VIBRATION ON THE TURBO-GENERATOR AT THE SMALL POWER PLANT

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INTRODUCTION

All rotating equipment vibrates to some degree, but as older bearings and components reach the end of their product life, they begin to vibrate more dramatically and in distinct ways. Ongoing monitoring of equipment allows these signs of wear and damage to be identified well before the damage becomes an expensive problem. In this article we intend to analyze the importance of vibration measurement at the hydro-electrical power plant.

1. VIBRATION FOR TURBINE GENERATOR SHAFT

Vibration of turbine-generator shaft occurs due to the disturbance of electric power system. The coupling interaction between disturbance of electric power system and vibration of shafts makes turbine-generator oscillate. Alternating stress due to large vibration decreases the life of shafts, even results in shaft broken. It is very important in time to do the measurement and analyzes of the system condition [2].

Power plant turbo-generator sets should run around the clock – not only to keep power flowing but also to improve the machinery´s life expectancy, which is shortened every time machines are started up and shut down. While it is unfortunate when a turbo-generator set needs to be shut down for diagnosis or due to excessive vibration, it is entirely futile if no faults are subsequently found.

In the fig. 1 is illustrate the cross-section view of a generating unit.

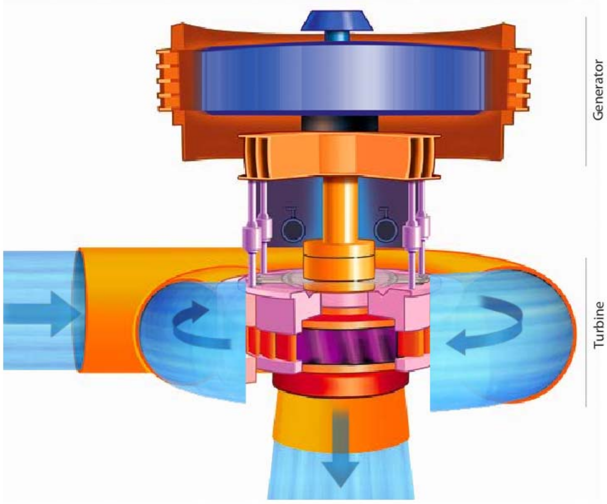

Figure 1. Cross-section view of a generating unit, update 10.04.13[1].

2. EXAMPLE

Decrease downtime and increase savings, is generically known as condition monitoring. When used correctly, it can result in huge cost savings compared to traditional maintenance methods.

Traditional maintenance methods are preventive - Components are replaced according to a fixed schedule whether worn or not. Traditional

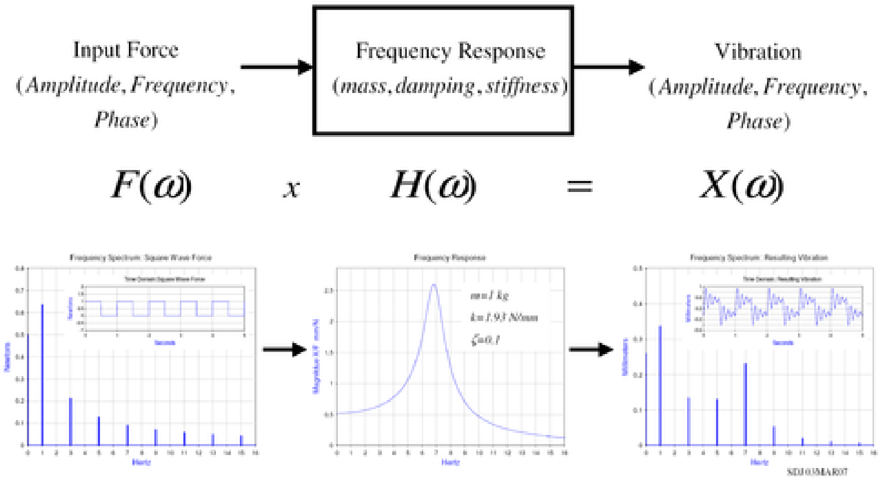

Figure 2. Frequency response model, update 10.03.13.

maintenance methods are also reactive, repairing components only after they have broken down.

Neither of these methods is ideal, although both are very common throughout the heavy industry sector, and both tend to incur much higher costs than methods that use vibration analysis.

3. USED STANDARDS

For evaluate the results at the Hydro electrical Power Plant from Czech Republic, the real data was according to the standard ČSN ISO 10816 – 3, for the power equipment from 300 kW to 50 MW:

Table 1. Standard ČSN ISO 10816 – 3.

Categories	V_{ef} (mm/s)
A/B	2,3
B/C	4,5
C/D	7,1

Categories:

A – this class is characteristic for a new installations.

B – installations, whose vibrations are placed in these limits are characteristic by a long time of function.

C – installations, whose vibrations are placed in these limits are considered dangerous in function/running for a long time.

D – installations, whose vibrations are placed in these limits are considered dangerous in function/running.

As an example of importance to control in time the vibrations, we are going to illustrate the real values for the Small Power Plant from Czech Republic.

The devices used was: VIBROTEST – 60, VIBROPORT – 41, acceleration sensor AS – 060 (Schenck Vibro).

Turbine characteristics: Kaplan, 110 rotation/min.

Generator characteristics: Synchronous, P_{max}=525 kW, 600 rotations/min.

Next we are going to illustrate the vibrations for the generator, bridge (on which is placed the generator) and the turbine- shaft vibrations in different time of measuring.

4. MEASUREMENT RESULTS

Measuring at the 16.02.10

Vibration measurement locations are shown in fig. 3. For clarity, all spectra are displayed with uniform amplitude scale 1.5 mm/s, for each set separately as spectrum overlay, first measuring point for generators and then measuring point for turbine - shafts.

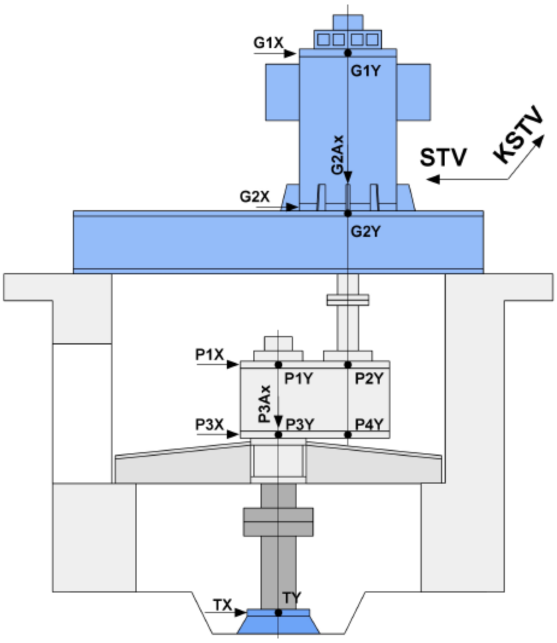

Figure 3. Frequency response model, update 16.02.10.

Figure 4. Frequency response model, update 16.02.10.

Figure 5. Frequency response model, update 16.02.10

Table 2. The average value of vibration at the various levels.

Part of system	Vef [mm/s]		
	Measuring Place	P=290 kW	Pmax=370 kW
Generator	G1X	1,58	1,51
	G1Y	1,54	1,50
	G2X	0,32	0,43
	G2Y	1,38	1,44
	G2Ax	1,00	0,84
Ax	P1X	0,50	-
	P1Y	0,52	-
	P2Y	0,40	-
	P3X	0,40	-
	P3Y	0,39	-
	P3Ax	0,37	-
	P4Y	0,31	-
Turbine	TX	0,12	-
	TY	0,15	-

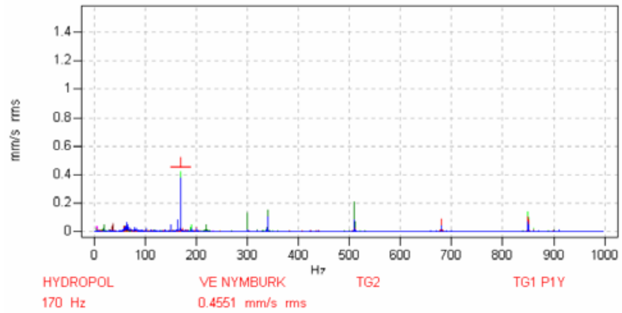

Figure 6. Vibrations of the shaft, update 16.02.10.

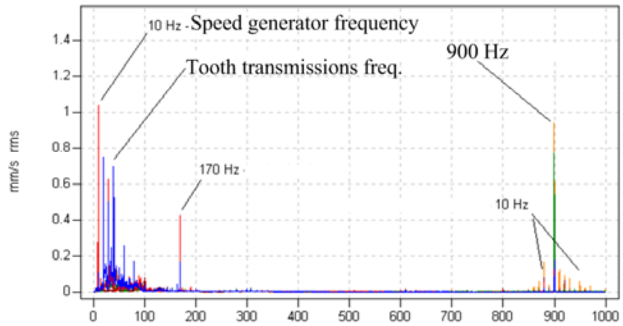

Figure 7. Vibrations of the generator, update 16.02.10.

All spectra contain the following basic components, see fig. 7:

- Speed generator frequency 10 Hz and his harmonics (20 Hz, 30 Hz, … etc).
- Tooth transmissions frequency 170 Hz and his harmonics (340 Hz …).
- Splined generator frequency 900 Hz lateral modulation band with a distance of 10 Hz.

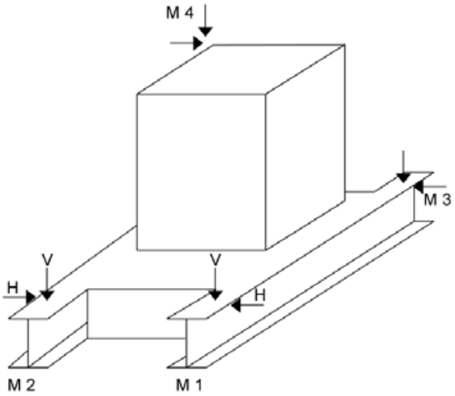

Figure 8. Scheme of the generator and bridge placement.

The measurements, witch was effectuated on the bridge are illustrated in fig. 8.

Measuring 21.03.13

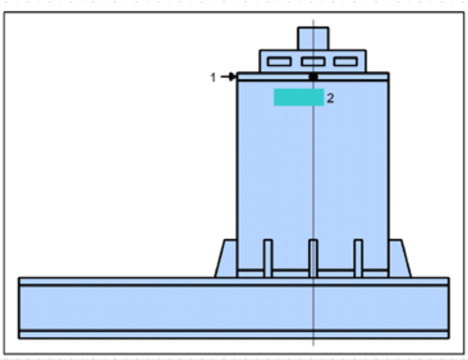

Figure 9. The scheme of the measuring places.

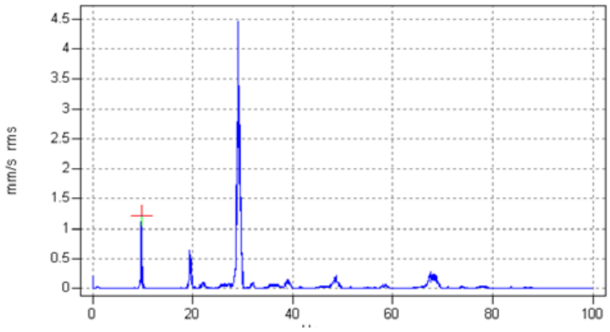

Figure 10. Vibrations of the generator, direction 2, update 21.03.13.

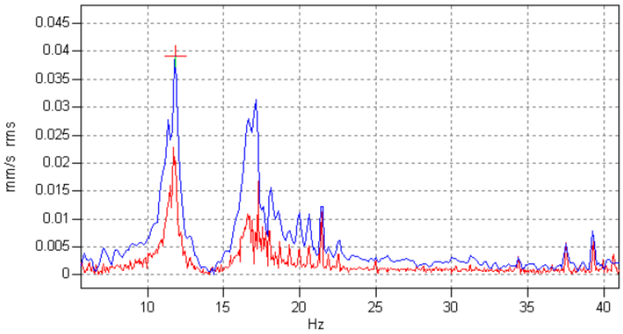

Figure 11. Vibrations of the bridge, update 21.03.13.

Analyzing the results of measurement the engineers detect the big values of the generator vibration.

Following detailed analysis of the measured values the engineers concluded that the problem is somewhere in the section bridge - generator.

To detect cause of the excessive vibration were performed several additional steps. First of all were taken out the cover anti-noise from the generator and performed new measurement.

Were detected thought of vibration the damage side – namely the instability in the location of shaft between generator and the bridge on witch generator is placed.

CONCLUSION

Analyzing the vibration levels it can be recommended to avoid operation at partial load, close to minimum values, but not over maximum, in order to keep relatively low levels of vibrations.

The hydro units don´t have problems in normal operation, in the vibration signals frequency spectra being observed remarkable amplitudes at frequencies identified as runner fundamental frequency and network frequency. Otherwise the signals are relatively clean.

From the example shown in the article is well seen the importance of performing regular measurements and their correct analysis.

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