Belt Faults

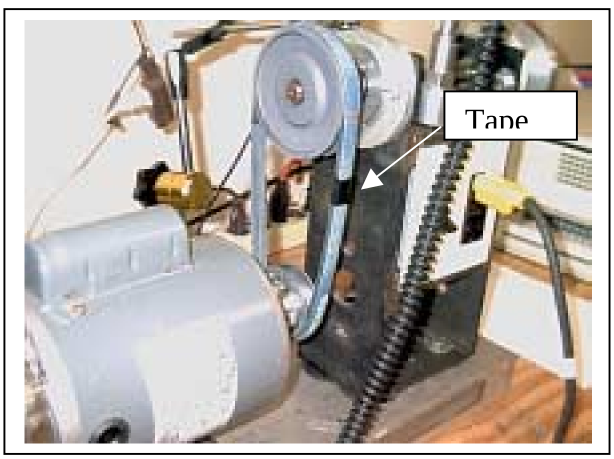
Belt drives can cause many strange looking spectra. To analyze and troubleshoot belt drives it is imperative to have a high resolution analyzer. I use one with 3200 lines of FFT. To those still using 400 lines that might seem like overkill. This paper, though, will show the necessity of high resolution when troubleshooting many vibration problems.

Belt and sheave problems can come in many forms. A bad belt seam or a dished belt, out of round sheaves on either the driver or driven shaft or both, angular misalignment of the sheaves, axial misalignment of the sheaves and any combination of any or all of the above. When faced with what appears to be a belt problem, realign the sheaves axially and angularly, then take your readings again. Sheave alignment is relatively straight-forward and a string will often get you all the accuracy you need. There are many expensive kits on the market for alignment of sheaves but for most applications, a string or a straight edge will get you the accuracy you need to rid yourself of vibration and wear problems.

Once you are sure of alignment, then your problems can be attributed to one of the other three causes: bad belt or an out of round sheave on the driver or driven shaft.

This paper looks at the vibrations produced by a bad belt.

For out purposes, we assume the belt has a bad seam. That causes a lump on the belt at one location. We simulate this by wrapping a piece of tape around the belt several times producing the lump.



Think about what this is going to do. Once per revolution of the belt, this lump is going to go over the driven sheave (and the driver but we aren't measuring the driver.) The rise of the belt is going to increase belt tension and put a hard downward force on the driven sheave. We would expect, then, to find vibration frequency at 1X the belt pass frequency.

We could calculate the belt pass frequency by knowing the driven shaft speed in rpm, the pitch diameter of the driven sheave and the belt length: BPF = pi*dia*speed/BL. But, we can also measure it and be much more accurate by using a tach or a strobe. We did this for our unit and found the BPF to 577 cpm.

Look at figure 1. Remember, the simulator has a lot of looseness in it that we noted in the first paper. So, we always have to refer back to the initial spectrum and mentally subtract out the spikes that are there under normal conditions. Figure 1 shows both spectra. The orange spectrum is our normal. The blue is the one caused by the tape on the belt.

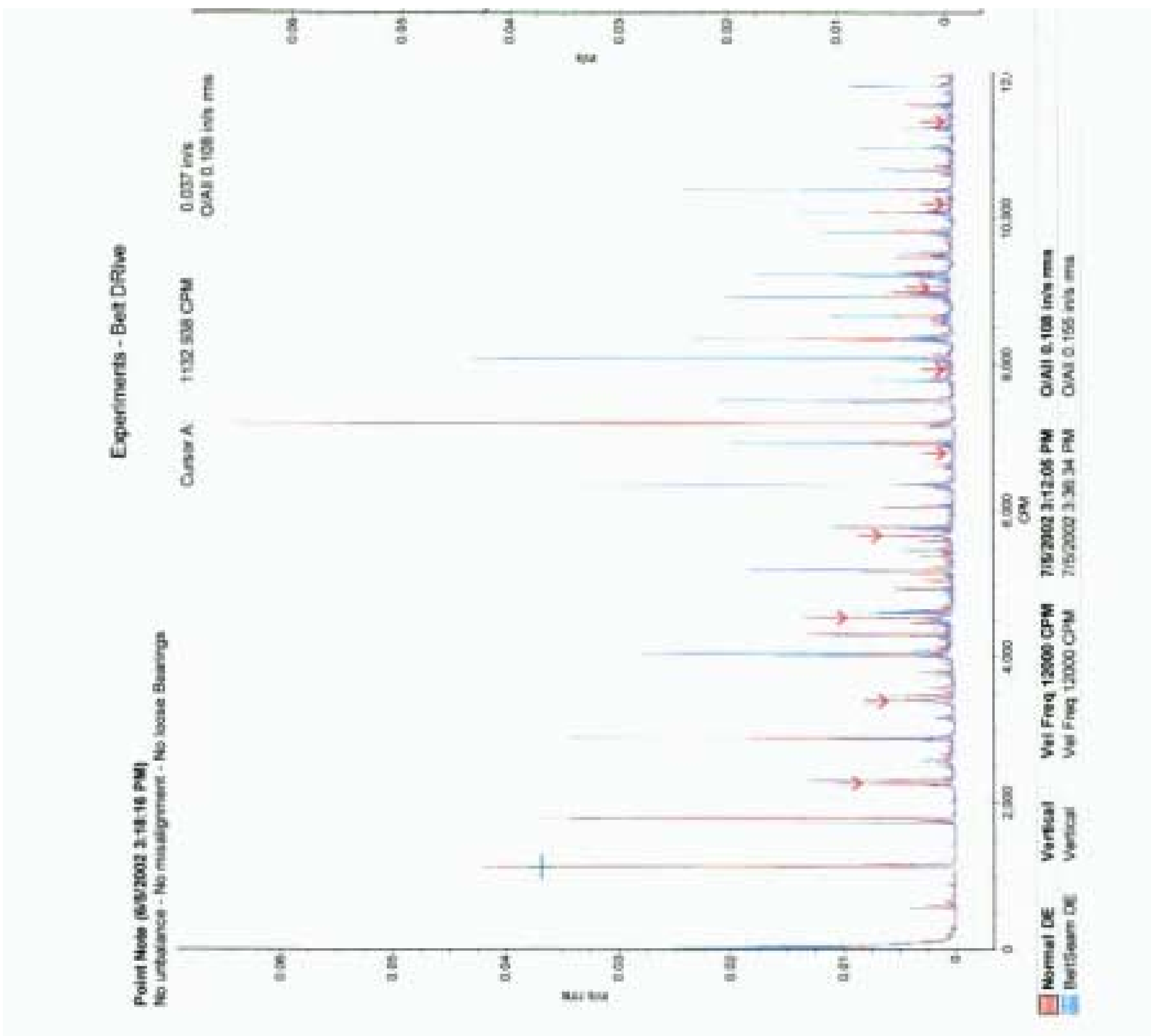


Figure 1

If you look carefully you see that there are two spikes at nearly every location. An orange and blue spike appears. Close to it is a blue spike with no orange component.

You can plainly see that the blue spikes are not harmonics of the shaft speed (shaft speed is marked with a cross.) The tape did something – but what?

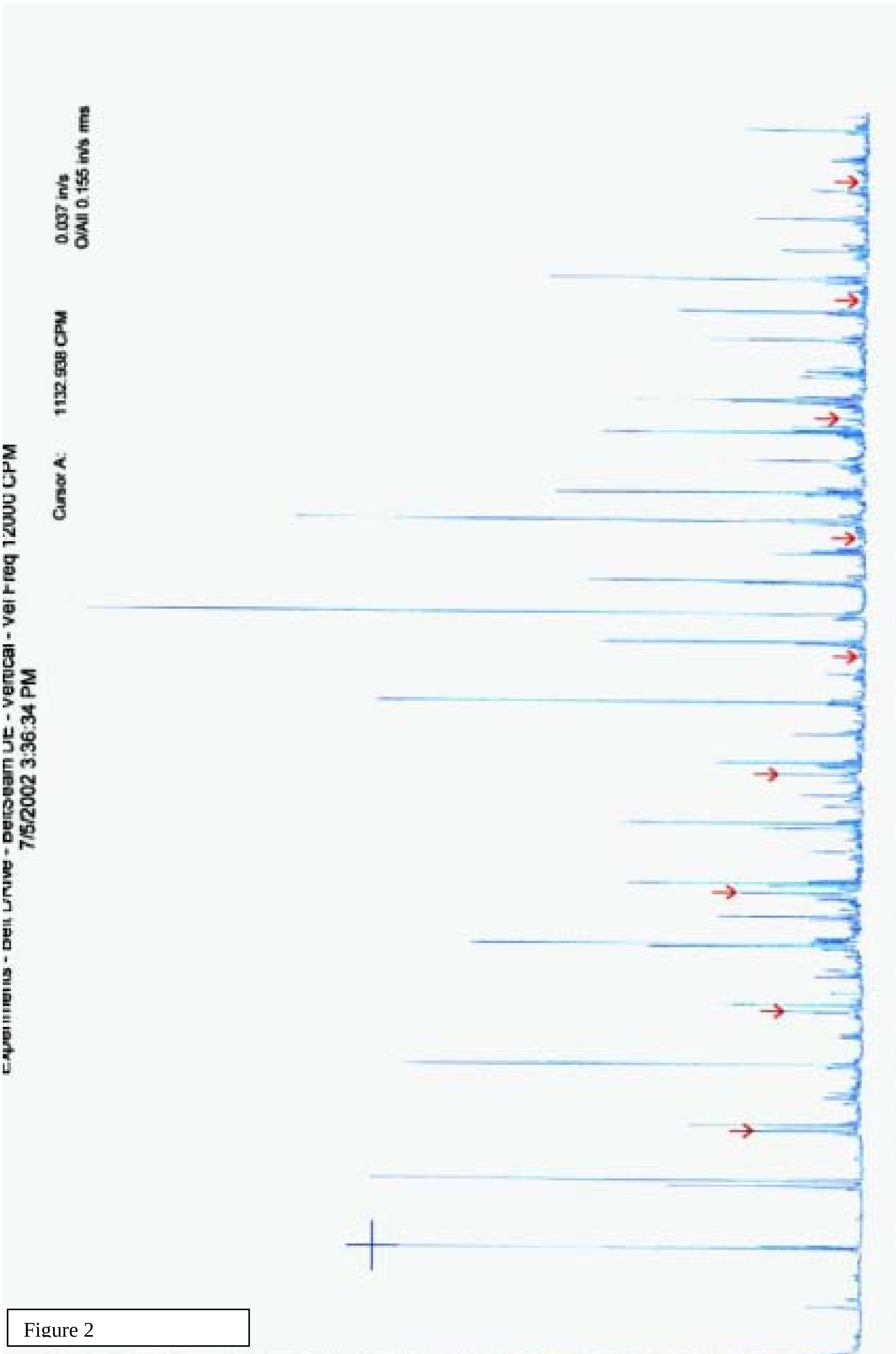
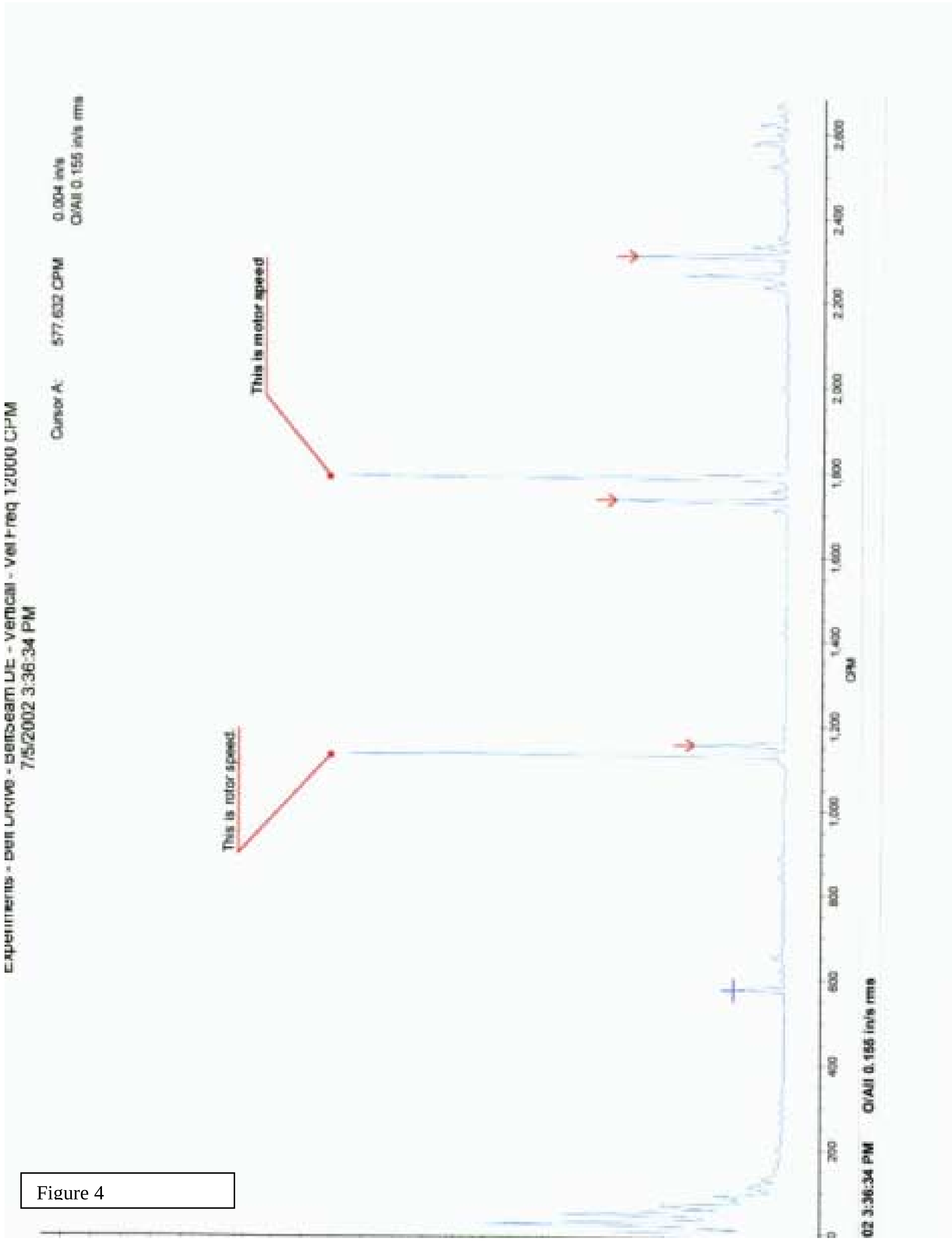


Figure 2

Figure 2 is just the spectrum of the machine with the tape on the belt. The “normal” spectrum has been removed. It becomes even more clear that there are two spikes close together at each location, as well as some others that were there from the “normal” condition (remember that big spike at 7200 cpm is due to electrical problems with the cheap motor I bought.)

Figure 3 is the same spectrum but expanded on the low end so we are only looking at 0 to 2600 cpm. Now it becomes very clear what is going on. The cursor is setting at BPF. The red arrows are at the harmonics of BPF. I have marked the rotor speed and the motor speed spikes for you. It becomes obvious that the tape has produced a forcing function with a frequency of 577 cpm. Because of the looseness in the simulator, that small forcing function has produced every harmonic out to at least the 19^{th} harmonic (20X.)



7/5/2002 3:36:34 PM
Cursor A: 577.632 CPM
0.004 in/s
O/All 0.155 in/s rms
This is motor speed
This is rotor speed
CPM
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
02 3:36:34 PM O/All 0.155 in/s rms

Figure 4

Figure 4 is the spectrum out to 12Kcpm again with the appropriate spikes marked.

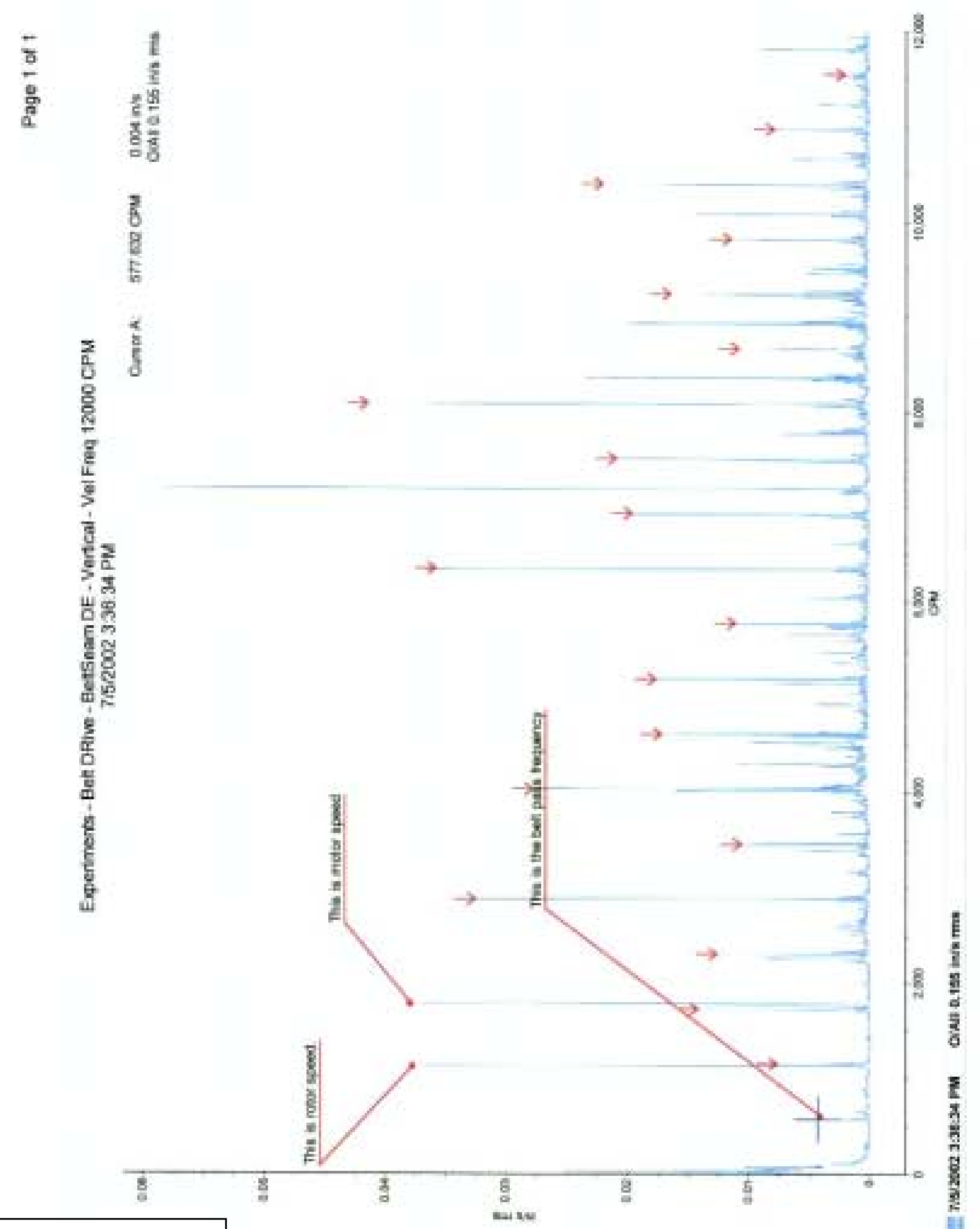


Figure 4

The classic belt fault is a spike at BPF. Since this is a sub-shaft speed spike, it should be pretty obvious that it is a bad belt. The experiment today shows that it is not always that obvious. A very small BPF forcing function can result in a very messy spectrum on a machine with looseness that leads the eye up to higher and higher frequencies. Don't get trapped by that deception. Always look very carefully at sub-shaft speed spikes.

I think the need for high resolution becomes obvious. The rotor speed and the first BPF harmonic were only separated by 21 cpm. A 400 line machine has a resolution of 300 cpm on a overall spectrum of 120 kcpm. On a 12kcpm spectrum (like we took) that is still only a resolution of 30 cpm. A 400 line machine would have shown that as only one spike. Use as much resolution as you have.