Starting, Manoeuvring and Running

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Starting-up, Manoeuvring and Arrival in Port

The following descriptions cover the standard manoeuvring system for the 50-98MC ,MC-C engines.

Since the manoeuvring system supplied for a specific engine may differ from the standard system, *Chapter 907 in Volume III and 'Plant Installation Drawings'* should always be consulted when dealing with questions regarding a specific plant.

1. Preparations for Starting

See Chapter 705, Item 3.3 regarding correct fuel oil temperature before starting.

Regarding checks to be made before starting, when cylinders are out of operation, see Chapter 704, 'Emergency Running with Cylinders or Turbochargers out of Operation', Item 3.

1.1 Air Systems

- Drain water, if any, from the starting air system. *See also Plate 70304, 'Starting Air System'.*
- Drain water, if any, from the control air system at the receivers.
- Pressurise the air systems.
  Check the pressures.
  See also Chapter 701, 'Alarm Limits'.
- Pressurise the air system to the pneumatic exhaust valves.

  Note: Air pressure must be applied **before** the lube oil pump is started. This is to prevent the exhaust valves from opening too much. *See also Chapter 702, Check C3.*
- Engage the lifting/rotation check rod mounted on each exhaust valve, and check that the exhaust valves are closed.

1.2 Lube Oil Systems

- Start the lube oil pumps for:
  - Engine
  - Camshaft
    - Engines without Unilub: camshaft lube oil pumps,
    - Engines with Unilub: camshaft booster pumps.
  - Turbochargers

  If the turbochargers are equipped with a separate, built-in, lubrication system, check the oil levels through the sight-glasses.

  Check the oil pressures. *See also Chapter 701, 'Alarm Limits'.*
- Check the oil flow, through the sight-glasses, for:
  - Piston cooling oil
  - Turbochargers
- Check that the cylinder lubricators are filled with the correct type of oil.
- Operate the cylinder lubricators manually.

  Check that oil is emitted.
  See also Chapter 702, Check C5.

  Note: Check regularly during service that the Load Change Dependent lubricators function properly. *See also the producer's special instructions.*

1.3 Cooling Water Systems

Note: The engine **must not** be started if the jacket cooling water temperature is below 20°C.

Preheat to minimum 20°C or, preferably, to 50°C. *See also Item 3.1 and Item 7 point 9.*

- Start the cooling water pumps.
- Check the pressures.
  See also Chapter 701, 'Alarm Limits'.

1.4 Slow-Turning the Engine

This must be carried out to prevent damage caused by fluid in one of the cylinders, and to check the reversing mechanism.

Before beginning the slow-turning, obtain permission from the bridge.

Note: Always carry out the slow-turning at the latest possible moment before starting and, under all circumstances, within the last 30 minutes.

Is the special slow turning device installed?	
YES	Follow procedure 1.4.A
NO	Follow procedure 1.4.B

1.4.A Slow-turn with Special Slow-Turning Device

1. Disengage the turning gear.

   Check that it is locked in the OUT position.

   Check that the indicator lamp for TURNING GEAR ENGAGED extinguishes.

2. Lift the locking plate of the main starting valve to the SERVICE position.
   Check the indicator lamp.

   - *The locking plate must remain in the **upper** position during running.*
   - *The locking plate must remain in the **lower** position during repairs.*

3. Open the indicator valves.

4. Turn the slow-turning switch to SLOW-TURNING position.

5. Move the regulating handle to START position.
   Check to see if fluid flows out of any of the indicator valves.

   Check that the individual air cylinders reverse the displaceable rollers for each fuel pump to the outer position.

6. When the engine has moved one revolution, move the handle back to STOP position.

7. Turn the reversing handle to the opposite direction of rotation.
   Repeat points 5 and 6.

8. Turn the slow-turning switch back to NORMAL position.

9. Close the indicator valves.

1.4.B Slow-turn with Turning Gear

1. Open the indicator valves.

2. Give REVERSING order by moving the reversing handle to the opposite direction of rotation.

3. Turn the engine one revolution with the turning gear in the direction indicated by the reversing handle.

   Check to see if fluid flows out of any of the indicator valves.

   Check that the individual air cylinders reverse the displaceable rollers for each fuel pump to the outer position.

4. Repeat points 2 and 3 in the opposite direction of rotation.

5. Close the indicator valves.

6. Disengage the turning gear.

   Check that it is locked in the OUT position.

   Check that the indicator lamp for TURNING GEAR ENGAGED extinguishes.

7. Lift the locking plate of the main starting valve to the SERVICE position.
   Check the indicator lamp.

   - *The locking plate must remain in the **upper** position during running.*
   - *The locking plate must remain in the **lower** position during repairs.*

1.5 Fuel Oil System

Regarding fuel oil temperature before starting, see Chapter 705, Items 3 and 3.3.

- Start the fuel oil supply pump and circulating pump.
  If the engine was running on heavy fuel oil until stop, the circulating pump is already running.
- Check the pressures and temperatures.
  See also Chapter 701, `Alarm Limits'.

1.6 Checking the Fuel Regulating Gear

- Close the shut-off valve of the starting air distributor to prevent the engine from turning. Check the indicator lamp.
- Switch over to control from the engine side control console.
  See description of the procedure on Plate 70302, Items 2-3.
- Turn the regulating handwheel to increase the fuel pump index, and check that all the fuel pumps follow to the FUEL SUPPLY position. With the regulating handwheel back in STOP position, check that all the fuel pumps show zero-index.
- Switch back to NORMAL control by following Plate 70302, Items 1-2 in the reverse order.
- Open the shut-off valve of the starting air distributor.
  Check that the indicator lamp extinguishes.

1.7 Miscellaneous

- Lubricate the bearings and rod connections in the regulating gear, etc., at the intervals stated in Chapter 702, Check A9.
- Switch on the electrical equipment in the control console.
- Set switch for the auxiliary blowers in AUTO position.

  The blowers will start at intervals of 6 sec.

Note: *See the Warning of scavenge air box fire due to incorrectly working auxiliary blowers on page 704.01.*

The engine is now ready to start.

2. Starting-Up

2.1 Starting

Start the engine as described under START-order in Item 8 for fixed pitch propeller plants

Note: If the engine has been out-of-service for some time, starting-up is usually performed as a quay-trial. Prior to this, it must be ascertained that:

1. The harbour authorities permit quay-trial.
2. The moorings are sufficient.
3. A watch is kept on the bridge.

2.2 Starting Difficulties

See also Chapter 703, Item 2.3, 'Supplementary Comments'

Difficulty	Point	Possible Cause	Remedy
Engine fails to turn on starting air after START order has been given	1	Pressure in starting air receiver too low.	Start the compressors. Check that they are working properly.
	2	Valve on starting air receiver closed.	Open the valve.
	3	Valve to starting air distributor closed.	Open the valve.
	4	No pressure in the control air system.	Check the pressure (normally 7 bar). If too low, change over to the other reducing valve and clean the filter.
	5	Main starting valve (ball valve) locked in closed position.	Lift locking plate to working position.
	6	Main starting valve (ball valve) does not function owing to activated turning gear locking device.	Release the turning gear locking device.
	7	Control selectors are wrongly set.	Correct the setting.
	9	Pistons in starting air distributor sticking.	Lubricate and make the pistons movable. Overhaul the starting air distributor.

Starting Difficulties cont. – *See also Chapter 703, Item 2.3, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
	10	Distributor wrongly adjusted.	Check the timing marks, *see Vol. II, Maintenance, proc. 907-I.*
	11	Sticking control valve for starting air distributor.	Overhaul the control valve slide.
	12	Starting air valves in cylinder covers defective.	Pressure-test the valves. Replace or overhaul defective valves, *see also Chapter 703, Item 7, 'Operations AFTER arrival in port'.*
	13	Control air signal for starting does not reach the engine.	Find out where the signal has been stopped and correct the fault.
	13A	Propeller blades are not on zero-pitch (CPP-plants).	Set pitch to zero position.
Engine does not reverse when order is given.	14	Coil of solenoid valve for the desired direction of rotation does not receive voltage.	*See the 'Bridge Control' instruction book.*
	15	Control air signal for the desired direction of rotation does not reach the engine.	By loosening one copper pipe at a time on the signal's route through the system, find the defective valve or pipe which stops the signal. Repair or replace the valve.
Engine turns too slowly (or unevenly) on starting air	16	'Slow-turning' (option) of engine adjusted too low.	Set the 'slow-turning' adjustment screw so that the engine turns as slowly as possible without faltering.

Starting Difficulties cont. – *See also Chapter 703, Item 2.3, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
	17	'Slow-turning' (option) is not cancelled (automatic control).	*See the 'Bridge Control' instructions.*
	18	Faulty timing of starting air distributor.	Check the timing, *see also point 10.*
	19	Defective starting valves in cylinder covers.	Pressure-test the valves for leakages, *see also Chapter 703, Item 7, 'Operations AFTER arrival in port'.* Replace or overhaul the defective valves.
Engine turns on starting air but stops, after receiving order to run on fuel.	20	Puncture valves not de-aerated.	Find the cause of the stop-order and correct the fault.
	21	Shut-down of engine.	Check pressure and temperature. Reset 'shut-down'.
	22	Sluggishness in the manoeuvring gear.	Lubricate the manoeuvring gear. Ensure that the fuel pumps, rod connections and bearings are movable. *See Chapter 702, Item 9.*
	23	Faulty adjustment of manoeuvring gear.	Check the rod connections.
	24	Governor air booster (Woodward) does not supply oil pressure to the governor during the starting air period. (Woodward governor only).	*See the Governor instructions.*
	25	The pre-set speed setting pressure to the governor (Woodward), is set too low, or for too short a period.	The pressure shall be set between 1.6 and 2.0 bar, and maintained for about 6 seconds.

Starting Difficulties cont. – *See also Chapter 703, Item 2.3, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
	26	Engine runs too long on starting air, so the governor has time to regulate the pump index downwards, before running starts on fuel oil.	Automatic running: Adjust the starting level. Manual running: Shorten the starting air period.
	27	Fault in governor.	Woodward governor Check that the governor functions with the correct oil pressure. Check that the limiting functions in the governor are adjusted correctly. Deflection at the starting moment shall be about 6 on the terminal lever scale. For further fault-finding, *see the Governor instructions.* Electronic governor *See the Governor instruction book.* *See also 'Difficulties during Running', Point 28, further on in this Chapter.*
Engine turns on fuel, but runs unevenly (unstable) and will not pick-up rpm.	28	Auxiliary blowers not functioning.	Start auxiliary blowers.
	29	Scavenge air limit set at too high or too low level.	Check level of scavenge air limiter. Check the scavenge air pressure and the exhaust gas pressure at the actual load. Compare the pressures with shop or seatrial observations.

Starting Difficulties cont. – *See also Chapter 703, Item 2.3, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
	30	Fuel filter blocked.	Clean the filter.
	31	Too low fuel pressure.	Increase the pressure.
	32	One or more cylinders not firing.	Check suction valve and puncture valve in fuel pump. Check individual index, if no index, check the rod connections and the safety shut-down system. If fault not found, change fuel valves.

2.3 Supplementary Comments

Item 2.2, 'Starting Difficulties' gives some possible causes of starting failures, on which the following supplementary information and comments can be given.

Point 1

The engine can usually start when the starting air pressure is above 10 bar. The compressors should, however, be started as soon as the pressure in the starting air receiver is below 25 bar.

Points 12, 26 and 28

The testing procedure describing how to determine that all starting valves in the cylinder covers are closed and are not leaking is found in Chapter 703, Item 7, 'Operations AFTER arrival in port'. If a starting valve leaks during running of the engine, the starting air pipe concerned will become very hot. When this occurs, the starting valve must be replaced and overhauled, possibly replacing the spring. If the engine fails to start owing to the causes stated under 12, this will usually occur in a certain position of the crankshaft.

If this occurs during manoeuvring, reversing must be made as quickly as possible in order to move the crankshaft to another position, after which the engine can be started again in the direction ordered by the telegraph.

Point 13

Examine whether there is voltage on the solenoid valve which controls the starting signal. *If not, see the special instruction book for the engine control system.*

If the solenoid valve is correctly activated or the engine is being manually controlled, trace the fault by loosening one copper pipe at a time on the route of the signal through the system, until the valve blocking the signal has been found. The failure can be due to a defective valve, or to the causes mentioned under points 8, 9, 10 and 21.

Point 21

If the shut-down was caused by overspeed, cancel the shut-down impulse by moving the regulating handle to the STOP position, whereby the cancellation switch closes, and the puncture valves are vented.

If the shut-down was caused by too low pressures or too high temperatures, bring these back to their normal level. The shut-down impulse can then be cancelled by actuating the appropriate "reset" switch on the alarm panel.

In emergency control mode, the shut-down signal is reset by moving the regulating handwheel to STOP position.

2.4 Checks during Starting

Make the following checks **immediately after starting:**

Check 1: Direction of Rotation

Ensure that the direction of propeller rotation corresponds to the telegraph order.

Check 2: Exhaust Valves

See that all exhaust valves are operating correctly.

Disengage the lifting/rotation indicators after checking the functioning.

Check 3: Turbochargers

Ensure that all turbochargers are running.

Check 4: Circulating Oil

Check that the pressure and discharge are in order (main engine and turbochargers).

Check 5: Cylinders

Check that all cylinders are firing.

Check 6: Starting Valves on Cylinder Covers

Feel over the pipes. A hot pipe indicates leaking starting valve. *See also Vol. III, Chapter 911, ``Safety Cap in Starting Air Line".*

Check 7: Pressures and Temperatures

See that everything is normal for the engine speed. In particular: the circulating oil (bearing lubrication and piston cooling), camshaft lubricating oil (engines without Unilub), fuel oil, cooling water, scavenge air, and control and safety air.

Check 8: Cylinder Lubricators

Make sure that the lubricators are working, and with an even ``drop height" level in all the sight glasses.

Check that the actuators on the Load Change Dependent lubricators are in the position for increased cyl. lub. oil dosage during starting and manoeuvring. *See the producer's special instructions.*

Check the oil levels in the centre glass, and the feeder tank.
See also Plate 70716.

NB: The lubricator pump stroke should be occasionally checked by measuring the free movement of the adjustment screw, which corresponds to the pump stroke.
See Chapter 707 regarding pre-calculating the pump stroke.

Follow the producer's special instructions for checking and adjusting the pump stroke.

3. Loading

3.1 Loading Sequence

Regarding load restrictions after repairs and during running-in, see Item 3.2.

If there are no restrictions, load the engine according to this programme:

Is the cooling water temperature above 50°C?

YES

- Increase gradually to:

  FPP-plants: 90% of MCR speed
  CPP-plants: 80% pitch

- Increase to 100% speed/pitch over a period of 30 minutes or more.

See also Plates 70305, 70311.

NO

- See table below.

Is the cooling water temperature between 20°C and 50°C?

YES

- Preferably, preheat to 50°C.
- If you start with a cooling water temperature below 50°C, increase gradually to:

  FPP-plants: 90% of MCR speed
  CPP-plants: 80% pitch.

- When the cooling water temperature reaches minimum 50°C, increase to 100% of MCR speed/pitch over a period of 30 minutes or more.
- *The time it takes to reach 50°C will depend on the amount of water in the system and on the engine load.*

See also Plates 70305, 70311.

NO

- Do not start the engine.
- Preheat to minimum 20°C, or preferably to 50°C.

  When 20°C, or preferably 50°C, has been reached, start and load the engine as described above.

See also Item 1.3, page 703.01.

3.2 Checks during Loading

Check 9: Feel-over Sequence

If the condition of the machinery is uncertain (e.g. after repairs or alterations), the "feel-over sequence" should always be followed, i.e.:

a) After 15-30 minutes' running on SLOW (depending on the engine size);

b) again after 1 hour's running;

c) at sea, after 1 hour's running at service speed;

stop the engine, open the crankcase, and feel-over the moving parts listed below (by hand or with a "Thermo-feel") on sliding surfaces where friction may have caused undue heating.

During feeling-over, the turning gear must be engaged, and the main starting valve and the starting air distributor must be blocked.

The starting air distributor is blocked by closing the cross-over valve.

Feel:

- Main, crankpin and crosshead bearings,
- Piston rods and stuffing boxes,
- Crosshead shoes,
- Telescopic pipes,
- Chains and bearings in the chain casing, and in the moment compensator chain drives (if mounted),
- Camshaft bearing housings,
- Thrust bearing / guide bearing,
- Axial vibration damper,
- Torsional vibration damper (if mounted).

After the last feel-over, repeat Check A1: *'Oil Flow', in Chapter 702.*
See also Chapter 704: Special Running Conditions, 'Ignition in Crankcase'.

Check 10: Running-in

For a new engine, or after:

- repair or renewal of the large bearings,
- renewal or reconditioning of cylinder liners and piston rings,

allowance must be made for a running-in period.

Regarding bearings: increase the load slowly, and apply the feel-over sequence, *see Check 9.*

Regarding liners/rings: *See Chapter 707, Item 4.13.*

⚠ **Operation in the barred speed range**

The main propulsion shafting system has a barred speed interval indicated in the maneuvering speed table at the engine control stand (or described in the Torsional Vibration Measurement supplied as Finished Drawings), where the main engine must not be operated continuously. In process of loading-up or loading-down of the engine the barred speed range is to be passed as quick as possible.

4. Running

4.1 Running Difficulties – *See also Chapter 703, Item 4.2, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
Exhaust temperature rises a) all cyl. ⋆)	1	Increased scavenge air temperature owing to inadequate air cooler function.	*See Chapter 706: The section entitled 'Evaluation of Records", point 3, 'Air Cooler Synopsis'.*
	2	Fouled air and gas passages.	Clean the turbine by means of dry cleaning/water washing. Clean the blowers and air coolers, *see Chapter 706 'Cleaning of Turbochargers and Air Coolers.* Check the back pressure in the exhaust gas system just after the T/C turbine side. ⋆)
	3	Inadequate fuel oil cleaning, or altered combustion characteristics of fuel.	*See Chapter 705 'Fuel & Fuel Treatment'.* ⋆)
	4	Wrong position of camshaft (Maladjusted or defective chain drive).	Check p_{max}. Check camshaft with pin gauge. Check chain tension.
b) single cyl.	5	Defective fuel valves, or fuel nozzles.	⋆)
	6	Leaking exhaust valve	Replace or overhaul the valve. ⋆)
	7	Blow-by in combustion chamber.	⋆)
	8	Wrongly adjusted, or slipped, fuel cam.	Check the fuel pump lead.
Exhaust temperature decreases. a) all cyl.	9	Falling scavenge air temperature.	Check that the seawater system thermostat valve is functioning correctly.

⋆) *See Chapter 706, 'Evaluation of Records', in particular the fault diagnosing table under Item 2.2*

Running Difficulties cont. – *See also Chapter 703, Item 4.2, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
	10	Air/gas/steam in fuel system.	Check the fuel oil supply and circulating pump pressures. Check the function of the de-aerating valve. Check the suction side of the supply pumps for air leakages. Check the fuel oil preheater for steam leakages.
b) single cyl.	11	Defective fuel pump suction valve.	Repair the suction valve.
	12	Fuel pump plunger or puncture valve sticking or leaking.	Replace the fuel pump or the puncture valve.
	13	Reversible roller guide in wrong position (reversible engines).	Check the roller guide mechanism for seized bearings, roller guide, roughened rollers or cam etc. In case of seizure being observed, check the cam shaft lub. oil filter as well as the by-pass filter for possible damage.
	14	Exhaust valve sticking in open position.	Replace the exhaust valve.
Engine r/min decrease	15	Oil pressure before fuel pumps too low.	Raise the supply and circulating pump pressures to the normal level.
	16	Air/gas/steam in the fuel oil.	*See point 10.*
	17	Defective fuel valve(s) or fuel pump(s).	Replace and overhaul the defective valve(s) and pump(s).
	17a	Fuel index limited by torque/scavenge air limiters in the governor due to abnormal engine load.	*See Chapter 706 'Observations during Operation', Item 2.1 'Operating Range Load Diagram'.*

Running Difficulties cont. – *See also Chapter 703, Item 4.2, 'Supplementary Comments'*

Difficulty	Point	Possible Cause	Remedy
	18	One (or more) reversible roller guides in wrong position (reversible engines).	*See point 13.*
	19	Water in fuel oil.	Drain off the water and/or clean the fuel more effectively.
	20	Fire in scavenge air box.	*See Chapter 704.*
	21	Slow-down or shut-down.	Check pressure and temperature levels. If these are in order, check for faults in the slow-down equipment.
	22	Combustion characteristics of fuel oil.	When changing from one fuel oil type to another, alterations can appear in the r/min, at the same pump index.
	23	Fouling of hull. Sailing in shallow water.	*See Chapter 706, 'Observations during Operation', Item 2.1, 'Operating Range Load Diagram'.*
Smoky exhaust	24	Turbocharger revolutions do not correspond with engine r/min.	Some smoke development during acceleration is normal; no measures called for. Heavy smoke during acceleration: Fault in governor limiters setting.
	25	Air supply not sufficient.	*See reference quoted under point 1.* Check engine room ventilation.
	26	Defective fuel valves (incl. nozzles).	*See point 5, and Chapter 706, Appendix 2 (incl. Plate 70618).*
	27	Fire in scavenge air box.	*See Chapter 704.*
	28	Governor failure/erratic regulation.	*See Item 4.2, 'Supplementary Comments.*

4.2 Supplementary Comments

Item 4.1, 'Difficulties when Running' gives some possible causes of operational disturbances, on which the following supplementary information and comments can be given.

Point 6

A leaking exhaust valve manifests itself by an exhaust temperature rise, and a drop in the compression and maximum pressures.

In order to limit the damage, if possible, immediately replace the valve concerned, or, as a preliminary measure, lift the fuel pump roller guide, *see Chapter 704 'Emergency Running', Case A.*

Point 7

In serious cases, piston ring blow-by manifests itself in the same way as a leaking exhaust valve, but sometimes reveals itself at an earlier stage by a hissing sound. This is clearly heard when the drain cock from the scavenge air box is opened. At the same time, smoke and sparks may appear.

When checking, or when cleaning the drain pipe, keep clear of the line of ejection, as burning oil can be blown out.

With stopped engine, blow-by can be located by inspecting the condition of the piston rings, through the scavenge air ports. Piston and cylinder liner become black in the area of blow-by. Sludge, which has been blown into the scavenge air chamber, can also indicate the defective cylinder.
See also Chapter 707, item 3, 'Scavenge Port Inspection'.

Since blow-by can be due to sticking of unbroken piston rings, there is a chance of gradually diminishing it, during running, by reducing the pump index for a few minutes and, at the same time, increasing the cylinder oil amount. If this is not effective, the fuel pump index and the p_{max} must be reduced until the blow-by ceases.

The pressure rise p_{comp}-p_{max} must not exceed the value measured on testbed at the reduced mean effective pressure or fuel pump index. Regarding adjusting of p_{max}, *see Vol. II 'Maintenance', Chapter 909.*

If the blow-by does not stop, the fuel pump roller guide should be lifted, or the piston rings changed.

Running with piston ring blow-by, even for a very limited period of time, can cause severe damage to the cylinder liner. This is due to thermal overheating of the liner. Furthermore, there is a risk of fire in the scavenge air boxes and scavenge air receiver, *see also Chapter 704 under 'Fire in Scavenge Air Box'.*

In case of severe blow-by, there is a general risk of starting troubles owing to too low compression pressure during the starting sequence.

Concerning the causes of blow-by, *see Chapter 707,* where the regular maintenance is also described.

Points 10 and 16

Air/gas in the fuel oil system can be caused by a sticking fuel valve spindle, or because the spring has broken.

If a defective fuel valve is found, this must be replaced, and it should be checked that no fuel oil has accumulated on the piston crown.

Points 13 and 18

In the normal running condition, the reversible roller guide is in a self-locking position. (Reversible engine).

However, in the event of increased friction in the roller guide mechanism (seizure), there is a risk that the roller guide link might change position.

Points 12 and 17

If, to obtain full load, it proves necessary to increase an individual fuel pump index by more than 10% (from sea trial value), then this in most cases indicates that the pump is worn out. This can usually be confirmed by inspecting the plunger. If the cut-off edge shows a dark-coloured eroded area, the pump should be sent for repair. This can usually be done by reconditioning the bore, and fitting a new plunger.

Point 28

If the fault lies in the governor itself, the special governor instruction book should be consulted.

External influences can also cause erratic regulation. For instance:

- main chain drive wrongly tensioned (Woodward governor),
- falling oil pressure to the governor (Woodward governor),
- lack of control air pressure (Woodward governor),
- sluggishness in the regulating gear,
- firing failure,
- unbalance in the load distribution between the cylinders, *see Chapter 706 'Evaluation of Records', Item 2.1.*

See also Item 2.2, 'Starting Difficulties', point 27.

4.3 Check during Running

Check 11: Thrust Bearing

Check measuring equipment.

Check 11A: Chain Tighteners

Check the chain tighteners for the cam shaft drive and the moment compensators (if installed). The combined chain tighteners and hydraulic damping arrangements should be readjusted, when the red-coloured part of the wear indicators is reached. *See Vol. II, Maintenance, Chapter 906.*

Check 12: Shut Down and Slow Down

Check measuring equipment.

Check 13: Pressure Alarms
(Pressure Switches)

General
The functioning and setting of the alarms should be checked.

It is **essential** to carefully check the functioning and setting of pressure sensors and temperature sensors.

They must be checked under circumstances for which the sensors are designed to set off alarm.

This means that sensors for low pressure/temperature should be tested with falling pressure/temperature, and sensors for high-pressure/temperature should be tested with rising pressure/temperature.

Checking
If no special testing equipment is available, the checking can be effected as follows:

a) The alarm pressure switches in the lubricating and cooling systems may be provided with a test cock, by means of which the pressure at the sensor may be decreased, and the alarm thereby tested.

b) If there is no such test cock, the alarm point must be displaced until the alarm is given. When the alarm has thus occurred it is checked that the pressure switch scale is in agreement with the actual pressure. (Some types of pressure switches have an adjustable scale).

   Then reset the pressure switch to the preselected alarm limit, which should cause the alarm signal to stop.

Check 14: Temperature Alarms (Thermostats)

See also Check 13, 'General'.
Most of the thermostatic valves in the cooling systems can likewise be tested by displacing the alarm point, so that the sensor responds to the actual temperature.

However, in some cases, the setting cannot be reduced sufficiently, and such valves must either be tested when the service temperature has been reached, or by heating the sensing element in a water bath, together with a reference thermometer.

Check 15: Oil Mist Detector

Check the oil mist detector.

Adjustment and testing of the alarm function is effected in accordance with the instructions given on the equipment, or in the separate Oil Mist Detector instruction book.

Check 16: Observations

Make a full set of observations, including indicator cards, *see Plate 70603 'Performance Observations' and Chapter 706, Appendix 1.* Check that pressures and temperatures are in order.

Check the load distribution between the cylinders, *see Chapter 706 'Evaluation of Records', Item 2.1.*

5. Preparations PRIOR to Arrival in Port

Note: *See Chapter 707, item 3.1, regarding scavenge port inspection prior to arrival in port.*

1. Decide whether the harbour manoeuvres should be carried out on diesel oil or on heavy fuel oil.
   See also Chapter 705, Item 4.2.

   Change-over should be carried out **one hour** before the first manoeuvres are expected. *See Chapter 705, Item 4.2, 'Fuel Change-over'.*

2. Start an additional auxiliary engine to ensure a power reserve for the manoeuvres.

3. Make a reversing test (FPP-plants)
   This ensures that the starting valves and reversing mechanism are working.

4. Blow-off any condensed water from the starting air and control air systems just before the manoeuvres.

6. Stopping

Stop the engine as described under STOP-order in Item 8 for fixed pitch propeller plants and in Item 9 for controllable pitch propeller plants.

See also Item 10, 'Crash Stop', regarding quick reduction of the ship's speed.

7. Operations AFTER Arrival in Port

When the 'FINISHED WITH ENGINE' order is received in the control room:

1. Switch over to control room control.

2. Switch-off the auxiliary blowers.

3. Test the starting valves for leakage:

   - Obtain permission from the bridge.
   - Check that the turning gear is disengaged.

     This is because a leaky valve can cause the crankshaft to rotate.
   - Close the valve to the starting air distributor.
   - Open the indicator valves.
   - Change-over to emergency control.

     See Item 8.4, 'Emergency Control from Engine Side', regarding the change-over procedure.

- Activate the START button.

  This admits starting air, but not control air, to the starting valves.

- Check to see if air blows out from any of the indicator valves.

  In this event, the starting valve concerned is leaky.

- Replace or overhaul any defective starting valves.

4. Lock the main starting valve in its lowest position by means of the locking plate.
   Engage the turning gear.
   Check the indicator lamp.
   Check that the valve to the starting air distributor is closed.

5. Stop the camshaft lube oil pump/ booster pumps.

6. Close and vent the control air and safety air systems.

   Do not stop the air supply to the exhaust valve air cylinders, as air draught through an open exhaust valve may cause the turbocharger shaft to rotate, thus causing bearing damage, if the lube oil supply to the turbocharger is stopped.

7. Wait minimum 15 minutes after stopping the engine, then:

   - stop the lube oil pumps
   - stop the cooling water pumps.

   This prevents overheating of cooled surfaces in the combustion chambers, and counteracts the formation of carbon deposits in piston crowns.

8. Fuel oil pumps:

Did engine run on heavy fuel oil until STOP ?
YES
• Stop the fuel oil supply pumps. • Do not stop the circulating pumps. • Keep the fuel oil preheated *The circulating oil temperature may be reduced during engine standstill, as described in Chapter 705, Item 3.2, 'Fuel Preheating when in Port'.* **Note:** Cold heavy fuel oil is difficult or even impossible to pump.
NO
• Stop the fuel oil supply and circulating pumps.

9. Freshwater preheating during standstill:

Will harbour stay exceed 4–5 days?
YES
• Keep the engine preheated or unheated. However, *see Items 1.3 and 3.1.*
NO
• Keep the engine preheated to minimum 50°C. *This counteracts corrosive attack on the cylinder liners during starting-up.* • Use a built-in preheater or the auxiliary engine cooling water for preheating of the engine. *See also Chapter 709, Item 3, 'Jacket Water Cooling System.*

10. Switch-off other equipment which need not operate during engine standstill.

11. *Regarding checks to be carried out during engine standstill, see Chapter 702, 'Checks during Standstill'.*

8. Engine Control System

8.1 General

For plants equipped with the fixed pitch propeller, the following modes of control are available:

- Remote control from control room
- Remote control from bridge (option)
- Emergency control

On Plate 70303 the maneuvering system is shown in following stages.

I: Remote control, stop & safety system
II: Remote control, start, ahead, astern
III: Emergency control, stop, start, ahead, astern

8.2 Remote Control from Control Room

The change-over valve, POS. (100), must be in its "Remote Control" position.
Stop, start, reversing (AHEAD or ASTERN) and speed setting orders are given manually, corresponding to the order from the bridge.
The conversion into pneumatic signals is effected by means of solenoid valves, POS. (84), (86), (88), (90), at the engine side.

8.3 Remote Control from Bridge (Option)

The change-over from the control room to the bridge is made by moving the change-over switch on the maneuvering console.
During the remote control from the bridge, start, stop, reversing (AHEAD or ASTERN), and speed-setting signals are given by the bridge telegraph handle.
The necessary functions such as changing to fuel at START level rpm, delay of reversing signals, and canceling of governor limiter at repeated starting are built-in electronically in the remote control system.

If the engine rpm falls below the starting level to the starting error level after change to fuel running, the remote control system automatically detects a starting error and carries out an automatically repeated start as exemplified in Plate 70305, Sequence Diagram.

8.4 Emergency Control from Engine Side

In the event of breakdown of the normal pneumatic maneuvering system, the governor or its electronics, then engine can be operated from the emergency console on the engine side.

Change-over with stopped engine:
See detailed description on Plate 70302.

Change-over with running engine:
Reduce the engine speed to max.80% of MCR.
Check that the position of reversing valve, POS. (105), corresponds to the present running direction.
Move the regulating handwheel to bring the tapered slots of the change-over mechanism in position opposite each other.
Put the blocking arm in emergency position.
Quickly move the impact handwheel "P" to the opposite position.
This disconnects the fuel pumps from the governor and connects them to the regulating handwheel on the emergency console.
Move the change-over valve, POS. (100), to EMERGENCY position.
This vents valves (84), (86), (88), and (90) and leads control air to the valves in the emergency console.

If STOP valve, POS. (102), is not deactivated, the engine now receives a stop order. Activate START valve, POS. (101), briefly and this air impulse deactivates STOP valve, POS. (102).
Set the engine speed directly with the regulating handwheel.

Note: When the governor is disengaged, the engine is still protected by the electric overspeed trip, i.e. the engine is stopped automatically if the revolution increases to the overspeed setting. The overspeed shut down can only be reset by moving the regulating handwheel to STOP position. Maneuvering must therefore be carried out very carefully, especially when navigating in rough weather.

8.5 Interlocks

The following interlocks are built into the maneuvering system.

1. Start-blocking with turning gear
   When the turning gear is engaged, the valve, POS. (115), is activated, whereupon the air supply to the valve, POS. (33), which forms part of the starting system, is blocked. This means that when the turning gear is engaged, the engine is unable to start.
   Active in all modes of control.

8.6 Safety System

The safety system is a completely separate system for the protection of the engine.

The pneumatic part of the safety system is separate from the control system and supplied with air via the valve, POS. (16), and is controlled by the safety system. In case of shut down the safety system activates the valve, POS. (127). Then an air signal is led to the puncture valve on each fuel pump whereupon the engine is stopped. The system is connected in all modes of engine control.

8.7 Sequence Diagram

Plate 70305

The diagrams show the most important signals in the maneuvering system during start, stop, reversing, etc.
The diagram may also be useful for trouble-shooting purposes.

Pos. Description

1 : Ball valve
For manual cutting-off of control air supply.

2 : Pressure transmitter
For alarm if control air supply pressure is too low.
Alarm point 5.5 bar.
For alarm if control air pressure is not vented during FINISHED WITH ENGINE.
Alarm point 0.5 bar.

3 : Ball valve
For manual cutting-off of air to exhaust valve.

6 : Pressure gauge
Indicates control air supply pressure.

7 : Magnet switch
Activated when reversing cylinder (13) is in AHEAD position.

8 : Magnet switch
Activated when reversing cylinder (13) is in ASTERN position.

9 : Ball valve
For manual blocking of air supply to air cylinder (13).

10 : Two-position, three-way valve
Leads air to reversing cylinder (13) for reversing to AHEAD position.

11 : Two-position, three-way valve
Leads air to reversing cylinder (13) for reversing to ASTERN position.

13 : Air cylinder
Reverses roller for fuel pump to AHEAD and ASTERN, respectively.

14 : Two-position, three-way valve
Prevents reversing of starting air distributor when starting air is supplied.

15 : Two-position, three-way valve
Prevents reversing of starting air distributor when starting air is supplied.

16 : Ball valve
For manual cutting-off of safety air supply.

17 : Pressure transmitter
For alarm if safety air pressure is not vented during FINISHED WITH ENGINE.
Alarm point 5.5 bar.
For alarm if safety air pressure is too low.
Alarm point 0.5 bar.

19 : Pressure gauge
Indicates safety air supply pressure.

Pos. Description

20 : Air receiver 40L
Reduces time lags in maneuvering system.

21 : Ball valve
For draining water from maneuvering system.

22 : Air receiver 40L
Reduces time lags in maneuvering system.

23 : Double non-return valve

25 : Two-position, three-way valve
Controls puncture valves on fuels pumps.

26 : Two-position, three-way valve
Prevents air inlet to starting air distributor in the event of leaking main starting valve. Allows air to pass during start.

27 : Two-position, five-way valve
Controls main starting valve and, if installed, slow-turning valve (open or closed).

28 : Two-position, three-way solenoid valve
Prevents supply air from opening main starting valve during slow-turning.

29 : Double non-return valve

30 : Double non-return valve

31 : Double non-return valve

32 : Throttle non-return valve
Delays venting of pilot signal to valves (26) and (27). The delay is adjustable. The purpose of this delay is to ensure that those cylinders which are in the 'starting-air' position when charging to fuel oil will get their normal starting air supply. This ensures a good start of the engine. Delay about 1 second.

33 : Two-position, three-way valve
Leads pilot signal to valves (26) and (27) when turning gear is disengaged.

34 : Double non-return valve

41 : Switch
Gives signal to maneuvering system when change-over mechanism is in remote control mode.

42 : Electrical governor actuator
Controls the amount of fuel injected.

Pos. Description

48 : Switch
Resets shut-down function (in safety panel) when regulating handle is in STOP position during manual control.

83 : Pressure switch
Gives signal to maneuvering system when engine is on remote control.

84 : Two-position, three-way solenoid valve
Gives pilot signal to valves (25) and (117) when STOP is ordered during control-room control or bridge control.

86 : Two-position, three-way solenoid valve
Gives pilot signal to valves (10) and (14) when AHEAD is ordered during control-room control or bridge control.

88 : Two-position, three-way solenoid valve
Gives pilot signal to valves (11) and (15) when ASTERN is ordered during control-room control or bridge control.

90 : Two-position, three-way solenoid valve
Leads pilot signal to valve (33) when START is ordered during control-room control or bridge control.

100 : Two-position, five-way valve
Leads air to manual control system or remote control systems, respectively.

101 : Two-position, three-way valve, hand-operated
Leads pilot signal to valves (33), (102) and (117) and supplies air to valve (105) when actuated during manual control. Gives combined START and STOP signal when actuated during manual control.

102 : Two-position, three-way valve, hand-operated
Leads pilot signal to valves (25) , (36) and (117) and supplies air to valve (105) when actuated during manual control.

103 : Double non-return valve

104 : Throttle non-return valve
Keeps AHEAD or ASTERN signal actuated for 6 seconds after START during manual control.

105 : Two-position, five-way valve, hand-operated
Leads pilot signal to valves (10) and (11), corresponding to order (AHEAD or ASTERN), when reversing during manual control.

107 : Pressure switch
Gives signal to maneuvering system when engine is on manual control.

Pos. Description

114 : Switch
Gives signal to lamp on maneuvering console when shut-off valve (118) is in service position.

115 : Two-position, three-way valve
Blocks start possibility when turning gear is engaged.

116 : Switch
Gives indication on bridge if turning gear is engaged.

117 : Two-position, three-way valve
Activates starting air distributor when STOP signal is received.

118 : Shut-off valve
For manual cutting-off of control air to starting air distributor.

119 : Switch
Gives indication on bridge when starting air distributor is blocked.

120 : Switch
Gives signal to lamps on maneuvering console to indicate whether main starting valve is in SERVICE position or BLOCKED position.

121 : Switch
Gives signal to telegraph system/communication system when main starting valve is blocked.

122 : Sensor for starting air pressure
Blocks start possibility from bridge if starting air pressure is too low.
Alarm point 15 bar.

125 : Air receiver 20 L
Reduces time lags in safety system.

126 : Ball valve
For draining water from safety system.

127 : Two-position, three-way solenoid valve
Actuates puncture valve on fuel pumps when shut-down signal is given from safety system.

128 : Double non-return valve

137 : Non-return valve
Prevents back-flow of air from exhaust valve.

138 : Pressure switch
For alarm if pressure is too low. Set point 5.5 bar.

150 : Reduction unit
Reduces starting air pressure to 7 bar.

Pos. Description

151 : Pressure switch
-Cancels tacho failure alarm from safety system when STOP signal is active.
-Alarm cut-out during stop.
-Activates solenoid valve (190) during STOP.

179 : Ball valve
For manual blocking of air supply to air cylinder (13).

197 : Non-return valve
Prevents back-flow of in feeding line for safety air supply.

198 : Pressure gauge
Indicates air to exhaust valve pressure.

199 : Testing valve
Distributor block with built-in testing valve for pressure switches/transmitters.

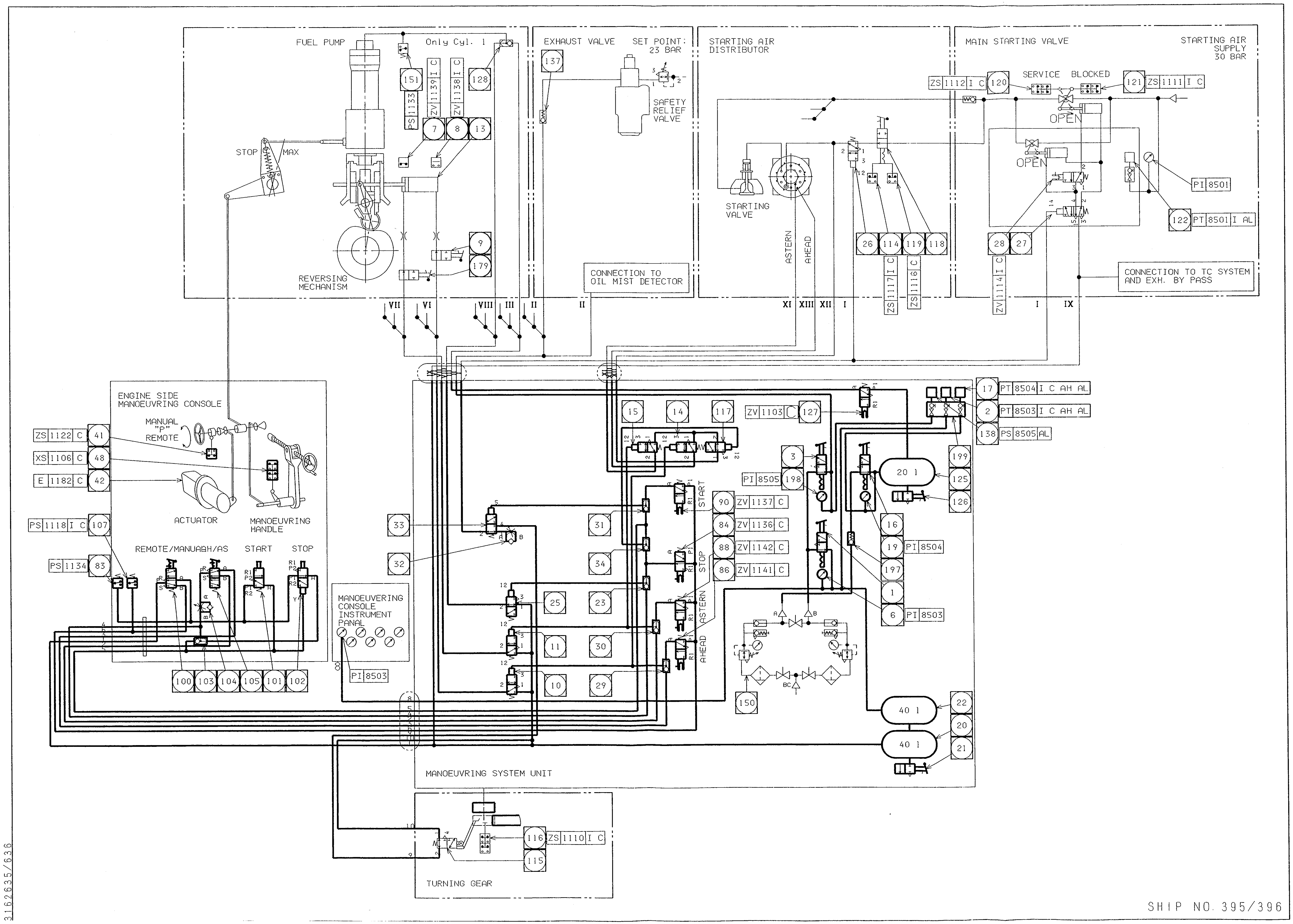
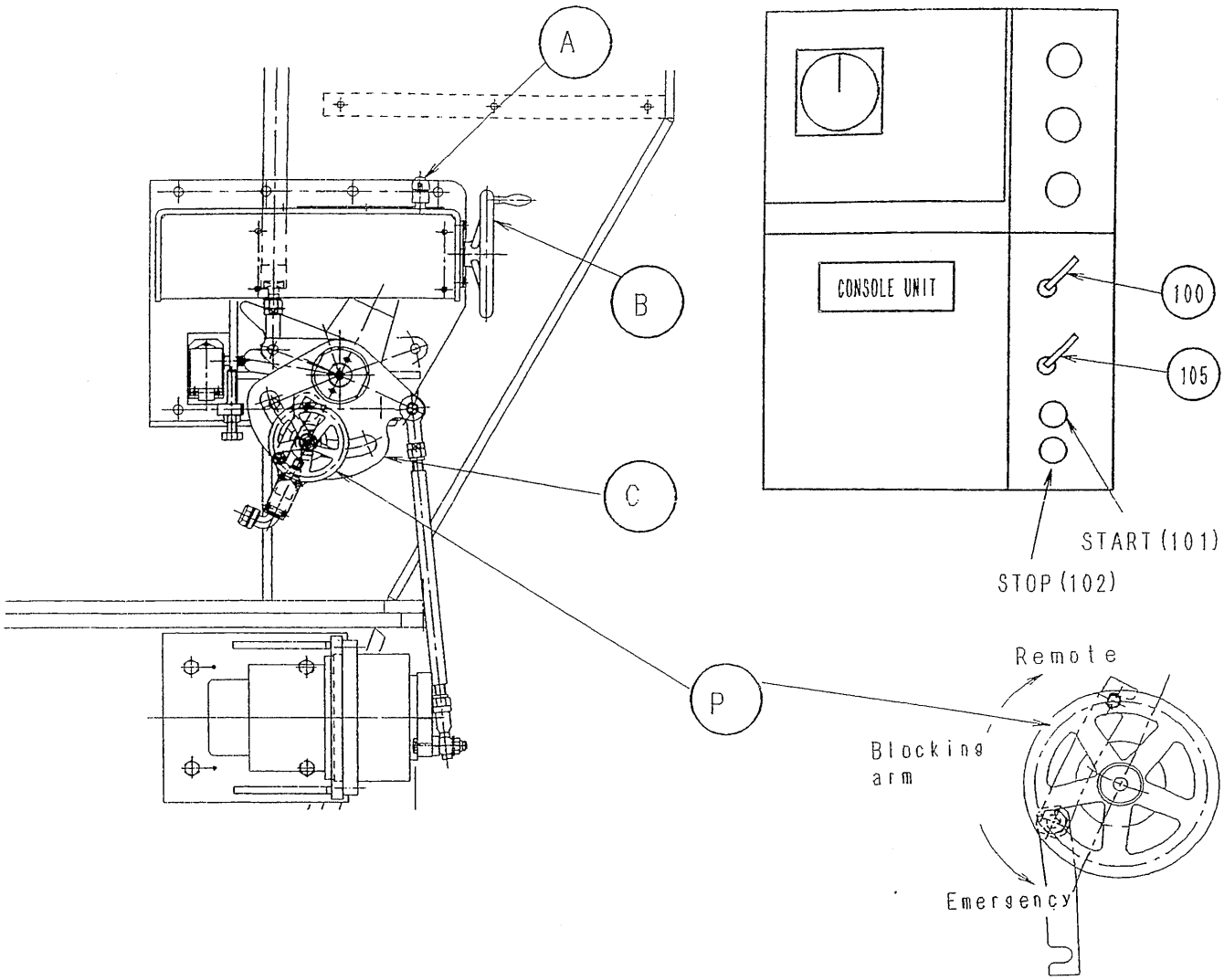

FUEL PUMP
Only Cyl. 1
STOP
MAX
REVERSING MECHANISM
PS 1133
ZV 1139 I C
ZV 1138 I C
EXHAUST VALVE
SET POINT: 23 BAR
SAFETY RELIEF VALVE
CONNECTION TO OIL MIST DETECTOR
STARTING AIR DISTRIBUTOR
STARTING VALVE
ASTERN
AHEAD
ZS 1117 I C
ZS 1116 C
MAIN STARTING VALVE
STARTING AIR SUPPLY 30 BAR
ZS 1112 I C
SERVICE
BLOCKED
ZS 1111 I C
OPEN
PI 8501
PT 8501 I AL
ZV 1114 I C
CONNECTION TO TC SYSTEM AND EXH. BY PASS
VII VI VIII III II II
XI XIII XII I
I IX
ENGINE SIDE MANOEUVRING CONSOLE
MANUAL "P" REMOTE
ZS 1122 C
XS 1106 C
E 1182 C
ACTUATOR
MANOEUVRING HANDLE
PS 1118 I C
PS 1134
REMOTE/MANUABH/AS
START
STOP
MANOEUVERING CONSOLE INSTRUMENT PANAL
PI 8503
ZV 1103
PT 8504 I C AH AL
PT 8503 I C AH AL
PS 8505 AL
PI 8505
20 l
ZV 1137 C
ZV 1136 C
ZV 1142 C
ZV 1141 C
START
STOP
ASTERN
AHEAD
PI 8504
PI 8503
40 l
40 l
MANOEUVRING SYSTEM UNIT
ZS 1110 I C
TURNING GEAR
SHIP NO. 395/396
3162635/636

Plate 70302-40A Change-over from Normal to Emergency



For changing-over to 'Emergency Control' with running engine, see Item 2.4 'Emergency Control from Engine Side' earlier in this Chapter.

1. Turn the handle 'A' anti-clockwise to free the regulating handwheel 'B'.

2. Put the blocking arm in emergency position.

3. Turn handwheel 'B' to move the innermost lever of the change-over mechanism 'C' to a position where the impact handwheel 'P' is able to enter the tapered slots in both levers. Quickly, turn the impact handwheel 'P' anti-clockwise, this causes disconnection of the governor and connection of the regulating handwheel 'B' to the fuel pumps.

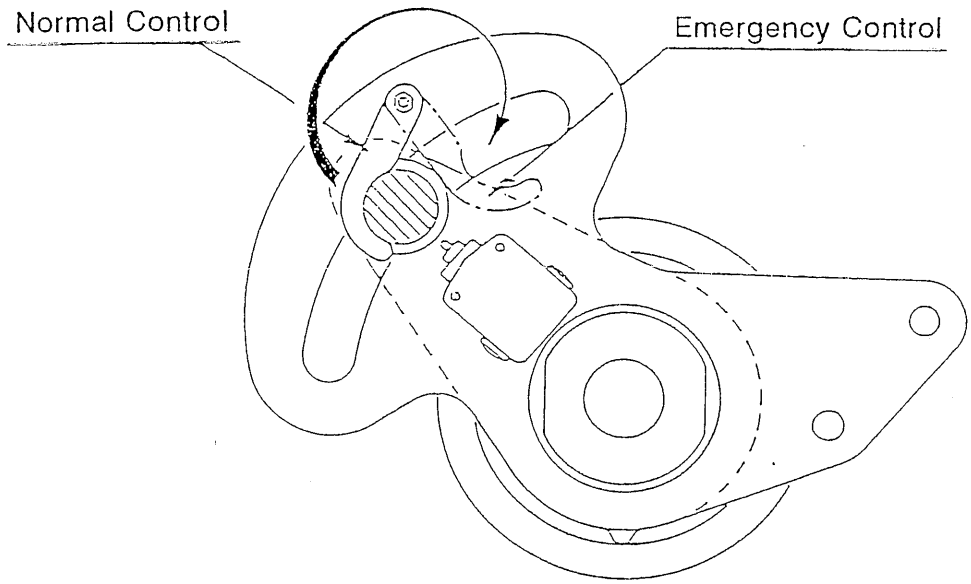
4. Change position of valve (100) from Normal to Emergency. Now air supply is led to the valves of the manoeuvring system for emergency running.

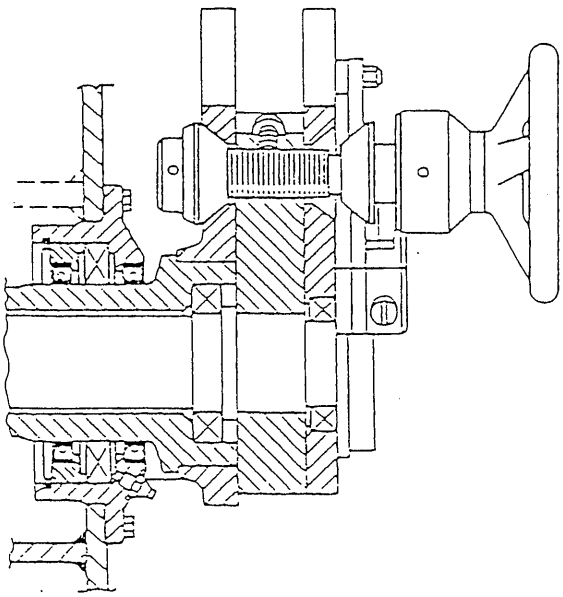
5. Check that valve (105), which is the "telegraph handle" of the emergency control system, is in the required position.

6. Ready for start. Start is described in 'Emergency Control from Engine Side'.

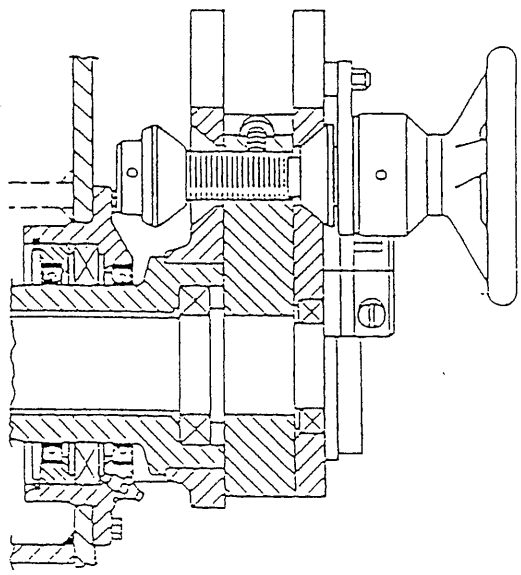
Note: Always keep the threads of the change-over mechanism well lubricated, to ensure a quick changing-over.

Emergency Control, Connection to Regulating Shaft





Emergency Control

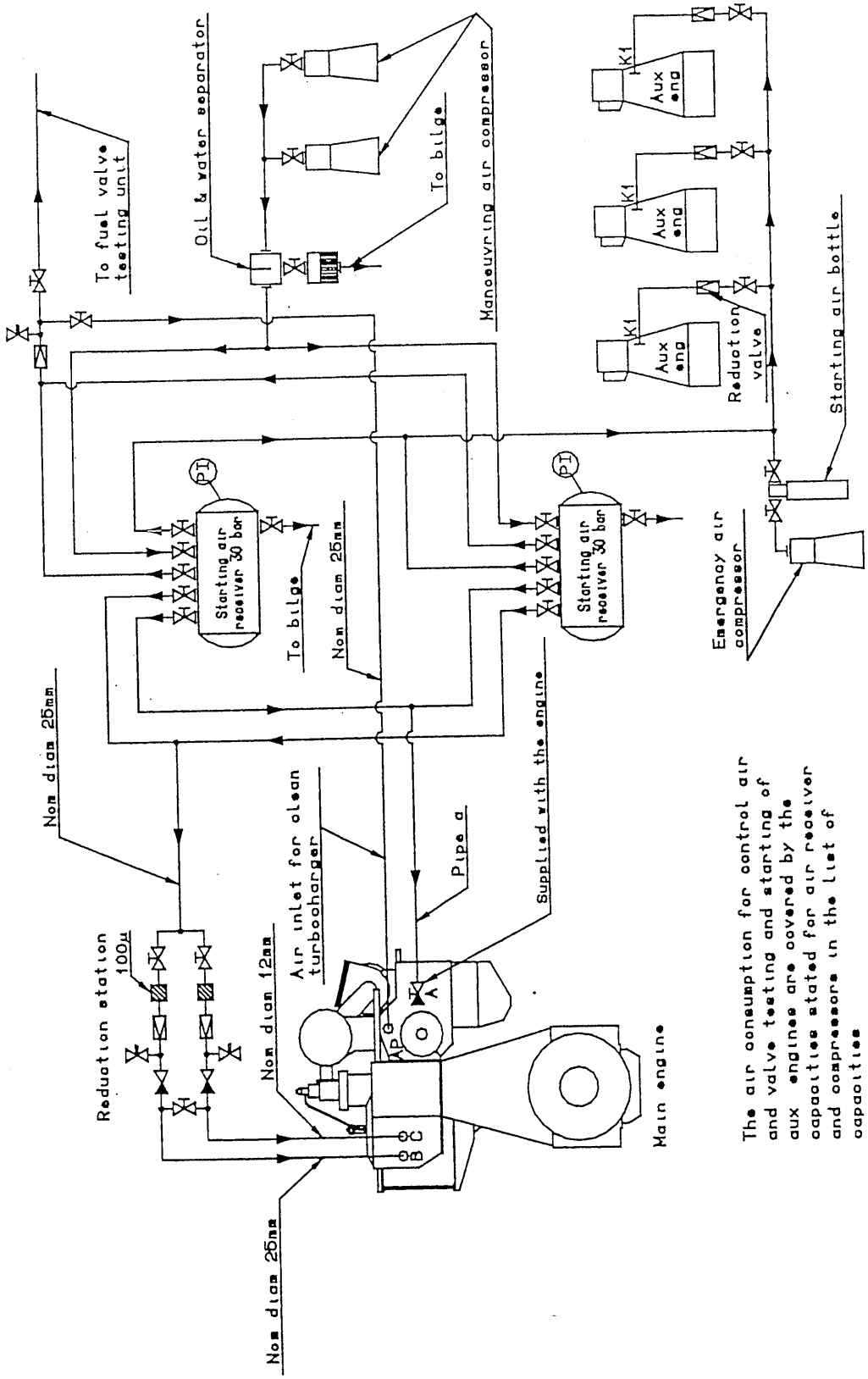


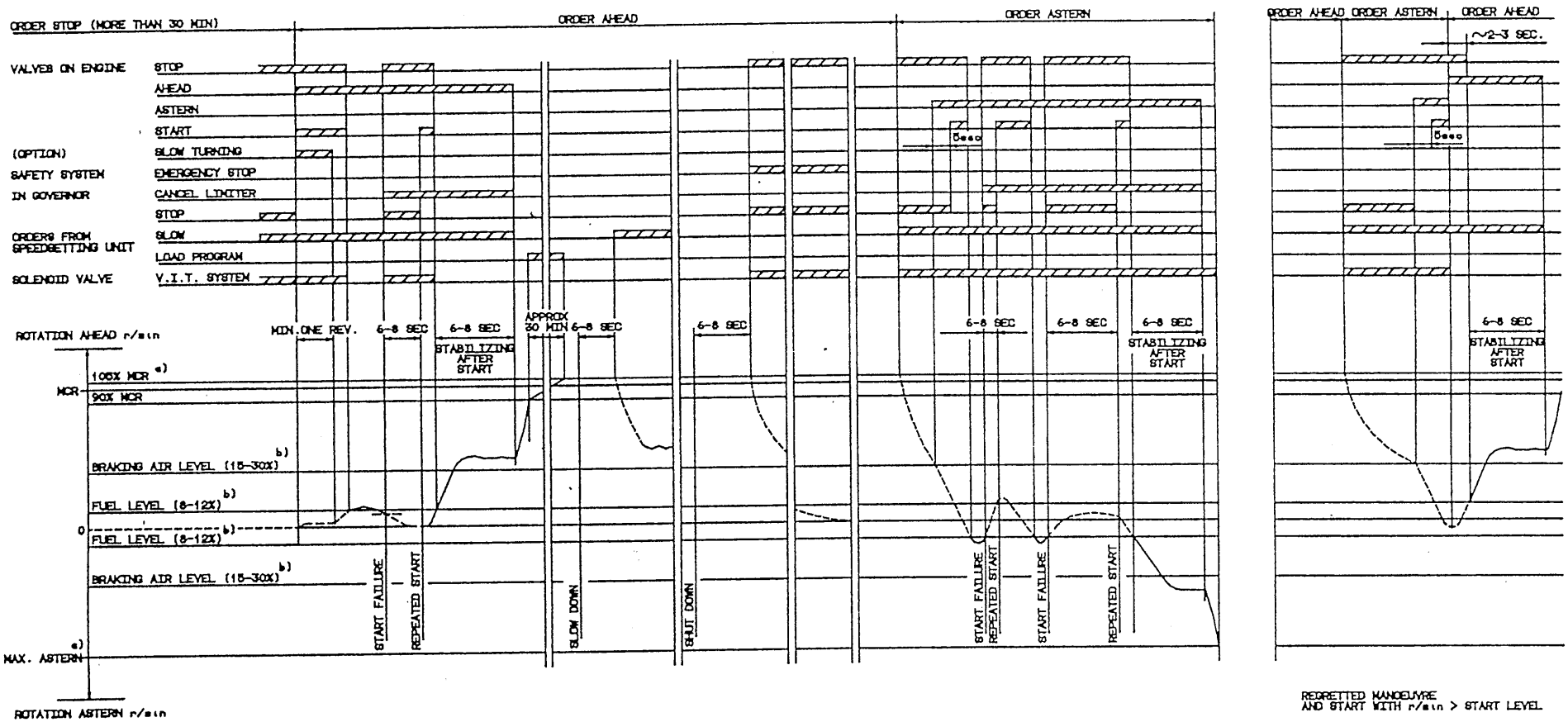
Normal Control

Plate 70304-40A Starting Air System

The system shown here is only for reference.

The actual system on each vessel is to be referred to another paper.





a) MAX.ASTERN 90% SPECIFIED MCR r/min FOR PLANTS WITH STANDARD EXHAUST CAMS.
80% SPECIFIED MCR r/min FOR PLANTS WITH LONG EXHAUST CAMS.

b) THESE VALUES GIVEN IN % REFER TO NOMINAL MCR r/min. (IF NOTHING ELSE STATED VALUES REFER TO SPECIFIED MCR r/min)

c) ONLY PERMISSIBLE FOR LIGHT RUNNING PROPELLER, REF. LOAD DIAGRAM FOR ACTUAL ENGINE

———— ENGINE RUNNING WITH FUEL ON.

-------- ENGINE RUNNING WITH FUEL OFF.

The system shown here is only for reference.

The actual system on each vessel is to be referred to another paper.

Sequence Diagram for Fixed Pitch Propeller Plant

Sequence Diagram, FPP Plant

Plate 70305-40A