Engine Room Simulator

ERS-L11 MAN B&W-5L90MC VLCC
Version MC90-IV

Machinery and Operation

Part 2

Automation & Control

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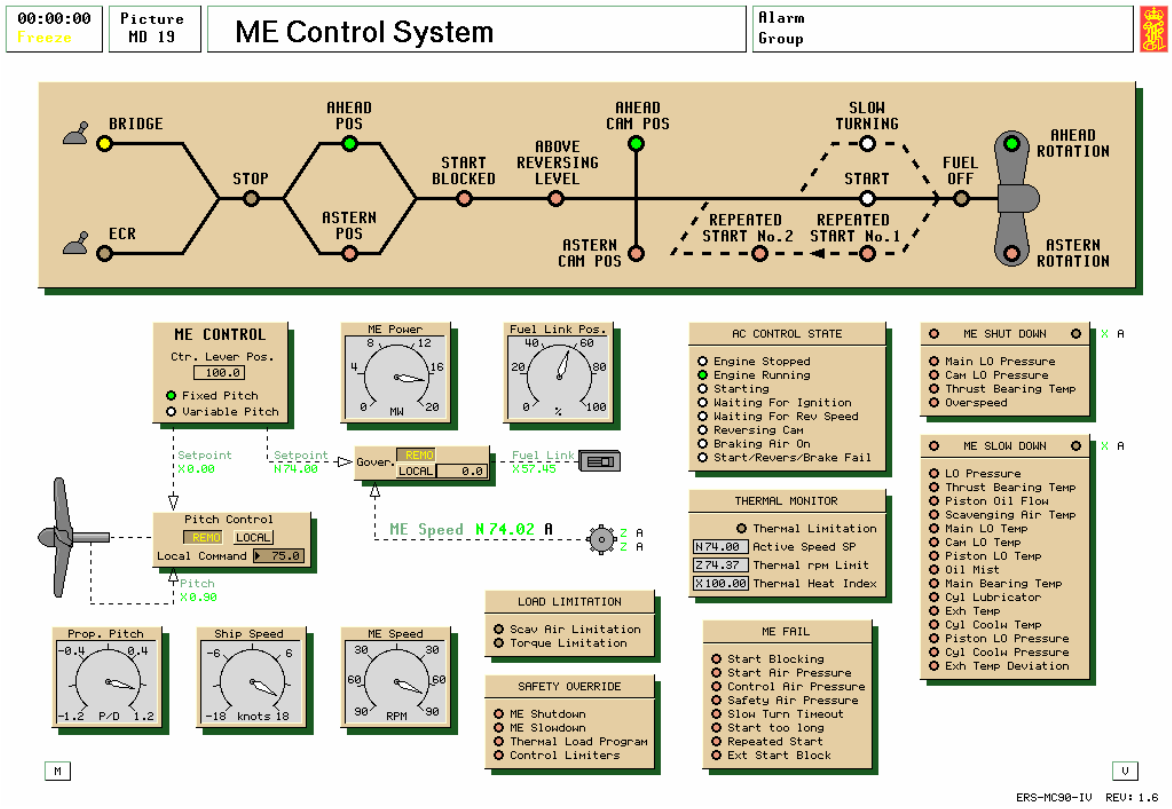
1 AUTOCHIEF CONTROL SYSTEM

1.1 AutoChief ME Control System



The main engine remote system is based on the Kongsberg Maritime AutoChief control system, which is installed onboard several hundred ships.

AutoChief is designed for remote control of both reversible and non reversible (CPP) engines.

The MC90-IV can be configured to operate as both FPP (Fixed Pitch Propeller) and CPP (Controllable Pitch Propeller).

The ME Control System has a mimic diagram that displays the following information on the diode panel:

- The command position (either bridge or engine control room)
- Stop command, when the fuel regulating lever is set to stop position
- Ahead, if the ahead direction is selected on the control panel
- Astern, if the astern direction is selected on the control panel
- Start blocked, if one or more of the following is activated:
    - Start failure: After 3 start attempts and the engine is
    - still not running
    - Start air pressure too low (default setting = 12 bar)

- Control air pressure too low (default setting = 2 bar)
- Safety air pressure too low (default setting = 2.5 bar)
- Reversing failure
- Start air admission period too long
- Failure of the engine to reverse when the emergency brake command has been activated
- Turning Gear engaged
- Engine tripped CHECK

- Above reversing level: When a running ahead or astern command is given, any braking air will not be supplied before the rpm is below the reversing level which is set to 33 rpm. When in Emergency Run, the reversing level is raised to 40 rpm.
- If the engine is not stopped within the Brake Air Time Limit (set to 8 seconds) the "Brake Air Failure" alarm will be activated. A braking failure could occur when an astern command is given whilst the engine is at full sea speed. The inertial effects of the vessel will cause the propeller to continue to rotate even those there is no fuel admission.
- Indication that the fuel pump reversing mechanism is in either the ahead or astern position.
- Indication that the slow turning operation has been selected. This will delay the normal start of the engine, but ensures that cylinder damage is prevented from possible water ingress.
- Indication that the start command is active. This will activate the pneumatic valves within the manoeuvring system and should result in a successful engine start.
- Indication that a repeat start command has been initiated by the ME control system. A repeat start will be automatically activated if the main engine speed does not reach the start level RPM within a preset time. After three attempts the system will trip, producing a start failure alarm. Further start attempts can only be made when the start block trip is manually reset.
- Indication of fuel off. Fuel injection is prevented, when the puncture valves fitted at the top of each fuel pump are opened by the stop air signal. This signal is present when the active manoeuvring lever is placed in the stop position, or there is an engine trip active.
- Indication of direction of propeller rotation.

In addition to the main mimic diagram there are also a number of "pop-up" menus that provide additional information.

AC CONTROL STATE
This panel will provide the operator with additional information, and the ability to adjust system parameters that are not present within the main mimic diagram.

Front panel indications (green lights)
- Engine stopped
- Indication of running
- Starting (command active, starting air should be supplied)
- Waiting for Ignition

- Waiting for Reversing Speed (The engine speed must fall below 27rpm, before starting air can be admitted to brake or stall the engine)
- Reversing Cam (camshaft is changing position)
- Braking Air On (Indicates that the engine rpm is below 27 and that starting air is being admitted. Note when the Limits override button on MD104 or MD110 is pressed, or the repeated start is active this limit speed is raised to 40rpm.)
- Start/Revers/Brake Failure

Pop-up window (AC Controller Constants)

- The governor's PID settings are available. These parameters are also available when popping up the governor directly. Changes of parameters at one place will automatically update the other. (default settings are gain = 2.0, Int time = 5 secs, Derivative time = 1 sec)
- Start Air Off Speed (setting of engine rpm for starting air cut off and fuel pump puncture valve closed, default setting = 18rpm)
- Start air Time Limit (max. time for starting air supply, default setting = 8 seconds). If the engine is not started within 8 seconds, Start failure alarm is activated
- Brake Air Time Limit (max. time for braking air supply, default = 8 seconds. If the engine is not stopped within 8 seconds under air braking, Braking failure alarm is activated
- Reversing speed (normal – 26.6 rpm, once the engine slows to this speed, the braking air will be admitted)
- Reversing speed (emergency – 40 rpm, if the engine fails to start, then the limits are increased to enable braking air to be admitted earlier)
- Critical speed low and high filter limits (40 to 42 rpm – this will prevent the automatic control operating the engine within the critical speed range, which will result in very high torsional vibration of the crankshaft)

ME SHUT DOWN

The shut down panel provides the operator with the settings for the various main engine shut down trips. Indications of shut down are provided at the Bridge and Engine Control Room (ECR) stations.

Front panel indications (red lights)

- Main LO Pressure
- Cam LO Pressure
- Thrust Bearing Temperature
- Overspeed

Pop-up window (AC Shut Down Limits)

- The active settings of the various shut down settings can be adjusted. The default settings are:
  - Main LO Inlet Pressure – 1.0 bar
  - Cam LO Pressure – 1.5 bar
  - Thrust Bearing Temperature – 85^{o}C
  - ME Overspeed

THERMAL MONITOR

The thermal monitor is provided to limit the heat load placed on the engine. The thermal monitor controls the speed at which the engine speeds up and slows down to minimise the thermal loading. The rate of speed change is time-dependant, but is also influenced by the temperature of the engine.
When the engine is cold, the maximum speed set point is reduced by the setting within the pop-up window (default 33 rpm). When running the main engine at any heat index below 100% there is also a max speed setpoint reduction, ref Fig19-1. The actual max speed reduction is illustrated on the front panel, and can be compared with the active speed setpoint.

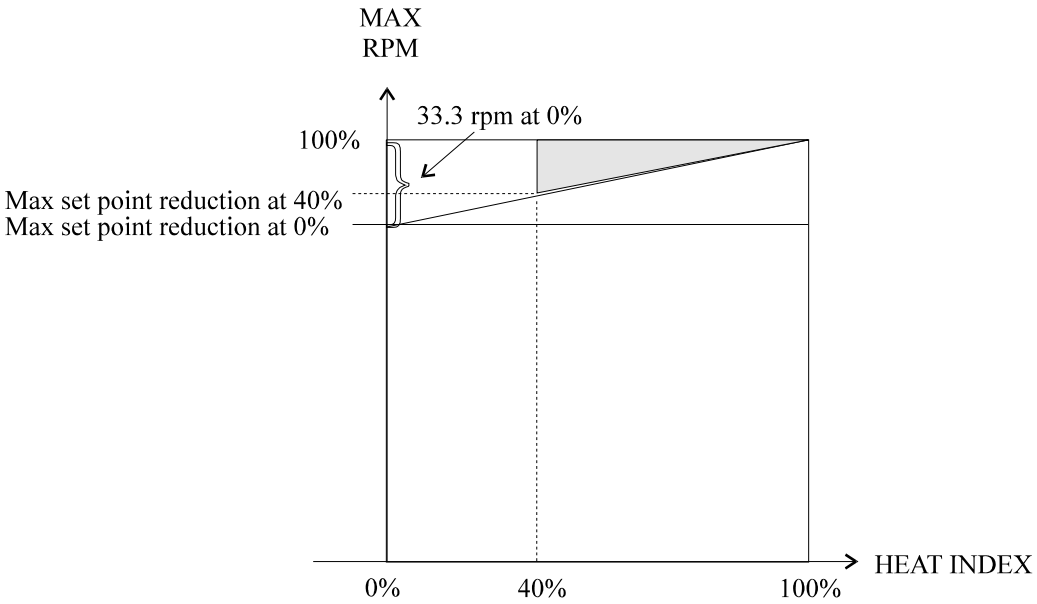
As illustrated in Fig 19-2, the heat index is decreasing when the load is below “Low load”, which is set to 5.4 Mw, and when the load is above “High load”, the heat index is increasing. The thermal heat up constant is set to 15% per min., while the thermal cool down constant is set to 5% per min. These values may be inspected and changed in the pop-up window in MD 19. As shown in the figure, the rate of the heat index is decreased when the load of the engine is above “High load” which is set to 12.6 Mw.

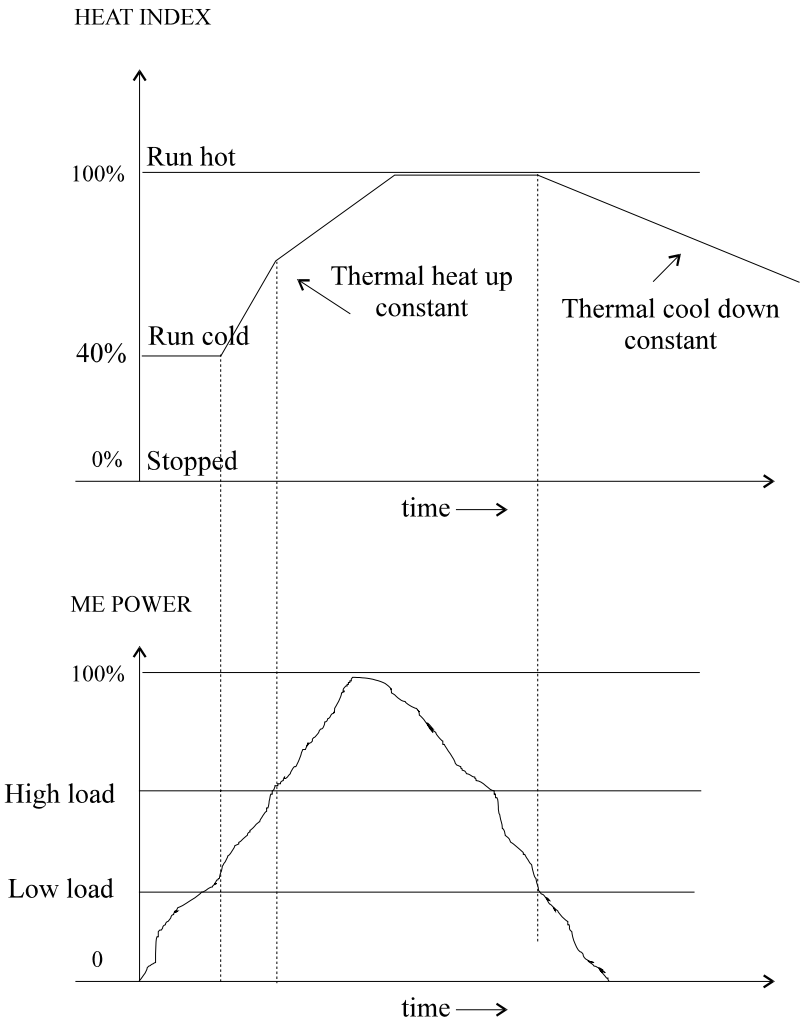
Front panel indications (yellow light and numeric values)

- Thermal Limiter (indication by lit diode when active).
- Active Speed Setpoint (indication of speed command from active control station)
- Thermal rpm Limit (indication will vary according to heat index)
- Thermal Heat Index (indication will vary according to load)

Pop-up window (Thermal Program Constants)

- The active settings of the various thermal program constants can be adjusted. The default settings are:
  - Max speed if ME cold (33 rpm)
  - Thermal Heat Up Constant (7%/min – this is the rate at which the engine is allowed to heat up once the engine load is above the ME Power high set-point)
  - Thermal Cool Down Constant (40%/min – this is the rate at which the engine can cool down once the engine load is below the ME Power low set-point)
  - ME Power Low (no heat up) (5.4MW – when the engine power developed is above this level then the heat index increase, which will also reduce the max speed set-point reduction)
  - ME Power High (slow heat up) (10.8MW – when the engine power reaches this level, then the thermal heat up constant rate will control the rate at which the heat index will rise)
  - Basic Speed SP Rate Limit (3.7 rpm/sec – this is the limit of speed increase that is permissible within the thermal program)
  - Basic Pitch SP Rate Limit (3.6 P/sec – this is the limit of pitch increase permissible within the thermal program)

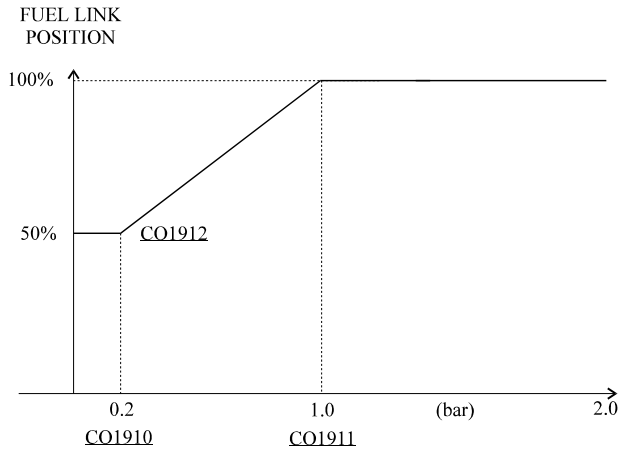

MAX
RPM
33.3 rpm at 0%
100%
Max set point reduction at 40%
Max set point reduction at 0%
HEAT INDEX
0%
40%
100%


HEAT INDEX
100%
Run hot
Thermal heat up
constant
Thermal cool down
constant
40%
Run cold
0%
Stopped
time
ME POWER
100%
High load
Low load
0
time

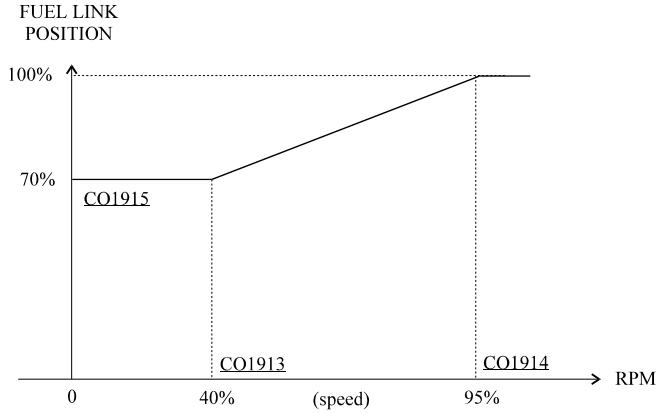
LOAD LIMITATION

The load monitor is provided to limit the load placed on the engine usually during speed increases. The thermal monitor provides the basic heat up control function on a time basis, but the load monitor will prevent thermal overloading of the engine caused by external factors, such as hull fouling, prevailing weather, etc. There are two limiters provided.

The scavenge air limiter monitors the scavenge air pressure and prevents admission of fuel that could result in exhaust smoke due to insufficient scavenge air being present.
Fig19-3 shows the relationship of fuel index with scavenge air. When the scavenge pressure is below 0.2bar, the max fuel link position is 40%. When exceeding 0.2 bar, the max fuel link position limit is allowed to increase until the scavenge pressure exceeds 1.0 bar.



The torque limiter monitors the engine speed and position of the fuel rack to prevent excess torque being developed by the engine, which would thermally overload the engine and hence increase combustion chamber stresses.
This is achieved by limiting the max fuel link position dependant upon the engine speed. From the relationship of Power = Engine Speed x Engine Torque ($P = \omega T$), the speed is monitored and compared to the fuel rack, which is proportional to the power output of the engine. Hence to maintain or limit a constant torque the relationship of fuel rack~engine speed is maintained.



Thus there are three limitations to control engine load-up:
The thermal limiter, which reduces the max fuel setting dependant upon heat index/engine power
The scavenge air limiter, which is dependant upon the scavenge air pressure, and
The torque limiter, which is dependant upon the engine speed itself.

Front panel indications (yellow lights)

- Scav Air Limitation (indication by lit diode when active).
- Torque Limitation (indication by lit diode when active).

Pop-up window (Load Limitation Constants)

- The active settings of the various shut down settings can be adjusted. The default settings are:
  - Scav. Air pressure 1 (Low) (0.0 bar)
  - Scav. Air pressure 2 (High) (1.0 bar – these two settings provide the datum pressure for the air/fuel rack relationship)
  - Max Fuel Link Position at Low Pressure (41% - this is the maximum setting of the fuel linkage when the scavenge pressure is at Scav. Air pressure 1 (low) or the start quantity of fuel. A high fuel setting with ensure a positive start but could lead to heavy starting and poor manoeuvrability)
  - Max Fuel Llink Position at High Pressure (65% - this is the setting of the fuel linkage when the scavenge pressure is at Scav. Air pressure 2 (high)
  - ME Speed 1 (Low) (44.4 rpm)
  - ME Speed 2 (High) (74.0 rpm)
  - Max Fuel Link Pos at Low Speed (33%)
  - Max Fuel Link Pos at High Speed (65% – This relationship between the low and high speed settings should ensure that the engine will operate within the parameters (not beyond line 8) of the load diagram on MD128)
  - Max Bridge Speed Setpoint (77.7 rpm)
  - Max Speed if Slow Down (44.4 rpm)

ME SLOW DOWN

The slow down system is provided to limit damage on the main engine when the operating parameters are outside normal limits. The engine power is reduced, which should reduce the effects of the defect, whilst maintaining a level of main engine power for propulsion and electrical supply (via the shaft alternator). This slow down panel provides the operator with the settings for the various main engine slow downs. Indications of slow down are provided at the Bridge and Engine Control Room (ECR) stations.

Front panel indications (red lights)

- Main LO Pressure (low)
- Thrust Bearing Temperature (high)
- Piston Oil Flow (low)
- Scavenge Air Temp (high)
- Main LO Temp (high)
- Cam LO Temp (high)
- Piston LO Temp (high)
- Oil Mist (high)
- Main Bearing Temp (high)
- Cylinder Lubricator (low flow)
- Exhaust Temp (high)
- Cylinder Cooling Water Temp (high)
- Piston LO Pressure (low)
- Cylinder Cooling Water Pressure (low)
- Exhaust Temp Deviation (high)

Pop-up window (AC Slow Down Limits)

The active settings of the various slow down settings can be adjusted. The default settings are:

- Main LO Pressure (1.2 bar)
- Camshaft LO Pressure (2.0 bar – NB Single indication of LO pressure only)
- Thrust Bearing Temperature (75^{o}C)
- Piston Cooling Oil Flow (16.9 kg/sec)
- Scavenge Air Temp (75^{o}C)
- Main LO Temp (60^{o}C)
- Camshaft LO Temp (70^{o}C)
- Piston LO Outlet Temp (70^{o}C)
- Main Bearing Temp (80^{o}C)
- Exhaust temp (460^{o}C)
- Cylinder cooling water temp (96^{o}C)
- Piston LO Pressure (0.5 bar)
- Cylinder cooling water pressure (0.5 bar)
- Exhaust temp deviation (45^{o}C)

ME FAIL
Main engine fail is caused by the inability to carry out a operator command.

Front panel indications (red lights)
- Start Blocking (due to a valve closed within the ME Manoeuvring system)
- Start Air Pressure (too low)
- Control Air pressure (too low)
- Safety Air Pressure (too low)
- Slow Turn Timeout (excess time on slow turn command)
- Start too long (excess time between start command and start level RPM)
- Repeated Start
- External start block (turning gear is engaged)

Pop-up window (AC Fail Limits)
The settings for the function are:
- Min Start Air Pressure (12 bar – required for engine starting operation)
- Min Control Air Pressure (2 bar – required for manoeuvring system operation)
- Min Safety Air Pressure (2.5 bar – required for operation of the fuel pump puncture valves that will stop fuel injection)
- Max slow Turn Time (no turn – 60 seconds, this will activate the fail as the engine only needs to operate on slow turn until one full revolution has been undertaken)
- Max Start Air Time (no turn – 6 seconds, this will indicate that the engine is not attaining the normal speed on air admission, or that the signal to admit fuel has failed to activate)

SAFETY OVERRIDE
Various overrides are provided at the Engine Control Room (ECR) or Bridge panel. Indication that a shut down and/or slow down is imminent is provided at these control panels. Hence the operator can pre-empt the engine load change by pressing the relevant over-ride button. Indication of an over-ride is provided within the front panel.
The specific shut down or slow down may be over-ridden only if the enable option is selected using the pop-up window. This pop-up window also allows the operator to adjust the shutdown and slowdown pre-warning time (default 30 and 120 seconds respectively).

Although the operator may enable the shut or slow down over-rides, the correct setting on variable page 1917 is also required, and these should be set by the Instructor. The following options are available to the Instructor:

0	=	Over-ride possible
1	=	No over-ride possible
2	=	No delay on shut down or slow down (i.e. instant acting)
3	=	No over-ride and no delay (i.e. 1 and 2 combined)

Note:- LO Pressure S/D, Overspeed S/D, and Turning Gear In S/D can not be over-ridden.

The front panel will also indicate that either the Thermal Load programme and/or the other load limits (scavenge air or torque limitation) is active. Both of these limits may be over-ridden by pressing the relevant button on the active ECR or Bridge manoeuvring panel.

PROPELLER TYPE / PITCH CONTROL

For educational purposes, the simulator can be configured in either fixed or variable pitch. The propeller type is selected at the active manoeuvring panel.

In the fixed pitch mode, the propeller pitch is fixed to a ratio of 0.9 Pitch/Diameter and the engine load is controlled by adjusting the engine RPM from the lever on the active manoeuvring panel.

In the variable pitch mode, the pitch can be adjusted either remotely at the active manoeuvring panel, or locally at the pitch control input on this screen MD19. For remote operation, refer to the description within MD104.

ME GOVERNOR

The speed control of the main engine is effected by the main engine governor. The governor control system compares the desired value from the active manoeuvring panel, with the actual or measured value of the engine speed. The governor is a three term PID controller, and the output is directly sent to the fuel linkage.

The governor control operation is similar to all controllers, in that the PID settings can be adjusted via the pop-up window.

The governor can also be placed in local control, when the active manoeuvring panel is changed to Local.

Operation of control system – Fixed Pitch Propeller in ECR control

1. Select governor operation in REMOTE
2. Select pitch control in REMOTE
3. Check that no shut down, slow down or safety override is present

Operation of control system – Fixed Pitch Propeller in Local control

1. Select governor operation in LOCAL
2. Select pitch control in REMOTE
3. Check that no shut down, slow down or safety override is present

Operation of control system – Variable Pitch Propeller in ECR control

1. Select governor operation in REMOTE
2. Select pitch control in REMOTE
3. Check that no shut down, slow down or safety override is present

Critical Speed Adjustment

The critical speed for this engine is between 40 and 42 rpm. We do not allow the engine to run within this rpm range. The AutoChief solves this by ignoring speed commands within

the critical speed range. The AutoChief “waits” for a speed command outside the critical rpm range before carrying out the new speed setting. Refer to figure 4.17.

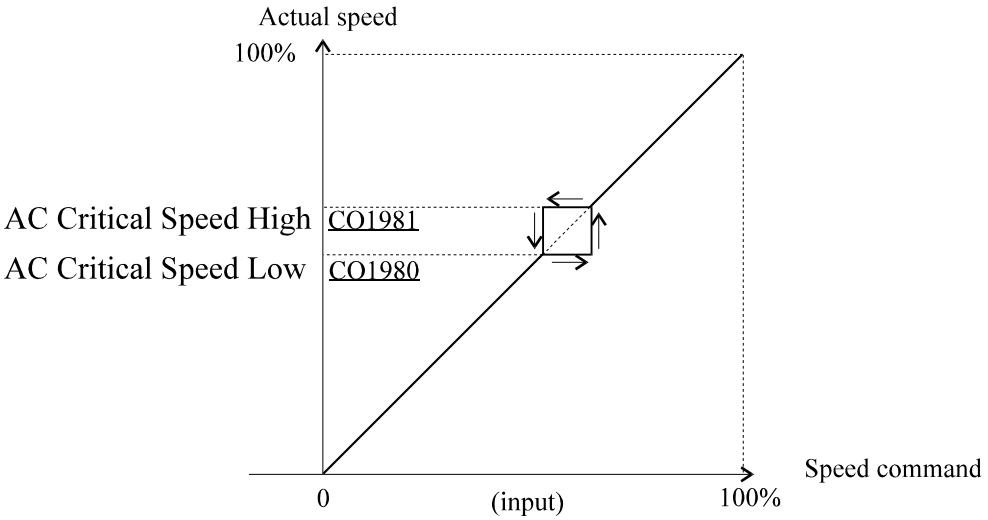
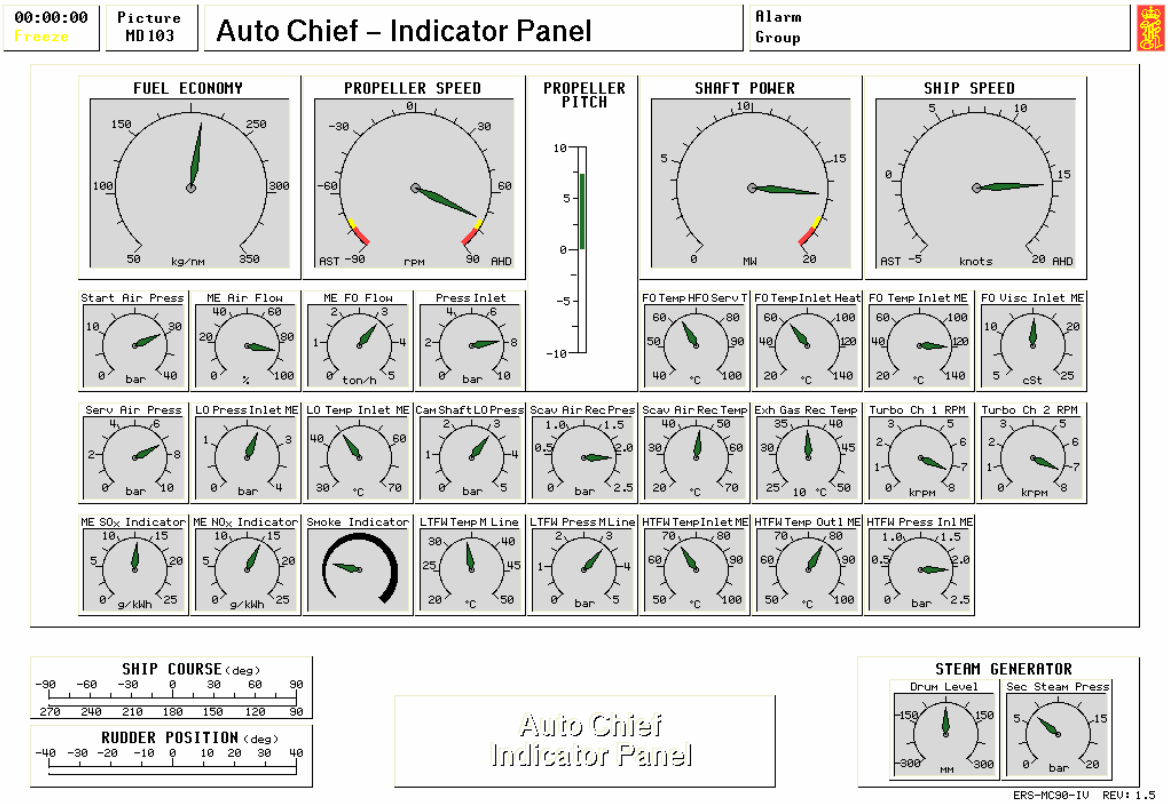


Fig. 4 - 1 Critical Speed

1.2 Main engine - Remote control functions

1.2.1 Indicator panel description



The indicator panel provides the operator with an overview of the main parameters that influence the main engine. Each of the gauges readings can be located on their individual operating or control screens.

The AutoChief - Indicator Panel includes the following readings:

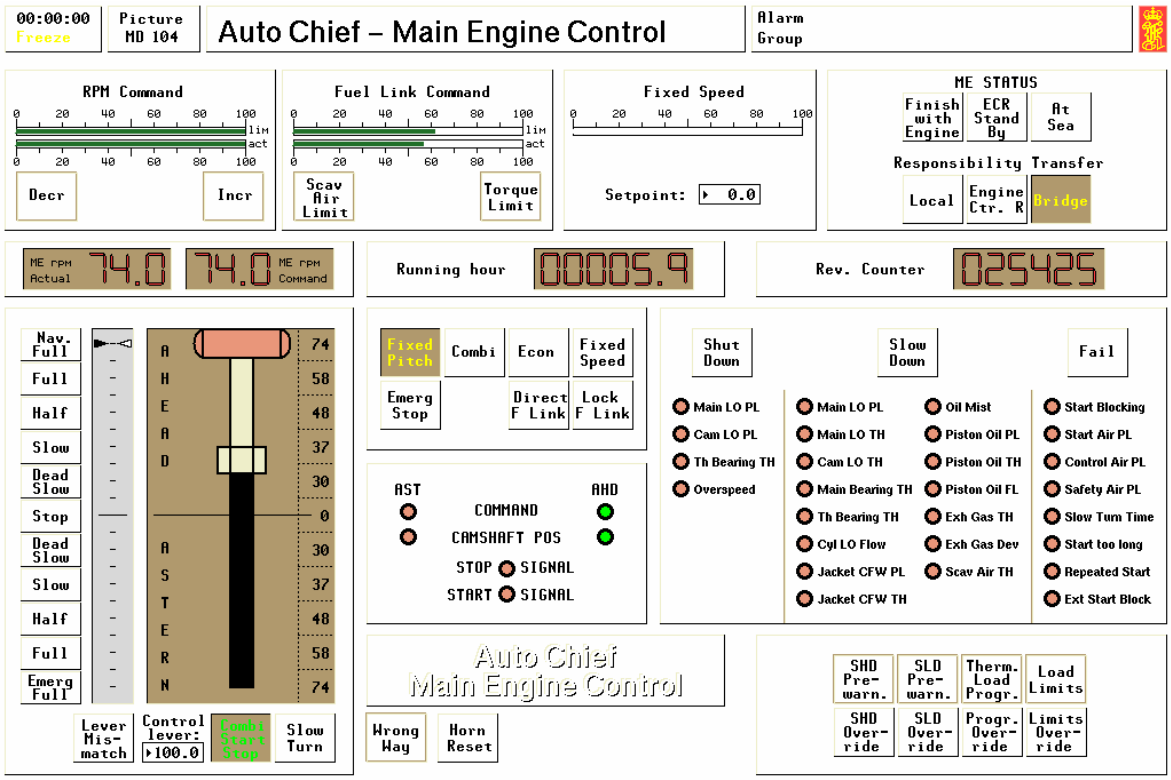
Main gauges
- Fuel Economy
- Propeller Speed
- Pitch Indicator
- Shaft Power
- Ship Speed

Panel gauges
- Start Air Pressure
- Main engine air flow
- Main engine fuel flow
- Main Engine Fuel Oil Pressure
- FO Temperature HFO Service Tank
- Fuel Oil Temperature inlet of the Heaters
- Main Engine inlet fuel oil temperature
- Main Engine Fuel Oil Viscosity

- Service Air Pressure
- Main Engine Lubricating Oil inlet Pressure
- Main Engine Lubricating Oil inlet Temperature
- Main Engine Cam Shaft Lubricating Oil Pressure
- Main Engine Scavenging. Air Pressure
- Main Engine Scav. Air Temperature
- Main Engine Exhaust Gas Temperature
- Main Engine Turbocharger 1 Speed
- Main Engine Turbocharger 2 Speed
- Main Engine NOx indicator
- Main Engine Smoke Indicator
- Main Engine LTFW Temperature
- Main Engine LTFW Water Pressure
- Main Engine HTFW Inlet Temperature
- Main Engine HTFW Outlet Temperature
- Main Engine HTFW Water Pressure
- Ship Course
- Rudder Position
- Oil fired boiler drum level
- Oil fired boiler steam pressure

1.2.2 Control panel description

Note that equipment and layout on graphic panel may differ from HW console equipment and layout.



The following controls are present at the AutoChief - ME Control Panel:

Controls

- Fuel control lever (also the combined RPM/Pitch lever when in combinator control)
- Emergency Stop
- Responsibility Transfer between Local/Engine Control Room/Bridge
- Status communication between Bridge and Engine Control Room for Finished with Engines/ECR Stand By/At Sea
- Control Mode between Fixed Pitch/Combinator/Economy/Fixed Speed/Direct Fuel Link/Locked Fuel Link
- Combinator mode Start/Stop
- Slow turn request button

Status indication

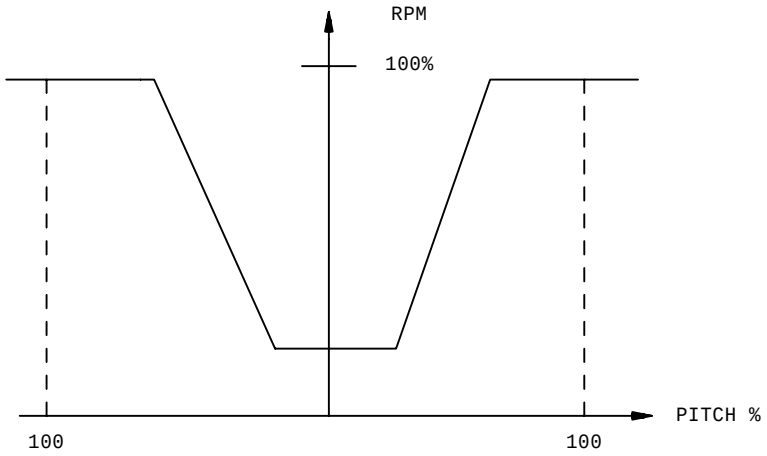
- Fuel lever command request
- Control Mode Combi/Fixed Speed/Economy/Fixed Pitch/Direct fuel link/Locked fuel link
- Bridge Telegraph
- Main Engine Shut Down
- Main Engine Slow Down

- Main Engine Fail Status
- Over-ride indicators for Shut Down/Slow Down/Thermal Load-Up programme/Load Limits
- Running hour
- Revolution counter
- ME RPM actual (digital and graphical display)
- ME RPM command (graphical display)
- ME RPM limit (graphical display)
- Bridge/ECR lever mis-match
- Fuel link command actual (graphical display)
- Fuel link command limit (graphical display)
- Fixed speed indication and set-point input

To allow the engine model to be use as an educational tool, various control modes can be selected:

Combinator
Fixed Speed
Economy
Fixed Pitch
Direct fuel link
Locked fuel link

Combinator
Combinator mode is used when a Controllable Pitch Propeller (CPP) function is required. The button beneath the fuel control lever controls stop and start of the engine.

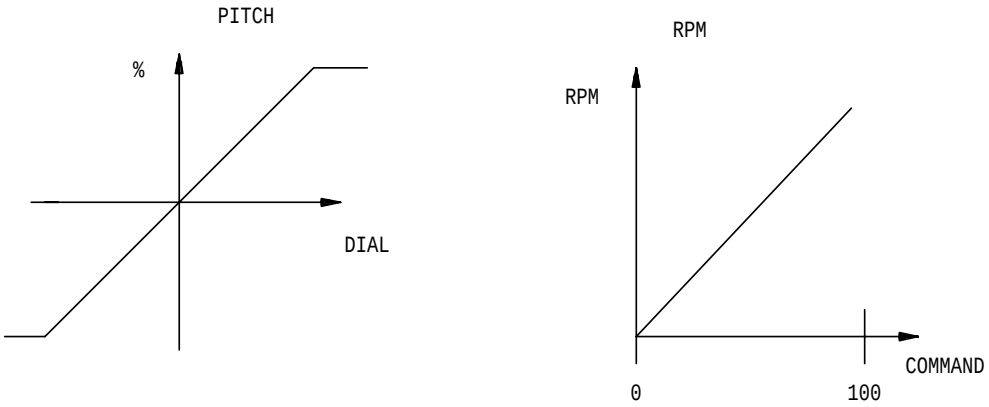


At zero pitch the engine speed is reduced to improve manoeuvrability, and as the fuel control lever is increased, then the pitch and engine speed increases until the engine is

operating at full speed. The relationship between speed and pitch is fixed, as shown in the graph shown.

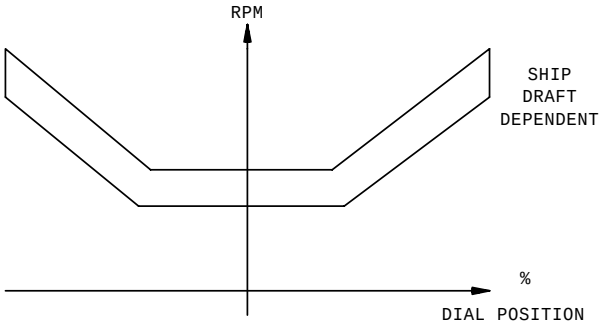
Fixed speed

In this mode the engine speed is set to a fixed value, and the pitch adjusted by the fuel control lever. This operating mode can be used for certain shaft alternator set-ups, but is not required with the converter unit model fitted within the MC90-IV model.



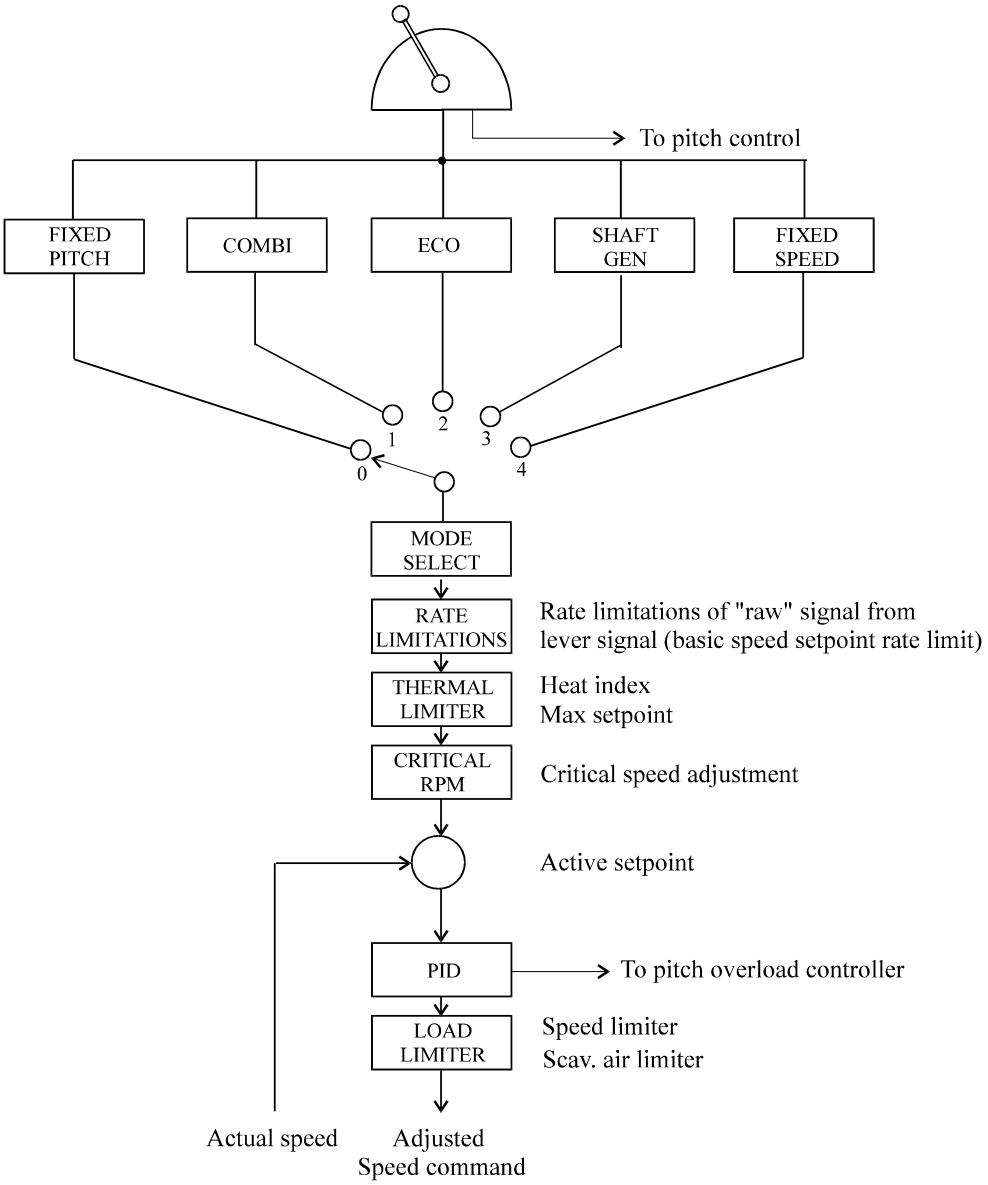
Economy mode

This mode makes the most efficient use of the combinator control, where the pitch/RPM settings are optimised by the computer. The acceleration of the engine is slower than with normal combinator control, with the vessel draft influencing the engine set-point speed.



Fixed Pitch

In this mode the propeller pitch is fixed at the optimum setting, close to the full power output of the engine. The speed of the engine is varied by the fuel control lever, with the speed signal being adjusted by the various limiters and filters, as shown.



Direct fuel link

In this mode the governor speed is set directly from the fuel control lever, and could be used to eliminate defects within the limiter controls. This would be activated when fault occurs in main engine governor unit. The system acts as if engine control handle and fuel linkage are directly related to each others position. i.e. when ECR handle is 50%, fuel link responds with 50% output.

Fixed fuel link
The fixed fuel link eliminates the small fuel lever movements that are common within the PID governor, and improves fuel efficiency. The dead-band around the desired set-speed is increased. Should the engine speed deviate significantly, then the governor will provide a corrective action to retain the required engine speed.

Emergency Stop

When this switch is activated, the engine is stopped as the fuel pump puncture valves are opened, spilling the high-pressure fuel generated by the fuel pump.

- Bridge — Transfer of the responsibility from the Engine Room to Bridge. (MD110)
- Eng. Control Room — Engine Control Room responsibility. Control of the actual command is from the engine room control console.
- Local Control — Control of the main engine is done from the local control console in the engine room; responsibility is transferred to and from the local console by using the push-button on the local control console.

Transfer of Responsibility

The responsibility buttons are provided to select the appropriate control station for the main engine. The options are:
Local – This control station would be selected when a problem or defect was present within the main engine control system, such as governor or control station hardware defect. Local control will not overcome a starting system malfunction, as the starting system is common to all control stations.
Engine Control Room – This control station would be selected for engine manoeuvring from the engine control room, such as engine testing, or in situations when specific engine control is required (such as when a shut down or slow down is over-ridden)
Bridge – This control station is normally the default control station and would be used under most operating conditions. Operating from the Bridge releases engine room personnel to monitor engine room operations.

Transfer from the ECR to Bridge
1. Check that the Bridge and ECR levers are matched by observing the indicators on the left of the fuel control lever, and the Lever mismatch light is unlit.
2. Press the push-button “BRIDGE” on AutoChief panel
3. The “BRIDGE” button then starts to flash.
4. When the Bridge accepts the transfer then the “BRIDGE” button turns to steady light. Note the Bridge personnel may be engine operators manning the Bridge panel MD110.

The ship is now controlled from the Bridge, ref MD110 for details. The engine would start up in standby mode (SBE), see SBE entry data for details.

Transfer from the Bridge to ECR

1. Check that the Bridge and ECR levers are matched by observing the indicators on the left of the fuel control lever, and the Lever mismatch light is unlit.
2. Press the push-button “ECR” on Bridge panel on MD110
3. The “ECR” button then starts to flash.
4. The operator now accepts the transfer to ECR by pressing the “ECR” button
5. The “ECR” button turns to steady light.

The ECR now has control of the engine, and should utilise the telegraph system to convey engine movement requests from the Bridge. This is carried out by:

1. Bridge presses the button of the required movement (on screen MD110)
2. The selected button on the telegraph on the Bridge and ECR starts to flash
3. The ECR personnel confirms the engine request by pressing the flashing button on their panel (MD104)
4. The engine direction and speed should be adjusted to comply with the Bridge request. Move handle to relevant engine speed by point and click on the interactive field (default settings are dead slow/slow/half and full positions) or by typing in desired command in the numeric window.
5. The engineer on duty can visually see the operation of the engine controls, with regard to ahead and astern command and actual camshaft position. The activation of both the stop and start signals can also be seen on this panel. If Wrong Way alarm is activated, the camshaft direction does not correspond with command from bridge.

Transfer from ECR to Local control

1. Press the push-button “Local” on AutoChief panel
2. The “Local” button then starts to flash.
3. On the Local Control screen MD20, the operator accepts the transfer then the “Local” button turns to steady light.

The ship is now controlled from the Local control station, ref MD20 for details.
The Local Control station personnel should utilise the telegraph system to convey engine movement requests from the Bridge. This is carried out by:

1. Bridge presses the button of the required movement (on screen MD110)
2. The selected button on the telegraph on the Bridge and Local Control panel starts to flash
3. The Local Control personnel confirms the engine request by pressing the flashing button on their panel (MD20)
4. The engine direction and speed should be adjusted to comply with the Bridge request.

Transfer from the Local Control to ECR

1. Press the push-button “ECR” on the Local Control screen on MD20
2. The “ECR” button then starts to flash.
3. The operator now accepts the transfer to ECR by pressing the “ECR” button on screen MD104
4. The “ECR” button turns to steady light.

ME Status indication
The status lights are used as a communication between the Bridge and ECR as the request for engine readiness. The actual engine readiness would be discussed by verbal communications, but the status lights are used to convey a request by the Bridge and an acceptance by the ECR.

Finished with Engines – This would be selected when the main engine is no longer required. Finished with Engine (FWE) would be selected when the vessel is in port, or at a secure anchorage. When the FWE signal is received, the engine systems would be partly shut down, and possible heating introduced. The following procedure could be instigated when FWE order is received:
1. Close the main engine start air isolation valve (MD59)
2. Place the Start air valve in the block position (MD18)
3. Engage the turning gear (MD20)
4. Open the Indicator Cocks (MD20)
5. Close the bypass valve of the HTFW Preheater, and open the steam inlet valve (MD10)

ECR Stand By – When standby (SBE) is selected, then the main engine should be ready for manoeuvring, up to and including full ahead or astern. The ECR should only accept SBE when the engine and its associated system are ready to provide full manoeuvring capabilities. As a minimum preparation the following subsystems would be ready:
1. Two diesel generators connected to the 440V board
2. Oil fired boiler operating and on-line
3. Sea suction on high (unless in light ballast conditions)
4. Auxiliary blowers operating in automatic
5. Two steering gear motors operating
6. Check that start air block valve is open.
7. Check that start air distributor block valve is open.
8. Check that indicator cocks are closed.
9. Check that turning gear is disengaged.
10. Reset any slow down or shut down alarms. Note: the speed lever must be set to stop position to be able to reset any shut downs.
11. Check that no safety overrides are present.

At Sea – This button is selected to communicate that the Bridge no longer requires full manoeuvring of the engine as the vessel is in open water. This will allows the engineering staff to operate the engine room systems in economical mode. As such one or more of the diesel engine would be replaced by the turbo and/or shaft alternator and then shut down. The speed and power of the engine would be increased up to the required full sea speed.

Engine Safety Panel
To operate the main engine safely, all critical parameters must be monitored in order to activate alarm and, if required, initiate automatic slowdown and/or shutdown of the engine.

The engine safety indicator panel will inform the operator that an engine failure has occurred and the parameters or channel that have triggered this failure. Classification Rules dictate that an engine failure requires a dedicated alarm, and that the failure should be manually reset. Adjustments of the actual failure setpoints can be adjusted within the ME Control System screen on MD19.

The various slowdown and shutdowns are monitored by the DataChief system, and transferred to AutoChief for initiation of the slowdown and /or shutdown. Each of the slowdown and shutdown parameters is grouped and represented by an indicator light on the AutoChief panel.

When the indicator light starts flashing, slowdown/shutdown procedures are initiated.

The safety system gives the operator the possibility to override shutdowns and slowdowns by pressing the relevant override buttons.

The system will (depending on set-up) give the operator a warning on slow down and shut down. The default time delay for slow down to be activated is 120 seconds. Within this period the operator may cancel the slow down. The actual diode will flash as long as the trigger or cause for slow down is present.

The default time delay for shut down to be activated is 30 seconds. Within this period the operator may cancel the shut down (except for the overspeed, turning gear in and lube oil pressure). The actual diode will flash as long as the cause for shut down is present.

Note that slow turning should be performed if the main engine has stood still for more than 30 minutes. ME slow turning is carried out by manually pressing the Slow-Turn button.

2 POWERCHIEF REMOTE CONTROL

2.1 Power Chief - Generator control

AUTO Puts the diesel generator into auto mode provided that:

- READY lamp is lit. See the conditions related to the READY lamp.
- In this mode the Power Chief will take care of starting and stopping, connecting and disconnecting and load sharing of the generators.
- If the lamp is flashing, the Auto mode is cancelled because of the READY conditions is no longer met.

READY Conditions related to the READY lamp:

- Engine Control in REMOTE
- LO Priming Pump in AUTO
- All trip RESETs
- Voltage Control ON

PRIOR 1 Lamp push-button to select highest priority, that is first in and last out.

PRIOR 2 Lamp push-button to select medium priority, that is later in and earlier out than number 1.

PRIOR 3 Lamp push-button to select medium priority, that is later in and earlier out than number 2.

2.1.1 Shaft generator - Remote control functions

START Starts the Synchronous condenser

STOP Stops the synchronous condenser.

READY Indicates that the shaft generator clutch is engaged

CONN Manual, remote connection of the generator breaker.

- To manually connect an engaged shaft generator via the power management system, switch off the **AUTO** and activate the **CONNECT** button. The power management system will automatically synchronise and connect the shaft generator to the bus bar.

DISCONN Manual, remote disconnection of the generator breaker.
- To manually disconnect a shaft generator via the power management system switch off the **AUTO** and activate the **DISCONNECT** button. The system will automatically reduce the load and disconnect.

RUN Lamp indicating that the Synchronous condenser is running.

IN Lamp indicating that the generator breaker is connected.

AUTO Puts the generator into auto mode provided that:
- READY and RUN lamps are lit.
- In this mode the Power Chief will take care of connecting and disconnecting and load sharing of the generator.
- If the lamp is flashing, the Auto mode is cancelled because of the READY conditions is no longer met.

PTI Selects Motor mode for the generator. Breaker must be connected before PTI can be selected.

PRIOR 1 Lamp push-button to select highest priority, that is first in and last out.

PRIOR 2 Lamp push-button to select medium priority, that is later in and earlier out than number 1.

PRIOR 3 Lamp push-button to select medium priority, that is later in and earlier out than number 2.

2.1.2 Control modes

The shaft and diesel generators may be operated in four different control modes, selected by pressing the dedicated push buttons at the Power Chief Generator Control panel.

- Equal load
- Optimal load
- Cyclic load
- Alert Mode

Equal load (symmetrical load sharing)
Providing the generators are in AUTO Equal load balances load evenly between generators, when two or more are running in parallel. Is normally selected when safety is the most important issue (during manoeuvring, loading, discharging etc.).

NOTE! In the first place the prime mover speed controller carries out the main control of the load sharing, while the Power Chief carries out the fine adjustment.

The settings for start and stop load can be read and changed at variable page.

Optimal load (asymmetrical load sharing)
Providing the generators are in AUTO, Optimal load **p**rovides maximum fuel economy and is usually selected during sea voyages. First priority takes “max load” while second priority takes the rest of the load

The settings for start and stop load can be read and changed at Variable Page.

Cyclic load
Cyclic load is selected by pressing the CYCLIC LOAD push-button. This mode is similar to the "Optimal load" mode, but after a certain period of time generator 1 and 2 will change in taking the highest load. This mode will cycle the load between the engines in such way that one of the diesels is running at max. load while the other diesel handles the remaining load and thereby prevents carbonising of the cylinders, valves etc. Is selected when it is necessary to run more than one diesel on low power.

The cycling period can be read and changed at Variable Page.

Alert Mode
Alert mode is selected when the automatic stopping of a generator is undesirable. Alert mode can be used with equal load, optimum load and cyclic mode.
When ALERT MODE is selected the automatic disconnection and stopping of generators is inhibited. This mode is used when a large excess capacity is required, i.e. manoeuvring, or when sudden large power surges may occur, i.e. when using the bow thruster.

NON ESSENTIAL LOAD TRIP - Flashes when alternators have been overloaded and non-essentials are tripped. Reset function by clicking on button.

HIGH POWER - Flashes when generator set reaches upper limit. To reset/acknowledge alarm click flashing button.

GENERATOR START / STOP REQUEST - Flashing button indicates upper load limit is near for running set. If in automatic mode, next generator set is started and connected automatically, or disconnected and stopped depending on requirements.

Operation procedure

1. Preparations before operating Power Chief-Generator Control

1.1 Diesel generators to be ready and in alarm free condition.

2. MANUAL mode

2.1 Push START button for the respective generator engine. When running light appears, generator is ready for connection to main bus bar.
2.2 Push CONNECT to connect generator to main bus bar.
2.3 If emergency generator is running it will automatically disconnect and stop. Shore power must be manually disconnected.
2.4 After connection of generator(s), voltage and frequency must be checked.

Note: On an actual ship adjusting frequency and load sharing is a continuous task unless switchboard is automated. When load changes, so do bus bar values.

3. Automatic power management

3.1 Connect first generator manually as described. Press buttons AUTO and PRIORITY 1 for this generator set.

3.2 After preparing of second generator, READY signal will be lit on PowerChief panel. Press buttons AUTO and PRIORITY 2 for this generator.

3.3 Select required control mode.

3.4 Second generator will automatically start, take load, and stop according to the electrical consumption and the selected control mode.

4. Shaft generators

4.1 A prerequisite for shaft generator operation is that the main engine remote control is in the Shaft Generator Mode

The functions AUTO and PRIORITY are not applicable for shaft generators– the shaft generators must always be managed manually.

2.2 Power Chief – Pump and Compressor Control

General

The PowerChief – Pump and Compressor Control manages automatic and manual remote operation of the compressors and pumps.

All pumps can be started and stopped locally from the engine room independently of the AUTO/MANUAL.

If the automatic control is not active (AUTO lamp button is not lit) the pumps may be started and stopped manually from the panel.

In AUTO mode the pumps and compressors are automatically started and stopped by the control functions including:

- Stand-by start at low pressure
- Auto stop at high pressure
- Restart after black-out
- Power check (start inhibit at “High Power”) on generators
- Cyclic operation of units

If there has been a disturbance in the AUTO system, for instance, a local start/stop or an alarm has occurred, the auto lamp and the start lamp start flashing.

Each Main Engine pump with stand by function may be set in auto cycle mode. In this mode the pump in service is automatically changed between pump no 1 and no 2.
The functions can be set on or off and the time period can be changed from variable page 7022.

When pressure drops below the "stand-by start limits", the stand-by unit is started automatically. Most of the low-pressure alarms are subject to "Automatic alarm blocking". The stand-by start function will be blocked as well during the same period of time.

The stand-by limits can be viewed and changed from variable page7021.

Both Main Engine auxiliary blowers will operate together in AUTO.

Each main air compressor can be selected as MASTER. The selected compressor will then start and stop at higher pressures than the non-selected compressor.

Operation procedure

1. Preparations before operating the compressors and pumps in remote or automatic

1.1 All systems must be lined up and tested before remote or automatic management.

2. **MANUAL mode**

2.1 Push START button.
2.2 When steady light, pump/compressor is running.
2.3 Push button on running pump/compressor to stop the pump/compressor.

3. **Pump AUTO mode:**

3.1 As in manual mode.
3.2 When first pump is running push AUTO.
3.3 Changing pumps in AUTO, deactivate AUTO and start selected pump and stop running pump.
3.4 Push button AUTO.

4. **Compressor AUTO mode.**

4.1 Ensure compressor is lined up.
4.2 Select Auto mode.
4.3 For main compressors select one to be master.

NOTE! If an object has developed faults, stand by pump/compressor will start. Flashing light in start button indicates start of stand by object. To remedy condition, stop object. Locate problem and “repair”. After a repair attempt or rectifying of running condition, follow normal AUTO procedure.

3 ALARM / MONITORING SYSTEM

The central alarm system is integrated in the DataChief Section. The alarm system consists of 28 alarmgroups with a corresponding red alarm indicator numbered from 1 through 28. Normally, all alarm lamps are turned dark. As soon as an alarm occurs, one of the alarm lamps starts flashing. Additional information is obtained by selecting the corresponding alarm group, from the alarm page directory.

Each alarm group covers alarm points from dedicated subsystems. The alarm point exceeded normal values, turns into a flashing mode.

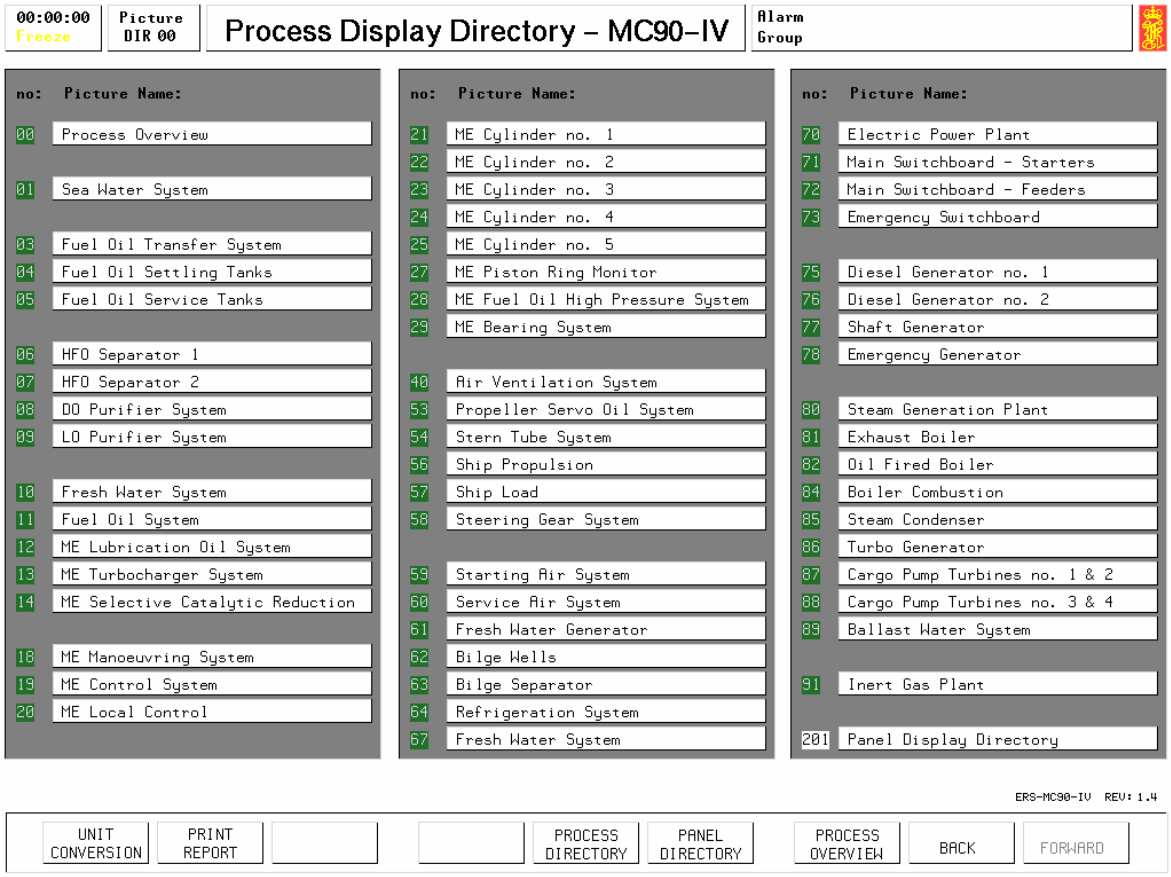
The Alarm point (displayed in the MD picture) turns to steady condition as soon as the operator moves the cursor to its location and resets the alarm by using the left hand side push-button of the tracker ball (mouse).

As soon as the measured value is within the alarm limit(s), the alarm indication turns off.

Measured values are displayed together with tag no., tag name, engineering units, and upper/lower limits for alarms. The limits can be altered from Instructor mode by point and click with centre tracker-ball button at limit and then type in new value, press “Enter” (Carriage Return).

The alarm log is displayed by pressing the F8 button on the keyboard, or if dedicated keyboard is a part of the delivery, the Alarm Log button.

Process Overview Diagram



This diagram shows the status of the engine room plant by:

- running/stop and alarm status for the main engine
- running/stop and alarm status for the steam system
- running/stop and alarm status for the electrical system
- running/stop and alarm status for the auxiliary systems

The status is shown by color codes:

Green:	Running
Red:	Alarm
Black:	Not in operation
Yellow:	Generator is connected to bus bars

All system diagrams can be accessed from this diagram by clicking on the various system icons.

4 PURIFIER CONTROL

The control of purifiers includes both automatic and manual control. The interval between each shooting sequence can be adjusted and the purifiers can be shot individually.

NOTE For Alcap purifier – please refer to instructions in the manual Machinery and Operation.

Start of the purifiers:

The purifiers are started and stopped from their local panels.

Modes of operation

The following modes of operation are selected by a mode selector on the local panels, MANUAL, and AUTO.

Switching from "MANUAL" to "AUTO"

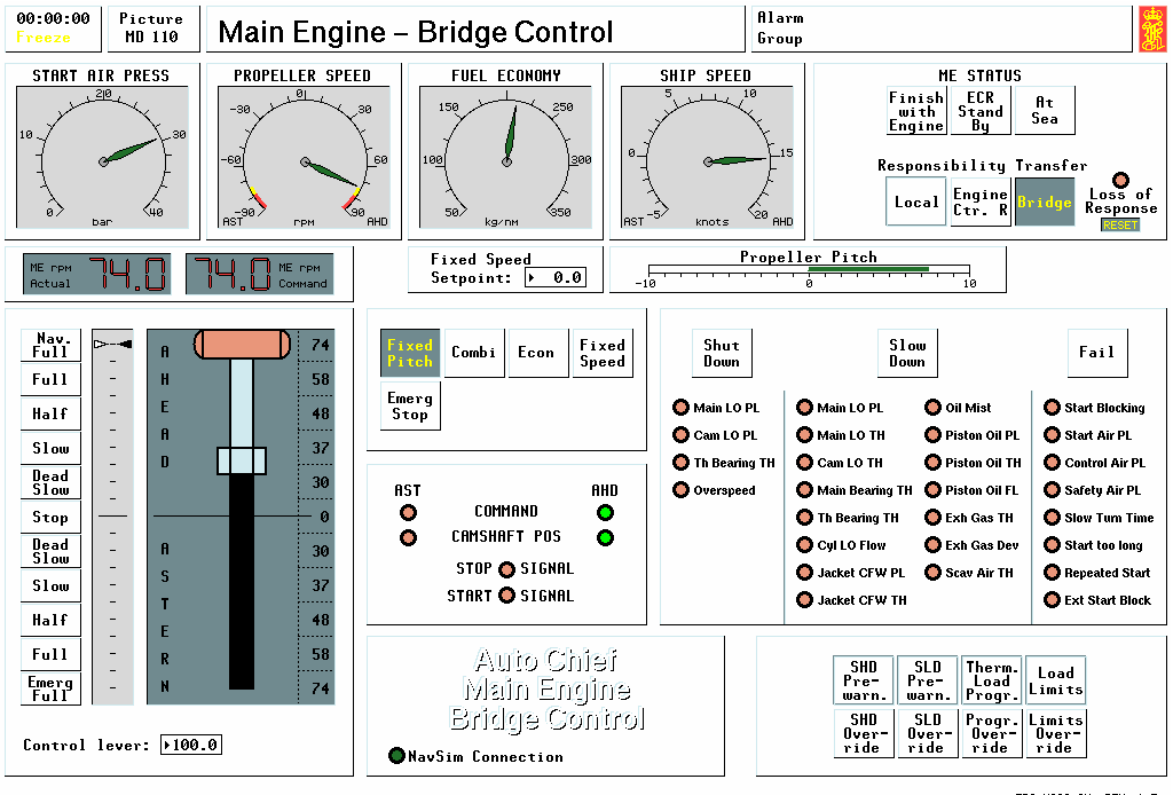
The purifier is shot periodically according to the shooting sequence recommended by the manufacturer. If the purifier is stopped in auto mode, the first part of a normal shooting sequence is performed immediately, and the bowl remains open; ready for later operation. The purifier has sufficient rotating moment of inertia to make this short shooting possible.

Switching from "AUTO" to "MANUAL"

Current shooting is interrupted immediately. The electrical connection to the control relays is broken. Alarms are reset. No monitoring or control functions are performed.

5 BRIDGE CONTROL PANELS

5.1 Main engine – Bridge control



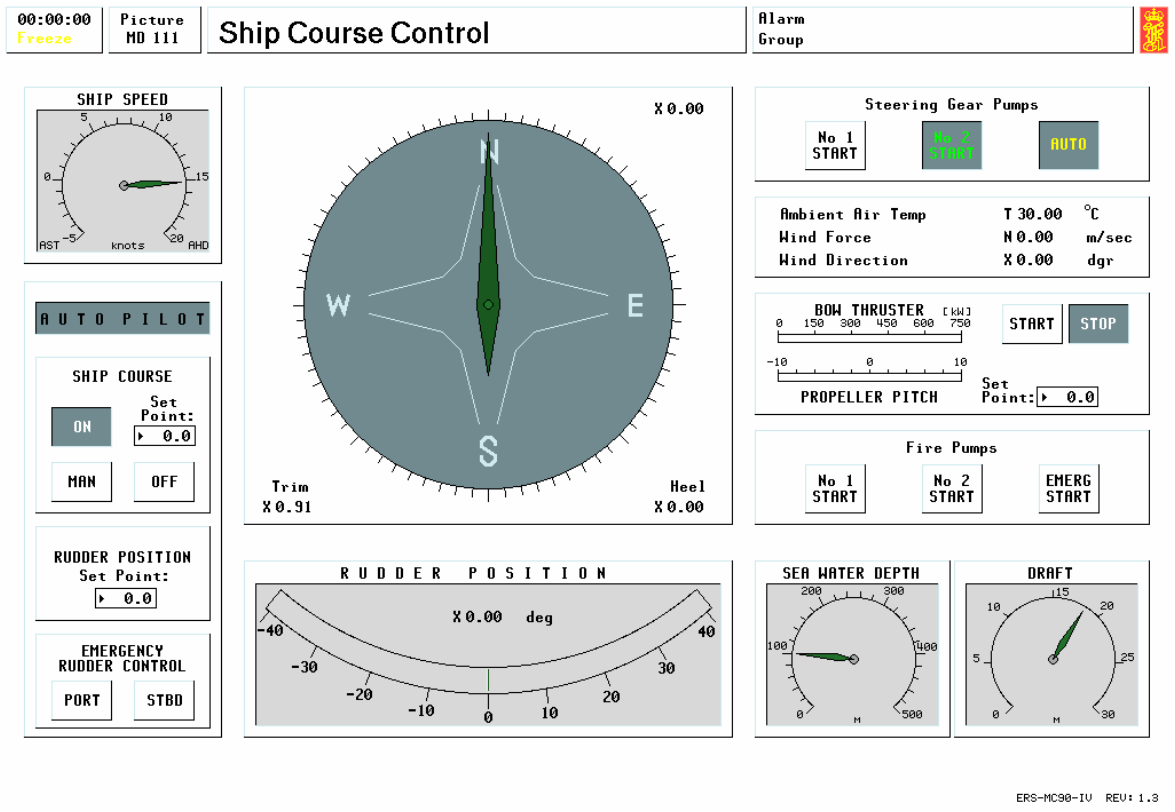
The control system fitted to the bridge is a mimic of that fitted within the Engine Control Room. Both panels have the same functionality, although same minor controls are different. Note that the Bridge has a starting air pressure gauge, which is mandatory for all engine manoeuvring positions.

Operations of the engine from the Bridge control station:

1. The Bridge panel must be selected. If not change over using the procedure listed within MD104 for responsibility transfer
2. Ensure that the main engine and auxiliary systems are operational. The engineering staff would confirm this, and would allow the engine to be placed on ECR Stand By status.
3. The engine direction and speed should be adjusted by moving the fuel control handle to desired engine speed by point and click on the interactive field (default settings are dead slow/slow/half and full positions). Manual typing in of desired command in the numeric window can also be used if a non standard speed was required..
4. The mimic diodes will indicate the ahead and astern command and actual camshaft position.

The Bridge are able to over-ride shut downs and slow downs from their panel, although they should inform the ECR of this action.

5.2 Ship course control



This screen is used to control the vessel manoeuvring using the steering gear and bow thruster. The actual environmental conditions of air temperature, wind force, wind direction, sea water depth, and vessel draft are displayed. These can be adjusted using the Sim Control variables on page 9002.

The main and emergency fire pumps can be started using this panel. If the engine room was operating under UMS conditions, then the Bridge should activate the fire pump start upon a fire alarm activation.

Under normal sea going conditions the following system should be operational:

1. One of the two steering gear pumps would be running, and the other placed in standby using the auto button
2. Autopilot set to ON, with the required course set point
3. The rudder would be moved by the autopilot to achieve the desired course, with a maximum rudder angle of +/- 15^{o}

Under standby engines (SBE) engines, the following systems should be operational:

1. Both steering gear pumps would be running.
2. The autopilot would be set to MANUAL, so that hand steering is possible.
3. Hand steering is accomplished by clicking the required rudder angle into numeric window of the rudder set-point. Note rudder angles to port are a negative input i.e. -25^{o} for port 25.
4. The bow thruster could be started after checking with the engineering staff that sufficient electrical generating capacity is present.
5. The bow thruster pitch is adjusted by clicking the required pitch setting into numeric window of the set-point. Note pitch settings to port are a negative input i.e. -5 for port 50% pitch.