6.3.3 Cooling System—Provide a closed circulating cooling system. ~~with an engine-driven centrifugal water pump.~~ An engine-driven centrifugal water pump, original coolant heat exchanger, original cooling tower, and coolant pump bypass valve may be used. When using these components, follow the specifications outlined in 6.3.3.1 and 6.3.3.2. An equivalent replacement system that could include an electrically-driven pump, replacement heat exchanger, replacement coolant tower, and automated flow control may be used. A suitable electric-motor-driven water pump from MP Pumps is recommended by Caterpillar. Pump details are as follows: MP Part number: 30885, CF1PMP SS 3-3 56C 6.0 T-2100, stainless steel pump, 3hp e phase; 230/460 VAC motor. An equivalent replacement system must meet all steady-state test temperature and pressure specifications (coolant outlet temperature: 93°C ±2.5°C; coolant delta temperature: 5°C ± 1°C; coolant inlet temperature: 88°C; coolant flow: 65 L/min ± 2 L/min; pressure drop across heat exchanger: 1.5 kPa maximum; coolant at jug pressure: 50 kPa). The equivalent replacement system must match engine-driven pump performance; to include engine startup, warmup, on-test conditions, cooldown, hot shutdowns, and programmed shutdowns. System details given in Fig. A8.1 show cooling system modifications; Fig. A8.2 shows coolant temperature, flow, and pressure measurement locations; ~~and~~ Fig. A8.3 shows a water pump bypass arrangement; and Fig. A8.4 shows the pressurized coolant system. See 6.3.3.5 regarding system cleaning.

6.3.3.1 Cooling System Modification—Modify the cooling system as shown in Fig. A8.4.

6.3.3.2 Coolant Flow, Control and Measurement—Modify the engine coolant lines from the cylinder head to the standpipe in accordance with Fig. A8.1. As shown, the coolant line contains (*1*) a calibrated Barco flowmeter, P/N BR 12705-16-31[11,12], 25.4 mm in diameter to measure the coolant flow and (*2*) a P/N 1Y496 orifice, 15.797 mm in diameter before the flowmeter to develop cooling system pressure and thereby to eliminate coolant cavitation. A system using original components must control coolant flow at 65 L/min ± 2.0 L/min at Step 5 (see Table A14.1) by a bypass valve downstream of the water pump, 19 mm in diameter. Replace the production hose and the restrictive 90° elbows that connect the bypass valve to the cylinder block by a Gates 20777 hose[13,12] or equivalent (see Fig. A8.3). An equivalent replacement system may omit the use of a bypass valve to control coolant flow. Measure the coolant pressure at the block to ensure that proper cooling system operation has been attained (see Fig. A8.2).

6.3.3.3 Engine Temperature Differential—As an indicator of coolant system performance, maintain the engine temperature differential (ΔT) (coolant temperature out of the cylinder head minus coolant temperature into the block) at 5.0 °C ± 1.0 °C. Also control the coolant temperature out at 93 °C ± 2.5 °C.

6.3.3.4 Engine Coolant—The engine coolant is a mixture of 50/50 volume ratio of coolant (Caterpillar brand P/N 8C3684 in a 3.8 L container or P/N 8C3686 in a 200 L drum)[14,12] to mineral-free water, the mineral content being ≤34.2 mg/kg of total solids in water. This coolant mixture may be used for up to six tests or three months, whichever comes first. Maintain the mixture at a 50/50 ratio of coolant to water and verify periodically with either a Caterpillar tester P/N 5P3514 or P/N 590957 or equivalent commercial tester. Keep the coolant mixture substantially free from solids contamination (total solids <5000 mg/kg) and at the correct additive level by checking with test kit P/N 8T5296.

6.3.3.5 Cooling System Cleaning Procedure, General—Clean the system when visual inspection shows the presence of (*1*) oil or grease (see 6.3.3.6), (*2*) mineral deposits or rust, or both (see 6.3.3.7). *When the cooling system is contaminated by both oil and scale, first remove the oil, then remove the scale*. Cylinder head coolant passages also may be cleaned after the head is removed.

(11) The sole source of supply of the Barco flowmeter (Venturi Meter) known to the committee at this time is P/N No. BR12705-16-31 from Aeroquip Co., Maddock Mechanical Industries, 833 N. Orleans, Chicago, IL 60610.

(12) If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

(13) The sole source of supply of the Gates hose known to the committee at this time is P/N 20777, available from The Gates Rubber Co., 900 S. Broadway, Denver, CO 80217-5887.

(14) The sole source of supply of the antifreeze known to the committee at this time is Caterpillar Brand, P/N 8C3684 (1-gal) or P/N 8C3686 (55 gal drum), from Caterpillar Inc., P.O. Box 610, Mossville, Il 61552-0610.

A8 | COOLING SYSTEM DETAILS

A8.1 See Figs. A8.1-A8.4.

FIG. A8.1 Piping Arrangement and Instrument Locations

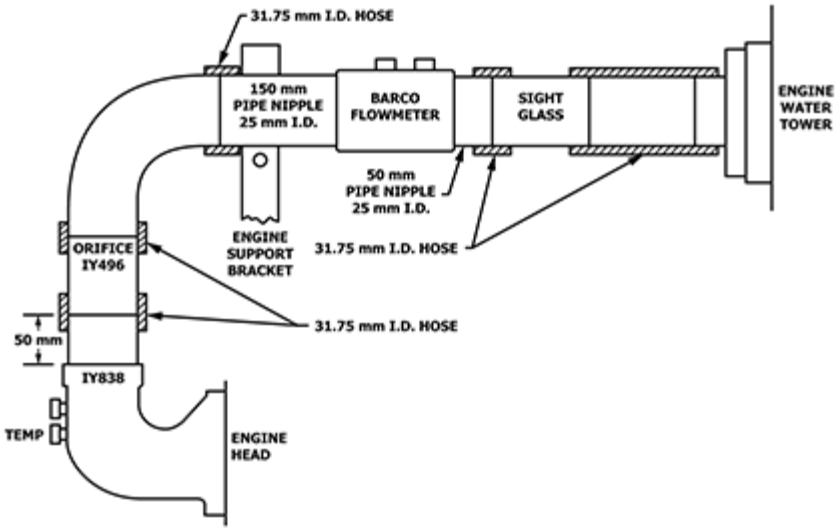


FIG. A8.2 Block Coolant Pressure Tap Location

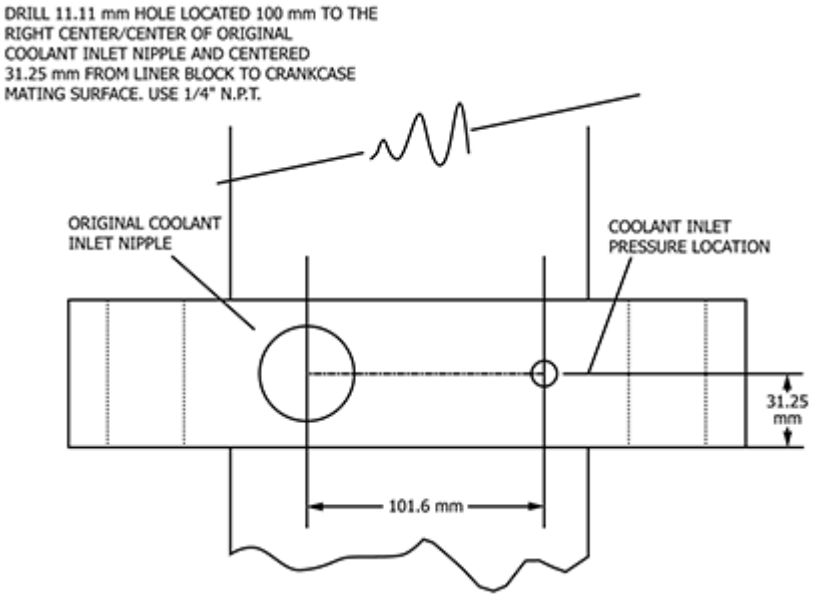
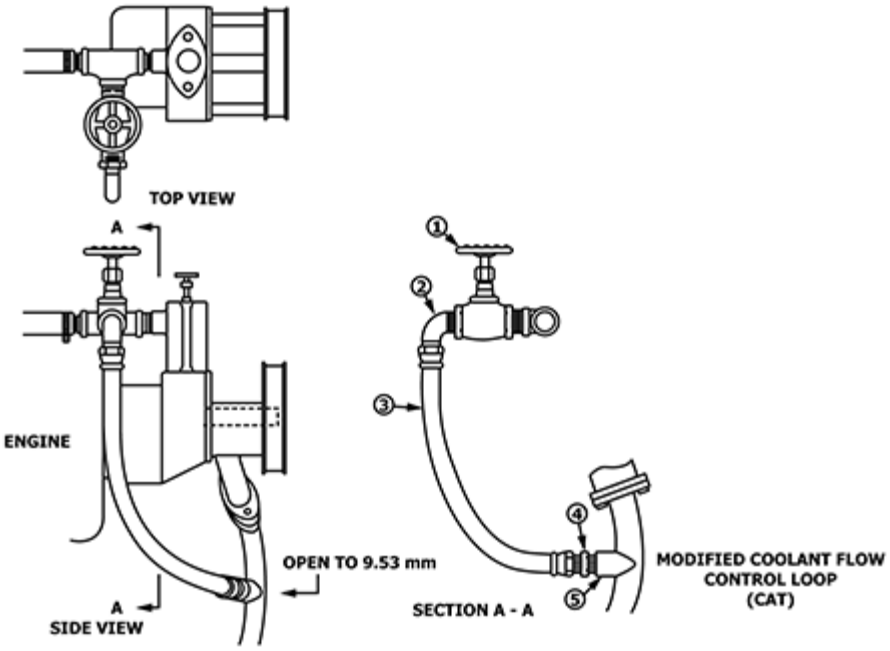


FIG. A8.3 Water Pump Bypass Arrangement



NOTE 1: 19.1 mm valve.

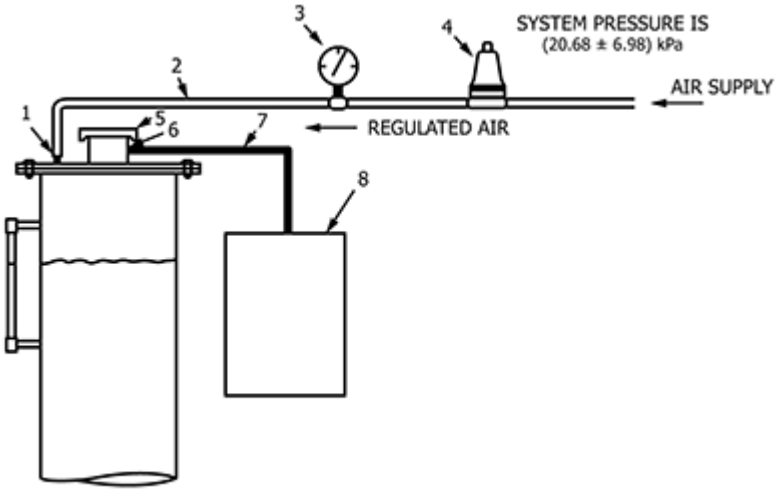
NOTE 2: 90° elbow $^{3}/_{4}$ in. MNPT - TO No. 10AN.

NOTE 3: No. 10 hose with swivels.

NOTE 4: Connector $^{3}/_{8}$ in. MNPT - TO No. 10AN. Drill to 11.1 mm inside diameter.

NOTE 5: Modify existing boss on the water pump intake. Drill and tap to $^{3}/_{8}$ in. NPT.

FIG. A8.4 Cooling System Modification



Pressurized Coolant System

NOTE 1: Legend:
1. 1/4 in. NPT-to No. 4AN (male connector)
2. No. 4 hose
3. Pressure gage 0 to 103 kPa
4. Pressure regulator (self bleeding)
5. Radiator cap 103 to 110 kPa
6. Radiator filler neck
7. Overflow tube
8. Overflow tank

NOTE 2: If the system builds to greater than regulator setting, then condensate will back-flow through regulator.