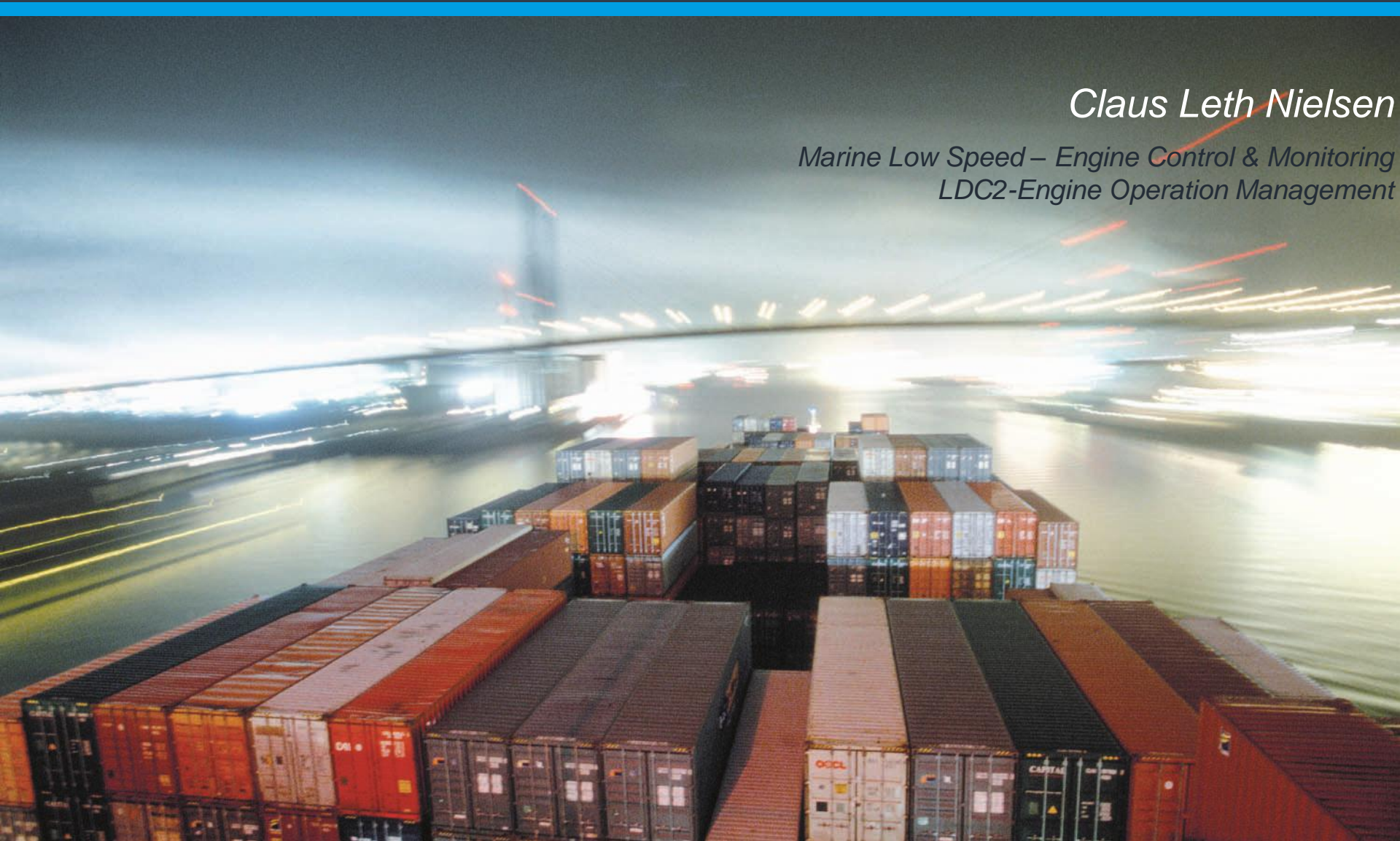


PMI Auto-tuning on ECS MOP



Claus Leth Nielsen

*Marine Low Speed – Engine Control & Monitoring
LDC2-Engine Operation Management*

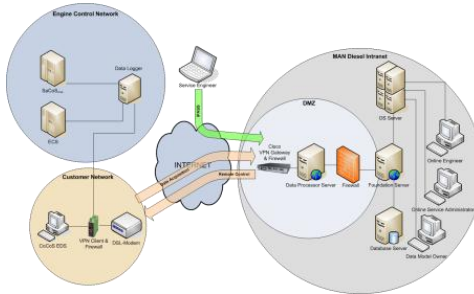


Disclaimer

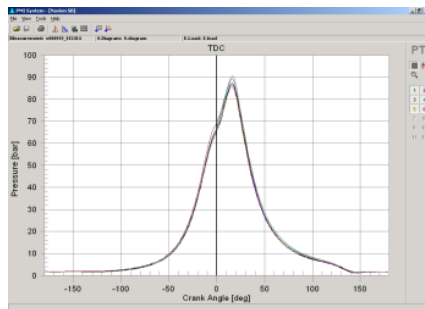


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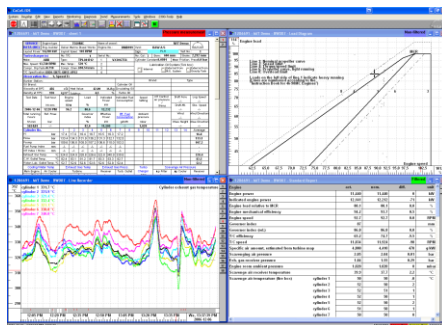
Engine Operation Management



➤ Online Service



➤ PMI



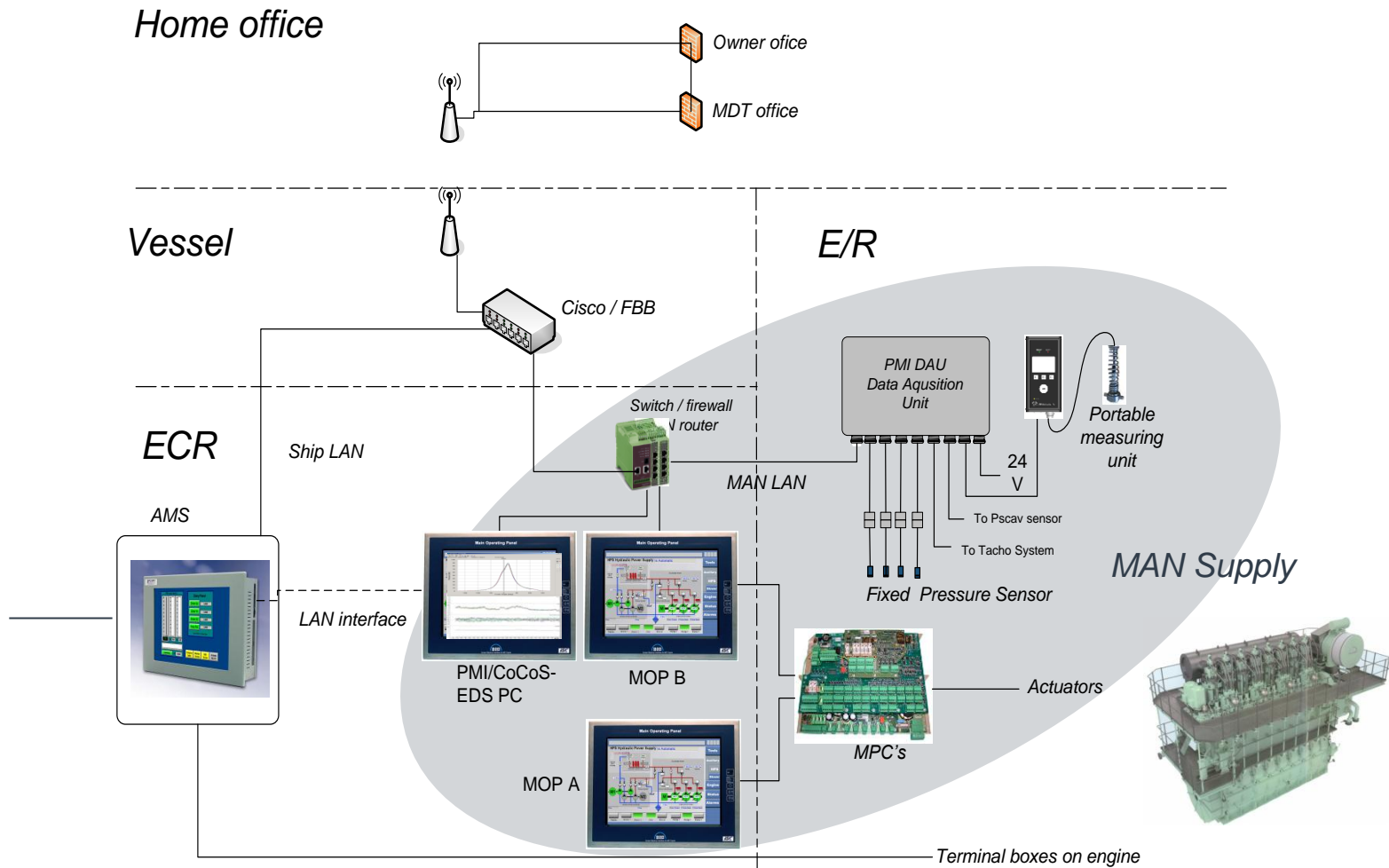
➤ CoCoS-EDS

Tools for:

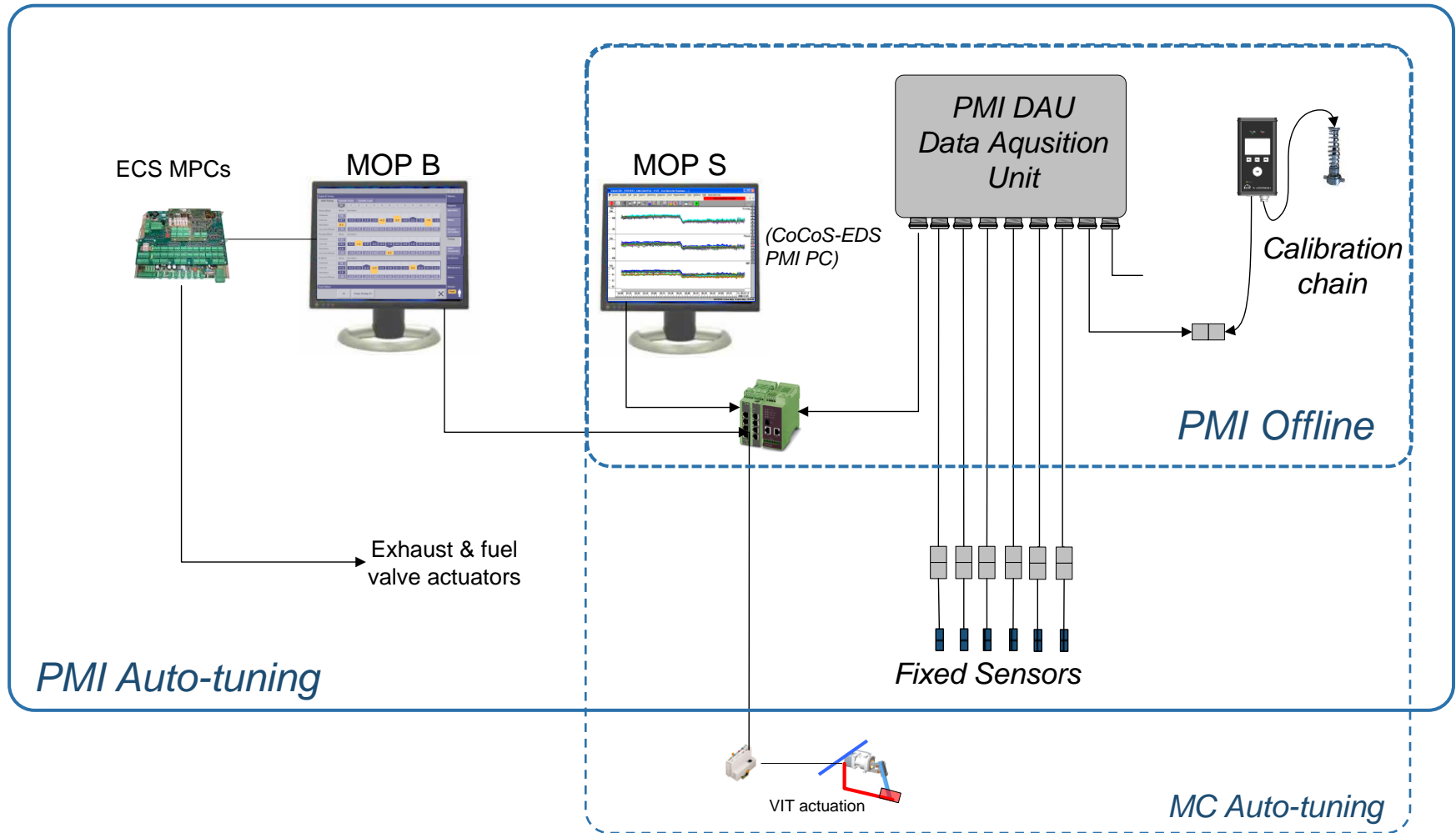
- Condition Monitoring
- Troubleshooting & Diagnostics
- Performance Evaluation
- Performance Optimization

PMI Auto-tuning

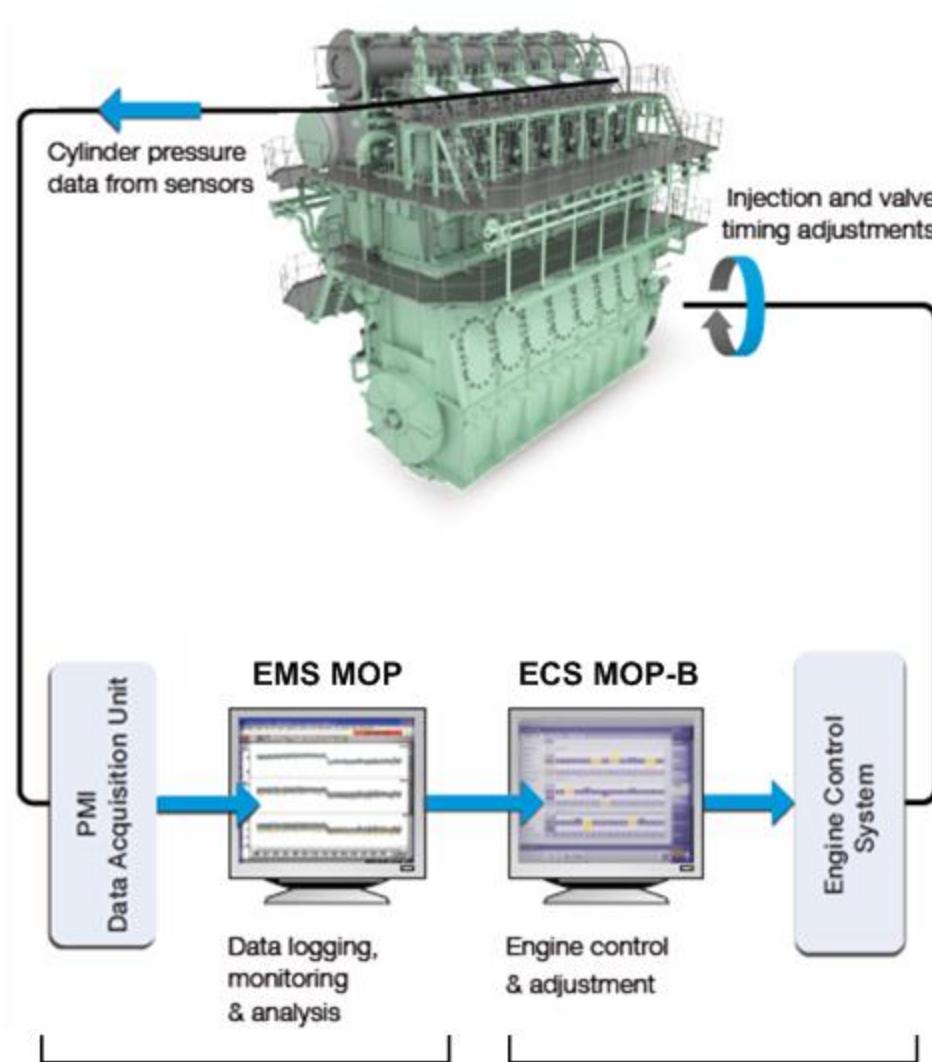
Remote monitoring / AMS interface



PMI Auto-tuning Family



PMI Auto-tuning closed-loop tuning



PMI Auto-tuning MOP Window



The screenshot shows the 'Engine Process Adjustment' window with the following components and callouts:

- 1. Continuous P_{max}** : Points to the 'Continuous Pmax' button at the bottom left.
- 2. Continuous P_{comp}** : Points to the 'Continuous Pcomp' button at the bottom left.
- 3. Auto balancing**: Points to the 'Auto' button in the 'Tune Values' section at the bottom.
- 4. Auto mean level**: Points to the 'Mean' column headers for the P_{max} and P_{comp} data tables.
- 5. Manual adjustment**: Points to the 'Manual Quality' tab at the top of the data tables.

The window displays data for P_{max} [Bar] and P_{comp} [Bar] across 12 cylinders. The 'Mean' column for both parameters shows a value of 0. The 'Deviation' columns show values of 0 for all cylinders. The 'Tune Values' section at the bottom shows 'STATUS: Tuning allowed' and 'REPORT: Last tuning successful'.

PMI Auto-tuning MOP Window



Mean panels Horizontal tabs Deviation panels

Parameter	Mean	Deviation
Pmax [Bar]	150	0.2, 0.1, 0.1, -0.1, -0.3, 0.0, 0.1, 0.3, -0.4, -0.1, 0.0, 0.1
Pcomp [Bar]	125	0.3, -0.1, 0.5, 0.2, -0.2, 0.1, -0.3, 0.1, 0.2, 0.0, -0.6, -0.2
Pi [Bar]	-	-0.1, 0.0, 0.1, 0.0, -0.1, -0.2, 0.1, 0.2, -0.1, 0.0, 0.2, -0.1

Mode button Information bar Command buttons

PMI Auto-tuning preconditions

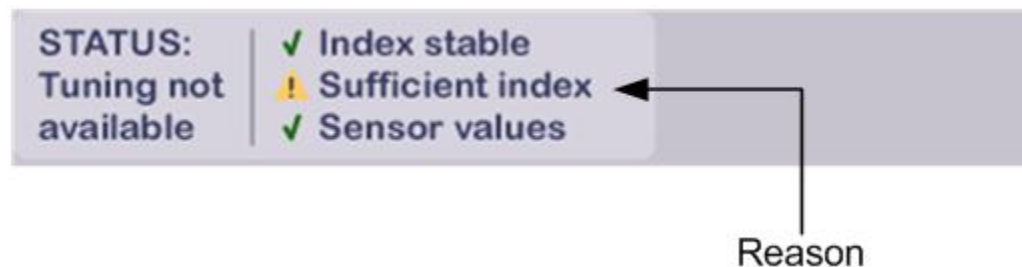


Status text:

Tuning allowed - Engine is operating in the allowable tuning range.

Tuning not available - Engine is not operating in the allowable tuning range.

Tuning in progress - The engine control system is either balancing or adjusting the mean pressure levels.



Report Text:

Last tuning successful - Operator initiated tuning completed successfully

Tuning rejected due to invalid sensor values - A pressure sensor is defective or pressure values are not valid.

Tuning incomplete due to max. adjust limit - Deviation too high or above adjustable range.

Tuning rejected ECU or CCU not available - Tuning cannot be made because the particular MPC device is busy with another task.

PMI Auto-tuning - balancing



The screenshot displays the 'Engine Process Adjustment' interface. It features three main data tables for Pmax, Pcomp, and Pi, each with 'Mean' and 'Deviation' columns across 12 cylinders. The Pmax deviation table has values: 0.0, -2.1, 0.5, -5.2, 0.0, 0.0, 8.0, 0.0, -0.5, 2.6, -2.3, -1.0. The Pcomp deviation table has values: -2.1, -0.8, 0.0, -0.5, -2.8, 4.0, 0.4, 0.6, 2.5, -0.9, -0.5, 0.1. The Pi deviation table has values: 0.2, 0.1, -0.5, -0.1, -0.1, 0.0, 0.1, 0.3, 0.0, 0.0, -0.1, 0.1. A red circle labeled '1' highlights the value '4.0' in the Pcomp deviation table, with the text 'Select either' next to it. Red arrows point from this circle to the 'Pmax' and 'All' buttons at the bottom. The 'Pmax' button is labeled '2a' and the 'All' button is labeled '2b'. A status box at the bottom left shows 'STATUS: Tuning allowed' with three green checkmarks: 'Index stable', 'Sufficient index', and 'Sensor values'. A right-hand sidebar contains various system status buttons like 'Alarms...', 'Engine Operation', 'Status', etc.

2a Press 2b Press

Depending on selected panel the button text (2a) will change – Pmax, Pcomp or Pi
Select the All button (2b) to simultaneously balance Pmax, Pcomp and Pi.

PMI Auto-tuning - mean adjustment



Engine ▶ Process Adjustment

Auto Tuning: Cylinder Load, Cylinder Press., Fuel Quality

All 1 2 3 4 5 6 7 8 9 10 11 12

Pmax [Bar]

Mean	Deviation	1	2	3	4	5	6	7	8	9	10	11	12
Ordered: 150													
Current: 146		0.6	1.0	0.3	-2.1	0.1	0.0	-0.5	2.9	-0.8	0.2	-0.8	-0.9
Deviation: 4													
Offset Auto/Cont.: 2		0.9	1.0	-2.0	2.5	0.7	2.0	1.1	3.2	0.8	0.0	-2.0	1.5

Pcomp [Bar]

Mean	Deviation	1	2	3	4	5	6	7	8	9	10	11	12
Ordered: 125													
Current: 120		-0.2	-1.9	0.5	-2.0	0.4	-0.6	-0.3	0.9	1.4	1.2	0.6	-0.4
Deviation: 5													
Offset Auto/Cont.: 3		2.2	-3.1	2.5	0.8	-2.2	2.5	-0.6	3.0	2.1	3.2	4.2	-3.5

Pi [Bar]

Deviation	1	2	3	4	5	6	7	8	9	10	11	12
Current	-0.1	0.0	0.1	0.1	-0.4	-0.2	0.0	-0.1	0.0	0.3	0.1	0.2
Offset	0.9	3.4	-2.0	-0.7	1.2	3.2	0.5	1.9	-2.0	1.1	-0.9	3.6

Continuous Pmax: On

Tune Values

STATUS: Tuning allowed

- ✓ Index stable
- ✓ Sufficient index
- ✓ Sensor values

Pmax All X

1 Select either

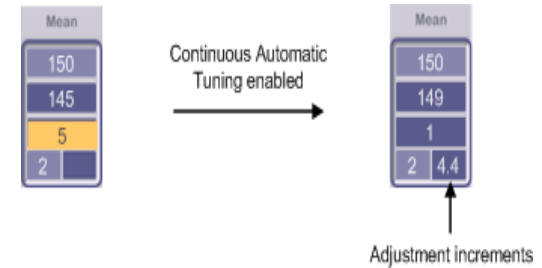
2 Press

PMI Auto-tuning – continuous tuning



The screenshot shows the 'Engine ▶ Process Adjustment' interface. Key elements include:

- Auto Tuning Section:** Contains 'Pmax [Bar]' and 'Pcomp [Bar]' parameters. The 'Pmax' section shows a 'Mean' of 150, 'Current' of 145, and 'Deviation' of 5. The 'Pcomp' section shows a 'Mean' of 125, 'Current' of 123, and 'Deviation' of 2. Below these are 'Pi [Bar]' and 'Offset' fields.
- Process Adjustment Panel:** A vertical sidebar on the right with buttons for 'Alarms...', 'Engine ▶', 'Operation', 'Status', 'Process Information', 'Process Adjustment', 'Chief Limiters', 'Auxiliaries...', 'Maintenance...', 'Admin...', 'Power Off', and 'Access'. A red arrow labeled '1 Press' points to the 'Process Adjustment' button.
- Continuous Pmax Section:** At the bottom, it includes a 'Tune Values' table, a 'STATUS' section with green checkmarks for 'Index stable', 'Sufficient index', and 'Sensor values', a 'REPORT' section stating 'Last tuning successful', and buttons for 'Pmax', 'All', and a close button.
- Annotations:** Red circles with numbers 1, 2, 3, and 4 indicate specific actions: '1 Press' on the 'Process Adjustment' button, '2 Select' on the 'Auto Tuning' tab, '3 Select' on the 'Deviation' field of the 'Pmax' section, and '4 Press' on the 'On' button.



- Adjustment limits – pmax
- +5bar/-10bar
- Adjustment limits – pcomp
- +2bar/-2bar

Alarm limits:

- Pmax deviation from avg – 10bar
- Pcomp deviation from avg. – 10bar
- Pi deviation from avg. – 2bar

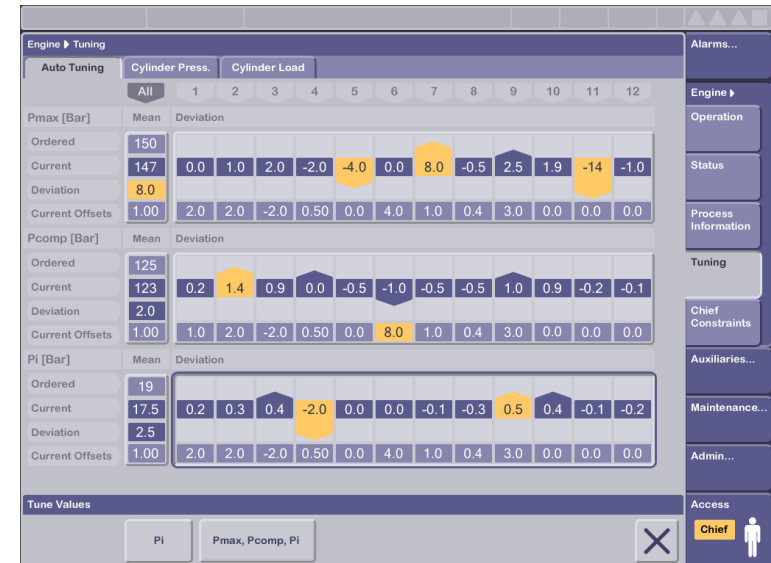
- Pmax supervision – 10bar
- Prise supervision – 5bar

PMI Auto-tuning benefits



Auto-tuning overall benefits:

- Fuel oil consumption
Reduction potential: +3 g/kWh
Reduction average: 1 g/kWh
- Low installation costs
Payback period estimated 6-15 month's
- Emission
CO₂ reduction
- Operation cost reduction
Reduced engine maintenance costs,
increased availability/reliability
- Simplified operability
Ease workload on crew
Ensures always well adjusted engine – Pressure rise control
Adapts automatically to changed fuel properties
- PMI online
Enhanced troubleshooting of combustion process



Thank You for Your Attention!



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