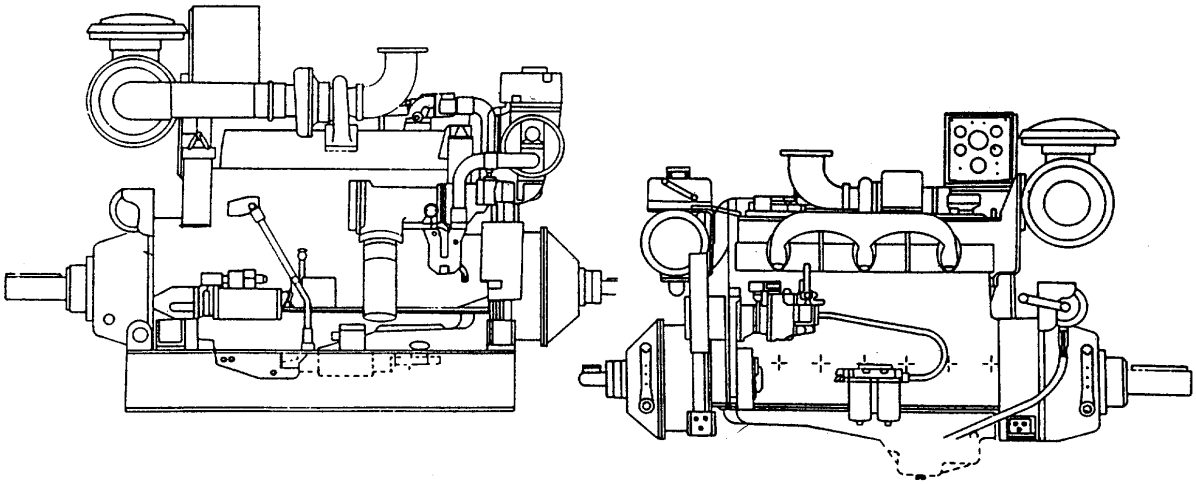
**TECHNICAL MANUAL**

**UNIT, INTERMEDIATE DIRECT SUPPORT**

**AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS**

**BOWTHRUSTER ENGINE FOR LANDING CRAFT UTILITY (LCU) NSN 1905-01-154-1191**





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**HEADQUARTERS, DEPARTMENT OF THE ARMY**
**17 JANUARY 1989**

TECHNICAL MANUAL

No.55-1905-223-24-5

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 17 January 1989

# UNIT, INTERMEDIATE DIRECT SUPPORT, AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

BOWTHRUSTER ENGINE
For
LANDING CRAFT UTILITY (LCU)
NSN 1905-01-154-1191

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter -or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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# CHAPTER 1

# INTRODUCTION



## SECTION I. GENERAL INFORMATION

1-1. Scope. The scope of this manual is as follows:

a. Type of Manual. Unit, intermediate direct support, and intermediate general support maintenance manual.

b. Model Number and Equipment Name. Bowthruster Engine, Model NT855-M.

c. Purpose of Equipment. Provides drive power to the bowthruster waterjet unit to maneuver the craft and provides power to the auxiliary fire pump.

1-2. Maintenance Forms, Records, and Reports. Department of the Army forms and procedures used for equipment maintenance are those prescribed by DA Pam 738-750, The Army Maintenance Management System.

1-3. Destruction of Material. Refer to TM 750-244-3 for instructions covering the destruction of Army materiel to prevent enemy use.

1-4. Reporting Equipment Improvement Recommendations (EIR). If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to: Commander, U.S. Army Troop Support Command; ATMN: AMSTR-MOF; 4300 Goodfellow Blvd.; St. Louis, Missouri 63120-1798. We'll send you a reply.

1-5. Preparation for Storage or Shipment. Administrative storage of equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the Preventive Maintenance Checks and Services (PMCS) charts before storing. When removing the equipment from administrative storage, the PMCS should be performed to assure operational readiness. Repacking of equipment for shipment or short term storage is covered in paragraph 245.

## SECTION II. EQUIPMENT DESCRIPTION AND DATA

1-6. General Description. The NT855-M is a 300 hp, 6 cylinder, water cooled diesel engine designed for marine use. This engine will furnish drive power to the bowtruster waterjet unit and to the number three fire pump.

1-7. Characteristics, Capabilities, and Features. A very broad view of the bowthruster engine is as follows:

a. Characteristics.

(1) Turbocharger allows more horsepower to be developed

(2) Fuel injectors deliver atomized fuel into the combustion chambers for ignition by heat of compressed air.

(3) Cooling is supplied by: coolant for engine operation heat; a lube oil cooler, which gives off heat to engine coolant; and an aftercooler, which cools (or warms) air before it reaches the turbocharger.

b. Capabilities and Features.

(1) Furnishes 300 hp to drive the waterjet.

(2) Has power takeoff clutch assemblies on each end to drive the waterjet and the auxiliary fire pump.

(3) Has both remote and local control station.

1-8. Location and Description of Major Components. FIGURE 1-1 shows views of each side of the engine with the locations of major components indicated. Refer to FIGURE 1-1 and the reference number key below for the description of these components.

a. Instrument Panel (1) An electrical panel on top of the engine that contains the local display of operational gauges and the switches for local control of the engine.

b. Air Cleaner (2). The filter canister and cover assembly located on the top, rear of the engine.

c. Intake Manifold (3). The intake air distribution piping (assembly) on the left side of the engine.

d. Sump Pump (4). The manually operated oil pump located on the left rear of the engine.

e. Fuel Filters (5). Two spin-on filters located together on the lower left side of the engine.

f. Lube Oil Pump (6). A gear driven pump located on the left front comer of the engine.

g. Fuel Pump (7). A PT (type G) pump and throttle assembly with a 24 volt shutoff valve, located on the left front of the engine.

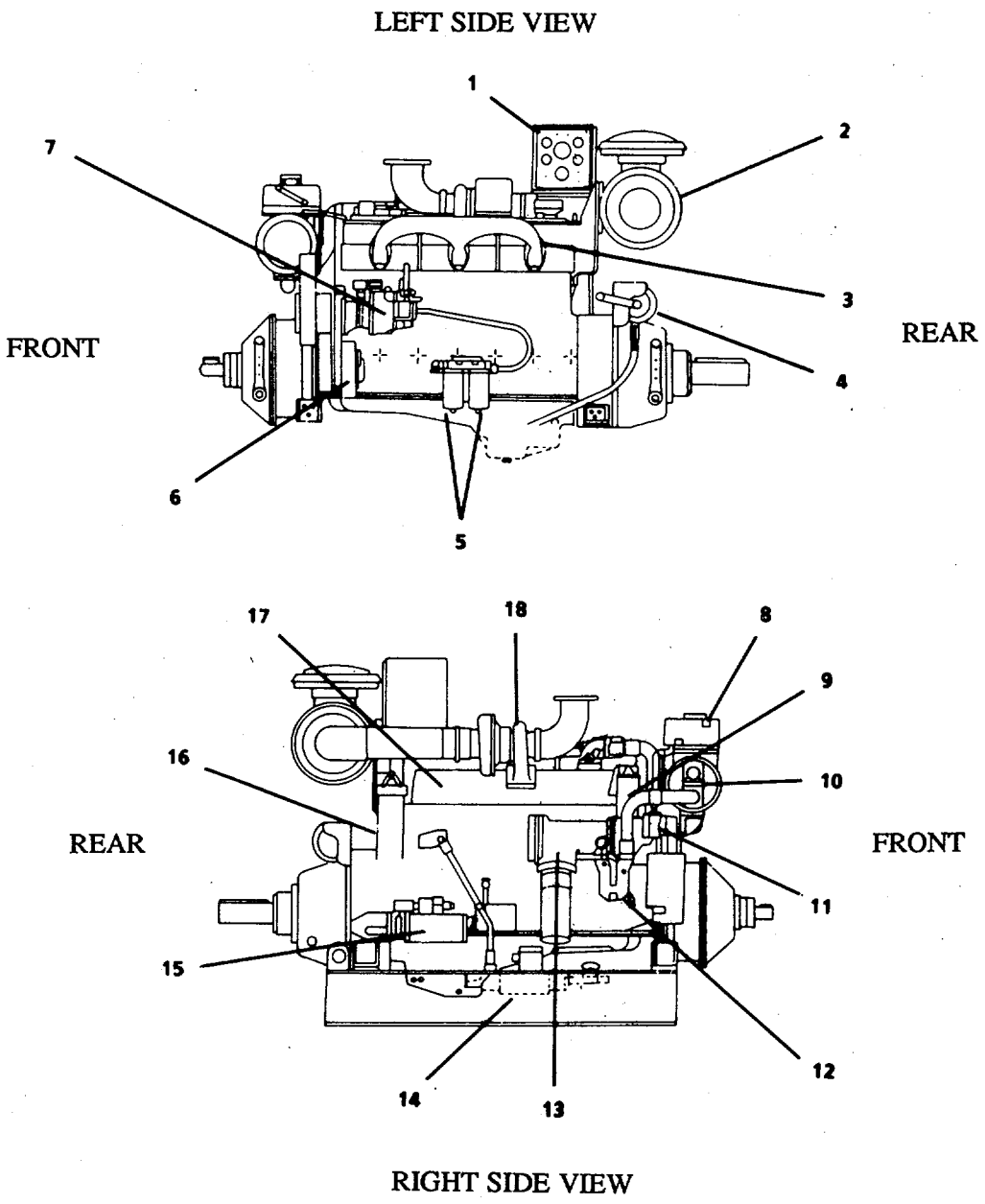


*FIGURE 1-1. Location of Major Components*

h. ExpansionTank(8). The fresh watertank with pressure cap and sight glass located on the top, front of the engine above the heat exchanger.

i. Water Filter (9). A spin-on filter located on the right side near the front of the engine.

j. Heat Exchanger (10). The horizontal, cylindrical tank assembly located on the front of the engine beneath the expansion tank

k. Fresh Water Pump (11). The belt driven pump located on the right front of the engine.

l. Seawater Pump (12). The U-shaped pump assembly on the right side of the engine connected to the heat exchanger seawater inlet piping.

m. Tube Oil Filter/Cooler (13). The spin-on filter and cooling core assembly located on the right side near the front of the engine.

n. Coolant Heater (14). The electric water jacket heater located at the right side of the oil pan.

o. Starter Motor (15). An electric motor, solenoid, and magnetic switch assembly on the right rear comer of the engine. The battery cables are connected to the starter.

p. Bypass Oil Filter (16). A spin-on filter located on the right rear comer near the top of the engine.

q. Exhaust Manifold (17). The water cooled exhaust air assembly on the right side of the engine. The turbocharger is mounted on this manifold.

r. Turbocharger (18). A turbine wheel unit mounted on the exhaust manifold on the right side of the engine.

s. Electrical System. Consists of the batteries, starter and solenoid, and instrument panel Batteries are located remote from the engine assembly. For maintenance information on batteries, refer to TM 55-1905-223-24-1.

1-9. Engine Identification Data. For model identification of an engine, check the data or serial number plate. The following example shows how the engine is identified.

NT 855-M
N = Model Identification
T = Turbocharged
855 = Cubic Inch Displacement
M = Marine Application

a. Engine Dataplate. The engine dataplate (FIGURE 1-2) shows specific information about your engine. The engine serial number and the Control Parts List (CPL) provide information for ordering parts and service needs.

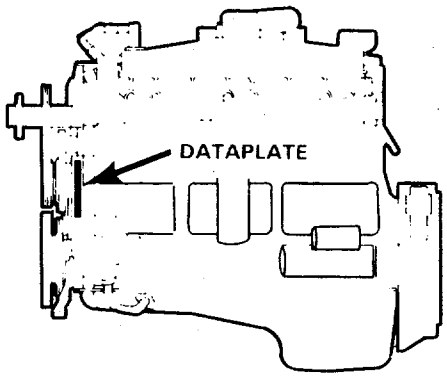


*FIGURE 1-2. Engine Dataplate Location.*

b. Serial Number and Control Parts List. Always record the serial number (1) of the engine, the CPL number (2), and the engine model number (3) on all orders for parts. This information is important for fuel pump calibration and correct identification of parts (FIGURE 1-3).

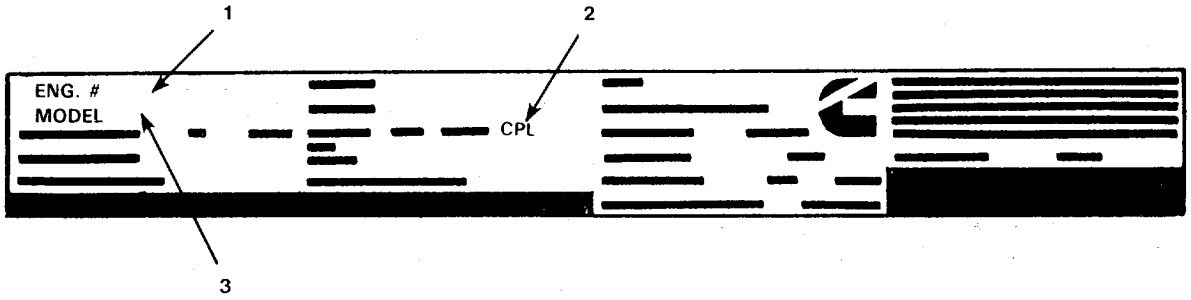


*FIGURE 1-3. Dataplate Information to Record.*

c. Fuel Pump Dataplate (Nameplate). The fuel pump dataplate is located on the top of the fuel pump. It provides information for fuel pump calibration (FIGURE 1-4).

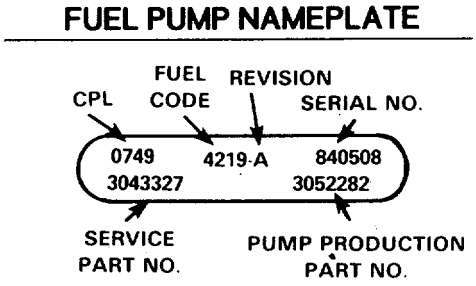


*FIGURE 1-4. Fuel Pump Dataplate.*

1-10. Equipment Data. Characteristics and reference data are provided in Table 1-1. Also see the equipment data given in the operator's manual, TM 55-1905-223-10.

Table 1-1. Equipment Data

| Characteristics | Reference Data |
|---|---|
| **GENERAL ENGINE DATA** | |
| Horsepower | 300 hp |
| Engine Speed at Maximum Output | 1800 rpm |
| Bore and Stroke | 5.5 in (140 mm) X 6.0 in (152 mm) |
| Displacement | 855 $in^3$ (14.0 litres) |
| Compression Ratio | 13.5:1 to 17.2:1 |
| Firing Order | 1-5-3-6-2-4 |
| Engine Weight (With Heat Exchanger and Clutches) | |
| Dry Weight | 3518 lb (1596 kg) |
| Wet Weight | 3757 lb (1704 kg) |
| Dimensions (overall) | |
| Length | 102.8 in (356.3 cm) |
| Width | 36.1 in (91.7 cm) |
| Height | 65.0 in (165.1 cm) |
| **AIR INDUCTION SYSTEM** | |
| Maximum allowable turbocharged intake restriction | 25 in $H_2O$ (64 cm $H_2O$) |
| **LUBRICATION SYSTEM** | |
| Oil pressure at idle (minimum allowable) | 10 psi (70 kPa) minimum |
| At no-load speed | 35-45 psi (240-310 kPa) |
| Oil capacity of engine: | |
| Bypass filter | 0.75 U.S. gl (2.8 liters) |
| Full flow filter | 0.93 U.S. gl (3.5 liters) |
| Oil pan capacity (high-low) | 9 to 7 U.S. gl (26-21 liters) |
| Total system capacity including filters | 11.0 U.S. gl (42 liters) |
| **COOLING SYSTEM** | |
| Coolant capacity (engine only) | 22 U.S. quarts (21 liters) |
| Standard thermostat modulating rang | 180-200°F (82-93°C) |
| Maximum coolant cylinder block pressure (pressure cap removed) | 40 psi (275 kPa) |
| Maximum allowable top tank temperature | 212°F (100°C) |
| Minimum recommended top tank temperature | 158°F (70°C) |
| Minimum recommended pressure cap | 7 psi (50 kPa) |

Table 1-1. Equipment Data - CONT

| Characteristics | Reference Data |
|---|---|
| **EXHAUST SYSTEM** | |
| Maximum allowable back pressure imposed by piping and silencer | 3 in Hg (75 mm Hg) |
| Exhaust pipe size (normally acceptable inside diameter) | 5 in (127 mm) |
| **FUEL SYSTEM** | |
| Engine idle speed | 650 to 750 rpm |
| Maximum allowable restriction to pump: | |
| With clean filter | 4 in Hg (100 mm Hg) |
| With dirty filter | 8 in Hg (200 mm Hg) |
| Maximum allowable fuel return line restriction: | 2.5 in Hg (63 mm Hg) |
| With check valves and/or overhead tanks | 6.5 in Hg (165 mm Hg) |
| Fuel Check Valve between Fuel Filter and Fuel Pump Minimum Opening Pressure | 0.3 psi (2.1 kPa) |
| Fuel Check Valve between Fuel Pump and Cylinder Head Opening Pressure | 3 to- 8 psi (21 to 55 kPa) |
| Fuel Check Valve in Fuel Drain Line Opening Pressure | 1/4 to 1/2 psi (13 to 25 mm Hg) |
| Derate Engine Fuel Rate for Hot Weather | 1% per 10° above 100°F (2% per 11°C above 380C) |
| Shutoff Valve Solenoid Coil Resistance 24 Volts (DC) | 28-32 ohms |
| **NOTE** The number of plates within a given battery size determines reserve capacity. Reserve capacity determines the length of time sustained cranking can occur. | |
| **ELECTRICAL SYSTEM** | |
| Maximum allowable resistance of starting circuit With 24-volt starter | 0.002 ohms |
| Minimum cranking speed without starting aid | 150 rpm |

1-11. Safety, Care, and Handling. Safety precautions must be observed at all times while performing maintenance. General WARNINGS and first-aid data appear in front of this manual. Review all safety information before starting any task. Carefully read through an entire maintenance procedure before performing any maintenance function. Make sure the task can be done safely. All WARNINGS, CAUTIONS, and NOTES are of great importance to your safety and the safety of the equipment.

## SECTION III. PRINCIPLES OF OPERATION

Overview. The principles of operation section will give you an overall description of how the bowthruster engine operates. Keep in mind that proper engine operation depends on two things: 1) Compression for ignition, and 2) that fuel be measured and injected into cylinders in the proper quantity at the proper time.

1-12. Diesel Engine Operation. Diesel engine operation is different from spark ignited engine operation. Compression ratios are higher and the charge taken into combustion chambers during the intake stroke consists of air only, with no fuel mixture. Injectors receive low-pressure fuel from the fuel pump and deliver it into individual combustion chambers at the proper time, in equal quantity, and in an atomized condition for burning. Ignition of fuel is caused by heat of compressed air in the combustion chamber.

a. Diesel Engine Cycles. It is easier to understand the function of engine parts if you know what happens in the combustion chamber during each of the four piston strokes of the cycle. The four strokes happen in this order: intake stroke, compression stroke, power stroke, and exhaust stroke (FIGURE 1-5). In order for the four strokes to function properly, valves and injectors must act in direct relation to each of the four strokes of the piston. The intake valves, exhaust valves, and injectors are camshaft actuated, linked by tappets or cam followers, push rods, rocker levers, and valve crossheads. The camshaft is driven by the crankshaft gear and that means rotation of the crankshaft directs the action of the camshaft, which then controls the opening and closing sequence of the valves and the injection timing (fuel delivery).

(1) Intake Stroke. During intake stroke, the piston travels downward, the intake valve is open, and exhaust valves are closed. The downward travel of the pistons allows air from the intake manifold to enter the cylinders. The intake manifold is pressurized with air from the turbocharger.

(2) Compression Stroke. At the end of the intake stroke, the intake valves close and the pistons starts upward on the compression stroke. The exhaust valves remain closed. At end of compression stroke, air in combustion chambers has been forced by the pistons to occupy a smaller space than it occupied at beginning of stroke, causing the air temperature to rise to a point high enough for ignition of fuel. During last part of compression stroke and early part of power stroke, a small metered charge of fuel is injected into the combustion chamber. Almost immediately after fuel charge is injected into combustion chamber, fuel is ignited by the existing hot compressed air.

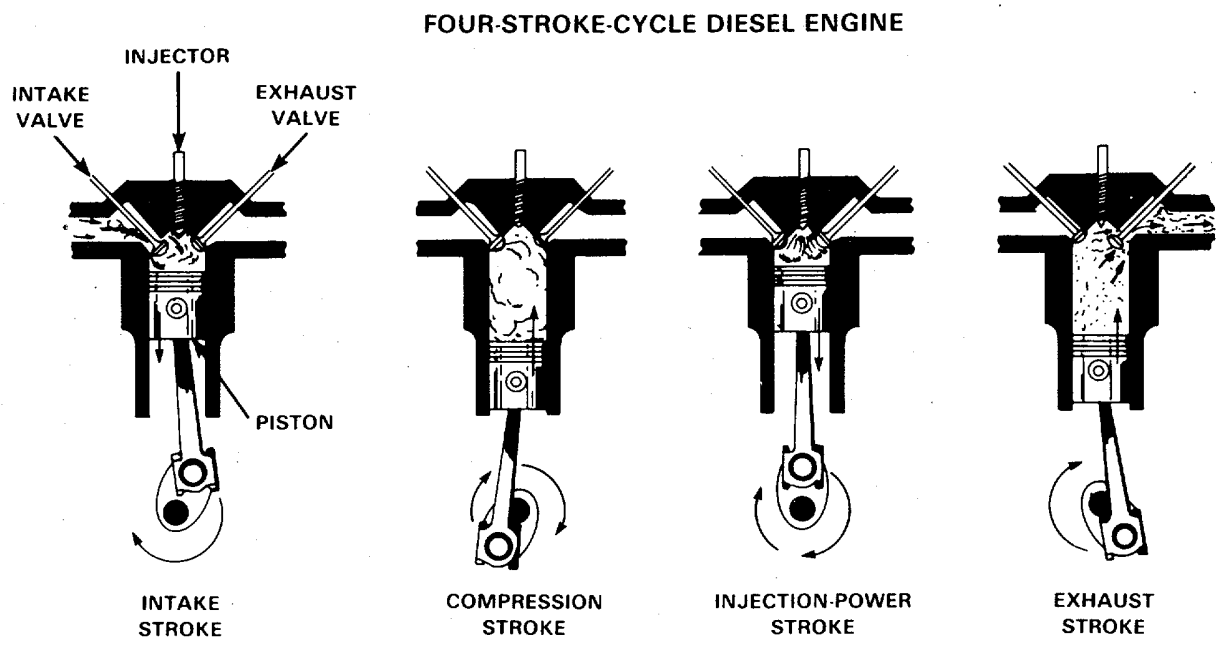


*FIGURE 1-5. Diesel Engine Cycles.*

(3) Power Stroke. During the beginning of the power stroke, the piston is pushed downward by the burning and expanding gases. Both intake and exhaust valves are closed. As more fuel is added and burns, gases get hotter and expand more, to further force the piston downward and add driving force to crankshaft rotation.

(4) Exhaust Stroke. During the exhaust stroke, intake valves are closed, exhaust valves are open, and piston is on the upstroke. Upward travel of the piston forces burned gases out of the combustion chamber through open exhaust valve ports and into the exhaust manifold.

b. Fuel System. The "pressure time" (PT) fuel system consists of the fuel pump, supply lines, drain lines, fuel passages and injectors.

(1) Fuel Pump. The fuel pump is coupled to the fuel pump drive which is driven from the engine gear train. Fuel pump main shaft in turn drives the gear pump, governor, and tachometer shaft assemblies. The PT (type G) fuel pump is made up of three main units: the gear pump, standard governor, and throttle.

(a) Gear Pump and Pulsation Damper. The gear pump is driven by the pump main shaft and contains a single set of gears to pick up and deliver fuel throughout the fuel system. Inlet is at the rear of the gear pump. A pulsation damper mounted to the gear pump contains a steel diaphragm which absorbs pulsations and smooths fuel flow through the fuel system. From gear pump, fuel flows through the filter screen.

(b) Throttle. The throttle provides a means for the operator to manually control engine speed above idle as required by varying operating conditions of speed and load. In the fuel pump, fuel flows to the throttle shaft. At idle speed, fuel flows past the throttle shaft. To operate above idle speed, fuel flows to the throttling hole in the shaft.

(2) PT Injectors. The injector provides a means of introducing fuel into each combustion chamber. It combines the acts of metering, timing, and injection.

(3) Fuel Lines and Connections. Fuel is supplied through lines to cylinder heads. A common drain line returns fuel not injected, to supply tank. Fuel connectors are used between the Inline engine cylinder heads to bridge the gap between each supply and drain passage.

(4) Shutdown Valve. An electric shutdown solenoid valve with a manual override is used on the fuel pump. In case of electrical failure, to start the engine, turn the manual knob clockwise to permit fuel to flow through the valve. To stop the engine, turn the knob fully counterclockwise. For normal operation with the electric valve, the manual control knob must be turned fully counterclockwise to permit the solenoid to open the valve when the switch is turned on.

c. Lubricating System. The bowthruster engine is pressure lubricated. Pressure is supplied by a gear type oil pump located on the side of the engine.

(1) System Operation. Oil is drawn into the pump through an external oil line connected to the oil pan sump. A screen in the sump filters the oil. Oil is drawn from the pan by the pump, out through a full-flow filter, and circulates back into the block.

(2) Lubricating Oil Flow. Oil flows from the pump to the filter/cooler, then flows to an oil header through internal drillings in the gear case. An oil header, drilled full length of block, fuel pump side, delivers oil to moving parts within the engine. Oil pipes carry oil from the camshaft to upper rocker housings and drillings through the block, crankshaft, connecting rods, and rocker levers complete the oil circulating passages.

d. Cooling System. The primary function of the cooling system is to remove the heat created by the engine and its support components. The excess heat energy that is not removed by the cooling system is carried away by exhaust gases and radiated into the atmosphere.

(1) Coolant Flow Path. Water (coolant) is circulated by a centrifugal water pump mounted on front of the engine. The water pump is belt driven. Water circulates around wet-type cylinder liners, through the cylinder heads, and around the injector sleeves. Injector sleeves, in which the injectors are mounted, are designed for fast dissipation of heat. The engine has a thermostat to control
engine operating temperature. FIGURE 1-6 shows the coolant flow path through the
engine.

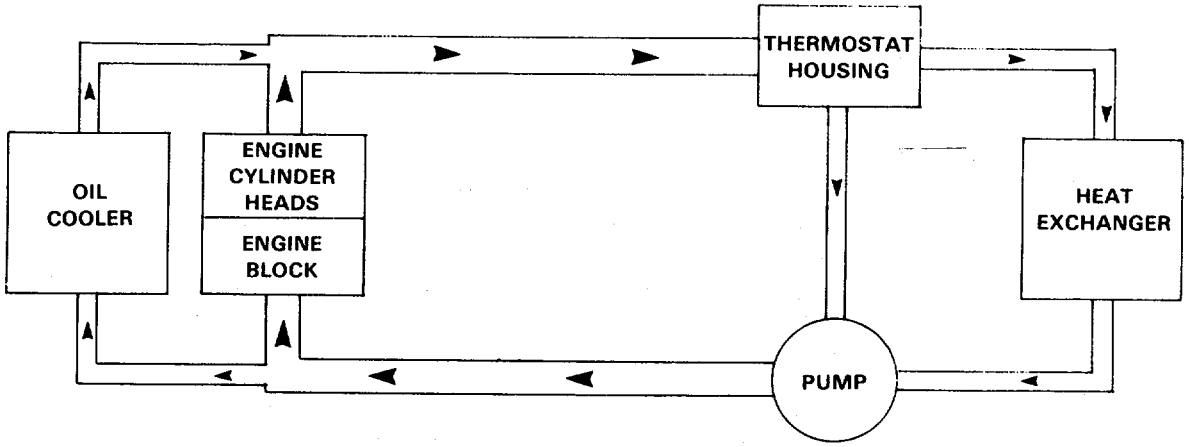


*FIGURE 1-6. Coolant Flow Path.*

(2) Water Filter. A water filter (corrosion resistor) bypasses a small amount of coolant from the system through a filtering and treating element which must be replaced periodically.

(3) Cooling System Venting. The cooling system must be designed to allow air to escape while filling the cooling system. During engine operation, coolant will continuously flow through the engine vent line to remove air. The cooling system vent line on traditional engines is plumbed from a one-eighth inch pipe trapped hole in the front water manifold to the heat exchanger tank above the coolant level.

(4) Coolant Cooling. The engine coolant is cooled in a heat exchanger. Sea water is circulated through the heat exchanger outlet connections.

(5) Coolant. Use ethylene glycol antifreeze year-round to provide freeze point and boil-over protection and always use good quality soft water in the cooling system. Refer to Army Technical Bulletin TB 55-1905-207-24, Treatment of Cooling Water, for antifreeze and additive requirements.

(a) Antifreeze. Too much antifreeze reduces freeze protection. Do not use more than 68 percent antifreeze or overheating may result. A mixture of 50 percent water and 50 percent antifreeze is sufficient for freeze protection to -34°F (-37°C).

(b) Sealing Additives. Sealing additives are not to be used in the cooling system. They will build up in the low flow areas and clog the cooling system.

(c) Soluble Oils. Do not use soluble oils in the cooling system. They may cause cylinder liner pitting and damage heat transfer surfaces, seals, and hoses.

(d) Coolant Additives and Filters. Diesel coolant additives are required to protect the cooling system from fouling and corrosion. The coolant filter is required to protect the coolant system from abrasive materials, debris, and precipitated coolant additives.

(6) Coolant Heating. The engine is equipped with a coolant heater that operates on the principle of thermosiphon when the engine is shut down. An oil pressure switch automatically turns the heater on and off. The heater comes on when the engine is shut down. Heated coolant expands and forces a flow check valve on the water inlet closed. The heated coolant is forced up the outlet to the top of the engine. When pressure drops in the tank, cold coolant enters the tank and the cycle is repeated. A flow through thermostat installed in the inlet line of the engine heater measures the coolant at its coldest point and keeps the coolant within the preset temperature range.

e. Air System. The diesel engine requires hundreds of gallons of air for every gallon of fuel that burns. For the engine to operate efficiently, it must breathe freely. Intake and exhaust systems must not be restricted. The intake air is routed through an air cleaner. The cleaner is mounted on the engine. Air is routed from air cleaner directly to intake air manifolds or turbocharger. The turbocharger forces additional air into combustion chambers, so that engine can burn more fuel and develop more horsepower than if it were naturally aspirated. The turbocharger consists of a turbine wheel and a centrifugal blower, or compressor wheel separately encased but mounted on and rotating with a common shaft. The power to drive turbine wheel - which in turn drives the compressor - is obtained from energy of the engine exhaust gases. Rotating speed of the turbine changes as the energy level of gas changes; therefore, the engine is supplied with enough air to burn fuel for its load requirements. The turbocharger is lubricated and cooled by engine lubricating oil.

f. Electrical System. The electrical power to the engine is a 24 volt circuit coming from the batteries to a magnetic switch, instrument panel, and starter motor and solenoid. Operational gauges and switches-for local control of the engine are mounted on the instrument panel on top of the engine.