Performance Adjustment on ME engine

Learning Objectives

The learning objective of this session is as follows:

- Introduction
- Performance adjustments process
- Estimated engine load adjustment
- What Pi, Pmax and Pcomp adjustment change on the engine.
- Performance evaluation
- Pcomp. adjustment
- Pi adjustment
- Pmax. adjustment
- PMI Auto-tuning system

Introduction

This presentation is a guidance for ME engine with PMI offline and online system.

It is made for Chief Engineers working on the electrically controlled engine and not familiar with the performance adjustments via the MOP screen.

This presentation explain how to use MOP screen to adjust the engine performance.

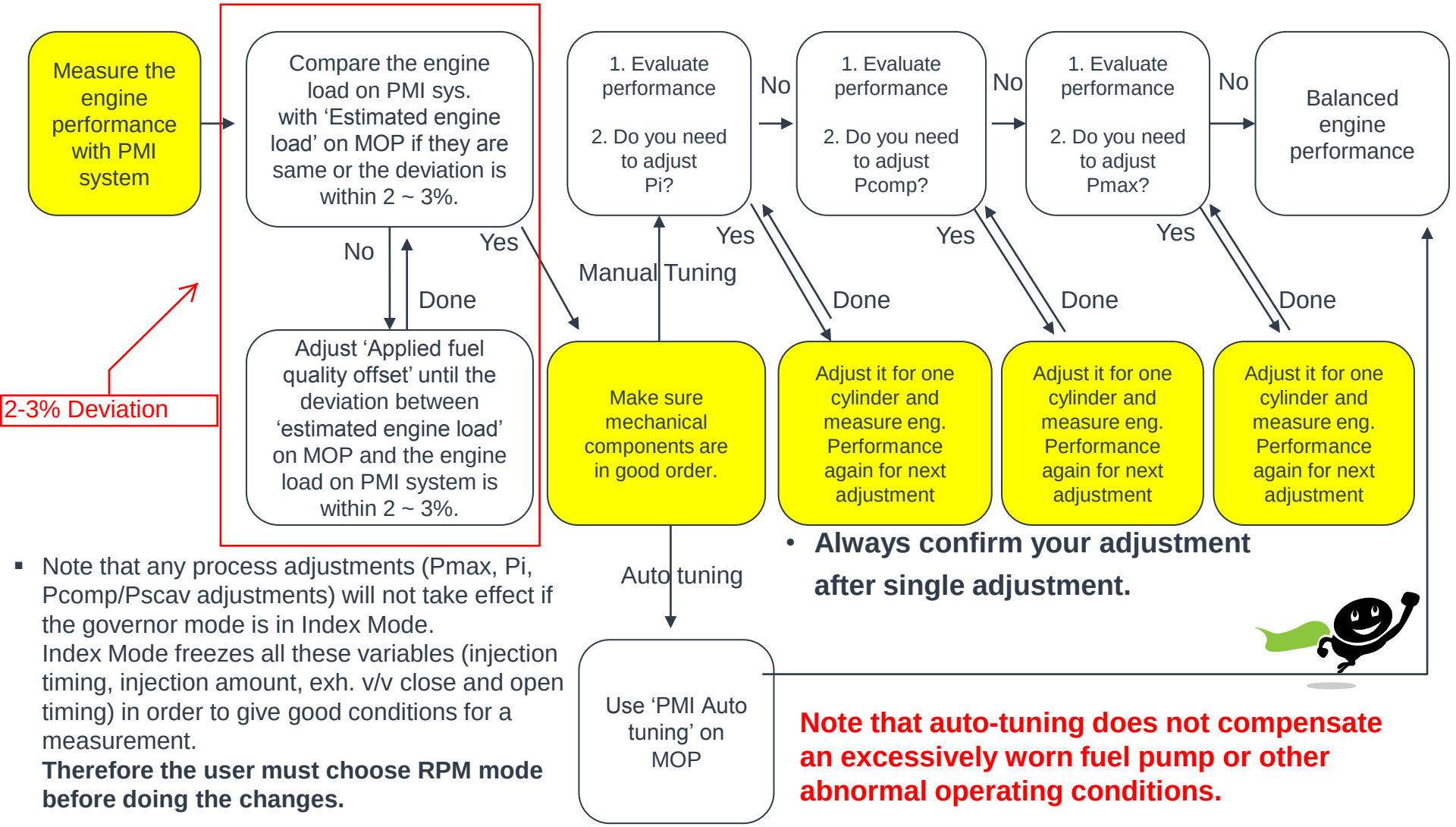
How often an adjustment/check should take place is difficult to say.

Some ship owners have a 1 time/months routine, some more often.
It is up to the ship owner/superintendent/CE to decide.

The evaluation of performance in this presentation is only for training purpose only.

- If you have any question, please feel free to send e-mail to PrimeServ.Academy-cph@mandieselturbo.com

Performance Adjustment Process



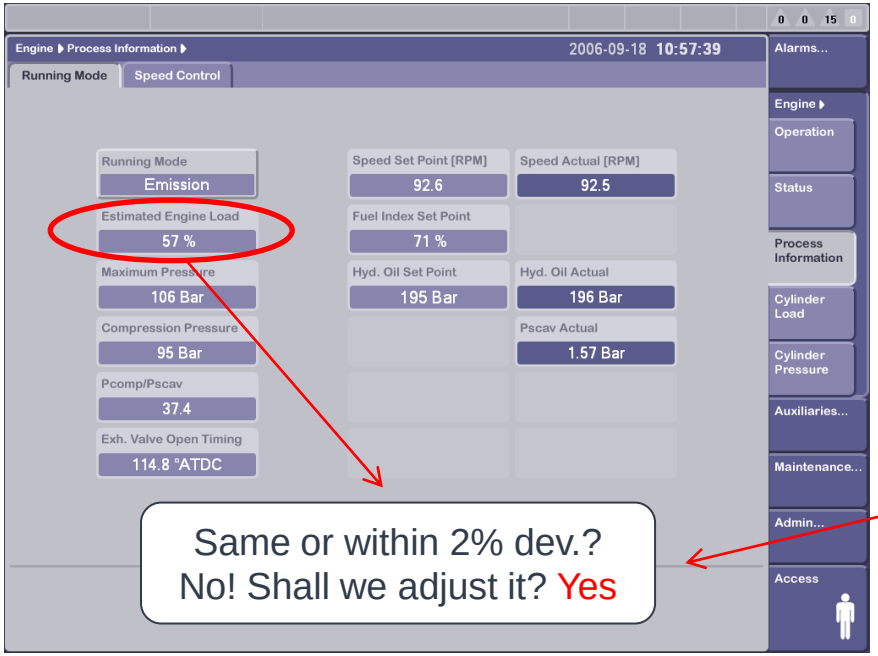
- Note that any process adjustments (Pmax, Pi, Pcomp/Pscav adjustments) will not take effect if the governor mode is in Index Mode.
  Index Mode freezes all these variables (injection timing, injection amount, exh. v/v close and open timing) in order to give good conditions for a measurement.
  Therefore the user must choose RPM mode before doing the changes.

- **Always confirm your adjustment after single adjustment.**

Note that auto-tuning does not compensate an excessively worn fuel pump or other abnormal operating conditions.

Estimated engine load adjustment

Step 1. Take a PMI measurement and check estimated engine load on MOP. If the deviation is bigger than 2% deviation, it can be corrected via fuel quality on the MOP screen.



- This picture is not from actual vessel on the right side.

Cylinder Number	p(i) [bar]	p(comp) [bar]	p(max) [bar]	p(comp)*/ p(scav)* [-]	Engine Speed [rpm]	Effective Power [ekW]	Effective Power [bhp]
1	10.46	96.9	110.2	35.3	84.4	2410	3277
2	11.26	96.5	111.9	35.2	84.4	2615	3555
3	11.02	96.3	109.9	35.1	84.4	2553	3471
4						3169	4309
5						2900	3943
6						3214	4370
7						3300	4487
8						3020	4107
9						3026	4114
10						3108	4225
11						3164	4301
12						2640	3589
Mean						2927	3979
Total						35118	47747

14	Test Date	Test Hour	Load		
15					
16	(yyyy-mm-dd)	(hh:mm)	%		
17	2012-05-27	10:00	49,26		
18	Effective Power (Calculate)	Indicated Power	Eff. Fuel Consumption		
19					
20	kW	kW	g/kWh		
21	35338	35568	194,66		
22	Cylinder No.		1	2	3
23	Pi, bar		10,46	11,26	11,02
24	Pmax, bar		110,2	111,9	109,9

- Load% can be calculated by performance sheet
- 12K98ME-C, 49% load, 18000 RH

Note: Too high deviation between internal load estimation and external load will influence the cylinder lubrication, engine performance, load and scavenging limiters.

Estimated engine load adjustment

Step 2. Check and adjust the estimated engine load on MOP as described below.

A. Manually enter the lower calorific value and density@15°C. (See fuel oil analysis report.)

B. Automatically 'Calculated Fuel Quality Offset' will take place.

C. Manually adjust 'Applied Fuel Quality Offset' same as 'Calculated Fuel Quality Offset'.

D. Measure engine load% with Torque meter (or PMI system).

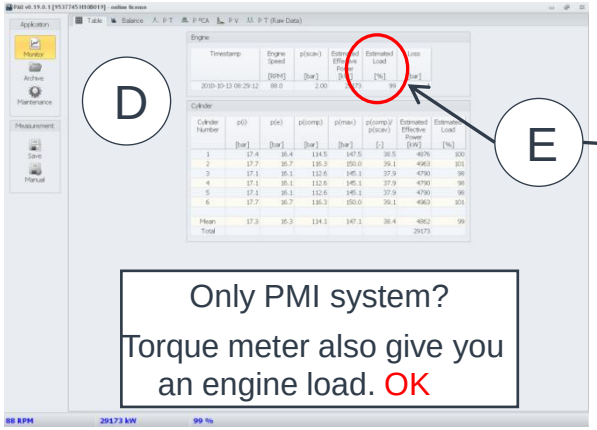
E. Compare estimated engine load% on MOP with Torque meter (or PMI system).

F. Manually adjust 'Applied Fuel Quality Offset' to make the estimated engine load on MOP the same as the load measurement on Torque meter (or PMI system).

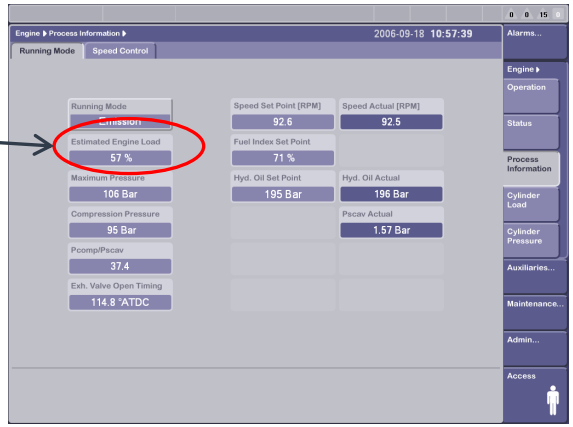
G. Repeat E and F until the difference between estimated engine load on MOP and PMI system is within 2%.

G

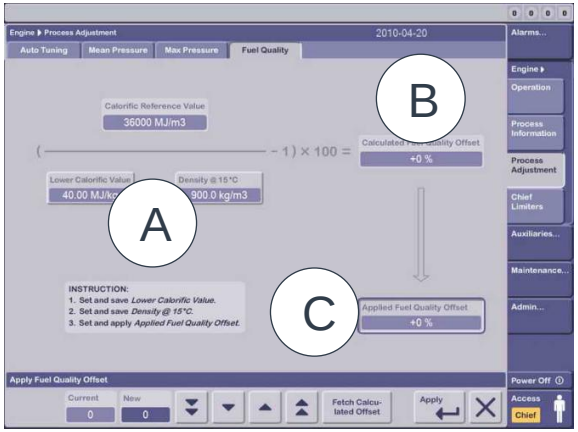
If est. engine load adjustment is done, Pcomp, Pi and Pmax may be adjusted.



<PMI System>



<MOP/Engine/Process Information>



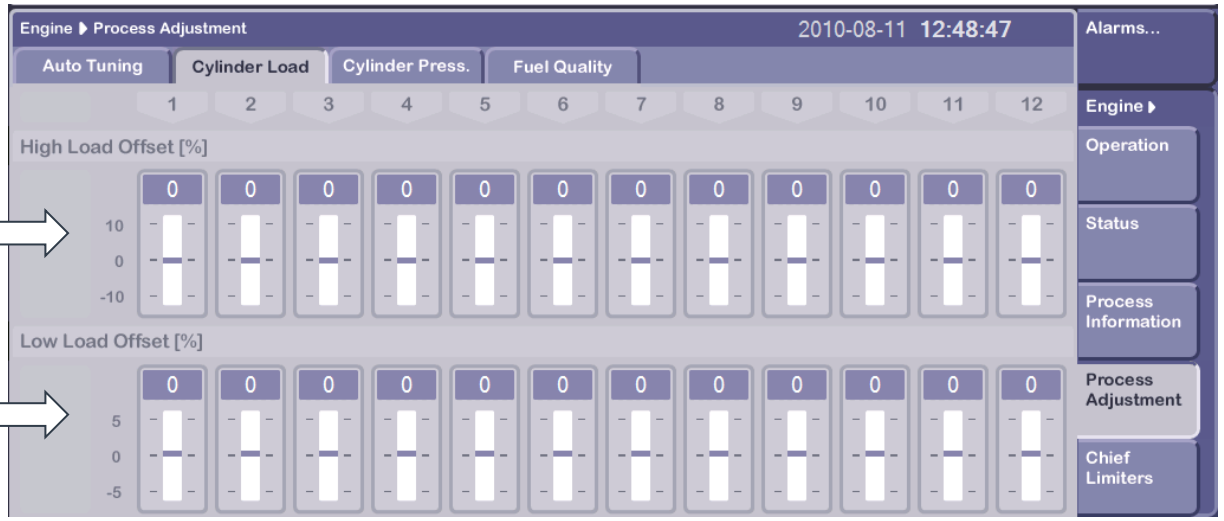
<MOP/Engine/Process Adjustment>

MOP Screens for a manual adjustment

- MOP screens are used for manual adjustment

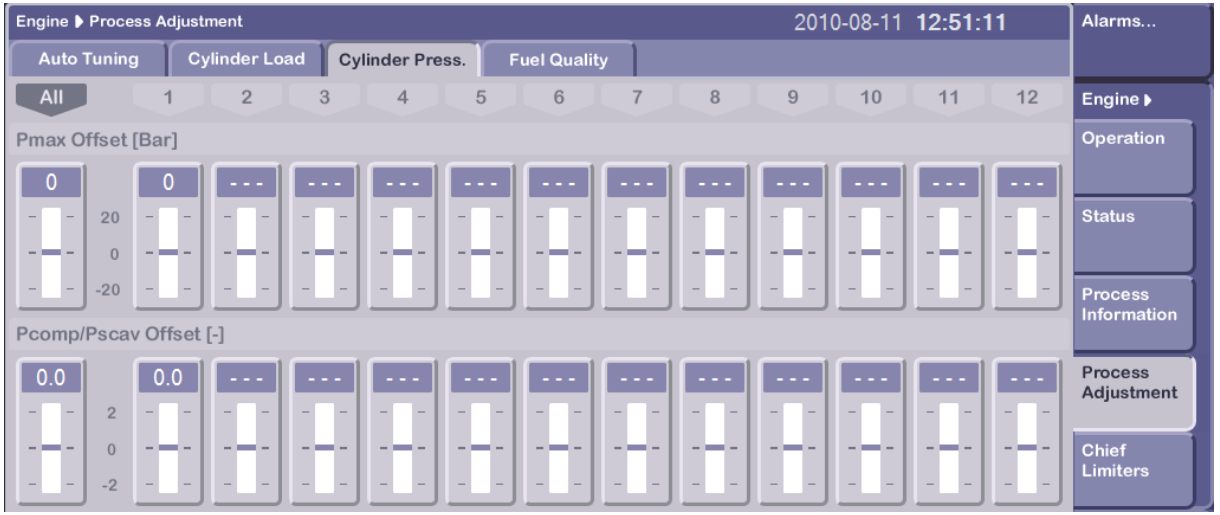
Fuel Index offset (Pi) at High Load in %.

Fuel Index offset (Pi) at Low Load in %



Pmax: Timing of fuel injection (corresponding to VIT)

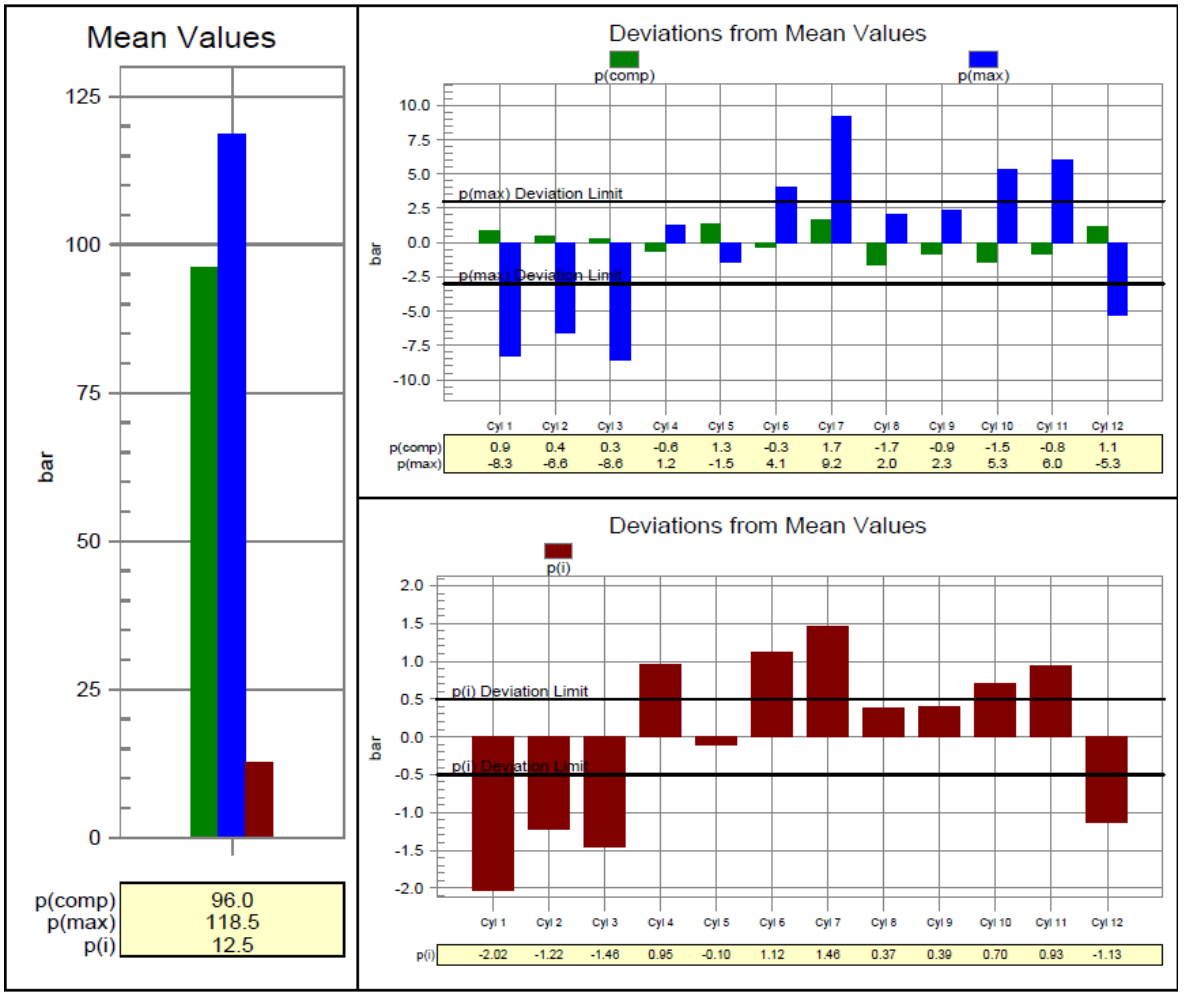
Adjustment of exhaust valve closing time



Performance evaluation

Step 3. Take a engine performance

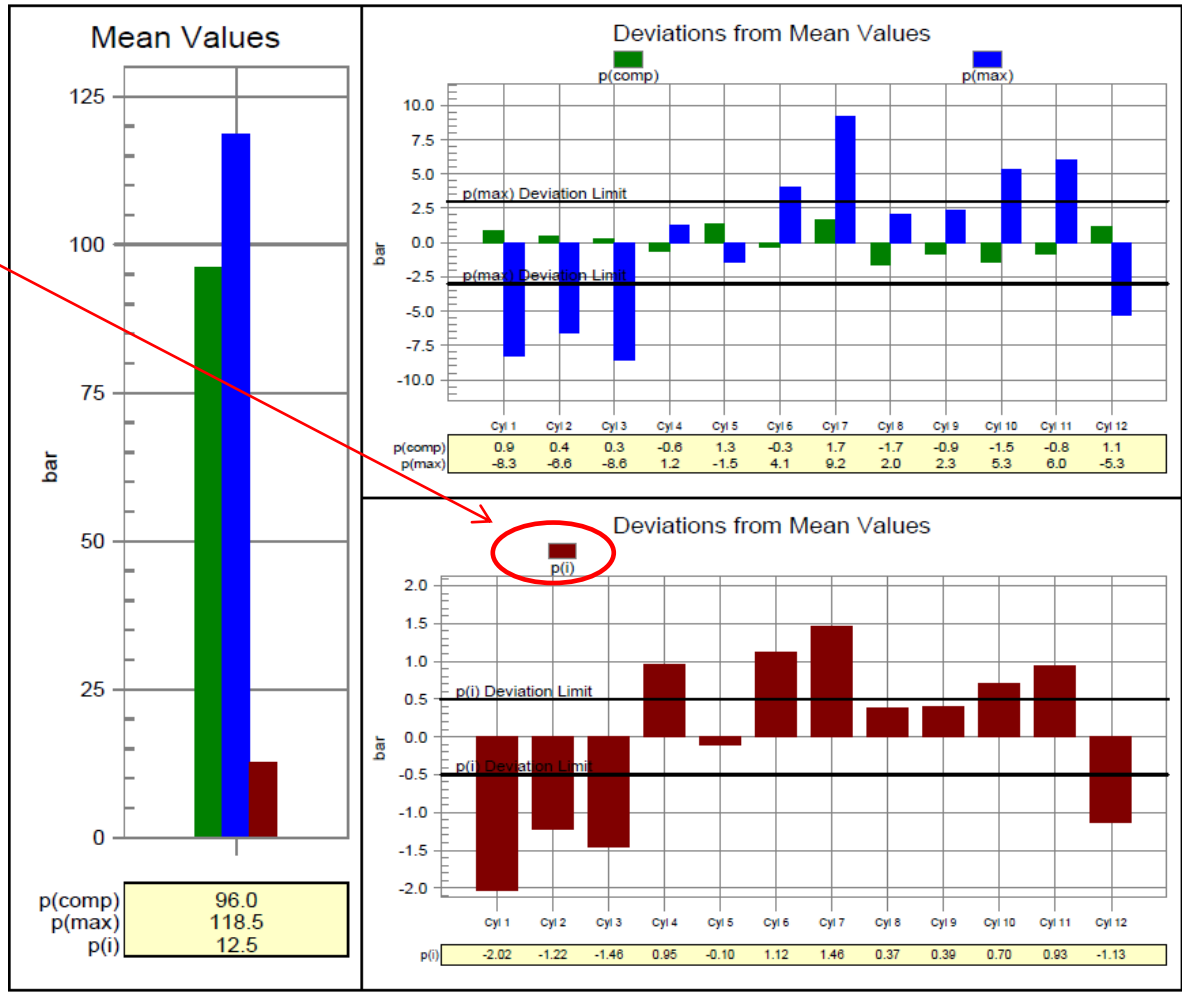
- Let's say that the graph from PMI measurement is for our engine.
- Can you see which engine parameter (Pi, Pcomp and Pmax) is necessary to be adjusted?
- 12K98ME-C, 49% load, 18000 RH



Pi Adjustment

Step 4. Based on the performance evaluation, let's do Pi adjustment first.

- Is Pi balanced within the tolerance (+/-) 0.5 bar on the right picture? No.
- Is the deviation too big? Yes
- If the deviation is very high and it will be necessary to make extreme adjustments on the MOP in order to get an acceptable output, Pmax, Pcomp, Pi. There is something mechanical wrong.
- 12K98ME-C, 49% load, 18000 RH



Pi Adjustment

▪Pi can be adjusted by using high or low load offset button on MOP.

- Pi tuning:

High(low) load offset=

(Δ Pi/Pi-mean value)X100

- Example)

Decrease 0.5 bar on No.4 cyl.

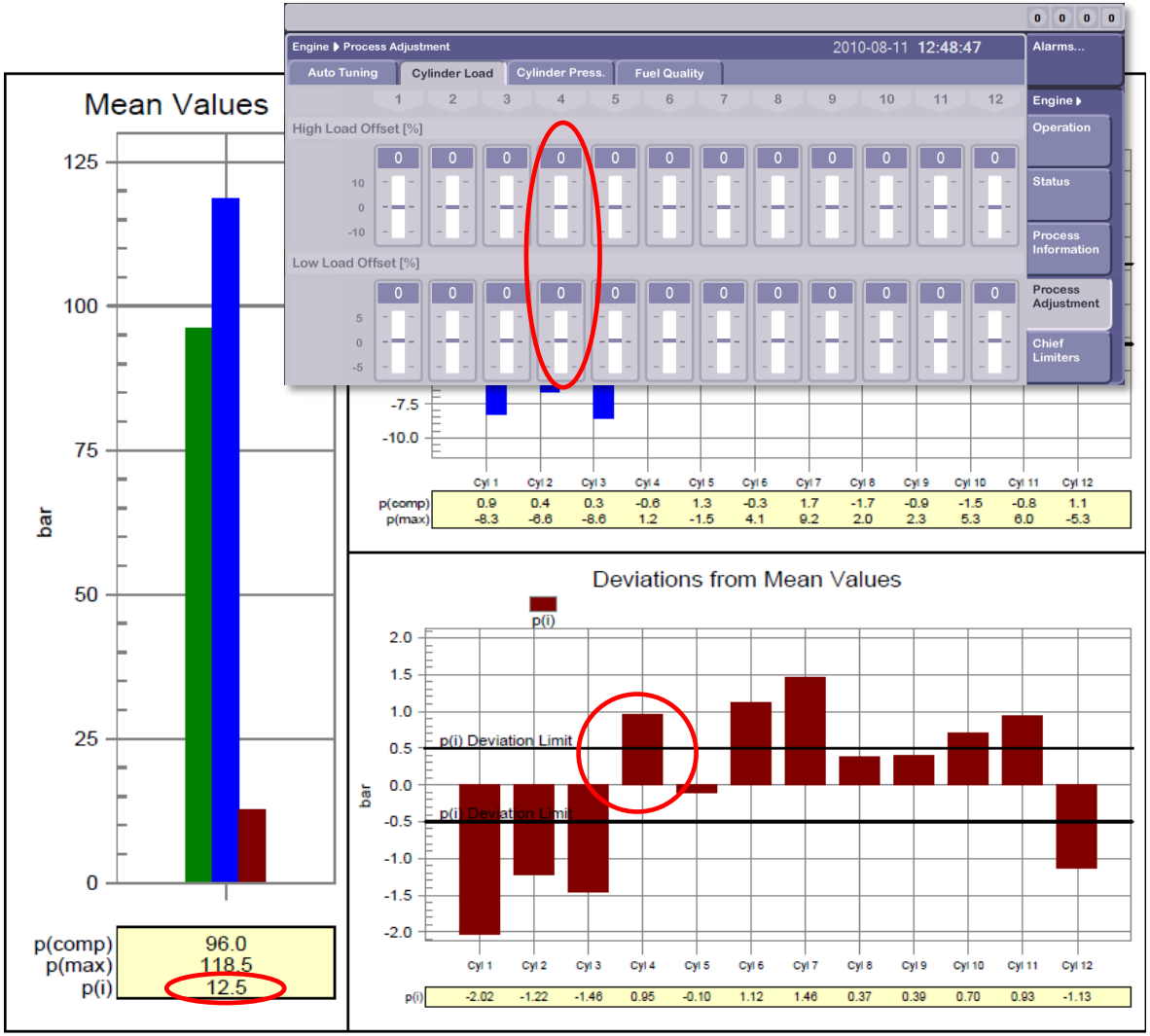
Offset=-0.5/12.5X100= (-4.0)

Enter (-4.0) to high(low) load offset on the cyl. No.4 on MOP

But, high load offset or Low load offset?

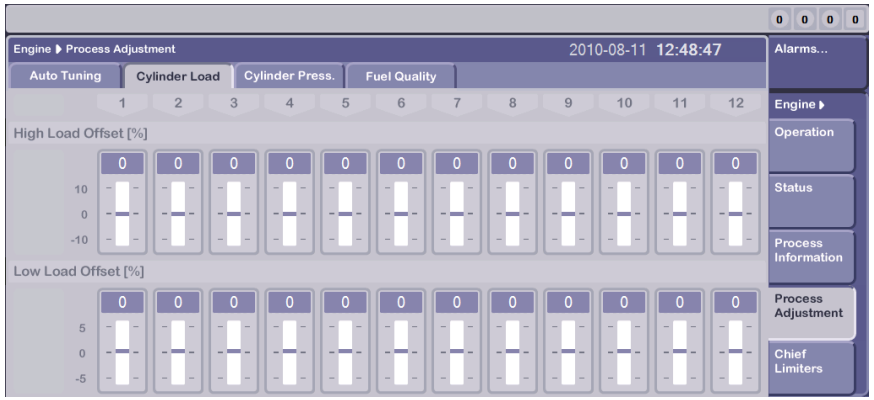
See the next slide.

- 12K98ME-C, 49% load, 18000 RH



Pi Adjustment

- There are high load offset and low load offset buttons to adjust Pi.



- If the load is higher than 50%, “High load offset” is used. High load offset will little change Pi at low load.

- If the load is below 50%, “Low load offset” is used. Low load offset will little change Pi at high load.

Pi must not be adjusted on the basis of the exhaust gas temperatures after each exhaust valve.

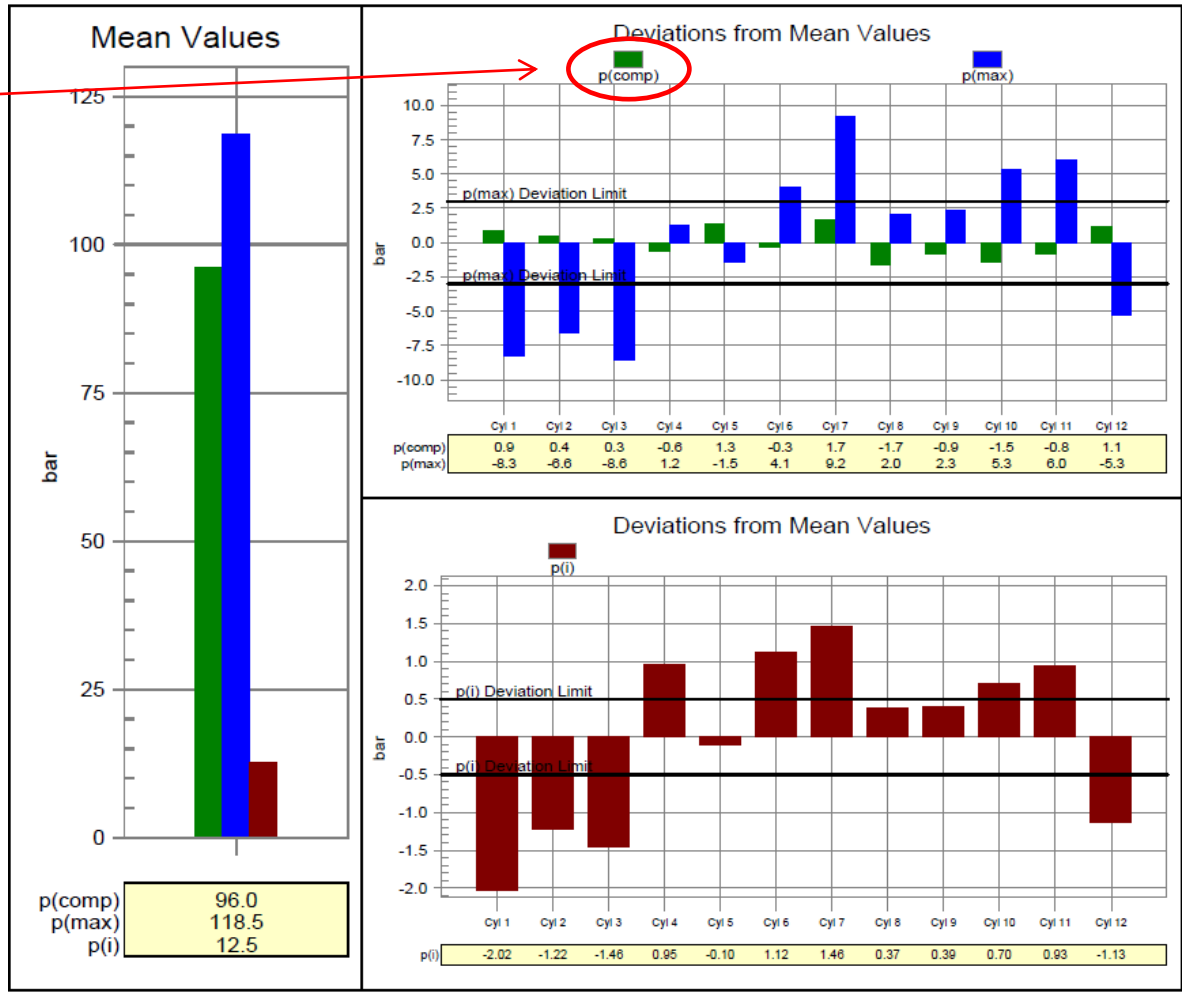
Increased Exhaust Temperature Level – Fault Diagnosing

Possible Causes	Diagnosing
a. Fuel injection equipment: – Leaking or incorrectly working fuel valves (defective spindle and seat) – Worn fuel pumps. If a high wear rate occurs, the cause for this must be found and remedied. **Note**: Inadequate cleaning of the fuel oil can cause defective fuel valves and worn fuel pumps.	As these faults occur in individual cylinders, compare: • fuel indexes • Indicator and draw diagrams *See Section 706-05.* Check the fuel valves: • visually • by pressure testing.
b. Cylinder condition: – Blow-by, piston rings *See also Chapter 703, Item ‘4.1, Running Difficulties’, point 7.* – Leaking exhaust valves *See also Chapter 703, Item ‘4.1, Running Difficulties’, point 6.*	These faults occur in individual cylinders. • Compare the compression pressures from the indicator and draw diagrams. *See Section 706-05.* • During engine standstill: Carry out scavenge port inspection. *See Section 707-01.* Check the exhaust valves.
c. Air coolers: – Fouled air side – Fouled water side	Check the cooling capability. *See Section 706-02.*
d. Climatic conditions: – Extreme conditions	Check cooling water and engine room temperatures. Correct T_{exhv} to reference conditions. *See Section 706-06.*
e. Turbocharger: – Fouling of turbine side – Fouling of compressor side	Use the turbocharger synopsis methods for diagnosing. *See Section 706-02.*
f. Fuel oil: – Type – Quality	Using heavy fuel oil will normally increase T_{exhv} by approx. 15°C, compared to the use of gas oil. Further increase of T_{exhv} will occur when using fuel oils with particularly poor combustion properties. In this case, a reduction of p_{max} can also occur.

Pcomp Adjustment

Step 5. Take new engine performance if any adjustment is done on the previous slide.

- Is P_{comp} within the tolerance (+/-3) bar on the right picture? Yes.
- Note it is usually not necessary to adjust P_{comp}.
- If Pcomp is unbalanced, you may need to first check the mechanical defect before any adjustment.
- See next slide.
- 12K98ME-C, 49% load, 18000 RH



Pcomp Adjustment

- Let's check the mechanical parts first prior to the adjustment as shown on the right.
- If you think that Pcomp adjustment is really necessary, see the next slide.

Mechanical Defects which can influence the Compression Pressure

Possible Causes	Diagnosis / Remedy
a. Piston rings: – Leaking	Diagnosis: *See Table Increased Exhaust Temperature Level – Fault Diagnosing* *Remedy: See Section 703-04.*
b. Piston crown: – Burnt	Check the piston crown by means of the template. *See Vol. II, Procedure 902-3.*
c. Cylinder liner: – Worn	Check the liner by means of the measuring tool. *See Vol. II, Procedure 903-2.*
d. Exhaust valve: – Leaking – The exhaust temperature rises. – A hissing sound can possibly be heard at reduced load. – Timing	Remedy: *See Section 703-04.* Check: – Hydraulic oil leakages, e.g. misalignment of high pressure pipe between exhaust valve actuator and hydraulic cylinder. – Damper arrangement for exhaust valve closing.
e. Piston rod stuffing box: – Leaking – Air is emitted from the check funnel from the stuffing box.	Small leakages may occur due to erosion of the bronze segments of the stuffing box, but this is normally considered a cosmetic phenomenon. *Remedy: Overhaul the stuffing box, see Vol. II, Chapter 902.*

<Operation manual 70602 Evaluation of Record>

Pcomp Adjustment

- How much of Pcomp. Would you like to adjust? Increase or decrease?
- $P_{,comp}$ tuning is done by entering a compression ratio Offset:

$$C_{,Ratio} = \Delta P_{Comp} / (P_{Scav}+1)$$

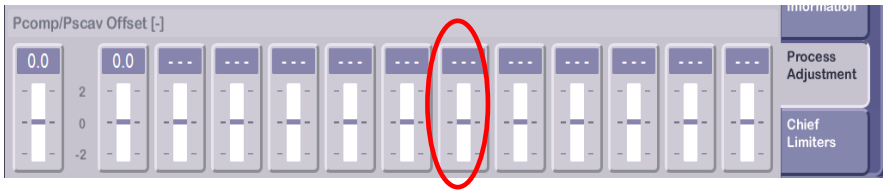
(Reading from P.scav sensor is corrected to Absolute value by adding athmospheric pressure, 1 bar)

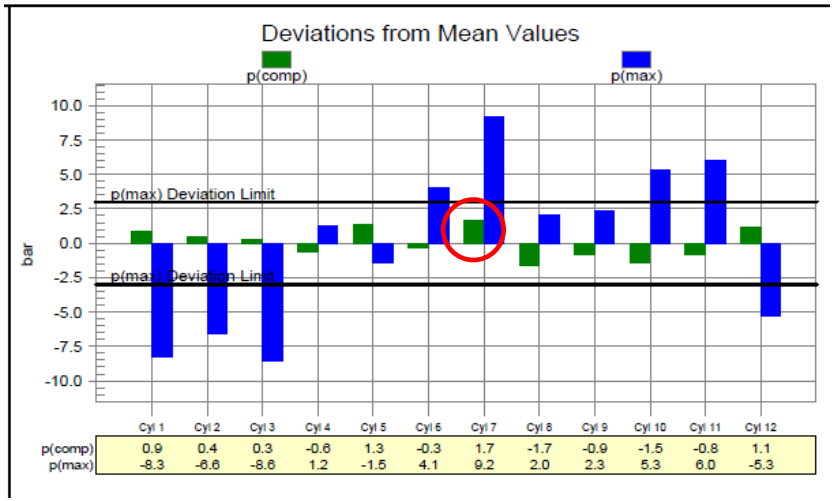
- Example)

Decrease Pcomp on No. 7 cyl. 1.7 bar.

C.Ratio= -1.7/(1.77+1)=-1.7/2.77=-0.6

Enter (-0.6) by using Pcomp/Pscav button on No. 7 cyl. on MOP.





Cylinder Number	p(i) [bar]	p(comp) [bar]	p(max) [bar]	p(comp)*/ p(scav)* [-]	Engine Speed [rpm]	Effective Power [ekW]	Effective Power [bhp]
1	10.46	96.9	110.2	35.3	84.4	2410	3277
2	11.26	96.5	111.9	35.2	84.4	2615	3555
3	11.02	96.3	109.9	35.1	84.4	2553	3471
4	13.44	95.4	119.7	34.8	84.4	3169	4309
5	12.38	97.4	117.0	35.5	84.4	2900	3943
6	13.61	95.7	122.5	34.9	84.5	3214	4370
7	13.94	97.7	127.7	35.6	84.5	3300	4487
8	12.85	94.4	120.5	34.4	84.4	3020	4107
9	12.87	95.1	120.8	34.7	84.4	3026	4114
10	13.19	94.6	123.8	34.5	84.5	3108	4225
11	13.42	95.2	124.5	34.7	84.4	3164	4301
12	11.35	97.1	113.2	35.4	84.5	2640	3589
Mean	12.48	96.0	118.5	35.0	84.5	2927	3979
Total						35118	47747

p(scav) = 1.77 bar

*=abs.

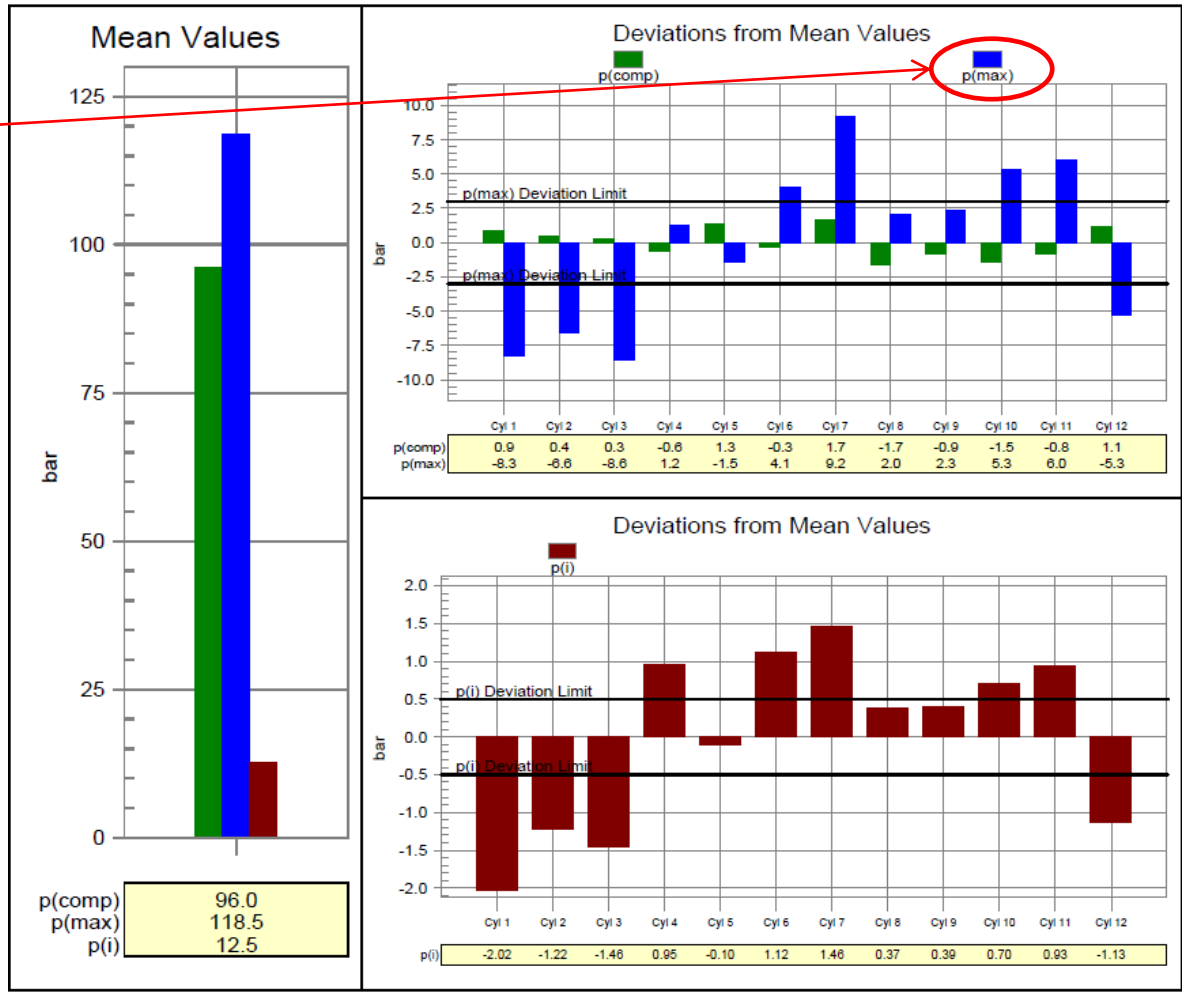
Pmax Adjustment

Step 6. Take new engine performance if any adjustment is done on the previous slide.

- Is the Pmax balanced within the tolerance (+/-) 3 bar on the right picture? No.
- Is the deviation too big? Yes
- It will be a good idea to check the fuel injection equipment in this case. i.e. worn fuel pump, leaking suction valve, defected fuel valve and etc.

Note that worn fuel pump or other abnormal operating conditions cannot be compensated.

- 12K98ME-C, 49% load, 18000 RH



Pmax Adjustment

- Pmax can be adjusted by entering Pmax bar directly to Pmax button on MOP.

- Example)

Decrease 2.0 bar on No.6 cyl.

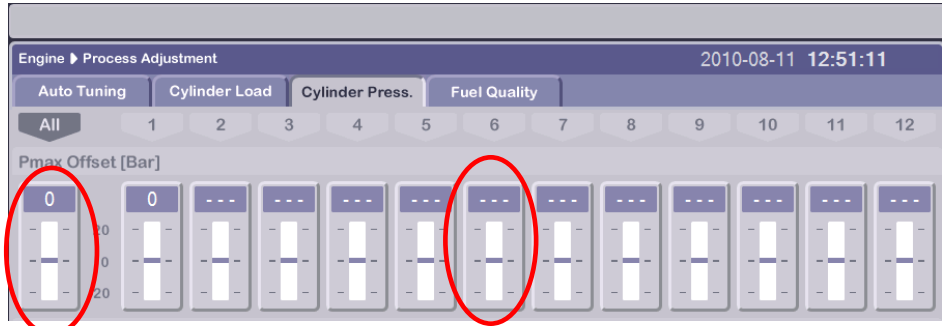
Enter (-2.0) to Pmax on the cyl. No.4 on MOP

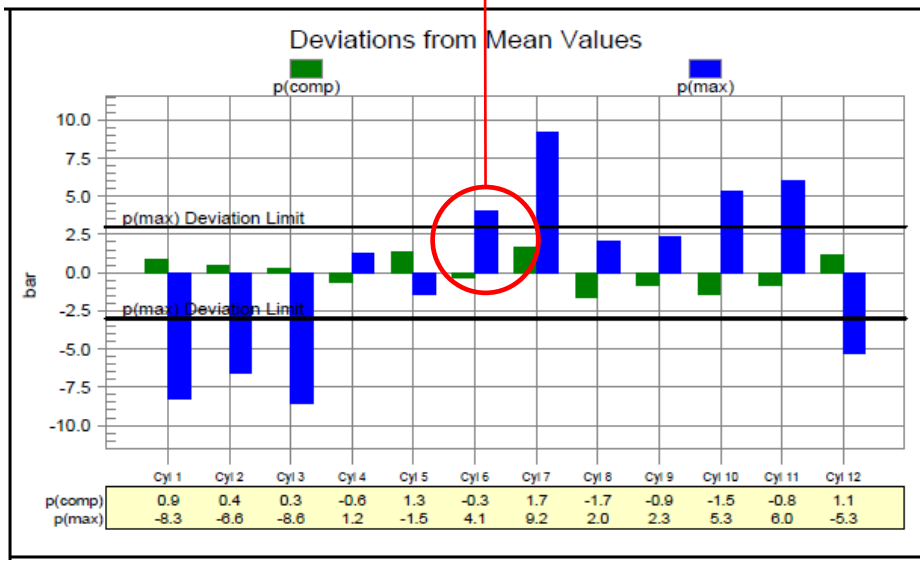
- **Applying an offset in Pmax at low load below break point, may lead to too high Pmax at high engine loads.**

- **It is required for safe engine operation to check the maximum pressures and re-adjust if necessary when engine load is increased.**

- **The "Pmax offset all" function is intended used when engine is running above Pmax Break Point. Executed at lower loads, it is required for safe engine operation to check the maximum pressure and re-adjust if necessary when engine load is increased.**

- 12K98ME-C, 49% load, 18000 RH



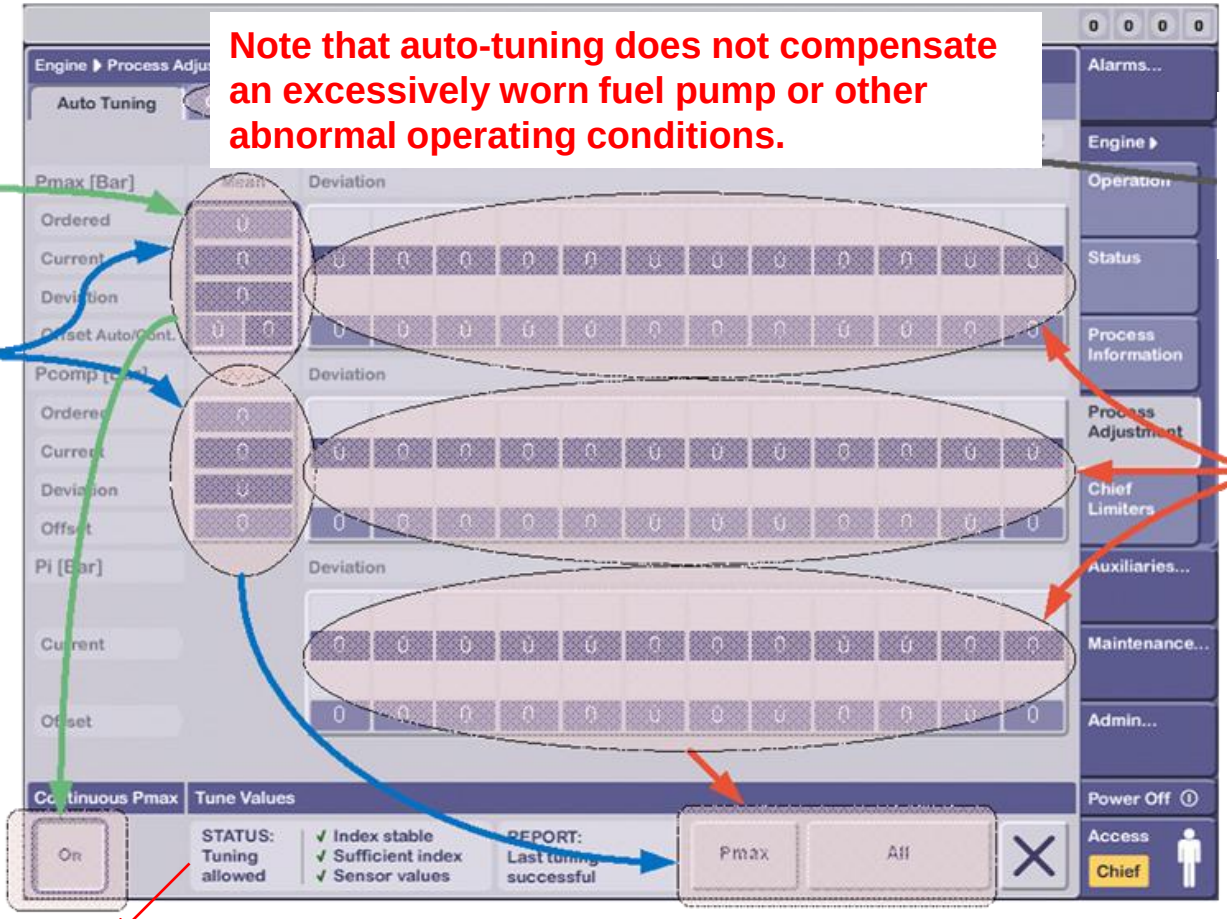


PMI Auto-tuning System

Note that auto-tuning does not compensate an excessively worn fuel pump or other abnormal operating conditions.

3. Contiuous Pmax

2. Auto mean level

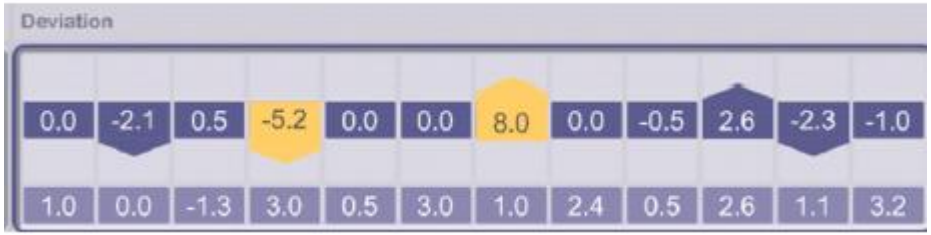


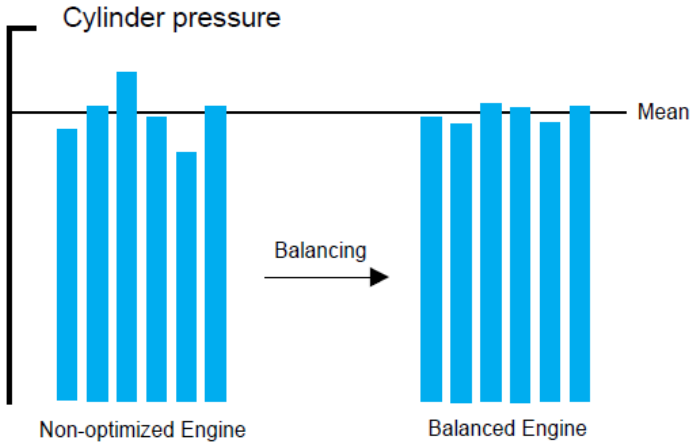
1. Auto balancing

- Index is stable: Engine is in steady state operation, indicated by a stable governor index
- Index is sufficient: Index is above minimum required level (app. 25% load, can be plant dependent)
- Sensor values: Valid sensor values are available from the PMI auto-tuning system and deviation between cylinders as well as towards the reference are not too large

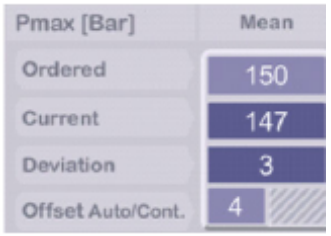
PMI Auto-tuning System

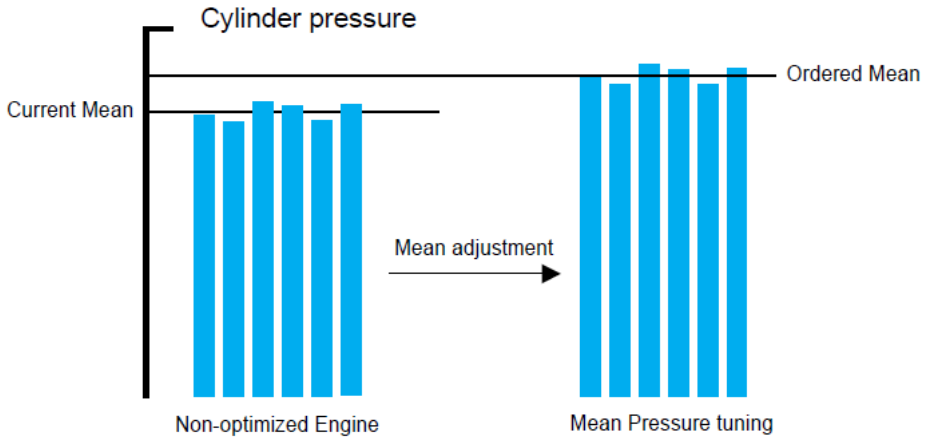
- Balancing cylinder pressures to minimize deviation from mean





- Adjusting cylinder mean pressures to ensure engine operation at the “ordered” (design) level.





PMI Auto-tuning System

1. Adjust Pi deviation

Only Pi deviation is available for adjustment.

a. Select the Pi deviation panel.
b. Press the Pi button, then wait to view the results.
c. Repeat step b, if the Pi deviation between cylinders need further adjustment.

Pi [Bar]	Deviation										
Current	0.2	0.1	-0.5	-0.1	-0.1	0.0	0.1	0.3	0.0	0.0	-0.1	0.1
Offset	0.6	2.2	-1.8	0.6	0.9	3.0	0.0	0.8	-3.0	0.5	-1.0	2.8

PMI Auto-tuning System

2. Adjust Pcomp deviation and mean

a. Select the Pcomp deviation panel (see Figure 10).
b. Press the Pcomp button, and then wait to view the results.
c. Repeat step b, if the Pcomp deviation between cylinders need further adjustment.

Pcomp [Bar]	Mean	Deviation										
Ordered	125											
Current	122	-2.1	-0.8	0.0	-0.5	-2.8	4.0	0.4	0.6	2.5	-0.9	-0.5	0.1
Deviation	3											
Offset	5	3.0	-2.2	-2.1	0.6	-1.2	2.3	-0.9	2.9	1.1	4.1	1.1	-3.5

d. Select the Pcomp mean panel.
e. Press the Pcomp button, then wait to view the results.
f. Repeat step e, if the Pcomp mean values need further adjustment.

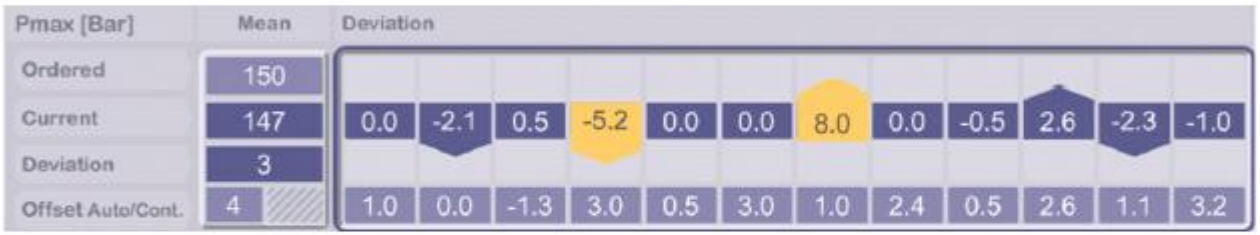
Pcomp [Bar]	Mean
Ordered	125
Current	122
Deviation	3
Offset	5

PMI Auto-tuning System

3. Adjust Pmax deviation and mean

The procedure below follows the adjustment of Pcomp deviation and mean, but this time the Pmax deviation and mean panel is selected.

a. Select the Pmax deviation panel.
b. Press the Pmax button, and then wait to view the results.
c. Repeat step b, if the Pmax deviation between cylinders need further adjustment.



d. Select the Pmax mean panel.
e. Press the Pmax button, and then wait to view the results.
f. Repeat step e, if the Pmax mean values need further adjustment.

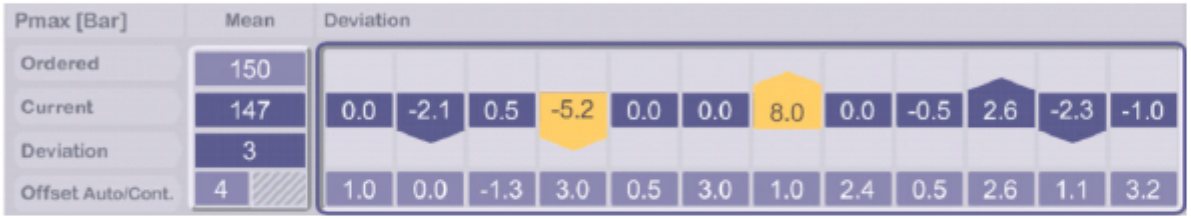
PMI Auto-tuning System

4. Adjust All

The 'All' button will adjust all the mean values or balance all the deviation parameters at the same time, i.e. Pmax and Pcomp mean or Pmax, Pcomp and Pi deviation.

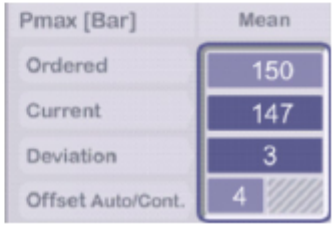
Adjustment of deviation:

a. Select either the Pmax or Pcomp deviation panel.
b. Press the "All" button, then wait to view the results.
c. Repeat step b, if the Pmax and/or Pcomp deviation between cylinders need further adjustment.



Adjustment of mean values:

a. Select the Pmax or Pcomp mean panel.
b. Press the All button, and then wait to view the results.
c. Repeat step b, if the Pmax and/or Pcomp mean values need further adjustment.

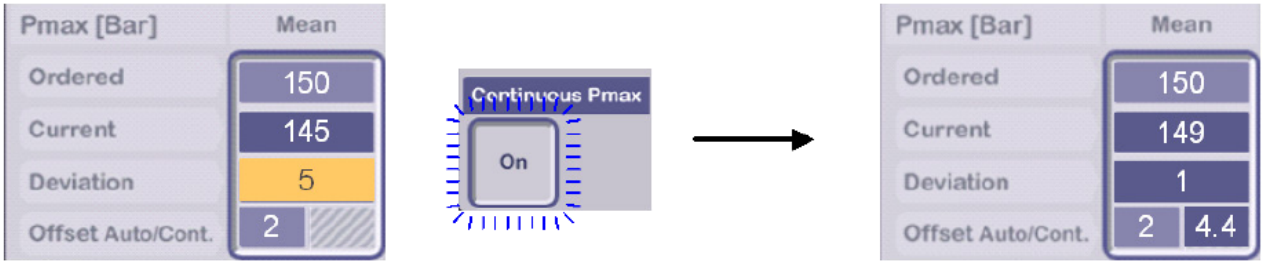


PMI Auto-tuning System

5. Continuous Pmax

When continuous Pmax tuning is enabled, it will continuously adjust the mean Pmax level so that the difference between the actual and reference value for the specific load is reduced. Therefore, any changes in ambient conditions and fuel oil qulaity are compensated. Continuous Pmax tuning is only available if the system status indicates "Tuning allowed". Tuning is allowed only if index is stable, sufficient, i.e. above 70%, and sensor values are valid.

a. Select the Pmax mean panel.
b. Press the “Continuous Pmax” button, and then wait to view the results.
c. The ‘Cont’ field will now be enabled and display the incremental adjustments to Pmax introduced by continuous Pmax tuning



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This data serves informational purposes only and is especially not guaranteed in any way.

Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.