, report fault codes by lighting a engine compartment LED flashing light, sense engine compartment temperature and activate fans if maximum temperature is exceeded, collect and store cooling system and vehicle performance histogram data. If fans lose communication with the engine or sensors they shall go into a default speed mode to avoid vehicle shutdown. This communication shall use the industry standard RP1210 compliant datalink adapters connected via the standard 9-pin diagnostic connector found in the engine compartment and interior of the bus. Independent diagnostic detection shall be capable of identifying specifically which fan, measured input parameter, or datalink input parameter is experiencing a fault condition. Report both active and previously active fault codes with the number of detections/occurrences, time of the first and most recent fault detection, and cumulative time the fault was active. Where electric fans are used for cooling there shall be ample field experience. As a minimum, 50 electric fan based cooling systems shall be in transit revenue generating operation for at least 2 years.

A sight glass to determine satisfactory engine coolant level shall be provided and shall be accessible by opening one of the engine compartment's access doors. A spring-loaded, push button type valve to safely release pressure or vacuum in the cooling system shall be

provided with both it and the water filler no more than 60 inches above the ground and both shall be accessible through the same access door.

The radiator, and charge air cooler if integrated, shall be of durable corrosion-resistant construction. Radiators with copper/brass construction shall be fitted with bolted-on removable tanks. Brazed aluminum radiators shall have welded cast tanks. Automotive crimped-on tanks are more susceptible to leaks and early failure, and shall not be used. The radiator shall be designed so a mechanic can gain access to a substantial portion of the side facing the engine for the purpose of cleaning the radiator in five minutes or less.

Radiators shall have a fin density 10 fins per inch or less and shall not have louvered/slit designs. These are more susceptible to clogging and deteriorating cooling performance over time and shall not be used. Radiators shall utilize a bar and plate design so they are robust and can be cleaned with high pressure spray wash.

For certain severe environments, a secondary cooler may be used to increase the ambient temperature capacity for a cooling system. The secondary cooler shall be remote mounted, but below the coolant surge tank. Air flow should be provided with brushless electric fans. If an application requires a boost pump to maintain coolant flow to the secondary cooler, a brushless electric water pump shall be used.

Radiator piping shall meet the requirements of Section 5.2.2.2.4. No heat producing components or climate control system components shall be mounted between the engine cooling air intake aperture and the radiator.

The radiator and charge air cooler shall be designed to withstand thermal fatigue and vibration associated with the installed configuration.

θ Baseline: Standard requirement for coolant filtration.

The engine cooling system shall be equipped with a properly sized water filter with a spin-on element and an automatic system for releasing supplemental coolant additives as needed to replenish and maintain protection properties.

θ Alternative: Delete the requirement for coolant filtration.

The water filter and its plumbing shall not be provided.

θ Baseline: Standard requirements for cooling fan operation.

The cooling fans shall be temperature controlled, allowing the engine to reach operating temperature quickly. The temperature-controlled fans shall not be driven when the coolant temperature falls below the minimum level recommended by the engine manufacturer. **Electric fans should provide independent control of the engine coolant and charge-air temperatures.**

θ Alternative: Fixed fan operation.

Not allowed

5.1.1.1.2 Charge Air Cooling

The charge air cooling system, also referred to as after-coolers or inter-coolers, shall provide maximum air intake temperature reduction with minimal pressure loss. The charge air radiator shall be sized and positioned to meet engine manufacturer's requirements. The charge air radiator shall not be stacked ahead or behind the engine radiator and shall be positioned as close to the engine as possible unless integrated with the radiator. Air ducting and fittings shall be protected against heat sources, and shall be configured to minimize restrictions and maintain sealing integrity.

Engine and Charge Air Cooler Cooling System - Electric

The cooling systems shall be of sufficient size to maintain all engine and transmission fluids and engine intake air at safe, continuous operating temperatures during the most severe operations possible and in accordance with engine and transmission manufacturers cooling system requirements. The cooling system fan controls should independently sense the temperatures of the operating fluids and intake air and if either is above safe operating conditions the cooling fans should be engaged. The fan control system shall be designed with a fail safe mode of "fan on". The cooling system in new condition shall have an ambient capacity with vehicle at max. GVW of at least 115°F at Peak Power and 120°F at Peak Torque using a 50-50 mix of ethylene glycol/water at sea level operation. Vehicle might require the following recirculation control features; vented curbside door, vented rear door and/or radiator skirt.