

Vibration Issues

Typical Causes for Gas
& Steam Turbines

Presentation Objectives

- I. Typical Causes/Corrective Measures
- II. Shorted Turns
- III. Items of Concern
- IV. Soft Feet Check/Correction
- v. Questions & Answers



I. Typical Causes / Corrective Measures



Typical Causes of Vibration

- Misalignment
- Soft Feet
- Mechanical Unbalance
- Rubs
- Electrical Unbalance

Misalignment

- Will typically increase over time
- Can be caused by foundation settling

Soft Feet

- Soft feet = loose shim packs between unit and foundation
- Will typically increase over time
- Can be caused by rusting of shim packs

Corrective Measure(s)

- Re-align unit
- Correct soft feet

Mechanical Unbalance

- Will typically increase over time
- Can be caused by
 - Dirt on rotor
 - Foreign object damage to turbine/compressor blades or buckets

Corrective Measure(s)

- Clean rotor
- Repair damage
- Balance rotor by adding weight

Rubs

- Typically seen after an outage or new installation
- Shows up over operating time
- Will increase amplitude after unit has reached speed

Corrective Measure(s)

- Sometimes a rub will “rub in” (open the clearances)
- Other times disassembly is required to correct the rub

Electrical Unbalance

- Caused by shorted turns in the rotor, causing hot spots
- Vibration levels will vary with load
 - in some cases load limiting

Corrective Measure(s)

Depends upon how severe shorts are...

- > 6 mils from FSNL to base load will require rewinding affected coil(s)
- Balancing can be done to allow unit to be run at a certain load point

II. Shorted Turns

Shorted Turns

- Occurring more often today because of unit cycling
- Caused by:
 - Start/stops
 - Copper expansion/contraction affects insulation

Shorted Turns (continued)

- Best determined via flux probe test
- Vibration can be checked by running the unit through the load range, measuring thermal growth
 - Does not measure exact # of shorts
 - Measures result of shorts
 - Even shorts/pole warning

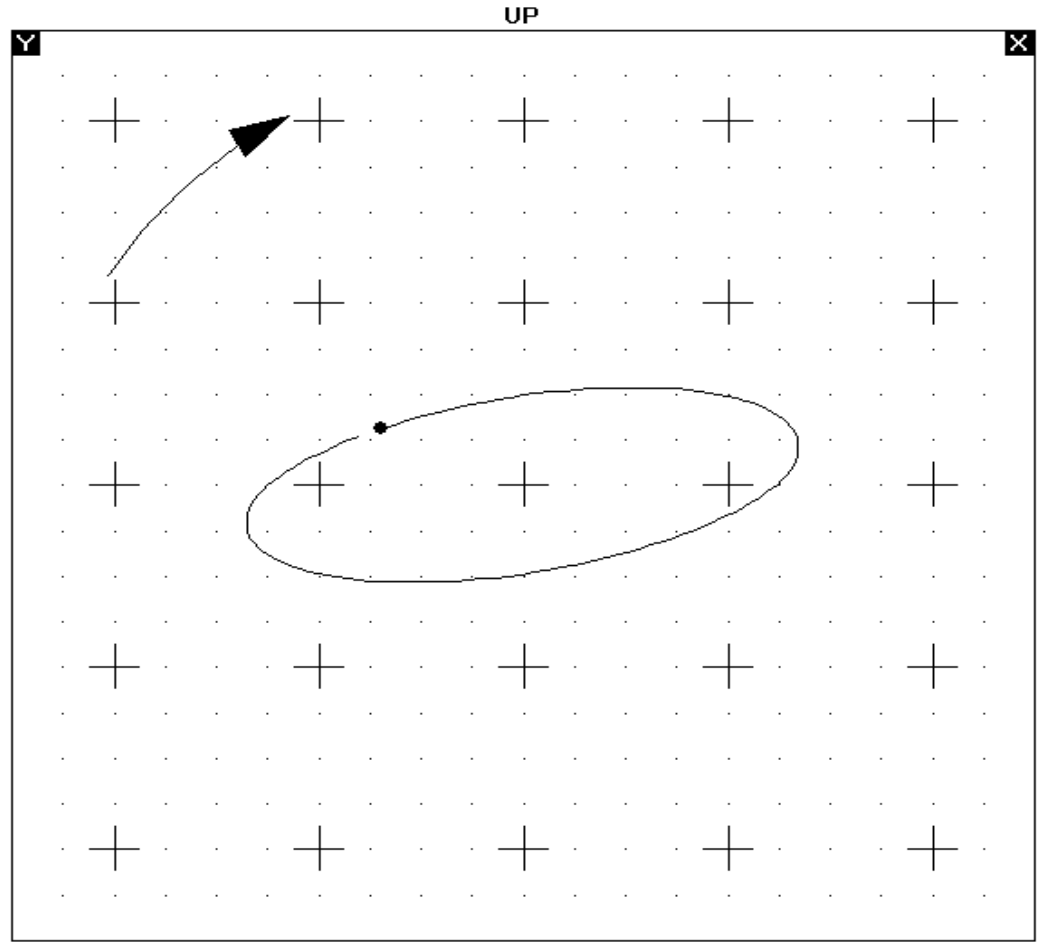
Shorted Turns (continued)

- If shorts are present, more current is required to make the same load point
- Excitation can become saturated with large amount of shorted turns

Summary

- Remember – good/complete set of data is vital to analyzing the cause of the vibration
 - Take data at the bearing caps
 - Vertical
 - Horizontal
 - Axial
 - Take data at shaft
 - Units equipped with X&Y Bentley Nevada probes provide sufficient data

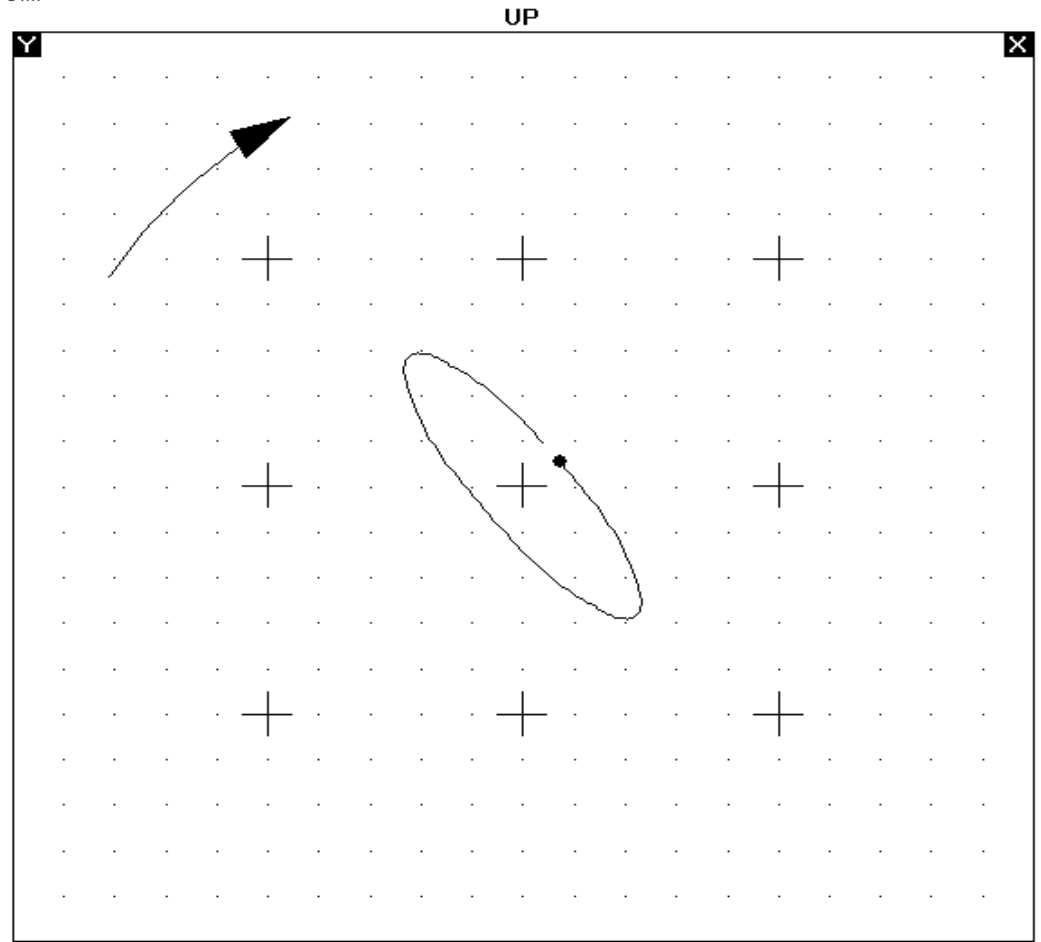
Y: #2 Turb Brg - TIE $\angle 45^\circ$ Left VECTOR: 3.52 mil pp $\angle 327^\circ$
X: #2 Turb Brg - TIE $\angle 45^\circ$ Right VECTOR: 4.66 mil pp $\angle 106^\circ$
MACHINE: Unit 2
26MAR2002 13:53:55.7 Startup 1X UNCOMP



ROTATION: Y TO X [CW]

5360 rpm

Y: #2 Turb Brg - X $\angle 45^\circ$ Left VECTOR: 0.720 mil pp $\angle 270^\circ$
X: #2 Turb Brg - Y $\angle 45^\circ$ Right VECTOR: 0.206 mil pp $\angle 336^\circ$
MACHINE: Steam Turbine
18APR2002 08:41:53.0 Startup 1X UNCOMP



0.1 mil /div

ROTATION: Y TO X [CW]

3240 rpm

III. Items of Concern

OEM Vibration Equipment

- Setup to show a pending problem
- Set to alarm at set value
- Trip unit at a higher level

OEM Vibration Equipment, continued

- Most equipment is set to look at overall vibration, not designed to identify specific problems
 - *Alarms are set to alarm operators to a potential problem*
- Most alarm points are set low enough to operate a unit safely at the alarm point vibration

After Market Vibration Equipment

- Some equipment (such as Bentley Nevada Trend Master) is not set up to diagnose a problem
- Only indicates increases in a vibration level

When a potential problem is noted, a vibration specialist should be contacted to determine the cause of the vibration

Alarm Points

- Usually set in mils pk/pk or in in/sec

Inches/Second Setting

- Typical alarm point is usually set at 0.5 in/sec, with the trip at 1.0 in/sec

Mils Peak/Peak Setting

- Alarm point in mils pk/pk depends on the speed of the unit
- For a unit rotating at 3600 RPM, the alarm is typically set at 3 mils pk/pk and 5 mils for the trip point

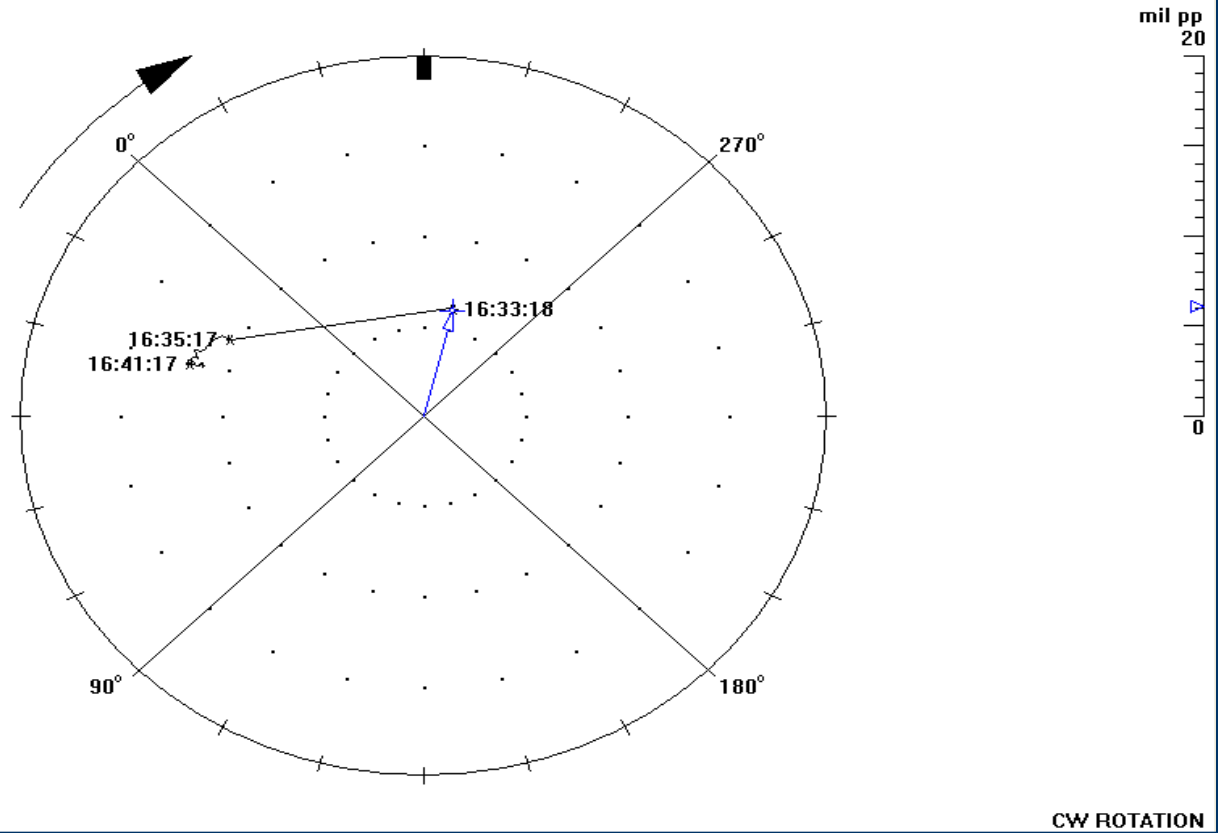
Setting Correlations

- Pk/Pk - The faster the speed of the unit, the lower the alarm point in mils
- In/Sec - Alarm and trip do not depend on speed as they are calculated on speed

Important to Remember

An increase in vibration means something is happening and needs to be investigated to determine if the unit can operate safely

POINT: GEN SHAFT GEAR END /45° Left 1X UNCOMP 6.02/301° @16:33:47
MACHINE: S/N 8383422
From 07DEC1993 16:33:18.4 To 07DEC1993 16:45:47.6 Steady State



Severe case of shorted turns - as soon as unit is synchronized, vibration jumps over 10 mils

IV. Checking for Soft Feet & Correcting

(written for Gas Turbines but can be adapted for Steam Turbines)



Step 1

- Check foundation by loosening the hold down bolts
- Give base a few hours to relax
- Tap each shim pack to see which is loose
- If loose, add a 10 mil shim
- Allow unit to relax

Step 1, continued

- Recheck shim pack
 - If all are tight, add additional 10 mils to those packs that were previously found to be loose
- Let unit relax
- Recheck all shim packs
- When all packs are properly loaded, proceed

Note for GE Frame 5 units

- There are four (4) shim packs directly under the Load Gear and two (2) under the Pedestal

Step 2

- Check alignment between the Load Gear and the Turbine
- Correct as needed

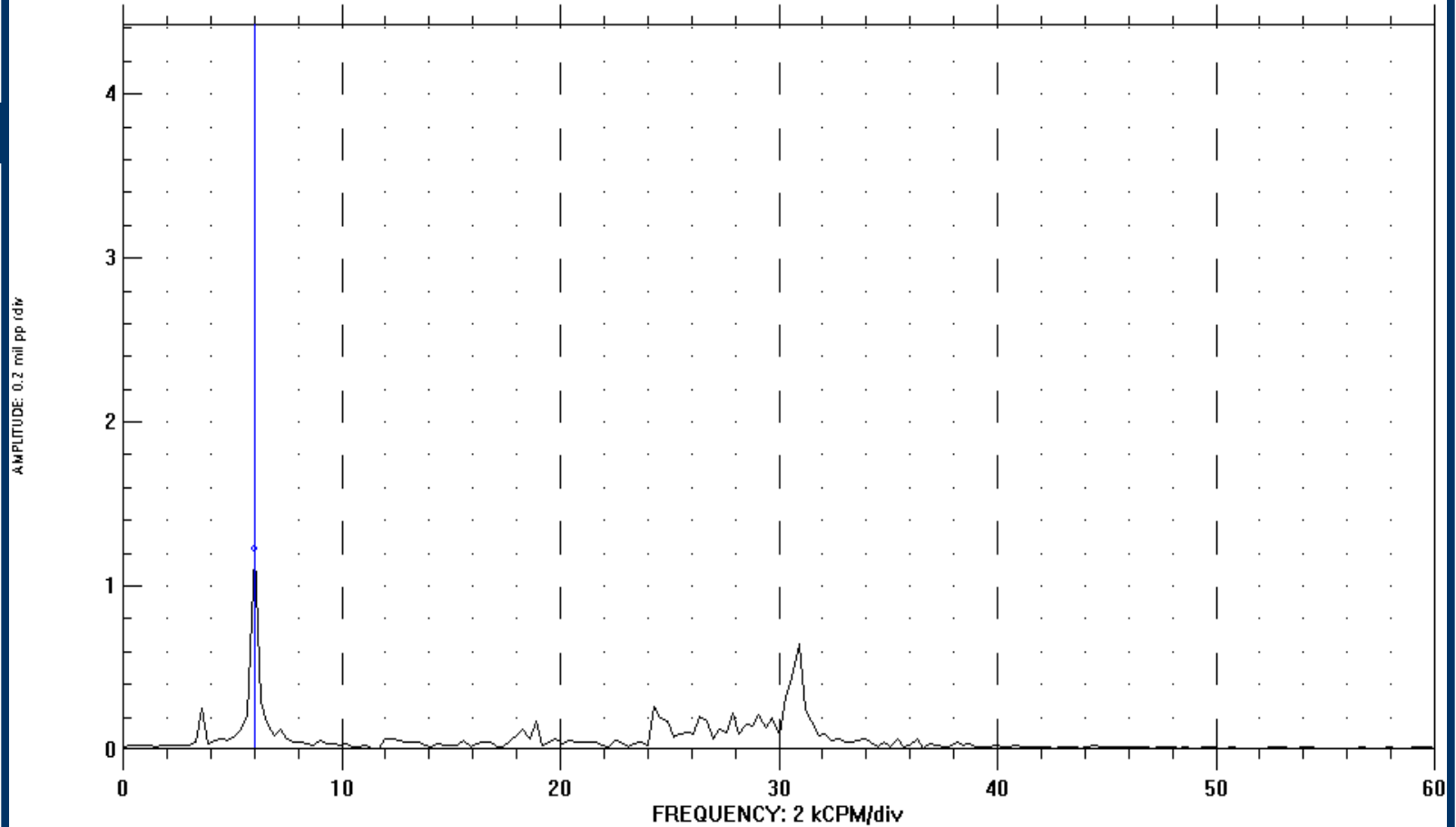
(Required because the load package will have moved while trying to load the shim packs)

Step 3

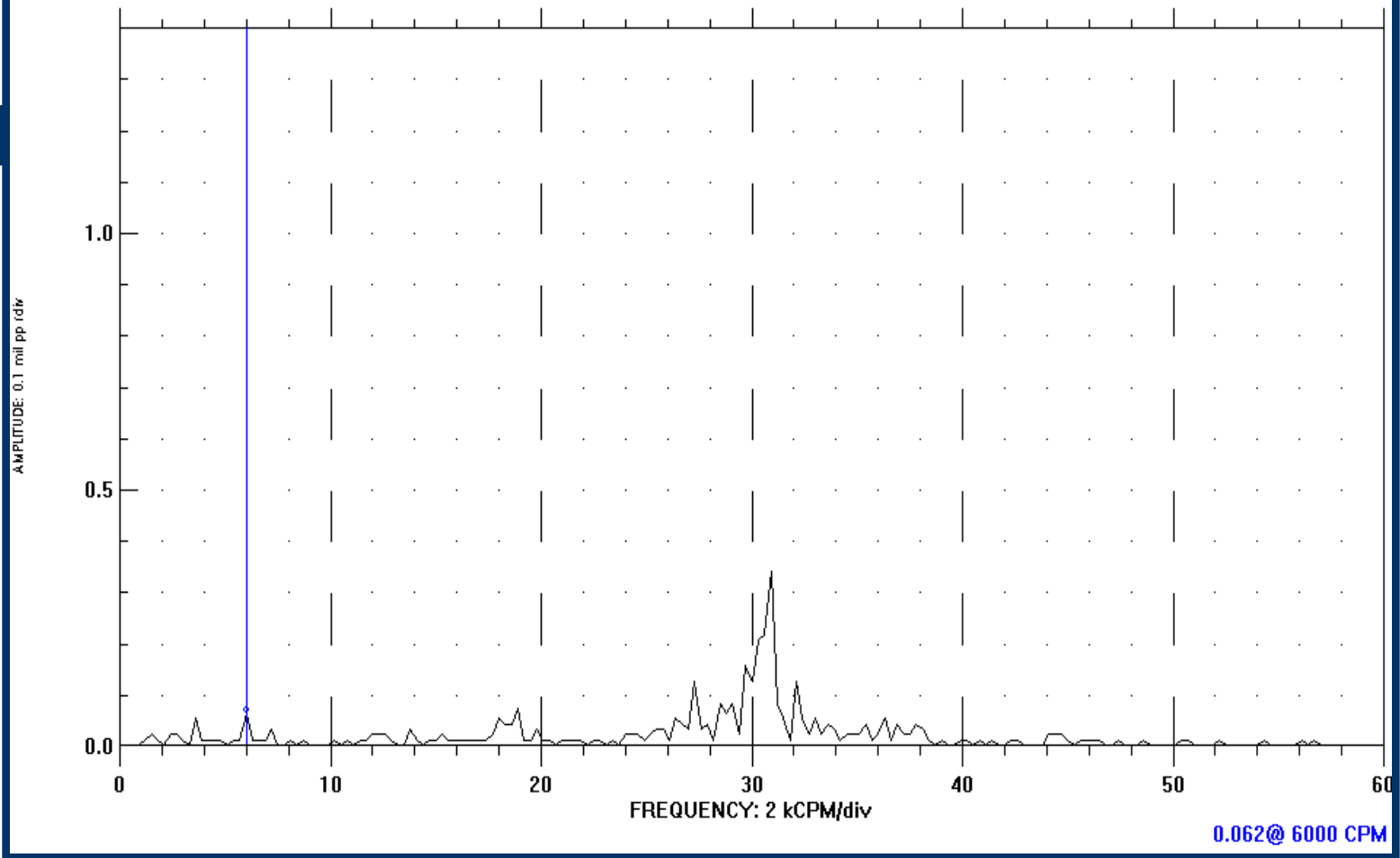
- Check alignment between Generator and Load Gear
- Correct, as necessary

A smooth running unit has to start with a good solid base

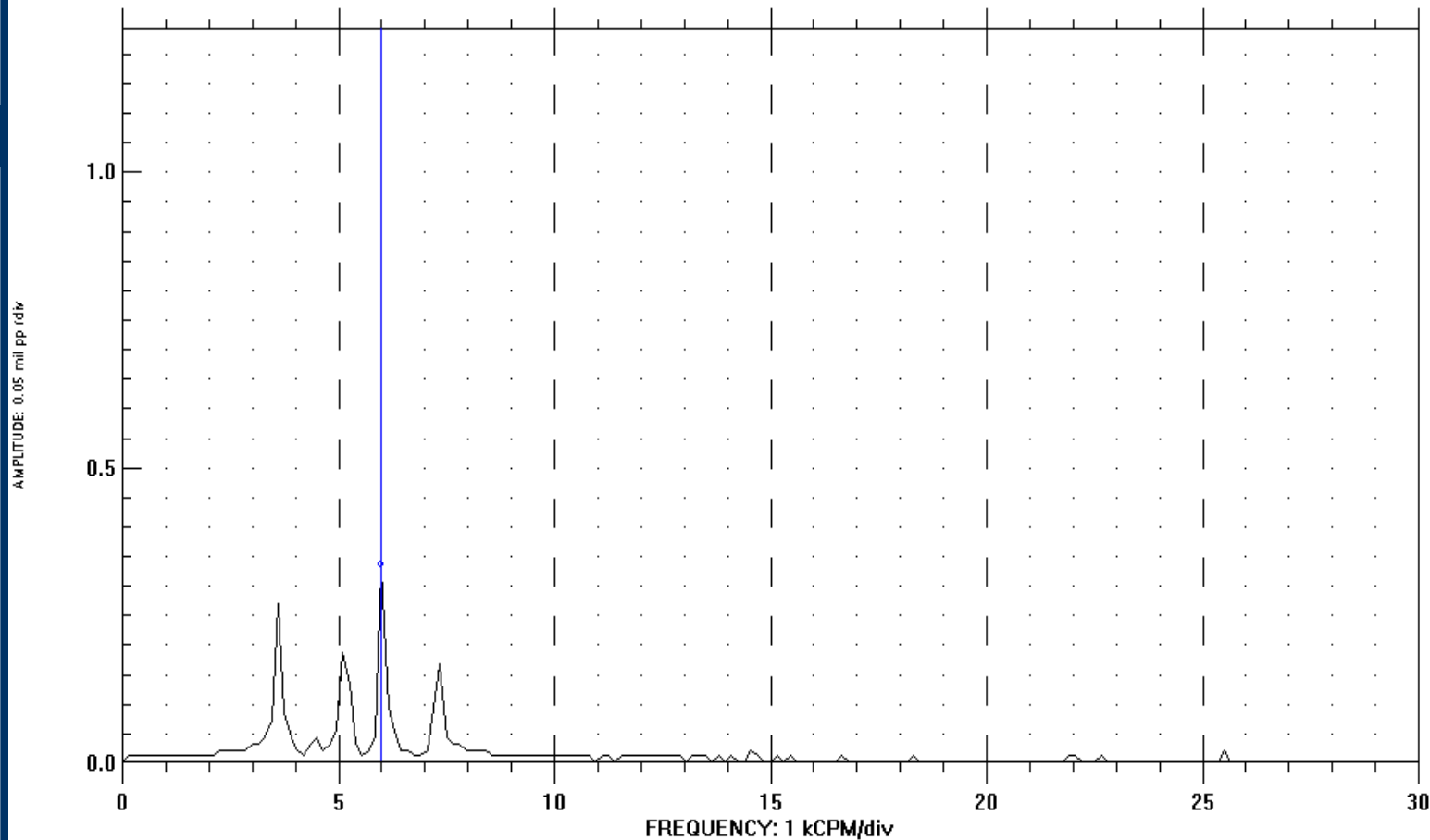
POINT: Access Gear Vert $\angle 0^\circ$ DIR AMPL: 3.34 mil pp
MACHINE: Unit 10 MACHINE SPEED: 3602 rpm
10 JUN 2003 13:46:13.1 Startup
WINDOW: None SPECTRAL LINES: 200 RESOLUTION: 300 CPM



POINT: Access Gear Horiz /90° Right DIR AMPL: 1.10 mil pp
MACHINE: Unit 10 MACHINE SPEED: 3604 rpm
13 JUN 2003 16:57:57.1 Startup
WINDOW: None SPECTRAL LINES: 200 RESOLUTION: 300 CPM



POINT: Pedestal Axial $\angle 0^\circ$ DIR AMPL: 0.735 mil pp
MACHINE: Unit 2b MACHINE SPEED: 3644 rpm
17 JUL 2002 15:52:13.1 Startup
WINDOW: None SPECTRAL LINES: 200 RESOLUTION: 150 CPM



V. Questions?