SERVICE REPORT

Major Overhaul 18K

February 2014

40024

ACP – Miraflores Power Station

Index

1. Basic data

Plant: Miraflores Power Station
Customer: ACP
Contract reference: TSA

Period: February 2014

Participants:

ACP
Site manager: Mr V. Serna
Mechanical Manager: Mr Roderick Vargas
Mech Supervisor: Mr Clinton Henry
Mech Foreman: Mr Damian Navarro

BWSC
Supervisor: Mr Robert Erkens
Mechanical Engineer: Mr Jonas Mertz
Project Manager: Mr Jørn P. Brøste
TSA Engineer: Mr Boguslaw Trzcinski

2. Technical systems

Diesel engine
Maker: MAN Augsburg
Type: 18V 48/60
Serial No.: 1 135 123
Engine No.: DE-6
Year: 2002
Running hours: 83916

TC
Maker: MAN Augsburg
Type: NA48/S-M 1033 A
Serial No.: 1 150 610 / 611
Year: 2002
Running hours: 83916

Generator
Maker: ABB
Type: AMG 1600UU14 LSED
Serial No.: 4569892
Year: 2002
Running hours: 83916
Lube oil system: from engine

3. Scope of work

90 K major overhaul in accordance with MAN maintenance engine schedule.

4. Executive summary

Dear Sirs,

The following is the report covering the mechanical work carried out during the major overhaul on unit DE-6.
The major overhaul was started on Monday 3 February 2014.

Engine DE-6 could not run full load due to high exhaust gas temperature and high RPM speed on both turbochargers.

Only the essential pictures have been implemented in this report.

The engine had been running from latest major overhaul (72K) 6 July 2012. At that point, the running hours were 71551. The engine was stopped for this overhaul with 83916 running hours; a total of 12365 hours.

5. Work and inspections carried out

Rocker arms, removal and inspection.
Cylinder heads removal, overhaul and inspection.
Piston removal, overhaul and inspection.
Piston skirts exchanged with new as per MAN CUS 227
Cylinder liners removal, replaced with new.
Main bearings removal, replaced with new.
Camshaft bearings removal, replaced with new.
Fuel injection pumps removal of two pieces for inspection.
Fuel injection valve removal, overhaul and inspection.
Charge air coolers overhaul.
Turbocharger inspection.
Vulkan coupling inspection
Overhaul inspection of the central water cooler.

6. Findings, wear, problems, comments

6.1. Rocker arms

All rocker arms were removed from the engine for cleaning, and one on each side was inspected.
The two rocker arm casings A5 and B2 were dismantled for inspection of the shafts and bearing; measurements were taken. The wear pattern of the bearing shows a normal condition. Also the shaft has a normal wear pattern. See enclosure No. 1.

6.2. Cylinder heads

All cylinder heads were dismantled for cleaning and overhaul.
Inlet valves, exhaust valves, exhaust cages, fuel injectors and starting air valves were removed for their individual overhaul.

Inlet valves B2 had blow-by markings, and two were found with too high run out. These valves were replaced with new ones. See enclosure No. 2.

Exhaust valves: 20 pieces were rejected; of these, 12 valves had scuffing marking on the stem, 6 had pitting marking in the lower area of the valve, 1 had a too large burn away area, and 1 was found with a high run out. See enclosure No. 3.
A MAN specialist of the Panama MAN office was called and asked to give a second opinion as per ACP request.
The specialist concluded that the valves could not be used for further operation, which was in line with BWSC's recommendation.
See attached report from MAN.


Exhaust valve with scuffing markings


Exhaust valve with pitting markings

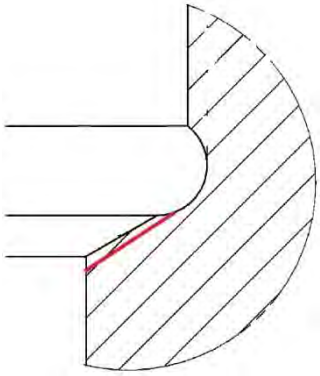
All exhaust cages were cleaned by means of sand blasting, and lapping of the sealing area was performed. One cage was rejected as the seat was cracked.

All starting air valves were overhauled and fitted with new O-rings.

Fuel injectors will be overhauled at a later date since overhauled injectors with new nozzles were installed instead.

All cylinder heads were cleaned and inspected.
The following cylinder heads were rejected; A2, A4, B2 and B7 due to the landing surface of the exhaust cage being worn down below the limit.


The grey ring is the landing surface for the exhaust valve cage.


When the rounding is even with the landing surface the cyl head is rejected and needs to be reconditioned.

Cyl	Out	Cyl	In
A2	1276584	A2	1276576 Order No.1171049
A4	1277164	A4	1277295
B2	1277077	B2	1276672 Order No. 1171047
B7	1277040	B7	2270335 Order No. 1171048

Cylinder head A4 is a complete cylinder head overhauled by ACP crew. The other three are only the naked cylinder heads.

All valve seats were machined by means of the cutting machine.

6.3. Pistons

All piston crowns were removed from the skirts, the crowns were cleaned and inspected, and the grooves were measured. See enclosure No. 4.
All piston grooves were within tolerance.
The new piston rings were also measured for later reference. See enclosure No. 5.

Of the 18 guide shoes, 8 were found in bad condition. ACP ordered all of them changed.


Guide shoe


Guide shoe

The pistons were installed with new skirts and new piston rings.


All pistons ready for installation

6.4. Cylinder liners

All cylinder liners were renewed and measured; see enclosure No. 6.
The following three liners have been put aside due to low running hours:
B8 has 44232 running hours
B9 has 17169 running hours
A8 has 40320 running hours
NOTE: These liners need to be honed, cleaned and measured, preserved and packed in a box for further use as spare parts.

New liners ready for installation.

Liner lubrication was checked.

6.5. Main bearings

All main bearings were renewed, and the journals were slightly polished.
Main bearing clearance were measured, see enclosure No. 7.
Measurements of the main bearing studs' elongation were taken, see enclosure No. 8.

6.6. Cam shaft bearings

All camshaft bearings were renewed. The old bearing shells were still in good condition. Clearance measurements were taken, see enclosure No. 7.

6.7. Fuel pump and drive unit

Fuel pump B4 was removed from the engine for inspection and also the drive unit.
The pump was dismantled in the fuel workshop and a normal wear pattern visible on the plunger. The fuel pump was cleaned and assembled with new O-ring and seals.
The drive unit was dismantled and inspected; no abnormalities were found. The unit was reassembled and installed in the engine.

6.8. Fuel injector valves

Reconditioned injector valves with new nozzle tips were installed; the removed injector valves will be overhauled at a later date.

6.9. Charge air coolers

Both charge air coolers were removed from the engine for cleaning.
The coolers have been in a bath for over 24 hours for cleaning. They were pressure tested and reassembled with the covers. Both coolers were assembled in the engine again.

6.10. Turbochargers

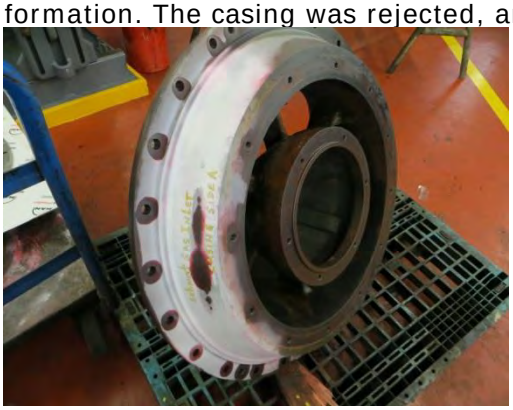
Both turbochargers were opened in both turbine side and compressor side for inspection and cleaning.
The nozzle rings were very dirty and were put in a water bath for several days. The final cleaning was done by means of sandblasting. Both nozzle rings were crack tested by NDT method dye-check. No cracks were found.
The shroud rings were replaced with new ones, and all bolts and lock washers were renewed.

Both compressor sides were cleaned and inspected; no abnormalities were found.


Nozzle ring before cleaning


Dye-check

The gas admission casing from "A" side turbocharger was found with a crack formation. The casing was rejected, and a new one was installed.


T/C "A" gas admission casing


Crack close up after exposure grinding

Turbocharger inspection sheet "A" side; see enclosure No. 9.
Turbocharger measuring sheet "A" side; see enclosure No. 10.
Turbocharger inspection sheet "B" side; see enclosure No. 11.
Turbocharger measuring sheet "B" side; see enclosure No. 12.

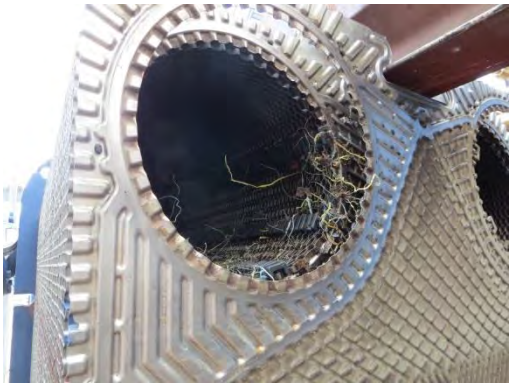
6.11. Vulkan coupling

The Vulkan coupling was inspected for cracks in the rubber elements, and the "S" measurements were taken.
The coupling was installed in March 2010 during the 55k overhaul. The coupling's running hours up till now are 28622 Hours.
The coupling is in good condition; no cracks were found in the rubber elements.
The measurements were taken; see enclosure No. 13.

6.12. Central cooler

The central cooler was opened up prior to Sondex specialist's arrival to site.
The central cooler was dirty but still in good condition. The latest inspection of the cooler was made in July 2009.
All plates were cleaned and removed from the unit for final inspection and to install new gaskets.

Plate on lake water side



Dirt on inlet side

The spacer ring between the water line and the cooler are in corroded condition. They have been put back as no new ones were available, why new ones need to be ordered for next overhaul.

Spacer ring in bad condition

Close up

7. Assembling of engine

New liners were installed with new O-rings.
The top land rings were reused and installed with new O-rings.
The pistons were installed with the reused piston crown, new skirts, new guide shoes and new O-rings.
Piston B7 also received all 8 new shank bolts, and piston A4 received one new shank bolt at location 8.
For measurement of tightening of the connection rod shank bolts' elongation see enclosure No. 14.
For piston alignment measurement sheet see enclosure No. 15.
Cylinder heads were installed with new O-rings and tightened in the correct order.

8. Start-up and performance test

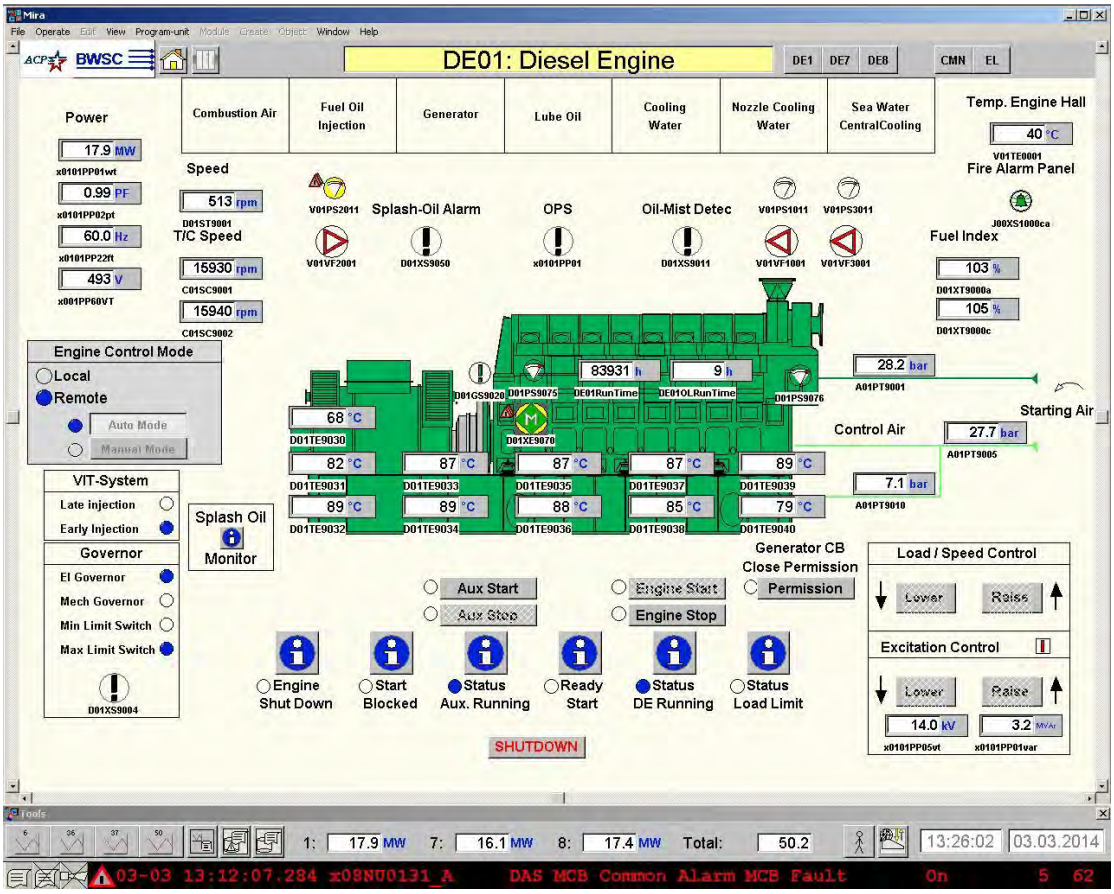
28 February, DE-6 was prepared for start-up. Cooling water was put on the engine and the pressure was raised; no leaks were detected. The pre-heater for the cooling water was turned on, and after several hours there were still no leaks. Nozzle cooling water was filled up; some small leaks were found on the connections, and these were tightened.
The engine was filled up with new oil and the separator with heating was started.
The night shift adjusted the valve clearance when the engine was around 45°C.

The two lube oil separators for De-6 had problems; the Alfa Laval unit was adding water into the oil and the Westfalia had high vibration alarms. The Westfalia unit was dismantled for inspection. The vertical shaft bearing had too much clearance and was replaced. The unit was restarted without any problems of vibration.
The oil had to be reheated.

1 March at 10:00 hours, BWSC inspected the back-flush filter for contamination. The filter unit was very dirty with pieces of paint, silicone and dust particles from the cleaning rags. A clean filter was installed and back- flush filter returned in operation. At 12:30, an inspection of the back-flush filter showed less dirt, but it was still not good enough for operation.
At 14:00 hours, the check of the back-flush filter showed no dirt inside the filter. Ok was given to prepare the engine for start-up.
At 16:15 hours, the unit was started up; no run alarm on splash oil sensor No. 2, as there was no temperature indication at all.
At 18:40, Instrumentation department checked the PT100 sensor which was found in good working condition. The cable was checked, and a loose connection was found.
At 19:15 hours, the engine was ready for the second start-up attempt. Start signal was given and the unit ran up to 150 RPM but was then shut down on "Over speed Protection".
Operation started the engine further twice, but the same alarm came up.
The instrumentation person was very tired and had already too many hours on site; consequently, operation called in a new person.
The RPM sensor was checked and found in good working condition, and an electrician was called in to check the cable. The problem cable was found damaged.
In the evening, the engine reached sufficient temperature, and the night shift took a web deflection. See enclosure No. 16.

2 March at 10:19, the unit was started without any problems.
The running in program was started; see enclosure No. 17.
Performance test at 50%; see enclosure No. 18.
Performance test at 75%; see enclosure No. 19.
At 20:32, DE-6 tripped on H/High lube oil temp after T/C "B".
The shift-charge operator could not get in contact with anyone from Instrumentation, and the engine was kept off until the next morning.

3 March, Instrumentation checked the two PT 100 sensors after T/C "B" side and found a loose connection.
The unit was started up again at 08:35, and breaker closed at 08:40 hours, the engine was slowly brought up to 85% load again to continue the running in program.
At 11:28, 100% load was reached, and a performance test was done; see enclosure No. 20.



9. Observations and recommendations

The following liners: A8, B8 and B9 still have a number of running hours left. They need to be honed and measured. The liners should be preserved and stored in a box for use as spare.
Four (4) cylinder heads were taken out of production, and they need to be sent to MAN for reconditioning of the exhaust cage landing surface.

10.List of pending items

There are no pending items. On behalf of BWSC A/S, we would like to thank ACP Miraflores Power Station for the good cooperation during the preparation and execution of this major overhaul.

Yours faithfully,

Burmeister & Wain Scandinavian Contractor A/S

Robert Erkens
Senior Mechanical Engineer

Rocker arm casing

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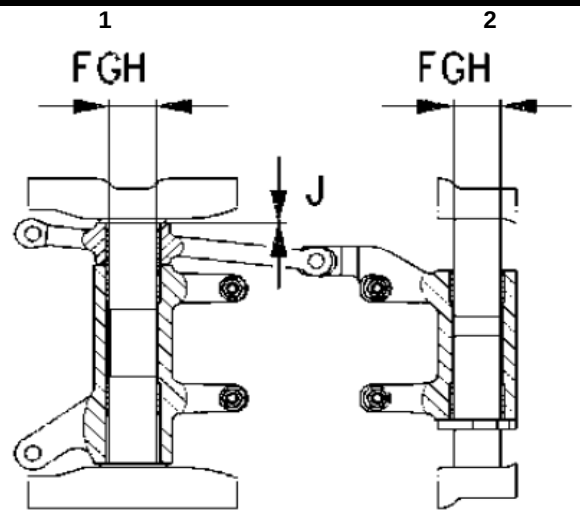
Author	
Name:	**Robert Erkens**
Department:	**TS 535**
Date:	**24 February 2014**

Engine	
Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**



		Max
F	90,00 +0,062 / -0,010	
G	0,084 - 0,156	0,18
H	90,00 -0,072 / -0,094	
J	0,600 - 2,100	

A Cylinder No.:		1	2	3	4	5	6	7	8	9
Bushing										
F	1					**90,04**				
	2					**90,06**				
Shaft										
H	1					**89,92**				
	2					**89,92**				
Clearance gap										
G	1					**0,12**				
	2					**0,14**				
Clearance gap										
J	1					**1,25**				

B Cylinder No.:		1	2	3	4	5	6	7	8	9
Bushing										
F	1		**90,05**							
	2		**90,06**							
Shaft										
H	1		**89,92**							
	2		**89,92**							
Clearance gap										
G	1		**0,13**							
	2		**0,14**							
Clearance gap										
J	1		**1,25**							

Remark:

Inlet valve cone

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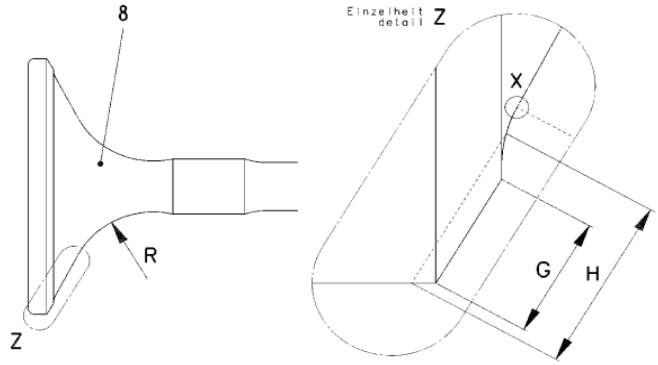
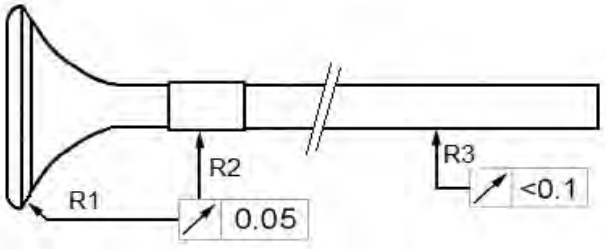
Author	
Name:	**Robert Erkens**
Department:	**TS-535**
Date:	**25 February 2014**

Engine	
Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**





G Measurement new **11,5** R1 / R2 **0,05**
H maximum **16** R3 **0,1**

Cyl No.:		B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,2**	**11,4**	**0,035**	**0,04**	**0,02**	
	Valve DE	**11,2**	**11,45**	**0,045**	**0,04**	**0,07**	
Cyl No.:	**A2**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,2**	**11,5**	**0,02**	**0,02**	**0,03**	
	Valve DE	**11,2**	**11,5**	**0,015**	**0,02**	**0,03**	
Cyl No.:	**A3**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,3**	**11,75**	**0,03**	**0,05**	**0,06**	
	Valve DE	**11,25**	**11,45**	**0,05**	**0,05**	**0,02**	
Cyl No.:	**A4**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,1**	**11,9**	**0,02**	**0,02**	**0,01**	
	Valve DE	**11,1**	**11,55**	**0,05**	**0,05**	**0,03**	
Cyl No.:	**A5**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,1**	**11,5**	**0,02**	**0,03**	**0,05**	
	Valve DE	**11,1**	**11,5**	**0,01**	**0,01**	**0,02**	
Cyl No.:	**A6**	B. grinding	A. grinding	R1	R2	R3	Remarks: DE valve out on run-out
	Valve FE	**11,1**	**11,35**	**0,01**	**0,02**	**0,005**	New valve installed.
	Valve DE		**New**	**0,6**	**0,9**		
Cyl No.:	**A7**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,2**	**11,3**	**0,01**	**0,02**	**0,02**	
	Valve DE	**11,25**	**11,55**	**0,01**	**0,02**	**0,05**	
Cyl No.:	**A8**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,25**	**11,8**	**0,05**	**0,05**	**0,02**	
	Valve DE	**11,3**	**11,9**	**0,05**	**0,05**	**0,02**	
Cyl No.:	**A9**	B. grinding	A. grinding	R1	R2	R3	Remarks:
	Valve FE	**11,5**	**11,65**	**0,05**	**0,01**	**0,04**	
	Valve DE	**11,6**	**12**	**0,05**	**0,02**	**0,04**	

General Remarks:

FE = Free end DE = Drive end

Inlet valve cone

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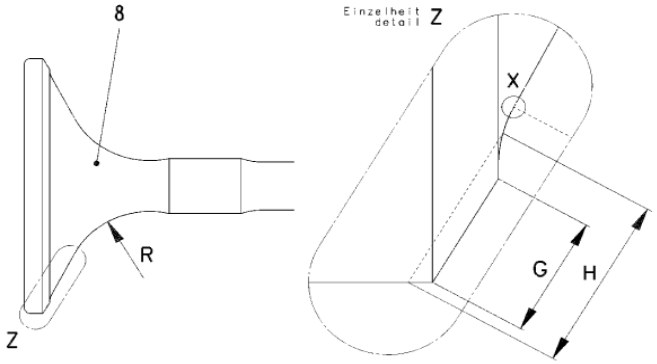
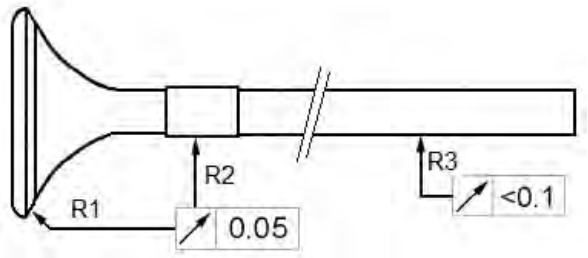
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**





G Measurement new	**11,5**	R1 / R2	**0,05**
H maximum	**16**	R3	**0,1**

Cyl No.:		B. grinding	A. grinding	R1	R2	R3	Remarks:
	B1						
Valve FE		**11,5**	**11,7**	**0,02**	**0,03**	**0,05**	
Valve DE		**11,5**	**12,1**	**0,03**	**0,03**	**0,04**	
Cyl No.:	**B2**	B. grinding	A. grinding	R1	R2	R3	Remarks: Both Valve Blow-by
Valve FE			**New**				New installed
Valve DE			**New**				
Cyl No.:	**B3**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**11**	**11,25**	**0,03**	**0,02**	**0,02**	
Valve DE		**11**	**11,25**	**0,02**	**0,01**	**0,03**	
Cyl No.:	**B4**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**11,2**	**11,3**	**0,04**	**0,03**	**0,03**	
Valve DE		**11,2**	**11,45**	**0,02**	**0,01**	**0,03**	
Cyl No.:	**B5**	B. grinding	A. grinding	R1	R2	R3	Remarks: DE valve R2 was 0,11 run-out
Valve FE		**11,2**	**11,25**	**0,02**	**0,04**	**0,01**	New Valve was installed
Valve DE			**New**		**0,11**		
Cyl No.:	**B6**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**11,15**	**11,25**	**0,02**	**0,01**	**0,01**	
Valve DE		**11,15**	**11,35**	**0,02**	**0,02**	**0,01**	
Cyl No.:	**B7**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**11,5**	**11,6**	**0,02**	**0,02**	**0,03**	
Valve DE		**11,35**	**11,45**	**0,03**	**0,03**	**0,02**	
Cyl No.:	**B8**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**11,2**	**11,45**	**0,03**	**0,04**	**0,02**	
Valve DE		**11**	**11,55**	**0,03**	**0,04**	**0,02**	
Cyl No.:	**B9**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**11,5**	**11,65**	**0,02**	**0,02**	**0,04**	
Valve DE		**11,4**	**11,55**	**0,01**	**0,01**	**0,03**	

General Remarks:

Exhaust valve cone

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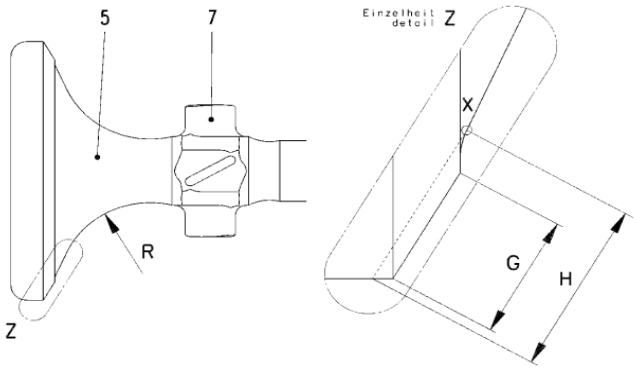
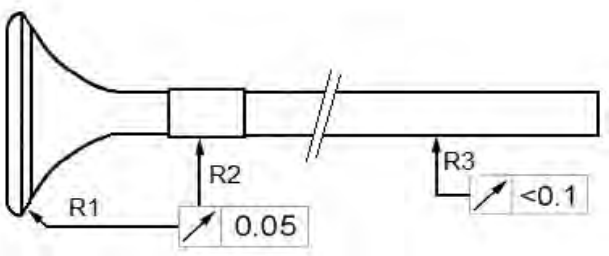
Author	
Name:	**J. Carranza & Robert Erkens**
Department:	**TS-535**
Date:	**18 February 2014**

Engine	
Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**





G Measurement new	**11,5**	R1 / R2	**0,05**
H maximum	**18,4**	R3	**0,1**

Cyl No.:		B. grinding	A. grinding	R1	R2	R3	Remarks:
	A1						FE valve was found with scuffing
Valve FE			**New**				New valve installed
Valve DE		**16,7**	**17,7**	**0,03**	**0,02**	**0,05**	Exh vakve from A2 in A1
Cyl No.:	**A2**	B. grinding	A. grinding	R1	R2	R3	Remarks: FE valve was found with scuffing
Valve FE			**New**				New valve installed
Valve DE			**New**				
Cyl No.:	**A3**	B. grinding	A. grinding	R1	R2	R3	Remarks: DE valve was found with pittings
Valve FE		**16,4**	**17,35**	**0,05**	**0,05**	**0,03**	on the lower part of the stem. New one inst.
Valve DE			**New**				
Cyl No.:	**A4**	B. grinding	A. grinding	R1	R2	R3	Remarks: FE valve was found with deep
Valve FE			**New**				burn-away marking 3mm. New one inst.
Valve DE			**New**				A4 recon Cyl head complet. DE v to B3
Cyl No.:	**A5**	B. grinding	A. grinding	R1	R2	R3	Remarks: DE exhaust valve new
Valve FE		**16,3**	**16,8**	**0,02**	**0,02**	**0,05**	
Valve DE			**New**				
Cyl No.:	**A6**	B. grinding	A. grinding	R1	R2	R3	Remarks: Both valves were found with
Valve FE			**New**				scuffing markings, New ones installed
Valve DE			**New**				
Cyl No.:	**A7**	B. grinding	A. grinding	R1	R2	R3	Remarks: FE valve was found with scuffing
Valve FE			**New**				New valve installed.
Valve DE			**New**				DE valve inst on B3
Cyl No.:	**A8**	B. grinding	A. grinding	R1	R2	R3	Remarks:
Valve FE		**16,7**	**17,1**	**0,03**	**0,04**	**0,07**	
Valve DE		**16,05**	**16,5**	**0,05**	**0,03**	**0,06**	
Cyl No.:	**A9**	B. grinding	A. grinding	R1	R2	R3	Remarks: Both valves were found with
Valve FE			**New**				scuffing markings, new ones installed.
Valve DE			**New**				

General Remarks: The valve were all new installed at 72K, running hours on all exhaust valves is 13365.
12 pieces of exhaust valve were rejected on scuffing markings and 6 pieces on pittings in the lower end of the stem.

FE = free end DE = drive end

Exhaust valve cone

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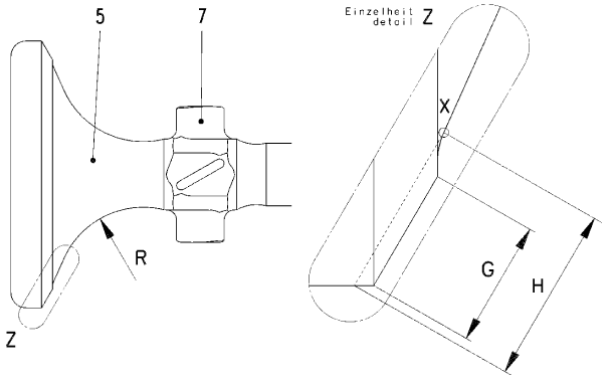
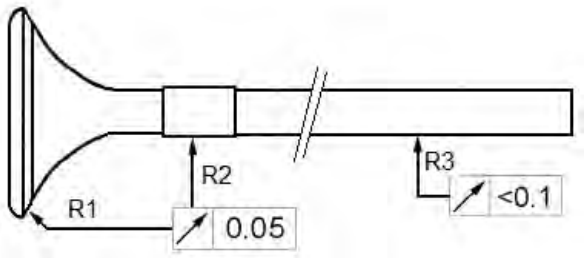
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**





G Measurement new	**11,5**	R1 / R2	**0,05**
H maximum	**18,4**	R3	**0,1**

Cyl No.:		B. grinding	A. grinding	R1	R2	R3	*Remarks:*
B1							Both were found with scuffing
Valve FE			**New**				Markings, new ones installed.
Valve DE			**New**				
Cyl No.:	**B2**	B. grinding	A. grinding	R1	R2	R3	*Remarks:* Both were found with scuffing
Valve FE			**New**				markings, new ones installed
Valve DE			**New**				
Cyl No.:	**B3**	B. grinding	A. grinding	R1	R2	R3	*Remarks:* Both were found with pitting
Valve FE		**16,35**	**16,65**	**0,03**	**0,02**	**0,07**	marking in the lower part of the stem.
Valve DE		**17,15**	**17,5**	**0,02**	**0,03**	**0,05**	Exh V. from A4 & A7 inst in B3
Cyl No.:	**B4**	B. grinding	A. grinding	R1	R2	R3	*Remarks:* FE side run-out to high and DE
Valve FE			**New**				had pittings, new installed
Valve DE			**New**				
Cyl No.:	**B5**	B. grinding	A. grinding	R1	R2	R3	*Remarks:*
Valve FE		**16,7**	**17,15**	**0,01**	**0,02**	**0,06**	
Valve DE		**16,35**	**17,5**	**0,02**	**0,02**	**0,05**	
Cyl No.:	**B6**	B. grinding	A. grinding	R1	R2	R3	*Remarks:*
Valve FE		**17**	**17,5**	**0,03**	**0,03**	**0,02**	
Valve DE		**17**	**17,25**	**0,04**	**0,05**	**0,02**	
Cyl No.:	**B7**	B. grinding	A. grinding	R1	R2	R3	*Remarks:* Scuffing marking on the stem
Valve FE			**New**				New installed.
Valve DE			**New**				
Cyl No.:	**B8**	B. grinding	A. grinding	R1	R2	R3	*Remarks:*
Valve FE		**16,3**	**16,8**	**0,03**	**0,03**	**0,04**	
Valve DE		**16,8**	**17,25**	**0,04**	**0,03**	**0,05**	
Cyl No.:	**B9**	B. grinding	A. grinding	R1	R2	R3	*Remarks:*
Valve FE		**16,85**	**17,15**	**0,03**	**0,02**	**0,04**	
Valve DE		**17**	**17,5**	**0,02**	**0,02**	**0,01**	

General Remarks:

Piston ring grooves

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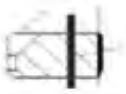
Author

Name:	**Robert Erkens**
Department:	**TS**
Date:	**08 February 2014**

Engine

Plant:	**ACP, Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston No.:		A1				A2			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:	144169		81-11-122		144230		81-11-223	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,235	8,225	8,200	12,085	8,235	8,220	8,200	12,095
	2	8,220	---	---	---	8,240	---	---	---
	3	8,225	---	---	---	8,235	---	---	---
	CS 4	8,235	8,225	8,195	12,090	8,240	8,220	8,195	12,090
	5	8,235	---	---	---	8,240	---	---	---
	6	8,220	---	---	---	8,245	---	---	---
	Cams 7	8,235	8,225	8,195	12,085	8,235	8,225	8,190	12,090
	8	8,230	---	---	---	8,245	---	---	---
	9	8,235	---	---	---	8,230	---	---	---
	FEE 10	8,225	8,225	8,190	12,095	8,245	8,225	8,200	12,090
	11	8,225	---	---	---	8,240	---	---	---
	12	8,225	---	---	---	8,235	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,23	8,23	8,20	12,09	8,24	8,22	8,20	12,09
Max. value:		8,24	8,23	8,20	12,09	8,24	8,22	8,20	12,10
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:	6	Skirt:	8	Crown:	6	Skirt:	8
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:		Skirt exchange				Skirt exchange			



1/4 deep measured

General remarks:

Piston ring grooves

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Engine

Plant:	**ACP, Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston No.:		A3				A4			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:	144169		81-11-135		144230		81-11-214	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,240	8,230	8,185	12,085	8,220	8,225	8,225	12,080
	2	8,245	---	---	---	8,215	---	---	---
	3	8,225	---	---	---	8,225	---	---	---
	CS 4	8,225	8,220	8,190	12,090	8,220	8,225	8,225	12,080
	5	8,250	---	---	---	8,210	---	---	---
	6	8,220	---	---	---	8,210	---	---	---
	Cams 7	8,220	8,230	8,195	12,085	8,225	8,225	8,185	12,090
	8	8,230	---	---	---	8,225	---	---	---
	9	8,220	---	---	---	8,220	---	---	---
	FEE 10	8,240	8,205	8,200	12,095	8,225	8,230	8,200	12,085
	11	8,245	---	---	---	8,230	---	---	---
	12	8,240	---	---	---	8,225	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,23	8,23	8,19	12,09	8,22	8,23	8,23	12,08
Max. value:		8,25	8,23	8,19	12,09	8,23	8,23	8,23	12,08
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,001	0,000
Max. wear (mm/1000 hrs)		0,001	0,001	0,000	0,001	0,000	0,001	0,001	0,000
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:	6	Skirt:	8	Crown:	6	Skirt:	8
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

1/4 deep measured

Piston No.:		A5				A6			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:	144216		81-11-20		144230		81-11-238	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,235	8,235	8,205	12,090	8,220	8,230	8,195	12,085
	2	8,230	---	---	---	8,210	---	---	---
	3	8,240	---	---	---	8,230	---	---	---
	CS 4	8,240	8,235	8,195	12,090	8,225	8,235	8,210	12,095
	5	8,235	---	---	---	8,235	---	---	---
	6	8,240	---	---	---	8,230	---	---	---
	Cams 7	8,235	8,240	8,205	12,080	8,210	8,225	8,200	12,095
	8	8,235	---	---	---	8,225	---	---	---
	9	8,235	---	---	---	8,225	---	---	---
	FEE 10	8,240	8,215	8,200	12,085	8,225	8,235	8,195	12,090
	11	8,240	---	---	---	8,230	---	---	---
	12	8,235	---	---	---	8,230	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,23	8,24	8,20	12,09	8,22	8,23	8,20	12,09
Max. value:		8,24	8,24	8,21	12,09	8,23	8,24	8,21	12,10
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:		Skirt:		Crown:		Skirt:	
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

1/4 deep measured

Piston ring grooves

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Engine

Plant:	**ACP, Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston No.:		A7				A8			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:	144230		81-11-217		144130		81-11-215	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,225	8,225	8,180	12,085	8,235	8,230	8,205	12,085
	2	8,225	---	---	---	8,240	---	---	---
	3	8,221	---	---	---	8,245	---	---	---
	CS 4	8,245	8,220	8,190	12,080	8,240	8,230	8,195	12,085
	5	8,215	---	---	---	8,235	---	---	---
	6	8,210	---	---	---	8,235	---	---	---
	Cams 7	8,225	8,225	8,195	12,075	8,235	8,235	8,205	12,090
	8	8,225	---	---	---	8,235	---	---	---
	9	8,225	---	---	---	8,240	---	---	---
	FEE 10	8,225	8,215	8,175	12,075	8,240	8,230	8,200	12,090
	11	8,220	---	---	---	8,235	---	---	---
	12	8,225	---	---	---	8,230	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,22	8,22	8,19	12,08	8,23	8,23	8,20	12,09
Max. value:		8,25	8,23	8,19	12,09	8,245	8,23	8,21	12,09
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,001	0,001	0,000	0,001	0,001	0,001	0,000	0,001
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:	8	Skirt:	6	Crown:	8	Skirt:	6
Piston exchange / Reason:		☐ yes				☑ yes			
Remarks:									

1/4 deep measured

Piston No.:		A9				B1			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:			81-11-233				81-11-183	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,250	8,220	8,190	12,100	8,225	8,215	8,180	12,095
	2	8,255	---	---	---	8,225	---	---	---
	3	8,250	---	---	---	8,225	---	---	---
	CS 4	8,290	8,225	8,200	12,100	8,230	8,220	8,185	12,080
	5	8,295	---	---	---	8,240	---	---	---
	6	8,295	---	---	---	8,235	---	---	---
	Cams 7	8,255	8,210	8,215	12,075	8,215	8,225	8,180	12,090
	8	8,275	---	---	---	8,225	---	---	---
	9	8,260	---	---	---	8,215	---	---	---
	FEE 10	8,260	8,210	8,200	12,105	8,215	8,210	8,185	12,080
	11	8,260	---	---	---	8,230	---	---	---
	12	8,260	---	---	---	8,225	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,26	8,22	8,20	12,10	8,23	8,22	8,18	12,09
Max. value:		8,295	8,225	8,200	12,100	8,240	8,220	8,185	12,095
Mean wear (mm/1000 hrs)		0,001	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,001	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:	8	Skirt:	6	Crown:	8	Skirt:	6
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

1/4 deep measured

Piston ring grooves

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Engine

Plant:	**ACP, Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston No.:		B2				B3			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:			81-11-17				81-11-19	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
 1/4 deep measured	ExhS 1	8,225	8,225	8,195	12,095	8,240	8,235	8,200	12,090
	2	8,225	---	---	---	8,240	---	---	---
	3	8,255	---	---	---	8,235	---	---	---
	CS 4	8,215	8,225	8,205	12,100	8,250	8,240	8,200	12,095
	5	8,220	---	---	---	8,250	---	---	---
	6	8,215	---	---	---	8,250	---	---	---
	Cams 7	8,215	8,225	8,210	12,075	8,250	8,235	8,205	12,090
	8	8,225	---	---	---	8,240	---	---	---
	9	8,225	---	---	---	8,240	---	---	---
	FEE 10	8,220	8,215	8,185	12,085	8,235	8,240	8,195	12,090
	11	8,225	---	---	---	8,235	---	---	---
	12	8,230	---	---	---	8,240	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,22	8,23	8,20	12,10	8,24	8,24	8,20	12,09
Max. value:		8,255	8,225	8,205	12,100	8,250	8,240	8,200	12,095
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,001	0,001	0,000	0,001	0,001	0,001	0,000	0,001
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:	8	Skirt:	6	Crown:	8	Skirt:	6
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

Piston No.:		B4				B5			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:			81-11-242				81-11-221	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
 1/4 deep measured	ExhS 1	8,235	8,230	8,205	12,100	8,250	8,240	8,220	12,095
	2	8,235	---	---	---	8,250	---	---	---
	3	8,245	---	---	---	8,245	---	---	---
	CS 4	8,240	8,235	8,190	12,100	8,250	8,200	8,200	12,090
	5	8,245	---	---	---	8,250	---	---	---
	6	8,230	---	---	---	8,240	---	---	---
	Cams 7	8,235	8,235	8,195	12,090	8,240	8,210	8,200	12,095
	8	8,235	---	---	---	8,235	---	---	---
	9	8,235	---	---	---	8,240	---	---	---
	FEE 10	8,235	8,230	8,195	12,095	8,245	8,200	8,205	12,095
	11	8,225	---	---	---	8,245	---	---	---
	12	8,225	---	---	---	8,240	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,23	8,23	8,20	12,10	8,24	8,22	8,21	12,09
Max. value:		8,245	8,235	8,205	12,100	8,250	8,240	8,220	12,095
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,001	0,001	0,000	0,001	0,001	0,001	0,001	0,001
Piston skirt operation hrs:									
Piston condition code		Crown:	8	Skirt:	6	Crown:	8	Skirt:	6
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

Piston ring grooves

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Engine

Plant:	**ACP, Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston No.:		B6				B7			
Piston crown operating hours:		83916				83916			
Time since last overhaul:		12365				12365			
End code No.:	COC No.:			81-11241				81-11-151	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,225	8,225	8,185	12,095	8,240	8,250	8,200	12,095
	2	8,225	---	---	---	8,235	---	---	---
	3	8,225	---	---	---	8,240	---	---	---
	CS 4	8,225	8,225	8,195	12,080	8,235	8,235	8,200	12,100
	5	8,230	---	---	---	8,240	---	---	---
	6	8,235	---	---	---	8,235	---	---	---
	Cams 7	8,235	8,235	8,190	12,090	8,235	8,220	8,195	12,105
	8	8,230	---	---	---	8,235	---	---	---
	9	8,220	---	---	---	8,235	---	---	---
	FEE 10	8,210	8,220	8,190	12,085	8,240	8,220	8,200	12,095
	11	8,220	---	---	---	8,235	---	---	---
	12	8,220	---	---	---	8,230	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,22	8,23	8,19	12,09	8,24	8,24	8,20	12,10
Max. value:		8,235	8,225	8,195	12,095	8,240	8,250	8,200	12,100
Mean wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Max. wear (mm/1000 hrs)		0,000	0,001	0,000	0,001	0,000	0,001	0,000	0,001
Piston skirt operation hrs:		0				0			
Piston condition code		Crown:	8	Skirt:	6	Crown:	8	Skirt:	6
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

1/4 deep measured

Piston No.:		B8				B9			
Piston crown operating hours:						83916			
Time since last overhaul:						12365			
End code No.:	COC No.:			81-11-13				81-11-121	
Groove No.:		1	2	3	4	1	2	3	4
Grooves chrome plated:		☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes	☐ yes
	ExhS 1	8,225	8,215	8,190	12,090	8,255	8,230	8,200	12,100
	2	8,220	---	---	---	8,250	---	---	---
	3	8,220	---	---	---	8,240	---	---	---
	CS 4	8,230	8,225	8,185	12,075	8,255	8,275	8,190	12,100
	5	8,230	---	---	---	8,245	---	---	---
	6	8,235	---	---	---	8,225	---	---	---
	Cams 7	8,225	8,230	8,200	12,090	8,230	8,245	8,200	12,105
	8	8,225	---	---	---	8,235	---	---	---
	9	8,225	---	---	---	8,230	---	---	---
	FEE 10	8,220	8,210	8,180	12,070	8,235	8,245	8,200	12,080
	11	8,220	---	---	---	8,260	---	---	---
	12	8,225	---	---	---	8,250	---	---	---
Standard size:		8,20	8,17	8,17	12,04	8,20	8,17	8,17	12,04
Mean value:		8,22	8,22	8,19	12,08	8,25	8,25	8,20	12,10
Max. value:		8,235	8,225	8,190	12,090	8,260	8,275	8,200	12,100
Mean wear (mm/1000 hrs)						0,001	0,001	0,000	0,001
Max. wear (mm/1000 hrs)						0,001	0,001	0,000	0,001
Piston skirt operation hrs:									
Piston condition code		Crown:		Skirt:		Crown:		Skirt:	
Piston exchange / Reason:		☐ yes				☐ yes			
Remarks:									

1/4 deep measured

Piston Rings

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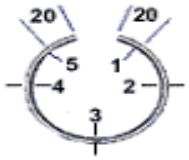
Author	
Name:	Robert Erkens
Department:	TS 535
Date:	20 February 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123
Operating hrs:	83916

Piston no.:		A1 old ring				A1 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,69	14,74	14,20	9,13
	2					14,70	14,70	14,21	9,11
	3					14,69	14,74	14,24	9,13
	4					14,68	14,73	14,23	9,13
	5					14,66	14,73	14,23	9,13
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,98	11,97
	5					7,98	7,98	7,98	11,97
Result:									
Remarks:									

General Remarks:

Piston Rings

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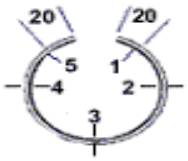
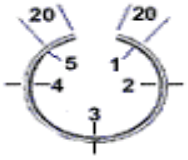
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		A2 old ring				A2 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,70	14,73	14,20	9,10
	2					14,75	14,69	14,18	9,12
	3					14,76	14,71	14,20	9,13
	4					14,71	14,71	14,22	9,11
	5					14,71	14,73	14,22	9,10
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,97	7,97	7,98	11,97
[mm]	3					7,97	7,98	7,98	11,97
	5					7,97	7,98	7,98	11,97
Result:									
Remarks:									

Piston no.:		A3 old ring				A3 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,73	14,68	14,20	9,11
	2					14,71	14,70	14,18	9,10
	3					14,74	14,70	14,21	9,16
	4					14,78	14,68	14,21	9,14
	5					14,69	14,67	14,20	9,10
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,97
[mm]	3					7,97	7,98	7,98	11,98
	5					7,97	7,98	7,98	11,98
Result:									
Remarks:									

Piston Rings

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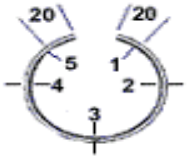
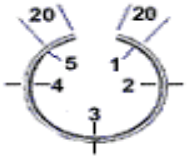
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		A4 old ring				A4 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,73	14,70	14,21	9,14
	2					14,70	14,71	14,17	9,15
	3					14,73	14,65	14,21	9,17
	4					14,68	14,67	14,21	9,16
	5					14,67	14,67	14,21	9,14
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,97	7,98	7,98	11,97
[mm]	3					7,97	7,98	7,98	11,97
	5					7,97	7,98	7,98	11,97
Result:									
Remarks:									

Piston no.:		A5 old ring				A5 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,74	14,72	14,20	9,14
	2					14,72	14,72	14,20	9,16
	3					14,76	14,74	14,22	9,18
	4					14,72	14,80	14,23	9,16
	5					14,75	14,73	14,20	9,15
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,97	7,98	7,98	11,97
[mm]	3					7,97	7,99	7,98	11,97
	5					7,97	7,98	7,98	11,97
Result:									
Remarks:									

Piston Rings

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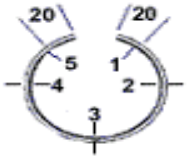
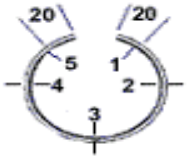
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		A6 old ring					A6 new ring		
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,74	14,73	14,17	9,11
	2					14,74	14,68	14,16	9,13
	3					14,75	14,73	14,18	9,15
	4					14,74	14,72	14,19	9,13
	5					14,75	14,73	14,17	9,12
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,98	11,97
	5					7,98	7,98	7,98	11,97
Result:									
Remarks:									

Piston no.:		A7 old ring					A7 new ring		
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,73	14,75	14,20	9,11
	2					14,73	14,68	14,18	9,10
	3					14,74	14,73	14,22	9,15
	4					14,73	14,72	14,22	9,16
	5					14,71	14,74	14,20	9,11
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,97	7,98	7,97	11,97
[mm]	3					7,97	7,98	7,97	11,96
	5					7,97	7,98	7,98	11,97
Result:									
Remarks:									

Piston Rings

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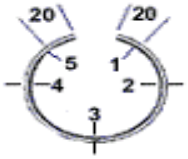
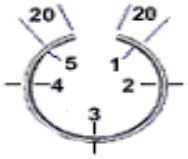
Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123
Operating hrs:	83916

Piston no.:		A8 old ring				A8 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,71	14,74	14,20	9,12
	2					14,69	14,67	14,19	9,12
	3					14,70	14,71	14,21	9,16
	4					14,68	14,71	14,21	9,11
	5					14,69	14,72	14,21	9,12
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,97	7,98	7,98	11,97
[mm]	3					7,97	7,97	7,98	11,96
	5					7,97	7,98	7,98	11,97
Result:									
Remarks:									

Piston no.:		A9 old ring				A9 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,73	14,74	14,20	9,11
	2					14,73	14,71	14,18	9,11
	3					14,73	14,72	14,21	9,14
	4					14,71	14,73	14,22	9,10
	5					14,72	14,73	14,20	9,10
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,97	7,98	7,97	11,97
[mm]	3					7,96	7,98	7,97	11,96
	5					7,97	7,98	7,97	11,97
Result:									
Remarks:									

Piston Rings

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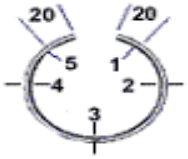
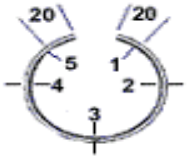
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		B1 old ring				B1 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GEO
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,70	14,75	14,21	9,11
	2					14,72	14,69	14,20	9,11
	3					14,75	14,74	14,22	9,13
	4					14,72	14,74	14,23	9,11
	5					14,69	14,74	14,22	9,10
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,98	11,99
	5					7,98	7,98	7,98	11,98
Result:									
Remarks:									

Piston no.:		B2 old ring				B2 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,70	14,73	14,22	9,14
	2					14,74	14,70	14,22	9,15
	3					14,72	14,73	14,23	9,15
	4					14,72	14,72	14,25	9,15
	5					14,68	14,74	14,23	9,14
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,99	11,98
	5					7,99	7,99	7,98	11,98
Result:									
Remarks:									

Piston Rings

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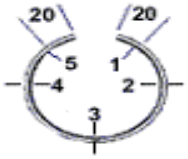
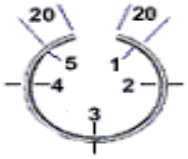
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		B3 old ring					B3 new ring		
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,74	14,75	14,20	9,11
	2					14,70	14,73	14,20	9,12
	3					14,70	14,73	14,20	9,15
	4					14,71	14,74	14,20	9,11
	5					14,68	14,74	14,20	9,10
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,97	11,98
[mm]	3					7,98	7,98	7,97	11,98
	5					7,98	7,98	7,98	11,98
Result:									
Remarks:									

Piston no.:		B4 old ring					B4 new ring		
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,68	14,75	14,19	9,10
	2					14,69	14,72	14,21	9,10
	3					14,69	14,75	14,19	9,12
	4					14,68	14,74	14,16	9,11
	5					14,68	14,76	14,17	9,10
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,98	11,98
	5					7,98	7,98	7,98	11,98
Result:									
Remarks:									

Piston Rings

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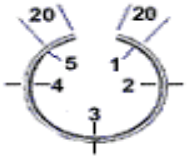
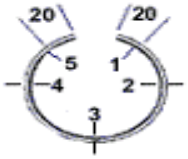
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		B5 old ring				B5 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:									
Time since last overhaul:									
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,68	14,74	14,22	9,16
	2					14,68	14,71	14,18	9,16
	3					14,69	14,73	14,23	9,17
	4					14,68	14,72	14,21	9,14
	5					14,68	14,72	14,23	9,15
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,98	11,98
	5					7,98	7,98	7,98	11,98
Result:									
Remarks:									

Piston no.:		B6 old ring				B6 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,68	14,74	14,22	9,15
	2					14,67	14,70	14,17	9,15
	3					14,68	14,71	14,20	9,13
	4					14,68	14,74	14,21	9,12
	5					14,64	14,74	14,21	9,13
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,99	11,97
[mm]	3					7,98	7,98	7,99	11,98
	5					7,98	7,98	7,98	11,98
Result:									
Remarks:									

Piston Rings

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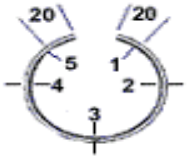
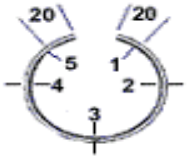
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		B7 old ring				B7 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,68	14,74	14,22	9,14
	2					14,64	14,69	14,21	9,13
	3					14,68	14,73	14,20	9,15
	4					14,70	14,73	14,20	9,18
	5					14,66	14,73	14,21	9,15
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,97
[mm]	3					7,98	7,98	7,98	11,97
	5					7,98	7,98	7,98	11,97
Result:									
Remarks:									

Piston no.:		B8 old ring				B8 new ring			
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,70	14,74	14,22	9,14
	2					14,68	14,70	14,18	9,12
	3					14,68	14,72	14,21	9,14
	4					14,65	14,72	14,22	9,14
	5					14,65	14,73	14,22	9,15
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,97
[mm]	3					7,98	7,98	7,98	11,97
	5					7,98	7,98	7,98	11,97
Result:									
Remarks:									

Piston Rings

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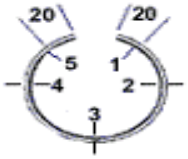
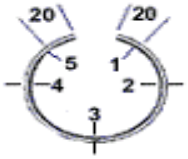
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**

Piston no.:		B9 old ring					B9 new ring		
Ring drawing no.:						1619	1583	1546	234
Ring make: (Code)						GOE	GOE	GOE	GOE
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:						0	0	0	0
Time since last overhaul:						0	0	0	0
Refitt./exch. in groove no.									
Measured at: [date]									
	1					14,70	14,75	14,22	9,14
	2					14,70	14,72	14,18	9,11
	3					14,71	14,74	14,22	9,14
	4					14,71	14,74	14,21	9,17
	5					14,72	14,74	14,21	9,15
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1					7,98	7,98	7,98	11,98
[mm]	3					7,98	7,98	7,99	11,98
	5					7,98	7,99	7,97	11,97
Result:									
Remarks:									

Piston no.:									
Ring drawing no.:									
Ring make: (Code)									
Ring charakteristics:									
Ring groove no.:		1	2	3	4	1	2	3	4
Operation time ring:									
Time since last overhaul:									
Refitt./exch. in groove no.									
Measured at: [date]									
	1								
	2								
	3								
	4								
	5								
Mean value:	[mm]								
Max. value:	[mm]								
Standard size:									
Mean wear: [mm/1000h]									
Max. wear: [mm/1000h]									
Ring height:	1								
[mm]	3								
	5								
Result:									
Remarks:									

Cylinder Liners

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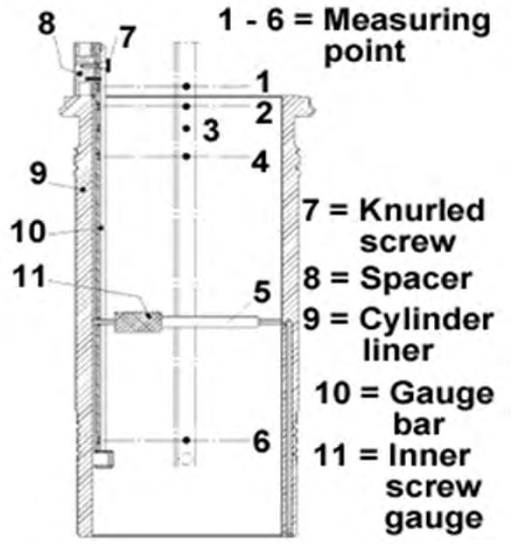
Author	
Name:	**Robert Erkens**
Department:	**TS**
Date:	**15 October 2014**

Engine	
Plant:	**ACP - Miraflores power station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**



Measuring piont 1 is only relevant for cylinder liner designs **without** top land ring.
For measurement, the spacer (8) is to be removed.
For cylinder liner designs with top land ring, the measurement is started at measureing piont 2.

The heights of the measurement levels refer to cylinder liner **without** top land ring.

Attention: Should the values measured exceed the max. permissible values for wear or ovality, the cylinder liner must be renewed.

Wear: Difference from the velues measured minus nominal dimensions.
Ovality: Difference from the values measured (intransverse and in longitudinal direction) of each plane.

Cylinder No.:		A1		A2		A3		A4	
Cyl. Operation hours		0		0		0		0	
Time since last overhaul		0		0		0		0	
Liner temperature		27		27		27		27	
COC-Ident No.		1301008		1301021		1301012		1139869	
Top land ring		☑ yes		☑ yes		☑ yes		☑ yes	
End code No.									
Standard Size:		480		480		480		480	
Height	Piont	along	across	along	across	along	across	along	across
		fill in the values after the comma only, eg. 0,08							
100	1	0	0	0	0	0	0	0	0
137	2	0,07	0,06	0,09	0,08	0,07	0,06	0,08	0,07
137	↗ 2 ↖	0,06	0,06	0,08	0,07	0,05	0,05	0,07	0,07
191,5	3	0,06	0,05	0,08	0,07	0,06	0,05	0,07	0,07
271	4	0,06	0,05	0,08	0,07	0,05	0,04	0,07	0,07
733	5	0,06	0,05	0,08	0,07	0,05	0,05	0,07	0,06
1093	6	0,06	0,05	0,08	0,07	0,05	0,05	0,07	0,07
Max. value 1/100 mm **P.2**		0,07		0,09		0,07		0,08	
Wear mm / 1000 Hrs **P.2**									
Limit max. wear **P.2**		1,44		1,44		1,44		1,44	
Max. ovality in mm		0,01		0,02		0,02		0,01	
Limit ovality		0,72		0,72		0,72		0,72	
Result:		1		1		1		1	

Remarks: **All liners are new installed for the 90K**

Cylinder Liners

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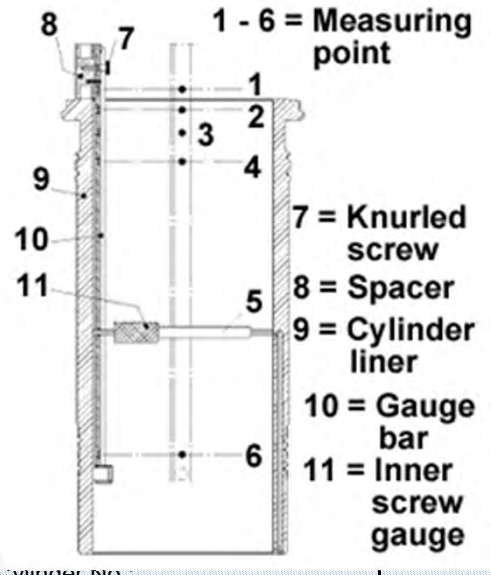
Engine

Plant:	**ACP - Miraflores power station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**



Measuring piont 1 is only relevant for cylinder liner designs **without** top land ring.
For measurement, the spacer (8) is to be removed.
For cylinder liner designs with top land ring, the measurement is started at measureing piont 2.

The heights of the measurement levels refer to cylinder liner **without** top land ring.

Attention: Should the values measured exceed the max. permissible values for wear or ovality, the cylinder liner must be renewed.

Wear: Difference from the velues measured minus nominal dimensions.
Ovality: Difference from the values measured (intransverse and in longitudinal direction) of each plane.

Cylinder No.:			A5		A6		A7		A8	
Cyl. Operation hours			0		0		0		0	
Time since last overhaul			0		0		0		0	
Liner temperature			27		27		27		27	
COC-Ident No.			1301033		1033910		1139876		1301032	
Top land ring			☑ yes		☑ yes		☑ yes		☑ yes	
End code No.										
Standard Size:			480		480		480		480	
	Height	Piont	along	across	along	across	along	across	along	across
			fill in the values after the comma only, eg. 0,08							
	100	1	0	0	0	0	0	0	0	0
	137	2	0,08	0,07	0,06	0,06	0,08	0,08	0,07	0,07
	137	↗ 2 ↖	0,07	0,07	0,06	0,05	0,08	0,08	0,06	0,06
	191,5	3	0,07	0,07	0,04	0,05	0,07	0,07	0,06	0,05
	271	4	0,06	0,07	0,04	0,04	0,07	0,07	0,06	0,05
	733	5	0,06	0,06	0,04	0,04	0,06	0,07	0,06	0,06
	1093	6	0,06	0,06	0,04	0,04	0,07	0,07	0,06	0,06
Max. value 1/100 mm **P.2**			0,08		0,06		0,08		0,07	
Wear mm / 1000 Hrs **P.2**										
Limit max. wear **P.2**			1,44		1,44		1,44		1,44	
Max. ovality in mm			0,01		0,01		0		0,01	
Limit ovality			0,72		0,72		0,72		0,72	
Result:			1		1		1		1	

Remarks:

Cylinder Liners

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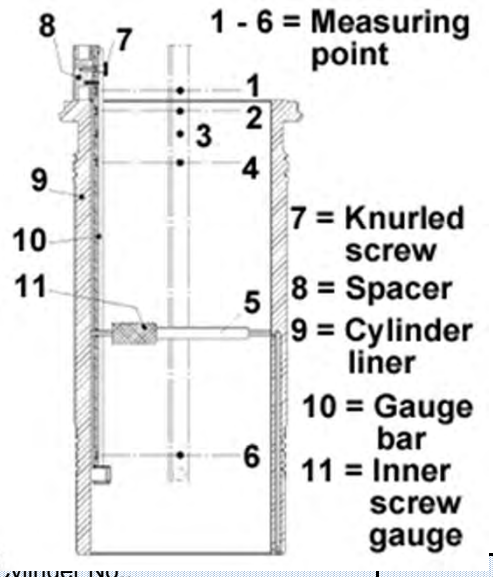
Engine

Plant:	**ACP - Miraflores power station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**



Measuring piont 1 is only relevant for cylinder liner designs **without** top land ring.
For measurement, the spacer (8) is to be removed.
For cylinder liner designs with top land ring, the measurement is started at measureing piont 2.

The heights of the measurement levels refer to cylinder liner **without** top land ring.

Attention: Should the values measured exceed the max. permissible values for wear or ovality, the cylinder liner must be renewed.

Wear: Difference from the velues measured minus nominal dimensions.
Ovality: Difference from the values measured (intransverse and in longitudinal direction) of each plane.

Cylinder No.:		**A9**							
Cyl. Operation hours		**0**							
Time since last overhaul		**0**							
Liner temperature		**27**							
COC-Ident No.		**1301037**							
Top land ring		☑ yes		☐ yes		☐ yes		☐ yes	
End code No.									
Standard Size:		**480**							
Height	Piont	along	across	along	across	along	across	along	across
		fill in the values after the comma only, eg. 0,08							
100	1	**0**	**0**						
137	2	**0,07**	**0,07**						
137	↗ 2 ↖	**0,06**	**0,06**						
191,5	3	**0,06**	**0,05**						
271	4	**0,06**	**0,05**						
733	5	**0,06**	**0,05**						
1093	6	**0,06**	**0,05**						
Max. value 1/100 mm **P.2**		**0,07**							
Wear mm / 1000 Hrs **P.2**									
Limit max. wear **P.2**		**1,44**							
Max. ovality in mm		**0,01**							
Limit ovality		**0,72**							
Result:		**1**							

Remarks:

Cylinder Liners

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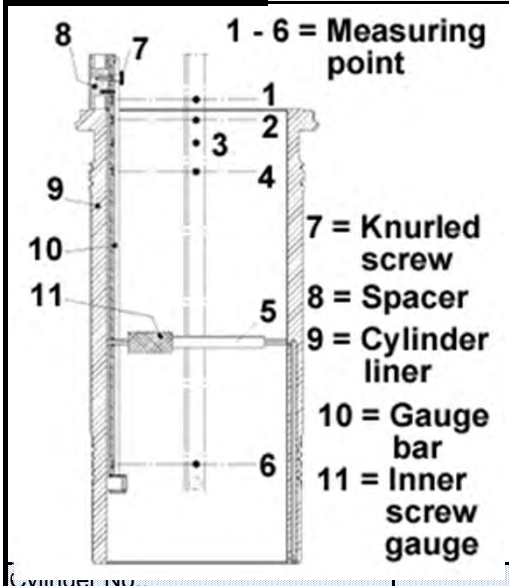
Engine

Plant:	**ACP - Miraflores power station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**



Measuring piont 1 is only relevant for cylinder liner designs **without** top land ring.
For measurement, the spacer (8) is to be removed.
For cylinder liner designs with top land ring, the measurement is started at measureing piont 2.

The heights of the measurement levels refer to cylinder liner **without** top land ring.

Attention: Should the values measured exceed the max. permissible values for wear or ovality, the cylinder liner must be renewed.

Wear: Difference from the velues measured minus nominal dimensions.
Ovality: Difference from the values measured (intransverse and in longitudinal direction) of each plane.

Cylinder No.:		B1		B2		B3		B4	
Cyl. Operation hours		0		0		0		0	
Time since last overhaul		0		0		0		0	
Liner temperature		27		27		27		27	
COC-Ident No.		1301006		1139882		1301038		1139877	
Top land ring		☑ yes		☑ yes		☑ yes		☑ yes	
End code No.									
Standard Size:		480		480		480		480	
Height	Piont	along	across	along	across	along	across	along	across
		fill in the values after the comma only, eg. 0,08							
100	1	0	0	0	0	0	0	0	0
137	2	0,07	0,07	0,06	0,05	0,06	0,05	0,08	0,07
137	↗ 2 ↖	0,06	0,07	0,06	0,06	0,05	0,05	0,07	0,07
191,5	3	0,06	0,06	0,05	0,05	0,05	0,04	0,07	0,06
271	4	0,05	0,06	0,05	0,05	0,05	0,04	0,07	0,06
733	5	0,05	0,06	0,05	0,05	0,05	0,04	0,06	0,06
1093	6	0,05	0,05	0,05	0,04	0,05	0,04	0,06	0,06
Max. value 1/100 mm **P.2**		0,07		0,06		0,06		0,08	
Wear mm / 1000 Hrs **P.2**									
Limit max. wear **P.2**		1,44		1,44		1,44		1,44	
Max. ovality in mm		0,01		0,01		0,01		0,01	
Limit ovality		0,72		0,72		0,72		0,72	
Result:		1		1		1		1	

Remarks:

Cylinder Liners

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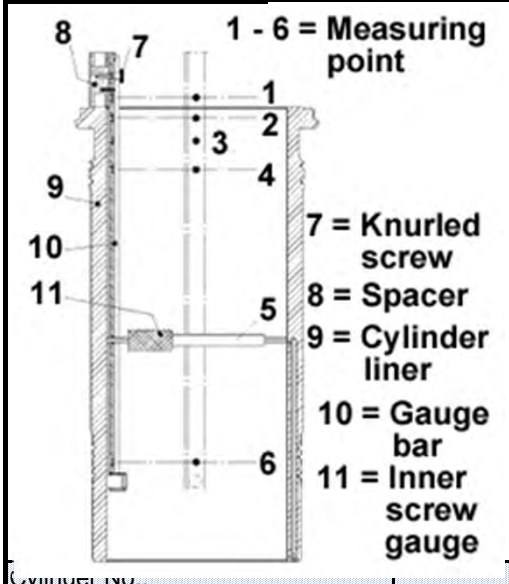
Engine

Plant:	**ACP - Miraflores power station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**



Measuring piont 1 is only relevant for cylinder liner designs **without** top land ring.
For measurement, the spacer (8) is to be removed.
For cylinder liner designs with top land ring, the measurement is started at measureing piont 2.

The heights of the measurement levels refer to cylinder liner **without** top land ring.

Attention: Should the values measured exceed the max. permissible values for wear or ovality, the cylinder liner must be renewed.

Wear: Difference from the velues measured minus nominal dimensions.
Ovality: Difference from the values measured (intransverse and in longitudinal direction) of each plane.

Cylinder No.:		B5		B6		B7		B8	
Cyl. Operation hours		0		0		0		0	
Time since last overhaul		0		0		0		0	
Liner temperature		27		27		27		27	
COC-Ident No.		1139871		1301036		1301014		1301039	
Top land ring		☑ yes		☑ yes		☑ yes		☑ yes	
End code No.									
Standard Size:		480		480		480		480	
Height	Piont	along	across	along	across	along	across	along	across
		fill in the values after the comma only, eg. 0,08							
100	1	0	0	0	0	0	0	0	0
137	2	0,07	0,07	0,08	0,08	0,07	0,06	0,08	0,07
137	↗ 2 ↖	0,06	0,06	0,07	0,07	0,06	0,05	0,07	0,07
191,5	3	0,06	0,06	0,07	0,06	0,05	0,05	0,07	0,07
271	4	0,06	0,06	0,07	0,06	0,05	0,04	0,07	0,07
733	5	0,06	0,06	0,07	0,06	0,05	0,04	0,07	0,06
1093	6	0,06	0,05	0,06	0,05	0,05	0,04	0,07	0,06
Max. value 1/100 mm **P.2**		0,07		0,08		0,07		0,08	
Wear mm / 1000 Hrs **P.2**									
Limit max. wear **P.2**		1,44		1,44		1,44		1,44	
Max. ovality in mm		0,01		0,01		0,02		0,01	
Limit ovality		0,72		0,72		0,72		0,72	
Result:		1		1		1		1	

Remarks:

Cylinder Liners

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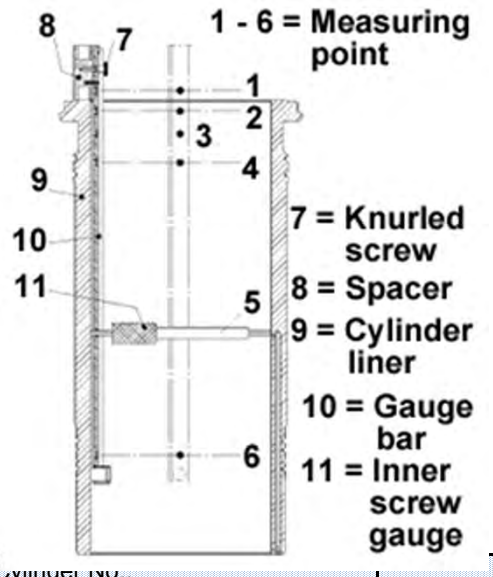
Engine

Plant:	**ACP - Miraflores power station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123**
Operating hrs:	**83916**



Measuring piont 1 is only relevant for cylinder liner designs **without** top land ring.
For measurement, the spacer (8) is to be removed.
For cylinder liner designs with top land ring, the measurement is started at measureing piont 2.

The heights of the measurement levels refer to cylinder liner **without** top land ring.

Attention: Should the values measured exceed the max. permissible values for wear or ovality, the cylinder liner must be renewed.

Wear: Difference from the velues measured minus nominal dimensions.
Ovality: Difference from the values measured (intransverse and in longitudinal direction) of each plane.

Cylinder No.:		**B9**							
Cyl. Operation hours		**0**							
Time since last overhaul		**0**							
Liner temperature		**27**							
COC-Ident No.		**1301024**							
Top land ring		☑ yes		☐ yes		☐ yes		☐ yes	
End code No.									
Standard Size:		**480**							
Height	Piont	along	across	along	across	along	across	along	across
		fill in the values after the comma only, eg. 0,08							
100	1	**0**	**0**						
137	2	**0,07**	**0,06**						
137	↗ 2 ↖	**0,07**	**0,06**						
191,5	3	**0,07**	**0,07**						
271	4	**0,06**	**0,06**						
733	5	**0,06**	**0,06**						
1093	6	**0,06**	**0,06**						
Max. value 1/100 mm **P.2**		**0,07**							
Wear mm / 1000 Hrs **P.2**									
Limit max. wear **P.2**		**1,44**		**1,44**		**1,44**		**1,44**	
Max. ovality in mm		**0,01**							
Limit ovality		**0,72**		**0,72**		**0,72**		**0,72**	
Result:		**1**							

Remarks:

Bearing clearance

BWSC
Your Global Energy Partner

Author	
Name:	Robert Erkens
Department:	TS
Date:	10 February 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V48/60
Engine No.:	1 135 123
Operating hrs:	83916

Main bearing clearance [1/100 mm]

Bearing No.:	0I	I	II	III	IV	V	VI	VII	VIII	IX	X
Values	**0,56**	**0,56**	**0,56**	**0,56**	**0,56**	**0,56**	**0,56**	**0,56**	**0,56**	**0,56**	**0,5**

Remarks: **Clearance when new: 0,52 - 0,66**

Cranshaft locating bearing clearances [1/100 mm]	Axial	**0,92**	

Remarks: **Clearance when new: 0,50 - 0,76 Max clearance is 0,95**

Crank pin bearings clearance [1/100 mm]

Bearing No.:	1	2	3	4	5	6	7	8	9
A	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**
B	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**	**0,50**

Remarks: **Clearance when new: 0,36 - 0,50**

Camshaft bearing clearance [1/100 mm] **A - side**

Bearing No.:	0I	1	2	3	4	5	6	7	8	9	10
Values	**0,18**	**0,18**	**0,18**	**0,2**	**0,2**	**0,18**	**0,2**	**0,2**	**0,18**	**0,2**	**0,18**
Bearing No.:	11	12	13	14	15	16	17	18	19	20	
Values	**0,2**	**0,23**	**0,2**	**0,18**	**0,2**	**0,18**	**0,18**	**0,2**	**0,2**	**0,16**	

Camshaft bearing clearance [1/100 mm] **B - side**

Bearing No.:	0I	1	2	3	4	5	6	7	8	9	10
Values	**0,18**	**0,23**	**0,18**	**0,2**	**0,2**	**0,2**	**0,18**	**0,18**	**0,18**	**0,2**	**0,23**
Bearing No.:	11	12	13	14	15	16	17	18	19	20	
Values	**0,2**	**0,2**	**0,2**	**0,18**	**0,2**	**0,2**	**0,2**	**0,2**	**0,18**	**0,18**	

Remarks: **Clearance when new 0,159 - 0,246**

Camshaft locating bearing clearances [1/100 mm]	Axial		

Remarks:

Tightening of main bearing and cylinder head

BWSC
Your Global Energy Partner

Author	
Name:	Robert Erkens - Damian Navaro
Department:	TS
Date:	10 February 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V48-60
Engine No.:	1 135 123
Operating hrs:	83916

All bolts are to be tightened with hydraukic pressure as instructed

Main bearing - cap tierod

Pressure stage		Initial stage	Tightening pressure	Zero position dial gauge
Oil pressure	bar	400	1400	400

Δ_L		Min.	Max.
Elongation	mm	4,3	4,8

Bearing No.	I	II	II	IV	V	VI	VII	VIII	IX	X
A side	**4,64**	**4,74**	**4,71**	**4,72**	**4,73**	**4,71**	**4,74**	**4,74**	**4,77**	**4,71**
B side	**4,67**	**4,66**	**4,77**	**4,72**	**4,77**	**4,73**	**4,76**	**4,79**	**4,75**	**4,76**

Main Bearing - cross tierod

Pressure stage		Initial stage	Tightening pressure
Oil Pressure	bar	400	1400

Main bearing 0I (locating bearing)

Pressure stage		Initial stage	Tightening pressure
Oil Pressure	bar	1000	1000

Camshaft bearing

Pressure stage		Initial stage	Tightening pressure
Oil Pressure	bar	1000	1000

Cylinder head

Pressure stage		Initial stage	Tightening pressure
Oil Pressure	bar	750	800
		Nuts 2, 4, 6 and 8	Nuts 1, 3, 5 and 7

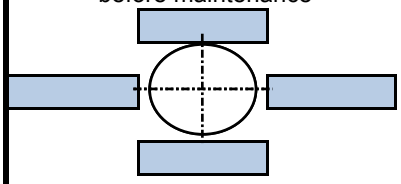
Remarks: New Main Bearings installed.

Service Report Turbocharger NA

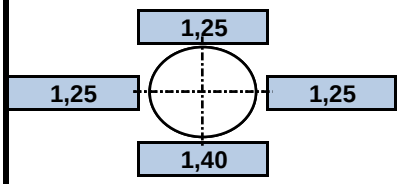
BWSC
Your Global Energy Partner

Author			
Name:	**Robert Erkens**		
Department:	**TS**		
Date:	**15 February 2014**		
Engine			
Plant:	**ACP Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**	Turbocharger type:	**NA48/S**
Engine No.:	**1 135 123 - DE-6**	Turbocharger No.:	**A-side**
Operating hrs:	**83916**		

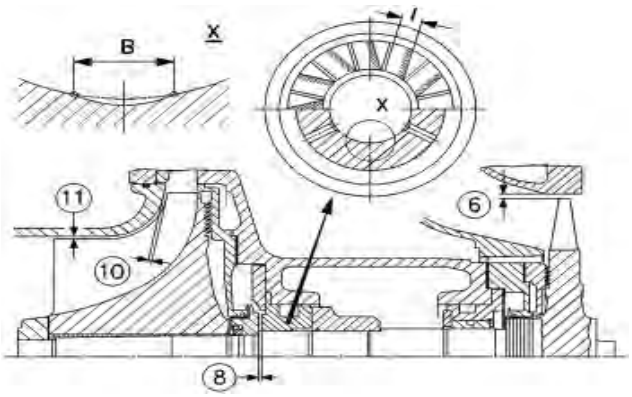
Compressor wheel, gap (11)
before maintenance



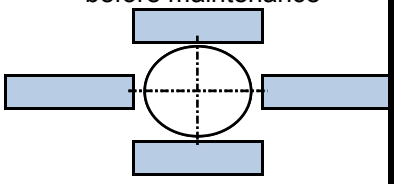
after maintenance



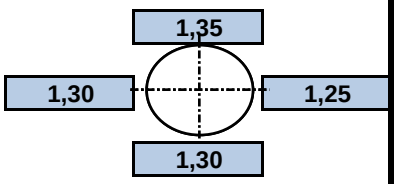
Turbine blade "h"	**98mm**



Turbine rotor, gap (6)
before maintenance



after maintenance



Compressor wheel COC-No.:
18413

Turbine rotor COC-No.:
61097

Maintenance	6	8	10	11	I	B
Tolerance	1,30		2,10	1,65	≤ 6,00mm	≥ 30 mm
Before			---			
After	**1,35**	**0,29**		**1,40**		

Turbocharger check list

BWSC

Author			
Name:	**Robert Erkens**		
Department:	**TS**		
Date:	**17 February 2014**		
Engine			
Plant:	**ACP - Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**	Turbocharger Type:	**NA48S**
Engine No.:	**1 135 123 - DE6**	Turbocharger No.:	**A-side**
Operating hrs.:	**83916**	Operating hrs. last overhaul	**77835**

Air intake casing, if provided
- ☐ fouled

Silencer, if provided

Air filter mat
- ☐ replaced

reason _____

Felt linings
- ☐ fouled
- ☐ wavy ☐

Speed transmitter, if provided
- ☐

Speed indicator, if provided
- ☐

Insert
- ☑ used ☐ replaced
- ☐ fouled

Signs of touching
- ☐ axial ☐ radial
- ☐ over the entire circumference
- ☐ in sections of the circumference

location _____

Compressor casing
- ☑ fouled
- ☐ cracks
- ☐ damaged by foreign object

Bearing casing
- ☐ fouled ☐ cracks

Sealing air bores
- ☐ clogged ☐ cleaned

Oil bores
- ☐ clogged ☐ cleaned

Seals
- ☐ replaced

Sealing air valve, if provided

Valve plate
- ☐ movable ☐ replaced

Locating bearing
- ☐ used ☐ replaced
- ☐ fretting marks ☐ wear
  - ☐ axial face, compressor side
  - ☐ axial face, turbine side

Band width **(B)** _____ mm

Diffuser
- ☑ used ☐ replaced
- ☐ fouled

Vanes
- ☐ bent ☐ incipient cracks
- ☐ damaged by foreign object

Compressor wheel
- ☑ used ☐ replaced

reason _____
- ☐ fouled

Signs of touching
- ☐ axial ☐ radial
- ☐ over the entire circumference
- ☐ in sections of the circumference

location _____

Blades
- ☐ bent ☐ incipient cracks
- ☐ damaged by foreign object

Bore
- ☐ fretting corrosion

Locating ring
- ☑ used ☐ replaced
- ☐ fretting marks ☐ wear
- ☐ fretting corrosion

Thrust ring
- ☑ used ☐ replaced
- ☐ fretting marks ☐ wear
- ☐ fretting corrosion

Labyrinth disk, compressor side

Sealing cover
- ☑ used ☐ replaced
- ☐ abnormal running-in pattern
- ☐ wear
- ☐ signs of touching

End cover, turbine side
- ☑ used ☐ replaced
- ☐ abnormal running-in pattern
- ☐ wear
- ☐ oil coke ☐ cleaned

Turbine rotor
- ☑ used ☐ replaced

reason _____
- ☐ balanced
- ☑ fouled

Signs of touching
- ☐ axial ☐ radial
- ☐ over the entire circumference
- ☐ in sections of the circumference

reason _____

Blades
- ☑ bent
- ☐ incipient cracks
  - ☐ blade
  - ☐ blade foot
  - ☐ foot
- ☑ damaged by foreign object
- ☐ erosion
- ☐ deposits
  - ☐ slightly
  - ☐ heavily
  - ☐ one-side

Bearing points
- ☐ fretting marks ☐ wear

Seating faces
- ☐ fretting corrosion

Location _____

Labyrinth tips
- ☐ oil coke ☐ wear

Shroud ring
- ☑ used ☐ replaced

reason _____
- ☑ fouled
- ☐ erosion

Signs of touching
- ☐ over the entire circumference
- ☐ in sections of the circumference

location _____

Turbocharger check list

Engine

Plant:	**ACP - Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**	Turbocharger Type:	**NA48S**
Engine No.:	**1 135 123 - DE6**	Turbocharger No.:	**A-side**
Operating hrs.:	**83916**	Operating hrs. last overhaul	**77835**

Plain bearing
- [x] used [ ] replaced
- [ ] fretting marks [ ] D1 [ ] D2 [ ] D3
- [ ] wear [ ] D1 [ ] D2 [ ] D3

[x] please tick the appropriate box

Labyrinth disk, turbine side
- [x] used [ ] replaced
- [ ] wear
- [ ] oil coke [ ] cleaned

Turbine nozzle ring
- [x] used [ ] replaced

Vanes
- [ ] bent [ ] incipient cracks
- [ ] damaged by foreign object
- [ ] impacts
- [ ] deposits
  - [ ] slightly
  - [ ] heavily
  - [ ] tinder covered

Gas-admission casing
- [ ] fouled
- [x] cracks
- [ ] erosion
- [ ] damage by foreign object

Screwed connections
- [ ] slack [ ] broken
- [ ] replaced

Gas outlet casing
- [ ] fouled
- [ ] cracks
- [ ] damage by foreign object

Screwed connections
- [ ] slack [ ] broken
- [ ] replaced

Gaps and clearance, (admissible values, see C1 chapter 2.5.5 "Gaps and Clearances")

Item 6	Turbine rotor / shroud ring	radial gap	**1,35**	mm
Item 8	Locating bearing / locating ring	axial clearance	**0,29**	mm
Item 10	Compressor wheel / insert	axial gap		mm
Item 11	Compressor wheel / insert	radial gap	**1,4**	mm
Item 16	Face run out, compressor wheel			mm

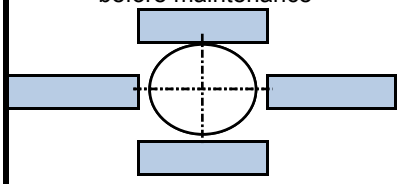
Remarks: Turbocharger was opened up on the turbine side by removing the "Gas-admission casing.
The nozzle ring was very dirty on the back side of the blades, shroud ring was also dirty.
The nozzle ring and shroud ring where removed of the casings for cleaning by means of sand blasting.
Turbine blades are fouled but no abnormalities where found.
The compressor side was inspected by removing inlet sucktion pipe, cleaned and measurements were taken.

Service Report Turbocharger NA

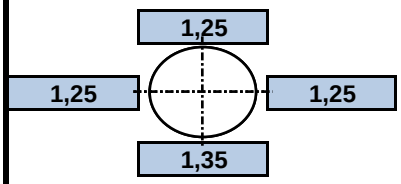
BWSC
Your Global Energy Partner

Author			
Name:	**Robert Erkens**		
Department:	**TS**		
Date:	**15 February 2014**		
Engine			
Plant:	**ACP Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**	Turbocharger type:	**NA48/S**
Engine No.:	**1 135 123 - DE-6**	Turbocharger No.:	**B-side**
Operating hrs:	**83916**		

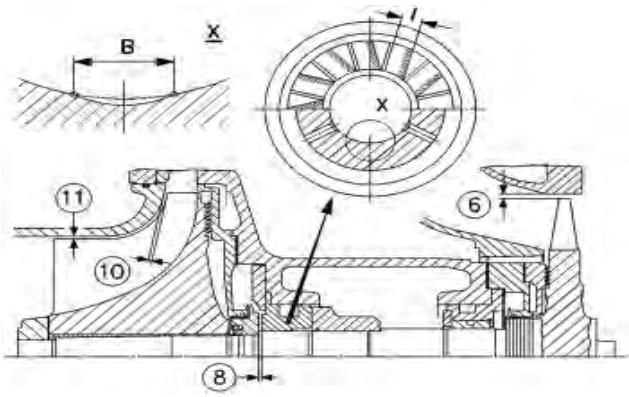
Compressor wheel, gap (11)
before maintenance



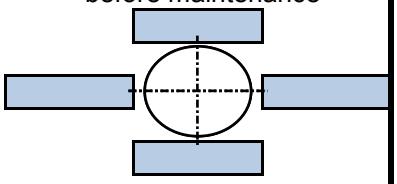
after maintenance



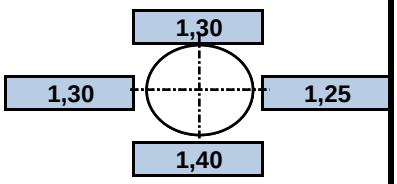
Turbine blade "h"	**98mm**



Turbine rotor, gap (6)
before maintenance



after maintenance



Compressor wheel COC-No.:
18474

Turbine rotor COC-No.:
65509

Maintenance	6	8	10	11	l	B
Tolerance	1,30		2,10	1,65	≤ 6,00mm	≥ 30 mm
Before			---			
After	**1,35**	**0,29**		**1,40**		

Turbocharger check list

BWSC

Author			
Name:	**Robert Erkens**		
Department:	**TS**		
Date:	**17 February 2014**		
Engine			
Plant:	**ACP - Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**	Turbocharger Type:	**NA48S**
Engine No.:	**1 135 123 - DE6**	Turbocharger No.:	**B-side**
Operating hrs.:	**83916**	Operating hrs. last overhaul	**77835**

Air intake casing, if provided
- ☐ fouled

Silencer, if provided

Air filter mat
- ☐ replaced

reason _____

Felt linings
- ☐ fouled
- ☐ wavy ☐

Speed transmitter, if provided
- ☐

Speed indicator, if provided
- ☐

Insert
- ☑ used ☐ replaced
- ☐ fouled

Signs of touching
- ☐ axial ☐ radial
- ☐ over the entire circumference
- ☐ in sections of the circumference

location _____

Compressor casing
- ☑ fouled
- ☐ cracks
- ☐ damaged by foreign object

Bearing casing
- ☐ fouled ☐ cracks

Sealing air bores
- ☐ clogged ☐ cleaned

Oil bores
- ☐ clogged ☐ cleaned

Seals
- ☐ replaced

Sealing air valve, if provided

Valve plate
- ☐ movable ☐ replaced

Locating bearing
- ☐ used ☐ replaced
- ☐ fretting marks ☐ wear
  - ☐ axial face, compressor side
  - ☐ axial face, turbine side

Band width **(B)** _____ mm

Diffuser
- ☑ used ☐ replaced
- ☐ fouled

Vanes
- ☐ bent ☐ incipient cracks
- ☐ damaged by foreign object

Compressor wheel
- ☑ used ☐ replaced

reason _____
- ☐ fouled

Signs of touching
- ☐ axial ☐ radial
- ☐ over the entire circumference
- ☐ in sections of the circumference

location _____

Blades
- ☐ bent ☐ incipient cracks
- ☐ damaged by foreign object

Bore
- ☐ fretting corrosion

Locating ring
- ☑ used ☐ replaced
- ☐ fretting marks ☐ wear
- ☐ fretting corrosion

Thrust ring
- ☑ used ☐ replaced
- ☐ fretting marks ☐ wear
- ☐ fretting corrosion

Labyrinth disk, compressor side

Sealing cover
- ☑ used ☐ replaced
- ☐ abnormal running-in pattern
- ☐ wear
- ☐ signs of touching

End cover, turbine side
- ☑ used ☐ replaced
- ☐ abnormal running-in pattern
- ☐ wear
- ☐ oil coke ☐ cleaned

Turbine rotor
- ☑ used ☐ replaced

reason _____
- ☐ balanced
- ☑ fouled

Signs of touching
- ☐ axial ☐ radial
- ☐ over the entire circumference
- ☐ in sections of the circumference

reason _____

Blades
- ☑ bent
- ☐ incipient cracks
  - ☐ blade
  - ☐ blade foot
  - ☐ foot
- ☑ damaged by foreign object
- ☐ erosion
- ☐ deposits
  - ☐ slightly
  - ☐ heavily
  - ☐ one-side

Bearing points
- ☐ fretting marks ☐ wear

Seating faces
- ☐ fretting corrosion

Location _____

Labyrinth tips
- ☐ oil coke ☐ wear

Shroud ring
- ☑ used ☐ replaced

reason _____
- ☑ fouled
- ☐ erosion

Signs of touching
- ☐ over the entire circumference
- ☐ in sections of the circumference

location _____

Turbocharger check list

Engine

Plant:	**ACP - Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**	Turbocharger Type:	**NA48S**
Engine No.:	**1 135 123 - DE6**	Turbocharger No.:	**B-side**
Operating hrs.:	**83916**	Operating hrs. last overhaul	**77835**

Plain bearing
- [x] used [ ] replaced
- [ ] fretting marks [ ] D1 [ ] D2 [ ] D3
- [ ] wear [ ] D1 [ ] D2 [ ] D3

[x] please tick the appropriate box

Labyrinth disk, turbine side
- [x] used [ ] replaced
- [ ] wear
- [ ] oil coke [ ] cleaned

Turbine nozzle ring
- [x] used [ ] replaced

Vanes
- [ ] bent [ ] incipient cracks
- [ ] damaged by foreign object
- [ ] impacts
- [ ] deposits
  - [ ] slightly
  - [ ] heavily
  - [ ] tinder covered

Gas-admission casing
- [ ] fouled
- [x] cracks
- [ ] erosion
- [ ] damage by foreign object

Screwed connections
- [ ] slack [ ] broken
- [ ] replaced

Gas outlet casing
- [ ] fouled
- [ ] cracks
- [ ] damage by foreign object

Screwed connections
- [ ] slack [ ] broken
- [ ] replaced

Gaps and clearance, (admissible values, see C1 chapter 2.5.5 "Gaps and Clearances")

Item 6	Turbine rotor / shroud ring	radial gap	**1,40**	mm
Item 8	Locating bearing / locating ring	axial clearance	**0,29**	mm
Item 10	Compressor wheel / insert	axial gap		mm
Item 11	Compressor wheel / insert	radial gap	**1,35**	mm
Item 16	Face run out, compressor wheel			mm

Remarks: Turbocharger was opened up on the turbine side by removing the "Gas-admission casing.
The nozzle ring was very dirty on the back side of the blades, shroud ring was also dirty.
The nozzle ring and shroud ring where removed of the casings for cleaning by means of sand blasting.
Turbine blades are fouled some of the tips are bent due to a foreign object.
The compressor side was inspected by removing inlet sucktion pipe, cleaned and measurements were taken.

Vulkan Coupling

BWSC
Your Global Energy Partner

Author			
Name:	**Lonas Mertz / Robert Erkens**		
Department:	**TS 535**		
Date:	**22 February 2014**		
Engine			
Plant:	**ACP- Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**		
Engine No.:	**1 135 123 DE-6**	Coupling Type	**DOKU 1G582Y 0026E**
Operating hrs:	**83916**	Coupling Hrs	**28622**

Figure 1

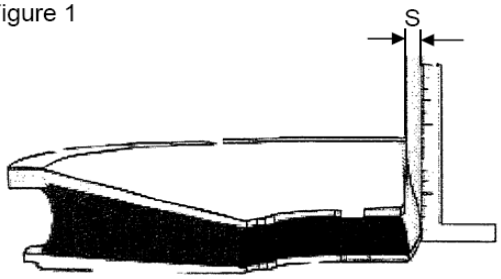
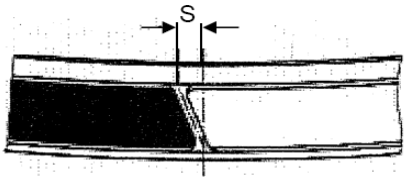
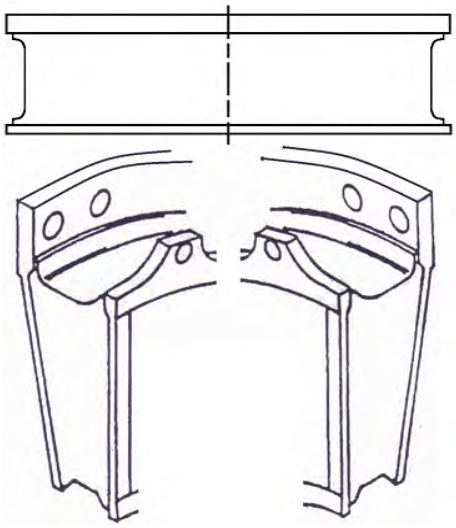


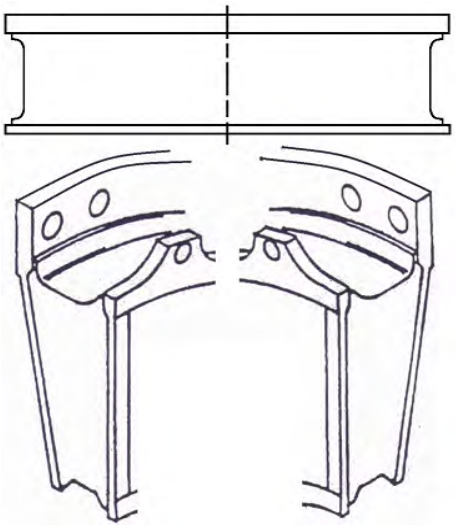
Figure 2



	Date of last measurement							
				22-Feb-14	3-Jul-13	12-Oct-11	26-Nov-10	25-Feb-10
1-1				36	35	35	21	18
1-2				36	38	35	21	18
1-3				36	37	35	21	18
1-4				36	37	35	21	18
2-1				36	40	35	21	18
2-2				36	40	35	21	18
2-3				36	40	35	21	18
2-4				36	40	35	21	18

Note: To draw in a crack line, please double click on the below shown picture





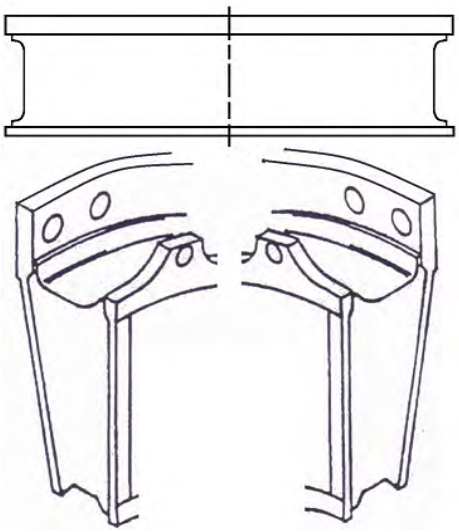
	1-1	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	

	1-2	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	

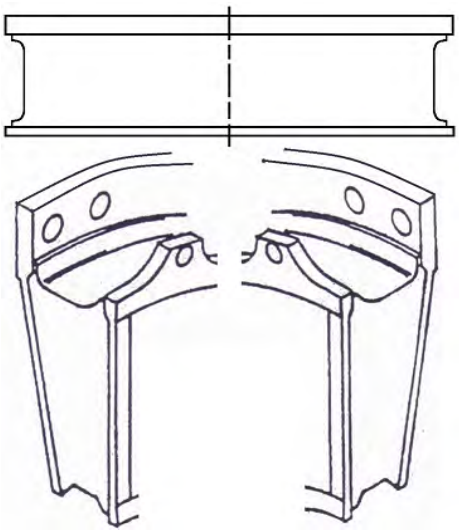
Vulkan Coupling

Your Global Energy Partner

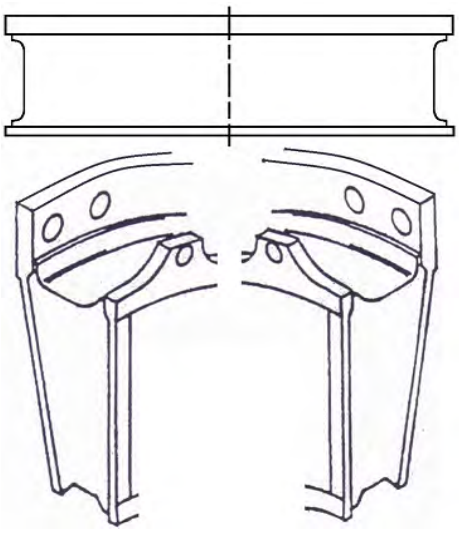
Engine			
Plant:	**ACP- Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**		
Engine No.:	**1 135 123 DE-6**	Coupling Type	**DOKU 1G582Y 0026E**
Operating hrs:	**83916**	Coupling Hrs	**28622**



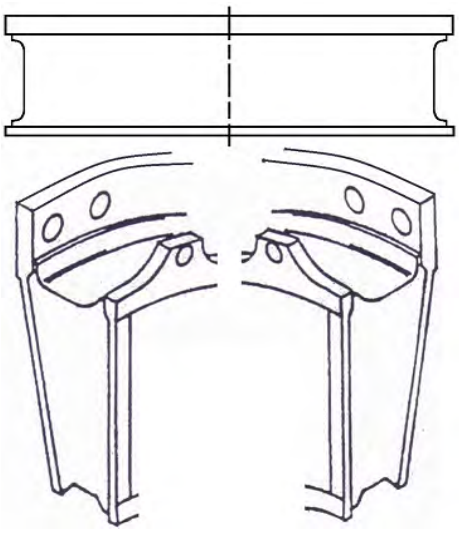
	1-3	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	



	1-4	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	



	2-1	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	

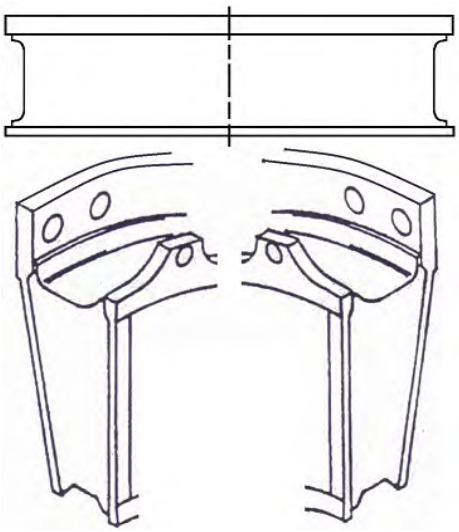


	2-2	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	

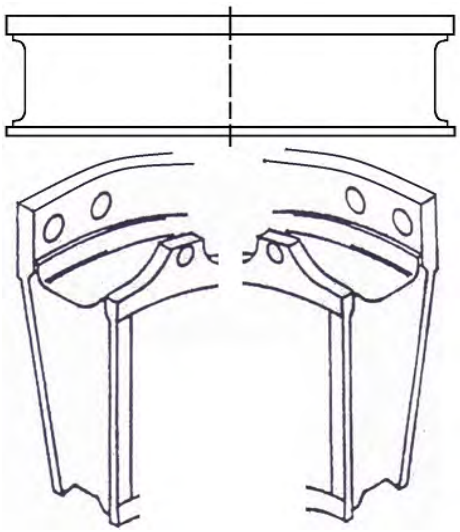
Vulkan Coupling

Your Global Energy Partner

Engine			
Plant:	**ACP- Miraflores Power Station**		
Engine type:	**MAN 18V 48/60**		
Engine No.:	**1 135 123 DE-6**	Coupling Type	**DOKU 1G582Y 0026E**
Operating hrs:	**83916**	Coupling Hrs	**28622**



	2-3	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	



	2-4	
	Long mm	
	Deep mm	
	Wide mm	
	Drop mm	

Remarks: No cracks were found.

Tightening of connection rod shank bolts

BWSC
Your Global Energy Partner

Author	
Name:	
Department:	
Date:	

Engine	
Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**

Length not tightened = **276** [mm]
Oil Pressure = **800** [bar]

Δ_L Soll = **0,55** [mm]
Δ_L Nominal = **0,4** [mm]

Viewer from piston onto connecting rod

FEE = Free engine end
CS = Coupling side

		Measurement values L_u, L_g and bolt elogation Δ_L [mm]								
A - Bank		**Cylinder - No.**								
		1	2	3	4	5	6	7	8	9
Bolt 1	L_u	0,05	0,02	0,05	0,03	0,03	0,05	0,03	0,02	0,05
	L_g	0,51	0,51	0,51	0,53	0,53	0,54	0,55	0,53	0,53
	Δ_L	**0,46**	**0,49**	**0,46**	**0,50**	**0,50**	**0,49**	**0,52**	**0,51**	**0,48**
Bolt 2	L_u	0,02	0,03	0,03	0,03	0,05	0,03	0,01	0,04	0,05
	L_g	0,50	0,52	0,53	0,51	0,53	0,53	0,50	0,53	0,52
	Δ_L	**0,48**	**0,49**	**0,50**	**0,48**	**0,48**	**0,50**	**0,49**	**0,49**	**0,47**
Bolt 3	L_u	0,03	0,03	0,03	0,05	0,00	0,04	0,02	0,04	0,06
	L_g	0,51	0,51	0,51	0,53	0,52	0,55	0,52	0,54	0,52
	Δ_L	**0,48**	**0,48**	**0,48**	**0,48**	**0,52**	**0,51**	**0,50**	**0,50**	**0,46**
Bolt 4	L_u	0,07	0,02	0,05	0,05	0,06	0,03	0,05	0,05	0,04
	L_g	0,50	0,47	0,53	0,52	0,50	0,51	0,54	0,54	0,52
	Δ_L	**0,43**	**0,45**	**0,48**	**0,47**	**0,44**	**0,48**	**0,49**	**0,49**	**0,48**
Bolt 5	L_u	0,02	0,02	0,04	0,05	0,05	0,05	0,01	0,04	0,06
	L_g	0,50	0,51	0,52	0,51	0,50	0,54	0,52	0,50	0,54
	Δ_L	**0,48**	**0,49**	**0,48**	**0,46**	**0,45**	**0,49**	**0,51**	**0,46**	**0,48**
Bolt 6	L_u	0,03	0,01	0,03	0,04	0,05	0,08	0,01	0,05	0,04
	L_g	0,51	0,53	0,52	0,51	0,52	0,56	0,53	0,52	0,53
	Δ_L	**0,48**	**0,52**	**0,49**	**0,47**	**0,47**	**0,48**	**0,52**	**0,47**	**0,49**
Bolt 7	L_u	0,05	0,02	0,05	0,06	0,06	0,07	0,01	0,04	0,04
	L_g	0,52	0,51	0,50	0,53	0,52	0,55	0,52	0,50	0,53
	Δ_L	**0,47**	**0,49**	**0,45**	**0,47**	**0,46**	**0,48**	**0,51**	**0,46**	**0,49**
Bolt 8	L_u	0,02	0,00	0,03	0,03	0,04	0,07	0,05	0,06	0,03
	L_g	0,52	0,52	0,51	0,53	0,53	0,55	0,54	0,50	0,53
	Δ_L	**0,50**	**0,52**	**0,48**	**0,50**	**0,49**	**0,48**	**0,49**	**0,44**	**0,50**

Remarks:
Piston A4 shank bolt number 4 had a strange damage this one was change for a new one.

Tightening of connection rod shank bolts

BWSC
Your Global Energy Partner

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V48/60**
Engine No.:	**1 135 123 DE-6**

Length not tightened = **276** [mm]
Oil Pressure = **800** [bar]

Δ_L Soll = **0,55** [mm]
Δ_L Nominal = **0,4** [mm]

Viewer from piston onto connecting rod

FEE = Free engine end
CS = Coupling side

Measurement values L_u, L_g and bolt elogation Δ_L [mm]

B - Bank		Cylinder - No. 1	2	3	4	5	6	7	8	9
Bolt 1	L_u	0,02	0,02	0,04	0,02	0,05	0,05	0,05	0,03	0,05
	L_g	0,51	0,51	0,52	0,52	0,52	0,54	0,53	0,54	0,56
	Δ_L	**0,49**	**0,49**	**0,48**	**0,50**	**0,47**	**0,49**	**0,48**	**0,51**	**0,51**
Bolt 2	L_u	0,02	0,04	0,03	0,02	0,06	0,03	0,05	0,04	0,07
	L_g	0,51	0,50	0,52	0,51	0,54	0,53	0,55	0,52	0,52
	Δ_L	**0,49**	**0,46**	**0,49**	**0,49**	**0,48**	**0,50**	**0,50**	**0,48**	**0,45**
Bolt 3	L_u	0,02	0,00	0,04	0,00	0,08	0,05	0,02	0,04	0,05
	L_g	0,52	0,51	0,52	0,50	0,54	0,54	0,52	0,49	0,53
	Δ_L	**0,50**	**0,51**	**0,48**	**0,50**	**0,46**	**0,49**	**0,50**	**0,45**	**0,48**
Bolt 4	L_u	0,03	0,02	0,04	0,02	0,07	0,04	0,06	0,04	0,06
	L_g	0,52	0,51	0,50	0,51	0,55	0,55	0,56	0,52	0,53
	Δ_L	**0,49**	**0,49**	**0,46**	**0,49**	**0,48**	**0,51**	**0,50**	**0,48**	**0,47**
Bolt 5	L_u	0,03	0,04	0,05	0,03	0,05	0,03	0,04	0,04	0,05
	L_g	0,51	0,51	0,51	0,51	0,50	0,52	0,51	0,53	0,50
	Δ_L	**0,48**	**0,47**	**0,46**	**0,48**	**0,45**	**0,49**	**0,47**	**0,49**	**0,45**
Bolt 6	L_u	0,03	0,04	0,05	0,04	0,05	0,02	0,03	0,03	0,06
	L_g	0,51	0,52	0,52	0,50	0,52	0,50	0,50	0,53	0,49
	Δ_L	**0,48**	**0,48**	**0,47**	**0,46**	**0,47**	**0,48**	**0,47**	**0,50**	**0,43**
Bolt 7	L_u	0,04	0,05	0,05	0,04	0,02	0,03	0,02	0,06	0,07
	L_g	0,53	0,52	0,53	0,53	0,51	0,53	0,53	0,54	0,56
	Δ_L	**0,49**	**0,47**	**0,48**	**0,49**	**0,49**	**0,50**	**0,51**	**0,48**	**0,49**
Bolt 8	L_u	0,05	0,05	0,05	0,01	0,03	0,04	0,05	0,05	0,03
	L_g	0,51	0,52	0,51	0,50	0,53	0,52	0,55	0,54	0,52
	Δ_L	**0,46**	**0,47**	**0,46**	**0,49**	**0,50**	**0,48**	**0,50**	**0,49**	**0,49**

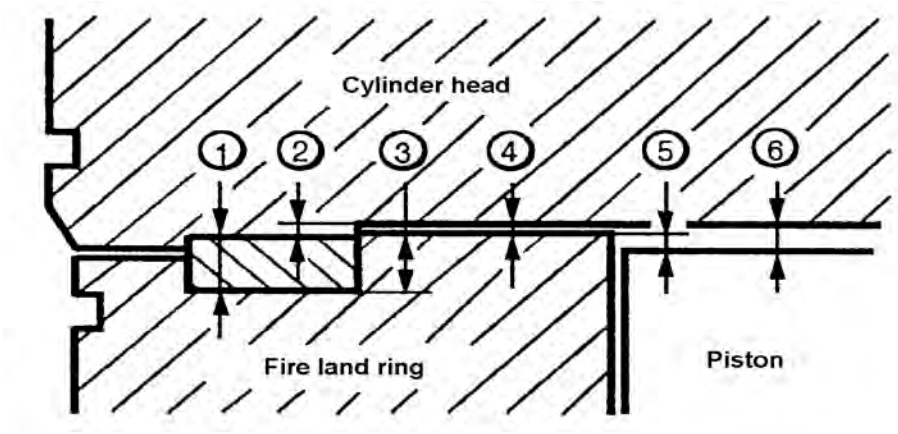
Remarks: Piston B-7 all shank bolts were replaced for new ones.

Piston Alignment

BWSC
Your Global Energy Partner

Author	
Name:	Fernando Flores & Robert Erkens
Department:	TS-535
Date:	21 February 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123 DE-6
Operating hrs:	83916



(4) = (1) + (2) - (3)

(6) = (4) + (5)

Cylinder No:		1	2	3	4	5	6	7	8	9
Seal ring Thickness (mm)										
M1	A-side	10,97	10,97	10,98	10,98	10,97	10,98	10,96	10,97	10,96
	B-side	10,99	10,98	10,98	10,98	10,98	10,99	10,98	10,98	10,98
Slot depth - cylinder head (mm)										
M2	A-side	2,00	1,99	1,97	1,96	1,99	2,00	1,98	1,95	2,00
	B-side	1,99	1,95	1,98	1,98	2,01	1,97	1,96	1,98	1,99
Slot depth - Fire land ring (top land ring) (mm)										
M3	A-side	11,06	11,06	11,06	11,06	11,06	11,07	11,07	11,06	11,06
	B-side	11,06	11,07	11,06	11,07	11,06	11,05	11,07	11,06	11,07
Gap cylinder head - Fire land ring (mm) this is calculated.										
M4	A-side	1,91	1,90	1,89	1,88	1,90	1,91	1,87	1,86	1,90
	B-side	1,92	1,86	1,90	1,89	1,93	1,91	1,87	1,90	1,90
Piston - TDC (mm)										
M5	A-side	3,04	3,12	3,45	2,86	2,85	2,90	2,87	2,97	3,16
	B-side	3,00	2,93	3,40	2,90	2,77	2,95	3,14	2,92	2,93
Compression gap (mm) this is calculated.										
M6	A-side	**4,95**	**5,02**	**5,34**	**4,74**	**4,75**	**4,81**	**4,74**	**4,83**	**5,06**
	B-side	**4,92**	**4,79**	**5,30**	**4,79**	**4,70**	**4,86**	**5,01**	**4,82**	**4,83**

Remark:

Crankshaft alignment

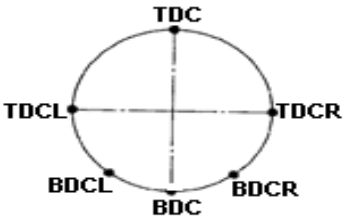
BWSC
Your Global Energy Partner

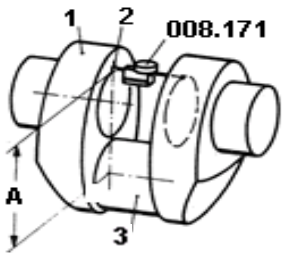
Author	
Name:	Robert Erkens
Department:	TS 535
Date:	01 March 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123 DE-6
Operating hrs:	83916

90° left of TDC (TDCL)
Left of BDC (BDCL)
Bottom dead centre (BDC)

Right of BDC ((BDCR)
90° right of TDC (TDCR)
Top dead centre (TDC)





1 = Crank web
2 = Measuring point (punch mark)
3 = Crank pin
A = Distance between measuring points
008.171 = Dial gauge (measuring device)

Turn the crankshaft in the turning direction of Engine up to the desired measuring positions.
At every position, take readings of magnitude and direction (+ or -) of the indicated measured values in comparison to the initial value (Zero) and enter them into the table.
Attention: In case of a V-type engine, make sure that the measuring device is not damaged by the slave connecting rod while turning the crankshaft.

( ) Line engine (•) Vee engine

Cyl. 1 driving end

Engine ( ) rigid coupled (•) flexible coupled (•) operating direction clockwise ( ) operating direction anticlockwise

Mounting ( ) frame ( ) rigid (•) flexible ( ) semi-resilient

Values for deflection measurement in 1/100 mm

Engine (•) hot cond. ( ) cold cond.

Ambient 35 ° C
Oil temp. 48 ° C
Coolingwater temp. 58 ° C

RL	LL	1	2	3	4	5	6	7	8	9
BDCL	BDCR	0	0	0	0	0	0	0	0	0
TDCL	TDCR	-2,9	4	-0,8	-2,4	-3,7	-4,4	-5,4	-3,9	-1,8
TDC	TDC	-10,4	-0,4	-2,9	-4,9	-5	-6,5	-7,9	-5,7	-4,4
TDCR	TDCL	-9,5	2,3	-0,2	-1,5	-1,7	-1,5	-2,2	-0,9	-1,6
BDCR	BDCL	0,5	4,2	1	-0,4	1,4	1,4	0,3	1,2	-0,1

Web deflection in 1/100 mm +/- 23
Measuring point distance (A) in mm 580

With the engine in operating temperature, negative values which are by 20% higher are admissible.

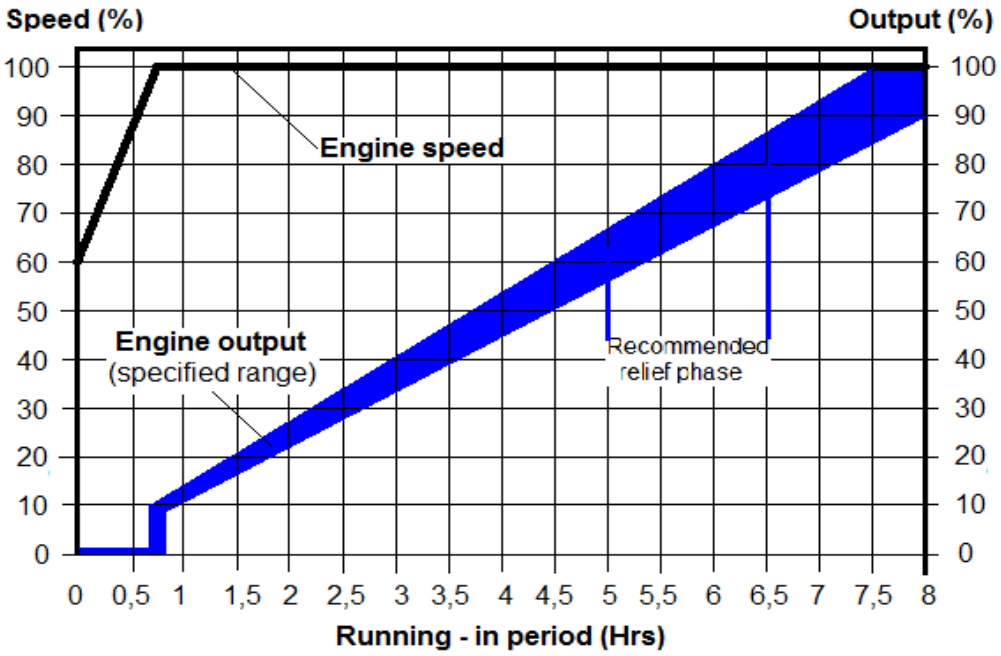
These are the maximum deflection values and the measuring point distances A. The maximum values apply to all cylinders with the engine either cold or at operating temperature, either rigidly or flexibly coupled.
If the actual deflection values exceed the figures listed above, the crankshaft has to be realigned.
Please also note: The difference of the TDC measurements of the neighbouring cylinders should not be larger than the maximum admissible crank web deflection.

Remarks:

Running-in Program

BWSC
Your Global Energy Partner

Author	
Name:	**Robert Erkens**
Department:	**TS-535**
Date:	**03-03-2014**
Engine	
Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83916**



Please note the recommended relief phase after 5.0 and 6.5 hours

Engine start		Time:	**10:19**										
Engine on load		Time:	**11:12**										
E [%]	**10**	**20**	**30**	**40**	**50**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**100**
Time	11:12	12:12	13:12	14:12	15:30	17:20	17:50	18:20	18:50	20:26	09:11	09:41	10:43
Load	1,8	3,6	5,4	7,2	9	10,8	11,7	12,6	13,5	14,4	15,3	16,2	18
Exh av		398	420	425	421	414	415	411	414	416	417	419	434
MB av		77,5	78,3	79,1	79,8	81,7	82,4	83	83,6	84,3	85	85,5	85,1
Spl av		68,8	69,7	69,9	70,2	70,6	71,1	71,4	71,6	71,7	71,8	72,4	

Exh av = Exhaust Gas Temperature Average
MB av = Main Bearings Temperature Average
Spl av = Splesh Oil Temperature Average
General remarks: MW loading table 10% every hour
After 1 hour of full load the engine can be adjust as needed.
Leave Cylinder lube oil in Run mode.

Remarks: Performance test need to be done at 50%, 75% and 100% load.
2-March-14 16:20 Hrs performance test done 50% load, 18:00 Hrs exhaust temp on A1 & B2 high adjusted
19:56 Hrs performance test done 75% load, 20:32 Hrs engine trip on L.O. Outlet T/C "B" temp H/High
3-March-14 08:40 Hrs DE-6 back on line, 11:28 Hrs performance test done 100% load.

Engine Performance sheet

BWSC
Your Global Energy Partner

Author	
Name:	Solis & Herrings
Department:	Operaciones
Date:	02 March 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123 DE-6
Operating hrs:	83922

Date		02 March 2014	
Time		15:55:00	
Run. hours <= 100%	[h]		
Run. hours > 100%	[h]		
Total running hours	[h]	83922	
Governor		**A**	**B**
Load governor	scale	4,9	
Fuel pump index 1	[mm]	38	36
Fuel pump index 2	[mm]	34	38
Fuel pump index 3	[mm]	35	31
Fuel pump index 4	[mm]	29	33
Fuel pump index 5	[mm]	36	33
Fuel pump index 6	[mm]	33	36
Fuel pump index 7	[mm]	36	36
Fuel pump index 8	[mm]	35	33
Fuel pump index 9	[mm]	34	32
Average	[mm]	34,4	34,2
Filters			
Consumption Lube oil			
Lube oil filter flush.Interv.	[1/h]		

Consumption Fuel oil			
Fuel oil filter flush.Interv.	[1/h]		

Exhaust gas		**A**	**B**
Exh. gas press. aft. Tc	[mm]		
Temp. after cyl. 1	[°C]	471	422
Temp. after cyl. 2	[°C]	414	488
Temp. after cyl. 3	[°C]	414	382
Temp. after cyl. 4	[°C]	378	420
Temp. after cyl. 5	[°C]	424	387
Temp. after cyl. 6	[°C]	415	446
Temp. after cyl. 7	[°C]	412	441
Temp. after cyl. 8	[°C]	413	399
Temp. after cyl. 9	[°C]	410	385
Average	[°C]	416,8	418,9
Before turbocharger	[°C]	515	520
After turbocharger	[°C]	458	461
n tc A/B	[rpm]	10520	10540

Remarks:

Engine Performance sheet

BWSC Your Global Energy Partner

Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83922**

Ignition pressures			**A**	**B**
Cylinder	**1**	[bar]	**103**	**89**
Cylinder	**2**	[bar]	**91**	**99**
Cylinder	**3**	[bar]	**89**	**90**
Cylinder	**4**	[bar]	**98**	**87**
Cylinder	**5**	[bar]	**96**	**90**
Cylinder	**6**	[bar]	**89**	**102**
Cylinder	**7**	[bar]	**92**	**90**
Cylinder	**8**	[bar]	**93**	**95**
Cylinder	**9**	[bar]	**91**	**90**
Average		[bar]	**93,6**	**92,4**

Power		
Geno power	[kWe]	**8900**
Engine power	[kW]	
Cos phi.		**0m94**
Voltage	[V]	**14000**
Current	[A]	**346**
Engine power	[%]	**50**
Engine n	[rpm]	**514**

Intake air		**A**	**B**
Ambient temperature	[°C]	**33,2**	
Temp.aft.ch.air cooler	[°C]	**47**	**45**
Press.aft.ch.air cooler	[bar]	**0,8**	**0,9**
Delta press.ch.air cooler	[mbar]	**0,013**	**0,016**
Delta press.inlet air filter	[mbar]	**-1,2**	
Suction press.bef.tc	[mbar]		
Blow-by flap		☐ on	☐ off
Charge air preheating		☐ on	☐ off
Crankcase pressure	[mm/H_2O]		

Fuel		
Press.before engine	[bar]	**8,5**
Temp.after preheater	[°C]	**136**
Viscosity aft.preheat.	[cSt]	**11,1**
Temp. service tank	[°C]	**92**
Temp. Bef. Engine	[°C]	**141**

Nozzle cooling water		
Press.bef.engine	[bar]	**3,7**
Temp.bef.engine	[°C]	**55**
Temp. Bef. Cooler	[°C]	

Lub oil main system		**A**	**B**
Press.bef. engine	[bar]	**41,0**	
Temp.bef. engine	[°C]	**58**	
Press.bef.tc	[bar]	**1,5**	
Temp.after tc A/B	[°C]	**71**	**71**

Jacket cooling water (HT)			
Press.bef.engine	[bar]	**3,7**	
Temp.bef.engine	[°C]	**83**	
Temp.aft.engine	[°C]	**90**	

Charge air cooling water (HT + LT)			
Press.bef.intercooler	[bar]	**1,1(HT)**	**2,9(LT)**
Temp.bef.intercooler HT	[°C]	**86**	
Temp.aft.intercooler HT	[°C]	**84**	
Temp.bef.intercooler LT	[°C]	**32**	
Temp.aft.intercooler LT	[°C]	**45**	

Bearing temperature		
OI	[°C]	**67,0**
I	[°C]	**79,0**
II	[°C]	**85,0**
III	[°C]	**79,0**
IV	[°C]	**82,0**
V	[°C]	**83,0**
VI	[°C]	**85,0**
VII	[°C]	**81,0**
VIII	[°C]	**80,0**
IX	[°C]	**83,0**
X	[°C]	**77,0**
Average	[°C]	**80,09**

Splash oil temperature		
Cyl. **1**	[°C]	**70,0**
Cyl. **2**	[°C]	**70,0**
Cyl. **3**	[°C]	**70,0**
Cyl. **4**	[°C]	**70,0**
Cyl. **5**	[°C]	**70,0**
Cyl. **6**	[°C]	**70,0**
Cyl. **7**	[°C]	**70,0**
Cyl. **8**	[°C]	**70,0**
Cyl. **9**	[°C]	**70,0**
Average	[°C]	**70,00**

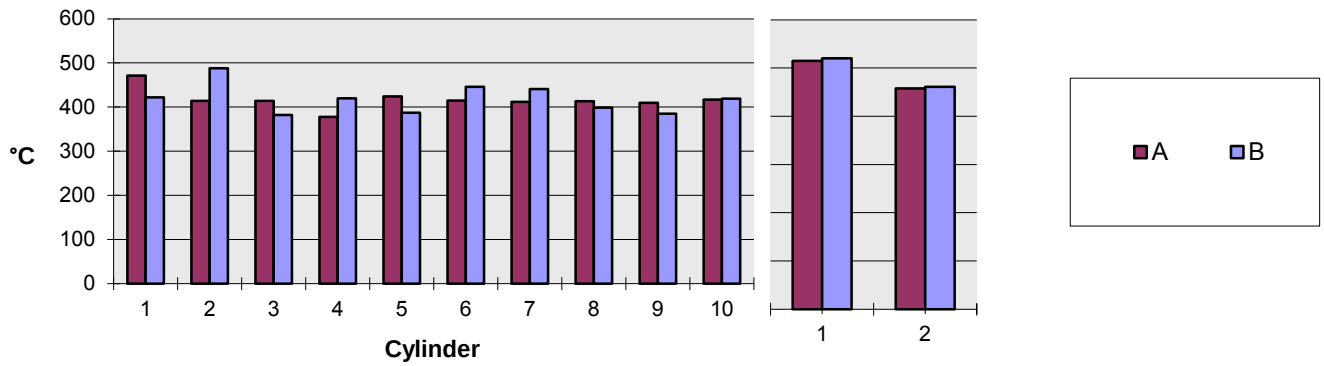
Engine Performance sheet

BWSC
Your Global Energy Partner

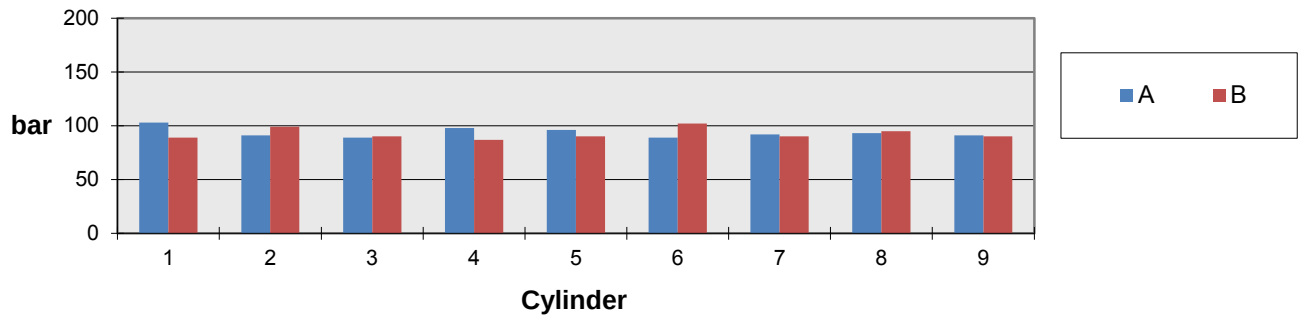
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83922**

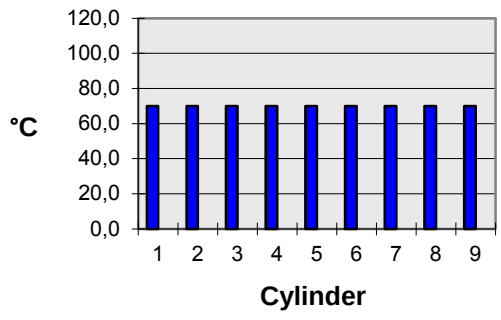
Exhaust gas temperature



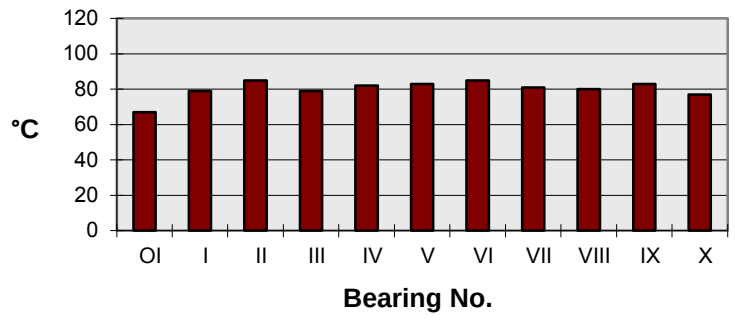
Ignition pressure



Splash oil temperature



Bearing temperature



Engine Performance sheet

BWSC
Your Global Energy Partner

Author	
Name:	Huan Roy Herrings
Department:	Operaciones
Date:	02 March 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123 DE-6
Operating hrs:	83925

Date		02 March 2014	
Time		15:55:00	
Run. hours <= 100%	[h]		
Run. hours > 100%	[h]		
Total running hours	[h]	83925	
Governor		**A**	**B**
Load governor	scale	6,7	
Fuel pump index 1	[mm]	46	47
Fuel pump index 2	[mm]	46	45
Fuel pump index 3	[mm]	46	43
Fuel pump index 4	[mm]	41	47
Fuel pump index 5	[mm]	48	46
Fuel pump index 6	[mm]	43	50
Fuel pump index 7	[mm]	47	50
Fuel pump index 8	[mm]	45	47
Fuel pump index 9	[mm]	45	46
Average	[mm]	45,2	46,8
Filters			
Consumption Lube oil			
Lube oil filter flush.Interv.	[1/h]		

Consumption Fuel oil			
Fuel oil filter flush.Interv.	[1/h]		

Exhaust gas		**A**	**B**
Exh. gas press. aft. Tc	[mm]		
Temp. after cyl. 1	[°C]	410	409
Temp. after cyl. 2	[°C]	409	413
Temp. after cyl. 3	[°C]	412	380
Temp. after cyl. 4	[°C]	384	407
Temp. after cyl. 5	[°C]	421	386
Temp. after cyl. 6	[°C]	412	434
Temp. after cyl. 7	[°C]	412	432
Temp. after cyl. 8	[°C]	414	393
Temp. after cyl. 9	[°C]	418	399
Average	[°C]	410,2	405,9
Before turbocharger	[°C]	506	507
After turbocharger	[°C]	401	398
n tc A/B	[rpm]	13720	13750

Remarks:

Engine Performance sheet

BWSC
Your Global Energy Partner

Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83925**

Ignition pressures			**A**	**B**
Cylinder	**1**	[bar]	**137**	**130**
Cylinder	**2**	[bar]	**139**	**138**
Cylinder	**3**	[bar]	**140**	**134**
Cylinder	**4**	[bar]	**156**	**130**
Cylinder	**5**	[bar]	**148**	**133**
Cylinder	**6**	[bar]	**139**	**146**
Cylinder	**7**	[bar]	**142**	**132**
Cylinder	**8**	[bar]	**141**	**139**
Cylinder	**9**	[bar]	**137**	**130**
Average		[bar]	**142,1**	**134,7**

Power			
Geno power	[kWe]		
Engine power	[kW]	**13400**	
Cos phi.		**0,97**	
Voltage	[V]	**14000**	
Current	[A]	**540**	
Engine power	[%]	**75**	
Engine n	[rpm]	**514**	

Intake air		**A**	**B**
Ambient temperature	[°C]	**33,2**	
Temp.aft.ch.air cooler	[°C]	**47**	**45**
Press.aft.ch.air cooler	[bar]	**0,8**	**0,9**
Delta press.ch.air cooler	[mbar]	**0,013**	**0,016**
Delta press.inlet air filter	[mbar]	**-1,2**	
Suction press.bef.tc	[mbar]		
Blow-by flap		☐ on	☐ off
Charge air preheating		☐ on	☐ off
Crankcase pressure	[mm/H_2O]		

Fuel		
Press.before engine	[bar]	**8,6**
Temp.after preheater	[°C]	**140**
Viscosity aft.preheat.	[cSt]	**11,7**
Temp. service tank	[°C]	**100**
Temp. Bef. Engine	[°C]	**140**

Nozzle cooling water		
Press.bef.engine	[bar]	**3,7**
Temp.bef.engine	[°C]	**57**
Temp. Bef. Cooler	[°C]	

Lub oil main system		**A**	**B**
Press.bef. engine	[bar]	**4,2**	
Temp.bef. engine	[°C]	**57**	
Press.bef.tc	[bar]	**1,5**	
Temp.after tc A/B	[°C]	**78**	**80**
Jacket cooling water (HT)			
Press.bef.engine	[bar]	**3,4**	
Temp.bef.engine	[°C]	**83**	**83**
Temp.aft.engine	[°C]	**90**	**90**
Charge air cooling water (HT + LT)			
Press.bef.intercooler	[bar]	**3,6**	
Temp.bef.intercooler HT	[°C]	**80**	**80**
Temp.aft.intercooler HT	[°C]	**83**	**83**
Temp.bef.intercooler LT	[°C]	**32**	**32**
Temp.aft.intercooler LT	[°C]	**38**	**38**

Bearing temperature		
OI	[°C]	**67,0**
I	[°C]	**80,0**
II	[°C]	**87,0**
III	[°C]	**84,0**
IV	[°C]	**86,0**
V	[°C]	**85,0**
VI	[°C]	**86,0**
VII	[°C]	**85,0**
VIII	[°C]	**83,0**
IX	[°C]	**86,0**
X	[°C]	**78,0**
Average	[°C]	**82,45**

Splash oil temperature		
Cyl. **1**	[°C]	**71,0**
Cyl. **2**	[°C]	**71,0**
Cyl. **3**	[°C]	**72,0**
Cyl. **4**	[°C]	**71,0**
Cyl. **5**	[°C]	**72,0**
Cyl. **6**	[°C]	**71,0**
Cyl. **7**	[°C]	**71,0**
Cyl. **8**	[°C]	**72,0**
Cyl. **9**	[°C]	**72,0**
Average	[°C]	**71,44**

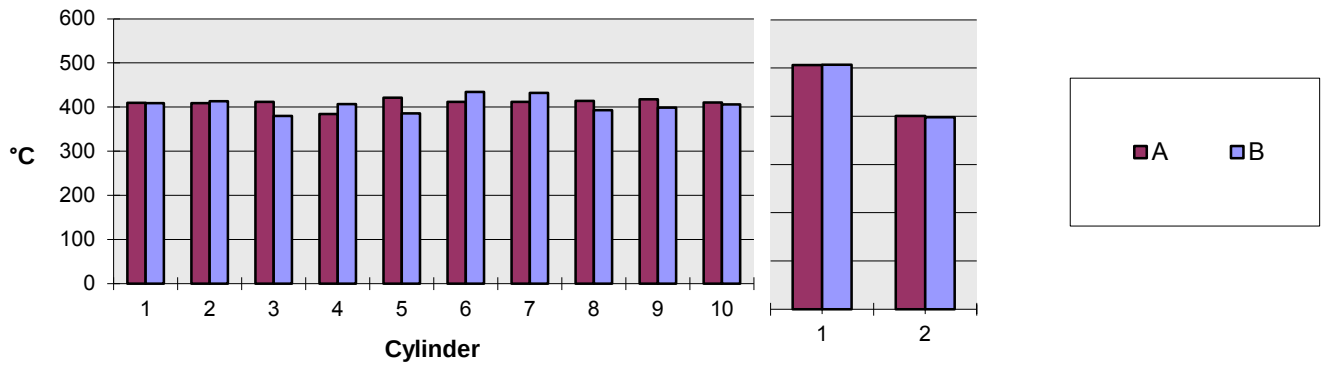
Engine Performance sheet

BWSC
Your Global Energy Partner

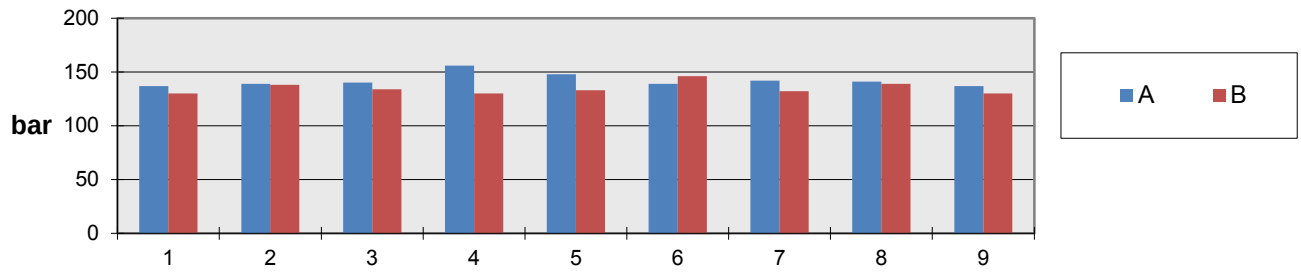
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83925**

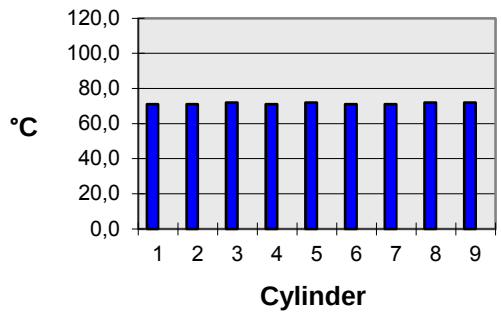
Exhaust gas temperature



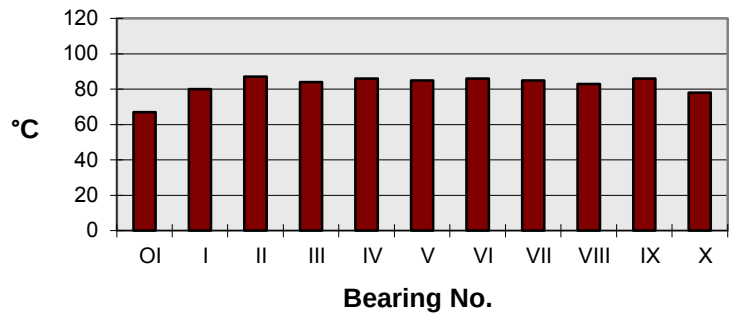
Ignition pressure



Splash oil temperature



Bearing temperature



Engine Performance sheet

BWSC
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Author	
Name:	Itzy G. & J. Rodriguez
Department:	Operaciones
Date:	03 March 2014

Engine	
Plant:	ACP - Miraflores Power Station
Engine type:	MAN 18V 48/60
Engine No.:	1 135 123 DE-6
Operating hrs:	83925

Date		03 March 2014	
Time		12:00:00	
Run. hours <= 100%	[h]		
Run. hours > 100%	[h]		
Total running hours	[h]	83929	
Governor		**A**	**B**
Load governor	scale	8,0	
Fuel pump index 1	[mm]	59	61
Fuel pump index 2	[mm]	58	59
Fuel pump index 3	[mm]	59	56
Fuel pump index 4	[mm]	54	58
Fuel pump index 5	[mm]	61	62
Fuel pump index 6	[mm]	58	61
Fuel pump index 7	[mm]	60	62
Fuel pump index 8	[mm]	59	57
Fuel pump index 9	[mm]	57	58
Average	[mm]	58,3	59,3
Filters			
Consumption Lube oil			
Lube oil filter flush.Interv.	[1/h]		

Consumption Fuel oil			
Fuel oil filter flush.Interv.	[1/h]		

Exhaust gas		**A**	**B**
Exh. gas press. aft. Tc	[mm]		
Temp. after cyl. 1	[°C]	437	433
Temp. after cyl. 2	[°C]	437	445
Temp. after cyl. 3	[°C]	442	420
Temp. after cyl. 4	[°C]	429	439
Temp. after cyl. 5	[°C]	440	414
Temp. after cyl. 6	[°C]	434	446
Temp. after cyl. 7	[°C]	438	458
Temp. after cyl. 8	[°C]	439	427
Temp. after cyl. 9	[°C]	444	425
Average	[°C]	437,8	434,1
Before turbocharger	[°C]	543	540
After turbocharger	[°C]	397	393
n tc A/B	[rpm]	16050	16050

Remarks:

Engine Performance sheet

BWSC
Your Global Energy Partner

Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83925**

Ignition pressures			**A**	**B**
Cylinder	**1**	[bar]	**175**	**172**
Cylinder	**2**	[bar]	**177**	**180**
Cylinder	**3**	[bar]	**173**	**180**
Cylinder	**4**	[bar]	**188**	**174**
Cylinder	**5**	[bar]	**180**	**181**
Cylinder	**6**	[bar]	**175**	**193**
Cylinder	**7**	[bar]	**175**	**179**
Cylinder	**8**	[bar]	**181**	**182**
Cylinder	**9**	[bar]	**178**	**176**
Average		[bar]	**178,0**	**179,7**

Power		
Geno power	[kWe]	
Engine power	[kW]	**18600**
Cos phi.		**0,99**
Voltage	[V]	**14000**
Current	[A]	**735**
Engine power	[%]	**105**
Engine n	[rpm]	**514**

Intake air		**A**	**B**
Ambient temperature	[°C]	**24**	
Temp.aft.ch.air cooler	[°C]	**50**	**47**
Press.aft.ch.air cooler	[bar]	**2,6**	**2,9**
Delta press.ch.air cooler	[mbar]	**0,013**	**0,016**
Delta press.inlet air filter	[mbar]	**-0,6**	
Suction press.bef.tc	[mbar]		
Blow-by flap		☐ on	☐ off
Charge air preheating		☐ on	☐ off
Crankcase pressure	[mm/H_2O]		

Fuel		
Press.before engine	[bar]	**3,8**
Temp.after preheater	[°C]	**134**
Viscosity aft.preheat.	[cSt]	**12,3**
Temp. service tank	[°C]	**94**
Temp. Bef. Engine	[°C]	**137**

Nozzle cooling water		
Press.bef.engine	[bar]	**3,3**
Temp.bef.engine	[°C]	**58**
Temp. Bef. Cooler	[°C]	

Lub oil main system		**A**	**B**
Press.bef. engine	[bar]	**4,1**	
Temp.bef. engine	[°C]	**58**	
Press.bef.tc	[bar]	**1,5**	
Temp.after tc A/B	[°C]	**84**	**85**
Jacket cooling water (HT)			
Press.bef.engine	[bar]	**3,9**	
Temp.bef.engine	[°C]	**81**	**81**
Temp.aft.engine	[°C]	**90**	**90**
Charge air cooling water (HT + LT)			
Press.bef.intercooler	[bar]	**2,9**	
Temp.bef.intercooler HT	[°C]	**70**	
Temp.aft.intercooler HT	[°C]	**81**	
Temp.bef.intercooler LT	[°C]	**33**	
Temp.aft.intercooler LT	[°C]	**41**	

Bearing temperature		
OI	[°C]	**68,0**
I	[°C]	**82,0**
II	[°C]	**89,0**
III	[°C]	**87,0**
IV	[°C]	**89,0**
V	[°C]	**87,0**
VI	[°C]	**88,0**
VII	[°C]	**88,0**
VIII	[°C]	**86,0**
IX	[°C]	**89,0**
X	[°C]	**79,0**
Average	[°C]	**84,73**

Splash oil temperature		
Cyl. **1**	[°C]	**72,0**
Cyl. **2**	[°C]	**72,0**
Cyl. **3**	[°C]	**73,0**
Cyl. **4**	[°C]	**72,0**
Cyl. **5**	[°C]	**73,0**
Cyl. **6**	[°C]	**72,0**
Cyl. **7**	[°C]	**73,0**
Cyl. **8**	[°C]	**73,0**
Cyl. **9**	[°C]	**73,0**
Average	[°C]	**72,56**

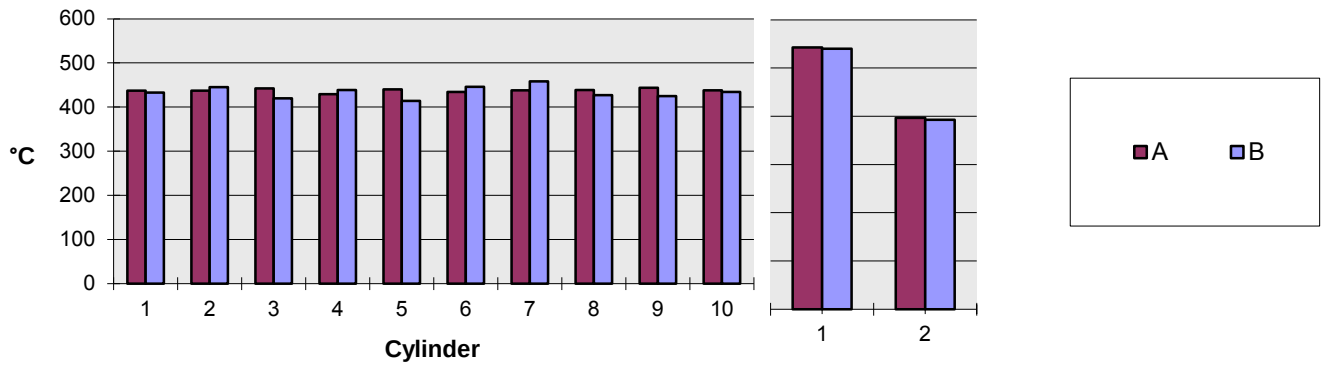
Engine Performance sheet

BWSC
Your Global Energy Partner

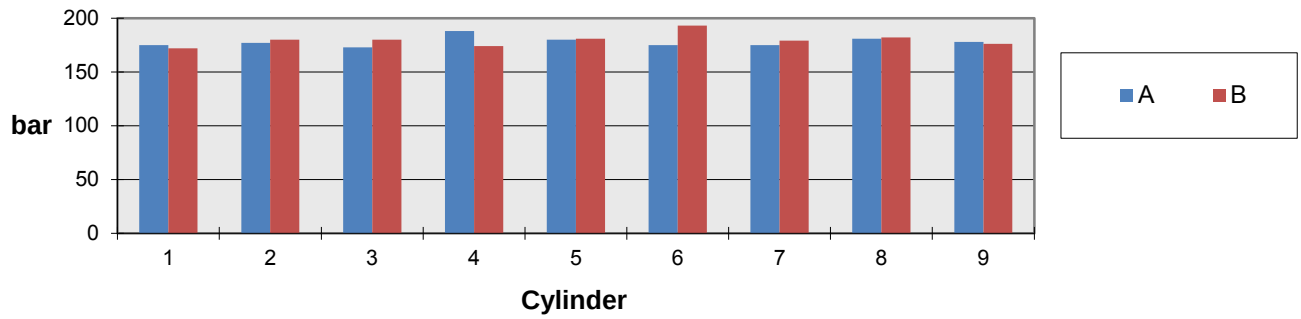
Engine

Plant:	**ACP - Miraflores Power Station**
Engine type:	**MAN 18V 48/60**
Engine No.:	**1 135 123 DE-6**
Operating hrs:	**83925**

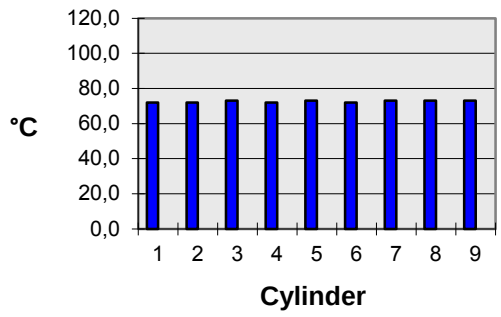
Exhaust gas temperature



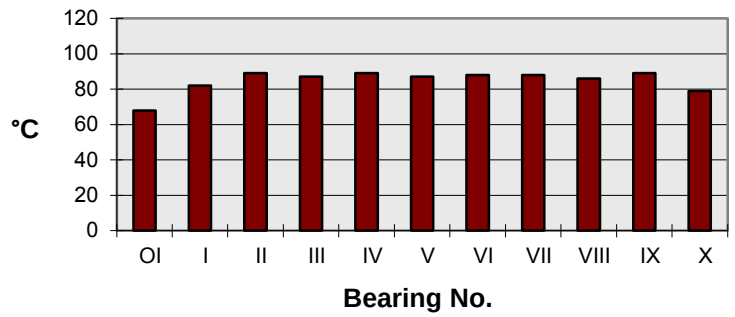
Ignition pressure



Splash oil temperature



Bearing temperature



MAN Diesel & Turbo
PrimeServ Panama

Service Report

Name of Power Plant	**Miraflores Power Plant**	**Order No**	**2014 – O – 0020**
IMO-No.		**Owner/Customer:**	**BWSC**
Engine Builder	**MAN Diesel SE, Ausgburg/Ger.**	**Requested by**	**Mr. Boguslaw Trzcinski**
Engine Type	**18 V48/60A**	**Visit by**	**Moises Herrera**
Engine No.	**1 135 123**	**Place**	**Miraflores, Panama**
Year of building	**2002**	**Work started**	**February 19th, 2014**
Running hours	**83,916**	**Work completed**	**February 19th, 2014**
Turbo Type	**NA 48/S (2 sets)**		
Turbo Charge No.	**1150610 / 1150611**	**Service Engineer**	
Running hours	**83,916**	**Superintendent**	**Moises Herrera**
Reason	**Technical evaluation of engine components.**		

Panama, February 25th, 2014.

Summary

Miraflores Power Plant was attended on February 19th at Miraflores, Panama on request of Mr. Boguslaw Trzcinski BWSC. Technical evaluation and comments should be done on damaged engine components.

Work done

A short meeting was carried out with BWSC staff. A crack was found in one of the exhaust admission casing after 12,365hrs. from the last exchange due to the same reason (see attached photographs).

Further, visual inspection was done on inlet and exhaust valves dismounted during the services. Scuffing and fretting marks was observed on the running surface of valve spindle. Further, pitting marks was noted on valve cone and valve spindle for some valves. Further, blow-by was also

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primeserv-panma@mandieselturbo.com
http:// www.man.eu
R.U.C. 1034641-1-543470 D.V. 39

observed on valve seat (see attached photographs). Hot corrosion wear on valve plate could be accepted to 3mm off as maximum. Permissible axial deviation is accepted until 0.05mm.

Remarks and recommendations:

Since valves are engine components working under high stress and movement, it is not recommended to mount inlet and exhaust valve with sign of scuffing, fretting, blow-by, pitting marks or excessive hot corrosion wear. Defective valve could fail causing a tremendous damage in engine.

Due to these valve observed during our visit have a short period of operation (12,365hrs.) from the last exchange, we recommend to contact our Technical department in Augsburg for further investigation. Engine data, fuel oil analysis, lube oil analysis, spare parts history, damage parts will be helpful to determinate the root cause of these abnormalities.

Moises Herrera
Supt.Eng.

Attachments

- **Photographs**

MAN Diesel & Turbo Panama Enterprises Inc
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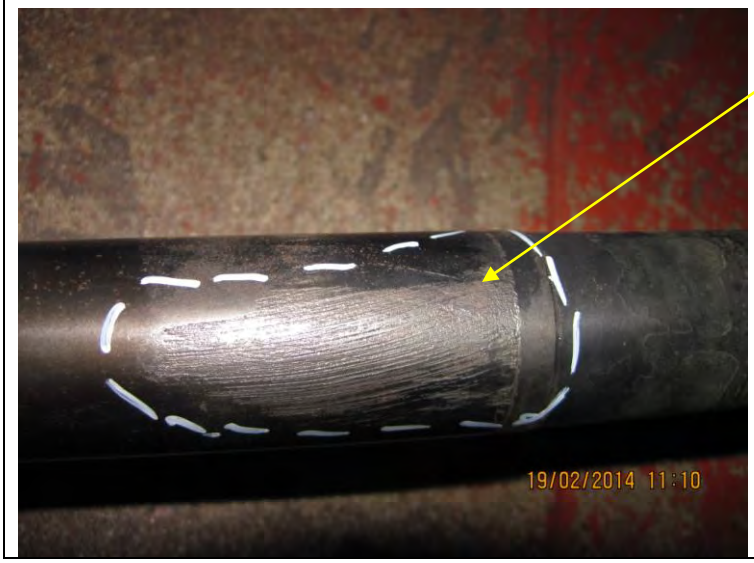
Pitting marks were observed on valve spindle and valve cone during our visit in some exhaust and inlet valves.



Scuffing and fretting marks were noted on running surface of valve spindle.

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R.U.C. 1034641-1-543470 D.V. 39

	**One valve was measured with 0.09mm as true running. Maximum permissible is 0.05mm. This valve should be discarded for any future use.** **0.09mm measured by power plant staff.**
	**Maximum wear by hot corrosion on the valve plate should not exceed 3.0mm.**
	**Valve seat damage by blow-by should be discarded of any repairing solution.**

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http:// www.man.eu
R.U.C. 1034641-1-543470 D.V. 39

A crack was observed in the exhaust admission casing, A-bank, after 12,365hrs from the last exchange.

Grinding-off was done in order to determinate how deep that crack is around the casing.

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http:// www.man.eu
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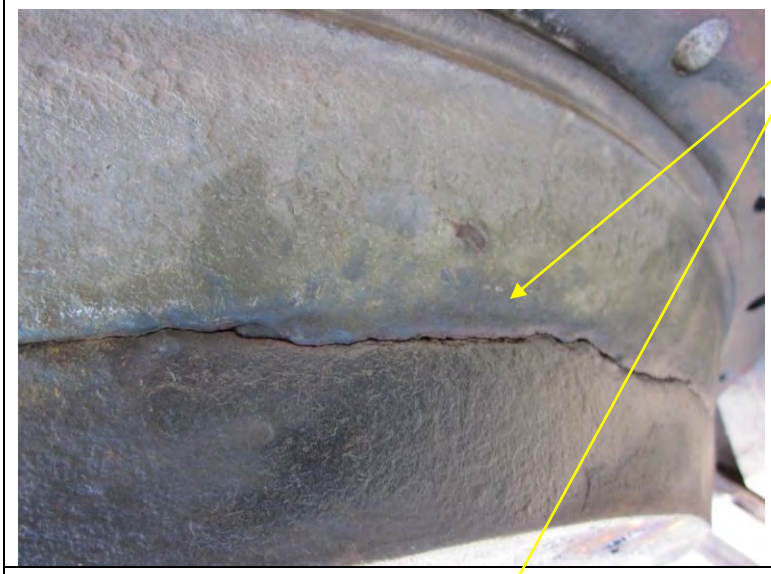

Exhaust admission casing, A-bank, found with crack during overhaul of 66,747hrs.

Crack observed in the exhaust admission casing, B-bank during the same maintenance mentioned above (66,747hrs.).

Both of them were exchanged by new spare parts (engine running hours in that moment 71,551hrs).

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