ADIKARI WISESA

WEBINAR MAINTENANCE SERIES

ADVANCE ANALYSIS OF VIBRATION MONITORING

OUTLINE

First Session

- Apa itu maintenance?
- Vibration Monitoring
- Tools Vibration Monitoring
- Perbedaan tipe sensor
- Transient vs Steady Data
- Analisa Vibrasi Lainnya

Second Session

- Study case

FIRST SESSION

APA ITU MAINTENANCE?

Figure 1-4 - ISO 17359: 2003 condition monitoring procedure flowchart

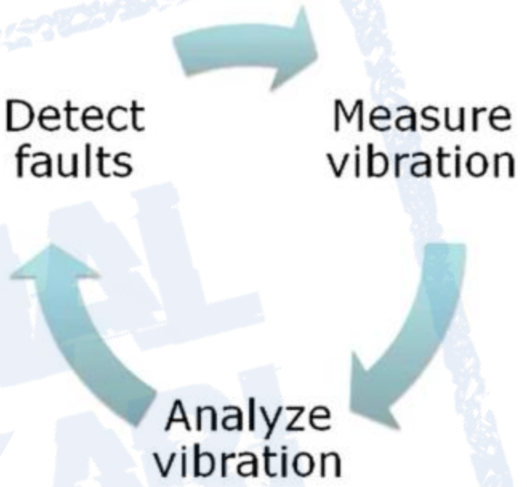
VIBRATION MONITORING

Technology / **Application**

	Vib	Lube	Wear	MCA	IR	US	Vis
Generator	✓	✓	✓	×	✓	✓	✓
Turbine	✓	✓	✓	×	✓	✓	✓
Pump	✓	✓	✓	✓	✓	✓	✓
Electric motor	✓	✓	✓	✓	✓	✓	✓
Diesel engine	✓	✓	✓	×	✓	✓	✓
Fan	✓	✓	✓	✓	✓	✓	✓
Gearbox	✓	✓	✓	×	✓	✓	✓
Cranes	✓	✓	✓	✓	✓	✓	✓
Electric circuit	×	×	×	✓	✓	✓	✓
Transformer	×	✓	×	✓	✓	✓	✓

Figure 1-11 - From Keith Young, paper in Maintenance Technology, June 1995

	Vib	Lube	Wear	MCA	IR	US	Vis
Wear	✓	×	✓	×	×	✓	~
Heating	✓	✓	✓	×	✓	×	~
Impact	✓	×	✓	×	×	✓	~
Corrosion	×	✓	✓	×	×	×	~
Fatigue	✓	✓	✓	×	×	×	~



- **Mechanical Vibration of Machinery**
  - Guidelines, limits, trips, alarms etc.
  - ISO 7919 – 1, 2, 3, 4, 5 Shaft measurements (i.e. proximity probes)
  - ISO 10816 – 1,2,3,4,5,6,7 Bearing housing measurements (i.e. accelerometers)

ADVANCED ANALYSIS???

TOOLS VIBRATION ANALYSIS

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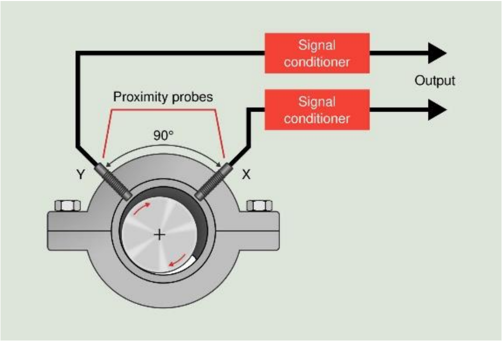
Tools /Software	Picture	Auxiliary
Single-Dual Channel AMS Health Machinery		    
Multi Channel Ez Thomas, Ez Analyst		

PERBEDAAN TIPE SENSOR

Parameter/ Tipe Sensor	Kelebihan	Kekurangan	Unit
Displacement / Eddy Current Probes	1. Wide freq. response (0-10 kHz) 2. Relative movement shaft 1-10 mm 3. T: -50 – 200 °C	1. Instalasi Mahal 2. Butuh kalibrasi jika berbeda material 3. Glitches tidak bisa dihilangkan	μm p-p atau mils
Velocity / Electro Dynamic Velocity Sensor	1. Tidak butuh power eksternal 2. Mudah digunakan 3. T: -50 – 200 °C	1. Tidak cocok pada mesin kecepatan rendah atau terlalu tinggi 2. Butuh kalibrasi jika berbeda temperatur	mm/s RMS atau in/s
Accelerometer	1. Very wide freq. response (0.1-30 kHz) 2. T: up to 125 °C 3. Stable to calibration 4. Aplikasi yang luas	1. Tidak cocok untuk mesin kecepatan rendah 2. T limit	mm/s^2 RMS atau in/s^2

ANALISIS TRANSIENT VS STEADY DATA

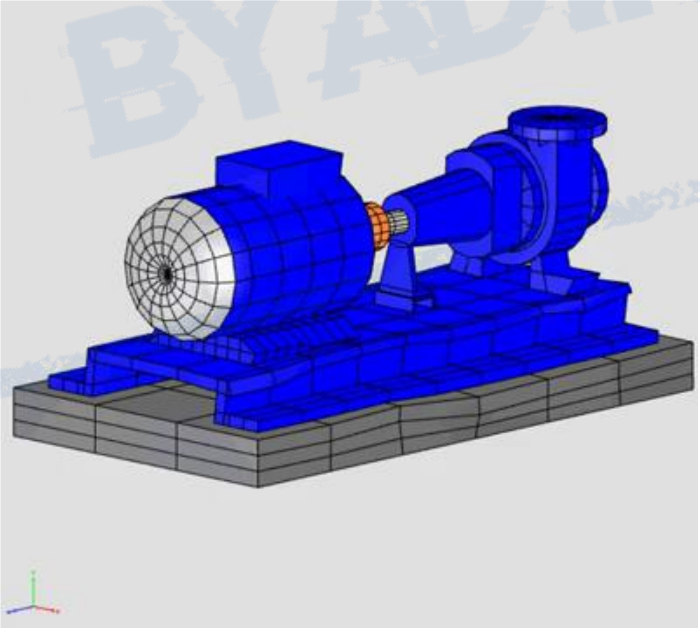
ANALISIS	TRANSIENT	STEADY	DESCRIPTION	REMARKS
Time Waveform	√	√	Nilai Vibrasi vs Waktu Record., menghasilkan pola tertentu	Unbalance, damaged belt, bearing fault, gearbox, kavitasi, rotating looseness
Spectrum	√	√	Nilai Vibrasi vs Freq., menghasilkan pola tertentu	Hampir semua permasalahan pada rotating equipment akan muncul
Strip chart	√	√	Nilai Overall Vibration vs Waktu Real Time	Mengetahui nilai vibrasi tertinggi
Bode Plot	√		Menunjukan lokasi natural freq., efek damping, perubahan fasa	Natural Freq untuk validasi resonansi
Polar Plot	√		Mekanisame sama dg bode plot, namun ditampilkan dalam polar	Natural Freq untuk validasi resonansi
Centerline Plot	√		Mengetahui pergerakkan shaft dari kondisi rest sampai steady di dalam bearing	Unbalance, MA, air gap fault, dll
Waterfall Plot	√	√	Nilai Vibrasi vs waktu dan kecepatan	Sama dengan spectrum, kelebihan bisa melihat perubahan niali vibrasi dalam 2 parameter secara bersamaan
Phase		√	Pergerakkan relatif pada mesin	Unbalance, MA, bent shaft, coocked bearing, looseness
Orbit	√	√	Pergerakkan shaft di dalam bearing dengan membandingkan 2 sensor displacement V dan H	Unbalance, MA, oil whirl, oil whib, rubbing

ANALISA LAINNYA

OPERATING DEFLECTION SHAPE

Memvisualisasikan suatu struktur dalam kondisi normal operasi, berdasarkan nilai magnitude vibrasi dan phase.

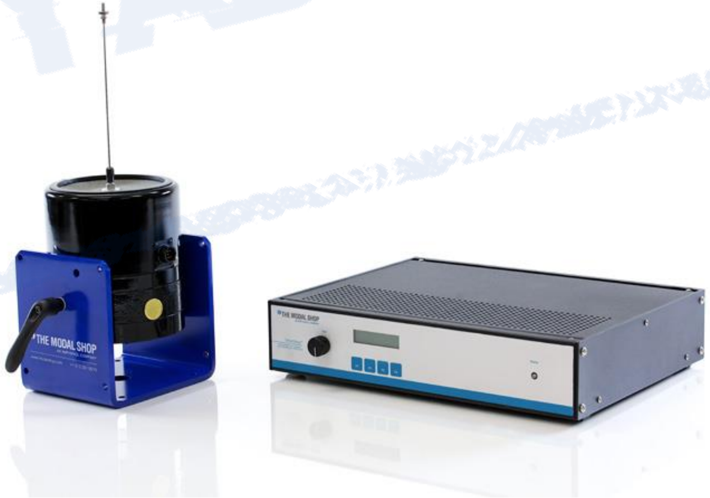
Fungsi: pengecekkan resonansi, weakness, looseness, soft foot, unbalance, dan MA



ANALISA LAINNYA

MODAL ANALYSIS

Analisa teknikal untuk mengamati natural freq., damping, dan shape mode. Dilakukan pada saat mesin mati. Dapat dikombinasi dg FEA untuk analisa: stresses, heat transfer, simulasi kegagalan, fluid dinamik. Fungsi: pengecekkan resonansi, weakness, looseness, soft foot, unbalance, dan MA



ANALISA LAINNYA

HIGH FREQUENCY TECHNIQUE

Very high frequency

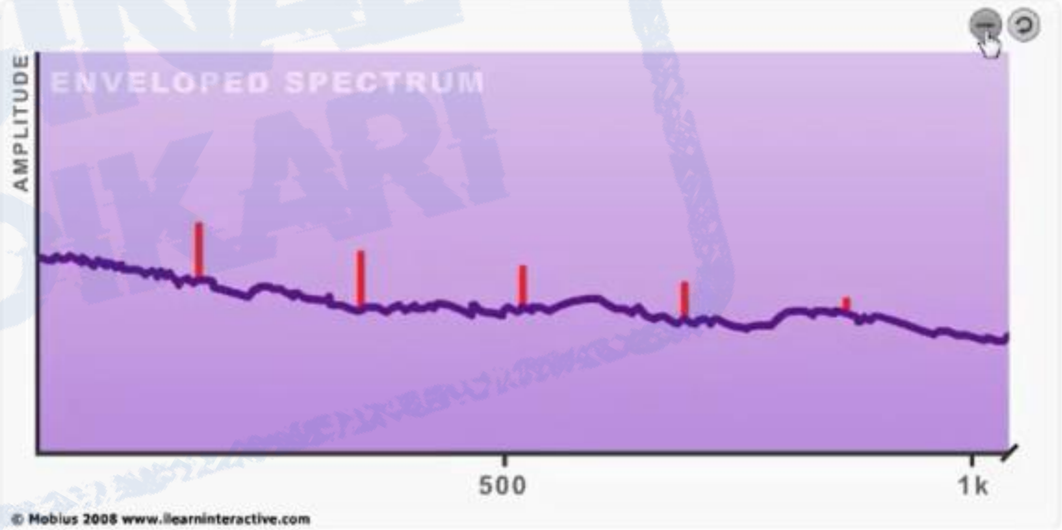
- Acoustic emission
- Shock pulse SPM®, Spike Energy™, SEE™, PeakVue®

High frequency

- Enveloping and Amplitude demodulation
- Acceleration spectrum

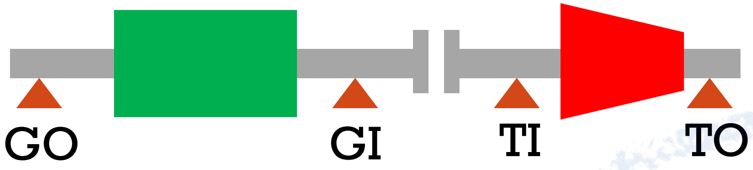
Mid-low frequency

- Velocity spectrum
- Time waveform analysis
- Overall level vibration



CASE STUDY

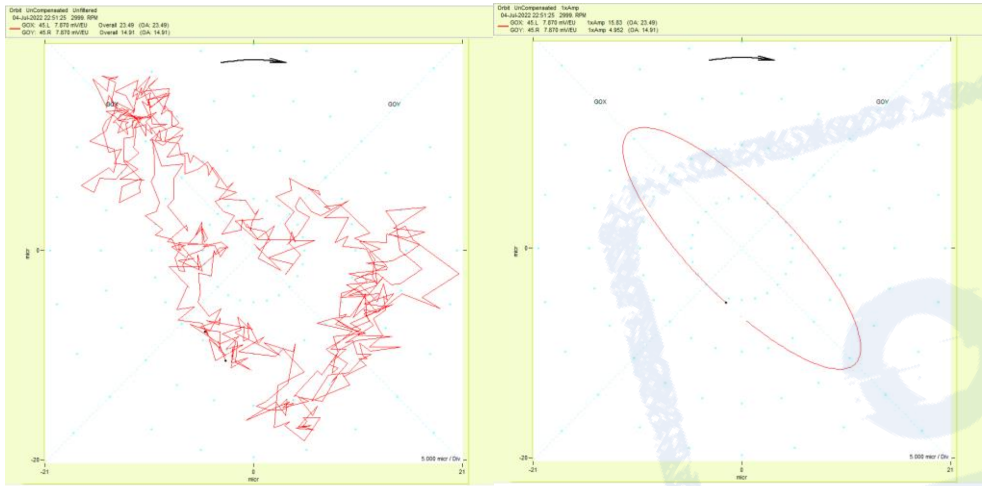
VIBRASI TURBIN UAP

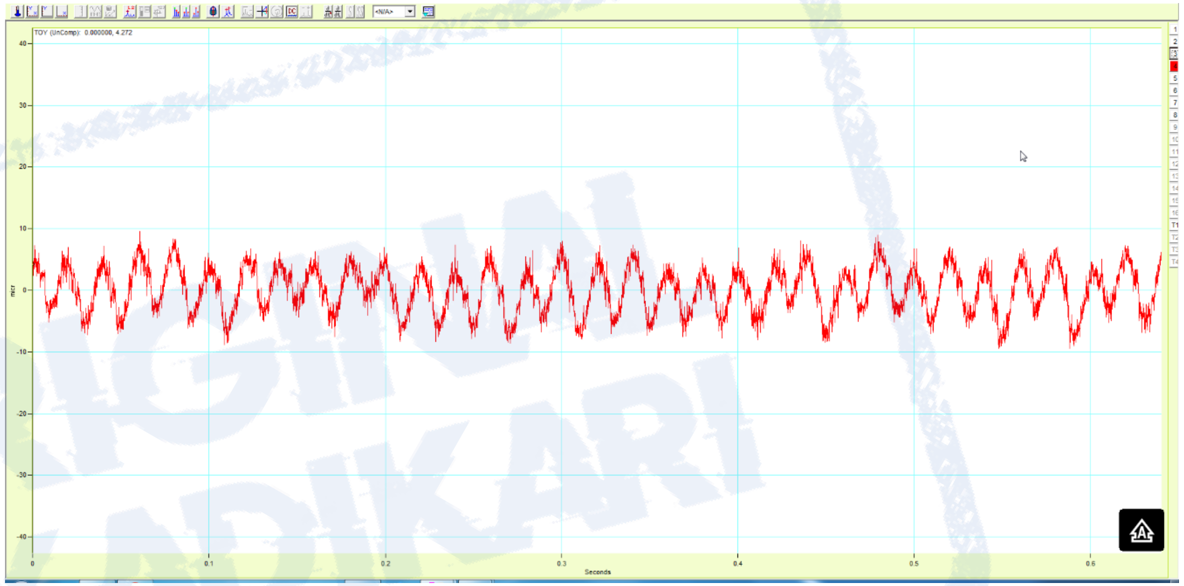


Dilakukan pengambilan data vibrasi pada turbin uap sebelum dilakukan overhaul.

Diperoleh nilai overall sebagai berikut:

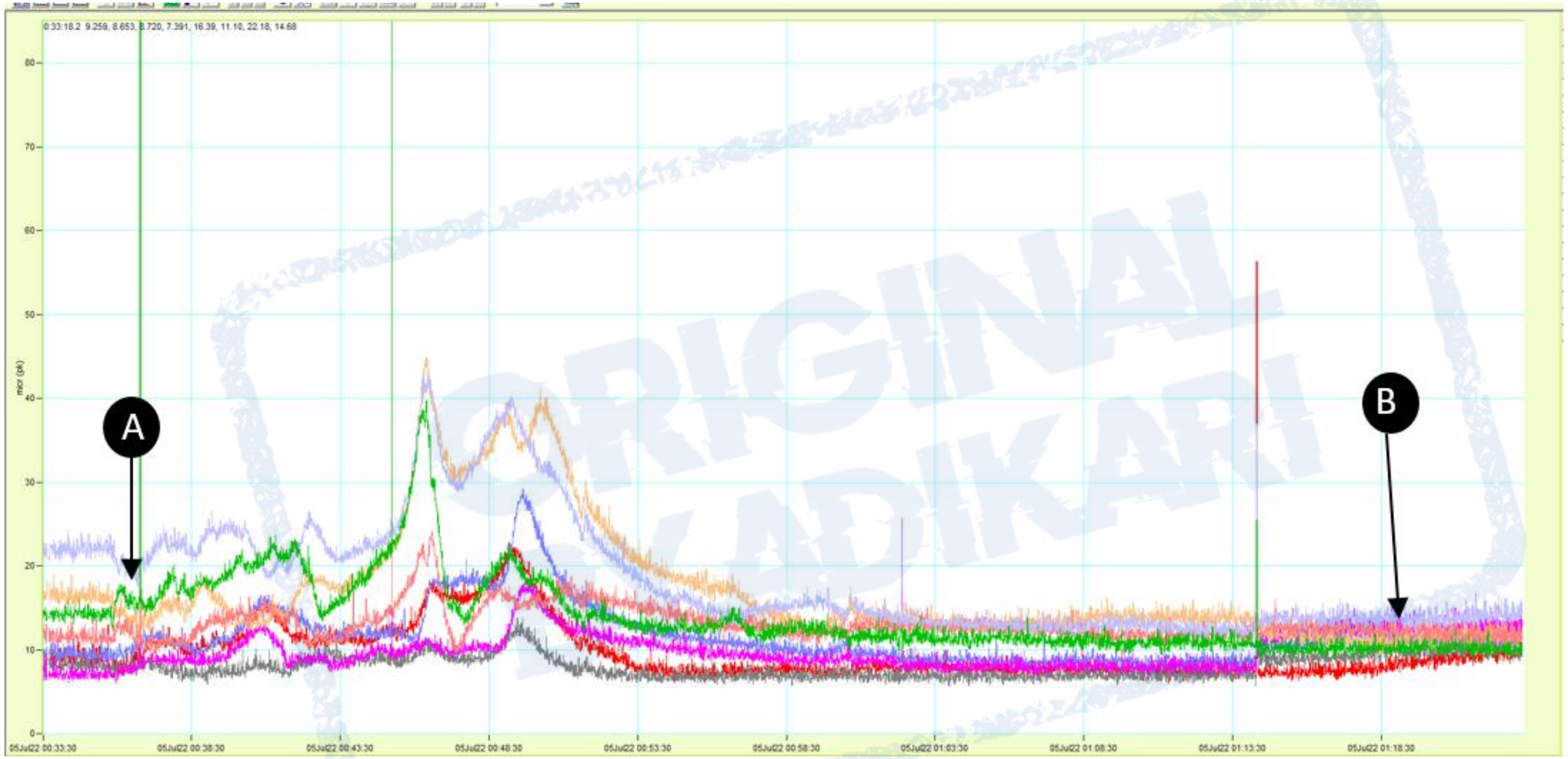
Measurement Point	Alarm/Shutdown (µm P-P)	Overall – 53MW Load (µm P-P)
TIX - Turbine Inboard Horizontal	120/250	41.96
TIY - Turbine Inboard Vertical	120/250	25.84
TOX - Turbine Outboard Horizontal	120/250	44.10
TOY - Turbine Outboard Vertical	120/250	30.44
GIX - Generator Inboard Horizonal	120/250	36.70
GIY - Generator Inboard Vertical	120/250	19.38
GOX - Generator Outboard Horizonal	120/250	50.60
GOY - Generator Outboard Vertical	120/250	32.50



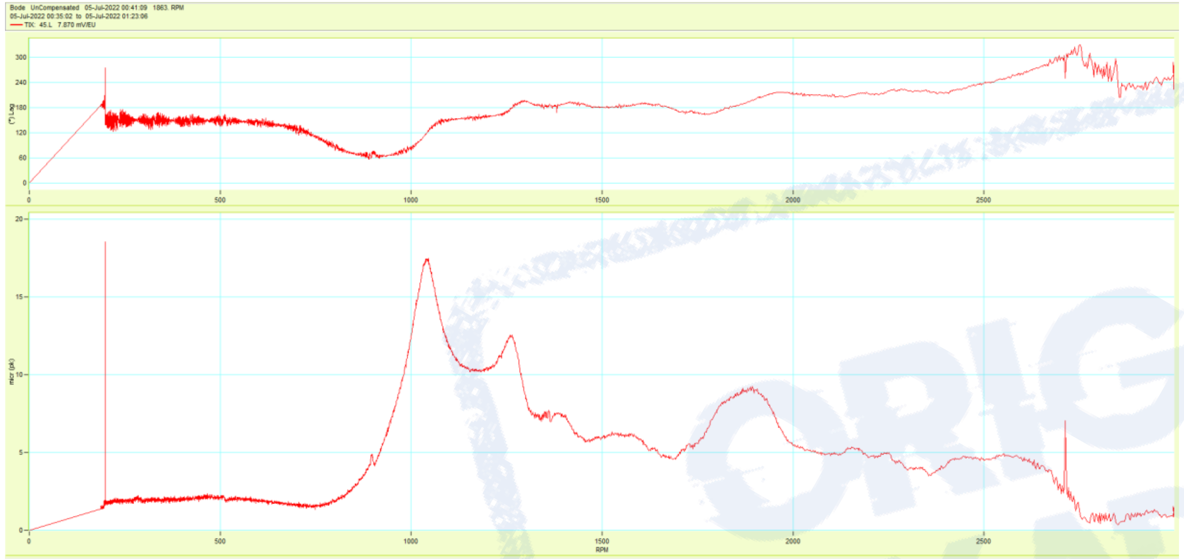


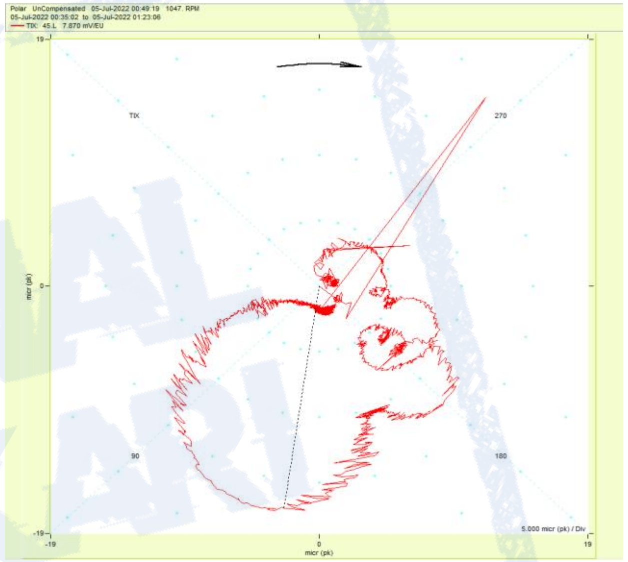
On turbine inboard bearing, unfiltered orbit plot shows erratic pattern with an elliptical shaped orbit at 1X vibration. This might indicate a preload condition on the turbine shaft, which can be caused by misalignment.

The time waveform turbine section shows a sinusoidal graph and will show a harmonic spectrum, in the generator section an impact phenomenon begins to appear but there is no modulation which indicates the absence of sidebands in the spectrum. In general, the possibility that we can observe through this time waveform is a bearing problem. We will need supporting analysis to verify this possibility.

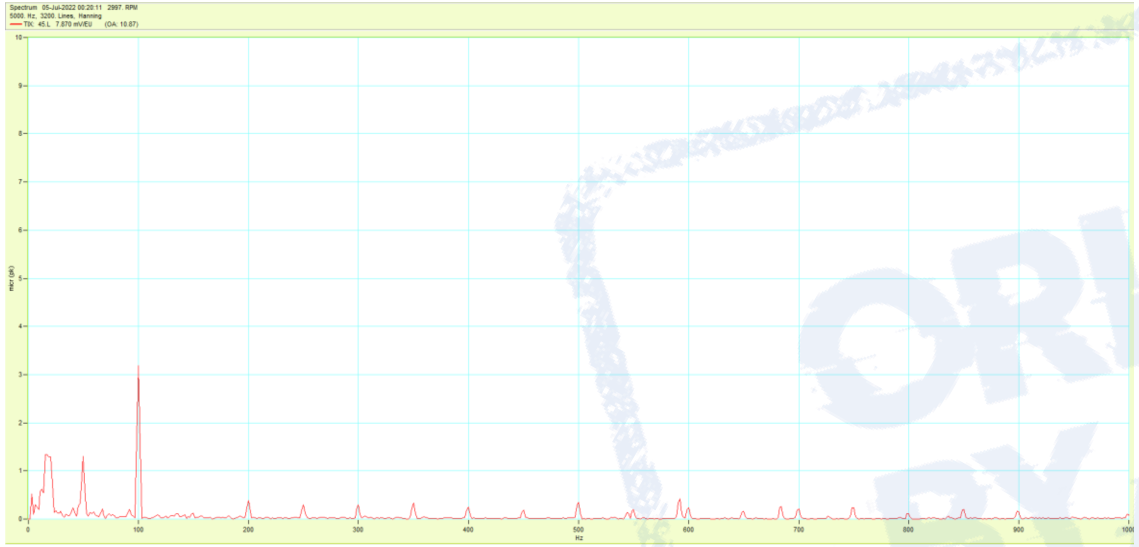


The coast down process starts from the unit with a load of 53MW until the unit stops at 0 RPM and no load. This process is divided into several conditions, namely when the load starts to be reduced from 53MW at the point before (A), after that the unit is in the FSNL condition at point (A). The FSNL condition of the rotating speed starts to approach 0 RPM (B).



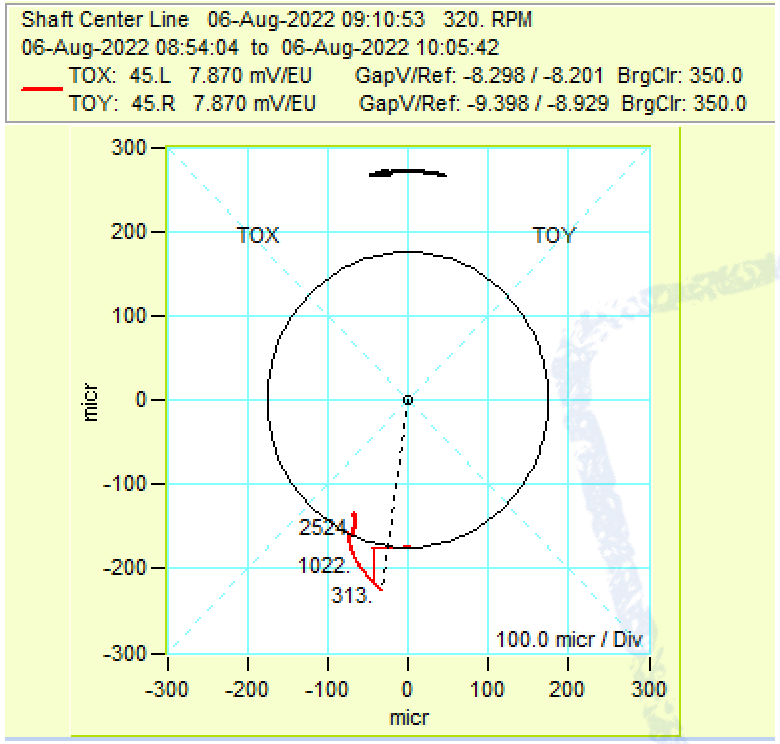


From the bode plot, it can be seen that the critical speed in the turbine section (Turbine Inboard and Outboard) occurs at around 1020 RPM @ 204 deg and 1896 RPM @ 194 deg.

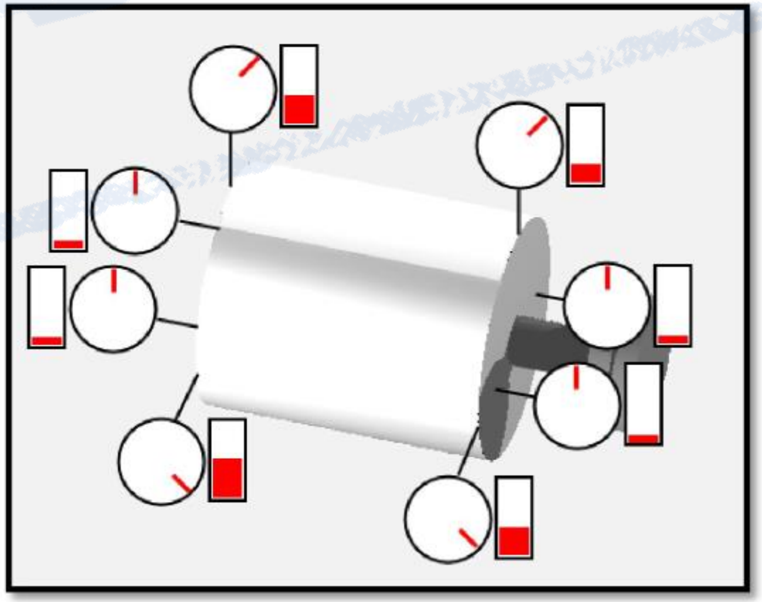


All data capture points show a 1X (50 Hz) harmonic spectrum. This spectrum may indicate loose in housing bearing, 1X peak and moderate at 2X indicates misalignment caused by soft foot. Misalignment caused by the soft foot will usually cause angular misalignment.

The waterfall plot on both turbine bearings are dominated by 1X and 2X peaks. During coast-down, there is a significant increase in amplitude of 1X peak when the turbine passes its critical speed at 1020 RPM, which then subsides afterwards.



On all four bearings it is shown that the shaft centerline were pressing against the bottom limit of the bearing clearance. This could indicate a possible sign of misalignment. It could also be caused by gap voltage reference error which was taken during slow roll process instead of during standstill. Considering low overall vibration level on all four bearings, it is still within normal condition.



REKOMENDASI

- Balancing (metode: trim run, splitting weight, four run balanced method, dll)
- Re-alignment (metode: straight edge/feeler gauge, Using laser MA, Dial indicator)
- Lakukan CLIT

THANK YOU

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