# Preface

## What does this book contain?

This instruction manual provides general guidance regarding operation and maintenance and gives a description of the design of the remote control system. It is also to be used as reference when ordering spare parts.

The manual is divided into a number of chapters that correspond to the main components/units of the remote control system. The number of each chapter is decided by our PSP–system (product specification system) and is the foundation stone of our EDP–system.

Each chapter consists of three main elements:

- **Instructions** (text concerning functionality, operation and maintenance)
- **Data** (list of symbols, wiring diagrams etc)
- **Spare part plates** (spare part illustrations and additional lists)

Reliable and safe operation of the remote control system is dependent on correct operation and maintenance. It is therefore important that the engine personnel is fully acquainted with the contents of this book.

The remote control system is delivered including a warranty clause which has been contractual agreed upon.

It is, of course, a precondition for the validity of such a warranty that the propulsion plant is operated in accordance with agreed requirements and recommendations.

Spare parts must be original spare parts purchased directly from MAN B&W Diesel, Alpha Diesel or from one of MAN B&W Diesel's authorized workshops or agents.

*1998–01–23*

## How do I order spare parts ?

Spare part plates consist of a drawing of the spare part and an accompanying list of the items shown on the drawing.

The drawing may not be completely identical to your plant and may also show some items that are not included in your plant. The additional list of items, however, is always in accordance with your specific plant.

Note that some items on the spare part drawings may only be delivered as part of a kit or complete assembled component. This is, however, generally stated on the drawing.

When ordering spare parts (or reference is made in correspondence) the following data must be specified:

1. Name of vessel (eg M/S Star)
2. Product identification no ( 4000 5476)
3. Spare part plate no (incl. edition no – eg 4 1505–01)
4. Item no (eg 16)
5. Description of part and quantity required (eg 4 bulbs)

These data are used in order to ensure correct supply of spare parts for the individual propulsion plants sold.

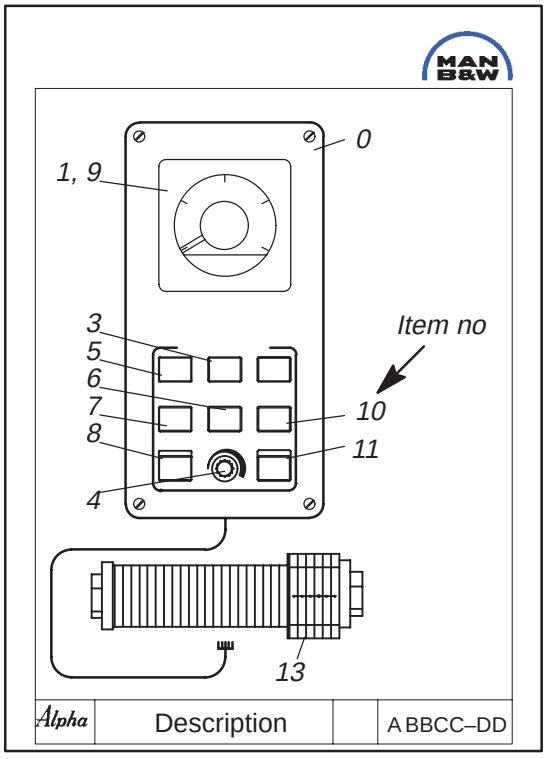



***Plate no A BBCC–DD***

*A:* *A = 4 for remote control system*

*BBCC:* *BB = chapter (main function)*
*CC = subfunction*

*DD:* *version*

*1998–01–23*

# 05. Data

## Description



## Data



*2001–11–28*

*2001–11–28*

# Operator instruction manual

*2001-09-26*

*2001–09–26*

# Table of contents



2001–09–26

*2001–09–26*

## Terminology

This is the terminology used in connection with the operator manual for AT2000 PCS.

Hard key, pushbutton or indication lamps:
**[COMBINATOR]**, **[TAKE CONTROL]**, **[BACK UP CONTROL ON/OFF]**.

Softkeys:
**“START”**, **“STOP”**, **“ENGAGE”**, **“END OPERAT.”ion**, **“START BLOCK”ing**.

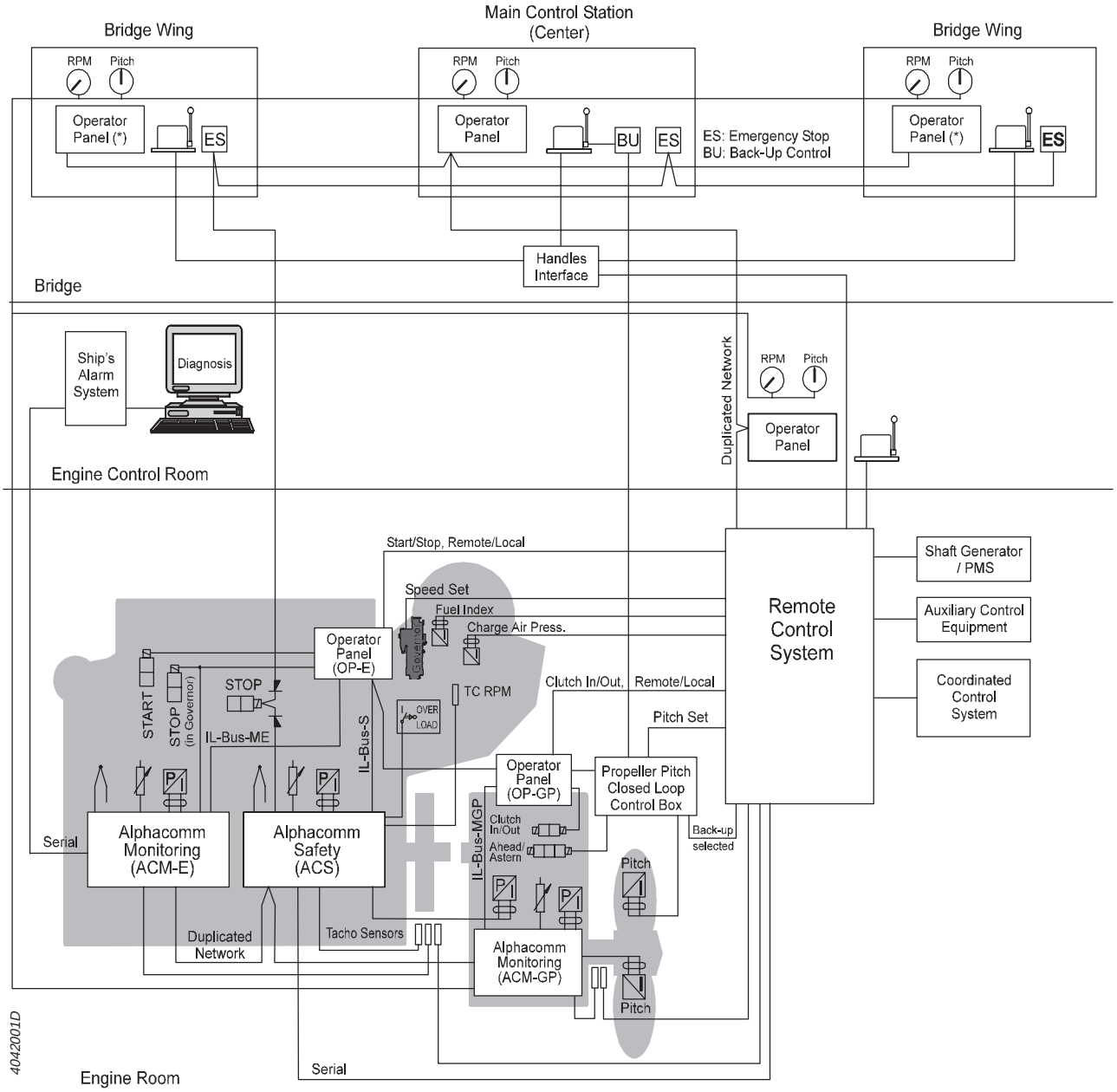
Status information:
**<Stopped>**, **<Slowt Req>**, **<Repeated start alarm>**

# 1. Introduction

The Alphatronic 2000 propulsion control system – AT2000 PCS – is used for remote control of a ship's propulsion line. A two–stroke low speed or four–stroke medium speed engine is connected to a controllable pitch propeller (CPP) through a reduction gearbox, with optional clutch control for the main engine clutch, power take–off (PTO) clutch to a shaft generator (SG) and the power take–in (PTI) clutch for a pony motor to startup the SG in PTI mode (optional) used for electrical take–home power.

The AT2000 PCS is operated by means of setpoint levers and standard AT2000 PCS panels with built–in four lines display.

***Fig 05.1***




***Propulsion control system, AT2000 PCS layout***

The AT2000 PCS is operated as a completely independent stand–alone system, with all information and internal alarms displayed on the PCS operator panels.

When the AT2000 PCS is delivered together with a MAN B&W Alpha four–stroke engine, the PCS is integrated on the Alphacomm units fitted on the engine. They ensure engine monitoring, engine safety system and gear monitoring by means of a communication network, enabling alarms, indications and measurement values from the Alphacomms to be displayed on the AT2000 PCS panels also.

The AT2000 PCS can provide control of:

- Main engine start/stop.
- Main engine setpoint (combinator, constant rpm and separate).
- Main engine load control (load control limitations).
- Main engine load reduction (rpm and/or load reduction).
- Main engine speed measurement (and indication).
- Combinator control from single lever in ECR and on the bridge.
- Controllable pitch propeller (CPP) setpoint system (combinator curves).
- Control transfer (bridge/ECR setpoint selection).
- Propulsion mode selection (combinator, constant rpm and separate).
- Bridge wing control with wing panels and electric shaft on setpoint levers.
- Serial interface to Alphacomm units on the main engine (if mounted).
- Alarm announcement and indication.

The AT2000 PCS can be extended with the following options:

- Clutch control (ME, PTO and PTI (engage/disengage)).
- Propeller shaft speed measurement and indication.
- Interface to PTO connected shaft generator (SG waiting station).
- Alternative propulsion (PTI mode).
- Power boost (ME + PTI simultaneously).
- Communication telegraph system for bridge order communication to ECR/Local.
- Manoeuvring order printer integrated in the system.

This document gives an overview of the hardware and describes the functionality in the system also including wiring overviews.

A description of the control lever system with possible electric shaft for the bridge wings can be found in chapter 4 25.

2001–09–26

## Definitions and abbreviations

| | |
|---|---|
| ACM–E | Alphacomm monitoring – engine |
| ACM–GP | Alphacomm monitoring – gear and propeller |
| ACS | Alphacomm safety |
| AI | Analogue input |
| AO | Analogue output |
| BT | Bow thruster |
| BU | Backup control |
| CPP | Controllable pitch propeller |
| DG | Diesel generator |
| DI | Digital input |
| DO | Digital output |
| ESS | Engine safety system |
| ECR | Engine control room |
| EXH | Exhaust |
| ER | Engine room |
| ENT | Enter key |
| ES | Emergency stop |
| ESC | Escape key |
| I/O | Input/output |
| LED | Light emitting diode |
| LMCS | Local monitoring control and safety systems – fitted on engine |
| ME | Main engine |
| MHP | Manoeuvre handle panel |
| MMI | Man machine interface |
| MSB | Main switch board |
| OD | Oil distribution (box) |
| OP–E | Operator panel locally on the engine |
| OP–GP | Operator panel locally on the gear and propeller box |
| PCP | Propulsion control panel |
| PCS | Propulsion control system |
| PIP | Propeller indicator panel |
| PLC | Programmable logic controller – gamma computer |
| PMS | Power management system – ships generator control system |
| PS | Port side |
| PTO | Power take–off |
| PTI | Power take–in |
| Rpm | Rotations per minute |
| SAS | Ship's alarm system |
| SB | Starboard side |
| SG | Shaft generator |
| SHD | Shut down |
| SLD | Slow down/load reduction |
| ST | Stern thruster |
| UPS | Uninterruptable power supply |

2001–09–26

*2001–09–26*

# 2. Hardware overview

The AT2000 PCS control functions for one propulsion line consisting of a two or four–stroke engine with gear, clutches, propeller shaft and controllable pitch propeller are handled by one AT2000 PCS process computer mounted in the PCS control cabinet.

The following parts of the remote control system are described in this section:

- AT2000 PCS main cabinet (process computer and I/O modules).
- PCS panels for remote control of the propulsion machinery.
- Setpoint levers.
- Electric shaft system for bridge wing controls.
- Communication telegraph system.

2001–09–26

## Serial interface, safety system

***Note***

*Four–stroke engines type L21/31 and L27/38 are equipped with a local monitoring, control and safety system type AT2000 LMCS fitted on the engine.*

The three Alphacomm computers used for the engine safety system (ACS), the engine monitoring (ACM–E) and the gear/propeller monitoring (ACM–GP) on the engine side are connected together by means of a network, allowing them to interchange information.

The Alphacomm safety system on the L27/38 medium–speed engine has LED bar graphs for local indication on the engine. The ACS is completely independent of the PCS, but connected with a serial interface to the PCS, making it possible to display all shutdown, overspeed and emergency stop indications on the PCS panel.

The ACM–E is taking care of the engine alarm sensors. The sensor values are also shown on LED bar graphs as local instrumentation on the engine. The ACM–E is completely independent of the PCS, but connected with a serial interface to the ship's alarm system, making it possible to display shutdown, overspeed, emergency stop and all engine, gear and propeller indications on the ships alarm system monitor.

The ACM–GP takes care of alarm sensors on the gear and propeller. The sensor values are also shown on LED bar graphs as local instrumentation.

Other types of main engines may be equipped with a standard safety system from the main engine manufacturer.

## AT2000 PCS main cabinet hardware

The AT2000 PCS main cabinet is built using the following hardware modules:

- ZM 401 Gamma micro CPU module
- SIM 401 Serial Interface Module with two channels.

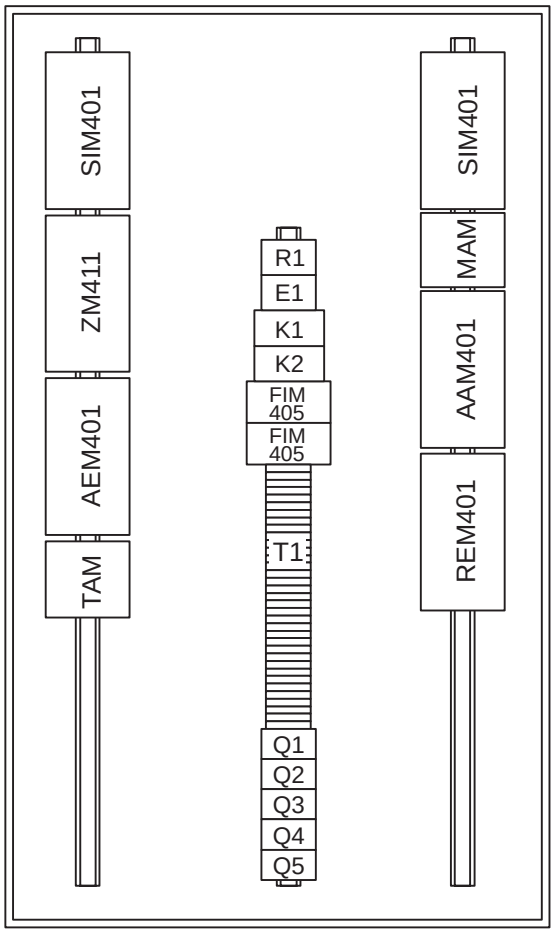
  For optional connection to the safety system, tacho adapter module, manoeuvring printer and service/load channel
- TAM Tacho adapter module for rpm pickups
- AEM 402 8 channels analogue input module (resistance, voltage or mA inputs)
- MAM 401 Input/output adapter for digital I/O modules
- AAM 401 4 channels analogue output module, 0/4–20 mA or 0–10 volt
- REM 401 16 digital input and 8 relay output
- FIM 405 Filter module for 24 Vdc power supply

For special applications of the AT2000 PCS, modules may be removed, exchanged or added.

Fig 05.2 shows the standard configuration of units inside the main panel.

Please refer to chapter 4 15 for the exact configuration.

***Fig 05.2***




***Main panel***

*2001–09–26*

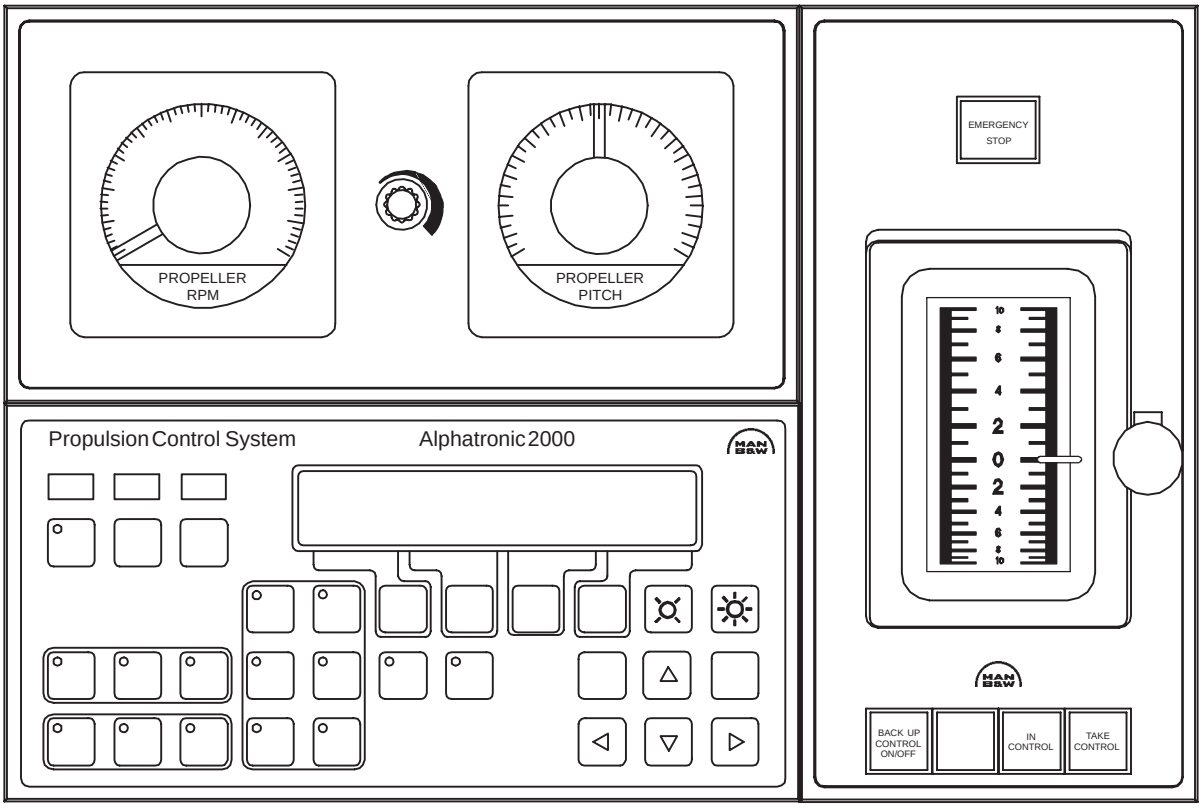
## Panels for remote control

For operation of a ship's propulsion line, the PCS is connected with PCS operator panels, including instruments for propeller rpm and pitch indication and a push–button for emergency stop:

- often one in the engine control room (ECR).
- one on the bridge.
- two panels on the bridge starboard and port wings (optional).
- a fifth panel can be mounted on an aft bridge (optional).

The PCS panel is mounted together with a setpoint lever on all control locations with PCS control, ie normally bridge and ECR, and optionally on the bridge wings.

***Fig 05.3***




*Propeller indicator panel PIP*

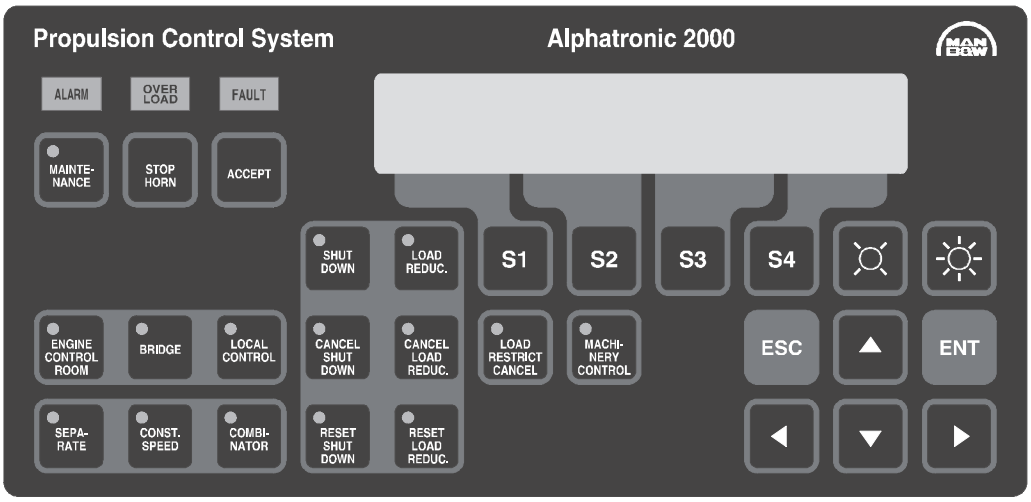
*Propulsion control panel PCP*

*Manoeuvre handle panel MHP*

***PCS panel common for all control locations***

2001–09–26

***Fig 05.4***




***Propulsion control panel***

## PCS panel functions

The following main functions are available on each control location for the main engine/ propulsion line (see fig 05.3):

- Analogue instruments for indication of shaft rpm.
- Analogue instruments for indication of propeller pitch.
- Dimmer potentiometer for illumination of the analogue instruments (bridge only).
- Emergency stop pushbutton.
- Setpoint lever.
- Pushbutton for back up control (bridge only).
- Pushbuttons and indications for transfer of control between control locations on the bridge.
- AT2000 PCS operator panel (see fig 05.4) with the following functions:
  - o Four lines display with 40 characters on each line.
  - o Softkeys **[S1] – [S4]** for operation of PCS functions.
  - o Six selection keys: **[ESC], [ENT]** and four **[ARROW]** keys.
  - o **[MACHINERY CONTROL]** for selection of PCS control functions.
  - o Control location selection and indication: **[BRIDGE], [ENGINE CONTROL ROOM]** and **[LOCAL CONTROL]**.
  - o PCS control mode selection and indication: **[COMBINATOR]**, **[CONSTant SPEED]** and **[SEPARATE]** mode.
  - o **[LOAD REDUC.]** indication, **[CANCEL LOAD REDUC.]** and **[RESET LOAD REDUC.]** operation.
  - o **[SHUTDOWN]** indication, **[CANCEL SHUTDOWN]** and **[RESET SHUTDOWN]** operation.
  - o **[LOAD RESTRICT CANCEL]** indication and operation key.
  - o **[OVER LOAD]** indication lamp for main engine overload switch.
  - o Keys for alarm functions inside the PCS.
    - ■ **[STOP HORN]** and alarm **[ACCEPT]** keys.
    - ■ **[MAINTENANCE]** key also giving access to alarm list, display channel, etc.
    - ■ **[DIMMER]** keys. 
    - ■ **[ALARM]** and **[FAULT]** indication lamps.

2001–09–26

The **[LOAD RESTRICT CANCEL], [RESET]** and **[CANCEL]** keys for shutdown and load reduction, and the **[COMBINATOR], [CONSTant RPM]** and **[SEPARATE]** PCS control mode selection keys are only working on the PCS panels in control, ie on anyone of the bridge panels during bridge control and on the ECR panel in ECR control.

## Safety system for the main engine

The engine safety system is connected to the AT2000 PCS, giving information about shutdown conditions. It is on most plants possible, via the operator panel of the PCS, to operate the important functions inside the safety system, such as reset shutdown and cancel shutdown. For certain plants, a separate panel will be used for operator communication with the safety system.

The connection between the PCS and the safety system may either be of the serial type or alternatively the hardwired type (a number of discrete signals between the two systems). The serial interface makes it possible to extract more information from the safety system, compared to a hardwired connection.

For four–stroke engines type 27/38 and 21/31, equipped with the electronics type AT2000 LMCS, there will be a serial interface to the safety system.

Please refer to the engine Instruction Manual for details of the safety system.

## Main engine and shaft speed measurement

The AT2000 PCS is using a tacho adapter module to interface the tacho pickup mounted close to the flywheel of the engine to the serial interface module used for measurement of the main engine speed.

The same type of tacho system is also used as tacho system for the propeller shaft, if not directly connected to the main engine without clutches.

## Setpoint control unit and levers

The bridge is equipped with a setpoint control unit on the bridge centre, as the bridge main station, fig 05.5. The setpoint control unit at bridge centre can be interconnected by means of an electric shaft system to one or more bridge wing stations.

As standard the ECR is equipped with a similar setpoint control unit. Optionally the system can be delivered without equipment in the engine control room.

Bridge centre and ECR setpoint levers are equipped with potentiometers with hardware connection to the PCS System.

The bridge – and ECR setpoint levers are completely independent of each other, ie they are not working as a communication telegraph system between bridge and ECR.

### Electrical shaft system

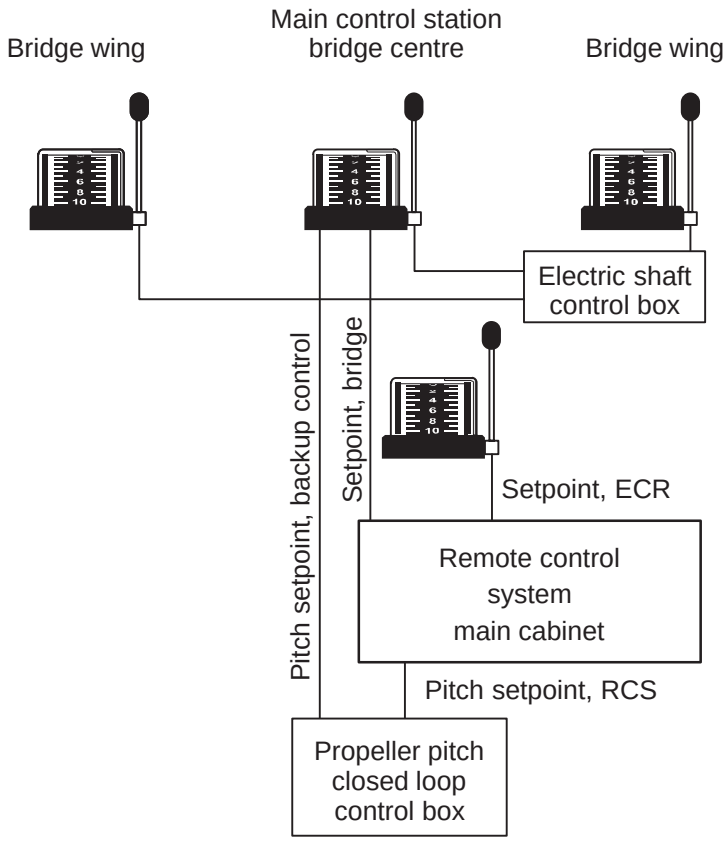
Ships with bridge wing control are equipped with an electrical shaft system interconnecting the bridge centre and bridge wing control levers.

The electrical shaft system is an integrated part of the complete remote control system, but it is based on components completely independent of the PCS gamma and all other items of the overall system.

The electric shaft system is a so–called synchronising system, in which non–activated control levers are following the active control lever, chosen as random, ie when the bridge centre is master, and the two bridge wing levers automatically follow the master lever in the bridge centre.

2001–09–26

***Fig 05.5***




***Setpoint levers***

2001–09–26

The system design secures that the lever chosen to be **"IN CONTROL"** will act as a master and the other handles on the bridge will follow its position. This will avoid any synchronizing of levers at the time of changing control position on the bridge, please refer to chapter 4 25.

### Bridge centre and wings control transfer

Each setpoint control unit on the bridge electrical shaft system is equipped with two lamps and one pushbutton for control transfer indication:

- Pushbutton **[TAKE CONTROL].**
- Lamp indication with dimmer for **[IN CONTROL]**. Illuminated at the bridge control position working as master.

To change the control position between the three control units on the bridge, press the **[TAKE CONTROL]** pushbutton on the new master control position and it will change immediately, indicated with steady light in the **[IN CONTROL]** lamp.

As the levers are already synchronised by the electrical shaft system, there is no need for further alignments before pressing the **[TAKE CONTROL]** pushbutton.

### Backup control of pitch from the bridge

In case of a breakdown of the PCS system or a critical failure in the PCS system, it will no longer be possible to start/stop the engine and engage/disengage the thrust clutch from the PCS panel or use the combinator curves and load controller functions in the PCS.

To solve this problem, the engine is started and engaged in local control and then the

**[BACKUP CONTROL ON/OFF]** pushbutton on the bridge is pressed to select pitch control directly from the bridge centre setpoint lever.

***Note***

*The propeller must be set to **"REMOTE"** and the **[BRIDGE CONTROL]** must be selected via the PCS panel before the **[BACK UP CONTROL ON/OFF]** pushbutton can be activated.*

*If the power supply is removed from the PCS, it will also be possible to select **[BACK UP CONTROL ON/OFF]** provided the propeller is set to "REMOTE"*

*For instructions on setting the propeller to **"REMOTE"**, please refer to chapter 82 of the gear or propeller instruction manual.*

In backup control the main engine is running at constant rpm, controlled by the main engine governor, and the propeller pitch is then controlled by means of an additional, independent setpoint potentiometer mounted on the bridge centre setpoint lever and connected directly to the CPP closed loop control system.

### Emergency operation

Emergency operation of the engine start/stop, clutch, rpm and propeller pitch is done from the local operator panels fitted on the engine and gear box, by means of selector switches, connected directly to the engine, clutch and CPP control system.

The Back up control and emergency operation is completely independent from the AT2000 PCS, ie also working when the PCS gamma CPU and operator panels in the AT2000 PCS system is switched off.

### Communication telegraph system

For optional communication of telegraph orders from the bridge to the ECR during ECR control and to the engine side in the engine room during local control, the system can be extended with a separate communication telegraph system, which is electrically independent of the PCS system.

Please refer to the separate manual in chapter 4 25 for a full description.

2001-09-26

*2001–09–26*

# 3. Description of main functions

## Auto mode set–up and close down of the engine

***Note***

*Not all plants are equipped with the auto mode set–up and close down function.*

When operated in auto mode, the system will make a complete set–up by means of a few soft–keys for the following functions: **“PREPARE” – “END”** and **“ENABLE” – “DISABLE”**, which are defined as follows:

- **Prepare:** An automatic start sequence, starting with the start signal to auxiliary subsystems, and when shut downs and startblockings etc disappear, it continues with slowturning and start of the engine, ending up in a (disabled) state, where the engine is running at idle rpm (or in case separate mode is selected the corresponding rpm setpoint will be selected) with zero pitch, ready to be enabled for propulsion.
- **Enable:** When the engine is running prepared for propulsion, enable, which is related to the **“CLUTCH IN”** soft–key on the first level of the machinery control, will engage the thrust clutch (if existing and selected) and connect the setpoint levers online in combinator mode so that pitch and rpm can be controlled.
- **Disable:** When the engine is enabled, ie the operator has the full online control by means of the setpoint levers, disable, which is related to the **“CLUTCH OUT”** soft–key on the first level of the machinery control, will disengage the thrust clutch (ME or propeller clutch) or in case of no thrust clutch, the propeller pitch will be set (locked) to zero pitch and control of engine speed will be changed to idle speed. In case that separate control is selected, the control of the engine speed will be changed to separate control.
- **End:** An automatic stop sequence, which will stop a disabled, running engine. And after the time–out of the postoperation of the auxiliary equipment, the start signal to the auxiliary subsystems will be removed. It also requires that the main start valve is manually closed and for two–stroke engines also that the control air and safety air valves are manually closed and vented.

Please refer to page 05–70 for machinery control soft–key structure and page 05–58 to see how the auto engine set–up and close down is operated.

## Manual mode set–up of engine

In manual mode, the operator must manually prepare the pumps from the motor–starters, start the engine, engage clutches, etc from the soft–keys for each individual machinery component. The operator must manually select the combinator or constant speed mode, depending on the speed requirements for whatever is connected to the PTO/PTI to enable power (set standby for propulsion).

### Slowturning

Slowturning of the main engine is normally used before the engine is started after a longer period of standstill. It is done by turning the engines a minimum of 1 or 2 revolutions on starting air. The slowturning function can be customised in different ways:

- Always working, ie automatic slowturning each time the engine is started,

2001–09–26

with the first 1 or 2 revolutions on air only.

- Automatic slowturning if the engine has been stopped for more than 10 minutes. In case the operator does not want the engine to be slowturned at the next start, it is possible by means of the **“CANCEL SLOWTURN”** softkey to reset the slowturn timer.

### Four–stroke engine slowturning

Slowturning is performed by the LMCS internally. The PCS will release the governor stop and activate the start valve as for a normal start. The LMCS will at the same time activate the safety stop valve.

When the engine has turned a minimum of 2 revolutions, the safety stop valve is released by the LMCS, and the start sequence will continue as a normal start sequence.

If the slowturning is not completed within 5 seconds, the engine is stopped again by activating the governor stop and deactivating the start valve and a **“SLOWTURNING TIME–OUT ALARM”** is released giving a startblocking which must be reset by the operator (using the stop or reset key) before a new start attempt can be executed.

### Two–stroke engine slowturning

A two–stroke engine is automatically slowturned when it has been stopped for more than 10 minutes. Slowturning is performed by releasing the governor stop and activating the start valve and stop valve as for a normal start and at the same time activating the slowturning valve. When the engine has turned a minimum of 1 revolution, the slowturn valve is released and the start sequence will continue as a normal start sequence.

If slowturning is not completed within 5 seconds, the engine is stopped again by activating the governor stop and deactivating the start valve and a **“SLOWTURNING TIME–OUT ALARM”** is released giving a startblocking which must be reset by the operator (using the stop or reset key) before a new start attempt can be executed.

## Manual start/stop of main engine

It is possible to start and stop the engine from the bridge as well as in the ECR.

Start/stop of the main engine is done by means of softkeys on the PCS panel in control. Please refer to page 05–59 for a detailed description of the **“START”** and **“STOP”** softkeys.

If the operator activates a start/stop softkey on a panel, which is not in control, nothing will happen, but a warning in form of a short beep is given at the buzzer.

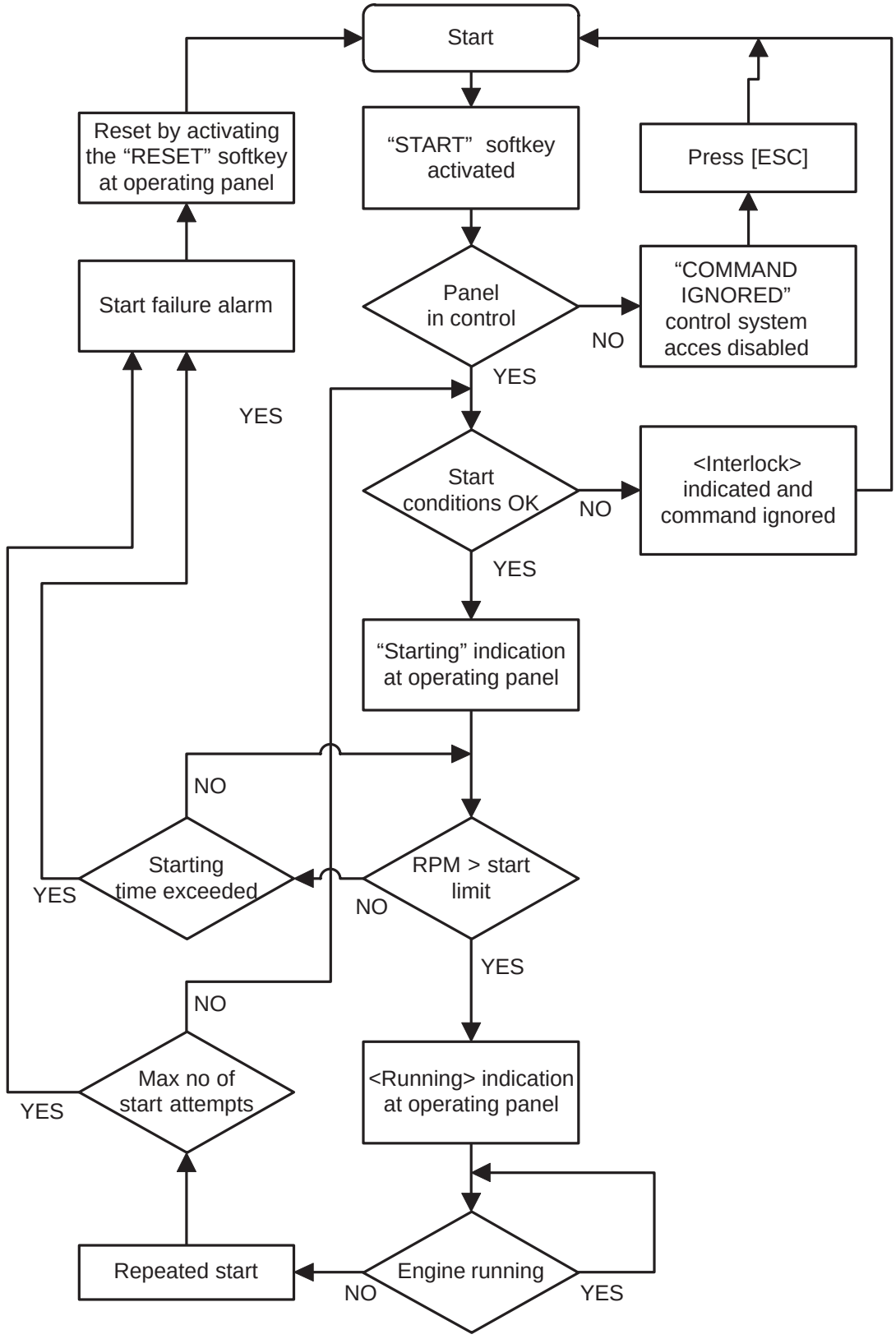
If a start softkey is activated from the panel in control with one or more start blockings active, nothing will happen, but an interlock information is displayed on the PCS panel display for the main engine start/stop.

If a start request with no blockings is done from the panel in control, the main engine will begin to be started, indicated by **<Starting>** on the panel until it is running, and then the indication will change to **<Running>.**

Please refer to fig 05.6 showing the start sequence flow diagram.

2001–09–26

*Fig 05.6*




***Main engine start sequence flow diagram***

2001-09-26

### Startblockings

If the engine is not ready for start, ie start is blocked, a **<Startblok>** indication is displayed on line two of the display, ie on the line above the **"START"** and **"STOP"** softkeys. When the engine is ready for start, the indication will change to either **<Stopped>** or **<Slowt Req>** indicating if the next start will be with or without slowturning.

At the PCS panel, it is possible to select a status list, displaying status for the different startblockings for the main engine. Please refer to page 05–65 for a detailed description of how to display the start blockings list.

The following startblockings may be relevant for the PCS system:

- ME local control on.
- ME safety system shutdown or emergency stop.
- Start failure (starting air time–out or max number of failed start attempts).
- Slowturning failure (time–out).
- Propeller pitch not zero (no thrust clutch).
- Propeller oil pressure low (no thrust clutch).
- Gear lubricating oil pressure low (no thrust clutch).
- Turning gear engaged.
- Starting air pressure low.
- Engine running.
- ME lub oil pressure.

Some startblockings can be cancellable by means of the **"CANCEL ST.BLK"** softkey. Please refer to page 05–59 for a description of how to use the cancel startblockings softkey.

Cancel start blockings will normally activate an alarm in the PCS system. To remove the cancellation of startblockings again, activate the **"CANCEL OFF"** softkey beside the **"CANCEL ST.BLK"** softkey.

### Start/stop

The engine is started by releasing the governor stop and activating the start valve. When the engine rpm passes the firing speed limit, the start valve is deactivated, and after the stabilising time the engine is running.

### Repeated start

If the start attempt is unsuccessful, a second start attempt is initiated and **<Rep.start>** is indicated and a repeated start alarm is released. After the maximum number of start attempts (normally three), the start sequence is terminated with an alarm for max start attempts and a startblocking which must be **"RESET"** from the softkey before further start attempts can be initiated. Please refer to page 05–59 for a detailed description of the **"RESET"** Softkey.

### Start in manual mode

When the engine is started in manual mode from the **"START/STOP"** menu, no repeated starts are performed automatically. Ie a start attempt where the engine rpm drops below the firing speed again, will activate the governor stop and initiate a **"START AIR TIME–OUT ALARM"** giving a startblocking which must be reset by the operator (using the stop or reset key) before a new start attempt can be executed.

### Auto mode

When the engine is started in auto mode from the **"PREPARE/END"** menu, it has three start attempts. If the engine rpm drops below the firing speed, the governor stop is activated, a **<Repeated start alarm>** is released and when the engine is stopped, ie

2001–09–26

the engine speed has been below 3 rpm for a short time, a new start is initiated releasing the governor stop and activating the start valve again.

If the engine stops again after three (3) start attempts, a **<Start failure alarm>** is initiated giving a startblocking which must be reset (using the stop or reset key) before a new start attempt can be executed.

## Gear and clutch control

A number of different gear and clutch configurations are covered by the PCS control system.

The purpose of the gear is either to reduce or to step up the speed from the engine and transmit the power to the propeller and/or to a power take off (PTO). For the four stroke medium speed engines, the gear is a combination of a step–up and a reduction gear. For the two stroke low speed engines, the gear is a pure step–up gear for a PTO and/or a PTI. For the set–up of different combinations of the power transmission, a number of clutches can be incorporated in the gear.

***Note***

*Please refer to the gearbox instruction manual for information of gear and clutches relevant for the actual propulsion plant*

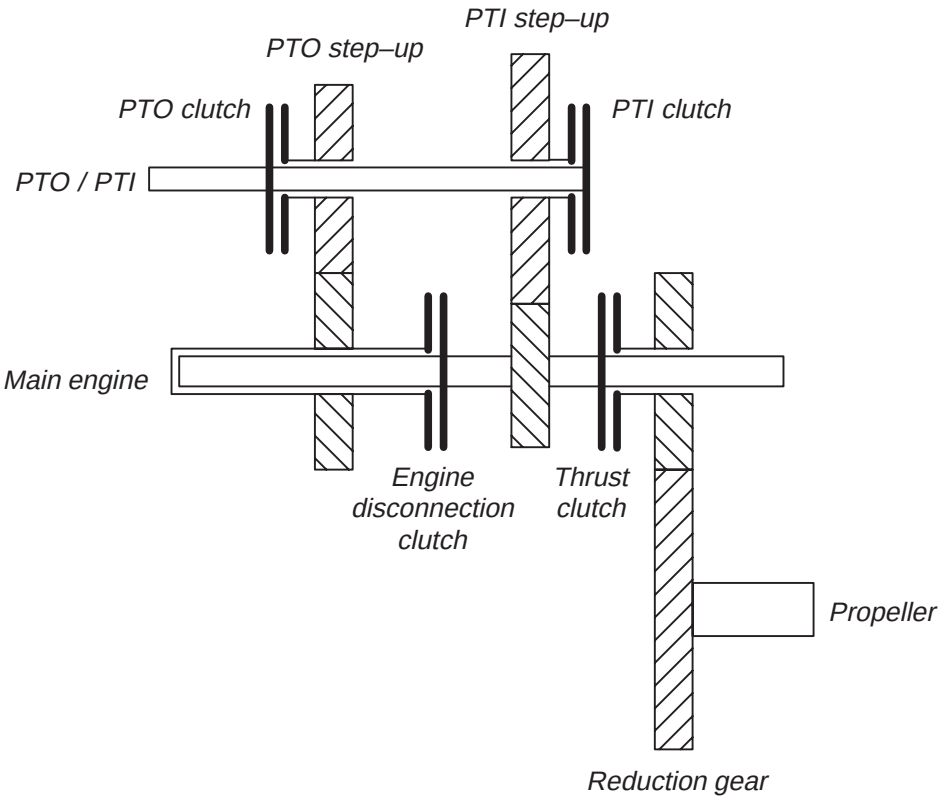
### Gear step–up section

The step–up section of the gear increases speed and is connected either via a PTO to a shaft generator or connected via a PTI to an el motor.

If the gear is arranged with a PTI shaft connected to an el motor for alternative propulsion power, the gear must be provided with an engine disconnection clutch for separation of the engine from the gear. The disconnection clutch is often a manually or semi–automatically operated clutch.

2001–09–26

***Fig 05.7***




***Gear and clutch arrangement***

If the step–up section is equipped with a common PTI/PTO shaft with different gearing ratios between the PTI and the PTO, this section must be provided with both a PTO clutch and a PTI clutch.

### Gear reduction section

A reduction section of the gear is used on four stroke propulsion plants for reduction of the engine speed. The reduction gear will very often contain a thrust clutch for disengaging of the propeller.

## Clutch control

The clutch control can be operated from the bridge as well as from the ECR.

Engage and disengage operations of thrust clutch, PTO clutch, PTI clutch and disconnection clutch are controlled by means of soft keys from the PCS panel in control. Please refer to page 05–64 for a detailed description of the clutch control soft keys.

If the operator activates a clutch control soft key on a panel which is not in control, nothing will happen, but a warning is given by the buzzer as a short beep.

If a clutch engage/disengage request with one or more blockings is given from the panel in control, nothing will happen, but interlock information for the clutch is displayed on the PCS panel.

If a clutch engage/disengage request with no blockings is requested from the panel in control, the clutch will be engaged/disengaged and the indication on the PCS display will change according to the new clutch position feedback.

### I/O interface for clutches

Each clutch has two inputs for clutch engage and clutch disengage solenoid valves and one pressure switch feedback indicating clutch engaged for a high pressure.

### Thrust clutch control

The thrust clutch is a clutch located inside the gearbox where it disconnects the propeller shaft output from the engine or the PTI input to the gearbox.

The thrust clutch is operator controlled by means of easily accessible soft keys on the first level of the **[MACHINERY CONTROL]**. Please refer to page 05–57 to see the soft key display for the **“CLUTCH IN”** – **“CLUTCH OUT”** menu.

The thrust clutch in/clutch–out valves are deactivated again when the correct engaged/disengaged feedback is present. If the correct feedback is not achieved within a maximum time–out, a clutch engage failure alarm is released.

Clutch engage failure will deactivate the clutch–in valve and initiate a disengage command.

Engaged feedback and clutch oil low pressure is a common feedback signal from a pressure switch/transducer in the hydraulic control line to the clutch.

Please refer to fig 05.8 for the thrust clutch engage sequence flow diagram.

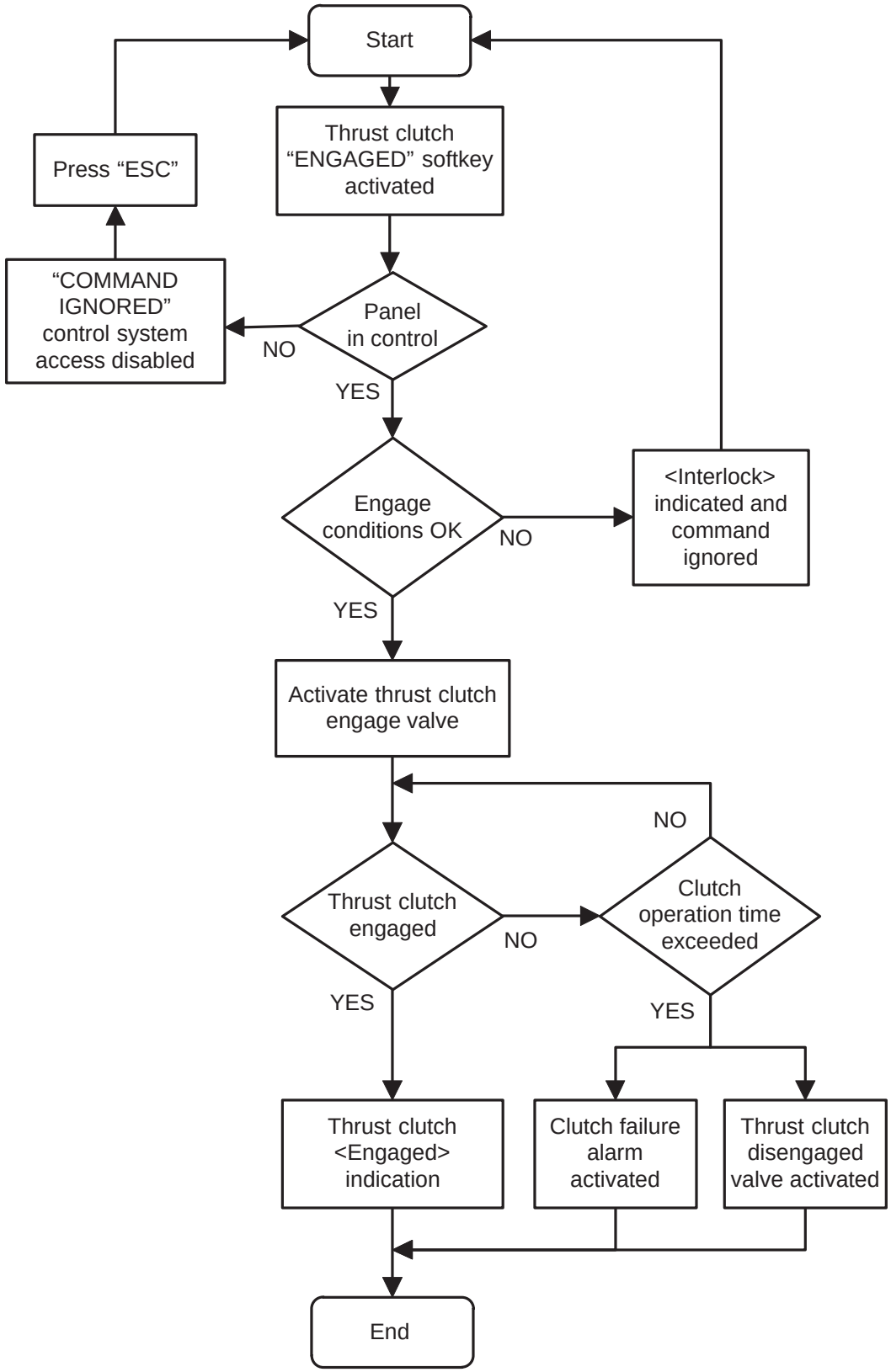
### Thrust clutch safety disengage

The following conditions will make an emergency disengage of the thrust clutch, and make an engage blocking as long as one of the below conditions are present:

- Main engine shutdown.
- Gear lubricating oil pressure low.
- Clutch **“ENGAGED”** control oil pressure low (will be inhibited during engage command).

2001–09–26

*Fig 05.8*




***Main engine thrust clutch engage diagram***

2001-09-26

### Thrust clutch engage condition

The following conditions must be fulfilled before it will be possible to engage the thrust clutch:

- CPP oil pressure normal.
- Pitch in zero.
- Maximum engine clutch–in rpm not exceeded (depending on gear type).
- Minimum time between engage commands.
- Main engine or PTI running.
- Propeller locking device off.

### PTO Clutch Control

A PTO clutch (optional) is a clutch used to control a mechanical PTO output from the gear, it can be used to supply eg a shaft generator or a hydraulic pump.

If the step–up section is equipped with a common PTI/PTO shaft with different gearing ratios between the PTI and the PTO, this section must be provided with both a PTO clutch and a PTI clutch.

### PTO clutch safety disengage

The following conditions will make an emergency disengage of the PTO clutch, and make an engage blocking as long as one of the below conditions are present:

- Main engine shutdown.
- Gear lubricating oil pressure low.
- PTO clutch **"ENGAGED"** control oil pressure low (will be inhibited during engage command).

### PTO clutch engage

The following conditions must be fulfilled before the PTO clutch for the SG can be engaged:

- Maximum engine clutch–in rpm not exceeded (for certain gear boxes).
- Minimum time between engage commands.
- PTI clutch disengaged.
- Main engine running and engaged.

### PTO clutch disengage

To disengage the PTO used for shaft generator operation, the following condition must be fulfilled:

- Shaft generator must be disconnected.

### PTI clutch control

A PTI clutch (optional) is a clutch used to control a mechanical PTI input from an el motor which can be used to supply alternative power for propulsion.

### PTI clutch safety disengage

The following conditions will make an emergency disengage of the PTI clutch and make an engage blocking as long as one of the conditions are present:

- Gear lubricating oil pressure low.
- PTI clutch **"ENGAGED"** control oil pressure low (will be inhibited during engage command).

### PTI clutch engage

The following conditions must be fulfilled, before the PTI clutch for the el motor can be engaged:

- Main engine stopped and engine disconnection clutch disengaged.
- Minimum time between engage commands.
- PTO clutch disengaged.
- Thrust clutch disengaged.
- El motor is running at nominal speed.

*2001–09–26*

### Engine disconnection clutch

An engine disconnection clutch is a clutch for separation of the engine from the gear. The disconnection clutch is often a manually or semi–automatically operated clutch which means that the engineer must synchronise the shafts manually, using the engine turning gear before the disconnection clutch can be engaged and the engine can be started again. The engine disconnection clutch must be disengaged whenever the el–motor is used for propulsion.

### Engine disconnection clutch engage

The following conditions must be fulfilled before the engine disconnection clutch can be engaged:

- PTI shaft stopped and PTI clutch disengaged.
- PTO clutch disengaged.
- Thrust clutch disengaged.

### Engine disconnection clutch disengage

To disengage the engine disconnection clutch, the following conditions must be fulfilled:

- Main engine must be stopped.
- Thrust clutch disengaged.
- PTO clutch disengaged.

## PTO interface to a shaft generator

When the PTO output is used for a Shaft generator, the following hardware interface signals to the Power Management System (PMS) are required:

- **"PTO IN SERVICE"** input (pulse) request to the PCS from PMS with request for PTO to be put into service. It may be the same as an automatic engage command to the PTO clutch, but not necessarily.
- **"PTO READY"** output from PCS to the PMS, when the PTO is engaged and RPM is within the required speed limits.
- **"PTO OUT OF SERVICE"** input (pulse) request to the PCS from PMS with request for PTO to be put out of service, or the engineer may disengage the clutch. PTO out of service is not possible as long as the MSB breaker is closed.
- **"SHAFT GENERATOR OUT OF SERVICE"** output from PCS to the PMS requesting a DG standby start and then the SG is to be disconnected from the MSB in case of a load reduction or shutdown prewarning eg.
- **"BUS BAR BREAKER CLOSED"** input to the PCS from PMS/SG, specifying that the SG is connected to MSB or a thruster eg, making interlocks on constant speed mode and PTO clutch disengage for the SG. A two–stroke engine will be shut down if it has been waiting for more than 2 minutes for disconnection of the SG in case of an RPM slowdown.
- **"MAINTAIN SPEED"** input to the PCS from a frequency converter running on a full range (50–100%) rpm, but not able to maintain the full load below 60 % rpm eg.

A constant speed shaft–generator with speed droop governor requires a +/–5% frequency adjustment interface from the power management system. Alternatively, if the diesel generator makes the synchronisation, internal fine–adjustment of the constant speed setpoint is sufficient.

- **"ENGINE SPEED RAISE"** input (pulse) to the PCS from PMS for frequency/load control up.

2001–09–26

- **"ENGINE SPEED LOWER"** input (pulse) to the PCS from PMS for frequency/load control down.

Different types of PTO functions will require different limitations on the speed range, which is achieved by selecting between different **"COMBINATOR CURVES"** for example SG on MSB (which can be constant speed for a directly connected SG or a limited variable, eg 60–100% for a SG connected through a frequency converter) or for thruster operation (which can be constant speed or a limited variable, eg 80–100%).

In combinator or separate mode, the demand for speed can be limited to the minimum RPM for a connected PTO, eg 80 % for a hydraulic pump.

## Main engine shutdown

The shutdown information is shown on three keys in the PCS panel, both on the ECR and on the bridge panels. It is in addition possible to see the status information about each shutdown input channel on the shutdown status display, if the engines safety system is equipped with serial communications facilities. Less information is avaible without serial communication facility. The three keys on the PCS panel are used for the following functions:

- **[SHUT DOWN]** indicating shutdown activated (steady light) or that the cancelled shut down is pending, but has been cancelled (flashing light). The key activates the display of the shutdown status list display when pushed.
- **[CANCEL SHUTD.]** indicating shutdown prewarning or cancellation possible (flashing light) or indicates if the shutdown is cancelled (steady light). Activation of the key will change the cancel status between **"ON"** and **"OFF"**.
- **[RESET SHUTD.]** activates reset of the shutdown memory. Flashing when reset is possible.

For the cancellable shutdowns, the operator on the bridge and in the ECR will get a shutdown prewarning alarm, before the shutdown is executed by the safety system.

During the prewarning delay for the shutdown (6 seconds), the LED in the **[CANCEL SHUTD.]** key on the PCS panel will flash. After the prewarning delay, the LED in the **[SHUTDOWN]** key on the PCS panels will go to steady light and the main engine will be stopped by the safety system.

To silence the buzzer the **[STOP HORN]** key must be activated, and to acknowledge the alarm, press the **[ACCEPT]** key. If more alarms are present, press **[ACCEPT]** again until all alarms are acknowledged.

During the prewarning delay, the operator has the possibility to cancel the shutdown, by pressing the **[CANCEL SHUTD.]** key, which is then indicated by steady red light in the key.

If the main engine is already stopped, before the **[CANCEL SHUTD.]** key is activated, then the shutdown must also be reset before it is possible to start the engine again.

To remove the cancel shutdown state, the **[CANCEL SHUTD.]** key must be activated once more.

Further information about the reason for the shutdown can be seen in the shutdown list on the PCS panels, which is selected by pressing the **[SHUT DOWN]** key. Please refer to page 05–67 for a detailed description of the shutdown list.

When the shutdown memory has been activated, the reason for the shutdown must be removed and a reset command executed, before a new start of the main engine is possible.

*2001–09–26*

When the reason for the shutdown has been removed, which is indicated by a flash in the **[RESET SHUTD.]** key, the shutdown is reset by pressing the **[RESET SHUTD.]** key on the PCS panel, or by activating the **"STOP"** softkey in the start/stop system.

## Emergency stop

The emergency stop function is independent of the safety system, with independent push–buttons on the bridge and in the ECR, each wired in parallel to the engine and the safety system.

Activation of one of the push–buttons will cause an emergency stop of the main engine even if the panel is not in control.

When the main engine has been stopped by use of the emergency stop function, restart of the engine is blocked until the emergency stop push–button has been released again and the shutdown memory has been reset.

For certain engine types, the three keys **[SHUT DOWN], [CANCEL SHUTD.]** and **[RESET SHUTD.]** are blinded, leaving operations and indications to a separate panel.

## Main engine load reduction

In case of a sensor requiring a load reduction, the load control function in the PCS takes care of reducing the load automatically. The propeller pitch is adjusted in order to limit the load according to the load reduction level. The engine rpm will normally be unchanged during load reduction.

The main engine load reduction system is an integrated part of the PCS system. The load reduction inputs are connected either directly to the AT2000–LMCS mounted locally on the engine and then transmitted on the serial line to the PCS system or, alternatively, load reduction request may come from the ships alarm system hardwired to the PCS system.

The load reduction information is shown on three keys in the PCS panel, both on the ECR and on the bridge panels. In addition it is possible to see the status information about each load reduction input channel on the load reduction status display. From the **[MAINTENANCE]** menu, it is possible to make adjustments and cut–outs on the individual load reduction input channels. The three keys on the PCS panel are used for the following functions:

- **[LOAD REDUC.]** key indicates load reduction activated (steady light). The key activates the display of the load reduction status when pushed.
- **[CANCEL LOAD REDUC.]** key indicates load reduction prewarning (flashing light) and indicates if the load reduction is cancelled (steady light). Activation of the key will change the cancel status between **"ON"** and **"OFF"**.
- **[RESET LOAD REDUC.]** key activates reset of the load reduction memory.

In case of a load reduction, the operator on the bridge and in the ECR will get a load reduction prewarning alarm. The load reduction is executed by the PCS system. Normally the prewarning time is set to 10 seconds.

During the prewarning delay for load reduction, the LED in the **[CANCEL LOAD REDUC.]** key on the PCS panel will flash. After the prewarning delay, the LED in the **[LOAD REDUC.]** key on the PCS panel will go to steady light, and the load on the main engine will be reduced by the PCS.

To silence the buzzer, the **[STOP HORN]** key must be activated, and to acknowledge the alarm press the **[ACCEPT]** key. If more alarms are present, press **[ACCEPT]** again until all alarms are acknowledged.

2001–09–26

During the prewarning delay, the operator has the possibility to cancel the load reduction, by pressing the **[CANCEL LOAD REDUC.]** key, which is then indicated by steady red light in the key.

Further information about the reason for the load reduction can be seen in the load reduction status list on the PCS panels, which is selected by pressing the **[LOAD REDUC.]** key. It will show a status line for each individual load reduction input to the PCS system. Please refer to page 05–67 for a detailed description of the load reduction list.

To remove the cancel load reduction function, the **[CANCEL LOAD REDUC.]** key must be activated once more.

When a load reduction has been activated, the reason for the load reduction must be removed and a reset command executed, before the load of the main engine can be increased to the commanded level again.

When the reason for the load reduction has been removed, which is indicated by flash in the **[RESET LOAD REDUC.]** key, the load reduction memory is reset by pressing the **[RESET LOAD REDUC.]** key on the PCS panel, or by moving the setpoint lever in command down below the limit for load reduction and then increase again. A load reduction is also reset, if the engine is stopped by means of the **"STOP"** softkey in the start/stop system.

## Setpoint system

The setpoint system converts the potentiometer setpoints from the setpoint levers mounted on the bridge and in the ECR, to main engine rpm setpoint output for the governor and CPP pitch setpoint output to the CPP closed loop controller. This conversion is done in accordance with the combinator curves set–up in the PCS system.

### Setpoint lever adjustments

In order to facilitate an easy adjustment of the setpoint lever inputs, the PCS includes the possibility to make a re–scaling from the PCS panel (password protected). It will be possible to adjust the following setpoint inputs:

- Pitch combinator setpoint bridge.
- Pitch combinator setpoint ECR.
- Separate rpm setpoint bridge (option).
- Separate rpm setpoint ECR (option).

Please refer to page 05–69 for a detailed description of the setpoint lever input adjustments.

### Main engine rpm governor setpoint

The main engine rpm is controlled either by an electronic governor or by a mechanical speed governor with a speed setting unit. The input to the electronic governor or the speed setting unit for a mechanical governor is normally a 4–20 mA current signal corresponding to the rpm range requested.

Speed droop, which enables parallel operation of two or more engines on the same gear or between the shaft generator and one or more diesel generators, might be included in the governor. It is supported by the PCS, with automatic load–sharing between engines, and with interconnection to frequency control inputs from the power management system.

The following strategies for the speed setting are included in the propulsion control system:

### Separate rpm control setpoint

Separate rpm control lever(s) is/are an option, which includes individual rpm and pitch control from the ECR and possibly also on the bridge. The main engine rpm is increased from idle rpm to maximum rpm according to the scale on the setpoint lever (lin-

2001–09–26

ear scale from idle rpm to max rpm) without any relations to the pitch setpoint.

The separate rpm setpoint is converted to a governor setpoint signal without any limitations, except for the critical speed limitation (optional), and slow down reduction which might limit the rpm setpoint also (optional).

### Variable rpm setpoint

Variable rpm setpoint is used in combinator control. The rpm is increased from idle rpm to max rpm according to the predefined combinator curve in the PCS:

- Fully variable combinator mode without SG, eg 50 – 100% rpm.
- Limited variable combinator mode with frequency converter SG on MSB, eg 60 – 100% rpm, or with a Thruster in limited variable mode, eg 80 – 100% rpm.

The variable rpm setpoint is converted to a governor setpoint signal with the following limitations:

In case of crash stop, the rpm is reduced to a predefined level during the manoeuvre before the pitch is moved from ahead to astern. When the “sign” of the pitch has changed, the rpm is increased again to the level determined by the setpoint lever position. This function will also take place for a crash stop in the opposite direction from full astern to full ahead.

An automatic load reduction will also limit the rpm setpoint (optional).

### Rpm setpoint behaviour during crash-stop manoeuvring

During normal operation the rpm setpoint to the governor is not limited in any way. When the setpoint lever is moved to a new position, the rpm setpoint corresponding to the new position is calculated without any restrictions and converted to a setpoint output for the governor.

However, in case of a crashstop manoeuvre, the following temporary limitation on the rpm setpoint will occur:

- In combinator mode, the rpm is reduced to an rpm level between idle and maximum (set in accordance with the minimum rpm for a variable speed SG) until the propeller pitch has changed direction (from ahead to astern). The purpose is to ensure optimal deceleration of the ship, and at the same time maintain a rpm high enough to take–up the load on astern.
- In constant rpm mode, the rpm setpoint is not changed during this manoeuvre.
- In separate mode, the position of the rpm Setpoint Lever alone determines the rpm setpoint.

### Constant rpm setpoint

Constant rpm for PTO and optional PTI operation is possible from both bridge and ECR control. The rpm setpoint for the governor is a fixed value corresponding to eg 50/60 Hz for shaft generator operation.

The constant rpm setpoint corrected for load variations on the shaft generator in case of a speed droop governor, is converted to a governor setpoint signal without any limitations.

As long as a constant frequency shaft generator is connected to the main switch board, it will not be possible to select another mode than constant rpm.

### PTO minimum rpm

In combinator or separate mode, the demand for speed can be limited to the minimum rpm, required from one of several connected PTO’s, used to eg drive a hydraulic pump for deck equipment.

If the setpoint request from the setpoint lever is going below the minimum rpm limit for one

2001–09–26

of the connected PTO's, the limit from the PTO with the highest minimum rpm will be the resulting rpm setpoint. When the operator increases the setpoint again, the function is removed.

Minimum rpm for a PTO connected SG will be handled by locking the setpoint in constant speed mode as long as a constant frequency SG is connected, or selecting the limited variable combinator mode for SG, as long as a variable frequency SG with frequency converter is connected. The variable frequency SG might also use to maintain the speed function in order to maintain the minimum rpm.

### Panel fine–adjustment of rpm

The operator can fine–adjust the rpm setpoint from any one of the PCS operator panels, independent of the control position.

This adjustment is done by means of two **"RAISE"** and **"LOWER"** softkeys, located on the control display for the setpoint system. The adjustment is limited to ± 5%.

### PMS fine–adjustment for frequency control

The rpm setpoint for a constant speed shaft generator can be fine–adjusted to compensate for the propeller and shaft generator load, to be able to maintain 50/60 Hz on the shaft generator.

This adjustment is based on hardwired rpm raise/lower signals from the power management system, and is limited to the adjusted speed–droop range, normally ± 5%.

### Slow down rpm setpoint

Main engine rpm for a four–stroke engine will normally be independent of the load reduction / slowdown function, ie it is only reducing the pitch and thereby the load of the main engine

For two–stroke engines, a slow down limitation of the rpm setpoint will normally be included, limiting also the main engine rpm to an adjustable limit after a certain time delay, or when a shaft generator has been disconnected from the MSB.

### Shaft generator waiting station hold

The SG waiting station hold is activated by the PCS when the rpm setpoint is lowered by the operator, where the setpoint will be maintained on a predefined level until the shaft generator is disconnected. After a predefined time–out the setpoint will be allowed to decrease to the setpoint requested.

### Rpm setpoint slope

Acceleration and deceleration are controlled by slew rates, specified in engine shaft rpm/sec. Another set of values is selected when the pushbutton **[LOAD RESTRICT CANCEl]** in the PCS panel is activated. This will lead to a faster response on the rpm setpoint.

### Maintain speed function

The maintain speed function is activated by means of an input from a variable speed shaft generator (eg connected with a frequency converter) running on a full range (50–100%) rpm, but not able to maintain the full load below eg 60 % rpm. When the setpoint drops below 60 %, the shaft generator activates the maintain speed function, and then the PCS selects the present setpoint as the minimum setpoint. When the operator increases the setpoint again, the function is removed.

### Critical speed protection

The critical speed function protects the main engine rpm from running inside a pre–defined window for barred speed range, where the main engine is not allowed to run due to torsional vibrations of the main engine or in the propeller shaft.

Two independent barred speed range windows can be defined in the PCS system, eg

2001–09–26

a lower range from 280 – 310 rpm and an upper range from 490 – 600 rpm.

### Speed droop compensation of setpoint

As an option, the rpm setpoint for a speed droop governor can be fine–adjusted to compensate for the propeller – and shaft generator load, making it possible to maintain 50/60 Hz on the shaft generator.

## Propeller pitch setpoint

The setpoint output from the PCS pitch control is converted into a setpoint signal for the CPP closed loop controller on the hydraulic part of the pitch propeller, but the output might be limited by the load controller. Please refer to page 05–46.

The CPP closed loop controller is a separate piece of hardware, mounted on the gear–box or on the hydraulic power pack, which takes care of the pitch position, based on the pitch setpoint output from the PCS.

In backup control, where the PCS pitch setpoint is not available, the CPP closed loop controller is instead using a separate setpoint potentiometer fittted in the main setpoint lever on the bridge, which is hardware connected directly to the closed loop controller, without involving the PCS.

### Variable pitch setpoint

The variable pitch setpoint is used together with separate rpm setpoint or together with PTO and optional PTI operation of the shaft generator in the constant rpm mode. The pitch setpoint is increased from 0 (zero pitch) to ± 100% pitch (ahead and astern) according to pre–programmed combinator curves for:

- Separate mode pitch setpoint curve, ie ± 100% pitch
- Constant speed with a SG connected to the MSB at 50/60 Hz, and ± 90% pitch or SG in thruster operation at 50/60 Hz, and +/–90% pitch. Max pitch is leaving enough available power, corresponding to the maximum load on the SG.
- PTI mode pitch setpoint curve if a PTI is fitted, eg ± 65% pitch. Max pitch is eg corresponding to max load on the SG when used as electrical motor.

### Combinator pitch setpoint

The combinator pitch setpoint is used together with variable rpm setpoint in combinator control. The pitch setpoint is increased from 0 (zero pitch) to +/– 100% pitch (ahead and astern) according to pre–programmed combinator curves for:

- Combinator mode without SG, eg 50–100% rpm and ± 100% pitch
- Combinator mode with a frequency converter SG connected to the MSB at, eg 60–100% rpm and ± 90% pitch or the SG in thruster operation in limited variable mode, eg 80–100% rpm and ± 90% pitch. Max pitch is leaving enough available power, corresponding to max load on the SG.

### Acceleration and deceleration slew rates

The acceleration and deceleration slew rates can be specified independently for ahead and astern direction and with a third separate curve for crash stop. The slew rates are adjustable with six independent pitch rates on each curve and five break points, which is common for the three curves. A crash stop is detected, when the setpoint is moved from more than 75% ahead where it has been for more than eg 60 seconds, to more than 75% astern within eg 15 seconds.

### Load control minimum selector

The load controller has influence on the pitch setpoint signal by using a minimum se-

2001–09–26

lector. The minimum selector will select the lowest of two signals: The pitch setpoint from the combinator curves (ie no load control limit) or the pitch limit from the load controller.

Typically, the load controller is active above 50% pitch. It is possible to specify the minimum pitch, where the load controller is active, eg 50% pitch.

### Local and backup control

During local and backup control of the propeller pitch, the propeller pitch setpoint output is set equal to the actual pitch feedback. This is done in order to secure a smooth transfer, when control is switched back to PCS control.

Also in case of a failure detected in the closed loop , the propeller pitch setpoint output is set equal to the actual pitch feedback.

### Zero pitch setpoint during shutdown and disabled propeller

The pitch behaviour during shutdown, depends on the type of shutdown, and also whether the system is equipped with a thrust clutch or not.

- If a thrust clutch **is not** included in the system, a shutdown or emergency stop will be commanding zero pitch to the setpoint system. The shutdown condition must be removed and reset, and the pitch setpoint lever must be put in zero position to reset the shutdown zero pitch command.
- When a thrust clutch is included in the system, a shutdown or emergency stop will disengage and stop the engine.
- In case of an overspeed shutdown, the actual propeller pitch position is not allowed to be changed, and if a thrust clutch is mounted on the system it will not be disengaged.

When the operator selects **“DISABLE”** on a propulsion system with a running engine which is enabled (ie the thrust clutch to the propeller is engaged), the thrust clutch is disengaged, the propeller pitch setpoint is commanded to zero pitch and the main engine rpm setpoint is set to idle or to Separate control.

As soon as the disabled engine is stopped, it will again be possible to control the propeller pitch by means of the setpoint lever. This will make it possible for the operator to test the whole pitch control system, from setpoint levers through the PCS and closed loop controller to the hydraulic propeller system, where the propeller movement will be send back to the pitch indication instruments by means of a feedback transmitter.

### Pitch feathering position control

Feathering position of the pitch propeller is used when the ship for some reason is sailing with only one of two propulsion lines. It adjusts the propeller pitch on the stopped propulsion line to a position where it is as streamlined as possible when pulled through the water by the other propeller on the ship.

The conditions for selecting feathering position of the pitch propeller is stopped engine or de–clutched propeller.

The feathering position is operated from the **“FEATHERING POSITION”** control function in the **“ME CONTROL FUNCTIONS”** machinery control group. Please refer to page 05–60 for selection and operation of the feathering position control function.

A similar function is also used on double ended ferries, supplied with a de–clutchable propeller in both ends and both propellers driven by the same engine.

2001–09–26

### Pitch setpoint slope

The pitch setpoint slope rates are specified by a fixed setting in % pitch/sec. This pitch setpoint slope is normally adjusted according to how fast the pitch is able to move from full ahead to full astern.

Another adjustment is selected when **[LOAD RESTRICT CANCEL]** is activated. This will give a faster response on the pitch setpoint.

### CPP booster pump

The electrical CPP booster stand–by pump is started in case of slow movement of the pitch. During normal operation only one driven pump is used to control the pitch. When the CPP booster pump has been started, it will be kept running for 5 minutes.

Certain four–stroke plants will not have this booster pump function. In these plants, the configuration will consist of a mechanically driven main pump and an electrical stand–by pump.

### Combinator control

The combinator control function in the PCS is active when combinator mode is selected. The setpoint commands to the main engine and the propeller pitch are based on the same setpoint lever. The setpoints are calculated based on predefined combinator curves in the PCS.

There is one curve for rpm and one curve for the corresponding pitch.

The combinator curves are calculated in such a way, that pitch reduction due to overload of the main engine will not take place during normal operating conditions.

## Transfer of control location

The PCS can be operated from the ECR panel and setpoint levers, or from the bridge panel and setpoint levers with optional bridge wing control operating in parallel to the bridge centre. Please refer to page 05–16 for a description of the change–over between bridge centre and the bridge wings.

The control location can be transferred between ECR and bridge control, or between bridge and ECR control on request from either a bridge panel, or on request from the ECR panel without a previous request from the bridge.

The control location making the request does not have to be the present control location.

The control location (bridge or ECR) requesting the new control location (ECR or bridge), must press the PCS panel key:

- **[BRIDGE]** if change from ECR – to bridge control is requested.
- **[ENGINE CONTROL ROOM]** if change from bridge – to ECR control is requested.

As soon as the request for the control transfer is initiated from the bridge or ECR, the buzzer in the bridge panels and the ECR panel will sound, and the lamp in the key for the new control location will start flashing, both on the bridge panel and in the corresponding lamp on the ECR panel. The buzzer sound for control transfer is making two short beeps followed by a 5 sec pause.

The lamp for the present control location will remain in steady light, until all conditions for the new control location are fulfilled upon which it will be switched off.

When the control transfer is acknowledged by pressing the flashing key on the PCS panel:

- **[BRIDGE]** if ECR – to bridge control transfer is acknowledged.
- **[ENGINE CONTROL ROOM]** if bridge – to ECR control transfer is acknowledged.

2001–09–26

The control location will be changed, when the setpoint levers are aligned.

The flashing lamps for the new control location will stop flashing and go to steady light. The lamps for the previous control location are switched off, and the buzzers will stop.

If the setpoint levers are not aligned, control transfer will not take place. The lamps for the new control location will continue flashing and the two–beep sound will continue until the change–over request is either cancelled, or the setpoint levers have been aligned.

If the request for control transfer is not acknowledged on the acknowledge location, the request key at the request location can be pushed again to cancel the change over request. If the control location has not changed (setpoint levers not aligned), the flashing is stopped and the buzzer is silenced without further consequences.

Transfer of control will not take place before the setpoint levers are aligned and acknowledgement is received from the acknowledge location.

### Forced change–over from bridge control to ECR control

Forced change–over from bridge to ECR control is possible as standard. This possibility may be excluded on some plants.

The engineer can make the forced change–over from bridge to ECR control by pressing the **[ENGINE CONTROL ROOM]** key on the ECR Panel, without a previous change–over request from the bridge.

The indication lamps for forced change–over from bridge control to ECR control are indicating in the following way:

**[BRIDGE]** control lamp, ie the old control location on the Bridge Panel and ECR panel are in steady light until transfer has taken place. Activation of the key for the bridge lamps will not change anything.

**[ENGINE CONTROL ROOM]** control lamp, ie the new control location on the ECR panel is changing immediately to steady light as soon as the forced change–over is initiated. The lamp in the bridge panel is flashing and the buzzer is sounding until the operator has acknowledged the forced change–over. This is just to let the bridge operator know that the control is no longer on the bridge, the bridge acknowledge has no actual influence on the change–over.

If setpoint levers are not aligned, ECR lamps are flashing until the ECR engineer making the forced change–over has aligned the setpoint levers.

### Setpoint levers alignment

To be able to transfer the control location between bridge and ECR, the setpoint levers for the two control locations must be aligned. For this purpose a setpoint display with bar graphs and digital readings of the setpoint lever positions is automatically displayed during the control change–over, if the levers are not aligned. Please refer to page 05–56 description of the setpoint system alignment display.

### Cable failure on setpoint levers

The setpoint potentiometers on all setpoint levers are individually supervised for cable failure, with an alarm for each potentiometer.

In case of cable failure on one of the setpoint potentiometers involved in a control transfer, the demands for alignment of the involved setpoint levers are cancelled.

It is not possible to transfer control to a control position, which has cable failure on the setpoint potentiometers, or other failures which makes it impossible to control the main engine and propeller pitch from that particular control position.

2001–09–26

### Local/remote control transfer

There are normally two switches in the machinery space, used for transfer of the control between local and remote. One switch is dedicated to the control of the propeller and the other one is for the control of the engine.

The control transfer of the PCS depends on the local/remote signal from the pitch control system. Local control at the propeller side is indicated at the **[LOCAL CONTROL]** key on the bridge and ECR panels.

The PCS is changed over to **[LOCAL CONTROL]** as soon as the “Pitch Local Control on” feedback signal to the PCS is activated. The LED indication on the **[BRIDGE]** control or **[ENGINE CONTROL ROOM]** control keys are switched off. In the ECR this change–over is done without any buzzer indication and confirmation from the operator. When changed from **[BRIDGE]** to **[LOCAL CONTROL]**, the LED in the **[LOCAL CONTROL]** key will start flashing and the buzzer will sound until acknowledged on the **[LOCAL CONTROL]** key to indicate for the navigator that **[BRIDGE]** control is no longer present.

To switch back to remote control, the local/remote switch in the operator panel – gear/propeller must be in position **[REMOTE]**.

This will activate the buzzer in the ECR panel and the **[ENGINE CONTROL ROOM]** control key will start to flash on all PCS panels.

To accept remote control, press the **[ENGINE CONTROL ROOM]** control key at the ECR Panel. Then the buzzer will stop, the **[ENGINE CONTROL ROOM]** control key will switch to steady light, the **[LOCAL CONTROL]** key will switch off, and the optional output for the remote control on lamp indication is switched on, and it will be possible to operate the pitch from ECR or bridge control again.

The local/remote control switch on the engine is used to block for remote start of the main engine, when it is in local control. As soon as the main engine is switched back to remote control, the startblock of the main engine is removed, and it will be possible to start and stop the main engine from ECR or bridge control again.

For two–stroke engines the PCS is changed over to **[LOCAL CONTROL]** when the engine is switched over from governor control to emergency control of fuel injection.

The two local/remote switches offer the following control possibilities:

1. ME and CPP both in local control: both must be operated in local control mode.
2. ME in local control and CPP in remote control: ME must be started and rpm controlled in local mode (eg direct control constant speed mode), but it will be possible to control the pitch by means of the PCS.
3. ME in remote and CPP in local control: ME control not possible, because ME is in remote control but the PCS is in local control, (PCS control depens on the CPP control position).
4. ME and CPP both in remote control: boh can be operated from the PCS.

### Local/remote control transfer to bridge

Control transfer from local to remote is normally acknowledged from the ECR panel, but in the following situations it will be possible to change directly from local to bridge control:

1. If the PCS loses contact to the ECR panel, eg due to a power failure or cable failure to the panel. The PCS is always supervising the panels, and in case of a lost connection to the ECR

2001–09–26

panel, it generates an alarm used to enable the control transfer directly to the bridge.

2. In configurations without an ECR panel.

## Mode control

The AT2000 PCS propulsion control system can be operated in three different modes:

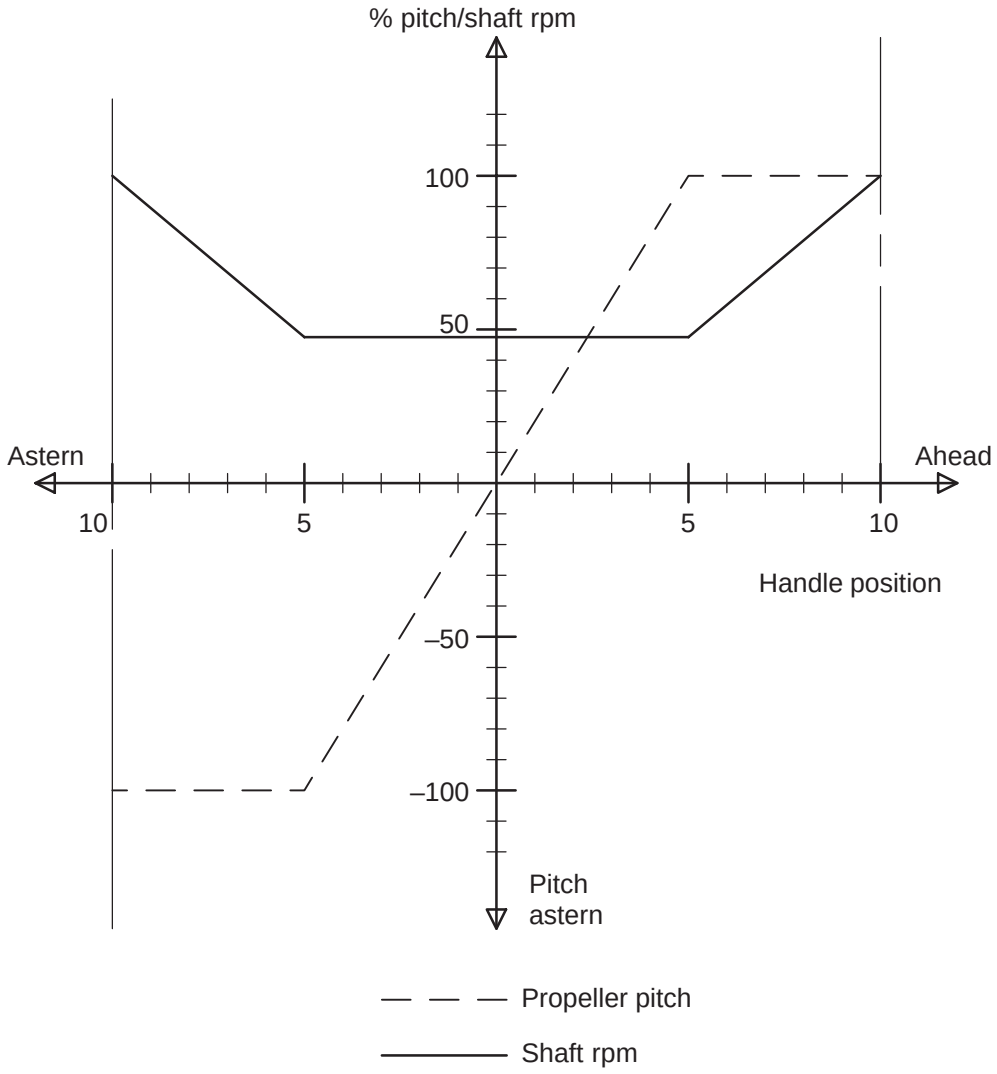
- Combinator mode
- Constant rpm mode
- Separate mode

The mode determines how the setpoint lever located at the panel in control is interpreted, ie the corresponding relationship between the setpoint lever position and pitch/rpm command.

### Combinator mode, fig 05.9

The combinator mode is normally used when sailing without a shaft generator, but in case the shaft generator is of the variable rpm type, ie equipped with a frequency converter, this mode can also be used for shaft generator operation.

***Fig 05.9***




2001–09–26

***Typical combinator curves for shaft rpm and the corresponding propeller pitch Combinator mode***

The setpoint lever controls both main engine rpm and pitch position according to pre–programmed combinator curves.

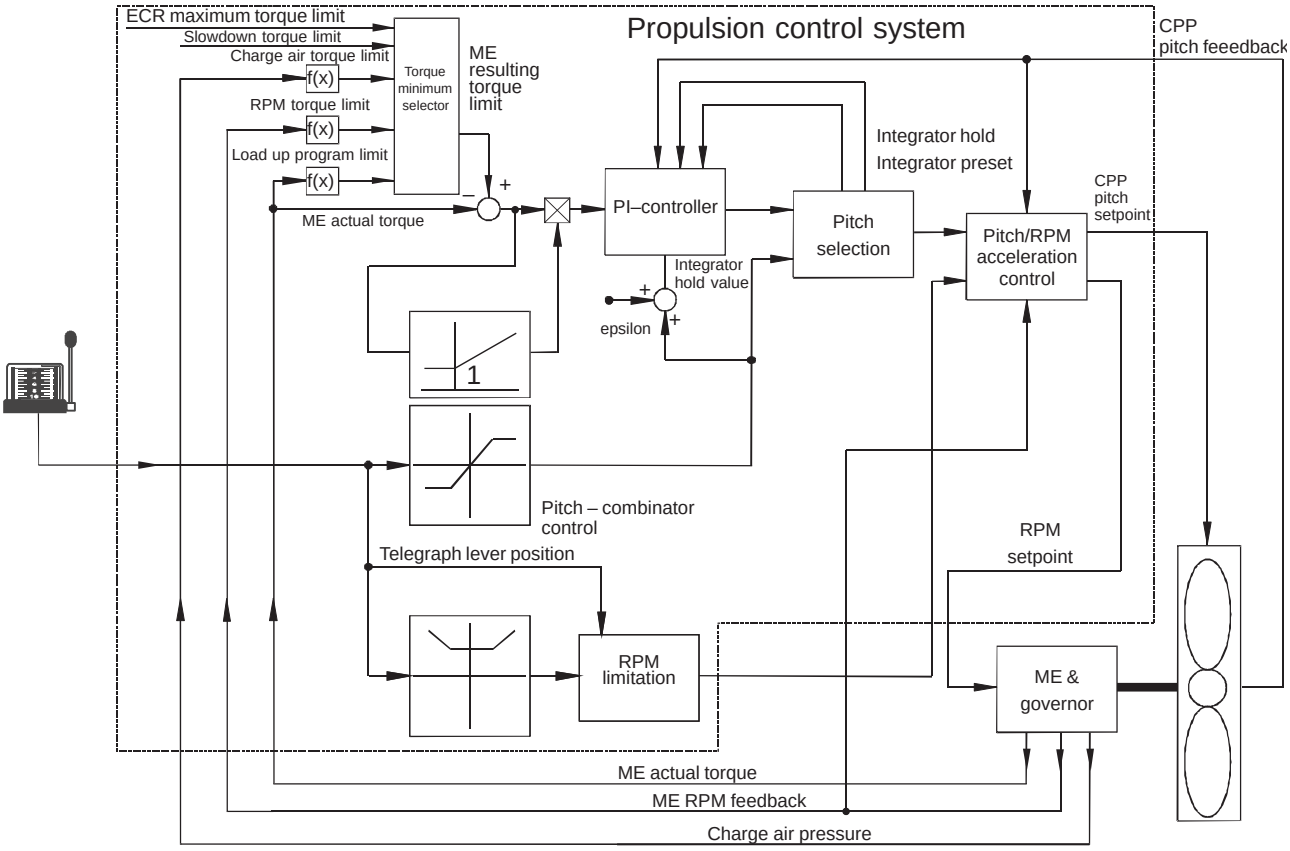
The rpm and pitch setpoints from the combinator control curves may be limited automatically in the following cases:

- Load up program active.
- Maximum ECR load limit is adjusted to a limit between 70% and 100%.
- Charge air limitation is active.
- Rpm/torque limitation is active.
- Main engine load reduction.

Please refer to fig 05.10.

The combinator mode is only available in case of diesel propulsion, ie not in case of PTI mode.

***Fig 05.10***




***Load controller in combinator control mode***

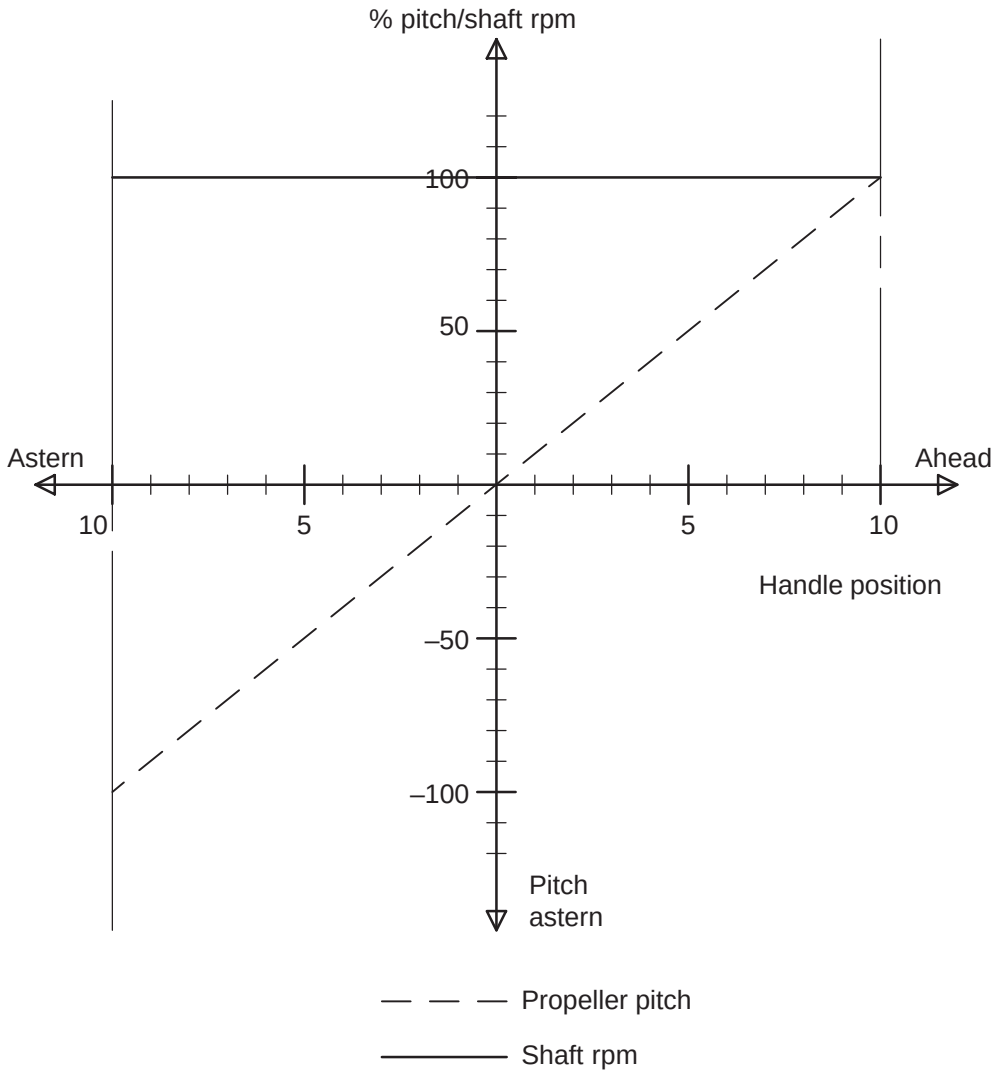
2001–09–26

**Constant rpm mode, fig 05.11**

The constant rpm mode is normally used for shaft generator operation, if it is connected directly to the MSB without a frequency converter. The setpoint from the PCS to the main engine governor is adjusted to a value corresponding to the MSB (main switch board) frequency.

In case of a main engine with a speed–droop governor, the governor setpoints can be continuously adjusted based on rpm raise/lower signals from the power management system in order to keep a constant MSB frequency, and to obtain a specified load sharing between the shaft generator and other running diesel generators.

***Fig 05.11***




***Combinator curves for shaft rpm and the corresponding propeller pitch***
***Constant speed mode***

2001–09–26

The propeller pitch is determined by the position of the lever on the bridge or in the ECR.

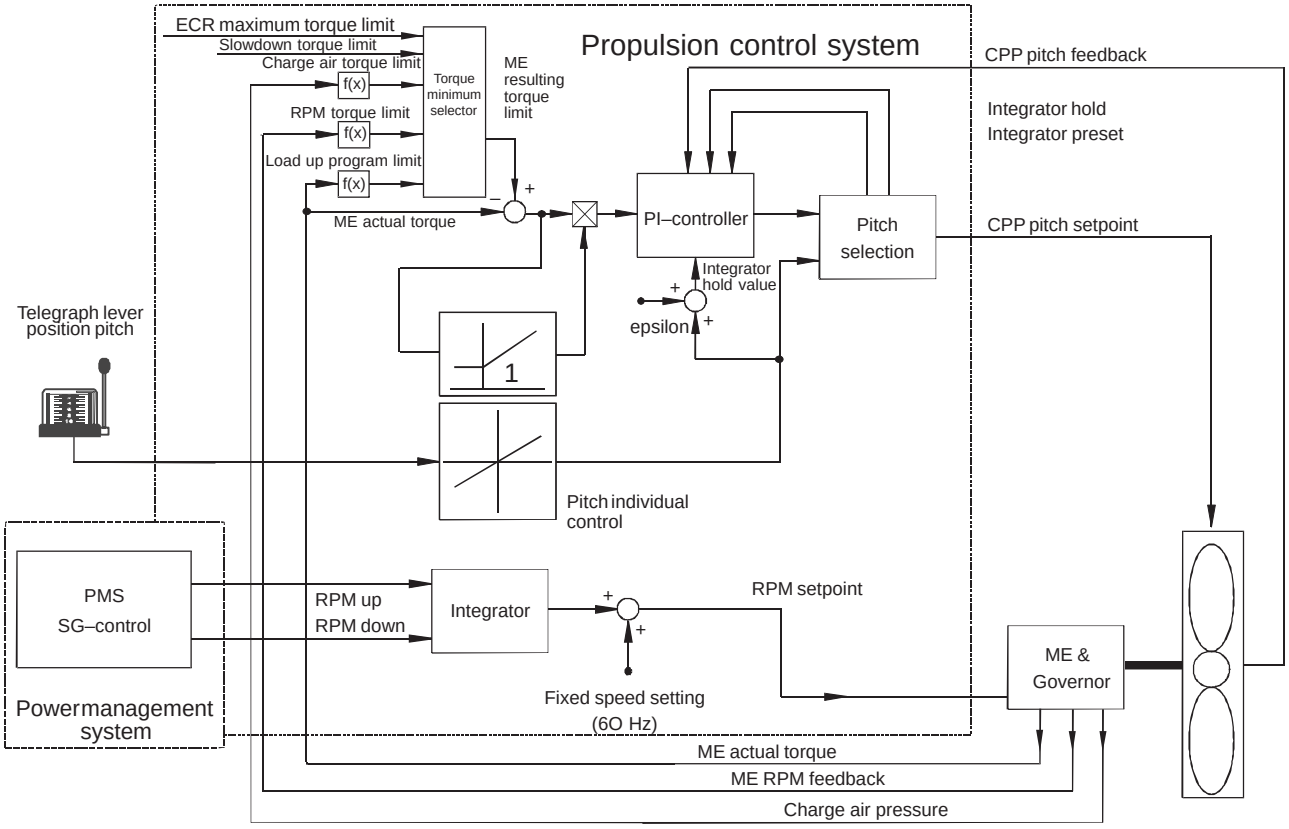
When the main engine is equipped with a governor without speed–droop, the governor is responsible for keeping the constant rpm corresponding to the MSB frequency.

Please refer to fig 05.12.

## PTO mode

The shaft generator works as a normal generator, ie power take off from the gear. The power management system can be set–up for operation with the SG alone on the MSB, or it can supply one or more of the ships thrusters. This will depend on the selected mode of the power management system.

***Fig 05.12***




2001–09–26

***PCS controller in constant rpm mode with frequency control of shaft generator***

### PTI mode

The shaft generator is in this mode used as an electric propulsion motor to drive the propeller (optional) via the gear. Please refer to fig 05.13.

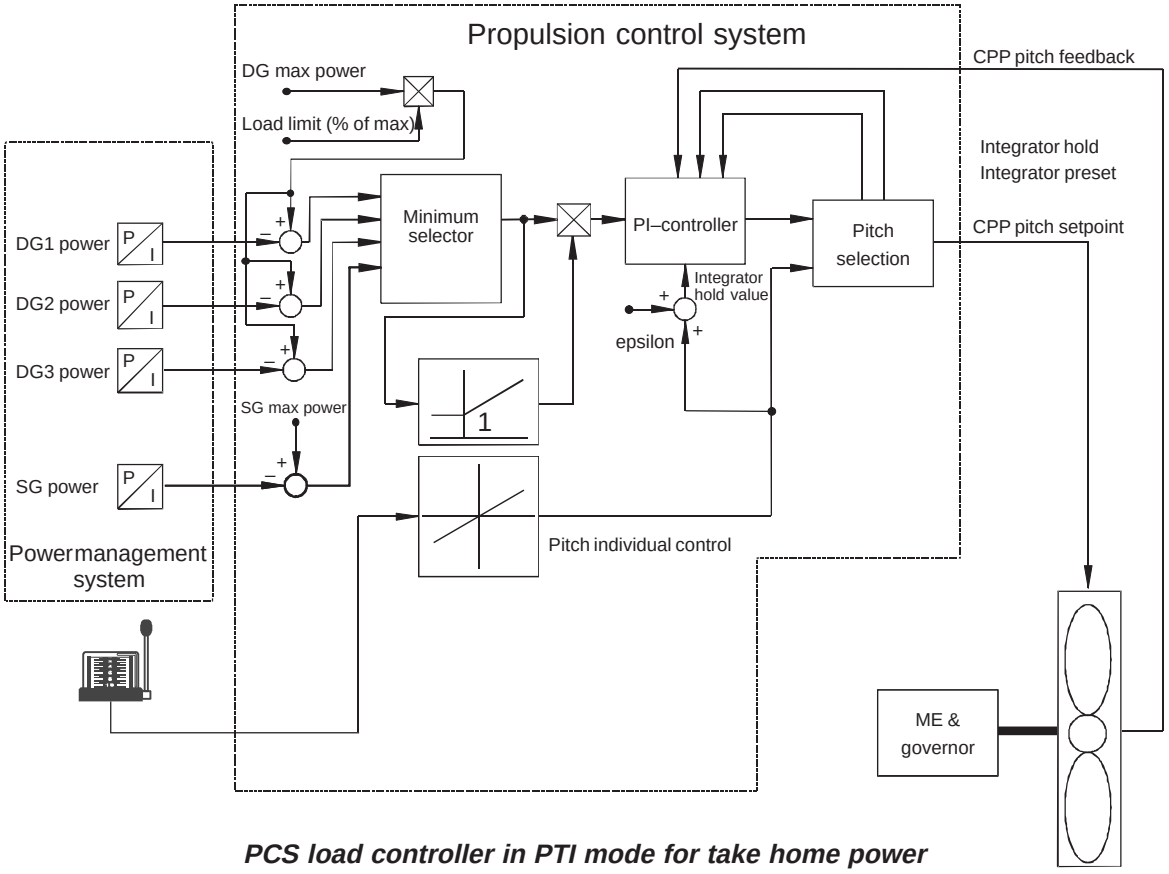
The PCS load controller includes an analog feedback signal for the actual SG motor load, which is used to protect the SG motor against overload by reducing the propeller pitch, if the measured “Actual SG motor load” becomes higher than 100%.

If the power on the MSB, which is available for PTI propulsion, is lower than the maximum load on the SG motor, the “Maximum SG motor load” limit in the PCS must be adjusted according to the available power on the MSB, and the load controller will then protect the diesel generators against overload.

As an option, it is possible to protect each individual DG connected to the MSB against overload from the propeller pitch, but this requires an additional DG power feedback input from each of the diesel generators. If the load of one of the generators is increased above a predefined limit, eg adjusted to 90–95% of the generators maximum load, then the pitch will be reduced to protect the diesel generator against overload.

Whether the shaft generator works as a generator or as a motor, is determined by the power management system.

***Fig 05.13***




***PCS load controller in PTI mode for take home power***

2001–09–26

## Separate mode

Main engine rpm and propeller pitch can be controlled individually. Separate mode is available from both the bridge and the ECR panels. As an option, a separate lever for control of the rpm may be supplied. Please refer to fig 05.14.

Rpm and pitch can be adjusted without any restrictions, however, if the adjusted pitch setpoint corresponds to an overload situation of the main engine with the present main engine rpm setpoint, the propeller pitch will be reduced until the main engine is no longer overloaded.

The separate mode is only available in case of diesel propulsion, ie not in PTI mode.

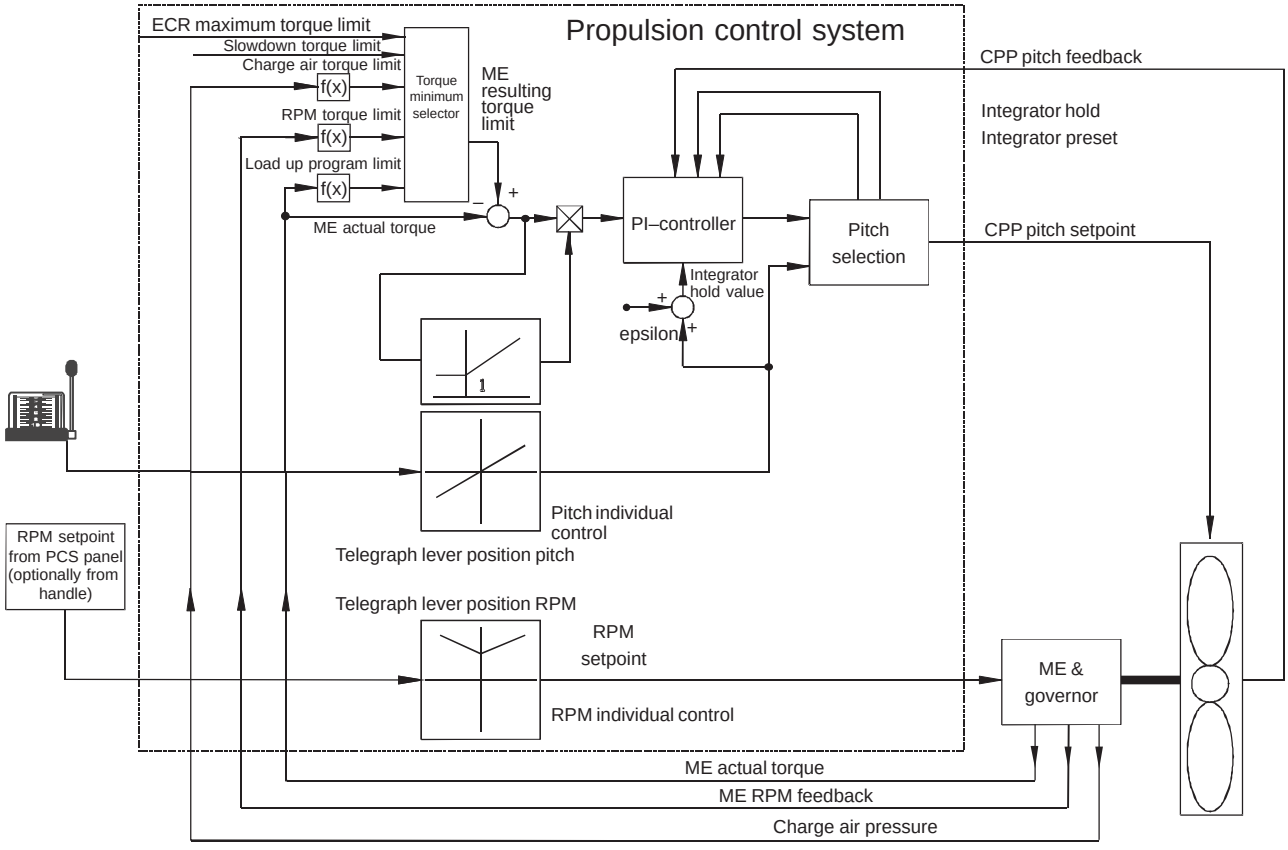
## Backup modes

In case of failure of the computerised part of the PCS System, eg a breakdown of the PCS CPU or other critical failures in the PCS system, it will no longer be possible to start/stop the engine and engage/disengage the thrust clutch from the PCS panel, or to use the combinator curves and load controller functions in the PCS. In this case it is recommended to select one of the two backup modes for control of the main engine rpm and propeller pitch.

These backup control and emergency operation modes are completely independent of the AT2000 PCS, ie they are also working when the PCS CPU and operator panels in the AT2000 system are switched off.

***Fig 05.14***

2001–09–26




***Load controller in separate control mode***

### Backup control

Backup control is a mode, where the engine can be started and engaged in local control, and then the **[BACKUP CONTROL ON/ OFF]** pushbutton on the bridge is pressed to select pitch control directly from the bridge centre setpoint lever.

In backup control, the main engine is running in constant rpm mode, controlled by the main engine governor, and the propeller pitch is then directly controlled by means of an additional, independent setpoint potentiometer mounted on the bridge centre setpoint lever and connected directly to the CPP closed loop control system.

Backup control can be selected while engine and propeller is running in remote control via the PCS.

### Emergency control of propulsion plant

Emergency operation of the engine start/ stop, clutch, rpm and propeller pitch is done locally in the machinery space.

Please refer to separate manuals for engine, gear and propeller.

### Load control during backup modes

During local control, it is the responsibility of the operator to avoid overload of the main engine. During operation in this mode, the operator will be given a warning on the **[OVERLOAD]** lamp in the PCS panels, if the propeller pitch is overloading the engine. The **[OVERLOAD]** indication lamp is hardwired directly to the limit switch on the main engine, or to an overload output on the electronic governor, and thus completely independent of the PCS CPU, communication network and other PCS panel functions.

## Mode changes

From the panels on the bridge and in the ECR the following modes are available:

- Separate mode
- Combinator mode
- Constant rpm mode

The new mode is selected by pressing the corresponding key (**[COMBINATOR]**, **[CONST. RPM]** or **[SEPARATE]**) on the panel in control.

If the operator activates a mode push–button on a panel, which is not in control, nothing will happen, but a warning is given by the buzzer as a short beep.

If a mode change is requested from the panel in control, while a blocking for the change is active, nothing will happen, but a warning is given by the buzzer as a short beep.

If a mode change with no blocking is requested from the panel in control, the lamp for the requested mode is turned on and the lamp for the previous mode is turned off.

When all requirements are fulfilled and the mode change is executed, all parts of the propulsion machinery are ready for the selected mode.

### Mode change requirements

#### Constant rpm mode → separate mode or combinator mode

If the shaft generator is connected to the MSB either as producer of power for consumers on the ship or for alternative propulsion, it is required that it is disconnected before start of the mode change is accepted.

#### Separate mode → combinator mode or constant rpm mode

There are no restrictions, which can block this mode change.

2001–09–26

## Mode change table

The below table describes the preconditions, actions and status for each mode change for systems without PTI.

| Mode change | Preconditions | Actions for the mode change | Remarks and status at the end of the mode change |
|---|---|---|---|
| Separate mode<br>to<br>constant rpm with<br>PTO on SG | ME running at variable rpm<br>Thrust clutch engaged<br>PTO clutch disengaged<br>SG disconnected | ME changed to constant rpm<br><br>PTO clutch engaged<br>SG connected as generator to MSB | There are no restrictions, which can block this mode change.<br>ME running at rpm corresponding to 50/60 Hz.<br>Pitch position according to pitch lever position (unless load control is active) |
| Constant rpm with<br>PTO on SG<br>to<br>separate mode | SG connected<br>PTO clutch engaged<br>Thrust clutch engaged<br>ME running at constant rpm | SG disconnected<br>PTO clutch disengaged<br><br>ME changed to variable rpm | ME running at rpm corresponding to rpm lever position.<br>Pitch position according to pitch lever position (unless load control is active). |
| Combinator mode<br>to<br>constant rpm with<br>PTO on SG | ME running at combinator rpm<br>ME clutch engaged<br>PTO clutch disengaged<br>SG disconnected | ME changed to constant rpm<br><br>PTO clutch engaged<br>SG connected as generator to MSB | There are no restrictions, which can block this mode change.<br>ME running at rpm corresponding to 50/60 Hz.<br>Pitch position according to pitch lever position (unless load control is active). |
| Constant rpm with<br>PTO on SG<br>to<br>combinator mode | SG connected<br>PTO clutch engaged<br>Thrust clutch engaged<br>ME running at constant rpm | SG disconnected<br>PTO clutch disengaged<br><br>ME changed to combinator rpm | ME rpm and pitch position (unless load control is active) according to lever position for combinator control. |
| Separate mode<br>to<br>combinator mode | ME running at variable rpm<br>Thrust clutch engaged<br>PTO clutch disengaged<br>SG disconnected | ME changed to combinator rpm | ME rpm and pitch position (unless load control is active) according to lever position for combinator control. |
| Combinator mode<br>to<br>separate mode | ME running at combinator rpm<br>ME clutch engaged<br>PTO clutch disengaged<br>SG disconnected | ME changed to variable rpm | There are no restrictions, which can block this mode change.<br>ME running at rpm corresponding to rpm lever position.<br>Pitch position according to pitch lever position (unless load control is active). |

The below table is added for systems with PTI

| Mode change | Preconditions | Actions for the mode change | Remarks and status at the end of the mode change |
|---|---|---|---|
| From stop mode<br>to<br>Constant rpm<br>PTI/SG mode | ME stopped<br>Thrust clutch disengaged<br>PTO clutch disengaged<br>SG disconnected | CPP set to zero pitch<br><br><br>SG connected as motor | Propeller Shaft are driven by diesel generators via the SG–motor at rpm corresponding to 60 Hz.<br>Pitch position according to pitch lever position. |
| Constant rpm<br>PTI/SG mode<br>to<br>stop mode | ME stopped<br>Thrust clutch disengaged<br>PTO clutch disengaged<br>SG connected as motor | CPP set to zero pitch<br><br><br>SG disconnected from MSB | ME stopped, disconnected and with zero pitch, ready to start–up for normal propulsion. |

## Load control

The load controller is a closed loop control in the PCS, taking care of the overload protection of the main engine. The propeller pitch is limited in order to adjust the load on the main engine according to the output from the load controller, ie the rpm for the main engine is independent of the output from the load controller.

Only if the pitch is not reduced, the fuel index will reach the maximum limit and in this situation, the governor might not be able to maintain the rpm of the main engine.

As long as the PCS load controller is active, the PCS is activating the governor cancel limits output, ie during all normal operation the main engine overload protection is taken care of by the PCS, and thus short time overload of the main engine will be allowed. The governor cancel limits output is only relevant for electronic governors.

The AT2000 PCS system includes the following load control functions for protection of the main engine:

- Load up program, cancellable.
- Charge air limitation, cancellable.
- Maximum load limitation (chief limit), non cancellable but adjustable.
- Rpm/torque limitation, non cancellable.
- Load reduction (slow down), cancellable on the **[LOAD REDUC. CANCEL]** key only.

When one of the cancellable limitations are active, it is indicated on the PCS panels with flashing red light in the **[LOAD RESTRICT CANCEL]** key. The active limit in the load controller will always be the limitation with the lowest output. To see which one of the limitations that are active, select the load controller status list on the display. Here it will also be possible to read the actual values for rpm, fuel index, charge air pressure, load program etc.

Please refer to page 05–66 for a detailed description the load controller status list.

The load control limitations can be cancelled, except for the maximum load limit adjustment and rpm torque limit. The limitations are cancelled by pressing the **[LOAD RESTRICT CANCEL]** key in the PCS panel. Activation is indicated by steady light in the **[LOAD RESTRICT CANCEL]** key. Cancel load restrictions activated rises the load limiter curves with a pre–adjusted percentage of the fuel index and changes the load–up program to a faster curve. Load reduction cancelled is removed again by pressing the **[LOAD RESTRICT CANCEl]** key once more.

Use of the load restrict cancel function will activate an alarm in the PCS system in order to warn the operators of this abnormal running condition.

### Load–up program

If the engine has been stopped or if the load on the engine has been below the “Load up program restart limit” (normally 20% load) for more than 10 sec, the PCS will protect the main engine loading up against thermal overload by limiting the propeller pitch. The load up program limits the load to a level between 60% and 100% of max power and slowly increases this limit to 100% within 5 minutes.

The condition for the load–up program to increase the load setpoint is that the actual load is within the 8% window size – the 2% window hysteresis, ie 6% from the load up program setpoint.

When the engine load is decreased more than the 8% window size + the 2% window hysteresis, the load up program limit will after 10 sec decrease from the present load, down to the new setpoint with an adjustable slope which is 5 times faster than the time for the load up program.

2001–09–26

The loading curves for the main engine load–up program are characterised by a number of adjustable break points. Please refer to fig 05.15 for the engine load–up program curves.

Load–up program active is indicated on the PCS panels with flashing light in the **[LOAD RESTRICT CANCEL]** key.

The load–up program can be cancelled by pressing the **[LOAD RESTRICT CANCEL]** key on the PCS panel. Activation is indicated by steady light in the **[LOAD RESTRICT CANCEL]** key.

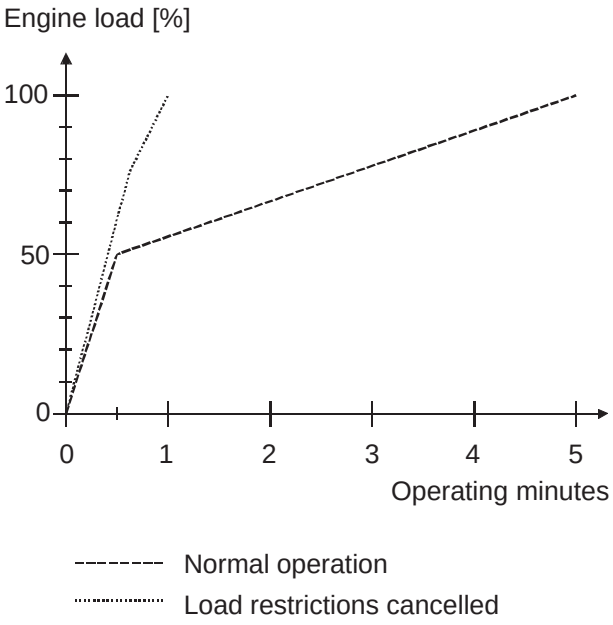
The above numbers refer to a standard setup of the system. Actual plants may be adjusted differently.

### Maximum load adjustment

At the PCS panel, it is possible to reduce the load of the main engine, by adjusting (password protected) the setting for maximum ECR load limit. The maximum ECR load limit can be adjusted in the range from 25% to 110%.

2001–09–26

***Fig 05.15***




***Load–up program limit curves***

Maximum load limit active is not indicated in the **[LOAD RESTRICT CANCEL]** key on the PCS panels, but the available power bar graph on the basic mode overview display will show the new maximum load.

The maximum load limit adjustment can not be cancelled, it must be readjusted. Please refer to page 05–61 for the procedure.

### Charge air limitation

The charge air limitation will protect the engine against overload by limiting the propeller pitch to reduce the fuel index/shaft torque, as a function of the main engine charge air pressure.

The main engine charge air limitation curve is characterised by a number of adjustable break points for the maximum fuel index/shaft torque with the corresponding charge air pressure.

Charge air limitation active is indicated on the PCS panels with flashing light in the **[LOAD RESTRICT CANCEL]** key.

The charge air limitation can be cancelled by pressing the **[LOAD RESTRICT CANCEL]** key on the PCS panel. Activation is indicated by steady light in the **[LOAD RESTRICT CANCEL]** key.

When the charge air limitation is cancelled, the load will be raised according to the curve for cancelled limits.

### Rpm/torque limitation

The rpm/torque limitation will protect the engine against overload by limiting the propeller pitch to reduce the fuel index/shaft torque, as a function of the main engine rpm.

The main engine torque limitation curve is characterised by a number of adjustable break points in a table for the maximum fuel index/shaft torque with the corresponding main engine rpm.

Torque limitation active is not indicated in the **[LOAD REDUCTION CANCEL]** key on the PCS panels.

The torque limitation cannot be cancelled by pressing the **[LOAD REDUCTION CANCEL]** key on the PCS panel.

### Load reduction

The load reduction function will automatically protect the engine when certain parameters are exceeding their limits. The actual list of parameters causing automatic load reduction can be found in the engine instruction manual.

The load reduction will limit the load on the main engine to a certain maximum load.

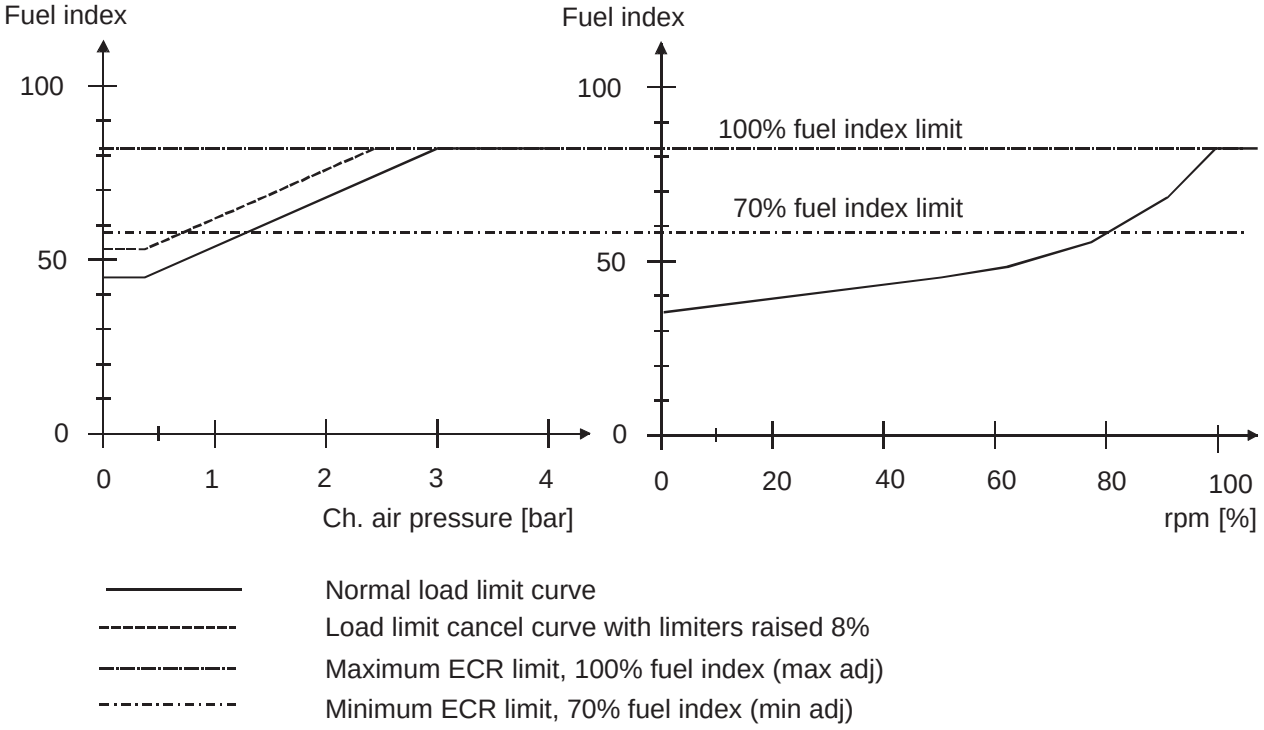
Load reduction active is indicated on the PCS panels by steady light in the **[LOAD REDUC.]** key.

The load reduction can be cancelled by pressing the **[LOAD REDUC. CANCEL]** key on the PCS panel. Activation is indicated by steady light in the key. Please refer to page 05–29 and page 05–67 for a detailed description of the load reduction system, and the records, which can be displayed on the load reduction status list.

When the load reduction is cancelled, the load will be raised as shown in fig 05.16.

2001–09–26

***Fig 05.16***




***Load controller limitations for charge air, rpm/torque and max limit***

### Load PI–controller

The load controller is operating by means of a PI–controller, which reduces the pitch set-point to the propeller,ie if the resulting torque from one of the limiters is lower than the actual main engine torque.

The main engine torque is calculated by means of the main engine fuel index and rpm.

The resulting torque from the limiters is the output from a minimum selector, with the value from the lowest of the limiters, ie charge air pressure, rpm/torque, load up program, load reduction and ECR maximum limit.

### Overload indication

When the main engine fuel index reaches 100% load, a switch on the fuel rack activates an **[OVERLOAD]** lamp in the PCS panels. In case of an electronic governor, the signal may come as a prewarning signal from the charge air and/or rpm/torque limits in the governor. This information is used during backup control of the pitch, since the load controller in the PCS will no longer prevent the main engine from overload.

## Jet assistance

Four–stroke engines equipped with AT2000–LMCS are using a jet assistance feature, designed to reduce the emission of visible smoke in three situations:

- During start of the engine.
- During clutch–in.
- During load increase.

Only during clutch in and load increase can the PCS activate the jet assist function.

The PCS transmitt the appropriate jet assist command on the serial interface line enabling the jet assistance to be activated if the charge air limit curve is exceeded when the **[LOAD RESTRICT CANCEL]** is activated.

The function is blocked in case of low starting air pressure and in case of charge air pressure above a limit where jet assistance has no effect.

## Charge air control

All charge air control functions are taken care of on the engine. The PCS can display status information.

Please refer to page 05–66 to see the charge–air status list layout.

## PTI control

In case the main engine is out of operation, the power take in (PTI) control takes care of the connection of an external power source, normally the shaft generator used as an electric motor, to the gear and propeller, using the SG as power maker for propulsion.

The set point system includes an independent combinator curve, where the maximum pitch for 100% set point ahead should be adjusted according to the maximum load on the SG motor.

The PCS load controller includes an analog feedback signal for the actual SG motor load, which is used to protect the SG motor against overload by reducing the propeller pitch, if the measured “Actual SG motor load” becomes higher than 100%.

If the power on the MSB, which is available for PTI propulsion, is lower than the maximum load on the SG motor, the “Maximum SG motor load” limit in the PCS must be adjusted according to the available power on the MSB, and the load controller will then protect the diesel generators against overload.

As an option, it is possible to protect each individual DG connected to the MSB against overload from the propeller pitch, but this requires an additional DG power feedback input from each of the diesel generators. If the load of one of the generators is in-

2001–09–26

creased above a predefined limit, eg adjusted to 90 – 95 % of the generator's maximum load, then the pitch will be reduced to protect the diesel generator against overload.

The following four sections will describe a sequence going through the steps:

- End operation (of engine)
- Prepare PTI
- End operation (of PTI)
- Prepare operation (of engine)

**End operation (of engine)**

When engine operation is stopped, activation of the "**END OPERATION**" key on the prepare/end set–up menu, will initiate the following control sequences for close down of diesel engine propulsion mode:

1. Disengaging the propeller thrust clutch (if incorporated in the gear), disconnecting the propeller shaft from the gear. In manual control this can be done from the thrust clutch menu in the gear and clutch group.
2. Disengaging the PTO clutch (if incorporated in the gear), disconnecting the PTO shaft from the shaft generator. In manual control this can be done from the PTO clutch menu in the gear and clutch group.
3. Main engine stop, if running. In manual control this can be done from the ME start/stop menu.
4. The **"END OPERATION"** sequence is finished when the engine is stopped.

**Prepare PTI**

The precondition for selecting PTI propulsion is that the main engine is stopped. When no interlock conditions for PTI Mode is present, the operator can activate the **"PREPARE PTI"** key on the prepare/end set–up menu, and the following control sequence will be initiated to set–up the PTI mode:

1. **"Start pre–operation"** signal is transmitted to the gear and propeller auxiliary systems for start of auxiliary equipment. In manual control, the auxiliary equipment must be started from the corresponding motor starters.
2. Disengage ME disconnection clutch, which is disconnecting the ME from the gear. In manual control this can be done from the ME disconnection clutch menu in the gear and clutch group.
3. Select **"PTI START"**. In manual control this can be done from the PTI control menu in the ME control group. This will send a signal **"Gear ready for PTI"** to the PMS/MSB, which will initiate the following operations for the shaft generator in the MSB:
   - Inhibit reverse power protection as long as the SG is used as motor.
   - Open the switch for de–excitation of the SG motor.
   - Start the SG as el motor.
4. When the tachometer on the PTI shaft detects that the PTI shaft speed > 97 %, a **"PTI running"** signal is send to the MSB, which will:
   - Close the switch for excitation of the SG motor.
5. After a short time delay, engagement of the PTI clutch (if incorporated) is connecting the propeller shaft to the PTI shaft. In manual control this can be done from the PTI clutch menu in the gear and clutch group.

The system is ready for propulsion in PTI mode when the PTI shaft is running and the PTI clutch is engaged. If no PTI clutch is incorporated in the plant engagement, the thrust clutch will connect the propeller shaft

2001–09–26

to the gear. In manual control this can be done from the thrust clutch menu in the gear and clutch group.

The PCS load controller is protecting the SG motor against overload by reducing the propeller pitch, if the measured **"ACTUAL SG MOTOR LOAD"** becomes higher than the adjusted **"MAXIMUM SG MOTOR LOAD"**. The **"MAX SG MOTOR LOAD"** must be adjusted according to the available power on the MSB, which again will depend on the number of DG's connected to the MSB.

### End operation (of PTI)

When PTI operation is stopped, activation of the "**END OPERATION**" key on the prepare/end set–up menu, will initiate the following control sequences for close down of the PTI propulsion mode:

1. Disengaging the propeller thrust clutch, disconnecting the propeller shaft from the gear. In manual control this can be done from the thrust clutch menu in the gear and clutch group.

   If no thrust clutch is incorporated in the plant, disengagement of the PTI clutch is disconnecting the propeller shaft from the PTI shaft. In manual control this can be done from the PTI clutch menu in the gear and clutch group.

2. Select **"PTI STOP"**. In manual control this can be done from the PTI control menu in the ME control group. This will send a signal **"PTI OUT OF SERVICE"** to the PMS/MSB, which will initiate the following operations for the el motor in the MSB:

   - Open breaker (to MSB) to trip the SG motor.

3. When the PTI shaft speed tachometer < 3 rpm, the ME disconnection clutch will be engaged, for connecting the ME to the gear again. This operation will require manual synchronisation of the engine, output shaft and gear input shaft. In manual control the ME disconnection clutch can be engaged again from the ME disconnection clutch menu in the gear and clutch group.

4. The PTI **"END OPERATION"** sequence is finished when the engine again is connected to the gearbox.

### Prepare operation (of engine)

To set–up propulsion with the main engine the operator can activate the **"PREPARE OPERAT."ion** key on the prepare/end set–up menu, and the following control sequences will be initiated to set–up the normal propulsion mode again:

1. **"START PRE–OPERATION"** signal is send to the engine, gear and propeller auxiliary systems for start of auxiliary equipment. In manual control, the auxiliary equipment must be started from the corresponding motor starters.

2. Start main engine. In manual control this can be done from the ME start/stop menu.

3. Engaging the PTO Clutch (if incorporated in the gear) is connecting the PTO shaft to the shaft generator. In manual control this can be done from the PTO clutch menu in the gear and clutch group.

The system is ready for propulsion when the diesel engine is running and the PTO clutch is engaged.

Engagement of the thrust clutch will connect the propeller shaft to the gear.

2001–09–26

### Set up operation with shaft generator

When the SG motor has been in service as el motor, the following sequences should be carried out before the shaft generator is ready to be connected to the MSB for supply of electrical power.

1. Select constant speed from the PCS panel, or from the external request to the SG interface.
2. When the constant RPM mode is selected and the engine is running at nominal speed, a **"GEAR READY FOR PTO"** signal is send to the MSB, which will:
   - Switch–on the reverse power protection.
   - Connect a battery for some seconds for re–excitation of the alternator.
   - Synchronise the DG and close the SG bus bar breaker.

## Alarm announcement and indication

New alarms in the PCS are activating the internal buzzer in the PCS panel, and shown in clear text on the basic mode overview picture as they appear, ie the oldest unacknowledged alarm is shown on line four. When the alarm is acknowledged by first pressing **[STOP HORN]** and then **[ACCEPT],** the next unacknowledged alarm will show up in line four. (Please refer to page 05–77, showing how to select the **"ALARM LIST"** from the **[MAINTENANCE]** menu.)

*2001–09–26*

The following input/failure/error will result in an alarm in the PCS system:

| ID | Text on display |
|---|---|
| 01C1AI01 | AEM402 module 01C1AI01 error |
| 01C1AI02 | MXM40x module 01C1AI02 error |
| 01C1C001 | SIO module 01C1C001 error |
| 01C1C002 | SIO module 01C1C002 error |
| 01C1M101 | AAM401 module 01C1M101 error |
| 01C1M102 | REM401 module 01C1M102 error |
| 01C1M103 | REM401 module 01C1M103 error |
| G1_LOP1 | PCS comm. to ECR Panel |
| G1_LOP2 | PCS comm. to Bridge Panel |
| G1_LOP3 | PCS comm. to PS Wing Panel |
| G1_LOP4 | PCS comm. to SB Wing Panel |
| G1_LOP5 | PCS comm. to Aft Bridge Panel |
| G1_STAT | PCS database status |
| STSTSTAT | ACS Serial Modbus Line Fail |
| SZI4740 | ME Shutdown Prewarning |
| SZI4700 | ME Non Cancellable Shutdown |
| SZI4737 | ME Shutdown Active |
| ZSI4735 | ME Sshutdown Cancelled |
| ME1_SHDP | ME Shutdown Prewarning |
| ME1_SHDN | ME Non Cancellable Shutdown |
| ME1_SHDA | ME Shutdown Active |
| ME1_SHDC | ME Shutdown Cancelled |
| ZSI4710 | ME Emergency Stop activated |
| SE1704 | ME Overspeed Activated |
| PT1224 | ME Lub Oil Pressure Low |
| PT1102 | ME H.T. C.W. Press Low |
| TE1104 | ME H.T. C.W. Temp High |
| DSH1230 | ME Oilmist Level High |
| PT2231 | ME Gear L.O. Press Low |
| ME1_SLDP | ME Load Reduction Prewarning |
| ME1_SLDN | ME Non Cancellable Load Reduction |
| ME1_SLDA | ME Load Reduction Active |
| ME1_SLDC | ME Load Reduction Cancelled |
| TE1224 | ME L.O. Temp Inlet High |

| ID | Text on display |
|---|---|
| PT1102A | ME H.T. C.W. Press Low |
| TE1104A | ME H.T. C.W. Temp High |
| TE1200 | ME Main Bearings Temp High |
| TE1600 | ME Exhaust Gas Deviation |
| TE2244 | ME Gear Thrust Bearing Temp |
| PT1312 | ME Starting Air pressure |
| ZS1705 | ME Turning Gear engaged |
| ME1_BLA | ME Startblocking Active |
| ME1_BLC | ME Startblocking Cancelled |
| ME1_SLF | ME Slowturning time–out failure |
| ME1_SAF | ME Start time–out failure |
| ME1_NOF | ME Max number of start attempts |
| MEPICKUP | ME Tacho Pickup failure |
| SHPICKUP | ME Shaft Tacho Pickup failure |
| ME1_rpmA | ME rpm Feedback (M) |
| ME1_rpm1 | ME rpm Feedback fault |
| ME1_SHRA | ME Shaft rpm Feedback (M) |
| ME1_POS | ME Control position fault |
| ME1_BTPA | ME BC pitch Setpoint fault (M) |
| ME1_BTRA | ME BC rpm Setpoint fault (M) |
| ME1_ETPA | ME ECR pitch setpoint fault (M) |
| ME1_ETRA | ME ECR rpm setpoint fault (M) |
| ME1_PAV | ME Available Power (M) |
| ME1_PCM | ME Power Demand (M) |
| ME1_PAC | ME Actual Power (M) |
| ME1_PFB | ME CPP Pitch Feedback fault (M) |
| ME1_PAL | ME CPP pitch miss–alignment |
| ME1_PFP | ME CPP Feathering pos. fail |
| ME1CL | ME clutch engage/diseng. fail |
| ME1_LLC | ME Load Limits Cancelled |
| ZT1401 | ME Fuel Index Feedback fault |
| PT1331B | ME Charge Air Pressure fault |
| TE1333 | ME Charge Air Temperature |
| ME_TCrpm | ME Turbo Charger rpm |

2001–09–26

**Buzzer warnings**

The buzzer warns with a short beep at bridge panels or ECR panel dependent on control location at:

- Activation of a PCS panel hard key on a panel which is not in control.
- Activation of a PCS control function softkey on a panel which is not in control.
- Start request for main engine with one or more start blockings.
- Request for clutch operation with one or more blockings.

*2001–09–26*

# 4. Operation

The PCS operation from the ECR and bridge panels is identical. Some functions are done by means of softkeys, where the function is displayed on the 4–line display, and operated by means of four softkeys **[ S1 ]** – **[ S2 ]** – **[ S3 ]** & **[ S4 ]**.

Up to five PCS panels can be connected on a PCS system with:

- one panel in the ECR (optionally removed).
- one panel on the bridge.
- two panels on the bridge wings (option).
- one panel on the aft bridge (option).

## Control right for PCS control functions

It is always possible to view the information on the displays, independent of the present control location.

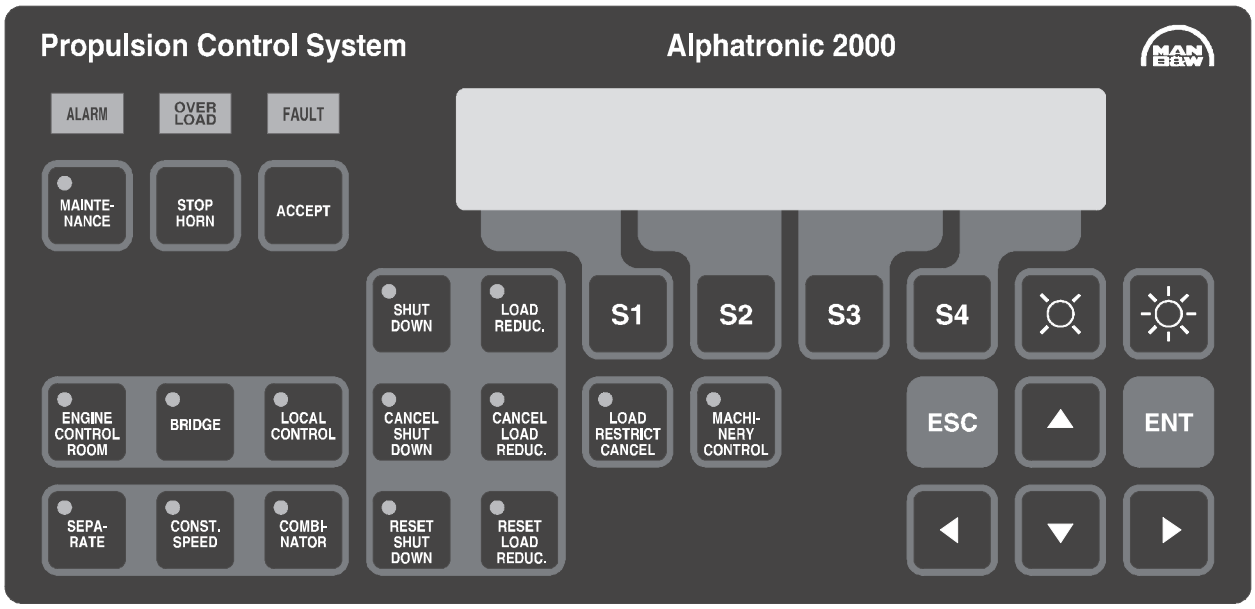
The softkeys with a control function on the different PCS control panels are only working on the PCS panels which are in control, ie on anyone of the bridge panels during bridge control and on the ECR panel during ECR control.

Activation of the softkeys for a PCS control function on a panel which is not in control, will activate the buzzer for a short time, to tell the operator that the operation, which he is trying to execute, is not allowed at the moment.

The bridge centre, port and starboard wing panels are working in parallel, ie when in bridge control, operation can be done from any of the bridge panels without taking the present control position for the electric shaft on the setpoint lever in consideration.

2001–09–26

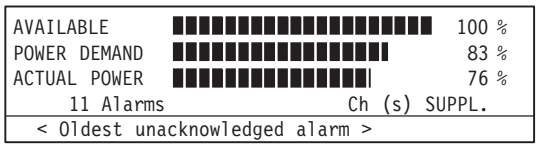
*Fig 05.17*




*AT2000 PCS operating panel lay–out*

## Basic mode overview display on PCS panel

The basic mode overview display shows the status for the available, requested and actual power for the propulsion system. Basic mode is the display selected, when the **[ESC]** key is pressed one or more times from another display, until the outermost level is reached.



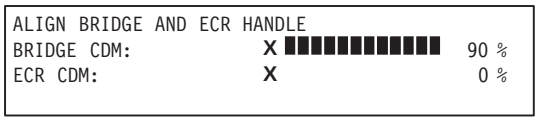

Indications on the fourth line will show the alarm status with:

- The number of present alarms when no unacknowledged alarms are present and the information of any alarm channels in manual suppression.
- Or the oldest unacknowledged alarm if any of these are present.

Alarm texts are normally shown in clear text, eg **"ACS SERIAL MODBUS LINE FAIL"**. It is however also possible alternatively to display the ID eg **"STSTSTAT"** of the alarm or the ID and the location eg **"STSTSTAT Located in PLC:1"**. It is possible to change between these three display modes by pushing the arrow keys ◀ or ▶ when the display is in basic mode.

### Setpoint system alignment

When the operators are changing the control position between ECR and bridge, this bargraph display for aligning the setpoint levers is automatically displayed.




To remove the display if for instance an alarm shows up then press the **[ESC]** key, or activate any other hard key. which, when activated will change the display.

### Other PCS panel indications

Indications on other PCS control functions might use the following definitions:

| | | |
|---|---|---|
| <MODE> | Local<br>Remote<br>Auto | Function block is in local control mode<br>Function block is in manual control mode<br>Function block is in auto control mode |
| <Feedback> | No feedb.<br>Disengage<br>Engage<br>D.engaged<br>Engaged<br>2 feedb. | Function block has no feedback activated<br>Function block is disengaging/closing/stopping<br>Function block is engaging/opening/starting<br>Function block is disengaged/closed/stopped<br>Function block is engaged/open/running<br>Function block has two feedback signals |
| <Interlk> | Interlock<br>Blocked | Function block is Interlocked by external input<br>Function block is blocked due to failure |
| <Status> | Off/normal, ie feedback not activated<br>On/active/shutdown/load reduction/st.block, ie feedback activated | |

2001–09–26

## Operation from PCS panel

To operate a PCS machinery control function by means of the softkeys on the PCS panel, the **[MACHINERY CONTROL]** key on the PCS panel should be activated at first.

***Note***

*Depending on options for the actual plant, some softkeys and the corresponding functions may be missing.*

Please refer to page 05–70 for an overview of all softkeys and status lists under the **[MACHINERY CONTROL]** key.

## Thrust clutch control on the first machinery control level

When the operator has pressed the **[MACHINERY CONTROL]** key on the PCS panel, the display will show the following softkey structure for the thrust clutch and the main engine restart on the first level and the included machinery control groups on the additional two levels:

| | | | |
|---|---|---|---|
| SELECT DIRECT COMMAND: | | | |
| \|S\|CLUTCH<br>\|1\|OUT | \|S\|CLUTCH<br>\|2\|IN | \|S\| START<br>\|3\| ME | \|S\| MORE<br>\|4\| |
| SELECT CONTROL GROUP: | | | |
| \|S\|SEPARAT<br>\|1\|RPM SET | \|S\|PREPARE<br>\|2\|/END | \|S\|START/<br>\|3\|STOP | \|S\| MORE<br>\|4\| |
| \|S\|GEAR &<br>\|1\|CLUTCH | \|S\| ME<br>\|2\|CONTROL | \|S\|STATUS<br>\|3\|LISTS | \|S\| MORE<br>\|4\| |
| \|S\|I/O<br>\|1\|ADJUST | \|S\|<br>\|2\| | \|S\|<br>\|3\| | \|S\| MORE<br>\|4\| |

Pressing the **“CLUTCH OUT”** key will disengage the main engine thrust clutch immediately, and command the pitch to zero position.

Pressing the **“CLUTCH IN”** key will engage the main engine thrust clutch immediately (if not interlocked) and release the pitch movement.

Pressing the **“START ME”** key will start the main engine, if ready for start. The purpose is to restart the main engine again after eg a blackout. This means that when the ship’s control system has restarted all the pumps, which were running before the blackout, then the operator will be able to make a quick restart by means of the (re)start key, which will reset the safety system shutdowns first and then start the engine.

## Machinery control functions selection on the second and third level

Pressing the “**MORE”** key will change from the primary machinery control softkeys on the first level, to the machinery control group selection on level two and three, giving access to the less used functions.

The requested machinery control group is selected by means of the corresponding **“GROUP NAME”** softkeys. Then the softkeys for the specific PCS control functions in that particular machinery control group are shown.

If a machine control group includes only one PCS control function, such as the main engine prepare/end set–up control and main engine start/stop control, it is shown directly when the corresponding machinery control group is selected.

## Separate rpm setpoint adjustment

Selecting the **“SEPARAT rpm Set”** key will change to a new list including the manual adjustment of the separate rpm setpoint, when the optional rpm setpoint lever for separate control is not included.

```
SET SEPERATE RPM
_SEPARATE RPM SETPT.                  789   RPM
```

To make the adjustments, select the **<Separate rpm Setpt.>** from the list by pressing the **[ENTER]** key.

Then the display will show the actual main engine rpm on the second line, the present rpm setpoint on the third line, and the new value can be adjusted on line 4, which also

shows the minimum (idle rpm) and maximum (100 % rpm) values for the adjustment.

```
SET SEPARATE RPM
 ME RPM FEEDBACK                    777   RPM
>SEPARATE RPM SETPT.                789   RPM
NEW VALUE:+0000789       [     500;      800]
```

To change the separate rpm setpoint, first select the digit you want to change using the ◀ and ▶ arrow keys and then use the ▲ and ▼ arrow keys to select the new value, and accept with the **[ENTER]** key. Push **[ESC]** when done.

## Main engine prepare/end set–up

The **“PREPARE/END”** key is selecting the function used to prepare/set–up the engine in the requested mode, ie **“PREPARE OPERAT.”**ion for normal operation and **“END OPERATION”** for close down when operation with the engine is finished. Please refer to the definition of ”Prepare/End” in page 05–19.

```
PREPARE / END SETUP
<END stat>  <PRE stat>  <PE comm>
|S|END      |S|PREPARE  |S|RESET
|1|OPERAT.  |2|OPERAT.  |3|
```

The status fields on line two has a status field for each mode above the corresponding mode command key, and a status field showing the key command activated above the **“RESET”** key.

| | | |
|---|---|---|
| <ENDstat> | Not ready | End operation not ready or Interlocked |
| | Ready | Ready for end operation |
| | Sel. idle | ME select idle speed sequence step in progress |
| | Pitch 0 | Zero pitch request to CPP control |
| | Disengage | Disengage command to thrust clutch |
| | Stop ME | Stop command to main engine |
| | Prop aux | Stop command to propeller auxiliary |
| | ME aux | Stop command to ME auxiliary |
| | Inactive | End operation mode is active (engine is inactive) |
| <PRE stat> | Not ready | Normal operation not ready or interlocked |
| | Ready | Ready for normal operation |
| | ME aux | Start command to ME auxiliary systems |
| | Prop aux | Start propeller auxiliary systems |
| | Res stblk | Reset ME startblocking |
| | Res slowd | Reset ME slowdown |
| | Res shutd | Reset ME shutdown |
| | Sel. idle | Select ME idle speed setpoint |
| | Start ME | Start command to main engine |
| | Normal | Normal operation mode is active |
| <PEcomm> | – | No prepare/end operation command in progress |
| | End | End operation command in progress |
| | Prepare | Prepare normal operation command in progress |

*2001–09–26*

### Main engine prepare/end status list

The main engine prepare/end control status display includes the following information:

```
PREPARE / END SETUP
 PREPARE/END COMMAND      PE Command
 END OPERATION STATUS     END status
 PREPARE STATUS           PRE status
```

## Main engine start/stop operation

Selecting the **“START/STOP”** key will go directly to the soft–keys for main engine start/stop.

The display will show the text for the function block on the first line, and information regarding the PCS control function, which can be operated by means of the softkeys on the second line.

To execute one of the commands, activate the corresponding softkey. Only one function can be operated at time.

```
ME START/STOP
<Mode    >  <Runstat>    <ME rpm>
|S| STOP    |S| START    |S|CANCEL    |S| MORE
|1|  ME     |2|  ME     |3|SLOWTRN.  |4|
|S|CANCEL   |S|CANCEL   |S| RESET    |S| MORE
|1| OFF     |2|STR.BLK  |3|          |4|
```

The main engine can now be **“STOP”ped** **“START”ed** and **“CANCEL SLOWTURN”** on the first level. Startblockings can be **“CANCEL”ed** and **“CANCEL’ed OFF”** on the second level by means of the **[ S1 ]** softkey. In case of failures (eg slowturn time–out or starting failure) these failures can be reset by means of the **“RESET”** softkey on the second level.

Indications for main engine on the second line include:

| | | |
|---|---|---|
| <Mode> | Local<br>E.C.R.<br>Bridge | Main engine in local control<br>Main engine in E.C.R. control<br>Main engine in bridge control |
| <Runstat> | Stopped<br>Slwt. req<br>Slwt. on<br>Slwt. oK<br>Slwt.fail<br>Starting<br>Str.block<br>Str.fail<br>Running<br>Stopping | Main engine is stopped<br>Main engine is stopped with slowturn request<br>Main engine is slowturning<br>Main engine slowturning finished<br>Main engine slowturn has failed<br>Main engine is starting<br>Main engine is startblocked<br>Main engine start is failing<br>Main engine is running<br>Main engine is stopping |
| <ME rpm> | | Main engine rpm |

### Main engine start/stop status list

The main engine start/stop control status display includes the following information:

```
ME START/STOP
 ME CONTROL LOCATION      <Mode>
 MAIN ENGINE STATUS       <Runstat>
 ME RPM                   <0 - 800 rpm>
 ME START AIR PRESS       <0 - 40.0 bar>
```

## Select main engine control functions

Selecting the **"ME CONTROL"** key will go to a new soft–key structure with the machinery control functions included in this group:

```
SELECT CONTROL FUNCTION:

|S| CPP      |S|FINEADJ   |S| LOAD     |S|TACHO
|1|CONTROL   |2|RPM.      |3|CONTROL   |4|SYSTEM
```

The actual PCS control function in the main engine control function group is selected by means of the **"GROUP NAME"** keys, and then the soft keys for the specific PCS control functions in that particular machine control group are shown.

### CPP propeller control

If the optional feathering control is included, selecting the **"CPP CONTROL"** key will go to the main engine CPP control, which can change between **"FEATHERing POS. ON"** and **"FEATHERing POS. OFF"** (ie pitch control on) control.

```
PITCH CONTROL
<CPPMode>    <CPPstat>    <Interlk>    <pitch %>
|S|CONTROL   |S|FEATHER   |S|          |S|
|1| PITCH.   |2| PITCH.   |3|          |3|
```

Indications on the second line include:

| | | |
|---|---|---|
| <CPPMode> | Local | CPP is in local control |
| | Backup | CPP is in backup control |
| | Remote | CPP is in remote PCS control |
| <CPPstat> | Offline | CPP is offline in local/backup control |
| | Online | CPP is in online PCS control |
| | Feather | CPP is offline feathered position |
| <Interlk> | Int.lock | CPP is offline in local/backup control |
| | Blocked | CPP is in online PCS control |
| <Pitch %> | ± 100% | Propeller pitch feedback |

2001–09–26

### Main engine setpoint fine–adjust

Selecting the **"FINEADJ RPM"** key will go to the main engine setpoint fine–adjustment display, with the possibility to fine–adjust the rpm setpoint, eg to be able to adjust the SG frequency around 50/60 Hz.

```
RPM FINE ADJUST
<FadjStat>        760          765     RPM
|S|FINEADJ    |S|FINEADJ    |S|RESET     |S|
|1|LOWER      |2|RAISE      |3|           |4|
```

Indications on the second line include:

| | | |
|---|---|---|
| <FadjStat> | Raise | Fine–adjust raise is activated |
| | Lower | Fine–adjust lower is activated |
| | Fadj max | Fine–adjust maximum reached |
| | Fadj min | Fine–adjust minimum limit reached |
| | Max rpm | Maximum rpm setpoint limit reached |
| | Min rpm | Minimum rpm setpoint limit reached |

2001–09–26

Each push on the **"FINEADJ RAISE"** softkey will eg increase the rpm setpoint by 1 rpm for a four–stroke engine and 0.2 rpm for a two–stroke engine, and decrease in the same way when used for the **"FINEADJ LOWER"** softkey.

On the left side of the display the setpoint from the setpoint lever or constant speed setpoint is shown, and on the right side the setpoint including the added fine–adjustment value is shown.

A third key **"RESET"** makes it possible for the operator to reset the fine–adjustment value, which is added to the setpoint back to zero.

The fine–adjustment of the setpoint is limited to eg ± 20 rpm for a four–stroke engine and ± ×5 rpm for a two–stroke engine.

This fine–adjustment is working in parallel to the optional fine–adjustment inputs from the power management system, used when a constant speed shaft generator is connected to the MSB.

### Load controller

Selecting the **"LOAD CONTROL"** key will go to the max load adjustment, because it contains no other control functions.

A list including only the adjustable setting from the load controller list will show up.

```
SET MAX LOAD
_MAX ENGINE LOAD          100.0%
```

To make the adjustment, select the ECR max load limit from the list by pressing the **[ENTER]** key.

Then key in the appropriate password when asked for it and the display will show the old value on line 3, and the new value can be typed in on line 4, which is also showing the minimum and maximum values for the adjustment.

The actual fuel index from the main engine is shown on line 2.

```
SET MAX LOAD
 ACTUAL ENGINE LOAD         89.3%
 MAX ENGINE LOAD           100.0%
NEW VALUE:+00088.8    [   50.0;         110.0]
```

To change the max engine load setpoint, first select the digit you want to change using the ◀ and ▶ arrow keys and then use the ▲ and ▼ arrow keys to select the new value, and accept with the **[ENTER]** key. Push **[ESC]** when done.

### ME tachometer selector

Selecting the **"ME TACHO SYSTEM"** will go to the main engine tacho selector display, with the possibility to manually **"SELECT TACHO 1"** from the PCS tacho system or **"SELECT TACHO 2"**. Default should during normal operation be **"AUTOSELect TACHO"** where it for safety reasons will automatically select the tacho with the highest rpm.

For engines with AT2000–LMCS, tacho 2 comes via the serial enterface. Some engines will not use two tachos.

```
ME TACHO SYSTEM
<TACMODE>    <TACHSEL>    <TACFAIL>    <ME rpm>
|S|SELECT    |S|SELECT    |S|AUTOSEL   |S|
|1|TACHO 1   |2|TACHO 2   |3|TACHO     |4|
```

Indications on the second line include:

| | | |
|---|---|---|
| <TacMode> | Auto | Auto–select highest tacho RPM |
| | Select 1 | Tacho 1 manually selected, makes alarm for tacho 2 |
| | Select 2 | Tacho 2 manually selected, makes alarm for tacho 1 |
| <TachSel> | Tacho 1 | Tacho 1 selected, (manually or auto) |
| | Tacho 2 | Tacho 2 selected, (manually or auto) |
| <Tacfail> | T1 fail | Tacho 1 in failure |
| | T2 fail | Tacho 2 in failure |
| <ME rpm> | 0–800 rpm | ME rpm for the selected tacho |

2001–09–26

### ME tacho system status list

The ME tacho system status list will display more detailed information about the ME tacho system than available under the control display.

```
ME TACHO SYSTEM
 ME SELECTED TACHO          0-800 RPM
 ME SELEC.TACHO STATE     OK/FAIL
 TACHO SELECTON MODE      <TacMode>
 SELECTED TACHO           <TachSel>
 TACHO 1                    0-800 rpm
 TACHO 1 STATE            OK/FAIL
 TACHO 2                    0-800 rpm
 TACHO 2 STATE            OK/FAIL
 TACHO FAIL STATE         <TacFail>
 SHAFT TACHO                0-300 rpm
 SHAFT TACHO STATE          OK/FAIL
```

## PTI control operation

Selecting the **“PTI CONTROL”** key will go to the PTI control menu, where the control mode can be changed between **“PTI STOP”**, ie main engine propulsion**, “PTI START”** with SG motor driven PTI propulsion and failure **“RESET”** in case of a PTI control failure.

```
PTI CONTROL
<Mode>       <Status>       0-100.0 %    SG LOAD
|S|PTI       |S|PTI       |S|RESET     |S|
|1|STOP      |2|START     |3|          |4|
```

Indications on the second line include:

| | | |
|---|---|---|
| <Mode> | ME MODE | PTI mode is not active, ie ME propulsion |
| | PTI MODE | PTI mode selected for propulsion |
| | PTI MODE | PTI mode selected for propulsion |
| <Status> | INTERLOCK | PTI operation not possible due to missing preconditions |
| | PTI OFFLine | PTI offline, ie no interlocks and ready for start |
| | PTI START | Gear ready for PTI, activating the start output to SG motor |
| | STARTFAIL | PTI start failure, ei PTI shaft not running within time–out |
| | PTI RUNN.ing | PTI shaft rpm to SG motor > 97 % of nominal speed |
| | PTI ONLINe | PTI running online, with shaft thrust clutch engaged |
| | PTI LIMIT ed | PTI running online, max load limited (ei load control active) |
| | PTI STOP | PTI out of service, activating the stop output to SG motor |
| | STOPFAIL | PTI stop failure, ie PTI shaft not stopped within time–out |
| | PTI ERROR | PTI control failure, eg due to a load feedback failure |
| <Act load> | 0–100.0 %/kW | Actual load on the SG Motor |

2001-09-26

### PTI Control Status List

The PTI Control Status display list includes the following information:

```
PTI CONTROL
 PTI LOAD CONTROL          NO LIMIT/SG/DGx LIMIT
 PITCH REQUEST               +/- 100 %
 LOAD CTRL. PITCH OUT        +/- 100 %
 SG MOTOR LOAD LIMIT       NO LIMIT/LIMITED
 SG MOTOR MAX LOAD           0-100.0 %/A/kW
 SG MOTOR ACTUAL LOAD        0-100.0 %/A/kW
 DG LOAD LIMIT             NO LIMIT/DGx LIMIT
 MAX DG LOAD                 0-100.0 % of max
 DG1 ACTUAL LOAD             0-100.0 %/A/kW
 DG2 ACTUAL LOAD             0-100.0 %/A/kW
 DG3 ACTUAL LOAD             0-100.0 %/A/kW
 DG4 ACTUAL LOAD             0-100.0 %/A/kW
 DG5 ACTUAL LOAD             0-100.0 %/A/kW
 PTI CONTROL MODE           <MODE>
 PTI CONTROL MODE           <STATUS>
```

***Note***

*DG load limits are optional, and requires an additional load feedback from each DG.*

### PTI load control adjustments

When the PTI load control display is active, adjustment of the maximum load for PTI operation is made by pressing the keys **[MAINTENANCE]** and **[S1]** (for machinery control) and then use the arrow keys for change between control, adjustment and status list.

```
PTI CONTROL
 SG MOTOR MAX LOAD                  0-1500  kW
>MAX DG LOAD.                       0-100.0 %
```

A new list including only the adjustable settings from the PTI control list will show up.

To make the adjustment, select the MAX SG MOTOR LOAD limit from the list by means of the **[ARROW]** and **[ENTER]** keys.

Then key in the appropriate password when asked for it and the display will show the old value on line 3, and the new value can be typed in on line 4, which is also showing the minimum and maximum values for the adjustment.

A related value, eg the actual PTO load on the SG motor is shown on line 2.

```
PTI CONTROL
 SG MOTOR ACTUAL LOAD                0-1500  kW
 SG MOTOR MAX LOAD                   0-1500  kW
NEW VALUE:+   1200       [       0;    32000]
```

To change the adjustment, type in the new value, and accept with the **[ENTER]** key.

The optional adjustment for max DG load is similar to the max SG motor load.

```
PTI CONTROL

MAX DG LOAD                            0-100 %
NEW VALUE:+     88       [       0;    110.0]
```

To change the adjustment, type in the new value, and accept with the **[ENTER]** key.

## Selection of gear and clutch control function

The actual PCS control function in the gear and clutch control group is selected by means of the **“GEAR & CLUTCH”** key, and then the soft keys for the specific PCS control functions in that particular machine control group are shown.

```
SELECT CONTROL FUNCTION:

|S|THRUST    |S|PTO       |S|SG/PTO    |S|DISCON.
|1|CLUTCH    |2|CLUTCH    |3|INTERF.   |4|DEVICE
```

**“DISCONnection DEVICE”** is optional for certain types of PTI control

### Thrust clutch operation

Selecting the main engine **“THRUST CLUTCH”** key will go to the ME thrust clutch control menu, where the thrust clutch can be **“DISENGAGE”d, “ENGAGE”d** and **“RESET”.**

```
THRUST CLUTCH
<Mode>       <Feedback>   <Interlk>
|S|DIS-      |S|ENGAGE    |S|RESET     |S|
|1|ENGAGE    |2|          |3|          |4|
```

### Thrust clutch control status list

The main engine clutch control status display list includes the following information, including all the conditions leading to an engage or disengage interlock:

| THRUST CLUTCH | |
|---|---|
| CONTROL MODE | <Mode> |
| FEEDBACK STATE | <Feedback> |
| INTERLOCK STATE | <Interlk> |
| ENGAGE TIMER RUNNING | OFF/ON |
| ME RPM TOO HIGH | OFF/ON |
| ME/SH RPM DIFF. HIGH | OFF/ON |
| CPP PITCH NOT ZERO | OFF/ON |
| CPP OIL PRESSURE LOW | OFF/ON |

### PTO clutch operation

Selecting the **“PTO CLUTCH”** key will go to the main engine PTO clutch control menu, where the PTO clutch can be **“DISENGAGE”d**, **“ENGAGE”d** and **“RESET”**.

| PTO CLUTCH | | | |
|---|---|---|---|
| <Mode> | <Feedback> | <Interlk> | |
| \|S\|DIS- | \|S\|ENGAGE | \|S\|RESET | \|S\|MORE |
| \|1\|ENGAGE | \|2\| | \|3\| | \|4\| |

### PTO interface to external power consumer (SG interface)

Selecting the **“SG/PTO INTERF.”** key will go to the main engine PTO interface status list, showing the status for the signals going between the PCS and an external power consumer, using a primary PTO, eg the shaft generator.

| PTO/SG INTERFACE | |
|---|---|
| SG PTO STATUS | NOT READY |
| CONSTANT SG REQUEST | OFF/ON |
| CONSTANT SG FEEDBACK | OFF/ON |
| LIM.VAR SG REQUEST | OFF/ON |
| LIM.VAR SG FEEDBACK | OFF/ON |
| DG STANDBY START | OFF/ON |
| MAINTAIN SPEED REQ. | OFF/ON |

The list shows if the PTO is ready for SG operation, if the SG is requested and online in constant or limited variable mode, if a standby diesel generator is requested to start or if a SG with frequency converter is asking the PCS to maintain the present speed.

## PCS panel status lists

Beside the status indications displayed on the PCS control functions, the machinery group for main engine status lists includes some additional PCS control functions including indication lists corresponding to the alarm groups for shutdowns, load reductions and startblockings in the PCS, and other for general indications of analog and digital inputs to the PCS, which are not shown in other lists.

| SELECT CONTROL OBJECT: | | | |
|---|---|---|---|
| \|S\|START \|1\|BLOCK | \|S\|CPP \|2\|CONTROL | \|S\|GOVER- \|3\|NOR | \|S\| MORE \|4\| |
| \|S\|LOAD \|1\|CONTROL | \|S\| SET- \|2\|POINT | \|S\|CH. AIR \|3\|CONTROL | \|S\| MORE \|4\| |
| \|S\|SHUT \|1\|DOWN | \|S\|LOAD \|2\|REDUCT | \|S\| \|3\| | \|S\| MORE \|4\| |

### Main engine startblockings list

Selecting the **“START BLOCK”ing** key will go to the main engine startblocking list showing the startblocking conditions. The status display for main engine startblockings will include information about whether the main engine start is ready for start on the first line, or startblocked on the second line and if the startblocking is cancelled.

The following lines will show the reasons for a startblocking of the main engine.

| START BLOCKINGS | |
|---|---|
| READY TO START | ON/OFF |
| START BLOCKED | OFF/ON |
| START BLOCKED CANCELLED | OFF/ON |
| LOCAL CONTROL | OFF/ON |
| SHUT DOWN | OFF/ON |
| START/FAIL | OFF/ON |
| SLOWTURNING FAIL | OFF/ON |
| TURNING GEAR ENGAGED | OFF/ON |
| ENG. LOCAL CONTROL | OFF/ON |
| CPP oil press low *1 | OFF/ON |
| CPP pitch not ZERO *1 | OFF/ON |
| Shaft locking device *1 | OFF/ON |
| Start air press low *4 | OFF/ON |
| Main start valve *2 | OFF/ON |
| Control air press *2 | OFF/ON |
| Safety air press *2 | OFF/ON |
| Exh. valve ctrl air *2 | OFF/ON |
| Aux. blowers ready *2 | OFF/ON |
| Disconnecting device *3 | OFF/ON |
| Gear lub oil press. *5 | OFF/ON |

2001-09-26

*1 Only relevant in case of no thrust clutch, otherwise they will be engage blockings.

*2 Only relevant for two–stroke engines.

*3 Only relevant for PTI operation.

*4 Replaces main start valve on four–stroke engines.

*5 Will on some plants work by means of a shutdown from the safety system.

### CPP propeller control status list

Selecting the **"CPP CONTROL"** key will go to the Main Engine CPP Control status list, which will show the following status information for the pitch control system:

| PITCH CONTROL | |
|---|---|
| CONTROL MODE | REMOTE |
| MODE | ONLINE |
| FEATHER CTRL INTRLOK | <Interlk> |
| PITCH FEEDBACK | ± 100% |
| PITCH COMMAND | ± 100% |
| PITCH MIS ALIGNED | NORMAL |
| CPP BOOSTER PUMP | STOPPED/STARTED |
| ZERO PITCH | ON/OFF |
| FEATHER POS. INPUT | OFF/ON |
| FEATHER POS. CONTROL | NORMAL/ALARM |

The lines for feathered control are optional.

### Main engine governor interface

Selecting the **"GOVERNOR"** key will go to the main engine governor interface list showing the status for the governor interface signals, and the values for the analog PCS settings to the governor.

| GOVERNOR INTERFACE | |
|---|---|
| ME RPM FEEDBAACK | 799 RPM |
| GOVERNOR SETPOINT | 800 RPM |
| SP.DROP COMPENSATION | 22 RPM |
| GOVERNOR STOP ON | OFF/ON |
| CANCEL LIMITS ON | OFF/ON |

The line for speed droop compensation is optional.

### Load controller status list

When the **"LOAD CONTROL"ler** is selected, the status list will display the status for each of the limitations in the load controller, including feedback for the corresponding signals used to calculate the limitations:

| LOAD CONTROL | |
|---|---|
| STATUS | NO LIMIT |
| PITCH REQUEST | ± 100.0% |
| LOAD CTRL. PITCH OUT | ± 100.0% |
| MAX ENGINE LOAD | 0–110.0% |
| ACTUAL ENGINE LOAD | 0–110.0% |
| ACTUAL FUEL INDEX | 0–100.0% |
| SEL. LOAD PROGRAM | NORMAL |
| LOAD PROGRAM STATUS | MIN |
| LOAD PROGRAM OUTPUT | 60–100.0% |
| RPM LIMITER STATE | LIMIT OFF/ON |
| RPM LIMITER OUTPUT | 0–100.0% |
| ME RPM | 0–800 RPM |
| CHARGE AIR LIM STATE | LIMIT OFF/ON |
| CHARGE AIR LIM OUTP | 0–100.0% |
| CHARGE AIR PRESSURE | 0–3.20 bar |
| LOAD REDUCTION STATE | OFF/ON |
| LOAD REDUCTION LIMIT | 40.0% |

### ME setpoint system status list

The main engine **"SETPOINT"** system status list will show the setpoint system status, and the values for the analog settings in the setpoint system of the PCS.

| SETPOINT SYSTEM | |
|---|---|
| BRIDGE PITCH SETPNT. | ± 100.0% |
| ECR PITCH SETPOINT | ± 100.0% |
| BRIDGE RPM SETPOINT | 0–800 RPM |
| ECR RPM SETPOINT | 0–800 RPM |
| SELECTED SETPOINT | 0–800 RPM |
| ADJUSTED SETPOINT | 0–840 RPM |
| ME MAINTAIN SPEED | OFF/ON |
| ME FIXED SPEED REQ. | OFF/ON |
| ME SG CONNECTED | OFF/ON |
| Bridge centre | OFF/ON |
| Bridge wing port | OFF/ON |
| Bridge wing starboard | OFF/ON |
| Bridge aft | OFF/ON |

The rpm setpoints are optional.

The el–shaft control position is optional

### Main engine charge air control status list

Selecting the **"CH. AIR CONTROL"** key will go to the main engine charge air control list showing the status information from the charge air system.

| CHARGE AIR CONTROL | |
|---|---|
| CHARGE AIR PRESSURE | 0–4.00 bar |
| CHARGE AIR TEMP | 0–150.0 deg. |
| TURBO CHARGER RPM | 0–40000 RPM |

2001–09–26

### Main engine shutdown list

Selecting the **[SHUT DOWN]** key will go to the main engine shutdown list showing the shutdown conditions. The main engine shutdown list can also be selected directly, by pressing the **[SHUT DOWN]** hard–key on the PCS panel. The status display for main engine shutdown shows information on the reasons for shutdown of the main engine, if the engine is equipped with the local electronics having a serial interface eg type AT2000–LMCS. For engines without this system, details of the reason may be omitted.

| SHUTDOWN | |
|---|---|
| ACS: SHD PREWARNING | OFF/ON |
| ACS: SHD ACTIVE | OFF/ON |
| ACS: SHD CANCELLED | OFF/ON |
| ACS: EMERGENCY STOP | OFF/ON |
| ACS: OVERSPEED | OFF/ON |
| ENG. LUB. OIL PRESS | OFF/ON |
| ENG. H.T. WATER PRESS | OFF/ON |
| ENG. H.T. WATER TEMP | OFF/ON |
| ENG. OIL MIST DENSITY | OFF/ON |
| GEAR LUB. OIL PRESS | OFF/ON |

### Main engine load reduction

Selecting the **[LOAD REDUCT.]** key will go to the main engine load reduction list showing the load reduction conditions. The main engine load reduction list can also be selected directly, by pressing the **[LOAD REDUCT.]** hard–key on the PCS panel.

The status display for main engine load reduction shows informations on the reasons for the main engine load reduction, if the engine is equipped with the local electronics having a serial interface eg type AT2000–LMCS. For engines without this system, details of the reason may be omitted.

| LOAD REDUCTION | |
|---|---|
| LOAD RED. PREWARNING | OFF/ON |
| LOAD REDUCT. ACTIVE | OFF/ON |
| LOAD RED. CANCELLED | OFF/ON |
| L.O. TEMP INLET | OFF/ON |
| H.T. C.W. TEMP INLET | OFF/ON |
| H.T. C.W. TEMP OUTL | OFF/ON |
| THRUST BEARING TEMP | OFF/ON |
| MAIN BEARINGS TEMP | OFF/ON |
| EXH. GAS DEVIATION | OFF/ON |

## Input/output adjustments

***Warning***

*Adjusting of inputs and outputs should only be carried out after consulting MAN B&W. Misadjustments may lead to loss of the ships manoeuvrability via the PCS.*

Selecting the **"In/OUTput ADJUST"** key on the group display, will go to a new soft–key structure with the machinery control functions, with inputs or outputs, which can be adjusted:

| SELECT CONTROL OBJECT: | | | |
|---|---|---|---|
| \|S\|CPP INP<br>\|1\|ADJUST | \|S\|CPP OUT<br>\|2\|ADJUST | \|S\|GOV OUT<br>\|3\|ADJUST | \|S\| MORE<br>\|4\| |
| \|S\|BRG PIT<br>\|1\|LEVER | \|S\|ECR PIT<br>\|2\|LEVER | \|S\|ECR RPM<br>\|3\|LEVER | \|S\| MORE<br>\|4\| |
| \|S\|BRG RPM<br>\|1\|LEVER | \|S\|<br>\|2\| | \|S\|<br>\|3\| | \|S\| MORE<br>\|4\| |

### Adjustment of pitch feedback

Selecting the **"CPP INPut ADJUST"** will make it possible to offset adjust the feedback signal in the three (four) positions: zero pitch, 100% Astern and 100% ahead and an optional for feathered position, by pressing the corresponding key, when the propeller pitch is in the corresponding position. The adjustment is password protected. The adjustment for feathered position is optional.

| CPP INPUT ADJUST | | | |
|---|---|---|---|
| <UNSCALED VALUE> | | <SCALED VALUE> | |
| \|S\|ADJUST<br>\|1\|ZERO | \|S\|ADJUST<br>\|2\|100% AS | \|S\|ADJUST<br>\|3\|100% AH | \|S\|ADJUST<br>\|4\|FEATHER |

On the left side of line two, the unscaled feedback input is displayed. The right side will show the scaled value corresponding to the position of the propeller.

***Note***

*It is necessary to wait until the propeller has obtained the requested position before the corresponding key is pushed.*

Adjustment must be carried out with stopped engine and propeller servo oil stand–by pump running.

### Pitch feedback adjustment status list

On the pitch feedback adjustments status list, the unscaled pitch feedback input, the scaled pitch feedback and the actual pitch command setpoint are displayed.

```
CPP INPUT ADJUST
 PITCH FEEDBACK INPUT    ± 80%
 PITCH FEEDB. SCALED     ± 100%
 PITCH COMMAND           ± 100%
```

### Adjustment of pitch output

Selecting the **"CPP OUTput ADJUST"** will make it possible to adjust the mA output (ie the Y = output axis on the pitch output table) for the five positions, eg corresponding to: zero pitch, –100% astern and +100% ahead, and optional for max astern and ahead (feathered) position. It must be checked if the pitch moves to the corresponding position, or if the output needs further adjustments.

It is also possible to adjust the internal PCS pitch setpoint (ie the X = input axis on the pitch output table) for the corresponding five pitch position breakpoints on the pitch output table. Normally only the Y – output axis will need to be adjusted. The adjustments are password protected.

```
CPP OUTPUT ADJUST
 PITCH OUTP TABLE X1       -110.00%
 PITCH OUTP TABLE Y1       -109.00%
 PITCH OUTP TABLE X2       -100.00%
 PITCH OUTP TABLE Y2        - 99.00%
 PITCH OUTP TABLE X3          0.00%
 PITCH OUTP TABLE Y3          0.00%
 PITCH OUTP TABLE X4         100.00%
 PITCH OUTP TABLE Y4          99.00%
 PITCH OUTP TABLE X5         300.00%
 PITCH OUTP TABLE Y5         291.00%
```

To make the adjustment, select eg the pitch output for +100% AH (ie output table Y4) from the list by means of the **[ARROW]** and **[ENTER]** keys.

Then key in the appropriate password when asked for it and the display will show the old value on line 3, and the new value can be adjusted on line 4, which is also showing the minimum and maximum values for the adjustment.

The actual pitch setpoint in percent (%) is shown on line 2, which for the 100% Ahead adjustment requires that the setpoint lever is put in a position requesting 100% pitch. The pitch setpoint request from the PCS, is the setpoint which is transformed to a mA signal for the CPP closed loop controller.

```
CPP OUTPUT ADJ
 PITCH COMMAND           100.00 %
 PITCH OUTP TABLE Y4      90.00 %
New value:+0098.77  [-320.00; 320.00]
```

To change the adjustment, adjust the "new value" by means of the arrow keys, and accept with the **[Enter]** key.

### Adjustment of governor output

Selecting the **"GOVernor OUTput ADJUST"** will make it possible to adjust the mA output for eg the following speeds listed in the display (corresponding eg to 50%, 60%, 80%, 100% and 105% rpm on a four–stroke engine). It must be checked if the main engine speed changes to the corresponding rpm setpoint, or if the output needs further fine–adjustments. The adjustment is password protected.

```
GOVERNOR OUTPUT ADJ
 RPM OUTPUT TABLE X1       380.0 RPM
 RPM OUTPUT TABLE Y1       380.0 RPM
 RPM OUTPUT TABLE X2       460.0 RPM
 RPM OUTPUT TABLE Y2       460.0 RPM
 RPM OUTPUT TABLE X3       610.0 RPM
 RPM OUTPUT TABLE Y3       610.0 RPM
 RPM OUTPUT TABLE X4       760.0 RPM
 RPM OUTPUT TABLE Y4       760.0 RPM
 RPM OUTPUT TABLE X5       800.0 RPM
 RPM OUTPUT TABLE Y5       800.0 RPM
```

To make the adjustment, select eg the constant speed output for 100% rpm (ie output table Y4) from the list by means of the **[ARROW]** and **[ENTER]** keys.

Then key in the appropriate password when asked for it and the display will show the old

2001–09–26

value on line 3, and the new value can be adjusted on line 4, which is also showing the minimum and maximum values for the adjustment.

The actual rpm setpoint is shown on line 2, which for the constant speed adjustment requires that constant speed is selected, and the internal rpm adjustment for constant speed is correct. The governor output request from the PCS, is the setpoint which is transformed to a mA signal for the main engine governor.

```
GOVERNOR OUTPUT ADJ
 ACTUAL rpm SETPOINT      750.0 RPM
 RPM OUTPUT TABLE Y4      750.0 RPM
New value:+00745.6   [  0.0; 3200.0]
```

To change the adjustment, adjust the “new value” by means of the arrow keys, and accept with the **[ENTER]** key.

### Adjustment of pitch setpoint levers

Selecting the **“BRidGe PITch LEVER”** will make it possible to adjust the setpoint in the three positions: zero pitch, 100% astern and 100% ahead by pressing a soft key, when the setpoint lever is in the corresponding position. The adjustment is password protected.

```
BRG PITCH LEVER ADJ
<UNSCALED VALUE>          <SCALED VALUE>
|S|ADJUST     |S|ADJUST     |S|ADJUST     |S|
|1|ZERO       |2|100% AS    |3|100% AH    |4|
```

On the left side of line two, the unscaled input is displayed. On the right side, the scaled value is displayed, corresponding to the position of the handle.

The ECR pitch setpoint lever adjustment is similar to the bridge pitch lever adjustment.

### Adjustment of rpm setpoint levers (optional)

Selecting the **“ECR RPM LEVER”** will make it possible to adjust the setpoint in the two positions: zero/min rpm and 100% rpm, by pressing the corresponding key, when the setpoint lever is in the corresponding position. The adjustment is password protected.

```
ECR RPM LEVER ADJ
<UNSCALED VALUE>          <SCALED VALUE>
|S|ADJUST     |S|ADJUST     |S|           |S|
|1|ZERO       |2|100%       |3|           |4|
```

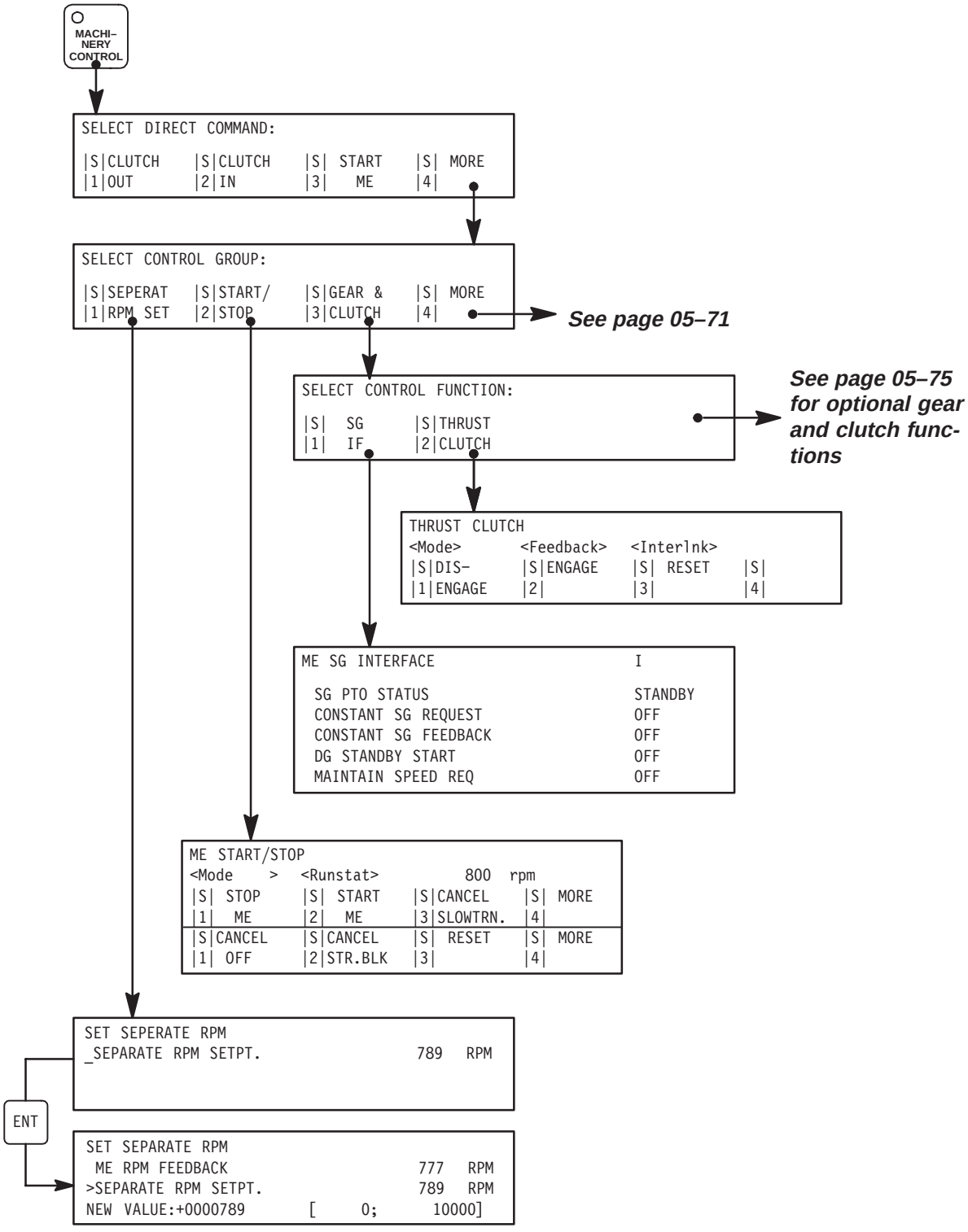
On the left side of line two, the unscaled input is displayed. On the right side, the scaled value is displayed, corresponding to the position of the handle.

The bridge rpm setpoint lever adjustment is similar to the ECR rpm lever adjustment.

2001-09-26

## Machinery control softkeys

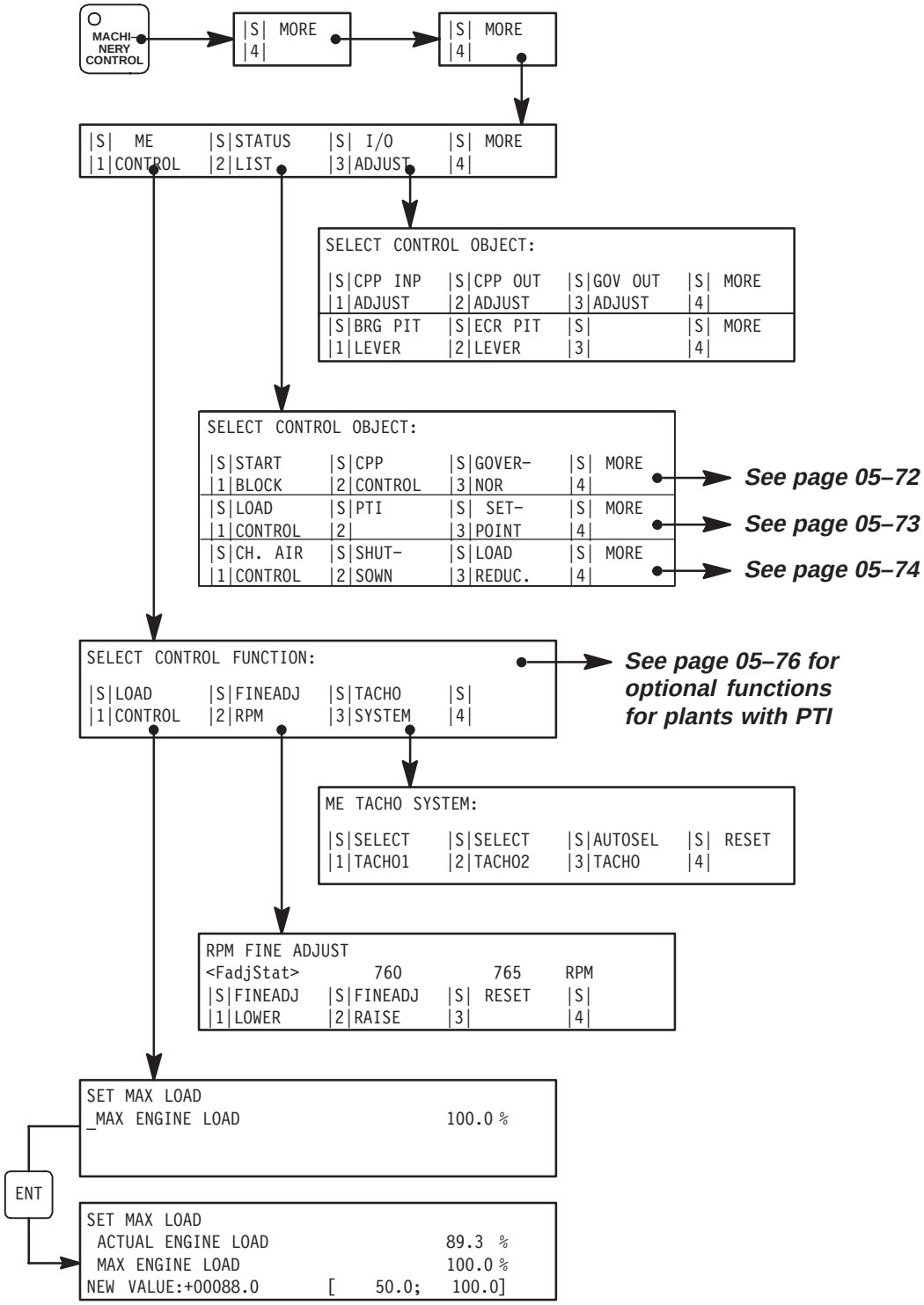
***Fig 05.18***




***Functions under the pushbutton "MACHINERY CONTROL"***

2001–09–26

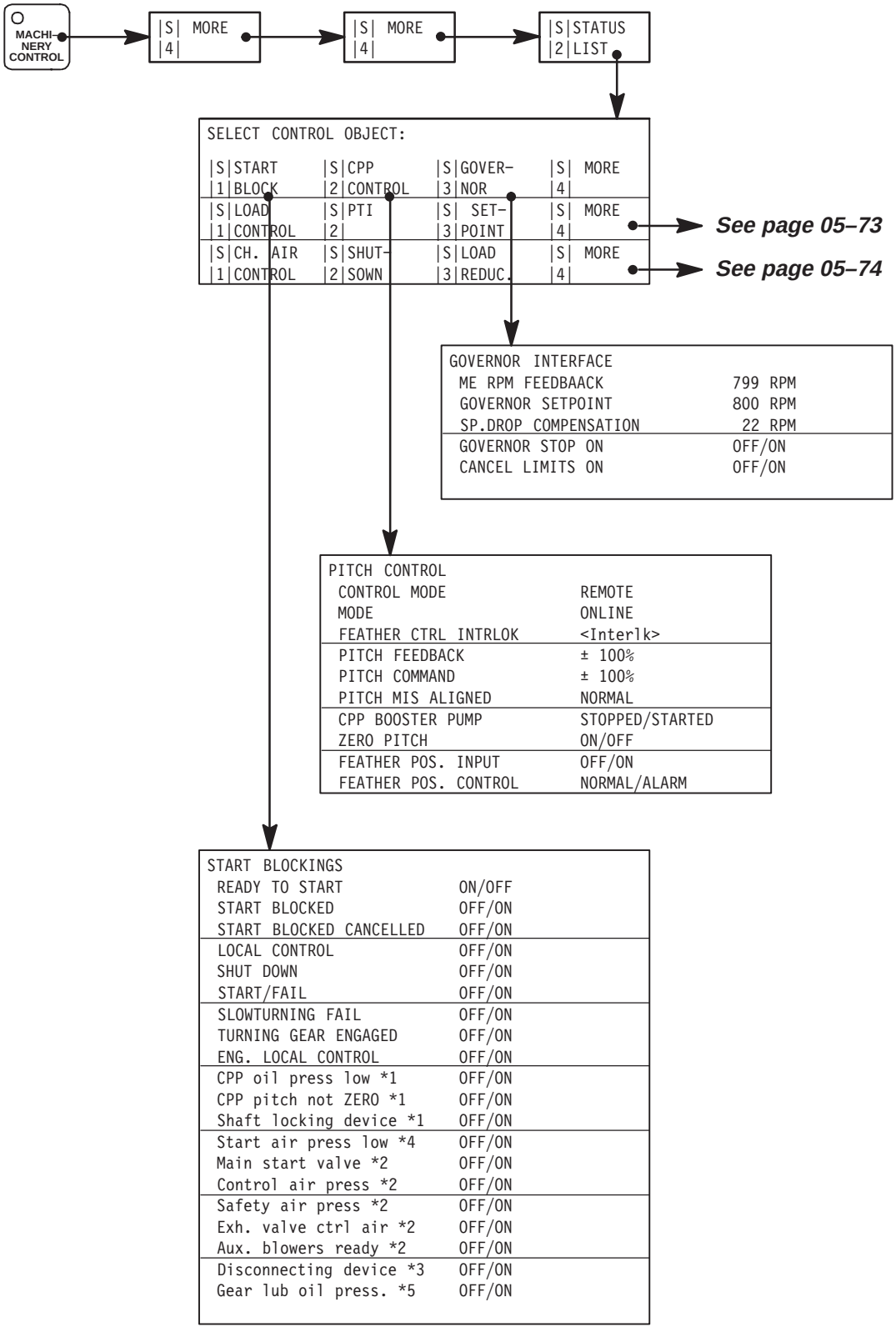
## Fig 05.18 (continued)




**Functions under the pushbutton “MACHINERY CONTROL”**

2001-09-26

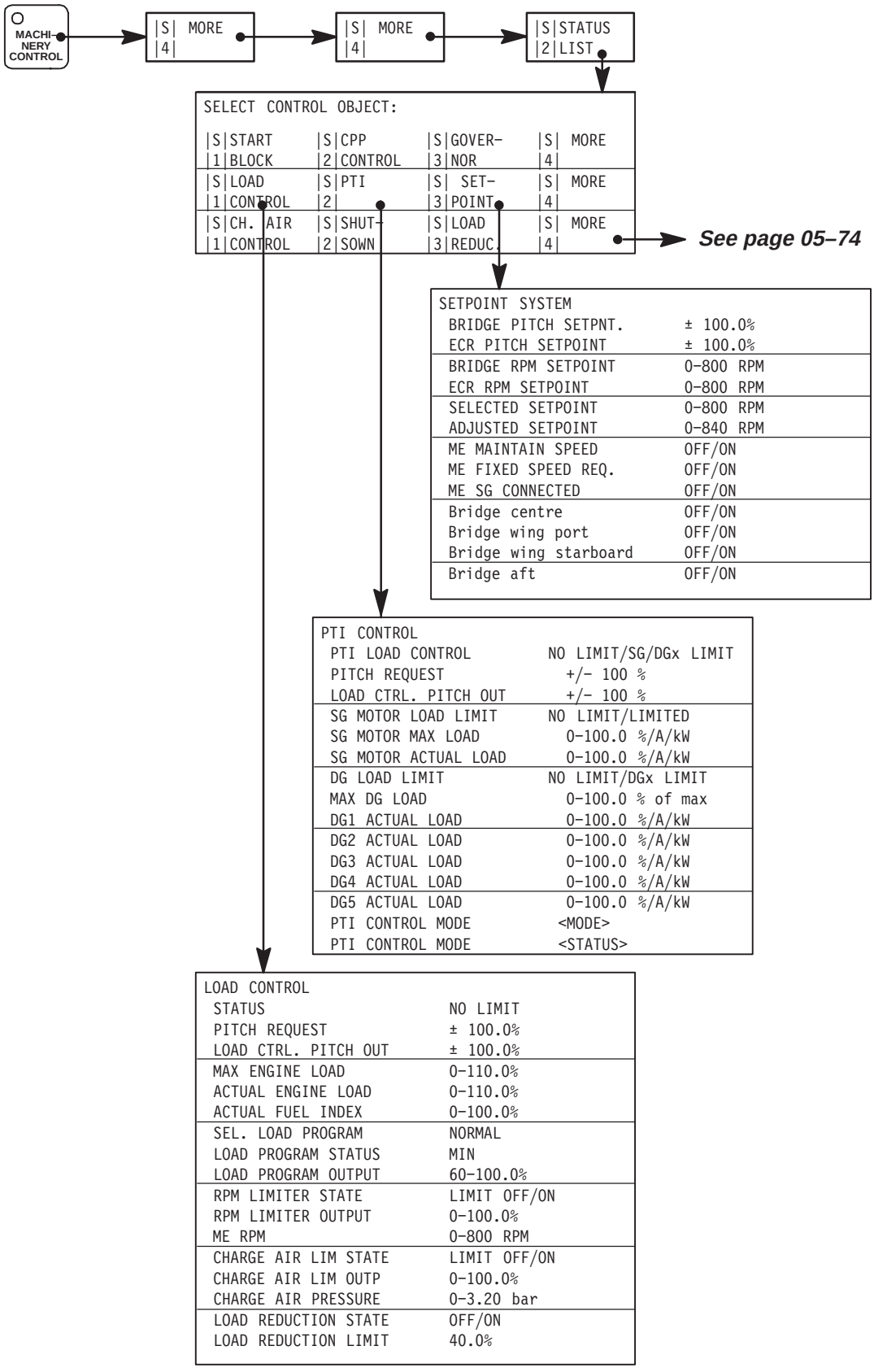
## Fig 05.18 (continued)




***Functions under the pushbutton "MACHINERY CONTROL"***
***Status lists***

2001–09–26

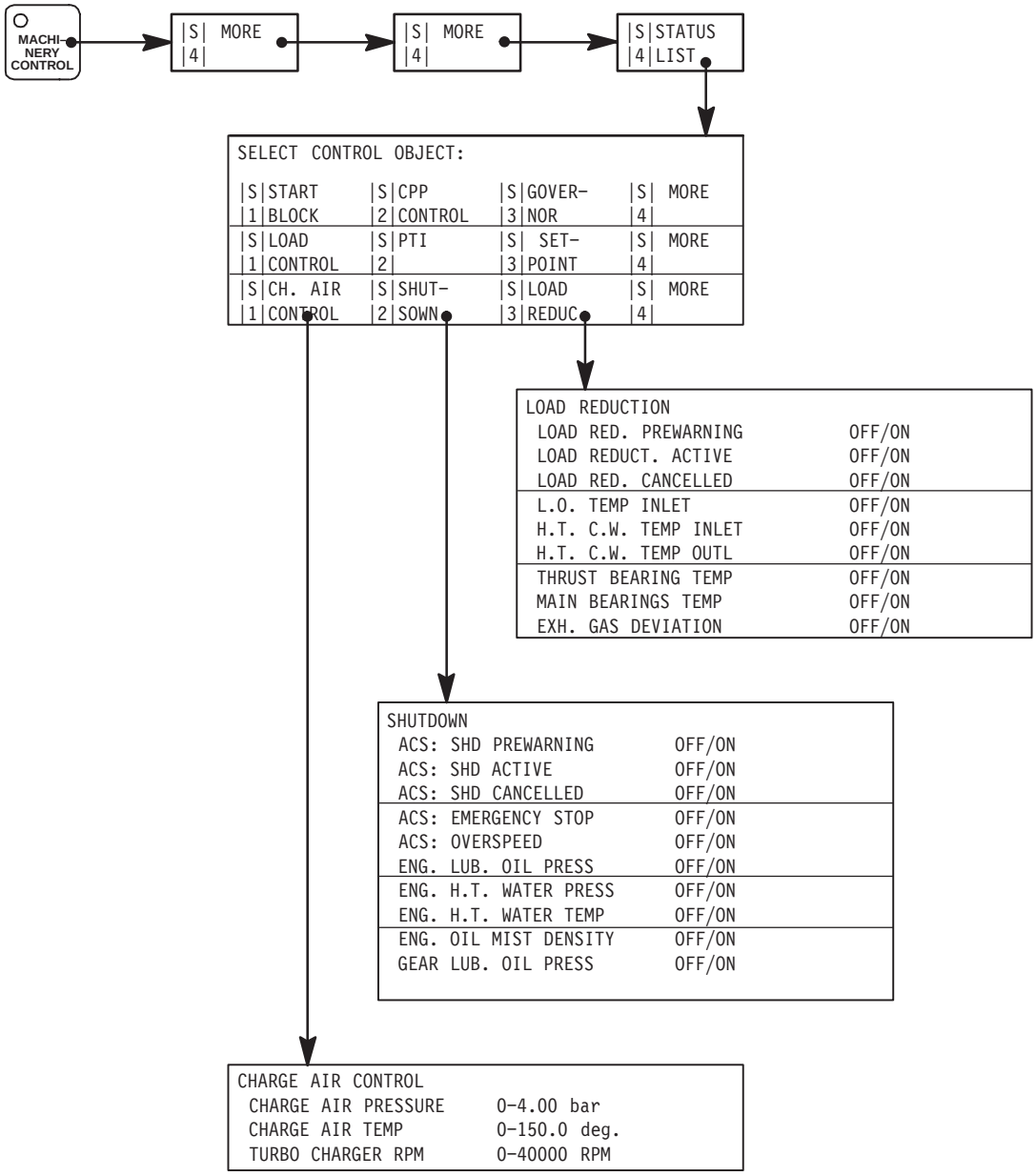
## Fig 05.18 (continued)




***Functions under the pushbutton "MACHINERY CONTROL"***
***Status lists***

2001-09-26

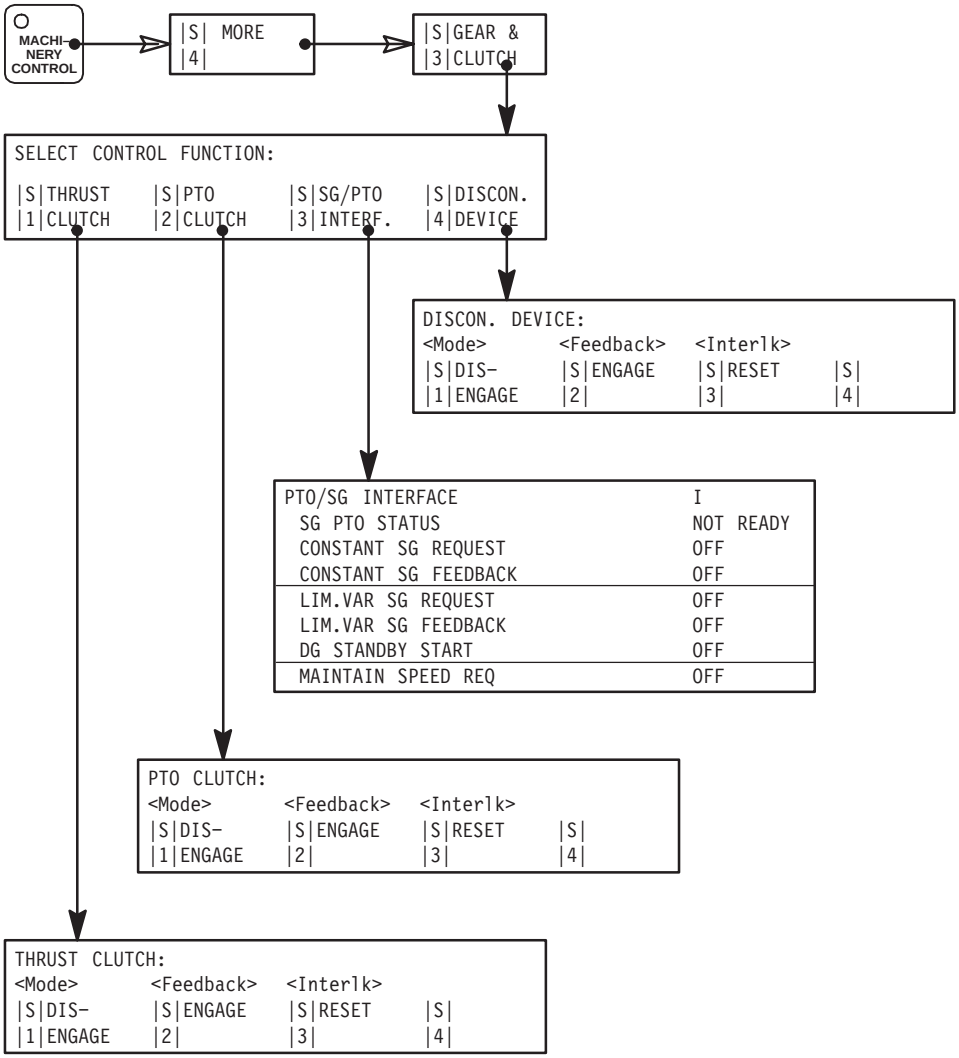
## Fig 05.18 (continued)




2001-09-26

***Functions under the pushbutton "MACHINERY CONTROL"***
***Status lists***

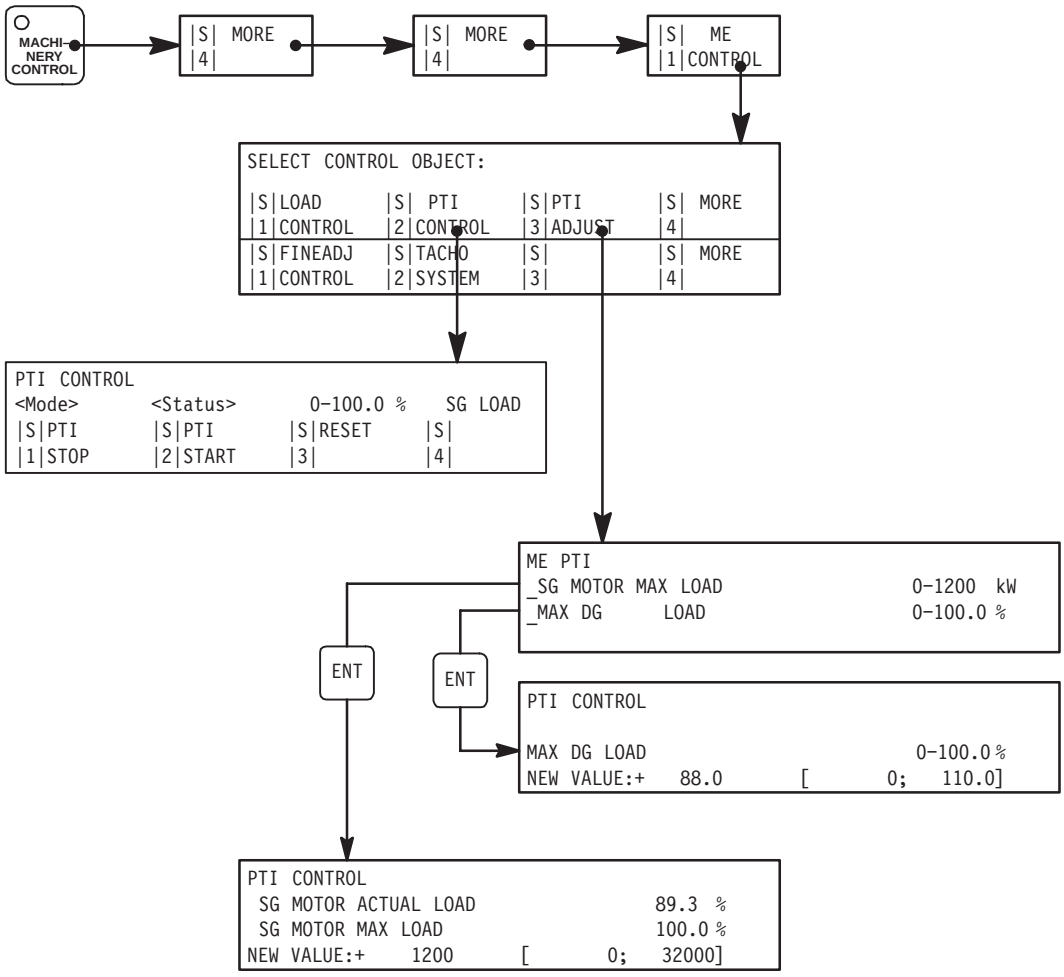
## Fig 05.18 (continued)




***Functions under the pushbutton "MACHINERY CONTROL"***
***Optional gear and clutch functions***

2001-09-26

## Fig 05.18 (continued)

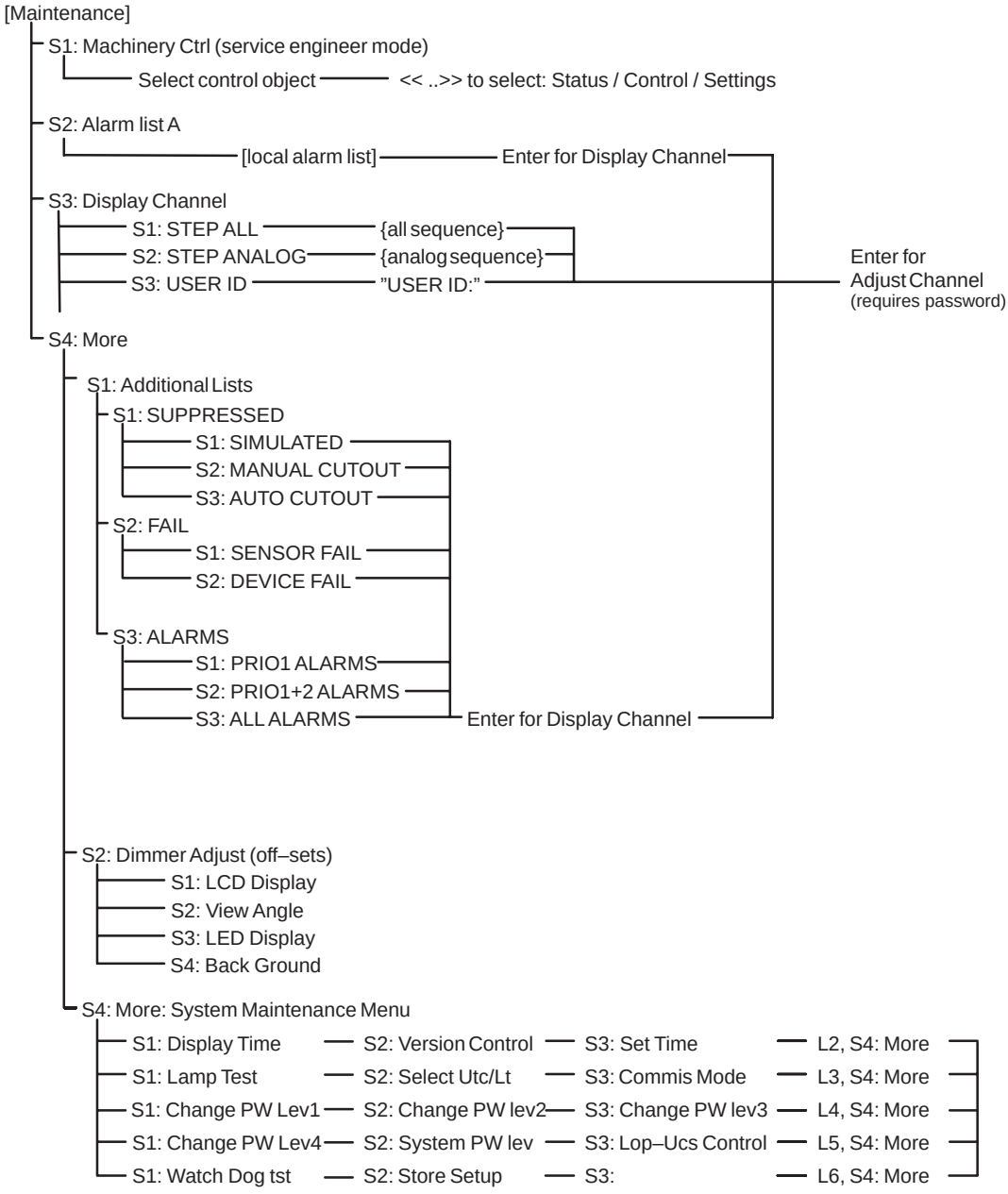



2001-09-26

***Functions under the pushbutton "MACHINERY CONTROL"***
***Optional functions for plants with PTI***

## Maintenance functions

Using the **[Maintenance]** key will lead to a number of detailed functions, usually not needed for the operation of the system.




2001–09–26

### Maintenance access to machinery control

When the **"MACHINERY CONTROL"** is accessed from the **[MAINTENANCE]** key, it will use the same soft–key structure, as if selected from the **[MACHINERY CONTROL]** hard–key.

### Maintenance shortcut to machinery control

Pressing the **[MAINTENANCE]** hard–key, when operating a machinery component function block from it's soft–key menu, and then selecting the **"MACHINERY"** soft–key in maintenance mode, the display will go directly to the same function block in **"SERVICE ENGINEER MODE"** where it is possible to change between **[STATUS]**, **[CONTROL]** and **[SETTINGS]** by means of the **[LEFT/RIGHT ARROW]** keys.

### Other maintenance functions

SELECT MAINTENANCE FUNCTION:

| | | | |
|---|---|---|---|
| MACHIN. CONTROLS | ALARM LISTS | DISPLAY CHANNEL | MORE |
| ADD. LIST | DIMMER ADJUST | | MORE |
| DISPLAY TIME | VERSION CONTROL | SET TIME | MORE |
| LAMP. TEST | SELECT UTC/LT | COMMIS MODE | MORE |
| CHANGE PW LEV1 | CHANGE PW LEV2 | CHANGE PW LEV3 | MORE |
| CHANGE PW LEV4 | SYSTEM PW LEV | LOP–UCS CONTROL | MORE |
| WATCH DOG TST | STORE SETUP | | MORE |

2001–09–26

# 5. Setpoint levers, electric shaft and communication telegraph

**Bridge setpoint levers**

The bridge centre lever is electrically connected to the PCS control cabinet, while the bridge wing levers are connected hereto by means of an electrical shaft system.

Please refer to a separate manual in chapter 4 25 for this equipment.

2001–09–26

*2001–09–26*

# 10. Operational equipment

## Spare part plates



2001–11–28

*2001–11–28*

# 15. Control units

## Spare part plates



*2001-11-28*

*2001–11–28*

# 25. Additional equipment

## Description



## Spare part plates



*2001–09–10*

*2001–09–10*

# Electrical shaft system

## General

The electrical shaft system synchronises the operating levers of all control units (= positions) connected. There is always just one position **[IN CONTROL]** (= **ON SERVICE**). The levers of all other control units will follow the lever movements of this position.

This way the propulsion or manoeuvring system can be controlled from different locations. Thus avoiding the necessity of installing, selecting and monitoring all kind of signal transmitters, switches, etc at all control positions.

The electrical shaft system synchronises all positions, as if they were mounted on a mechanical shaft.

One of the main benefits of the electrical shaft system over a mechanical shaft is its movement of reliability. When the lever of a position that is not **[IN CONTROL]** is blocked, the system will give an alarm, but the remaining levers can still be moved.

The position **[IN CONTROL]** cannot be influenced by the other positions.

Precision potentiometers are used to transmit the lever movements of the position **[IN CONTROL]**. The levers of the other positions are synchronised by means of servomotors.

### Operation

A position takes control over the system when the **[TAKE CONTROL]** button on that position is activated, or when the corresponding contact is closed by means of the propulsion control system.

While the position is **[IN CONTROL]**, the lamp / button is illuminated and the corresponding **[IN CONTROL]** contact is closed.

The system is provided with preferential switching. Initially, when the system is put into operation, the position on the main bridge will always be **[IN CONTROL]**.

Also when two **[TAKE CONTROL]** buttons are activated at the same time, the position on the main bridge will be **[IN CONTROL]** until only one button is activated.

## Starting up procedure

### Installation

- The wiring of all units should be undamaged during mechanical installation.
- Make sure all operating levers can move freely over their full range.
- All instruments must be connected according to the relevant wiring diagram.
- Measure the power supply voltage. It must correspond to the system design.
- Connect the power supply to the system. Make sure the polarity is correct!

### Starting operation

When the installation is completed, the electrical shaft system can be put into operation.

- Remove both fuses.
- Switch on the power.

***Warning***

*Insert both fuses, but if one or more potentiometer failure indicators are lit, remove the fuses immediately and examine the external wiring carefully!*

*Refer to the wiring diagram of the control box for the status indicator overview.*

*Normally, only the green status indicators for **[WHEELHOUSE ON SERVICE]** and **[SYSTEM O.K.]** will be lit.*

2001–10–08

2 05 20 59–0.1

- Check the taking over between the positions.
- Check the electrical shaft system for proper performance. It is now operational.

## Trouble shooting

### System status

To show the current status of the electrical shaft system, the main PCB 101250 inside the control box is provided with status indicators.

Please refer to the wiring diagram of the control box in chapter 4 35.

### Potentiometer failure

Each potentiometer is constantly being checked. If the wiper voltage is not within the specified range, a potentiometer failure alarm is generated.

This alarm will disable all servo amplifiers, causing all servo motors to be stopped.

Action required:

- Check the wiring of the affected position and the potentiometer itself.

### Line up failure

The servo motor units of all positions will always keep trying to line up the levers with the position **[IN CONTROL]**.

If a position is not lined up within the specified time, a line up failure alarm will be generated.

Action required:

- Check if the lever is not mechanically jammed.
- Check the wiring of the affected position.

If the line up failure occur in the stop position only, the friction device or clutch of the servo motor unit are adjusted too lightly.

If the line up failure occurs in the extreme positions of the levers, check if the wiper voltages of the potentiometers are equal.

## Maintenance

It is recommended to check whether the zero stop positions are identical for all operating levers from time to time. When these positions are correct, examine the line up accuracy. It should meet the imposed requirements.

***Note***

*Do not lubricate any mechanical part.*

2001–10–08

2 05 20 59–0.1

# Telegraph system type “Pointer”

## General

The pointer telegraph is a communication system designed to send orders from the bridge to the engine room or engine control room. Whenever a new command is issued, the telegraph alarm will be switched on. In order to mute the alarm, the command must be acknowledged at the selected position by moving the control lever to the position requested.

Precision potentiometers are used to transmit the orders. They are controlled by means of an operating lever equipped with either a knob or a cross lever.

Servo motors are used to move the pointers along the scales of the control units.

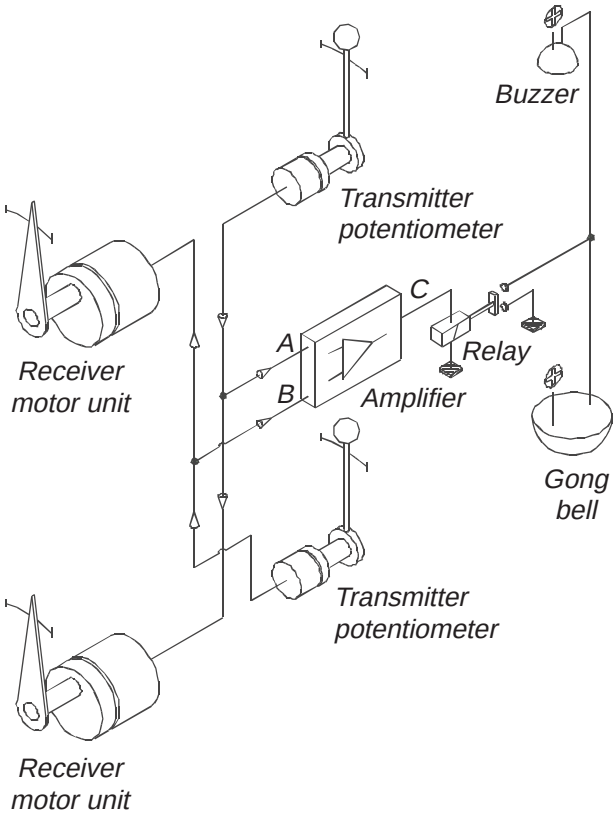
The system can be switched from telegraph mode to remote control (RC) mode by means of a single contact. In RC mode, the telegraph alarm section is disabled. The wheelhouse unit reply pointer is now connected to its own command lever. The RC mode is used to control the main engine directly from the wheelhouse by means of optional RC transmitters. Other possible options are:

- Acoustic alarms: bells, buzzers, horns
- Electrical shaft systems
- Pneumatic valves
- Code switches
- Wrong way contacts
- Special potentiometers (eg for RC or order recorder)
- Signal transmitters (eg 4–20mA)

Fig 25.1 shows the basic principle of the pointer telegraph system.

Both transmitter potentiometers are connected to the amplifier inputs A and B, and to the receiver motor units of the other position. With both command levers in the same position, there will be no voltage at output C and the alarm will be off. When either command lever is moved, output C will be driven high and the alarm will sound. The amplifier’s dead band is adjustable by means of a trim potentiometer. However, the factory setting should be adequate.

***Fig 25.1***



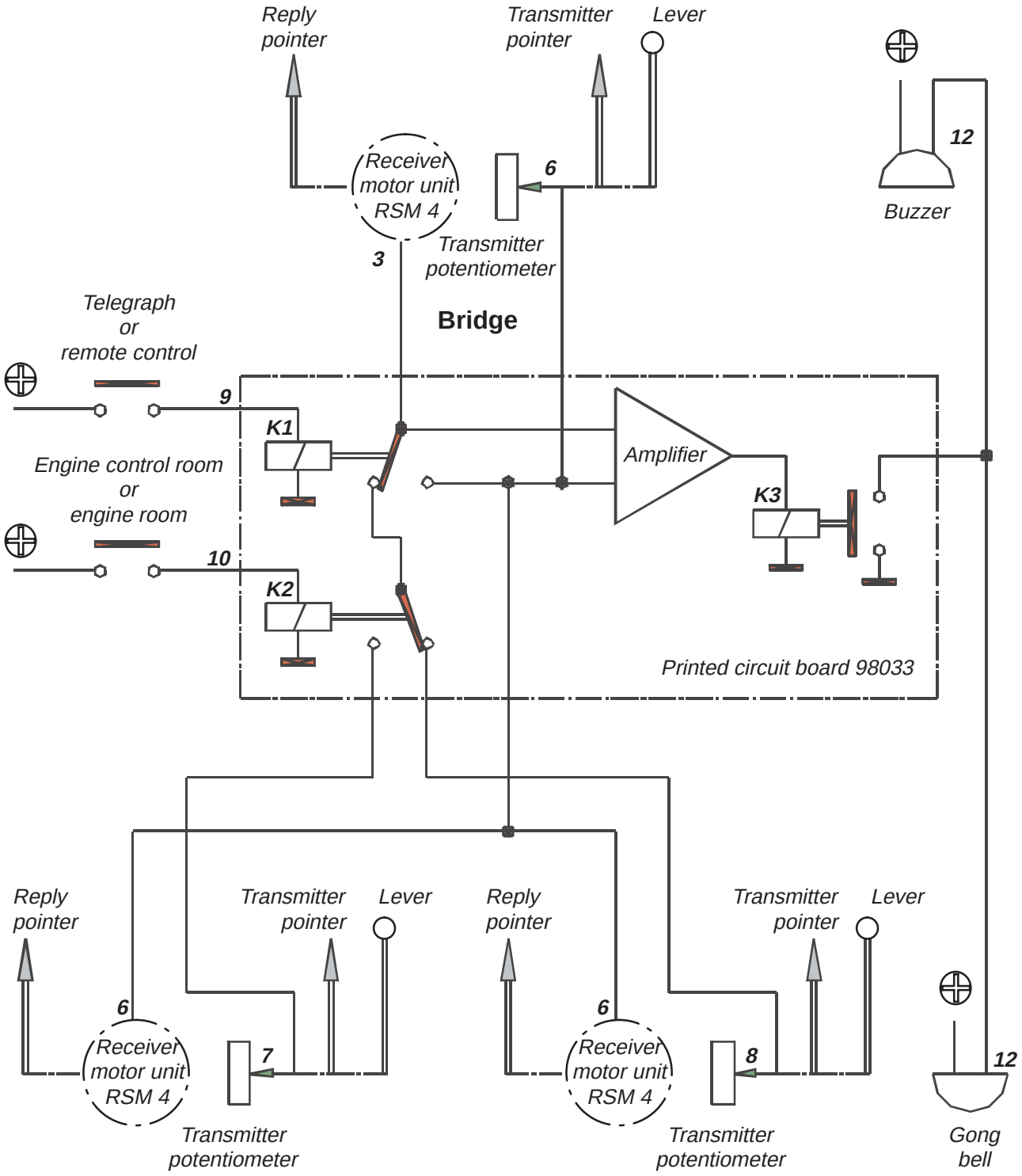

***Basic principle of the pointer telegraph system***

2001–10–08

2 05 20 58–8.0

In fig 25.2 the basic diagram has been extended with an extra operating position and RC selection. Relay K2 selects which position is on service, relay K1 selects either RC or telegraph mode.

***Fig 25.2***




2001–10–08

2 05 20 58–8.0

***Principle diagram of ECR and ER change over (on service selection)***

Fig 25.3 shows how the receiver motor units of ECR and ER are driven by the wheelhouse transmitter potentiometer.

### Operation

A new command is issued by simply moving the command lever of the wheelhouse to desired position. The telegraph alarm will sound. At the selected operating position, the command must be acknowledged by moving the command lever to the position indicated by the reply pointer which will mute the alarm. The reply pointer in the wheelhouse will indicate the position of the command lever in ECR or ER.

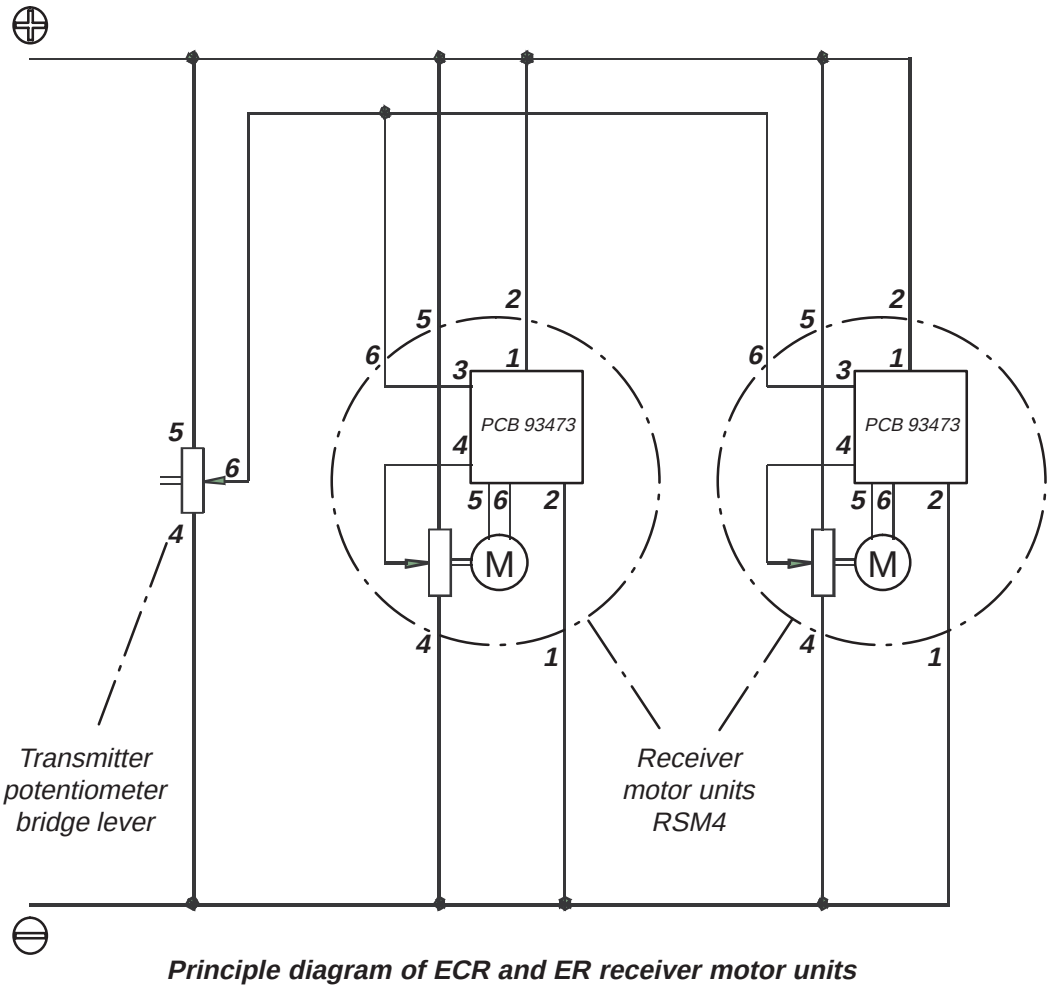
Position selection and switching to RC mode (if required) is done by means of single contacts as shown in fig 25.3.

## Starting up procedure

### Installation

- The wiring of all units should be undamaged during mechanical installation.
- Make sure all operating levers can move freely over their full range.
- All instruments must be connected according to the relevant wiring diagram.
- Measure the power supply voltage. It must correspond to the system design.
- Connect the power supply to the system. Make sure the polarity is correct!
- Check whether the installation fuse corresponds to the maximum current consumed.

***Fig 25.3***




***Principle diagram of ECR and ER receiver motor units***

2001–10–08

2 05 20 58–8.0

### Starting operation

When the installation has been completed, the telegraph system can be put into operation.

## Trouble shooting

### Blown fuse

1. Wiring connection wrong or short circuit.
2. Fuse rating wrong.

### Pointer movement errors

1. Pointer moves in wrong direction:
   transmitter potentiometer terminals 4 and 5 have been swapped.
2. Pointer stuck at scale end:
   wiper wire has been swapped with one of the others, this may cause the potentiometer to blow!
3. Pointer vibrates:
   one or more of terminals 3,4,5 or 6 are not connected.
4. Pointer does not move at all:
   defective motor unit due to excessive voltage.

### Alarm failure

1. Power not connected.
2. Defective relay K3 on alarm PCB 98033.
3. Bell clapper stuck to housing or defective bell.

Continuous alarm in full ahead or full astern position: end stops not adjusted properly.

## Maintenance

Most components are accessible through the bottom side of the control unit, except for the dial illumination parts which can be accessed after removing the protective cover from the top side of the unit. Always make sure that the power is switched off before dismantling any system part.

### Replacement of motor unit

When a receiver motor unit has been replaced, it should be adjusted as follows:

1. Loosen the screws that secure the sprocket to the shaft.
2. Set all command levers to the zero position.
3. Switch on the power supply.
4. Set the pointer to zero position and fasten the sprocket screws tightly.

### Replacement of potentiometer

When a transmitter potentiometer has been replaced, it should be adjusted as follows:

1. Set the command lever to zero position.
2. Measure the potentiometer's wiper voltage while rotating the potentiometer shaft until half the power supply voltage is measured.
3. Fasten the sprocket to the shaft and check whether the corresponding receiver pointer also indicates zero position.

The pointer telegraph system does not require any regular maintenance.

2001–10–08

2 05 20 58–8.0

# Power Supply

The power supply is an integrated unit consisting of :

- Constant voltage rectifier/battery charger.
- Back–up battery.
- Supervision and alarm circuit.
- Indicator for status and a voltage/current meter.

As long as the AC voltage is present, the 24 V (nom) DC voltage is provided from the constant voltage rectifier over the battery. The rectifier can deliver 15 ampere and when the consumption is less than this the difference will be used to charge the battery if necessary.

When the AC voltage is missing, the battery will supply the consumers. The battery has a capacity of 8 ampere/hour and will be able to keep the voltage at max consumption for at least 30 min. If the AC supply has not been re–established before the battery runs out of power, the voltage will be switched off at approx 19 V to keep a pre–defined condition and prevent damaging the battery.

The battery consists of two 12 V (nom) batteries. These are of the dry cell type and should last for at least 5 years under normal use.

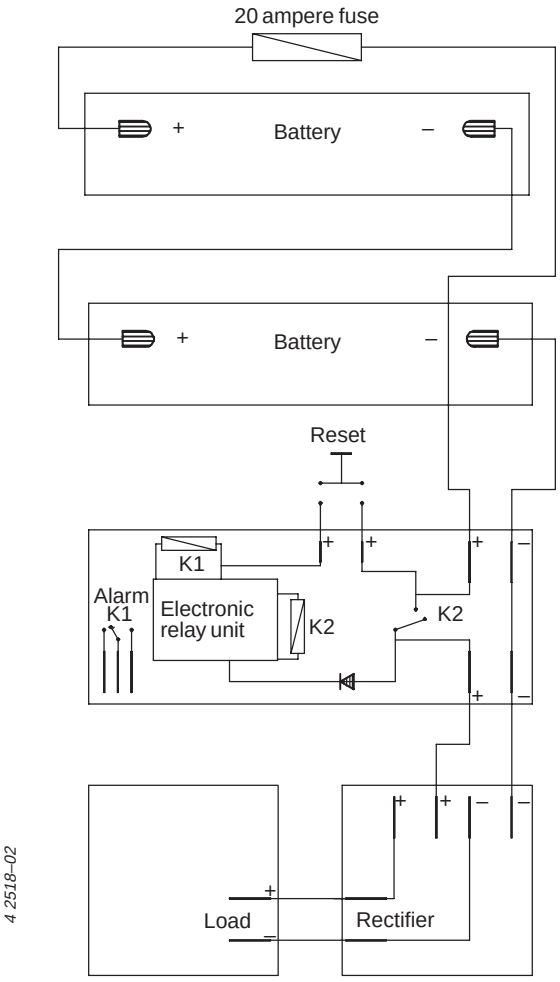
***Warning***

*The battery is not to be left without charging for more than max 3 months.*

The capacity of the battery should be tested at regular intervals, ie every 3 months to ensure that the power is sufficient in the case of an AC voltage failure. The test can be carried out by switching off the AC supply and measure the time that the output voltage stays above 20 V DC. It must be longer than 30 min.

In case of a power supply failure an NC contact is to be connected to the alarm system.

***Fig 25.4***




4 2518–02

***Principle overview of the power supply***

2000–11–19

*2000–11–19*

# 35. Plant drawings

## Description



## Data



## Wiring diagrams



2001–09–10

*2001–09–10*

# Installation guidance

## Mechanical installation

The wall mounted cabinets are normally fixed to a bulkhead, allowing 30 to 100 centimetres of free space between the bottom of the cabinet and the deck. This provides space for cables coming in through the cable flanges in the bottom of the cabinet. The cable flanges may be removed for drilling of holes for cable glands. Components delivered in terminal boxes or cabinets must not be removed from their casing. For electrical noise protection, an electric ground connection must be made from the cabinet to the ship's hull.

The cabinets must be installed in a place suitable for service inspection. Do not install the cabinets close to devices generating heat. The enclosure protection of the cabinets is IP55.

The control panels are fixed in the consoles by attaching the fixing screws from the rear after insertion of the panel from the front. For arrangement of propulsion control stations, please refer to the layout drawings delivered for the vessel in question.

## Electrical installation

For propulsion control, safety and monitoring systems, two lines of 24 V DC no break power supply with battery back–up must be available on the vessel as follows:

One safety supply with a consumption of 150W for local monitoring, control and safety systems.

One control supply with a consumption of 125W for propulsion control system and propulsion back–up control system.

Voltage: 24 V DC +30% –25% incl ripple

Max current each: 10 Amp fused

The 24 V DC supplies must not be connected before our service engineer has checked and approved the installation.

### Cable installation

For layout of cables and specific terminal connections, please refer to the cable plan and connection lists delivered for the vessel in question.

***Warning***

*The guarantee of Alpha Diesel does not cover burnt–off components caused by wrong connection or faulty installation.*

## Cables used for the Alphatronic 2000 system

### Type 1

Cables used for power supplies and sensor input/output:

Shielded cables with stranded wires must be used. The size of the power supply cables is specified in the cable plan, but it must always have sufficient capacity to ensure that the voltage drop does not exceed 1 volt from power supply to last consumer in the system. The individual cables shown on the cable plan must not be put together as one.

### Type 2

Communication cable for serial input/output:

RS422 communication lines used for the MODBUS connections must be screened 6 core cable with twisted pairs (3x2x0.5 or 3x2x0.75)

### Type 3

Network communication cables:

The network cables between propulsion control cabinet and propulsion control pan-

2001–11–22

2047849–6.1

els and between Alphacomm units on the propulsion units:

**Wires**: two twisted pairs, stranded wires (2x2x0,5 or 2x2x0,75)

**Impedance**: app 100 ohm

**Shielding**: copper braided shield with drain wire on the cable

Examples of cables:

BELDEN AWG 24, type No. 8102

LOCAP, type AWG 20, Digital No. 17–0130–01

NK Cables, type LJST–HF 2x2x0,5 FMGCG 2x2x0,75

***Note***

*Only stranded wires are accepted.*

## Laying up of cables

When placing the cables in the vessel the following must be taken into consideration:

1. Paralleling with mains voltage or radio cables (both radio supply and antenna) for more than 5 m, must be at a minimum distance of 500 mm. Crossing of mains voltage or radio cables in right angles must be at a minimum distance of 200 mm.
2. All screens must be connected to the cabinets and made as short and broad as possible.

## Cable marking

All cables must be marked so they are easily recognizable, according to the MAN B&W Alpha Diesel cable plan. All wires must be marked with the marking of the terminal in which they are inserted.

## Checking wires

We recommend a portable digital multimeter for measuring ohm values when checking the installation by the ”ringing through” method.

## Warning

The wires must not be tested for short circuits by high voltage equipment, ie meggers.

2001–11–22

2047849–6.1

# 80. Instrumentation

## Spare part plates



*2001–09–10*

*2001–09–10*

# 82. Remote control equipment

## Spare part plates



*2001–09–10*

*2001–09–10*

# 84. Monitoring equipment

## Data

Summary of monitoring equipment . . . . . *drawing no* 2 05 07 77–8

*2001–09–10*

*2001–09–10*

# 90. Tools

## Spare part plates



*2001–09–10*

*2001–09–10*