# MachineryWatch.Com, Inc. Case History

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| **Machine:** | **Vertical "Canned" Safety Injection Pump** |
| **Industry & Location:** | **Nuclear Power Generation, Virginia** |
| **Equipment:** | **Motor Driven (250 HP), Long (40') Drive Shaft and "Turbine" Pump, Motor Speed = 1781 RPM** |
| **Instrumentation:** | **MAARS Model 5000, accelerometers** |
| **Condition:** | **Piping and Motor Base Resonance, Turbulence, Whirl** |
| **Indication:** | **Excessive sporadic amplitude at 46% of RPM, Impact tests** |
| **Corrective Action:** | **Recommended reinstalling damping braces that had been disconnected, and altering conditions used for testing to reduce turbulence.** |

The emergency service pump cannot be tested in a normal pumping mode. Tests are done on a quarterly basis pumping through a small recirculation line that pumps to a tank. The result is that the pump is running far off the pump curve. There are 4 pumps at the site.

The pump has erratic vibration amplitudes. Levels do not cycle up and down with any consistency. The other pumps have "damping" braces at the floor level in the room where the motors are located. This is at the top of the pump "can".

The braces on this pump were removed because the attachment to the containment vessel wall was causing cracks in the concrete wall. Engineering calculations showed that the braces were unnecessary so they were removed.

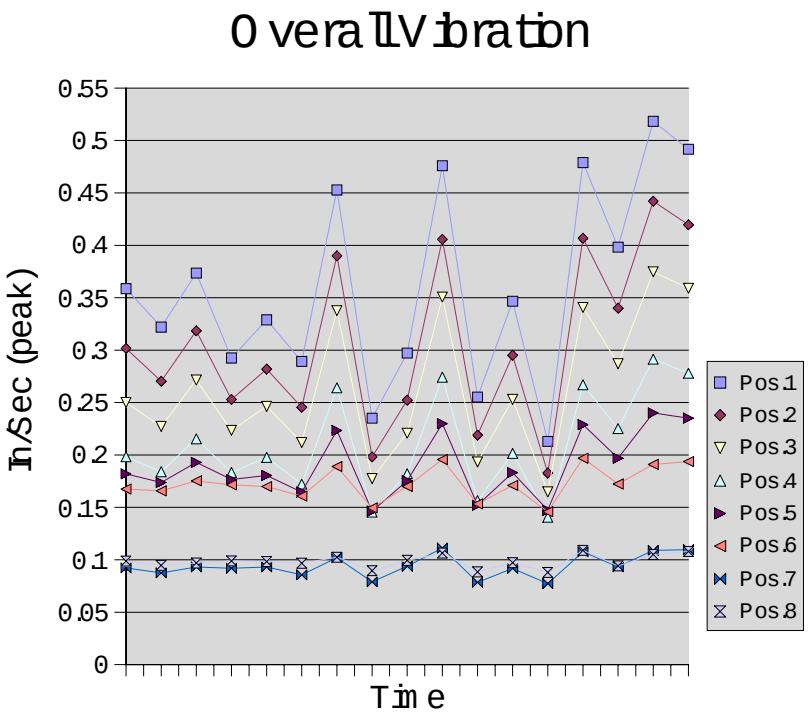
A couple years ago the recirculation piping was rerouted. Ever since, the velocity of the flows in the piping of this particular pump has been over 200 feet per second. While all the pumps have similar velocities this particular pump has the highest velocities. This is compounded by the fact that the piping has numerous elbows and few pipe hangers.

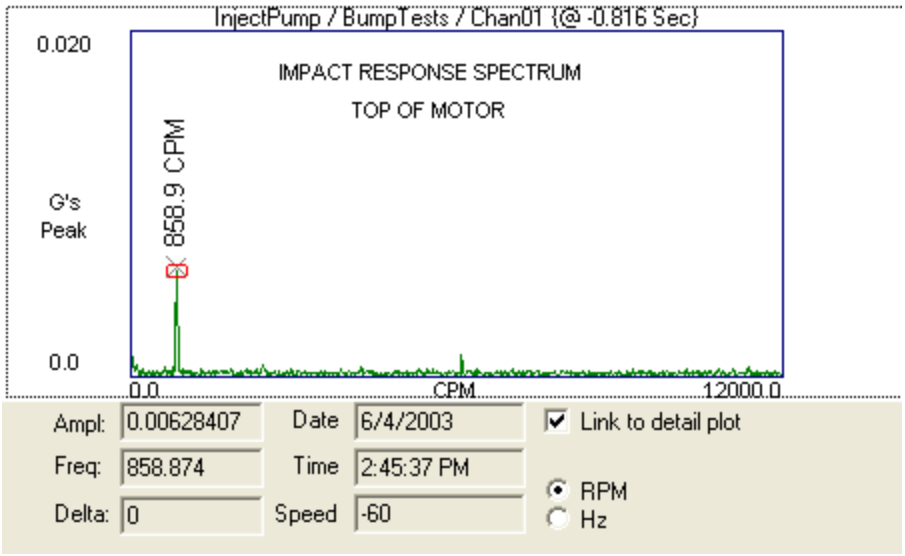
A few quick calculations showed that the pump was operating near it's "shut-off" head. This creates extremely turbulent flow as the fluid in the pump churns and the liquid in the pump discharge column collapses on itself within the pump casing. The turbulent flow creates a broadband energy that tends to excite natural frequencies. Finally, there is a tendency for vertical pumps with long fluid-lubricated bearings to "whirl" (that is orbit) within their bearings at a rate of 40-50% of running speed.

A review of data collected by the site personnel and provided before arrival indicated that all the excessive vibration energy was centered around 46% of RPM. This coincides with the whirl frequency tendency of vertical pumps.

The data oscillations are clearly visible in the included chart of overall vibration

levels at all measurement conditions over the period of a few minutes. A sketch of measurement positions is included. The piping and motor itself are shown to have a natural frequency in the area of 46% of running speed. This natural frequency, the tendency to whirl and the broadband variable energy of turbulent flow create an unpredictable excitation cycle in the vibration levels, causing the levels to cycle in and out of alarm.



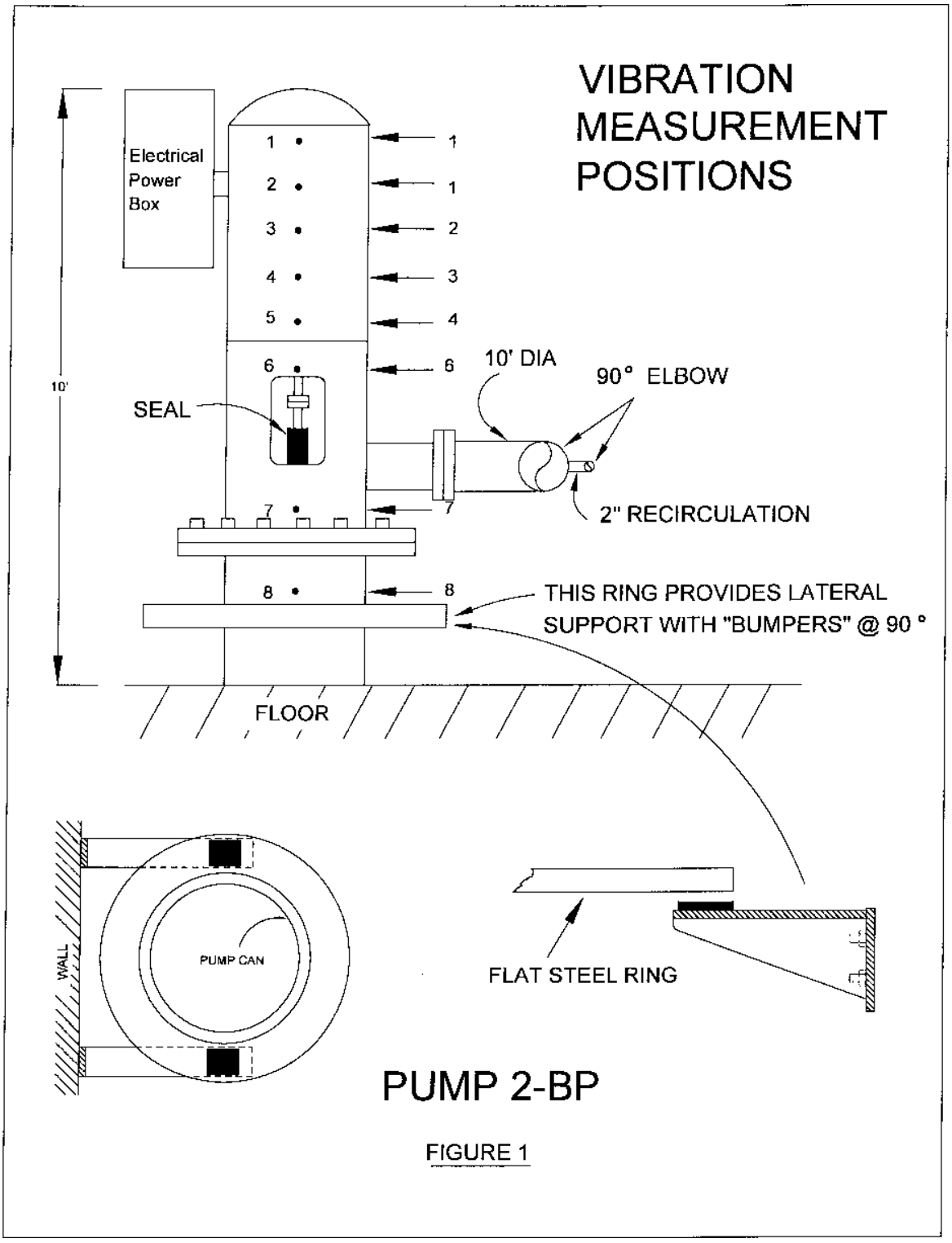
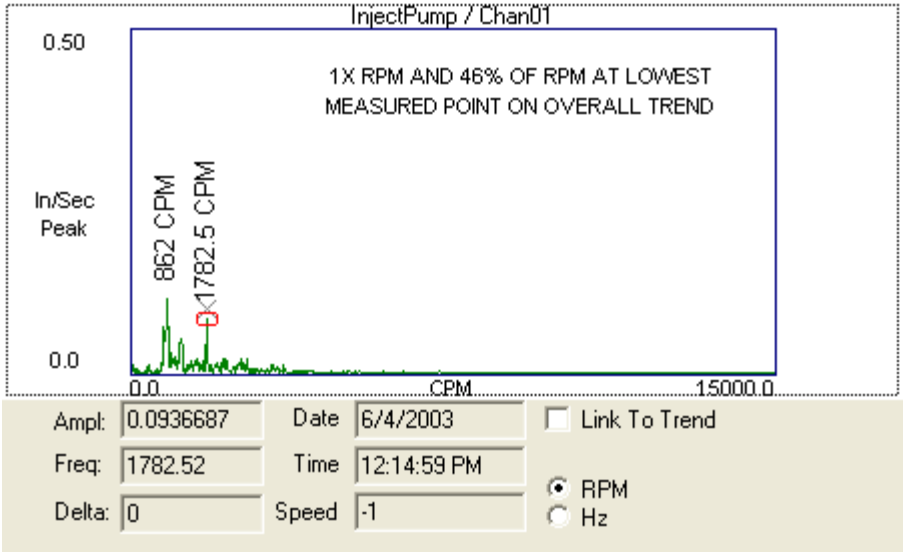
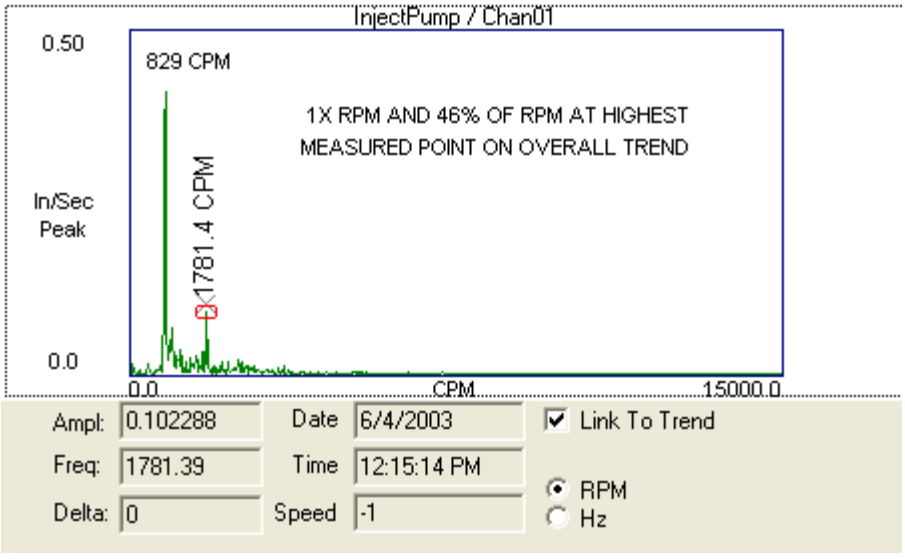



FIGURE 1

This is how the vibration varied over a period of 1.5 minutes.


InjectPump / Chan01
0.50
1X RPM AND 46% OF RPM AT LOWEST
MEASURED POINT ON OVERALL TREND
In/Sec
Peak
862 CPM
1782.5 CPM
0.0
0.0
CPM
15000.0
Ampl: 0.0936687
Date 6/4/2003
Link To Trend
Freq: 1782.52
Time 12:14:59 PM
RPM
Delta: 0
Speed -1
Hz


InjectPump / Chan01
0.50
829 CPM
1X RPM AND 46% OF RPM AT HIGHEST
MEASURED POINT ON OVERALL TREND
In/Sec
Peak
1781.4 CPM
0.0
0.0
CPM
15000.0
Ampl: 0.102288
Date 6/4/2003
Link To Trend
Freq: 1781.39
Time 12:15:14 PM
RPM
Delta: 0
Speed -1
Hz

The recommendations included reattaching the seismic damping braces and some modifications to make for more uniform testing conditions in terms of flow velocities so that velocities in all piping will be uniform. This will allow better comparisons to be made of one pump to another. Also it was recommended that the pipe supports be added to the 2" recirculation line which was also found to be resonant at 46% of running speed. Support was not provided for his pipe in accordance with standard piping handbook guidelines.

The recommendations are being considered for implementation, but have not yet been acted upon.