MAN Energy Solutions
Future in the making

ME-C control system I

Introduction and Multi Purpose Controller (MPC)

PrimeServ Academy Copenhagen

MAN PrimeServ

Learning objectives

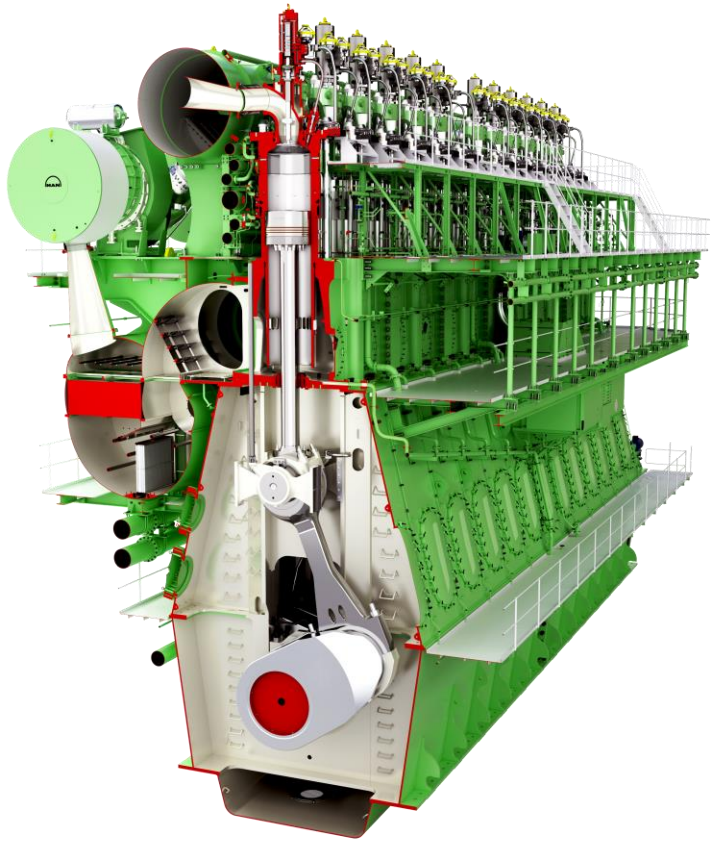
Upon completion of this module you …

– will be able to recognize the various components in the system.

– will be able to explain the build up of the control system.

ME engine introduction

Engine type designation

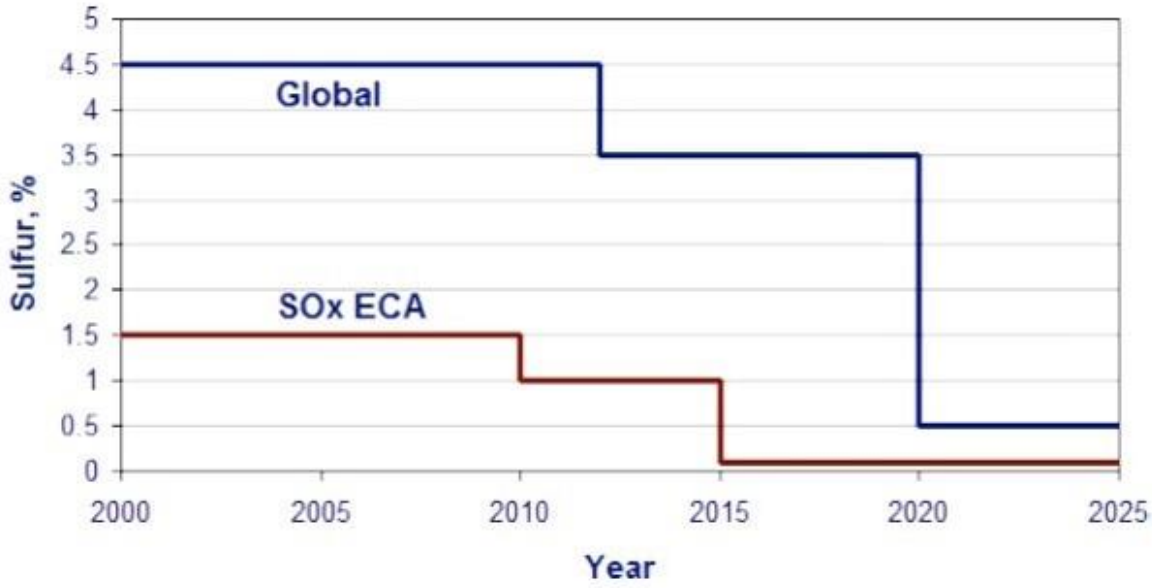


8S70ME-C10.5-GI-EcoEGR

- **Tier III technology**
  - (blank) Tier II only
  - **EcoEGR** EGR in Tier II and Tier III mode
  - **EGRBP** EGR with bypass matching
  - **EGRTC** EGR with TC cut-out matching
  - **HPSCR** High-pressure SCR
  - **LPSCR** Low-pressure SCR
- **Fuel injection concept**
  - (blank) Fuel oil only
  - **GI** Gas injection methane
  - **GIE** Gas injection ethane
  - **LGIM** Liquid gas injection methanol
  - **LGIP** Liquid gas injection LPG
- **Dot (.) number**
- **Mark number**
- **Engine concept**
  - **ME-C** Electronically controlled
  - **ME-B** Exhaust valve controlled by camshaft
- **Diameter of cylinder bore in cm**
- **Stroke/bore ratio**
  - **G** 'Green' ultra long stroke
  - **S** Super long stroke
- **Number of cylinders**

ME engine introduction

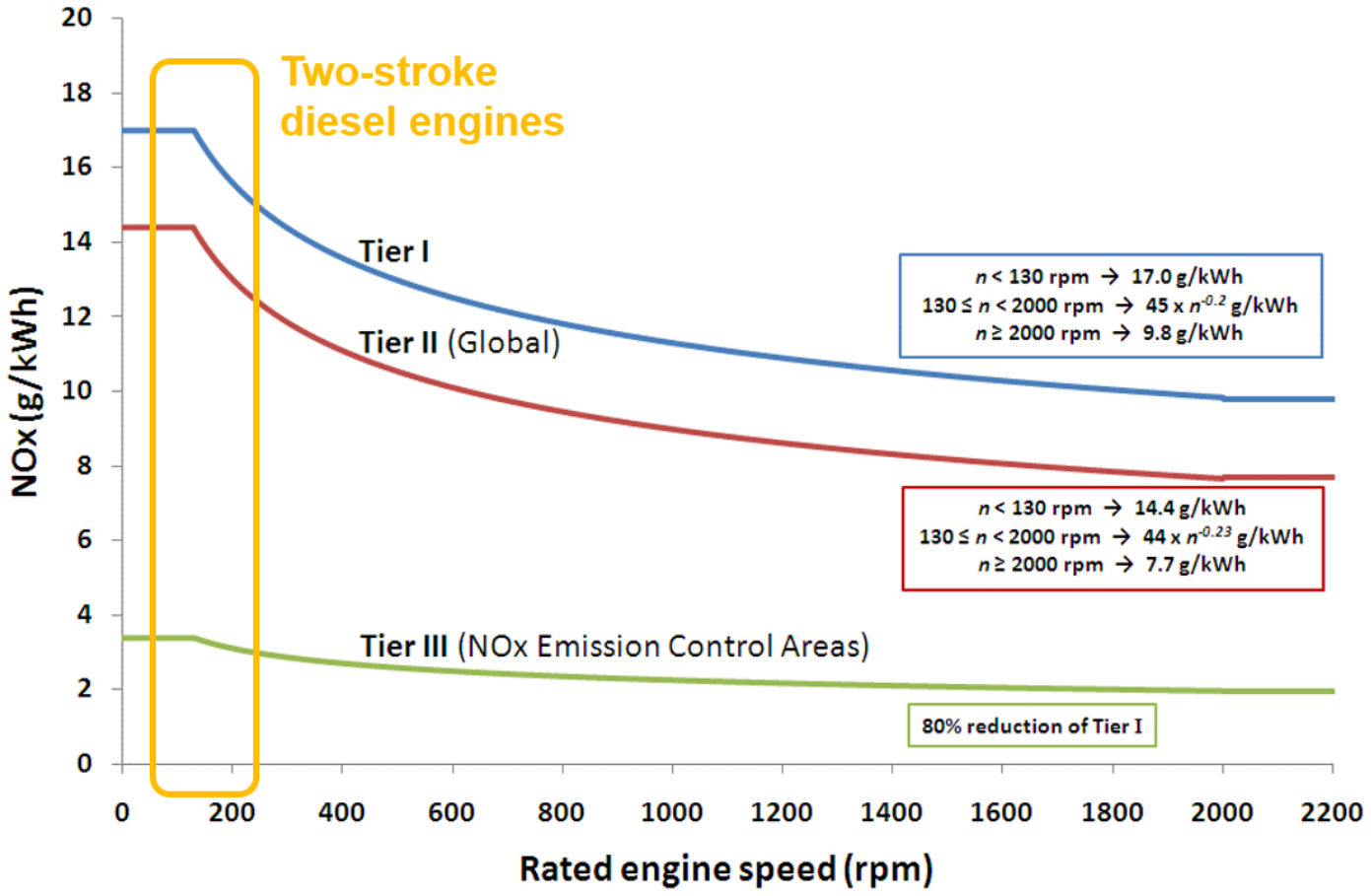
(S)ECA, Sulphur limits



S% in fuel: outside ECA 2020: 0,5%; inside of ECA 2015: 0,10%

ME engine introduction

ECA, NO_X limits



ME engine introduction

Tier III solutions

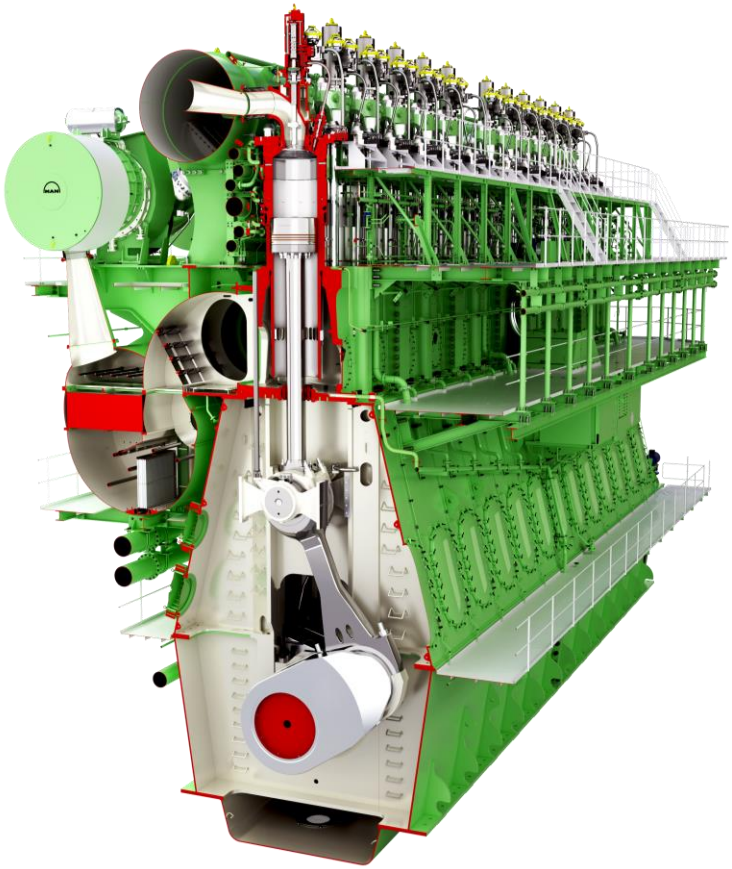
In order to comply with Tier III regulations, vessels have to be fitted with equipment / systems that actively can reduce the amount of NOx in the emissions.

Such equipment could be:

Selective Catalytic Reduction (SCR)

Exhaust Gas Recirculation (EGR)

Water in fuel



ME engine introduction

MAN - ES technologies

Tier III compliance for MAN two – stroke engines

EGR
On engine

SCR
High pressure

SCR
Low pressure

ME engine introduction

Development of the ME engine

1991	Start of intelligent engine project
1993	4T50MX equipped with electronic engine control equipment
1997	4T50MX with 2nd generation control equipment
1997/98	Design - Production - Installation of mechanical / hydraulic components for service test on M / T "Bow Cecil"
1997/98	Design and implementation of governor functionality and service test onboard ”Shanghai Express”
1998/’00	Design - Production - Test - Installation of engine control system on M / T ”Bow Cecil”
2000	Start of service test on M / T ”Bow Cecil”
2003	First production engine

ME engine introduction

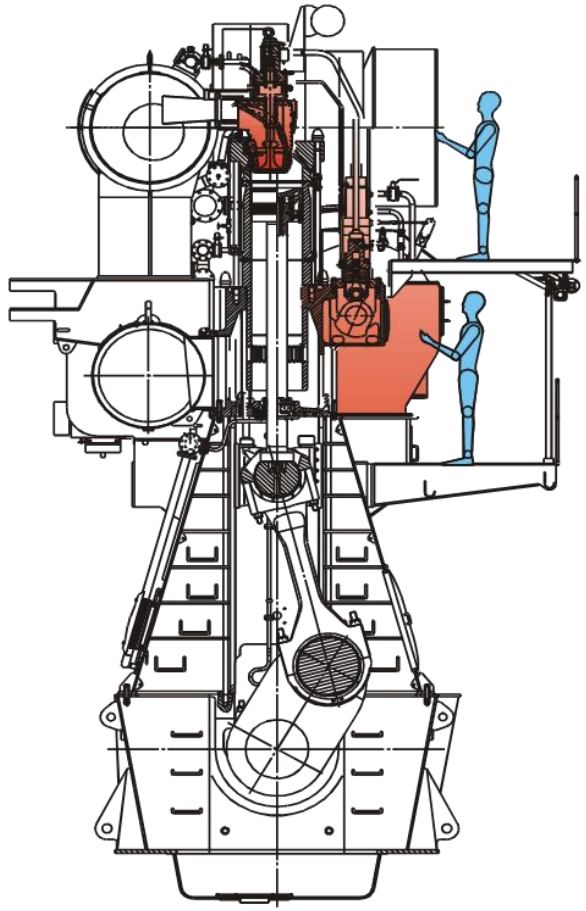
From MC - C to ME - C

- Fully integrated electronic control
- Low SFOC
- Superior performance parameters
- Appropriate fuel injection pressure and rate shaping at any load
- Improved emission characteristics
- Smokeless operation at any load
- Lower NOx on command

ME engine introduction

Omitted or redesigned components

- Chain drive
- Chain wheel frame
- Chain box on frame box
- Camshaft with cams
- Roller guides for fuel pump and exhaust valve
- Fuel pumps
- Exhaust valve and housing
- Exhaust actuator
- Starting air distributor
- Governor
- Regulating shaft
- Mechanical lubricator
- Emergency control panel



ME engine introduction

New components

Hydraulic Power Supply (HPS)

- Automatic backflush filter
- Electrical start up pumps
- Engine driven pumps

Hydraulic Cylinder Unit (HCU)

- Distribution block
- Double wall pipe (200 bar)
- FIVA / ELFI & ELVA and accumulator
- FOPB
- Exhaust valve actuator
- ME lubricator

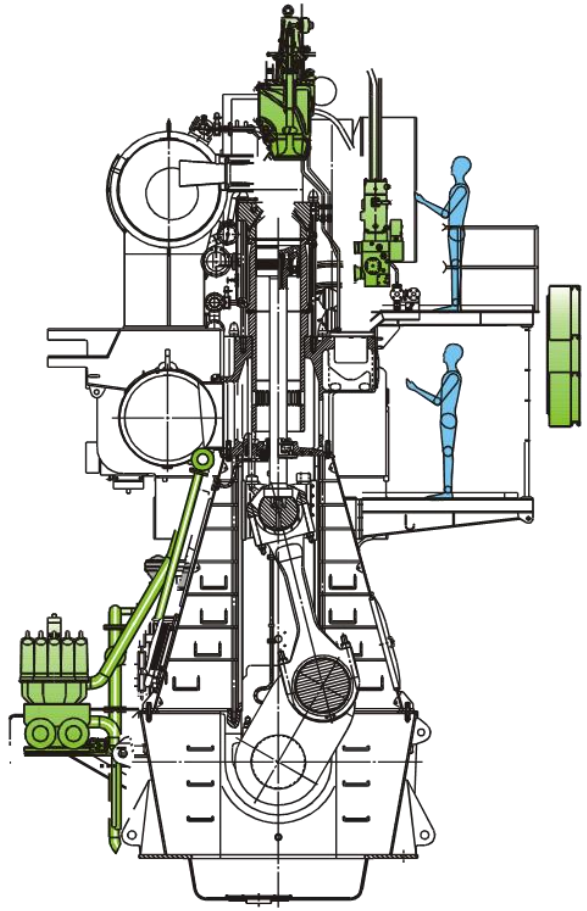
Engine Control System (ECS)

- MPCs

Crankshaft position sensing system (Tacho)

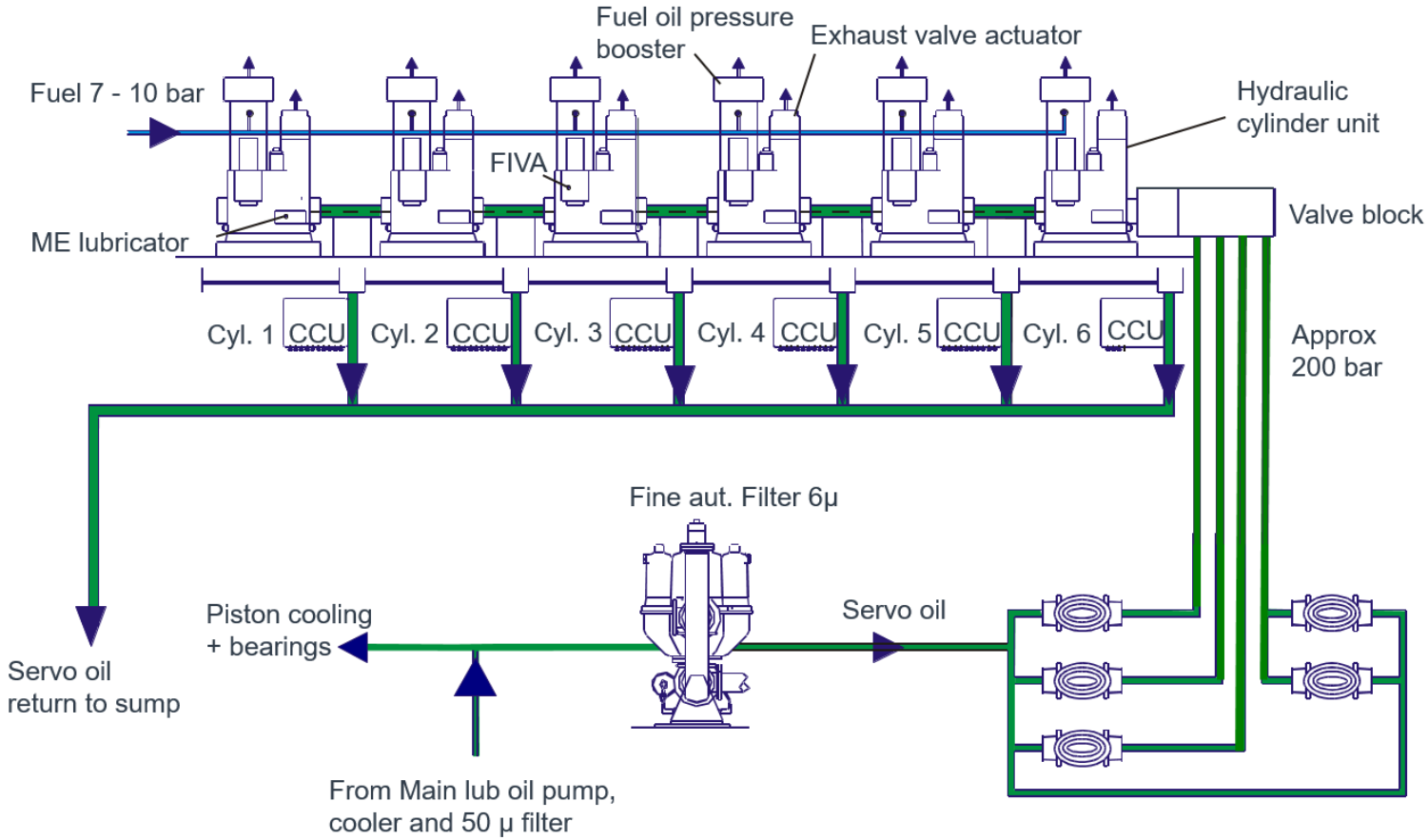
- Encoder A & B

Local Operation Panel (LOP)



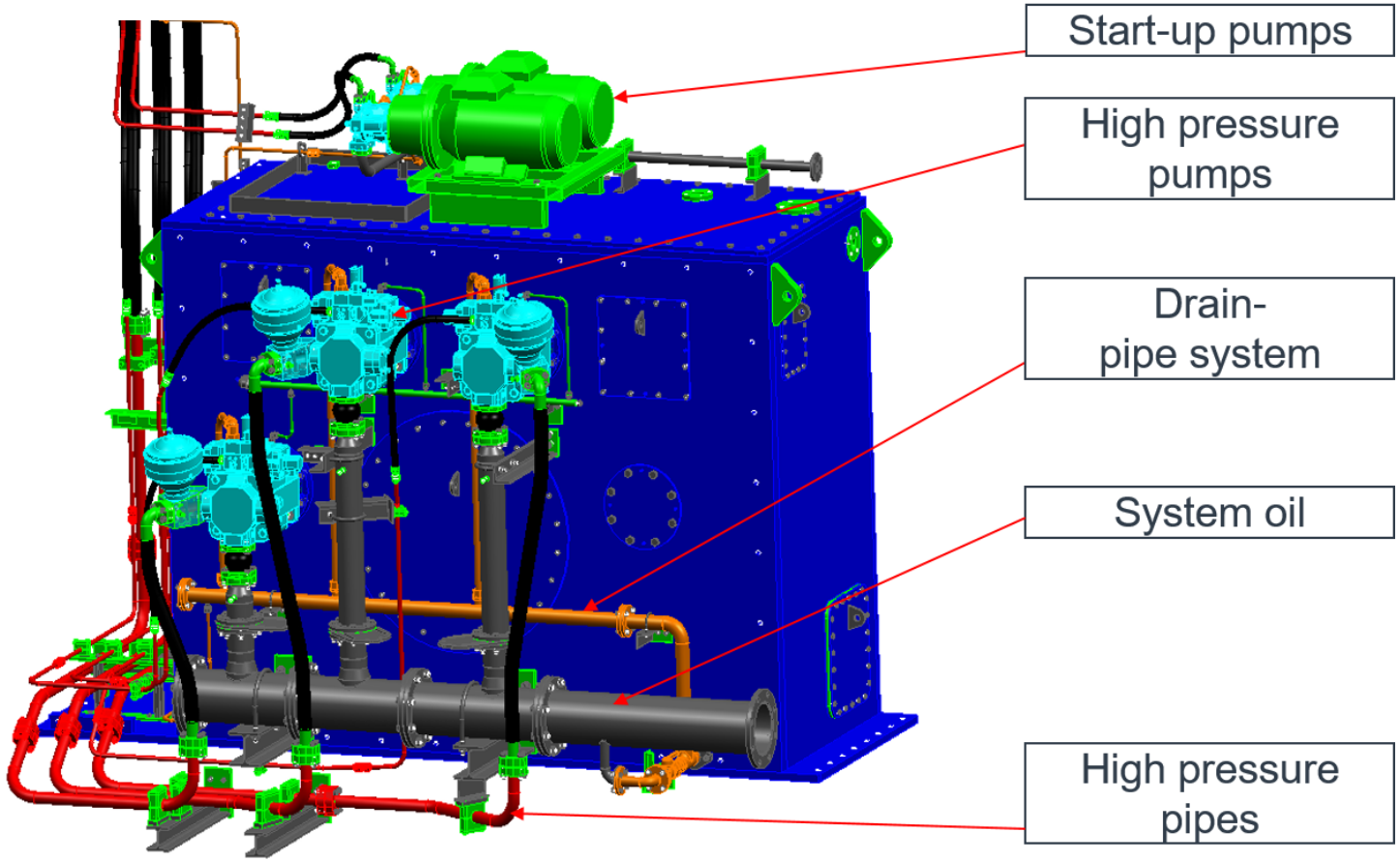
ME engine introduction

Hydraulic system



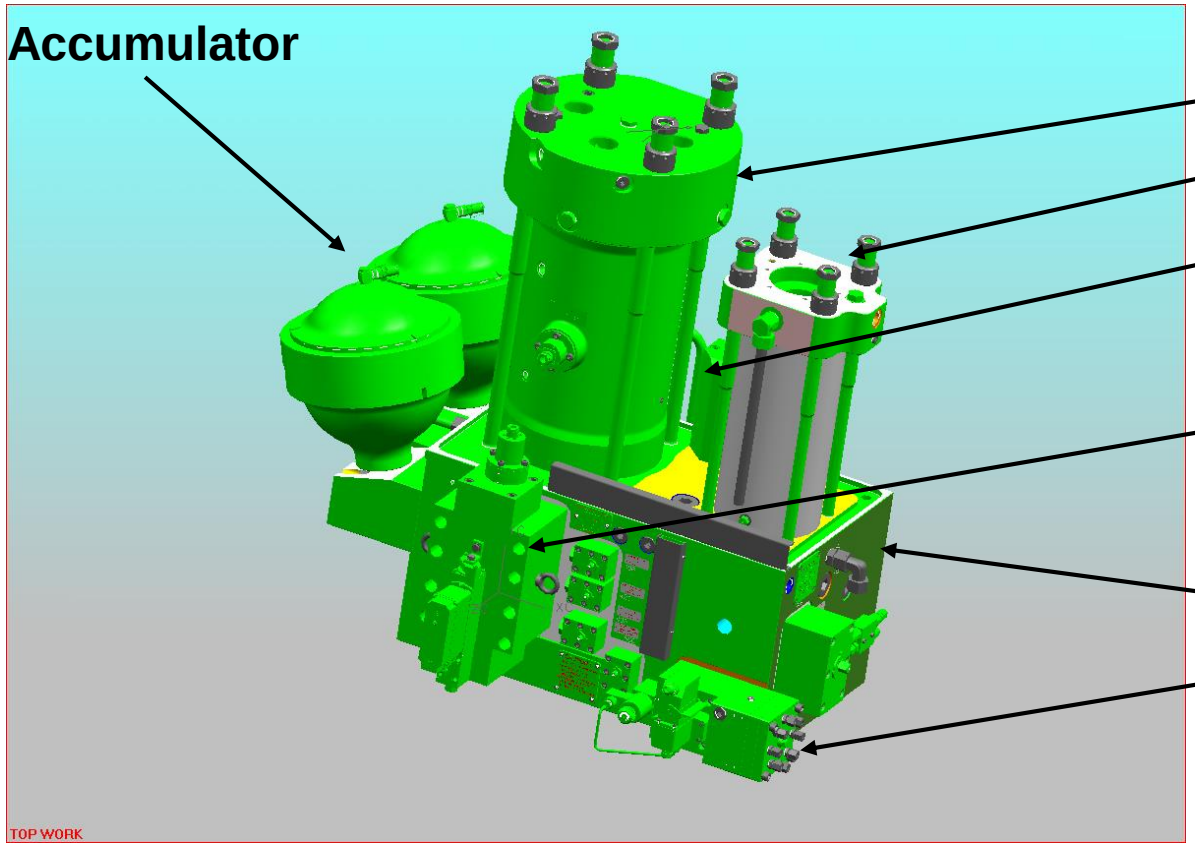
ME engine introduction

Hydraulic Power Supply (HPS)



ME engine introduction

Hydraulic Cylinder Unit (HCU)



Fuel oil pressure booster

Exhaust valve actuator

De-aeration unit

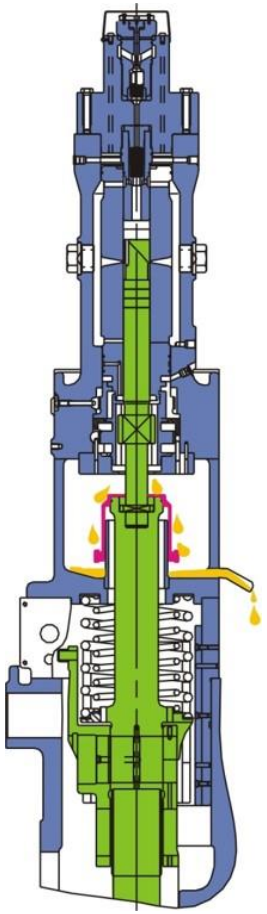
Fuel Injection and exhaust Valve Actuation (FIVA)

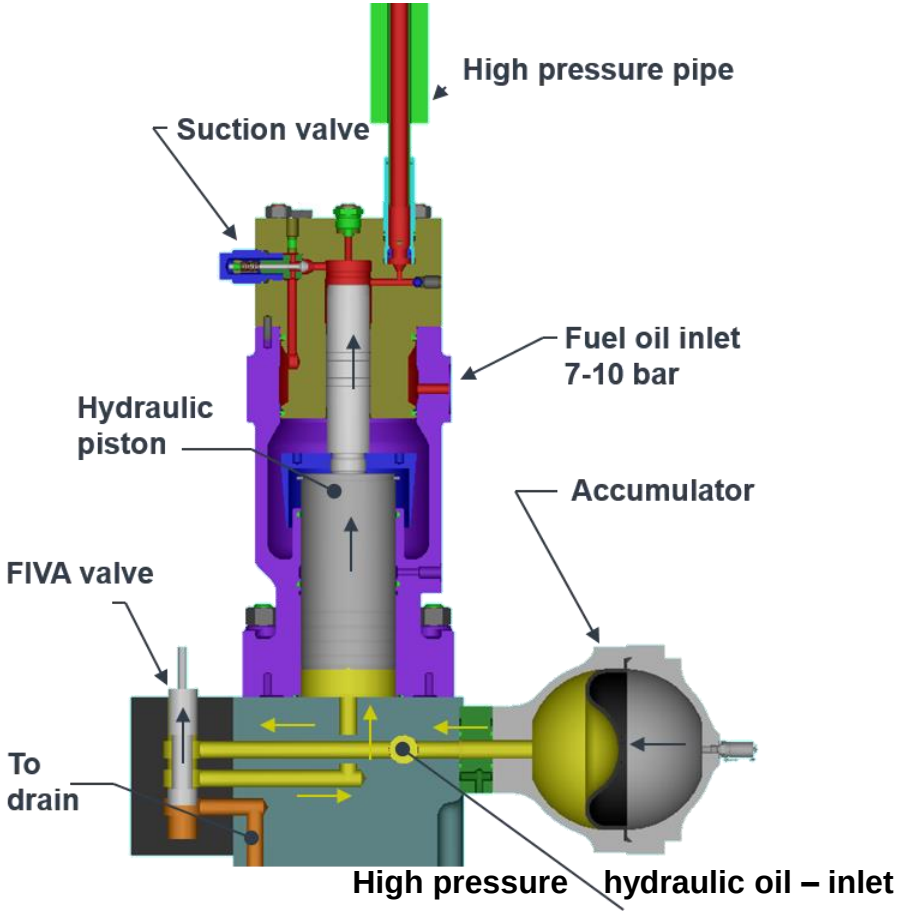
Distribution block

ME lubricator

ME engine introduction

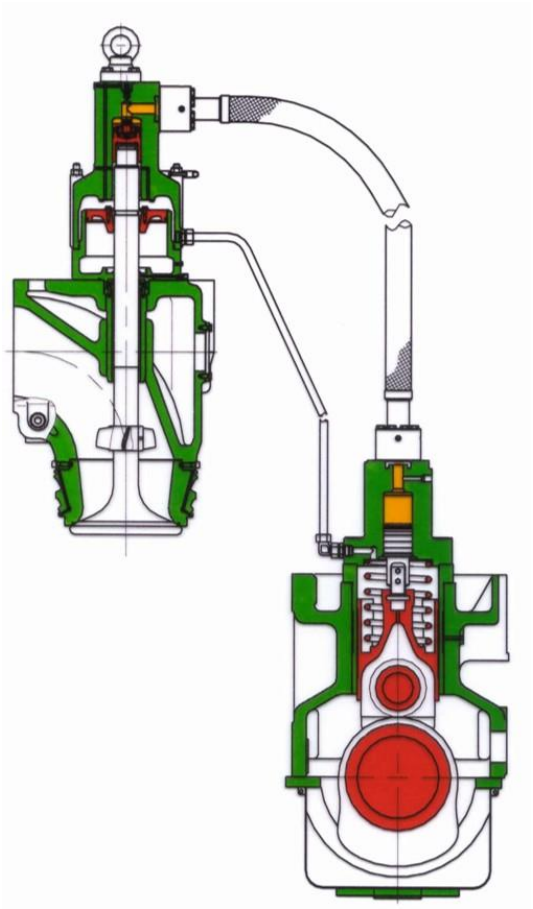
MC fuel pump to ME fuel oil pressure booster

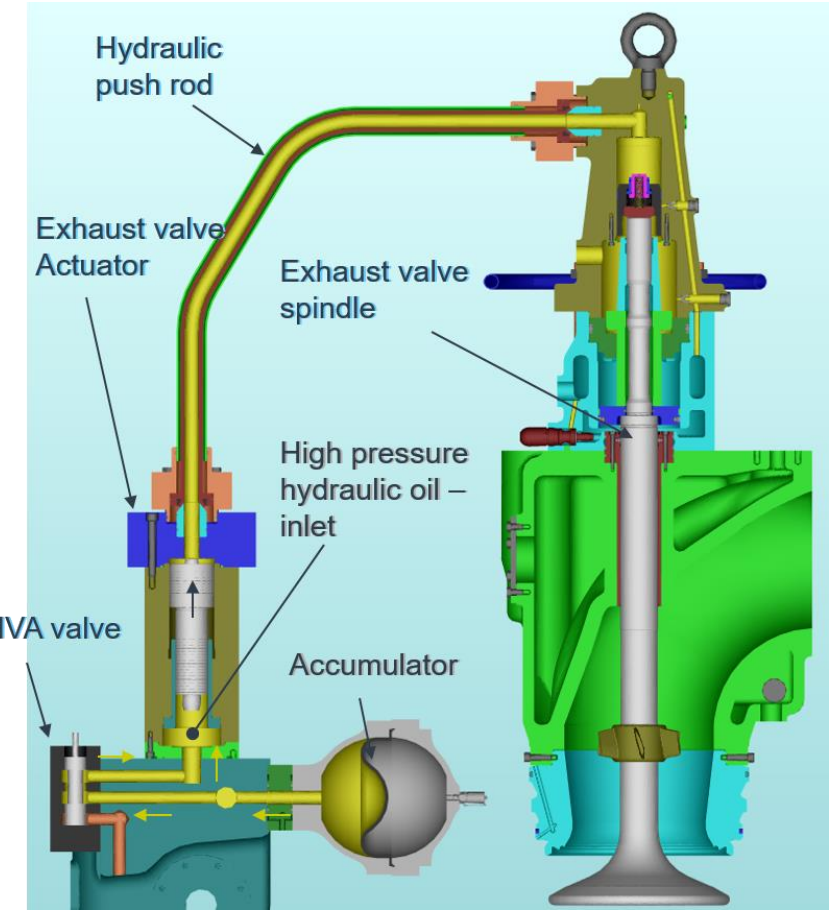




ME engine introduction

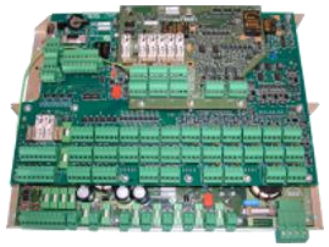
MC exhaust valve arrangement to ME exhaust valve arrangement

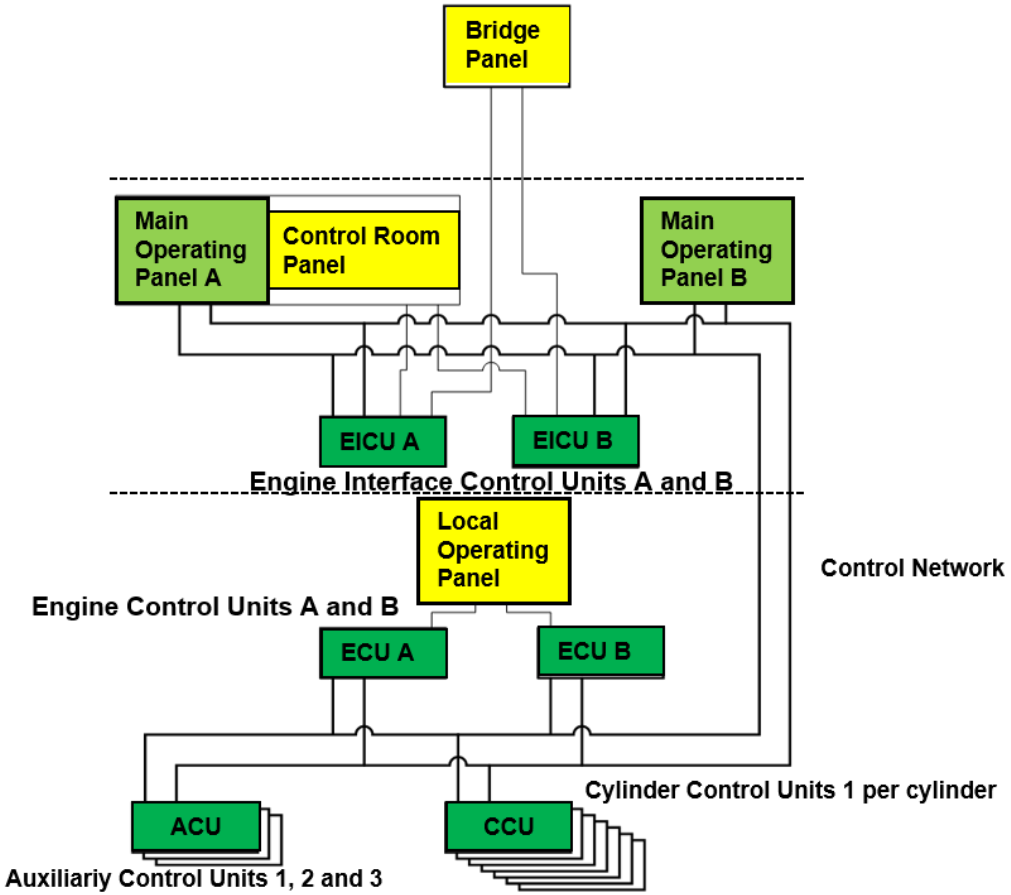




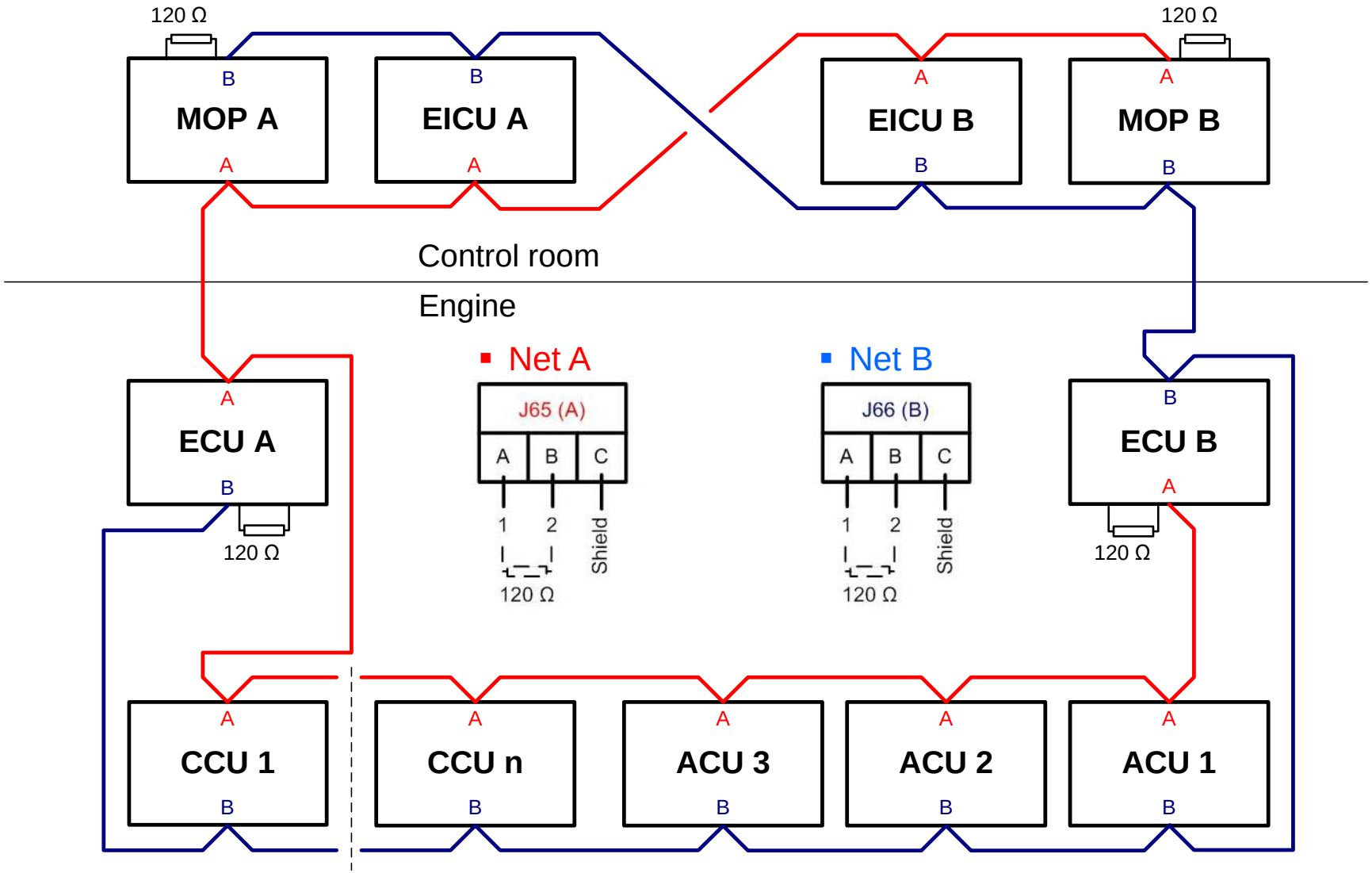
ME engine introduction

Engine Control System (ECS)



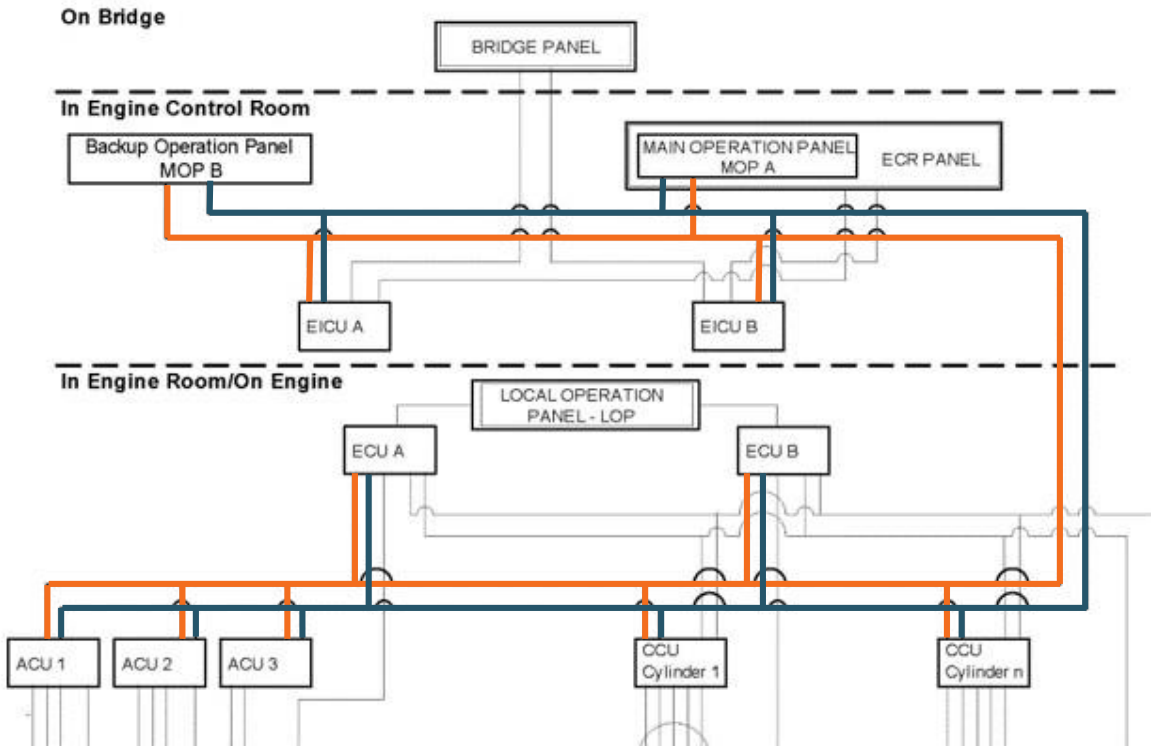


Control Network



ME engine introduction

MPC and control network



The Multi Purpose Controllers are identical hardware wise. They have different software configurations.

Two redundant control networks are connecting all Multi Purpose Controllers and both main operating panels computers.

A backup of the application- and setup- software is stored on both main operation panels.

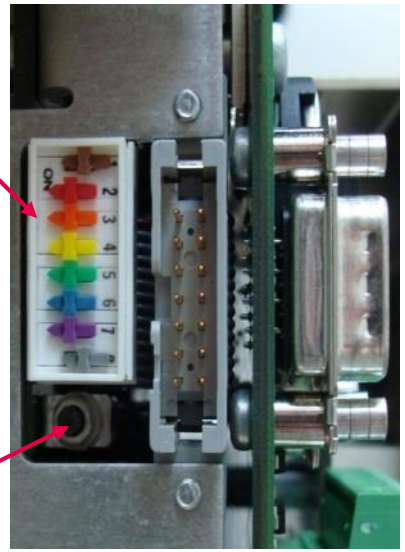
At replacement, the new controller is automatically configured with correct software via the control networks.

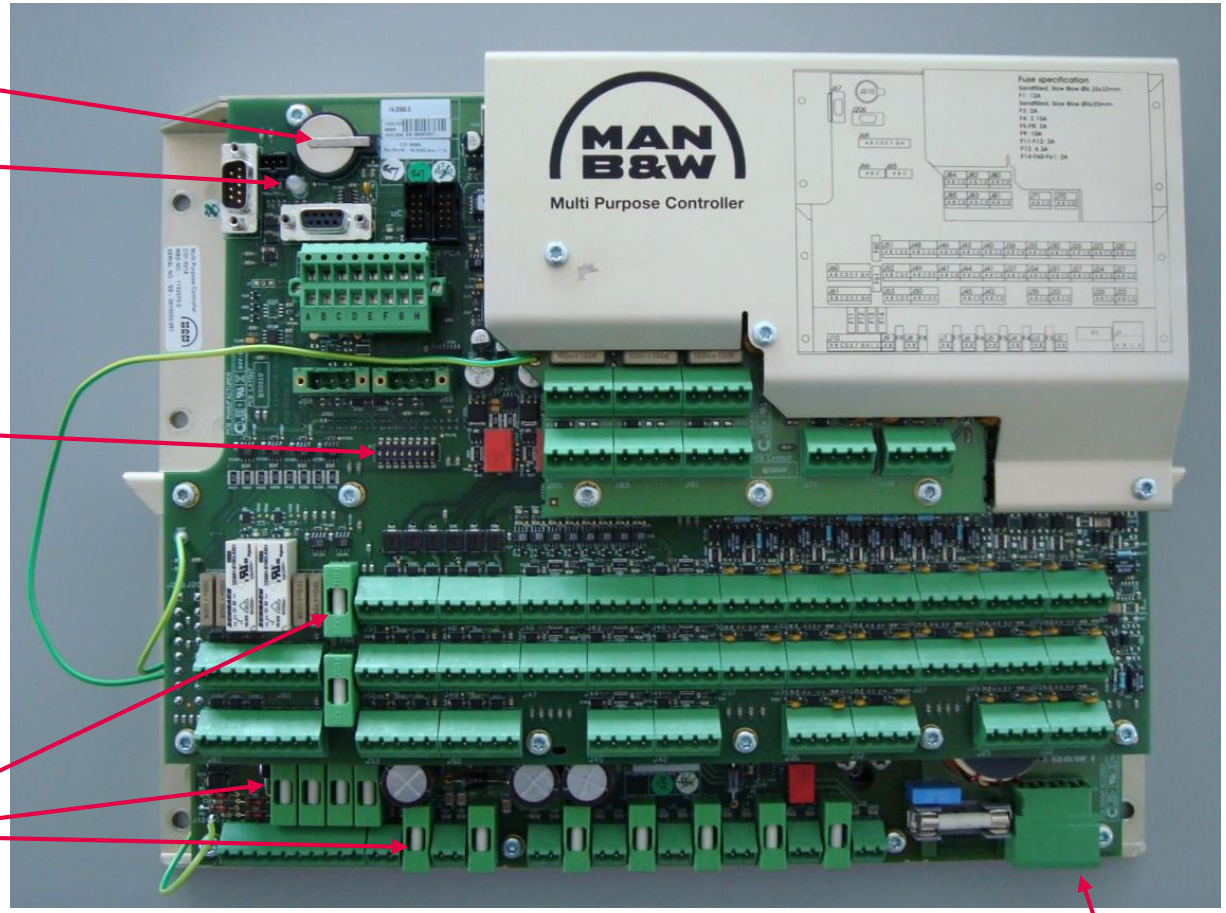
Bridge panel and engine control room panel are wired to EICU A & B.

Local operating panel is wired to ECU A & B.

ME engine introduction

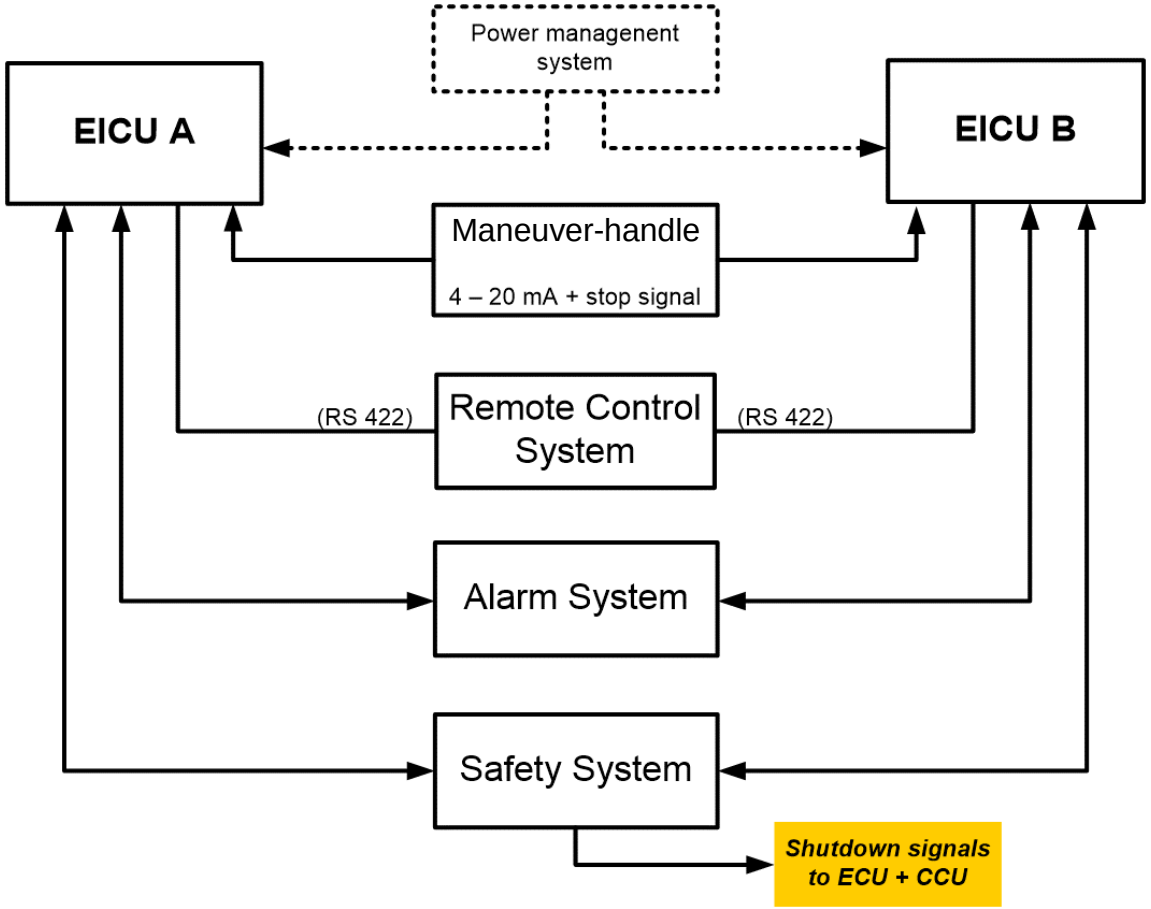
Multi Purpose Controller (MPC)





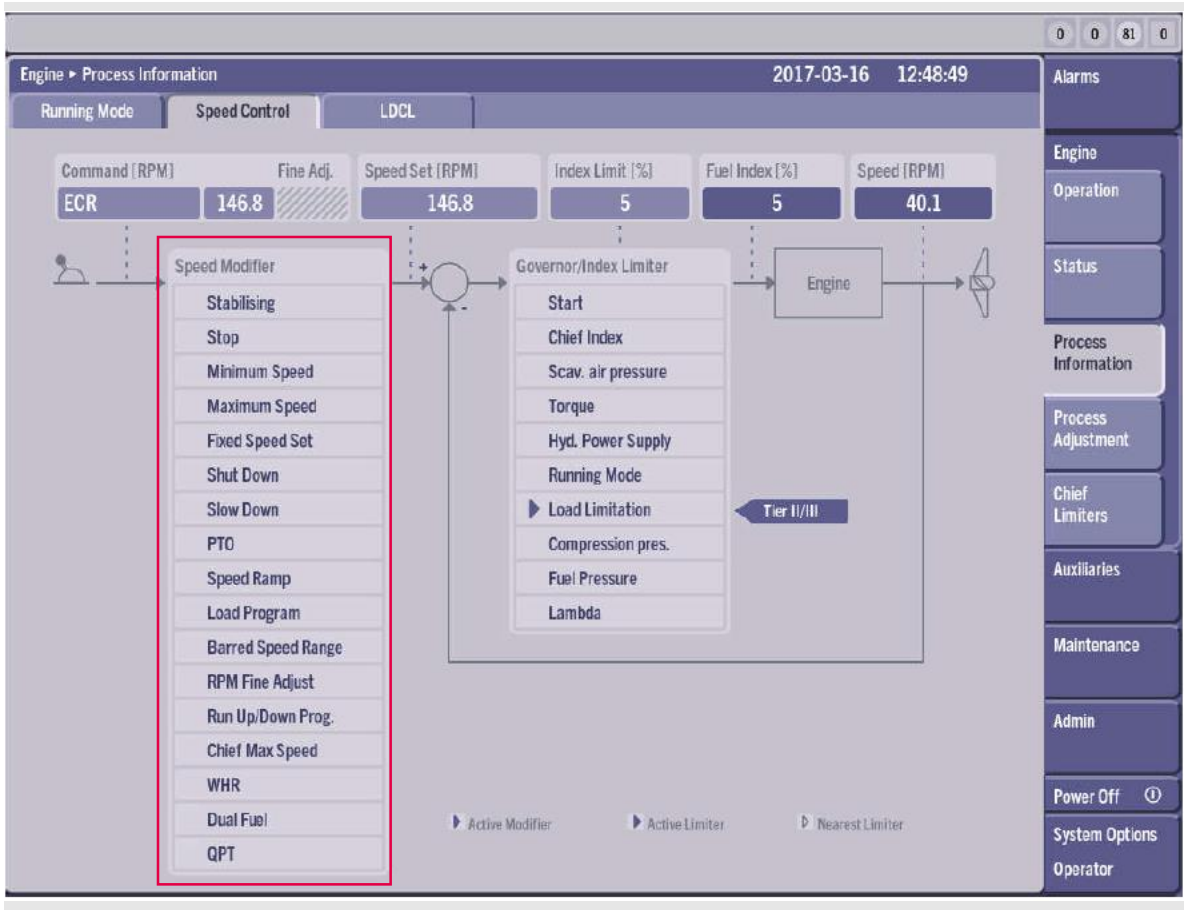
ME engine introduction

Engine Interface Control Unit (EICU)



ME engine introduction

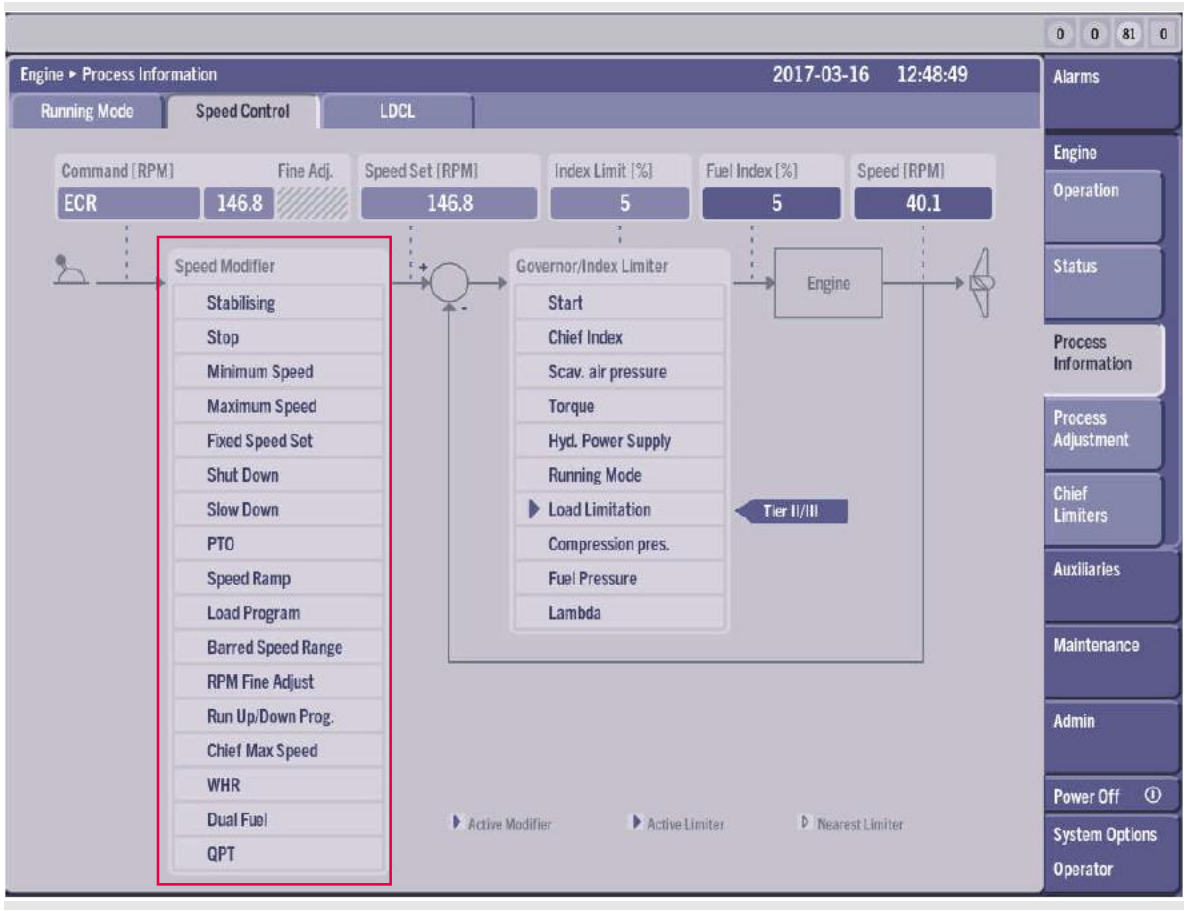
Engine Interface Control Unit (EICU) – Speed set point



- Pre defined RPM for starting
- Stop
- Gives the minimum set point
- Gives the maximum set point
- Only for CPP plants – Fixed speed set point when ‘Bridge command take’ is active
- Shut down = Stop
- Speed set point reduced to pre-defined slow down speed
- Speed set point set inside RPM range for shaft generator
- Speed ramp up/down 3 RPM/sec. Not cancellable.
- 80% - 100% RPM in 90 min. on large bore engines.

ME engine introduction

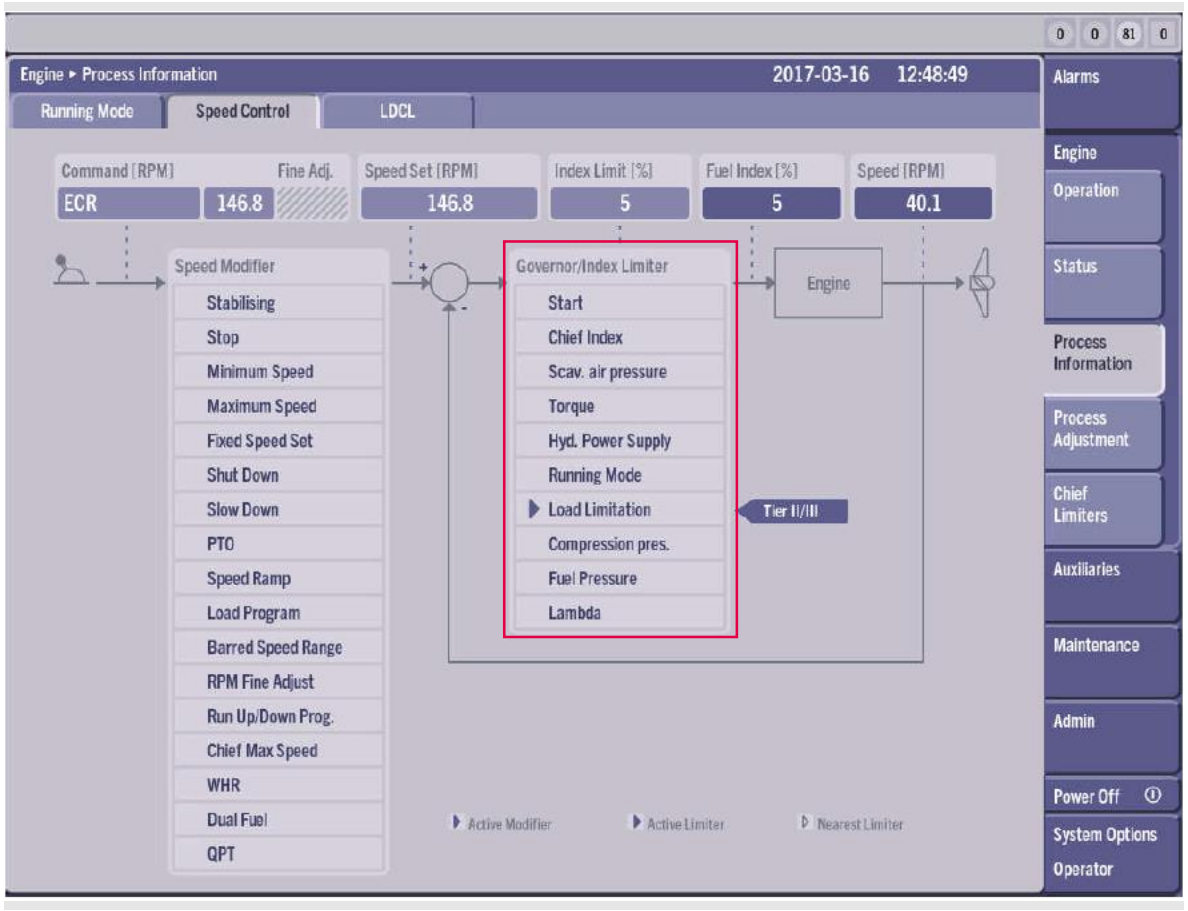
Engine Interface Control Unit (EICU) – Speed set point



- Modifies set point to be outside the barred speed range
- Fine adjustment of speed set point active
- Running up/down program active (optional)
- Chief can set max speed
- T/C cut out activated for low load operations, engine speed is limited (optional)
- Waste Heat Recovery. Engine speed is higher than ordered to keep shaft gen. connected (option)
- Engine running on dual fuel (optional)
- Quick Passing Through. Assits in passing through Barred speed range quickly

ME engine introduction

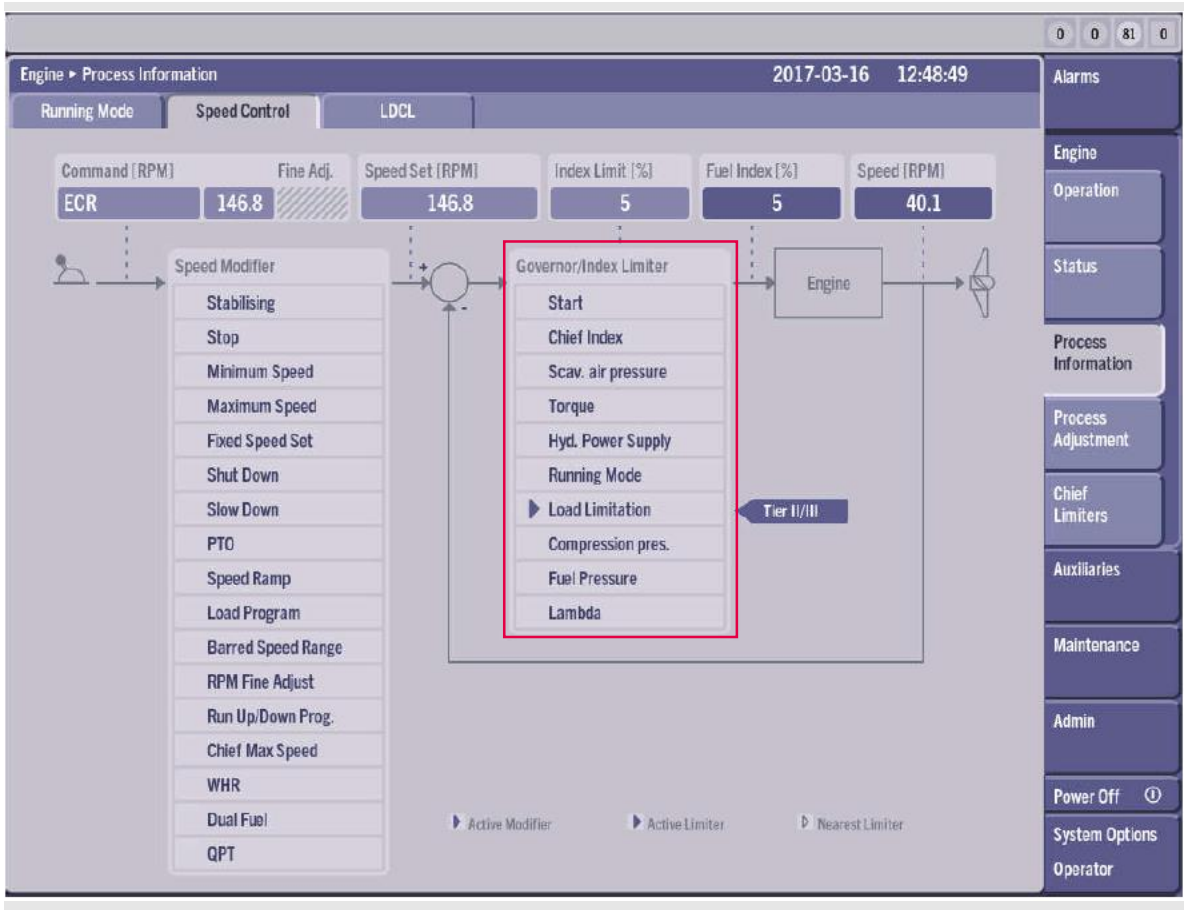
Engine Control Unit (ECU) – Governor & index limiter



– Pre defined index for starting
– Max fuel set by C/E, for individual or all cylinders
– A certain Pscav allows a certain index
– A certain RPM allows a certain index
– A certain hydraulic pressure allows a certain index
– A certain index in relation to the chosen running mode
– An allowed index in relation to Chief limiter, Max load setting, Tier II – Tier III condition, Condition based WHR, EGB, T/C cutout etc.

ME engine introduction

Engine Control Unit (ECU) – Governor & index limiter



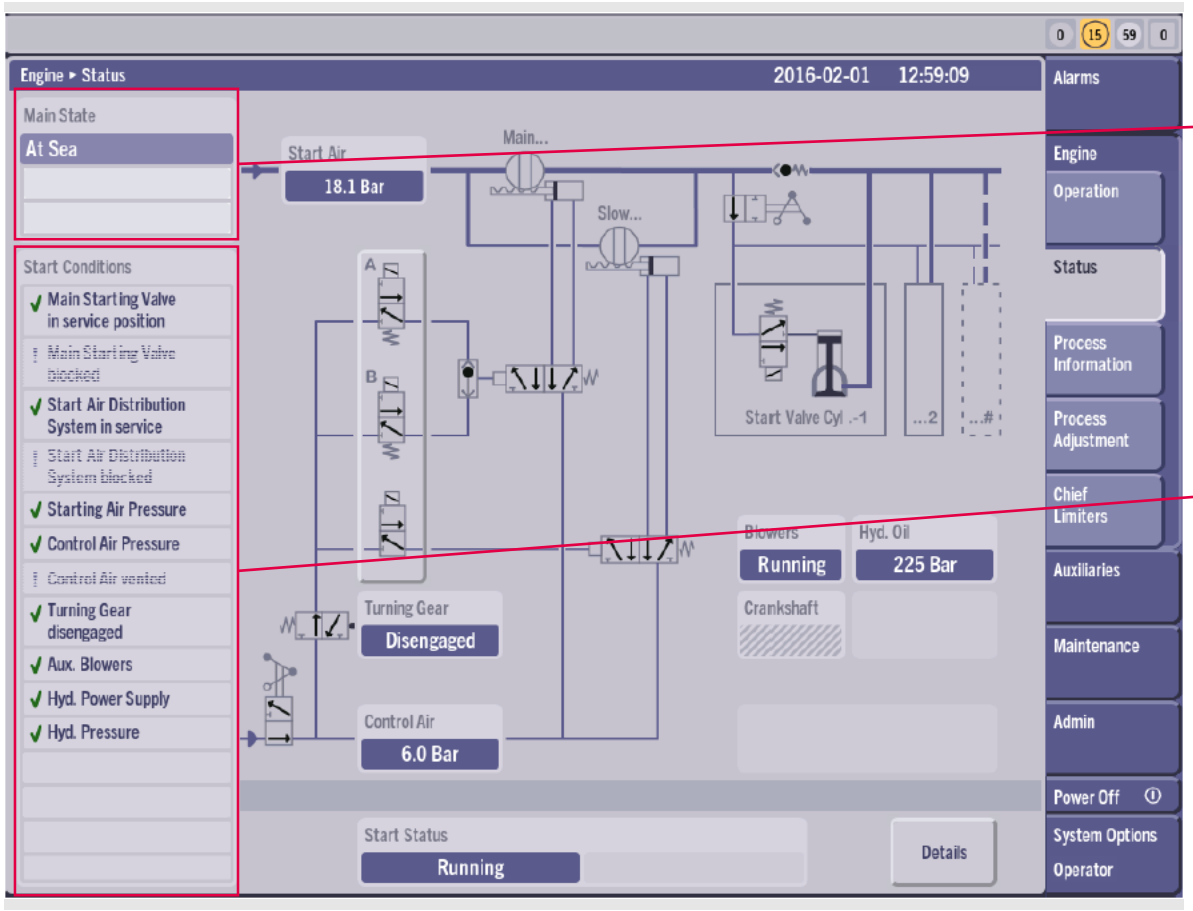
– An allowed index in case of a permanently closed exhaust valve

– This limiter is only uses in case of Common Rail systems. Limits the index if fuel pressure is low.

– Ensures a certain air to fuel ratio for combustion by limiting the index

ME engine introduction

Engine Control Unit (ECU) – Start block & checklist



Main State:

– Shows the main state of the engine FWE / Standby / At Sea

– Any warnings to the state and / or blockings will be shown here.

Start Conditions:

– Check list of conditions which must be met in order to have the engine in the corresponding state.

– One list for Finished With Engine (FWE) and one list for Standby

ME engine introduction

Engine Control Unit (ECU) – Injection profiles tier II engines

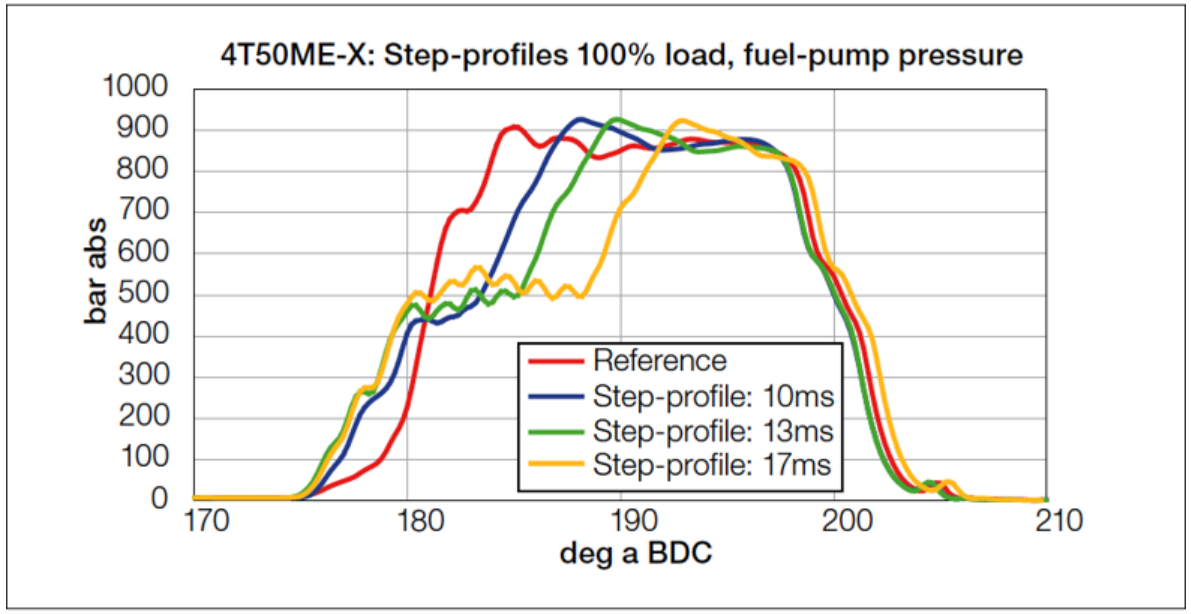


Fig. 12.10: injection profile investigations

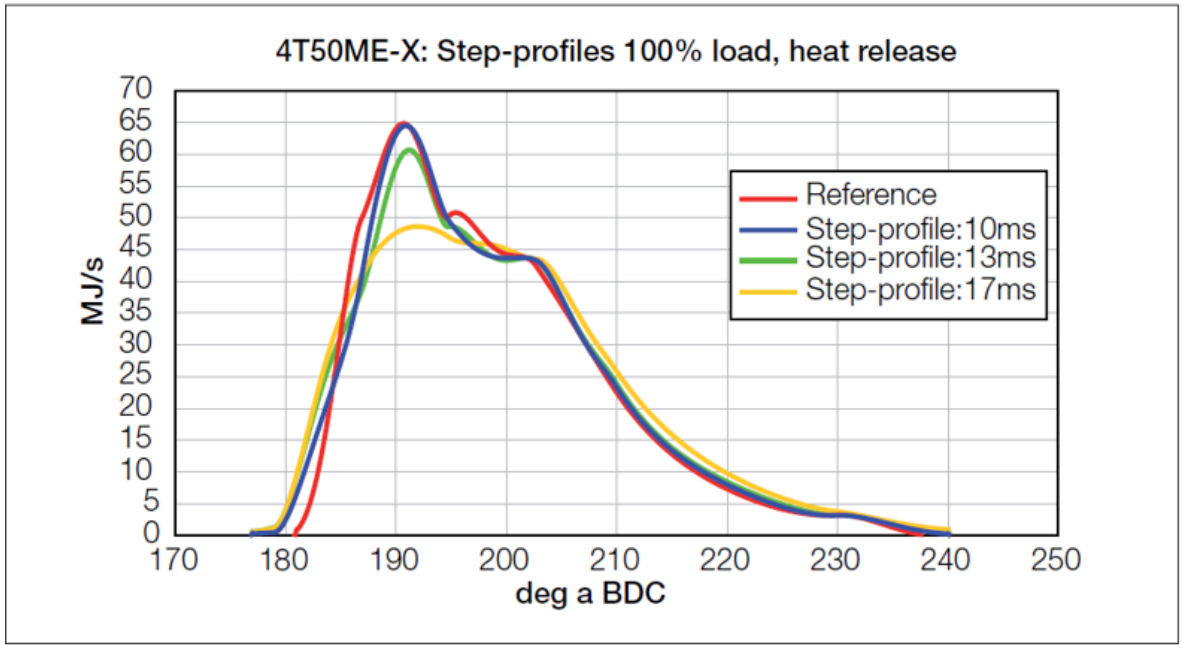
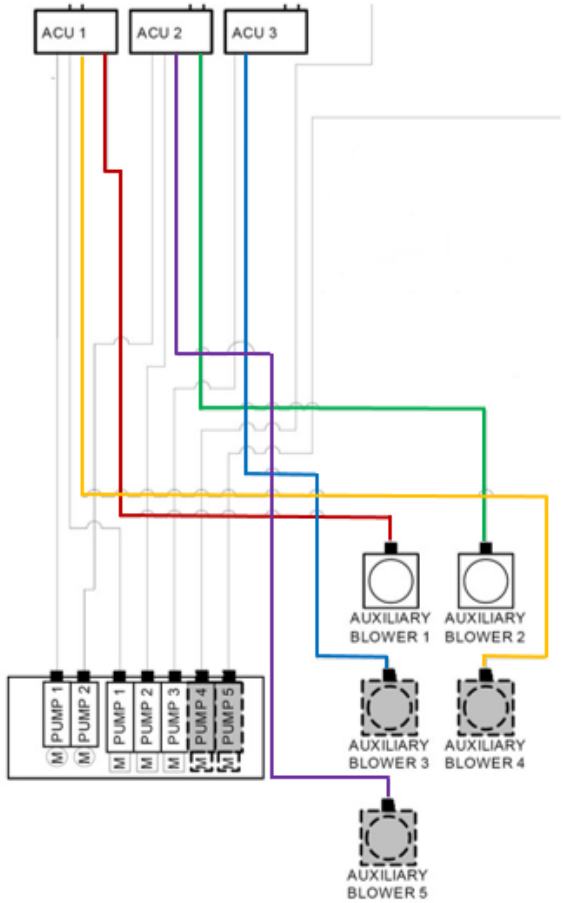


Fig. 12.11: Combustion pattern with different injection profiles

ME engine introduction

Auxiliary Control Unit (ACU) – Blower control



The blowers are started one by one in order to prevent overload of the electrical system.

In AUTO mode:

The blowers are started at ‘Prepare Start’

At engine running they are controlled by the scavenge air pressure. They stop at 0,7 bar (time delay), they start at 0,4 bar.

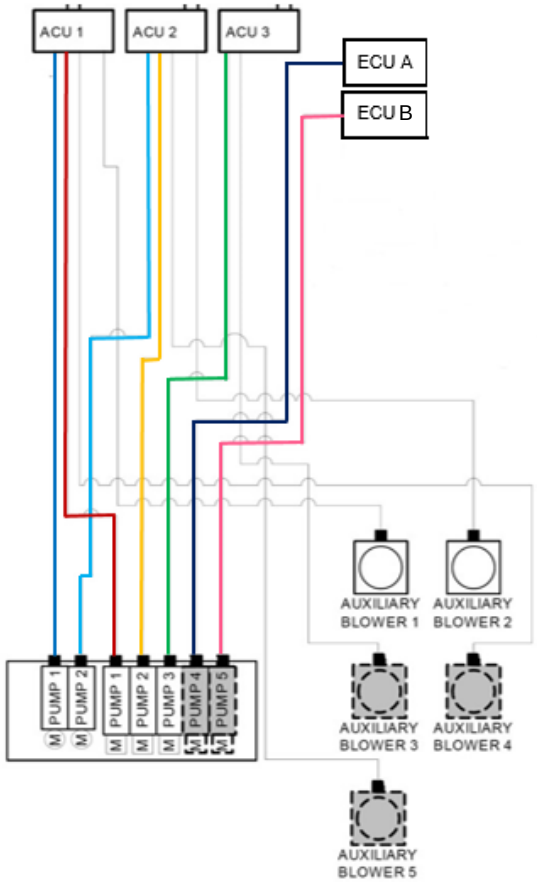
At engine stop they continue to run for a default 15-20 min.

In MANUAL mode:

Operation is controlled by the operator via the MOP.

ME engine introduction

Auxiliary Control Unit (ACU) – Pump control



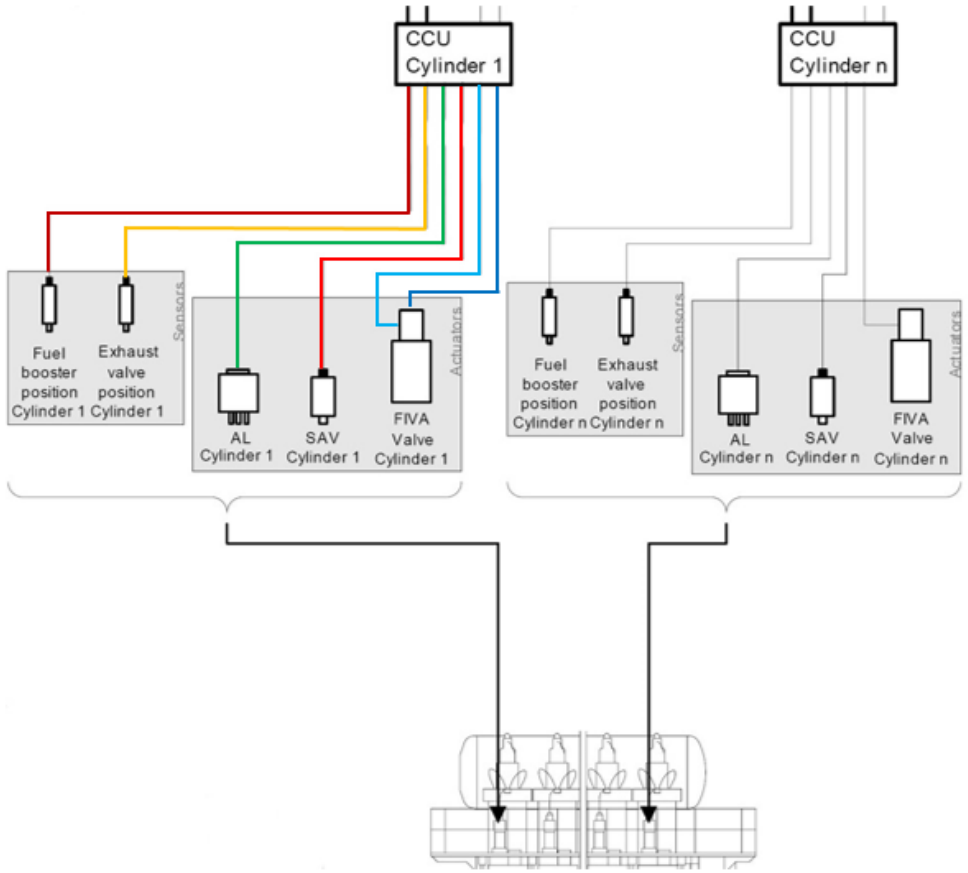
Electrically driven start-up pumps 1 & 2 are controlled by ACU 1 & 2

Engine driven pumps 1, 2, & 3 are controlled by ACU 1, 2 & 3 respectively. The control is modulated, based on the pressure set point and the actual hydraulic pressure.

Engine driven pumps 4 and 5 are the same type as 1, 2 and 3, but they are controlled digitally by ECU A & B, either max ahead or max astern.

ME engine introduction

Cylinder Control Unit (CCU)



FIVA : Fuel Injection, Valve Actuation

– Proportional valve for fuel injection.

– On / Off for exhaust valve operation

Control of FIVA movement

Monitor feedback from FIVA

Control of Start Air Valve (SAV)

Control of ME lubricator

Monitor feedbacks from lubricator

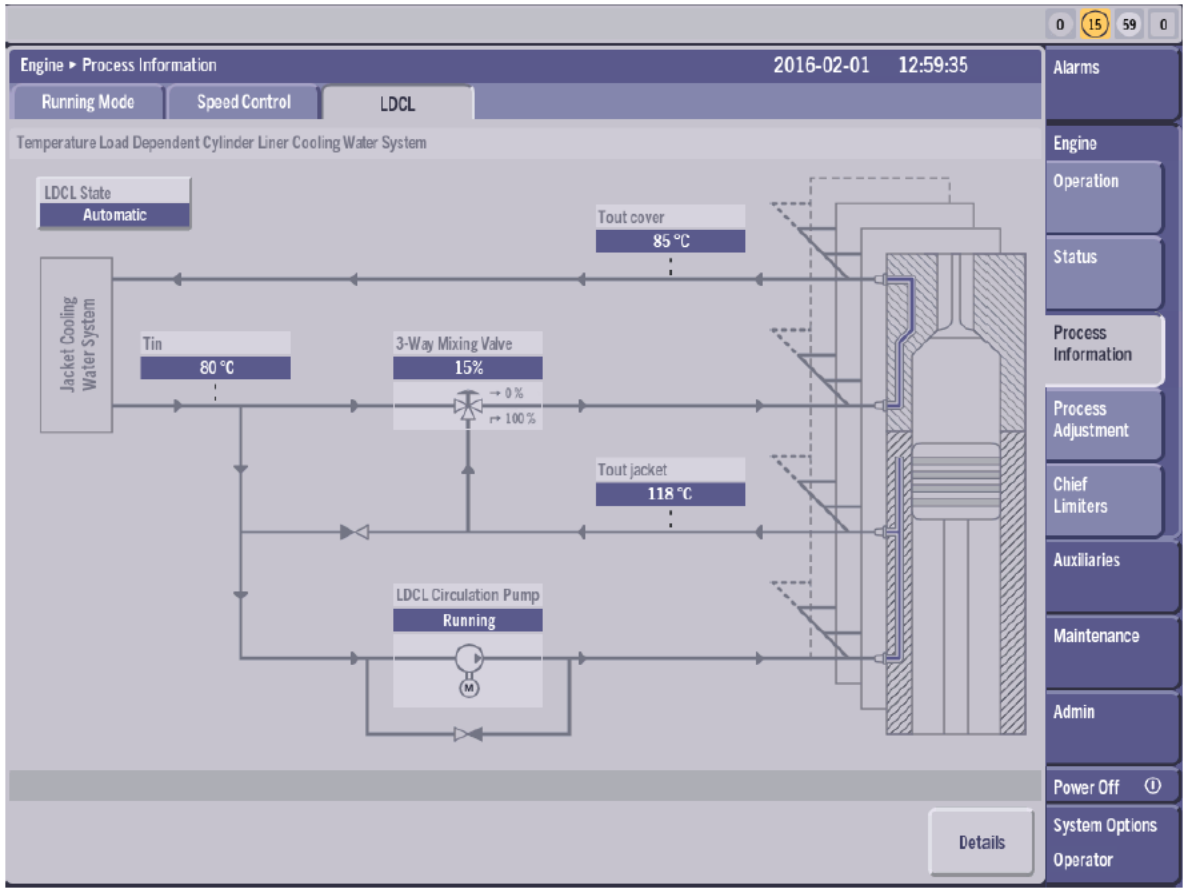
Monitor fuel oil booster feedback

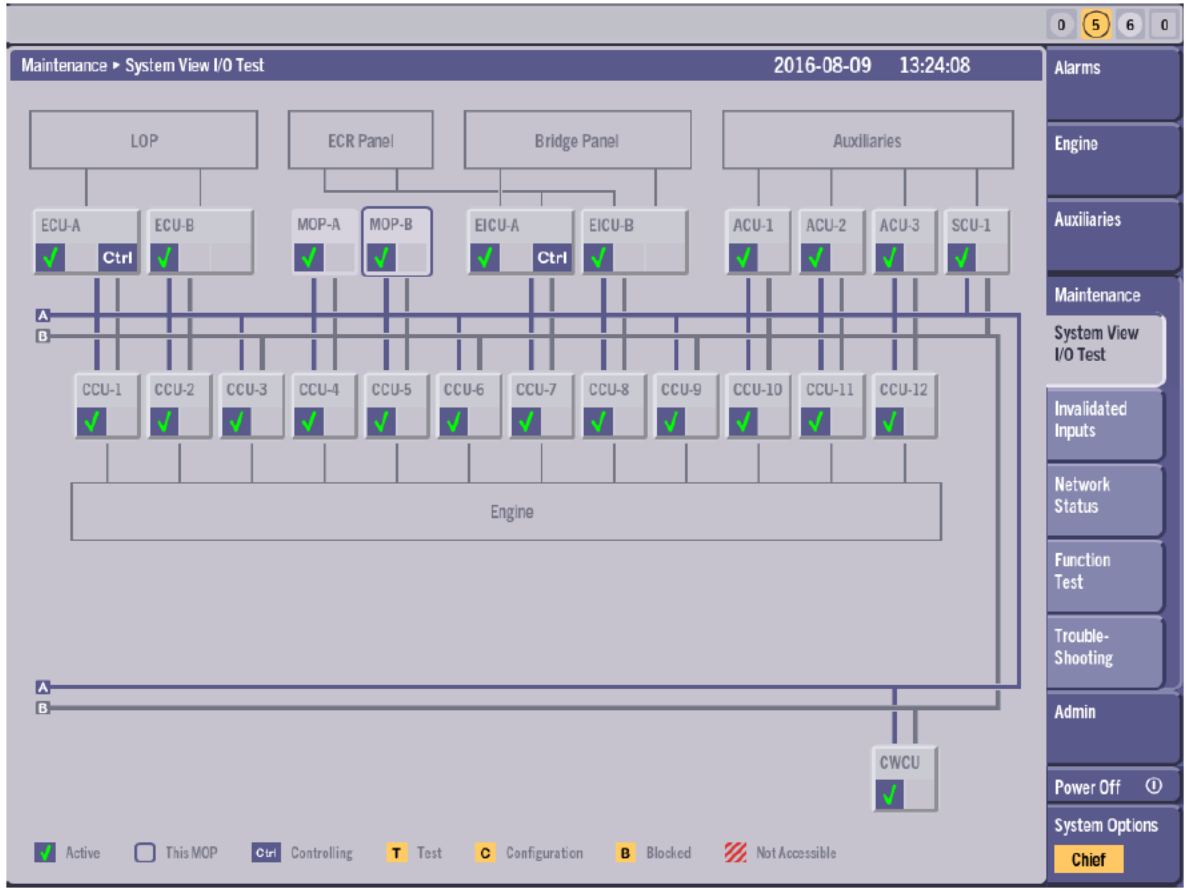
Monitor exhaust valve position feedback

One CCU per cylinder

ME engine introduction

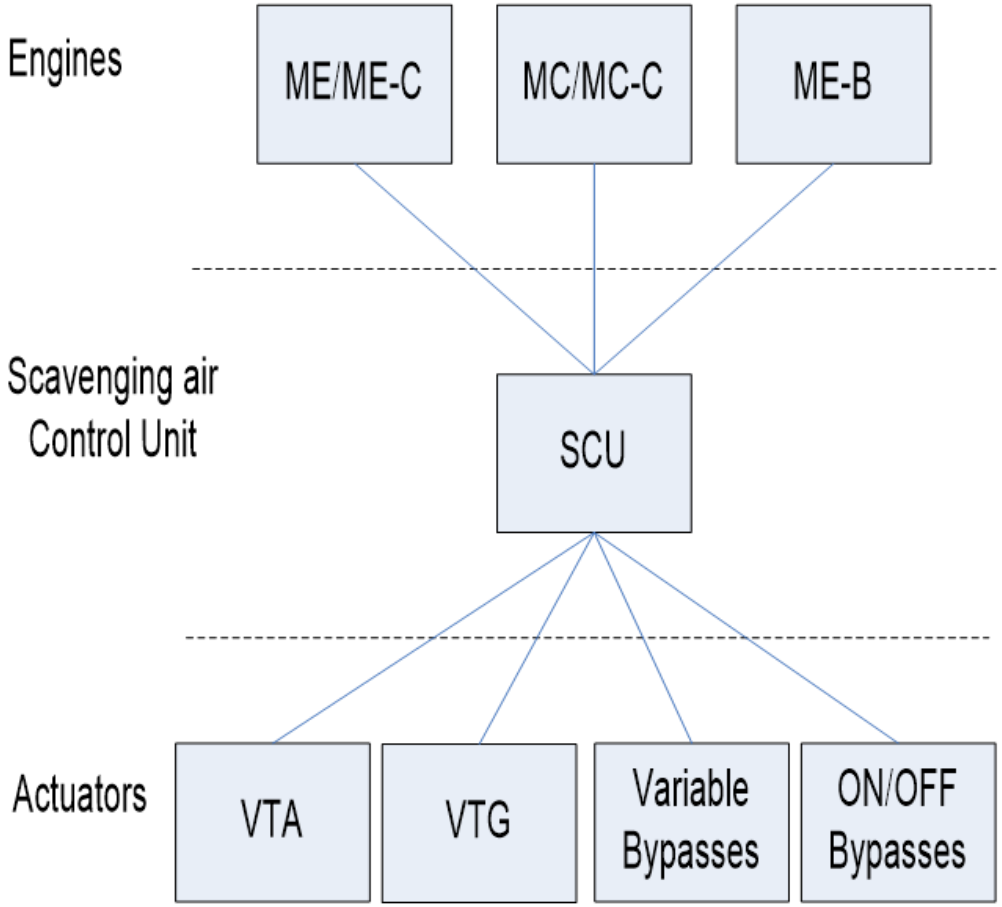
Cooling Water Control Unit (CWCU) – Temperature Load Dependent Cylinder Liner (LDCL)

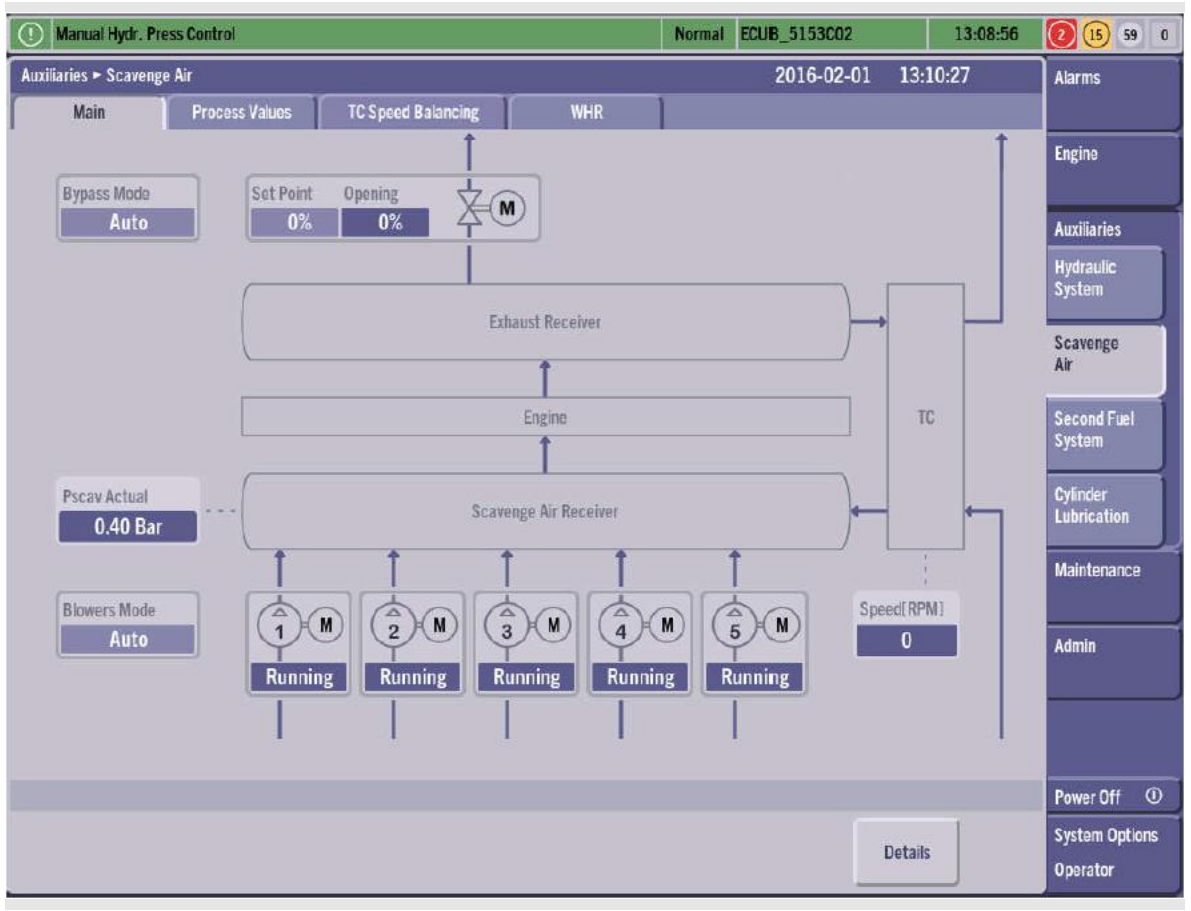




ME engine introduction

Scavenge air Control Unit (SCU) – VTA, WHR, EGB





ME engine introduction

Main Operating Panel (MOP)

Integrated PC

EC - MOP

MOP A:

- Touch screen
- Track ball
- Daily operation of engine

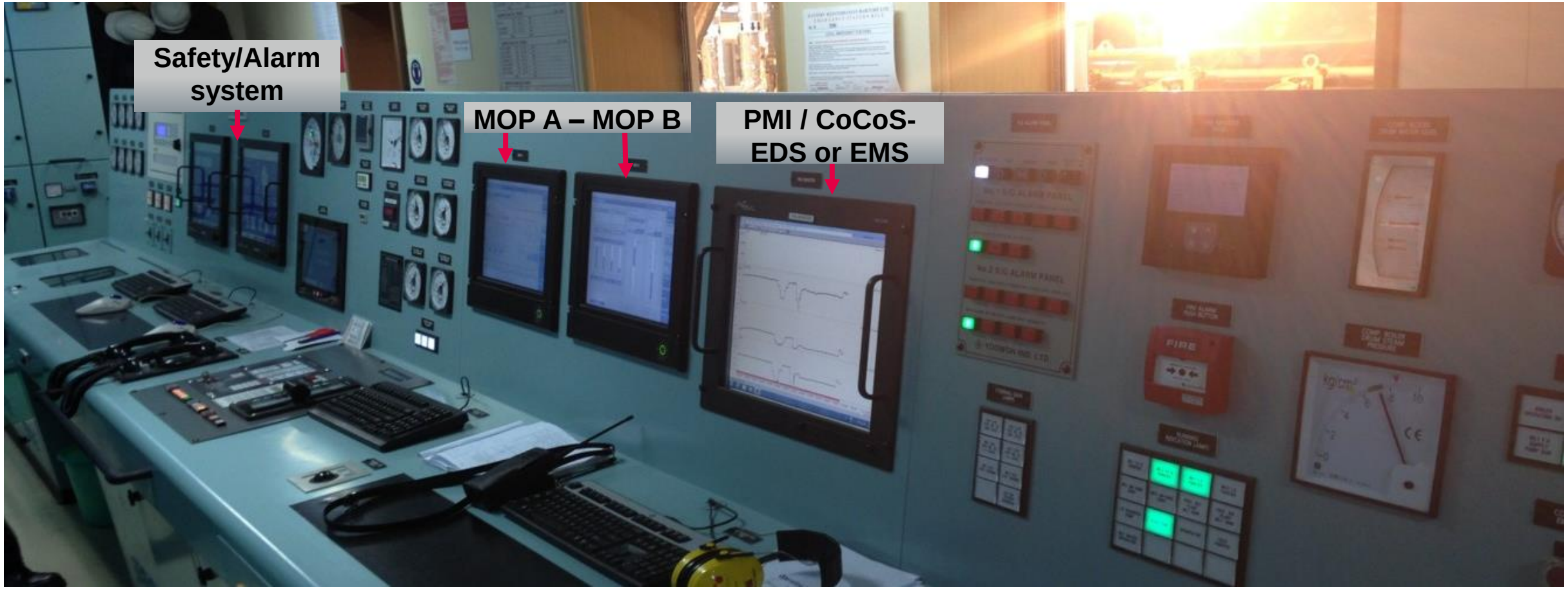
MOP B:

- Touch screen
- Keyboard with mouse
- Daily operation & trouble shooting of engine

Marine approved PC's with embedded Windows software.

ME engine introduction

Main Operating Panel (MOP)

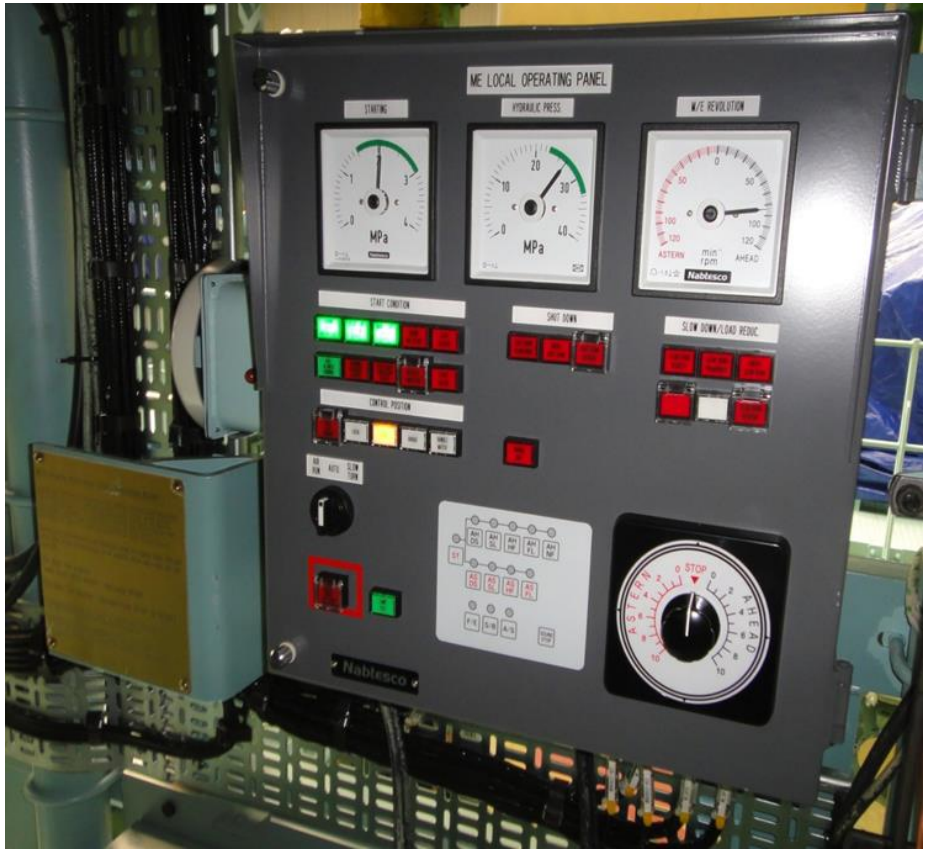


ME engine introduction

Local Operating Panel (LOP)

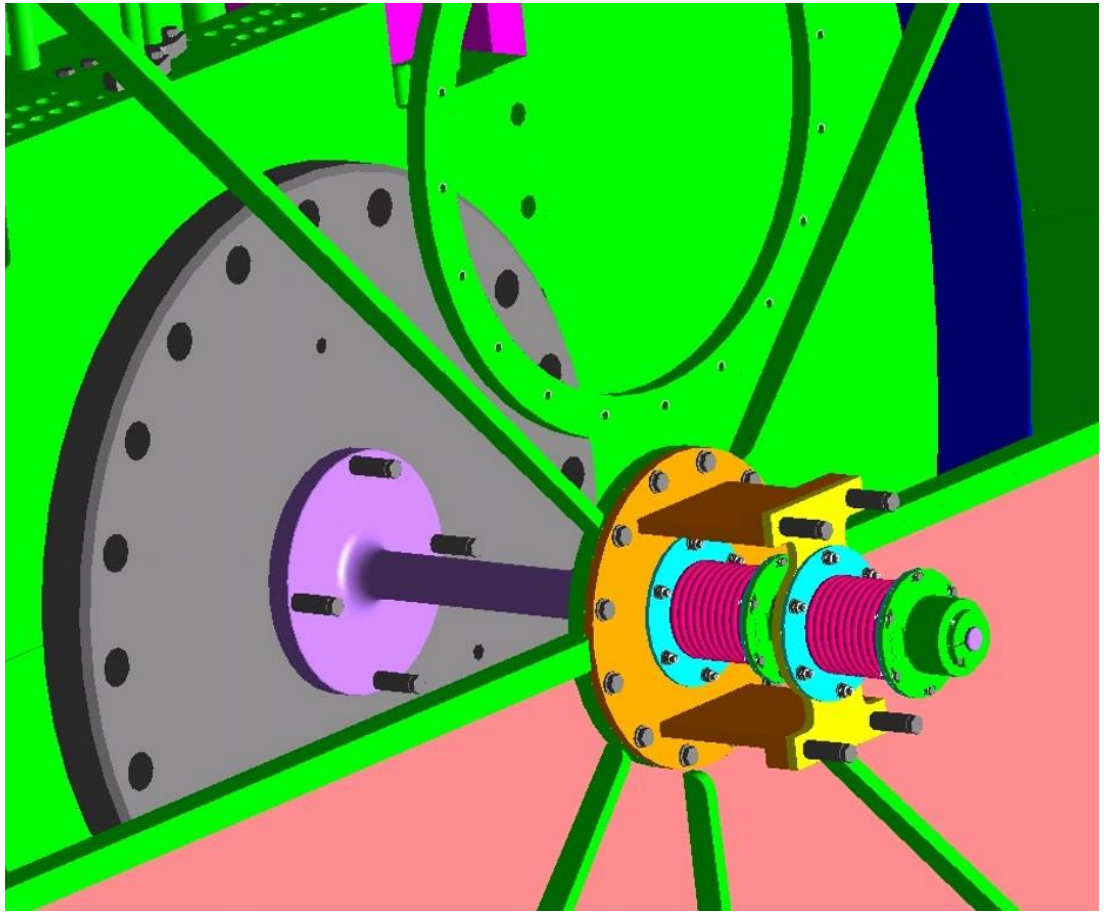
MAN - ES supplied

Nabtesco supplied



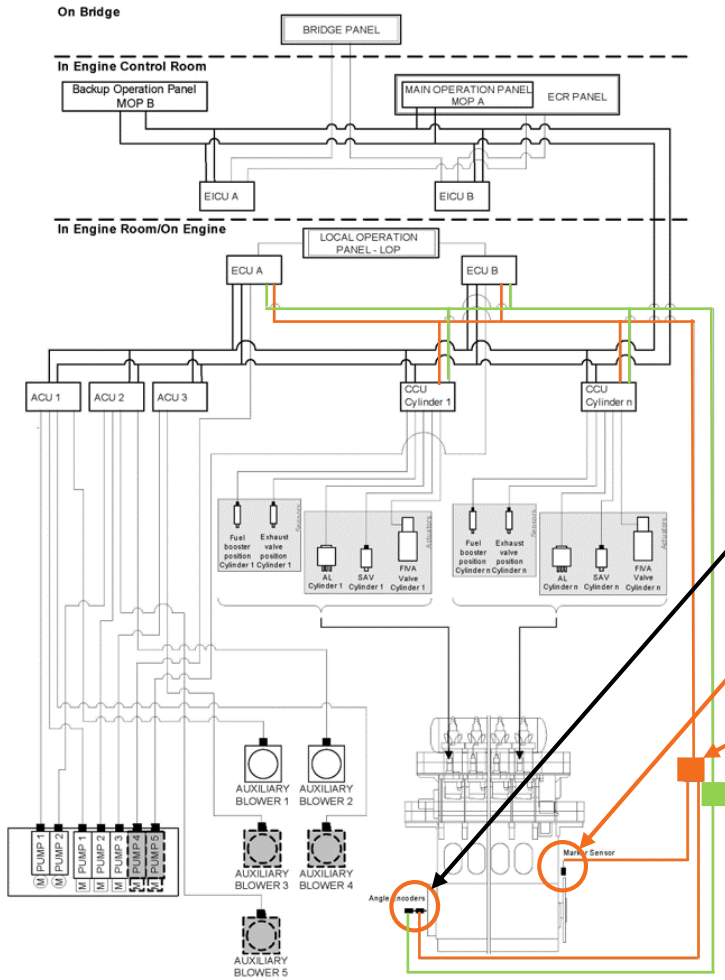
ME engine introduction

ME Tacho system



ME engine introduction

Tacho system - Schematic



There are two redundant encoders in the tacho system:

- **Encoder A**
- **Encoder B**

Reference sensor at fly-wheel

ECU A

- **Tacho signal for monitoring**
- **Power supply to TSA-A**

ECU B

- **Tacho signal for monitoring**
- **Power supply to TSA-B**

CCU's

- **Tacho signal for operation**

ME engine introduction

Tacho system – amplifier boxes

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Future in the making

Thank you very much!

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