vibration - thermography - oil analysis - laser alignment - in-situ balancing

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Vibration Analysis Report

Das Island
ADGAS
Power Station

GT 2 Generator Set

11th THROUGH TO ??th July 2009

Equipment

The following equipment was used to carry out the vibration analysis & In-Situ balance:

SKF Microlog CMVA60.	Serial No 602995
CMSS6155 Optical Phase Reference:	Serial No 1514483
Accelerometers: Number: 1	Serial No 003088
Number: 2	Serial No 003087

Dell Notebook Computer
SKF Prism4 Vibration Analysis Software.

Analyst

Mr T McManus.

Introduction

A Vibration Analysis was requested by Mr John Kerr of Quartzelec Abu Dhabi, on GT 2 Generator set situated on Das Island at the Adgas Power Station.

The vibration analysis was carried out after a major overhaul of the generator rotor and was to identify the reported increased vibration levels and if possible rectify the vibration to an acceptable level.

During the initial vibration analysis on the 16th July 2009 the generator set was ran at full speed with no load (FSNL), 5Mw and 12Mw.

The positions of the readings taken on the unit were:-

Generator
Drive (Quill Shaft) end Bearing:- Horizontal, Vertical & Axial.
Non drive end Bearing:- Horizontal, Vertical & Axial.

All quoted velocity amplitudes are mm/s RMS.
Overall Values are 30Kcpm frequency length.

Vibration Analysis Report

GT No.2

GT 2 Generator.
FSNL

Readings taken from this unit on the 16th July 2009 at FSNL showed overall vibration level's on the drive (Quill Shaft) end bearing were 2.8mm/s in the horizontal direction, which had a 1x frequency of 2.6mm/s (**See Fig 1 Generator drive end bearing horizontal spectrum**), and an overall level of 0.73mm/s in the vertical direction.

The overall vibration level's on the non drive end bearing were 5mm/s in the horizontal direction which had a 1x frequency of 4.7mm/s, and 7mm/s in the vertical direction, which had a 1x frequency of 6.6mm/s (**See Fig 2 Alternator non drive end bearing vertical spectrum**).

Fig 1
GT2 Generator Drive End Bearing
Horizontal Spectrum

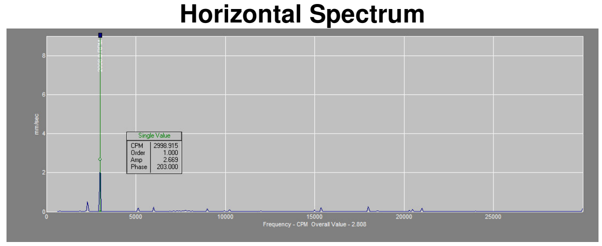
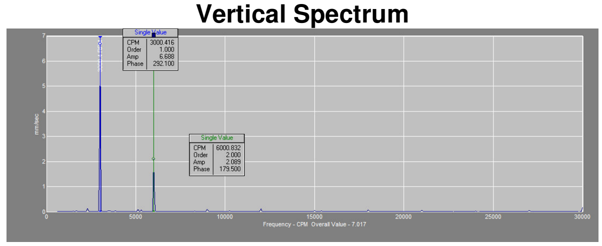


Fig 2
GT2 Generator Non Drive End Bearing
Vertical Spectrum



5Mw

As the load was increased to 5Mw the overall vibration level on the drive (Quill Shaft) end bearing increased to 3.43mm/s in the horizontal direction, which had a 1x frequency of 3.3mm/s, and an overall level of 1.32mm/s in the vertical direction.

The overall vibration level on the non drive end bearing remained at 5mm/s in the horizontal direction, and reduced to 6.4mm/s in the vertical direction, which had a 1x frequency of 6mm/s

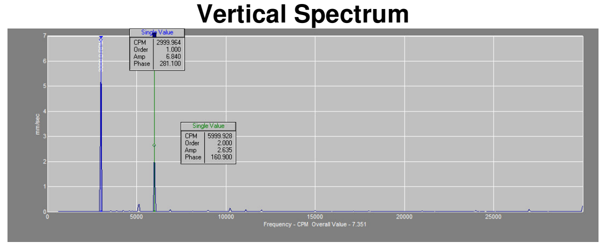
Vibration Analysis Report

12Mw

As the load was increased to 12Mw the overall vibration level on the drive (Quill Shaft) end bearing increased to 3.5mm/s in the horizontal direction, which had a 1x frequency of 3.4mm/s, and reduced in the vertical direction to an overall level of 0.8mm/s.

The overall vibration level on the non drive end bearing increased to 5.4mm/s in the horizontal direction. The vertical vibration increased to 7.4mm/s, due to an increase in electrical vibration, the 1x frequency was 6.8mm/s (**See Fig 3 Generator non drive end bearing vertical spectrum**)

Fig 3
GT2 Generator Non Drive End Bearing
Vertical Spectrum



Vibration Analysis Conclusion

After analysing the vibration readings and the on-site vibration monitoring system levels, see below.

Levels recorded at FSNL
Seismic Generator Non Drive End Vertical **11.7** (0-Peak)
Bentley Nevada.

Generator Drive End Horizontal	5.9mm/s (0-Peak)
Generator Drive End Vertical	1.7mm/s (0-Peak)
Generator Non Drive End Horizontal	8.6mm/s (0-Peak)
Generator Non Drive End Vertical	**10mm/s** (0-Peak)

The main concern centred on the non drive end bearing.

Using the vibration spectrums and phase results gathered by myself using the SKF Microlog CMVA60 during the analysis, I concluded it was possible a single plane balance could reduce the vibration to a satisfactory level.

Balance Report

GT No.2

Single Plane Balance Data
Non Drive End Bearing Horizontal

Reference Run
Speed 2998rpm
1x Magnitude 4.83mm/s
Phase 302°

260grams was added at 0°

Trial Run
Speed 2999rpm
1x Magnitude 3.9mm/s
Phase 329°
Resultant was 583grams @ 54° against rotation.

As a full 30-30 change had not been achieved the 260grams was moved 54°, to establish the correct angle before adding further weight.

Trim Run #1
Speed 3000rpm
1x Magnitude 2.6mm/s
Phase 291°
Resultant was 541grams @ 347° against rotation.

500 grams was moved 347° against rotation.

Trim Run #2
Speed 3000rpm
1x Magnitude 1.2mm/s
Phase 317°
Resultant was 677grams @ 3° against rotation.

Although the non drive end bearing vibration had reduced, the drive end bearing vibration had started to increase.

The generator drive end (quill shaft) bearing in the horizontal direction had increased from a high of 3.5mm/s @12Mw to an overall level of 4.8mm/s, and the vertical vibration had increased from a high of 1.3mm/s @5Mw to 5.6mms.

The single plane balance was therefore stopped all weights removed and a two plane balance started at 15.00 on the 18th July.

Balance Report

GT No.2

Two Plane Balance Data

Plane A Drive End Bearing Horizontal.
Plane B Non Drive End Bearing Horizontal

Reference Run

Plane A		**Plane B**	
Speed	3001rpm	Speed	3001rpm
1x Magnitude	3.1mm/s	1x Magnitude	5mm/s
Phase	241°	Phase	302°

309grams was added at 0° on Plane A

Trial Run # 1

Plane A		**Plane B**	
Speed	2999rpm	Speed	2999rpm
1x Magnitude	1.6mm/s	1x Magnitude	6.4mm/s
Phase	196°	Phase	270°

309grams was moved from Plane A and fitted at 0° on Plane B

Trial Run # 2

Plane A		**Plane B**	
Speed	3000rpm	Speed	3000rpm
1x Magnitude	4.2mm/s	1x Magnitude	4.1mm/s
Phase	249°	Phase	331°

The result from the reference run and the two trial runs was.
Plane A 861grms @ 318° against rotation.
Plane B 1115grms @ 320° against rotation.

A problem was encountered that 7 weights were already fitted in the drive end balance ring between 350° and 320°, meaning the fitting of the additional weights could not be spread over the correct angle. Therefore a decision was made to add 50% of the total weights to try and limit the loss of the angle and see how the unit responded.

Plane A 430grms added @ 318° against rotation.
Plane B 557grms added @ 320° against rotation.

Correction Run #1

Plane A		**Plane B**	
Speed	3001rpm	Speed	3001rpm
1x Magnitude	1.87mm/s	1x Magnitude	2.5mm/s
Phase	222°	Phase	345°

Balance Report

During the Correction Run #1 the following levels were recorded from the on-site monitoring system.

Seismic Generator Non Drive End Vertical 7.9 (0-Peak)
Bentley Nevada.

Generator Drive End Horizontal	4.4mm/s (0-Peak)
Generator Drive End Vertical	3.5mm/s (0-Peak)
Generator Non Drive End Horizontal	4.2mm/s (0-Peak)
Generator Non Drive End Vertical	7.0mm/s (0-Peak)

After the correction run a further 25% of weight was added 207grms (629grms in total) to the drive end and 278grms (835grms in total) to the non drive end, however the overall vibration increased possibly as result of the loss of angle.

Correction Run #2

Plane A		**Plane B**	
Speed	3001rpm	Speed	3001rpm
1x Magnitude	1.69mm/s	1x Magnitude	3.0mm/s
Phase	236°	Phase	35°

During the Correction Run #2 the following levels were recorded from the on-site monitoring system.

Seismic Generator Non Drive End Vertical 8.8 (0-Peak)
Bentley Nevada.

Generator Drive End Horizontal	3.9mm/s (0-Peak)
Generator Drive End Vertical	6.8mm/s (0-Peak)
Generator Non Drive End Horizontal	5.3mm/s (0-Peak)
Generator Non Drive End Vertical	7.6mm/s (0-Peak)

Balancing Conclusion

After re-analysing all of the balance data and relevant spectra gathered during the balance runs I concluded that the lowest acceptable levels, where all the readings were within 1mm/s of each other, had been achieved during the single plane balance Trim Run #1 when 260grms was fitted on the non drive end at 55° against rotation.

Therefore all the balance weights I had attached during the two plane balance were removed and 260grms at 55° against rotation on the non drive end were reinstalled. The unit was then ran up to full speed

Report

The readings recorded using SKF Microlog CMVA60 during the FSNL run, with the 260grms fixed to the non drive end at 55° against rotation, were as follows.

SKF Microlog CMVA60
FSNL mm/s rms

Generator Drive End		**Generator Non Drive End**	
Horizontal	3.6mm/s	Horizontal	3.1mm/s
Vertical	4.1mm/s	Vertical	3.9mm/s

The readings I recorded using the SKF Microlog CMVA60 in mm/s rms, were within acceptable levels for this class of machine using ISO 10816 standard.

The following levels were recorded from the on-site monitoring system.

Seismic Generator Non Drive End Vertical 6mm/s (0-Peak)
Bentley Nevada.

Generator Drive End Horizontal	6.8mm/s (0-Peak)
Generator Drive End Vertical	5.7mm/s (0-Peak)
Generator Non Drive End Horizontal	5.5mm/s (0-Peak)
Generator Non Drive End Vertical	6.4mm/s (0-Peak)

Conclusion

After discussing the levels with the Adagas and MJB on site personnel, it was agreed the rotor was now in a lower and more stable condition and rotating in a symmetrical orbit.

Therefore the machine was re-commissioned and readings recorded at 0%, 25%, 50% and 100% load.

See Next Page For Results of Load Tests.

Load Test Results

SKF Microlog CMVA 60 1x mm/s RMS						
	Gen DE Hor	Gen DE Ver	DE AX	Gen NDE Hor	Gen NDE Ver	DE AX
FSNL	3.6mm/s	4.2mm/s		3.1mm/s	3.9mms	
FSNL v	4.5mm/s	2.9mm/s	1.7mm/s	2.7mm/s	4mm/s	2.0mm/s
5Mw	3.3mm/s	3.3mm/s	1.5mm/s	3.9mm/s	3.9mm/s	2.1mm/s
10Mw	3.8mm/s	3.4mm/s	2.2mm/s	4.3mm/s	4.1mm/s	2.0mm/s
17.5Mw	4.1mm/s	3.6mm/s	1.0mm/s	4.4mm/s	4.2mm/s	2.3mm/s
Seismic Velocity mm/s 0-Peak						
FSNL					6.0mm/s	
FSNL v					6.5mm/s	
5Mw					6.2mm/s	
10Mw					6.4mm/s	
17.5Mw					6.3mm/s	
Bentley Nevada Mm/s 0-Peak						
FSNL	6.8mm/s	5.7mm/s		5.5mm/s	6.4mm/s	
FSNL v	6.2mm/s	3.6mm/s		4.9mm/s	6.5mm/s	
5Mw	6.0mm/s	4.6mm/s		6.0mm/s	6.0mm/s	
10Mw	8.0mm/s	5.4mm/s		6.6mm/s	6.1mm/s	
17.5Mw	9.1mm/s	7.8mm/s		7.0mm/s	6.1mm/s	

Conclusion

The readings taken using the SKF Microlog CMVA 60 and an independent accelerometer are all at an acceptable level for this class of machine using ISO Standard 10816.

The Seismic Velocity probe readings, which provide the alarm/trip protection for the machine also remained at a satisfactory level.

However the levels recorded on the Bentley Nevada system in particular the Gearbox/Generator Quill shaft position increased substantially when the load went to 10Mw and above. However this is not due to 1x rotational speed (see SKF levels at 10 & 17.5Mw) but is possibly related to gear meshing frequencies within the gearbox.