



## Detecting Rolling Element Bearing Faults Using the ECHO® Wireless Vibration Monitoring System

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## Detecting Rolling Element Bearing Faults Using the Echo<sup>®</sup> Wireless Vibration Monitoring System

In an ideal world, a vibration analyst would like to have a full set of overall and broadband data continuously on all vibration monitoring points. This would provide the best set of data to detect and diagnose machinery faults. Unfortunately, it is generally prohibitive to get a full set data more than once per month or quarter due to personnel limitations with walk around monitoring systems. This could be automated using an online monitoring system, but the cost of such systems and of running the associated cable generally prohibits this on all but the most critical equipment.

**The Echo® Wireless Vibration Monitoring System** offers an affordable and acceptable compromise by increasing the number of "looks" at a machine by a factor of about 100 over most route-based methods. It eliminates the cost of running expensive cabling to a control room (as is generally required with continuous online monitoring systems), and provides "at-a-glance" status of all plant machinery being monitored (Figure 1). The system also makes a specifically selected set of overall measurements that when used together are sensitive to most common machinery faults, especially those in rolling element bearings.

👷 Echo System Overview for. Demo Kit   IMI Calibration - Depew, NY			
Reports Sort			
Maximum Alert Level Last Update Tuesday, December 03, 2013 9:41 AM Sorted by : Smart Sort Page 1 of			
32836   CP3 R1 B Ex Pump 2241   1-5 NDE Motor (2)	1 22838   CP3 RI B EX Pump 2241   1-7 DE Pump	91   CSS 13 Cryst Recirc Fan   OB (2)	**32839   CP3 R1 B Ex Pump 2241   1-8 ND
126   CSS 13 Cryst Recirc Fan Motor   DE (1)	131   TPA N2 Compressor	132   TPA N2 Compressor 1411   ND (L)	B2896   CSS9 N2 Fan 4030   8-1 NDE Motor (1)
32897   CSS9 N2 Fan 4030 [8-2 DE Motor (1) 32898   CSS9 N2 Fan 4030 [8-3 DE Fan (1) 32898   CSS9 N2 Fan 4030	32899   CSS9 N2 Fan 4030           8-4 NDE Fan (1)	32900   CSS9 N2 Fan 4040  8-5 NDE Motor (1)	82901   CSS9 N2 Fan 4040   8-6 DE Motor (1)
32902   CSS9 N2 Fan 4040  8-7 DE Fan (L)  8-8 NDE Fan (L)	32904   CP2 Main Hot Oil           Pump 1600   9-1 NDE	32905   CP2 Main Hot Oil Pump 1600   9-2 DE	32906   CP2 Main Hot Oil Pump 1600   9-3 DE Pump
32907   CP2 Main Hot Oil Pump 1600   9-4 NDE 32908   CP2 Main Hot Oil Pump 1601   9-5 NDE	32909   CP2 Main Hot Oil Pump 1601   9-6 DE	32910   CP2 Main Hot Oil Pump 1601   9-7 DE Pump	32911   CP2 Main Hot Oil Pump 1601   9-8 NDE
97   CSS 13 Cryst Recirc Fan   IB (2) 100   CSS 12 Cryst Recirc Fan   OB (2)	101   CSS 12 Cryst Recirc Fan   IB (2)	Blower   DE (2)	125   D&E Transfer Blower   ND (2)
32832   CP3 R1 A Ex Pump 2240   1-1 NDE Motor (2)	32834   CP3 R1 A Ex Pump           2240   1-3 DE Pump (2)	32835   CP3 R1 A Ex Pump 2240   1-4 NDE Pump (2)	82840   CP3 R1A Polymer Pump 1010   2-1 NDE
32841   CP3 R1A Polymer         32842   CP3 R1A Polymer           Pump 1010   2-2 DE         Image: Comparison of the pump 1010   2-3 DE Pump	32843   CP3 R1A Polymer           Pump 1010   2-4 NDE	32844   CP3 R1B Polymer           Pump 1020   2-5 NDE	B2845   CP3 R1B Polymer           Pump 1020   2-6 DE
32846   CP3 R1B Polymer Pump 1020   2-7 DE Pump	32848   CP4 R1 Ex Pump           2240   3-1 NDE Motor (2)	2240   3-2 DE Motor (2)	82850   CP4 R1 Ex Pump 2240   3-3 DE Pump (2)
32851   CP4 R1 Ex Pump 2240   3-4 NDE Pump (2) 32852   CP4 Rc1 Ex Pump 2241   3-5 NDE Motor (2)	32853   CP4 R1 Ex Pump           2241   3-6 DE Motor (2)	22854   CP4 R1 Ex Pump 2241   3-7 DE Pump (2)	32855   CP4 R1 Ex Pump 2241   3-8 NDE Pump (2)
32856   CP3 RLB Ex Pump 2240   4-1 NDE Motor (2)	32858   CP3 RLB Ex Pump 2240   4-3 DE Pump (2)	32859   CP3 R1B Ex Pump 2240   4-4 NDE Pump (2)	32860   CP3 R1B Ex Pump 2241   4-5 NDE Motor (2)
32861   CP3 R1B Ex Pump 2241   4-6 DE Motor (2) 32862   CP3 R1B Ex Pump 2241   4-7 DE Pump (2)	32263   CP3 R1B Ex Pump           2240   4-8 NDE Pump (2)	32864   CP4 Main Hot Oil Pump 1600   5-1 NDE	82865   CP4 Main Hot Oli Pump 1600   5-2 DE
32866   CP4 Main Hot Oil Pump 1600   5-3 DE Pump IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	32868   CP4 Main Hot Oil           Pump 1601   5-5 NDE	32869   CP4 Main Hot Oil Pump 1601   5-6 DE	82870   CP4 Main Hot Oil Pump 1601   5-7 DE Pump
32871   CP4 Main Hot Oli Pump 1601   5-8 NDE Pump 1600   6-1 NDE	32873   CP3 Main Hot Oil           Pump 1600   6-2 DE	22874   CP3 Main Hot Oil Pump 1600   6-3 DE Pump	32875   CP3 Main Hot Oil Pump 1600   6-4 NDE

Figure 1 – Echo® System Overview that provides "At-A-Glance" Status of Machinery

Echo® makes three overall measurements: RMS Velocity, RMS Acceleration, and True Peak Acceleration. From these measurements it then calculates Crest Factor, derived peak velocity, and derived peak acceleration.

These measurements are sensitive to various types of machinery faults:

- The velocity measurements are sensitive to common lower frequency faults such as unbalance and misalignment.
- The RMS Acceleration measurement detects higher speed faults such as gear mesh, broken rotor bars, and loss of bearing lubrication.
- True Peak Acceleration is most sensitive to impacts caused by bearing defects and some gear faults such as a chipped tooth.
- Crest Factor is often used as an indication of fault severity.

Many analysts use velocity as the primary parameter for trending and indication of a developing fault. Unfortunately, this does not always work well with rolling element bearing faults. Often the bearing frequencies and associated sidebands for severely faulted bearing are low in amplitude compared to the other vibrations in the system. Therefore they do not cause enough of a change in the overall velocity to detect the fault early. On the other hand, high pass filtered True Peak Acceleration is extremely sensitive to impulsive faults and is an excellent indicator of a bearing fault. Once the fault causes an alarm in the system, an analyst should take broadband waveform measurements on the machine to complete the diagnostics.



Figure 2 – General Purpose Accelerometer Mounted on a Centrifugal Pump sending vibration signal to a nearby EchoPlus® Wireless Junction Box

Figure 2 above shows a general purpose IMI Model 603C01 mounted on a centrifugal pump. A short standard sensor cable is run to an IMI EchoPlus® Wireless Junction Box close to the pump, as pictured in Figure 3. The EchoPlus® Wireless Junction Box "wakes up" periodically (3 times per day default), sequentially powers each sensor (8 per box), makes the overall measurements stated above, and transmits them wirelessly to a centrally located receiver. Therefore there is no need for long expensive cable runs to a control room that could be a half a mile or more away.



Figure 3 – EchoPlus® Measuring One of Eight Connected Accelerometers

Stand-alone battery powered Echo® Wireless Vibration Sensors are also available with the Echo® system and make the same set of overall measurements. Figure 4 shows IMI Echo<sup>®</sup> Wireless Vibration Sensors mounted on fan bearings.



Figure 4 – Echo® Wireless Sensors Mounted on Recirculating Fan Bearings

Below are examples of overall measurements taken with the Echo<sup>®</sup> System on a centrifugal pump. Examination of these trend plots demonstrates how True Peak Acceleration clearly detects the rolling element bearing fault before any indication is given by either RMS Velocity or RMS Acceleration.

Both the RMS Velocity (Figure 5) and the RMS Acceleration (Figure 6) trend plots shown below do not trip their alarms and the velocity would probably never be considered to be indicating a problem. When the bearing was replaced, there was little change in the RMS Velocity or RMS Acceleration vibration levels.



Figure 5 – RMS Velocity Trend Plot of Faulted Bearing



Figure 6 – RMS Acceleration Trend Plot of Faulted Bearing



Figure 7 – True Peak Acceleration Trend Plot of Faulted Bearing

The True Peak Acceleration trend plot (Figure 7 above) clearly shows high amplitudes exceeding the alarm levels of the faulted rolling element bearing. When the bearing was replaced, the vibration smoothed out well below the warning alarm level.

Clearly the High Pass Filtered True Peak Acceleration measurement is the most sensitive to rolling element bearing faults. It is a technique that not only works on machinery like pumps and motors but also on slow speed systems like paper rolls.

Contact IMI Sensors for a demonstration of the Echo® Wireless Vibration Monitoring System and find out how Echo® can help you avoid unexpected failures, lost production, high maintenance costs and keep your production machinery running.



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