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14th November 2003

Att: XXXXXXXX

Ref: 15MW Hydro Generator Sets #1 and 2 at your Pingston location.
 Generator #1: serial # 167955-1 / Generator #2: serial # 167955-2
 Dave,

Further to my site visit on the 12th I have pleasure in submitting my report:

According to ISO standards these generator sets would be classified as class III machines, the following table is a guide for vibration severity in this classification:

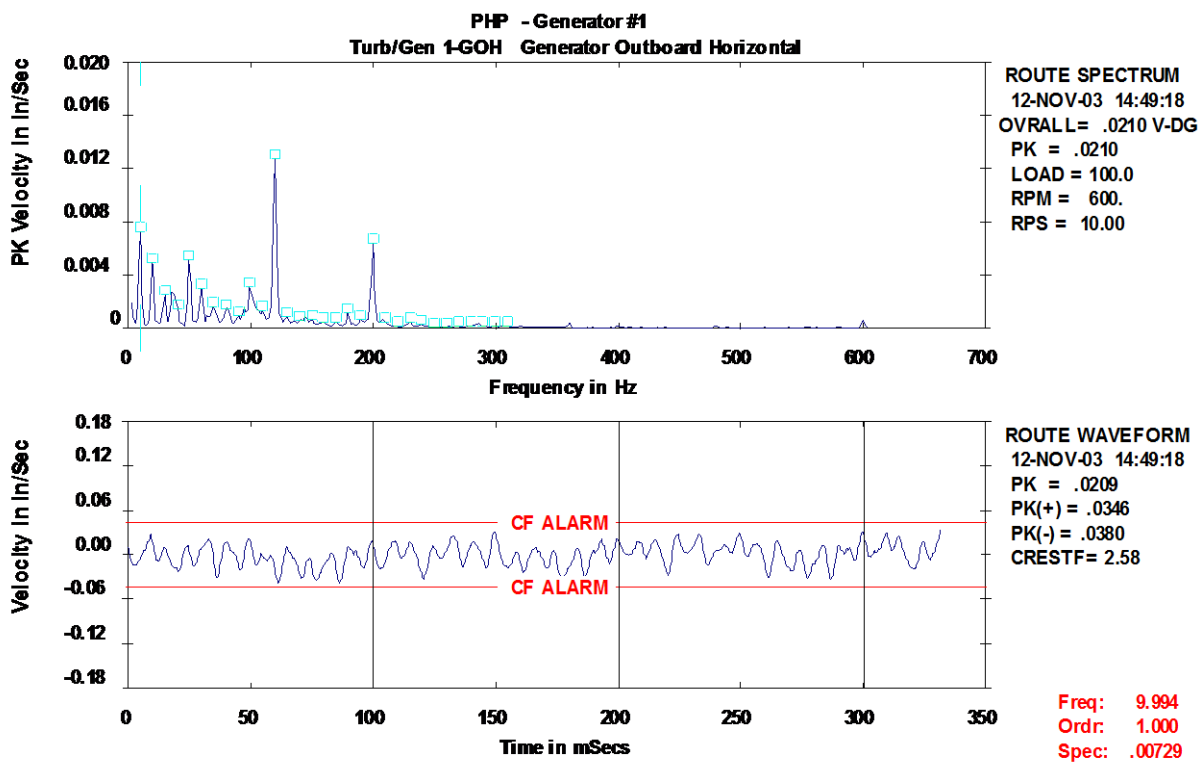
Range MM/Sec Peak	Range In/Sec Peak	Vibration Severity
0 – 2.54	0 – 0.1	A (Good)
2.54 – 6.37	0.1 – 0.25	B (Acceptable)
6.37 – 15.8	0.25 – 0.62	C (Rough)
Over 15.8	Over 0.62	D (Not Acceptable)

Overall vibration levels:

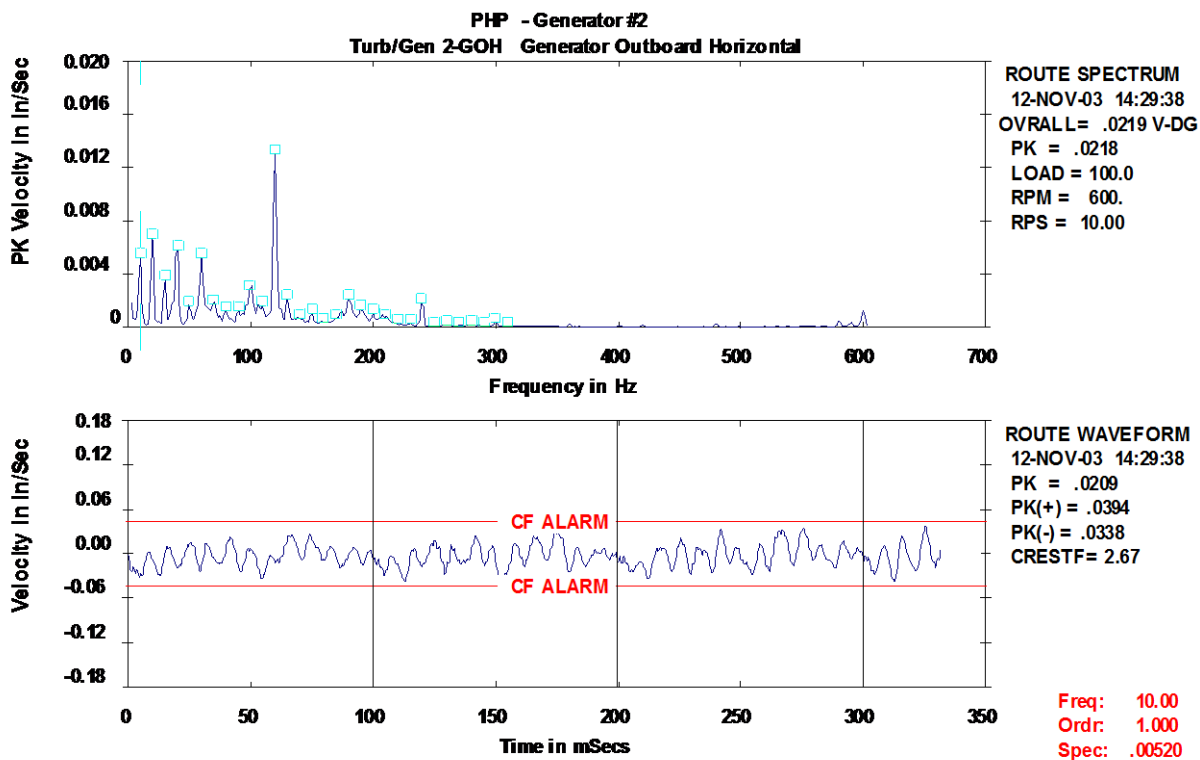
Generator #1		Generator #2	
	mm/sec – In/sec (Peak)		mm/sec – In/sec (Peak)
GOH	0.534 – 0.021	GOH	0.555 – 0.021
GOV	0.390 – 0.015	GOV	0.566 – 0.022
GOA	0.879 – 0.034	GOA	1.906 – 0.075
GIH	0.993 – 0.039	GIH	0.850 – 0.033
GIV	1.206 – 0.047	GIV	0.880 – 0.034
TIH	1.026 – 0.040	TIH	1.690 – 0.066
TIV	1.054 – 0.041	TIV	1.021 – 0.040
TOH	0.950 – 0.037	TOH	1.387 – 0.054
TOV	0.769 – 0.030	TOV	0.719 – 0.028
TOA	1.148 – 0.045	TOA	0.632 – 0.024

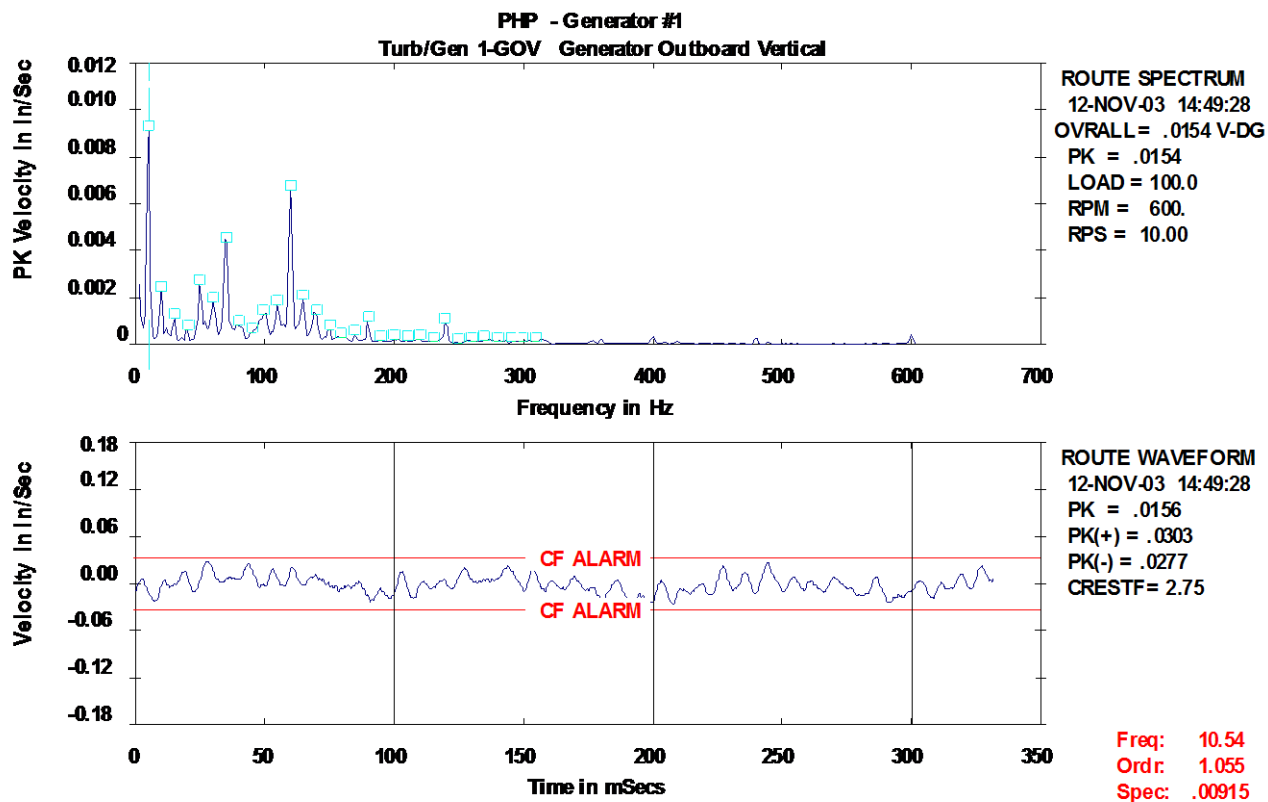
Abbreviations: G – Generator, T – Turbine, O – Outboard, I – Inboard, H – Horizontal, V – Vertical, A – Axial

When the above chart is compared with the ISO chart the general indications are that both units are in good condition. However with spectral analysis it is possible locate some minor issues, I have put matching measurement point locations from each unit on the same page for ease of comparison.

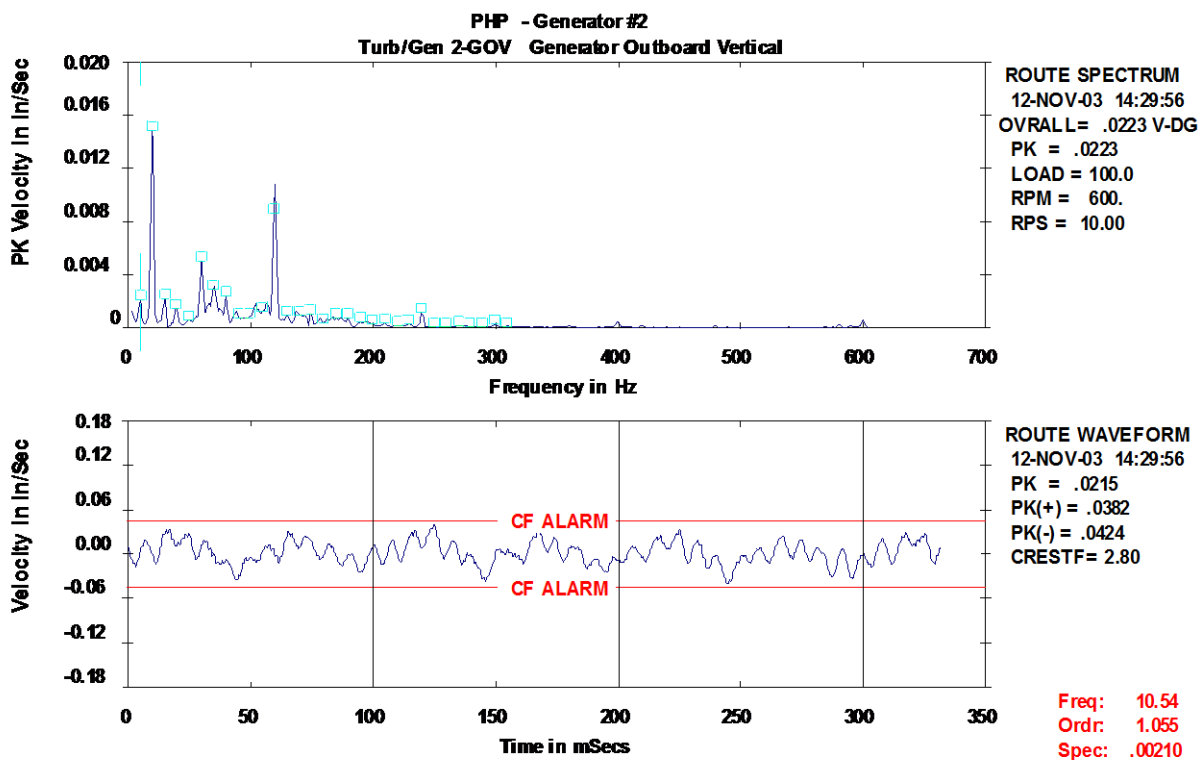


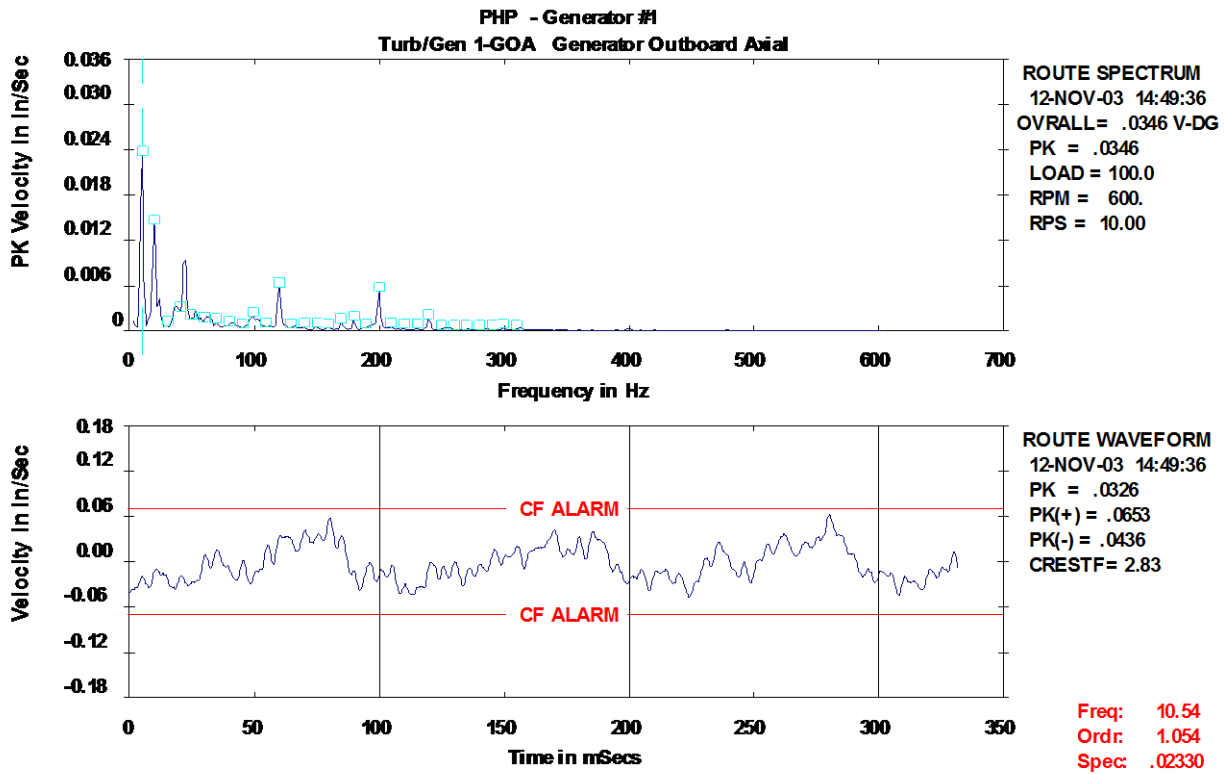
No problems apparent at these locations. The high peaks in both spectral charts are at 12 X RPM and are probably inherent pole pass frequencies.



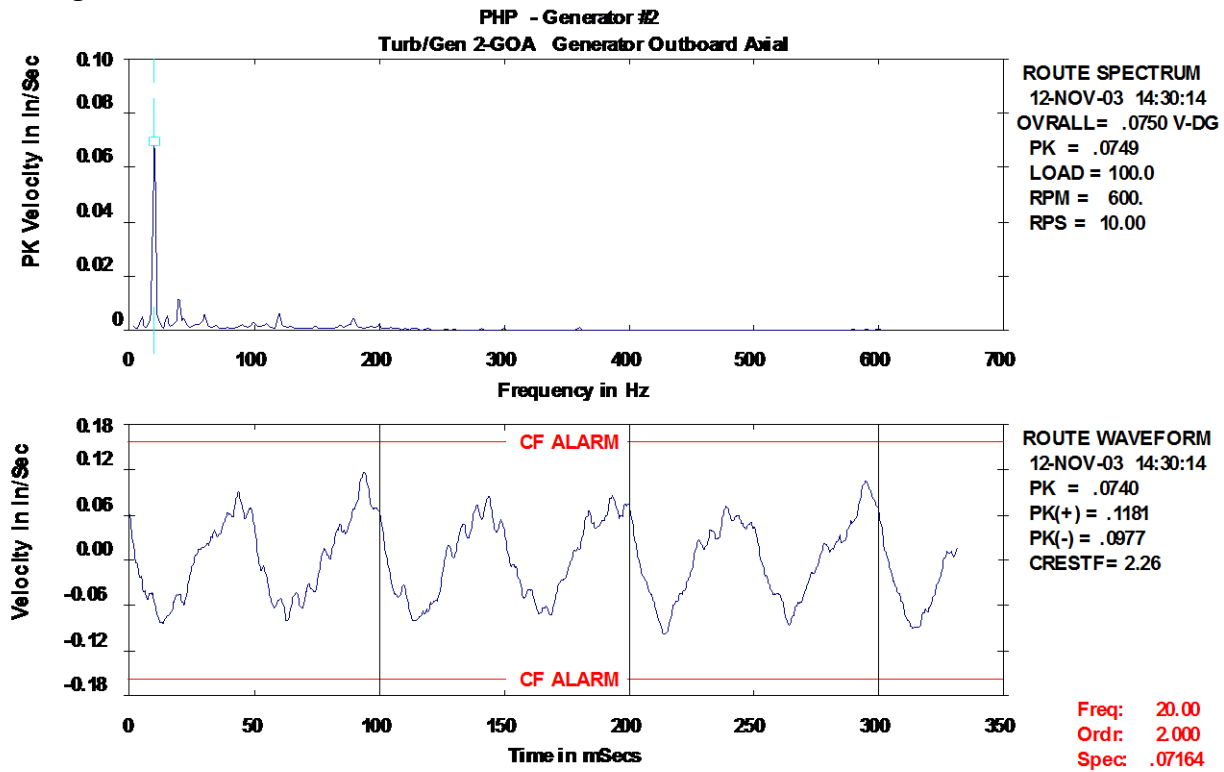


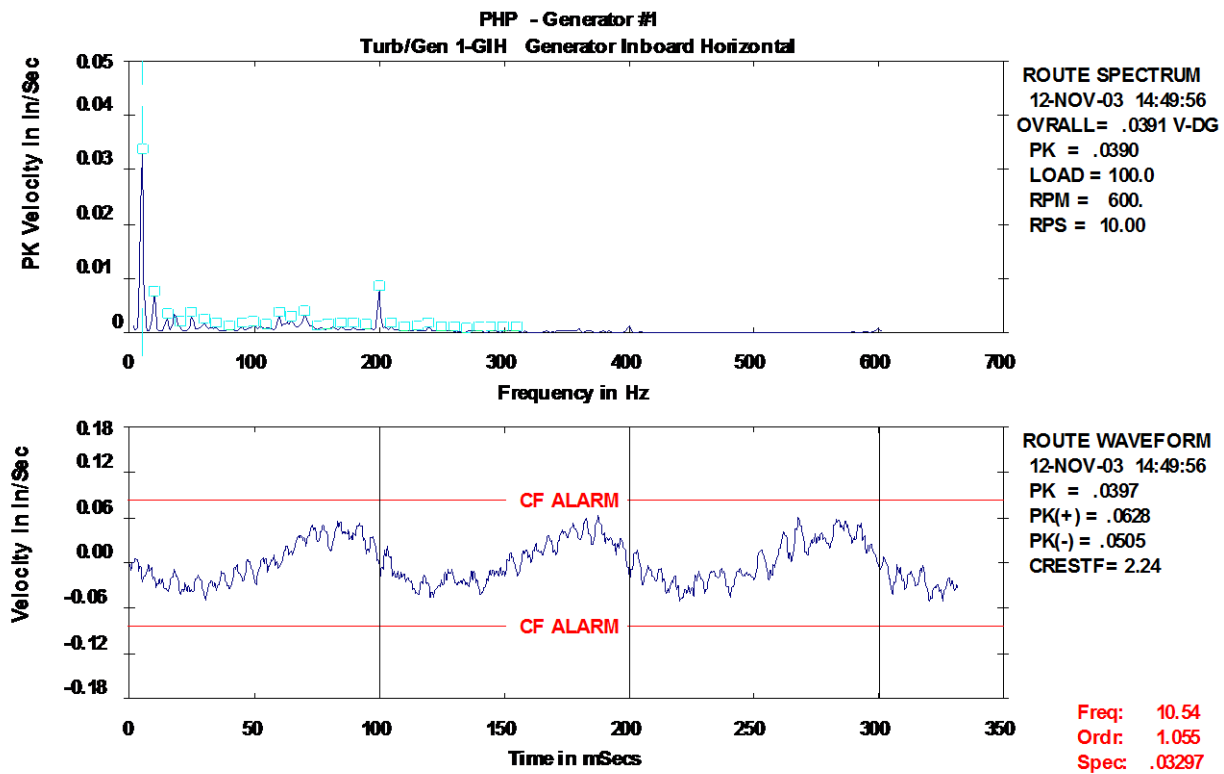
No problems at these locations. The spectral peaks are normal inherent frequencies (machine noise).



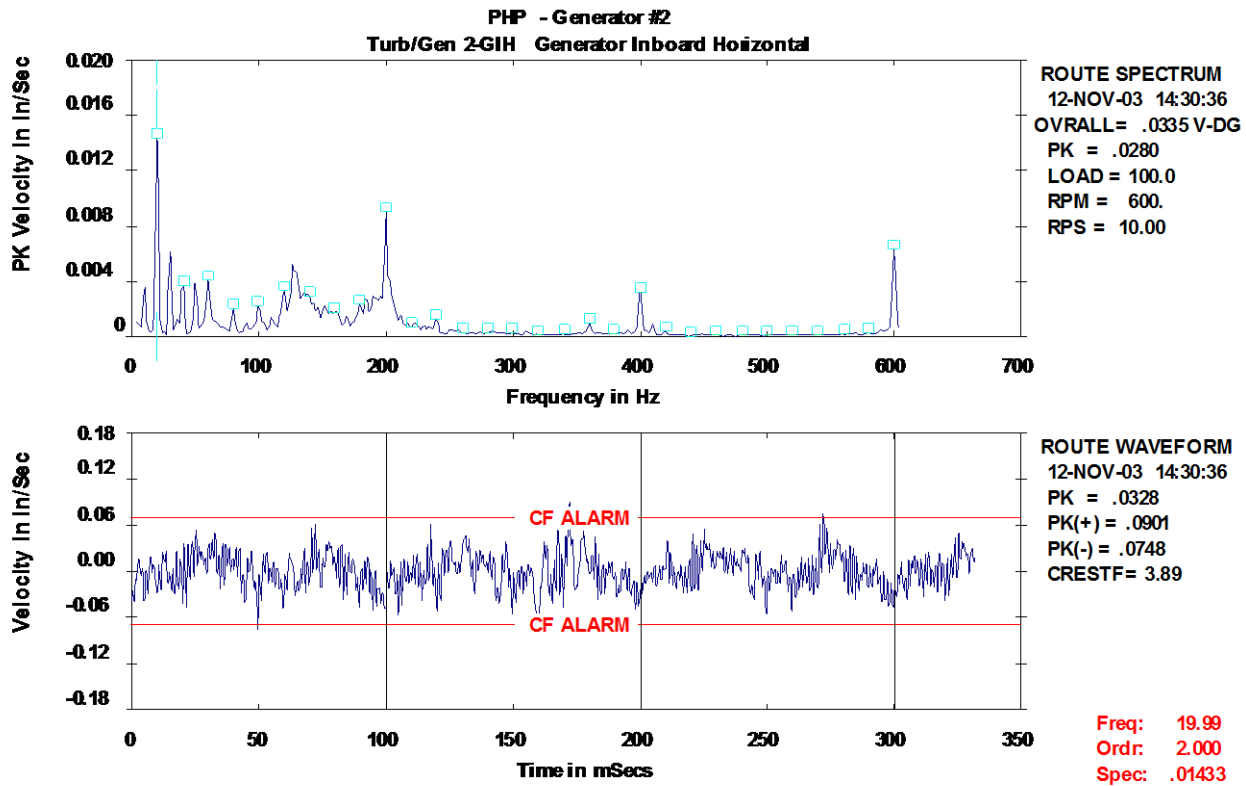


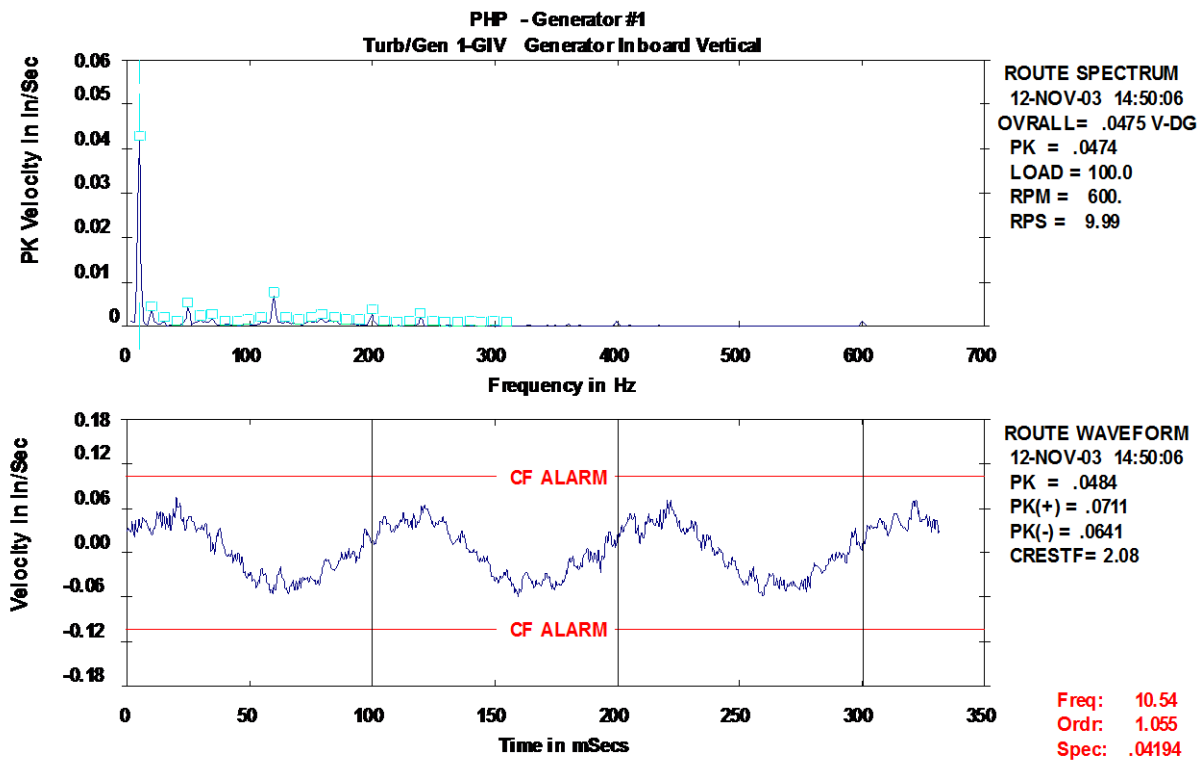
On generator # 2 the high peak is at twice the operating rpm and is probably caused by slight coupling misalignment.



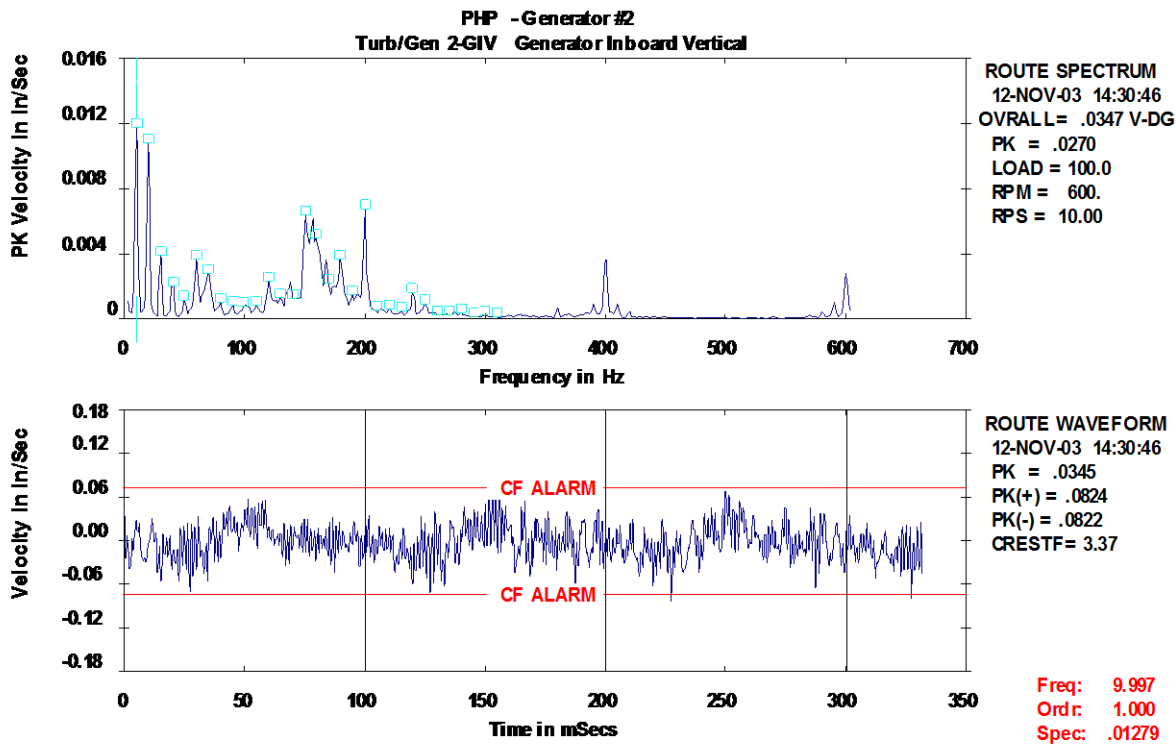


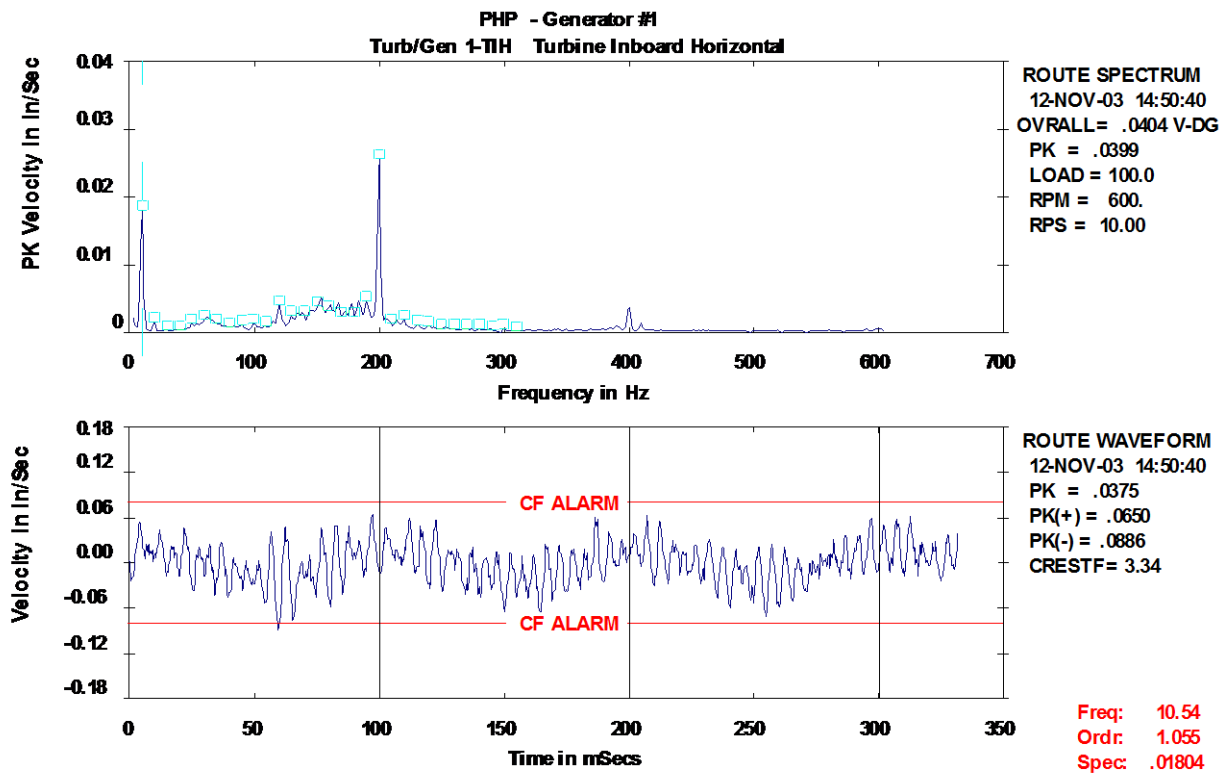
Generator #1 rotor appears to be slightly unbalanced, generator #2 has a relatively high 2 X amplitude which again indicates a misaligned coupling.



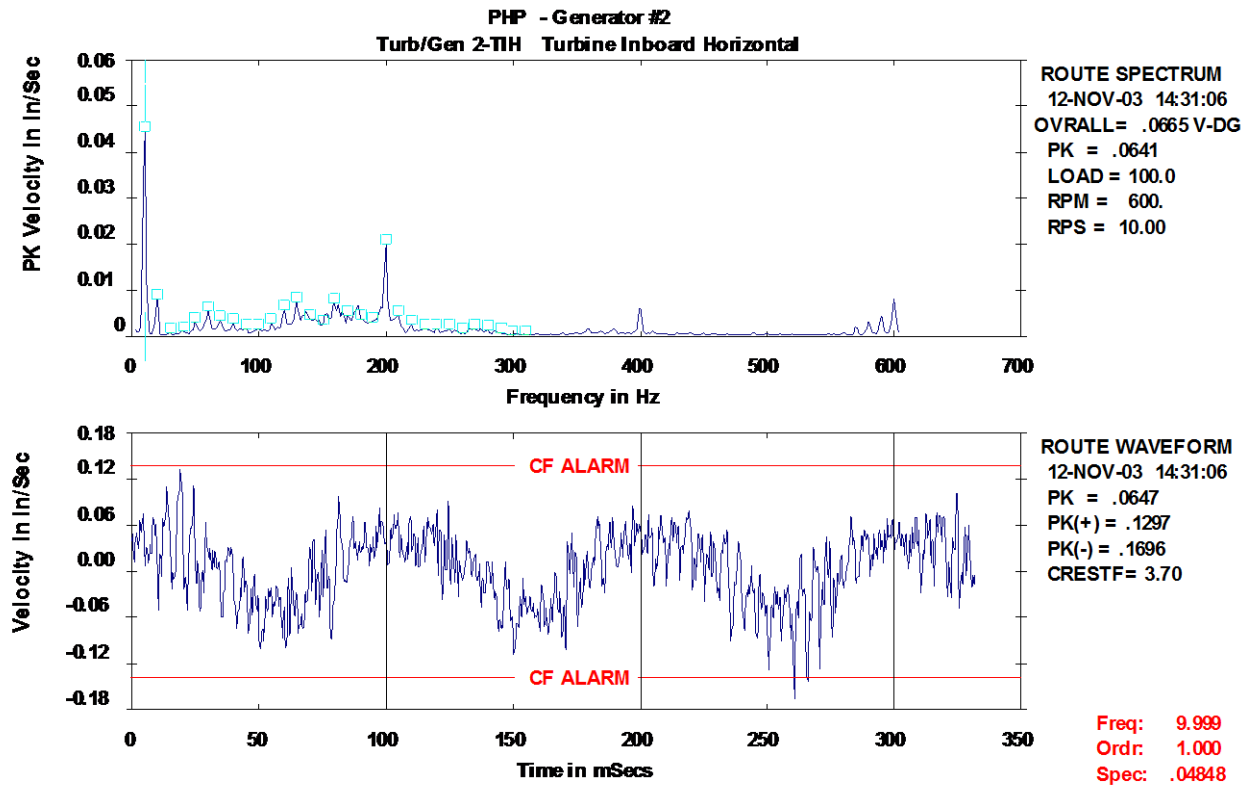


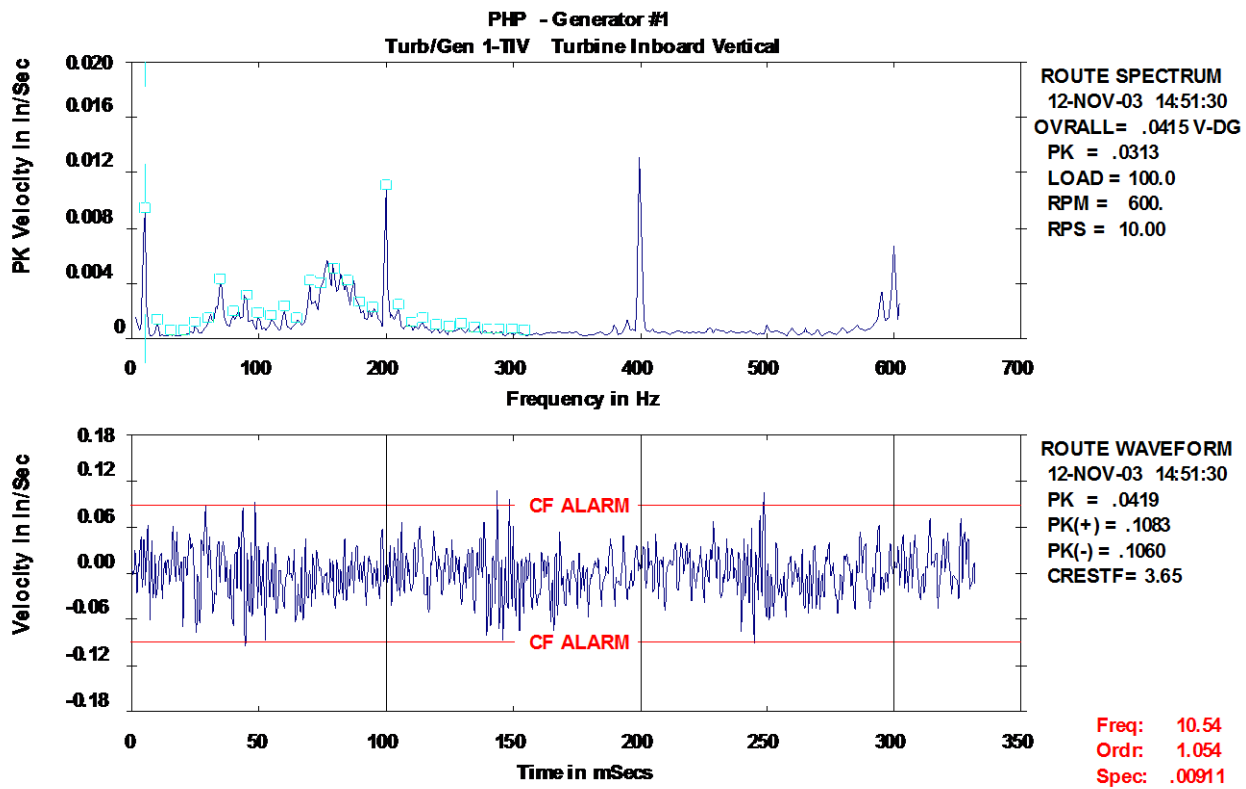
Same issues as found in the above horizontal measurements are in evidence on both generators in the vertical plane.



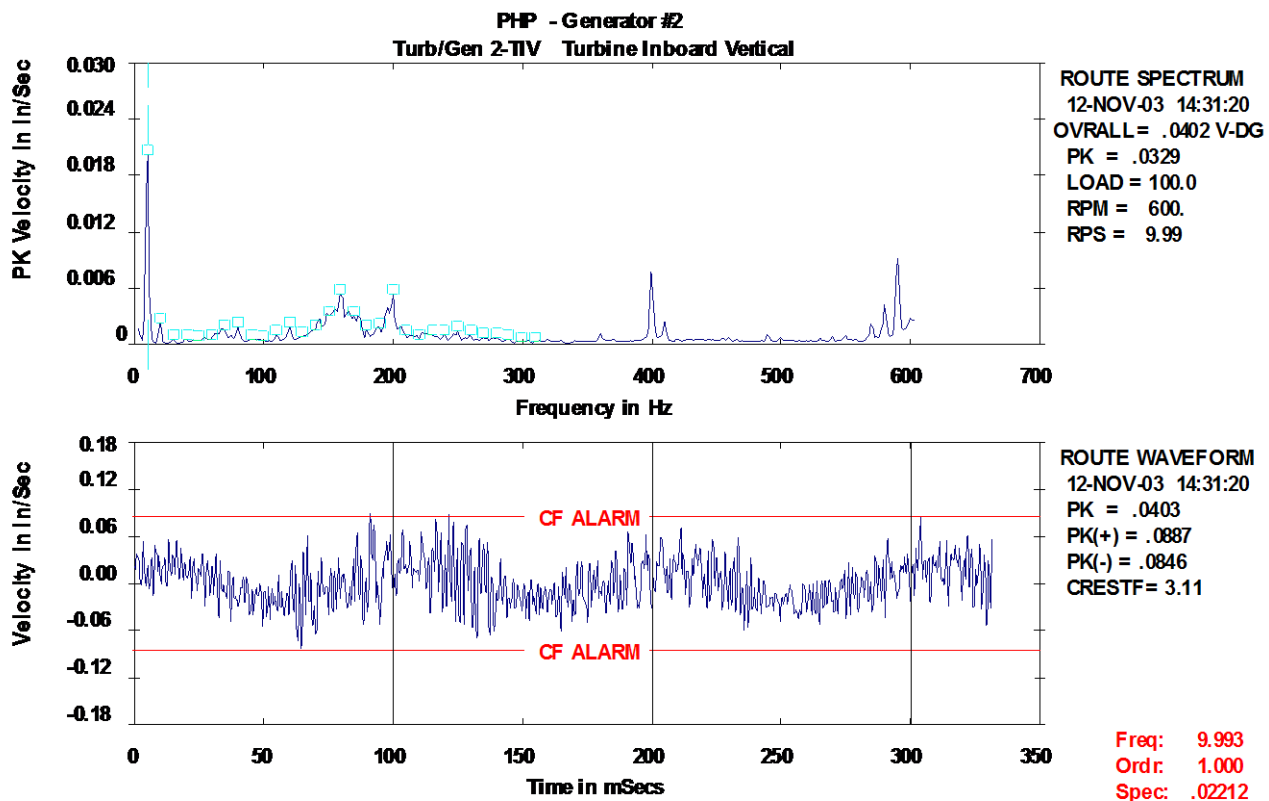


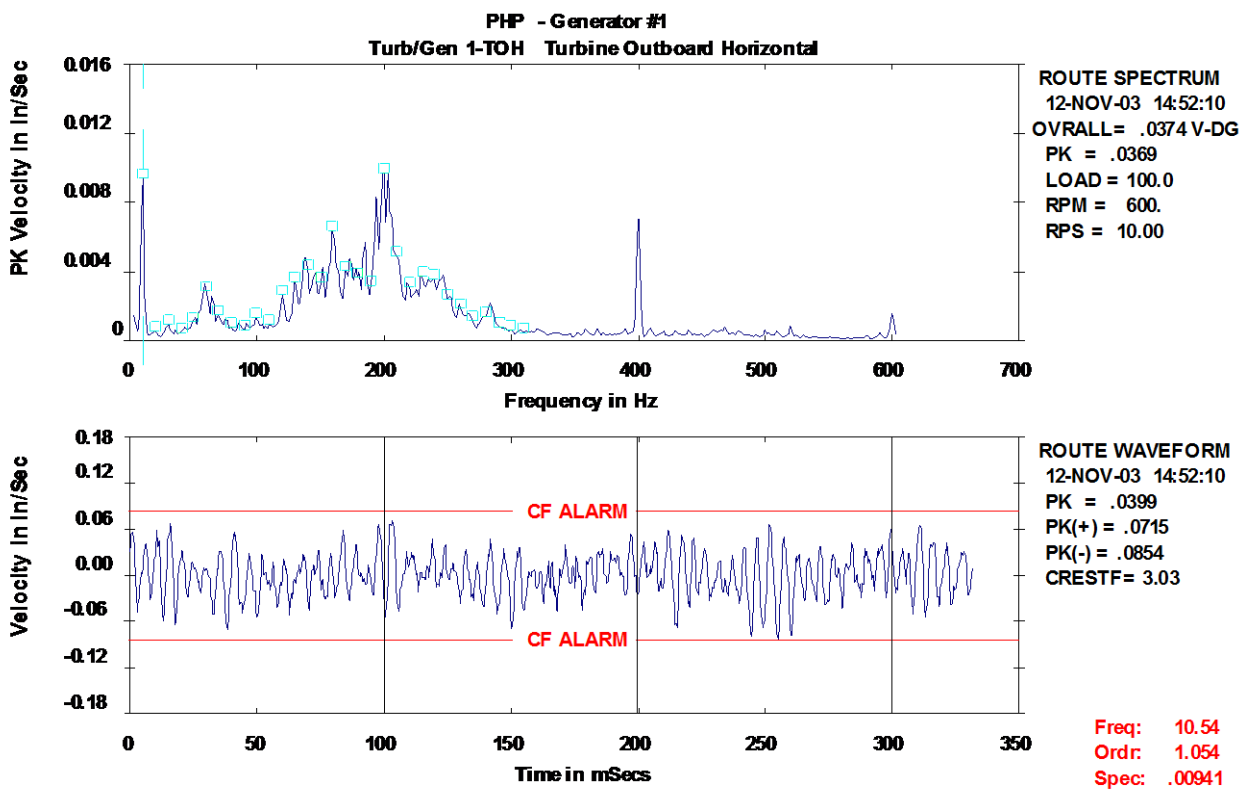
Both turbines have high frequency vibration at 20 X the RPM, this is a normal “driving force” vibration (20 buckets on the arbor). Turbine # 2 is slightly out of balance.



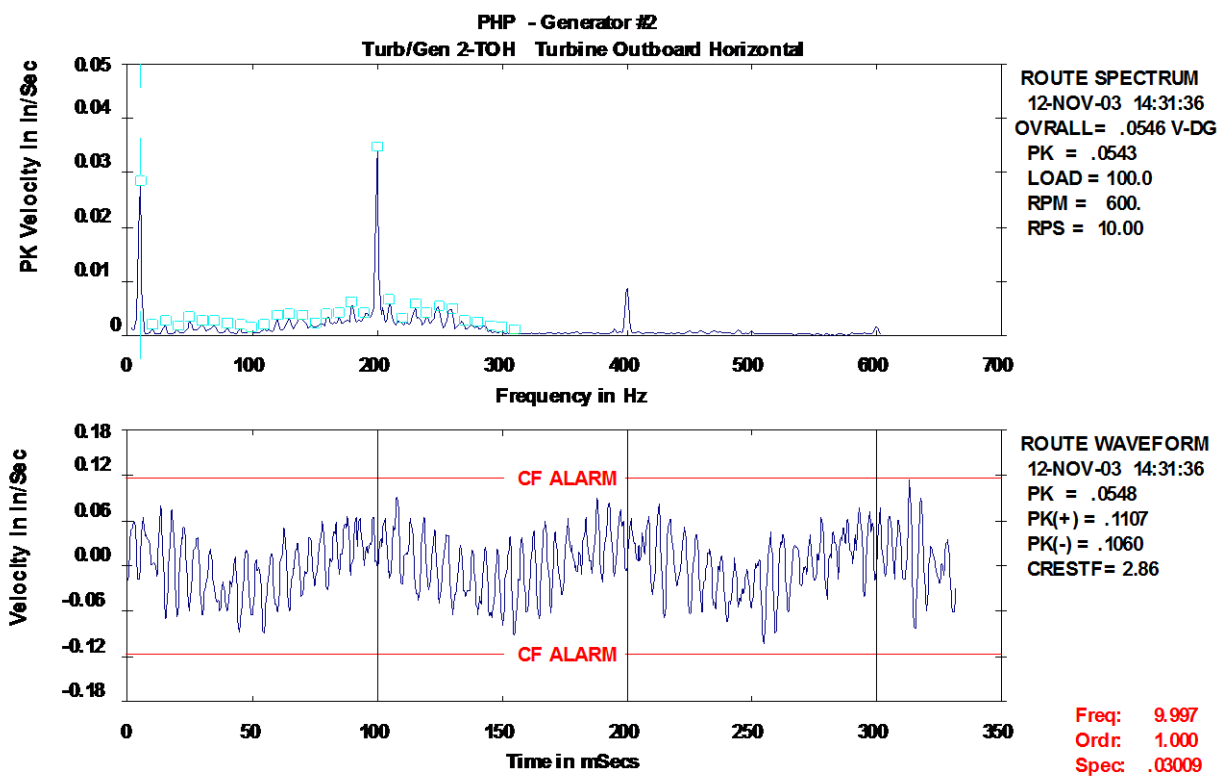


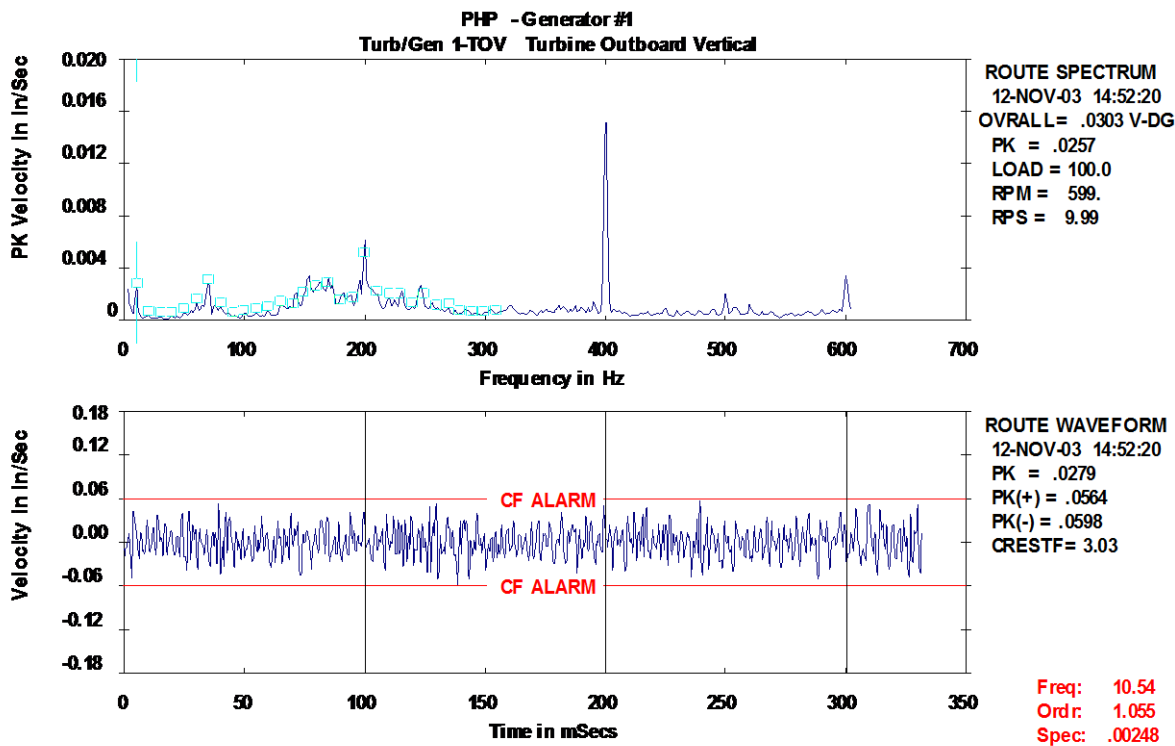
No problems apparent at these locations. The unbalance on turbine #2 noted in the horizontal plane is not as apparent in the vertical axis because of the relative stiffness in the vertical plane.



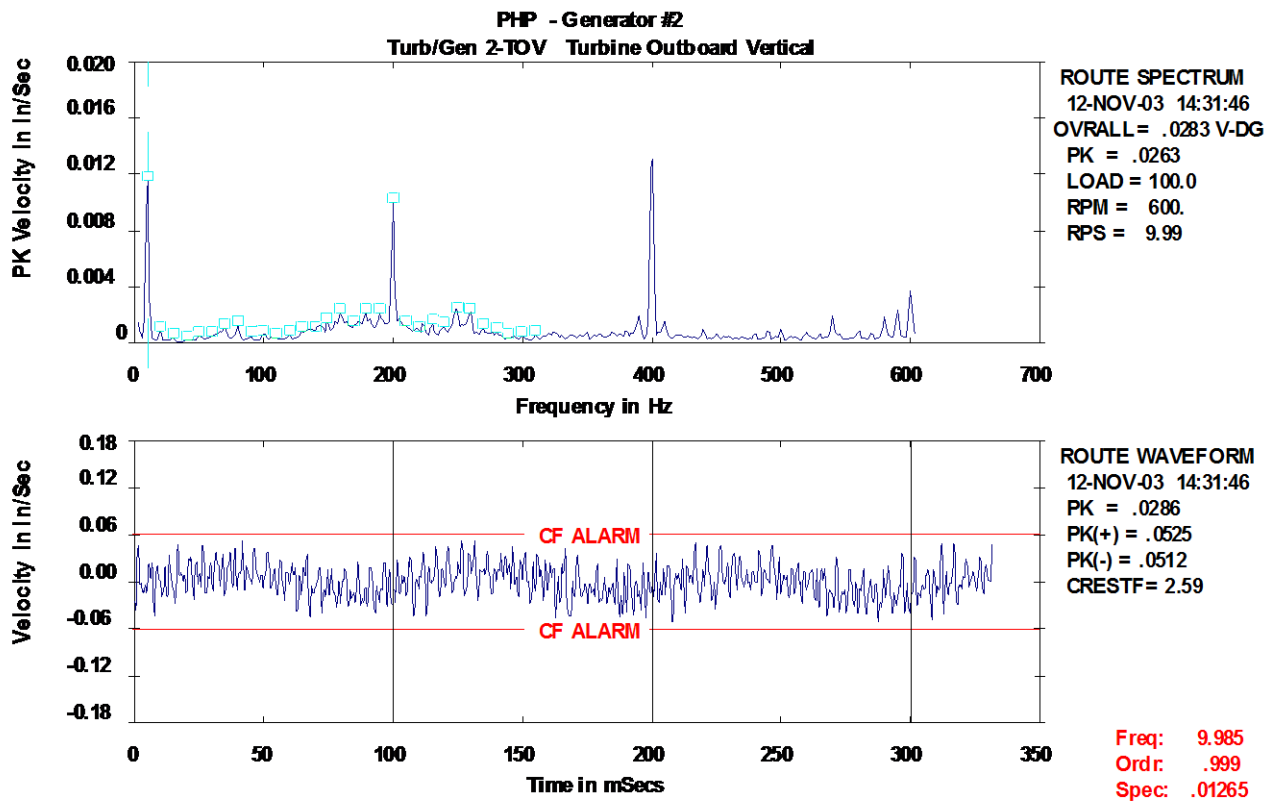


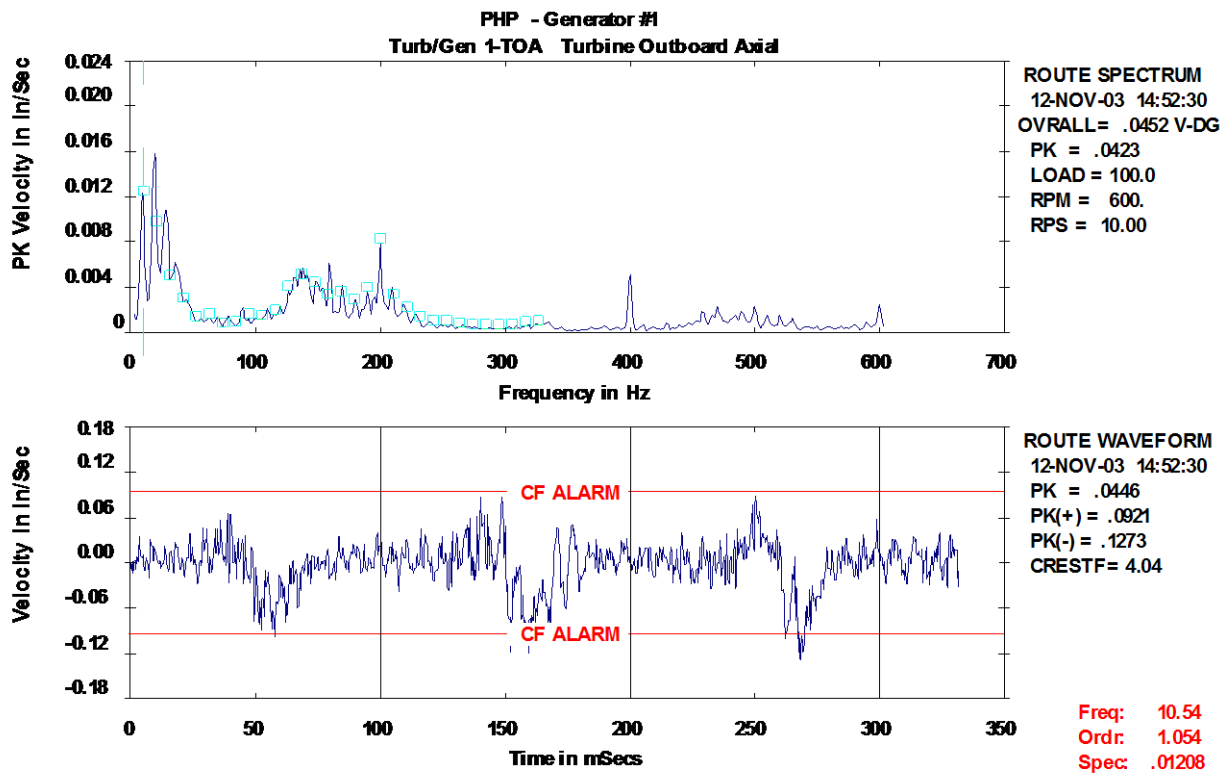
No problems in these locations other than the slight unbalance on turbine #2.



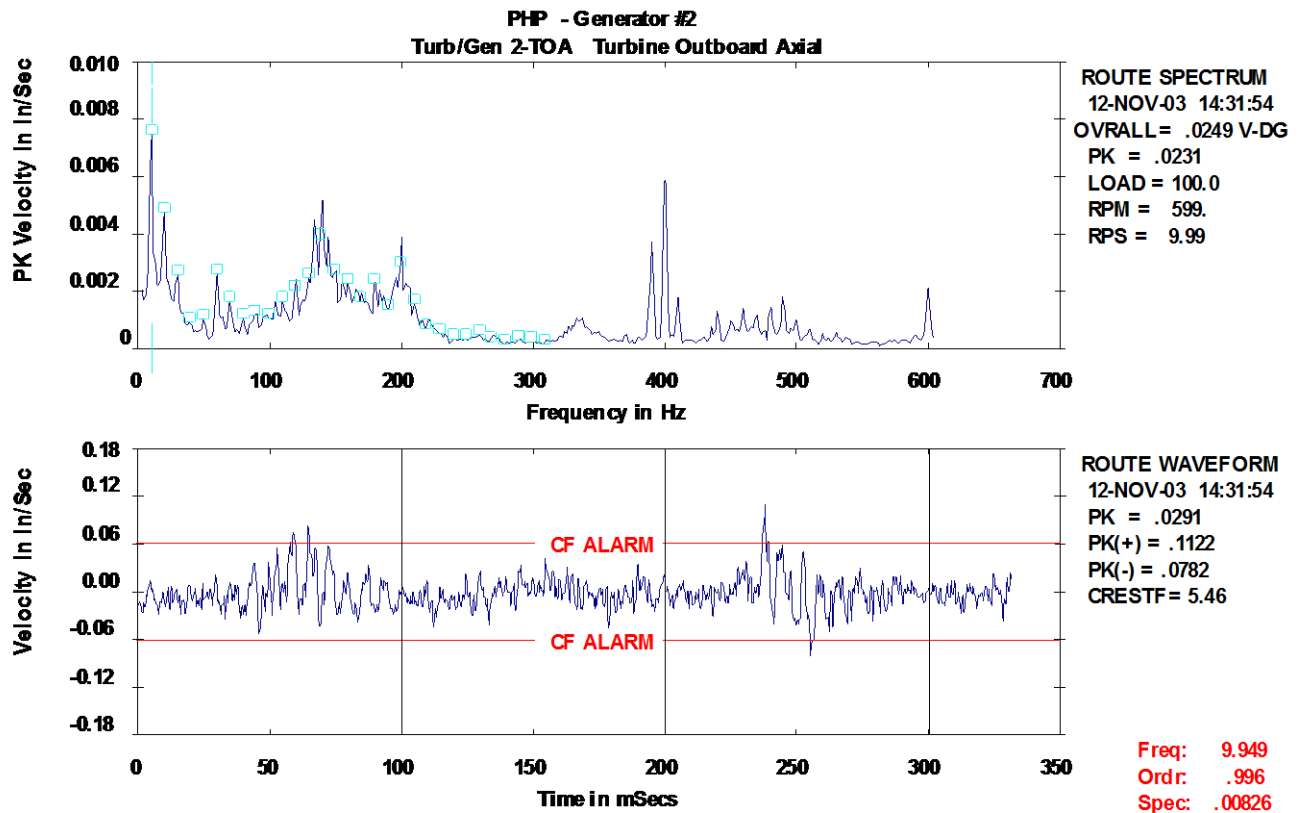


No problems apparent at these locations. The unbalance on turbine #2 noted in the horizontal plane is not as apparent in the vertical axis because of the relative stiffness in the vertical plane.





Amplitudes on both turbines are low, however the unusual waveform noted on turbine #1 could be an indication of thrust bearing problem.



To Conclude:

The highest vibration amplitude recorded during my survey was on #2 generator in the axial position, to ensure longevity of the machine I think that it would be prudent to check the coupling alignment with the aid of a laser alignment system.

The unbalance noted on turbine #2 is low and would not normally be of any concern; however, in my opinion because of the problems that you encountered on turbine #1, I think that it would be wise to carry out a magnetic particle inspection of the bucket welds, my reasoning behind this is that if another bucket is breaking away from the arbor it would initially show as unbalance.

The only other notable observation was turbine #1 thrust bearing, the amplitudes recorded at this location are low but have an the waveform is irregular. To give more accurate analysis both machines should be analyzed on a regular basis so that the spectral information can be trended.

One final comment is that the vibration alarms in your control room appear to be set to low and could be triggering “nuisance alarms” The vibration trip alarm appears to be OK but both of these settings should be confirmed with the manufacturer.

I trust that the above report is in line with your requirements and if you have any further questions please do not hesitate to contact me.

Regards: Rob Brentnall

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