OPERATION

This Chapter describes the method of operating the engine and the function of the controls.

Operating Data

The following temperatures, pressures, speeds, etc., are the maximum or minimum values that can be permitted without impairing the efficiency and maximum service life of the engine. During all running the instruments must be watched carefully to ensure that these limitations are not exceeded.

Performance Limitations

	Crankshaft Rev/Min	Propeller Rev/Min	B.H.P.	Time Limitation
Minimum continuous	600	323	-	None
Maximum continuous	1800	969	2400	None
Maximum power	2100	1131	3100	15 minutes (above 1800 c.rev/min

Maximum permissible acceleration

Idling to 1400 c.rev/min in not less than 1 minute
1400 c.rev/min to 2100 c.rev/min in not less than 2 minutes

Maximum permissible outlet temperatures

Oil	^{o}F	220
	^{o}C	105
Coolant	^{o}F	194
	^{o}C	90

Maximum permissible exhaust manifold back pressure

At maximum c.rev/min	lb/sq.in	1.0
	kg/cm^2	0.0703

Maximum permissible exhaust stub temperature

All cylinders	^{o}F*	830
	^{o}C*	460

* see NOTE 2 next page

Typical Temperatures and Pressures

As the engine temperatures and pressures are unlikely to remain constant from day to day under varying ambient conditions, the precise values that will be obtained under all varying conditions cannot be simply tabulated, but extremes that might be encountered can be expressed as a range. In the following table, therefore, ranges of values are given as a guide to the correct functioning of the engine; the operator will, however, quickly become familiar with the temperatures and pressures to be expected in his locality.

		Slow running		Continuous rating	Maximum rating
Crankshaft	rev/min	600-700	1400	1800	2100
Oil Pressure	lb/in^2	30$^{\delta}$	80	80	80
	kg/cm^2	2.11	5.63	5.63	5.63
Clutch Oil Pressure	lb/in^2	125-135	145-155	155-165	165-175
	kg/cm^2	8.8-9.5	10.2-10.9	10.9-11.6	11.6-12.3
Oil Inlet Temperature	^{o}F	112-122	112-122	112-122	112-122
	^{o}C	45-50	45-50	45-50	45-50
Coolant Pressure	lb/in^2	7.0-9.0	20-25	35-40	47-52
	kg/cm^2	0.5-0.6	1.4-1.8	2.5-2.8	3.3-3.7
Coolant Outlet Temperature	^{o}F	170-180	170-180	170-180	170-180
	^{o}C	77-82	77-82	77-82	77-82
Fuel Pressure	lb/in^2	-	20-25	20-25	20-30
	kg/cm^2	-	1.4-1.8	1.4-1.8	1.4-2.1
Exhaust Temperature	^{o}F*	145-270	415-540	500-675	600-750
	^{o}C*	80-150	230-300	280-375	335-415

NOTE 1 $^{\delta}$ Whilst this is a 'safe' pressure for this condition, the low oil pressure warning system will be operative.

NOTE 2 * A conversion factor of 5/9 (9/5) should be used when converting ^{o}F to ^{o}C (^{o}C to ^{o}F).

Control Operation

The engine is controlled by a Master Control Lever and a Shut-down lever positioned in the engine control booth. On certain installations, the Master control lever is duplicated at the Bridge position.

The Master Control Lever is interconnected by a single control cable with the engine governor and serves to select clutch engagements and speed control. The Master control cable is connected, at a break-unit on the governor, with a second control cable linking the governor and hydraulic control unit. Movements of the Master lever from Neutral, in an Ahead or Astern direction, are limited initially by an hydraulic gate which prevents power being applied until the selected clutch has been engaged. Once the selected clutch has engaged, the Master lever may be moved over the full range from idling speed to full power in the required direction of travel. Return of the lever to the Neutral position, returns the engine speed to idling and disengages the clutch.

The Shut-down lever, mounted adjacent to the Master control lever, has two positions, 'Run' and 'Stop' and is interconnected with the governor shut-down mechanism. Movement of the lever to the 'Run' position sets the governor at a condition ready for engine starting and running. When the lever is moved to 'Stop', the shut-down mechanism on the governor is moved to set the governor servo valve to the 'No fuel' position.

The control levers for a twin engine installation are grouped on a control console in the engine control booth. The engine instruments which register the engine pressures, temperatures, speeds etc., are sited on the Port and Starboard sides of the console, being related to Port and Starboard engines.

Starting and Running Procedure

Prior to the initial start of each day, a Daily inspection, as specified in the current Maintenance Schedule should be carried out.

Starting and stopping instructions are given on page 7. The starting preliminaries must be carried out before the first start of the day, but not necessarily before any subsequent starts during the day.

Starting

To assist in starting the engine in low ambient temperatures and, in order to conserve the supply of starting air in the main reservoir air bottle it may be necessary to operate the cold starting aid.

The number of capsules required to be used at any given time will vary dependent upon engine coolant temperature and ambient air temperature. Operators will soon become familiar with the requirements best suited to their particular sphere of operations, however, the following figures based on engine temperature may be used as a general guide.

3 or 4 capsules may be required with an engine coolant temperature of 10°C (50°F), while for a coolant temperature of 20°C (68°F) the engine may start without the use of the cold starting aid or possibly 1 capsule may be required.

NOTE: In extreme low ambient temperatures, although the actual engine/engine room temperature may be at an acceptable level, it may be found necessary, in order to obtain a successful start, to increase the quantity of fluid in the system by inserting an additional 2 or 3 capsules. This must not however be common practice. The capsule chamber will hold the contents of 18 capsules and, with a full charge of air in the reservoir bottles, the contents of approximately 12 capsules could be exhausted during one starting sequence, this quantity must however be considered excessive and never more than 8 capsules should be discharged into the engine at any one time. Should an abortive start occur under these conditions, the engine must be blown through with fuel off before attempting another start sequence.

If difficulty is experienced in starting the engine in ambient air temperatures of minus 10 °C (14 °F) or below, it may be found necessary to set the retractable maximum stop in the retracted position. Generally this will only be necessary in exceptional circumstances. When the stop is used in the retracted position, it is ESSENTIAL that it be returned to the normal position once the engine has started.

When the engine has started, check that the engine pressures are registering as follows:

Main Oil Pressure . . .	Has risen to more than 45 lb/in^2	(3.1kg/cm^2)
Clutch Oil Pressure . . .	Has risen above 80 lb/in^2	(5.6kg/cm^2)
Fuel Pressure . . .	Not less than 10 lb/in^2	(0.7kg/cm^2)
Coolant Pressure . . .	Registering between 5-10 lb/in^2	(0.35-0.7kg/cm^2)

If the pressures are satisfactory, continue to run the engine until the oil coolant and exhaust temperatures are stabilized within the range quoted in the Operating Data in this Chapter.

Diesel engines have a tendency to emit oil into the exhaust system if submitted to prolonged periods of slow running or low power operation. Operators are therefore advised against prolonged running of the engine at idling and at low power conditions to avoid 'wetting' of the exhaust system with oil. When an engine has been warmed through prior to an operational sortie but is not immediately required, it should be shut-down. When the craft is operating under conditions where prolonged slow ahead running is required, consideration should be given to shutting down one engine and operating the other at an increased power to compensate.

Low Oil Pressure

A low oil pressure warning device, set to operate on a falling pressure of 40 lb/in^2 (2.8kg/cm^2), is positioned in the engine control booth. This warning device may take the form of either a warning light illuminated red, or of a warning horn which sounds when the oil pressure is abnormally low.

It should be noted that, if the engine speed is reduced rapidly to slow running from a prolonged condition of high power, it is possible that the warning device may operate indicating low oil pressure. Under these conditions this may not be a serious fault but a transient condition due to the temperature of the oil, the warning device ceasing operation as the oil cools and becomes more viscous.

Should the warning device operate under conditions other than those quoted above, the engine should be shut-down and an investigation made into the cause of the warning.

Handling Under Way

When the running checks have been made and the temperatures are normal, the engine is ready for operation 'in gear'. The instructions for running ahead and for running astern are similar. The control positions are marked on the Master Control Lever quadrant.

To propel the boat, move the Master Control Levers from NEUTRAL to SLOW AHEAD or to SLOW ASTERN as required. The levers will be arrested at the selected position due to the action of the hydraulic gate, a momentary drop in the clutch oil pressure will be observed as the selected clutch engages, the pressure quickly building up again to the normal figure. When the clutch oil pressure has returned to normal, it will be found that the Master Control Levers are free to move again in the selected direction of travel. Continued movement of the levers towards FULL AHEAD or FULL ASTERN, as selected, will progressively increase the engine speed. Speed increase should not be in excess of the times stated in the Operating Limitations in this Chapter.

From a condition of power Ahead or Astern, movement of the Master Control Levers towards Neutral will progressively decrease the speed of the engines. The selected clutches will automatically disengage when the levers are returned to the Neutral position.

During all running the engine instruments should be constantly watched, the engines must not be operated outside the limits quoted in the Operating Limitations in this Chapter.

Trailing in Starting

When running on one engine with the boat under way, the second engine can be rotated for starting by its trailing propeller.

The Ahead clutch supply ducts in the gearbox casings of each engine are interconnected by a pipe and two cocks, one cock positioned on the gearbox of each engine. Clutch oil pressure from a running engine, in addition to maintaining the Ahead clutch of that engine in an engaged condition, can also be used to engage the Ahead clutch of the engine to be started, the engine thus being rotated by the action of the trailing propeller.

Procedure

1. Set the crankshaft speed of the running engine at 1200 rev/min

2. Open the trailing-in cross connection cock on the running engine.

3. Set the Shut-down lever of the engine to be started at 'Run' and the Master Control Lever at Slow Ahead.

4. Open the trailing-in cross connection cock on the engine to be started. Close the cock as soon as the engine has started. Close the other cross connection cock.

   Note: Prolonged use of the cross connection system will result in draining oilfrom one engine to the other If an engine does not start within 5 seconds of opening the cross connection cock as at (4) above, close the cock and investigate the cause of the failure to start.

5. Observe the clutch oil pressure of the engine just started and if satisfactory select the engine speed required.

   Note: If the engine has been started from cold, carry out the instructions under "Running" in this Chapter.

Starting Procedures

Starting preliminaries (before initial start of each day)

1. Carry out the daily inspection
2. Check that the sea-water cocks are open
3. Check that the fuel and oil inlet cocks are open
4. Prime lubricating oil system
5. Operate the fuel priming pump until a fuel pressure of at least 10lb/in^2 registers on the gauge.
6. Insert the required number of capsules into the cold starting aid unit and prime the system by operating the priming cock. When necessary set the retracted maximum stop in the retracted position.

WARNING
The fluid used in the starting aid system is highly inflammable

Starting

1. Set the master control lever to the NEUTRAL position
2. Move the shut-down lever to RUN
3. Depress the air start lever and hold until the engine fires
4. If the retractable maximim stop has been used, return the stop to the normal position when the engine has started.

STOPPING

Normal Stop

1. Move the master control lever to the NEUTRAL position
2. Move the shut-down lever to STOP

In an emergency the engine can be stopped, at any condition, by moving the shut-down lever to STOP

Final Stop (after the day's run)

1. Stop the engine in the normal manner
2. Carry out an after running inspection