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

unit 4, Roseberry Court, Ellerbeck Way, Stokesley,
North Yorkshire, TS9 5QT.

tel: 01642 714710 website: www.vibrotech.co.uk

Vibration Analysis Report

ENI Oil Company
GT 6 Gas Generator, Turbine, Gearbox & Alternator
20th-30th January 2007

Equipment

The following equipment was used to carry out the vibration analysis:

SKF Microlog:	CMVA60.	Serial No 602995
Accelerometers:	Number: 1	Serial No 001
	Number: 2	Serial No 2584

Dell Notebook Computer
SKF Prism4 Vibration Analysis Software.

Analyst

Mr A Analyst.

Introduction

A Vibration Analysis was requested by an International Maintenance Service Company, on GT 6 Gas Generator, Turbine, Gearbox & Alternator set at an ENI Oil site, in Libya.

Prior to the analysis been carried out, an in-situ service of the alternator was carried out by the International Maintenance Service Company. (Our Customer)

The vibration analysis was to identify the cause of the excessive vibration reported on the gearbox output shaft and the alternator non drive end, after the alternator was removed for overhaul in January 2005 and re-fitted in April 2006.

As the site visit progressed it was discovered that vibration has been an issue on this unit since it was commissioned in 1983, and not since a previous overhaul of the alternator.

A visit to the ENI site had been carried out by Siemens in June 2006, and a report compiled (Ref 2006/361). In the report it states that after independently trim balancing the coupling and the non drive end of the alternator, the vibration continued to be an issue in a loaded condition.

The Siemens report (Ref 2006/361) raised a concern over the gearbox support beam ‘rocking’, possibly caused by a lack of support. The report also noted the gearbox beam had extra struts welded to it, and a hydraulic jack had been used to stiffen the beam but this had no affect on the vibration. His conclusions and recommendations in the report centred on this beam.

During my initial inspection of GT 6 & GT 5 (brother & sister units next to each other) on arrival at site, the gearbox beams on both units became a focal point due to the 4 struts welded in a vertical position on GT 6, and the issues raised in the Siemens report.

I highlighted this to the Siemens representative on site, and he informed myself that in the past they have encountered resonance issues on some beams at 25hz.

Report

25th January 2007

Due to the issue raised regarding resonance's on other gearbox support beams, a 'bump test' was carried out on the 4 supporting beams of GT 6 skid.

This was performed by 'bumping' the beams in 3 horizontal positions (left side, centre & right side), and recording the results.

The bump test on the gas generator support beam indicated resonant frequencies at 1500cpm and 6300cpm (See Fig 1 gas generator support beam centre)

The bump test on the gearbox support beam indicated a resonant frequency at 1500cpm (See Fig 2 gearbox support beam centre)

The bump test on the alternator support beams indicated resonant frequencies on the drive end beam at 7800cpm and 14700cpm (See Fig 3 alternator drive end support beam centre), and the non drive end beam at 6450cpm and 14400cpm (See Fig 4 alternator non drive end support beam centre)

Although the gas generator beam showed resonant frequencies of 1500cpm & 6300cpm the rotating frequency of the gas generator is 7000cpm to 11000cpm, so this beam raised no concerns. The alternator beams indicated resonance's between 6450cpm & 14700cpm, as the alternator has a rotating frequency of 1500cpm these 2 beams also raised no concerns.

However the gearbox support beam showed a resonant frequency of 1500cpm, this matched the output speed of the gearbox and immediately became a concern.

Fig 1
Gas Generator Support Beam Centre

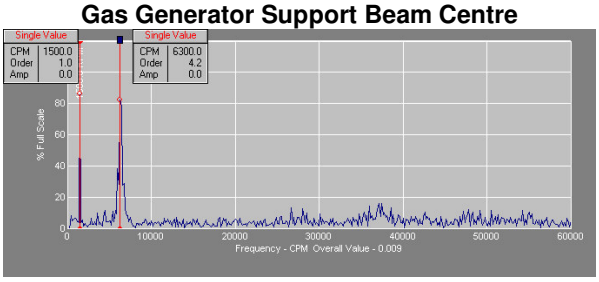


Fig 2
Gearbox Support Beam Centre

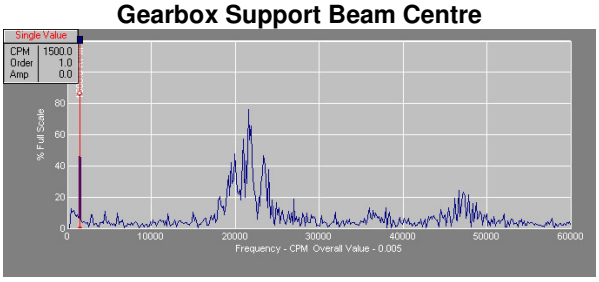


Fig 3
Alternator Drive End Support Beam Centre

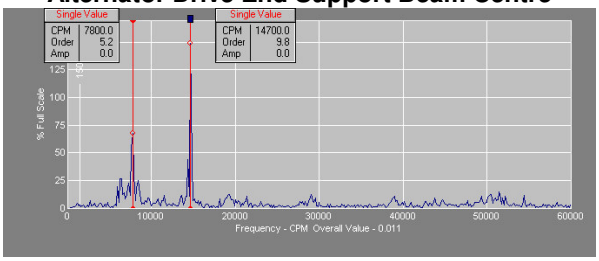
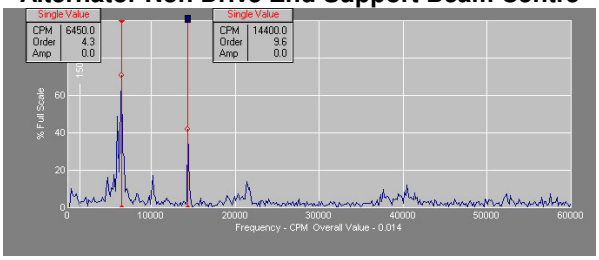


Fig 4
Alternator Non Drive End Support Beam Centre



Report

28th January 2007

After a series of delays the unit was run, and the resultant vibration data collected could then be compared to the bump test results. Data was taken from 7 positions along the unit in the horizontal, vertical and axial directions, horizontal readings were also taken from the 4 support beams at the same positions (left side, centre & right side) the bump tests were carried out.

Initially the unit was run at no load with full excitation, then 1mw, 1.5mw and finally 2mw.

During the run on the 28th January the vibration on the alternator remained at a steady and acceptable level (See Fig 5 alternator drive end horizontal)

However during this run the axial vibration on the gas generator, turbine and input of the gearbox started to increase due to a frequency of 1500cpm (See Fig 6 gas generator axial trend & Fig 7 gas generator axial waterfall spectrum)

The increases from the gas generator, turbine and gearbox input, matched the increases on the gearbox support beam, which had substantially higher vibration than the other 3 beams. The vibration on this beam increased from 5.9mm/s to 8.4mm/s due to the 1500cpm resonant frequency. (See Fig 8 support beams).

Although the vibration was increasing, the levels reported by Siemens in their report (Ref 2006/361) of 14.5mm/s on the gearbox horizontal was not reached (See Fig 9 gearbox horizontal waterfall spectrum). It was therefore decided to leave the unit running overnight at 2mw and to carry on with the data collection the following day

Fig 5
Alternator Drive End Horizontal

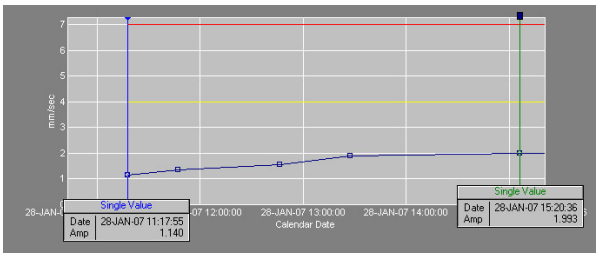


Fig 6
Gas Generator Axial Trend

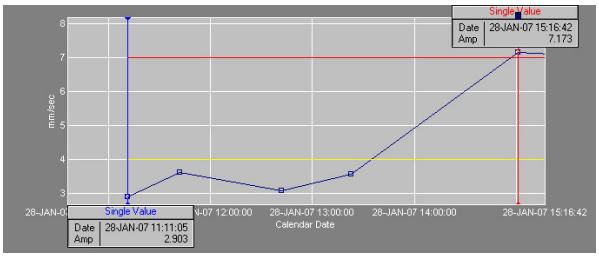


Fig 7
Gas Generator Axial Waterfall Spectrum

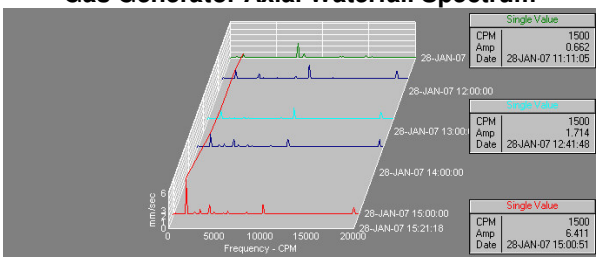


Fig 8
Support Beams

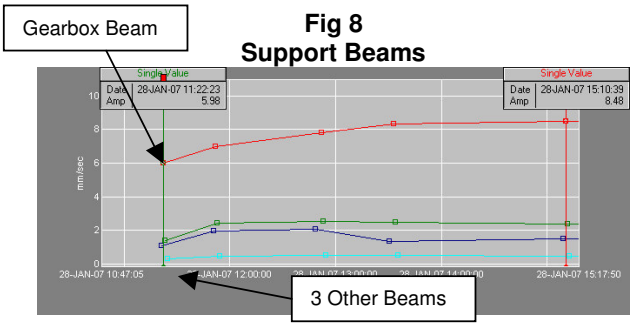
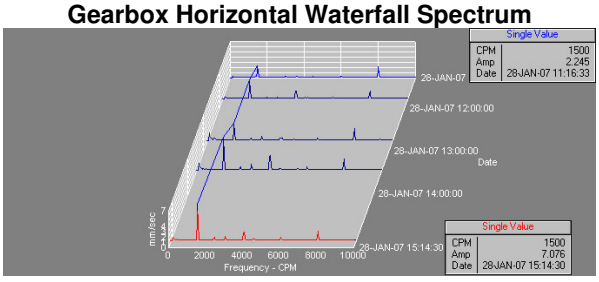


Fig 9
Gearbox Horizontal Waterfall Spectrum



Report

29th January 2007

On returning to site it was discovered the set had 'tripped' on high vibration overnight. It could not be ascertained which of the 2 on line vertical vibration sensors had 'tripped', therefore an attempt was made to re-start the set. Whilst trying to re-start, the set kept 'tripping' on high vibration this was traced to a fault within the on line system which was exchanged for the GT 5 system.

After re-starting, the unit was run at 2mw and data taken over a seven hour period. During this time the vibration on the alternator remained steady and at an acceptable level (See Fig 10 alternator drive end horizontal)

Also over the seven hour period the axial vibration on the gas generator remained at an acceptable level (See Fig 11 gas generator axial trend & Fig 12 gas generator axial waterfall spectrum), this was due to the 1500cpm been at a reduced level and remaining steady.

Although the gearbox support beam vibration remained high (See Fig 13 gearbox support beam), the 1500cpm resonant frequency was at half of the previous days level.

Fig 10
Alternator Drive End Horizontal

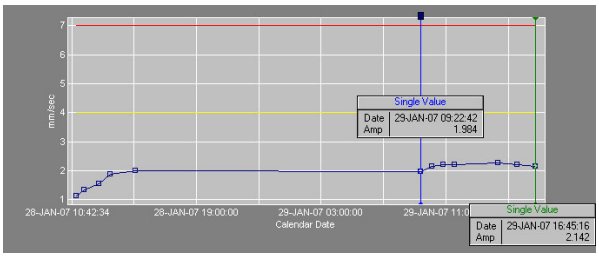


Fig 11
Gas Generator Axial Trend

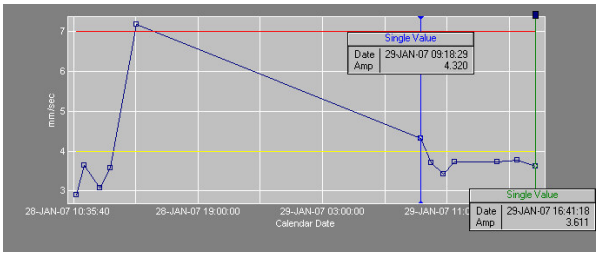


Fig 12
Gas Generator Axial Waterfall Spectrum

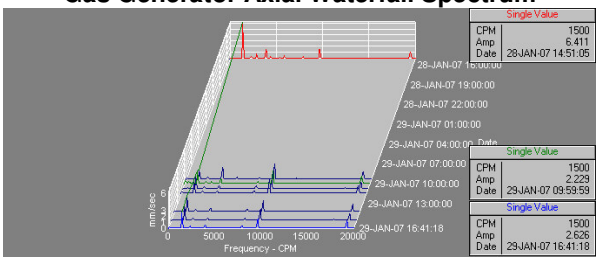
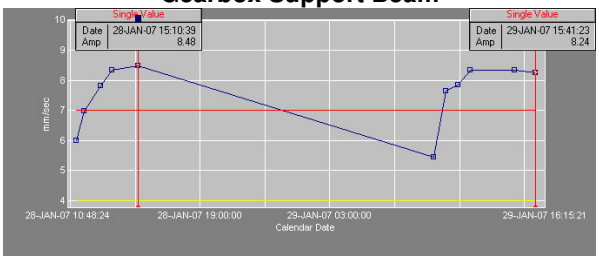


Fig 13
Gearbox Support Beam



Conclusion

After running the set for seven hours at 2mw, a discussion was held to go through the information collected during the bump test, the vibration and the on-site service of the alternator.

During the discussion the representative from the maintenance company and myself informed Siemens that there was nothing found in the service, or the vibration data gathered from the alternator that would cause vibration on this set.

It was explained to Siemens that putting together the results from the skid bump tests with the vibration data taken from the generator set and support beams, the issue of vibration on this unit was centred around the gearbox support beam.

It was also explained that although the Siemens report (Ref 2006/361) suggested the gearbox support beam was 'rocking', it was in fact resonating. When this beam began to resonate, it initiated an axial movement along the set.

When the resonance is not excited the vibration in the horizontal, vertical and axial directions remains steady. However on the 28th January 2007 the resonance in the gearbox support beam had been excited and the axial vibration on the gas generator, turbine and gearbox began to increase.

This may explain the damage caused to the alternator in 2005, as during the site visit the plant personnel informed us the alternator shaft had been known to thrust backwards and forwards. As the on-line system is in the vertical direction the axial vibration could reach a very high and damaging level before it is detectable in the vertical direction.

It was recommended to Siemens to remove the resonance from gearbox support beam.