

Practical On-Line Vibration Monitoring for Papermachines

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ABSTRACT

During the past 20 years, condition monitoring has evolved as a significant opportunity to increase profits within a wide variety of industries. Vibration Analysis is one of the most powerful condition based maintenance technologies, and the cornerstone of many predictive maintenance programs. It is also widely utilized for troubleshooting and fault diagnosis of machinery and structures. In recent years, much emphasis has been given to on-line or permanently installed vibration monitoring for machinery that is inaccessible, critical to process, and/or very expensive. This article will provide a practical overview of system components, installation considerations, and benefits of on-line monitoring. Key points and an innovative approach will be explained by discussing several recent installations.

Keywords: vibration, monitoring, analysis

1. INTRODUCTION

The future advancement of equipment condition monitoring technologies is intrinsically tied to the application and development of on-line or permanently installed systems. As the advantages of asset management and reliability strategies become widely accepted and aggressively implemented, significant emphasis is being placed on equipment condition monitoring. In fact, the historic barrier between production and maintenance will soon fall victim to the understanding that equipment condition data is as important as process parameters, and significantly influences production, quality, safety, and profitability.

For many industrial facilities, on-line vibration monitoring systems are used as machinery protection systems, and therefore installed only on critical equipment. The objective is to eliminate process downtime through equipment that is 100% available and reliable. At the same plant, there may also be monitoring of general purpose machinery using portable instruments. The objective of this program is to reduce maintenance expense through early detection of equipment and component defects. As on-line systems become readily available and accepted, walk around monitoring programs are improved using permanently installed sensors and hardware, typically installed at inaccessible or hazardous locations.

The next logical progression is a paradigm shift from focus on maintenance practices to focus on asset management. Historically, plant operators have had easy access to relevant process data (temperature, pressure, flow, etc) to make decisions. Clearly, augmenting the process information with relevant equipment condition data, in an easily understood format, can lead to substantial improvements in productivity and profitability. If they are provided with the right data, operators can observe the interaction between process and plant machinery. Equipment condition alarms may prompt plant operators to adjust process conditions, thereby avoiding equipment failure and associated down time. An example is pump cavitation, which can be easily observed with vibration measurements, and corrected by modifying process conditions.

2. SYSTEM FEATURES & REQUIREMENTS

The integration of operations and maintenance will significantly improve asset management practices, resulting in increased productivity and profitability. On-line vibration monitoring systems will play a key role in the transition

to asset management only if the right information is provided to the right personnel. With this purpose or objective in mind, there are several obvious system features, which determine the overall success of the system.

2.1 User Interface

In order for equipment condition information to be properly utilized by plant operators, the data must be current, and presented in an easily understood format. The most common graphical user interfaces utilize an equipment schematic or photograph, with “traffic light” alarm indicators. For the example shown in Figure 1, below (paper machine dryer gears), the red circle at gear pinion 17 indicates high vibration alarm. Also note the “tool tip” window, which provides some additional information regarding the measurement location.

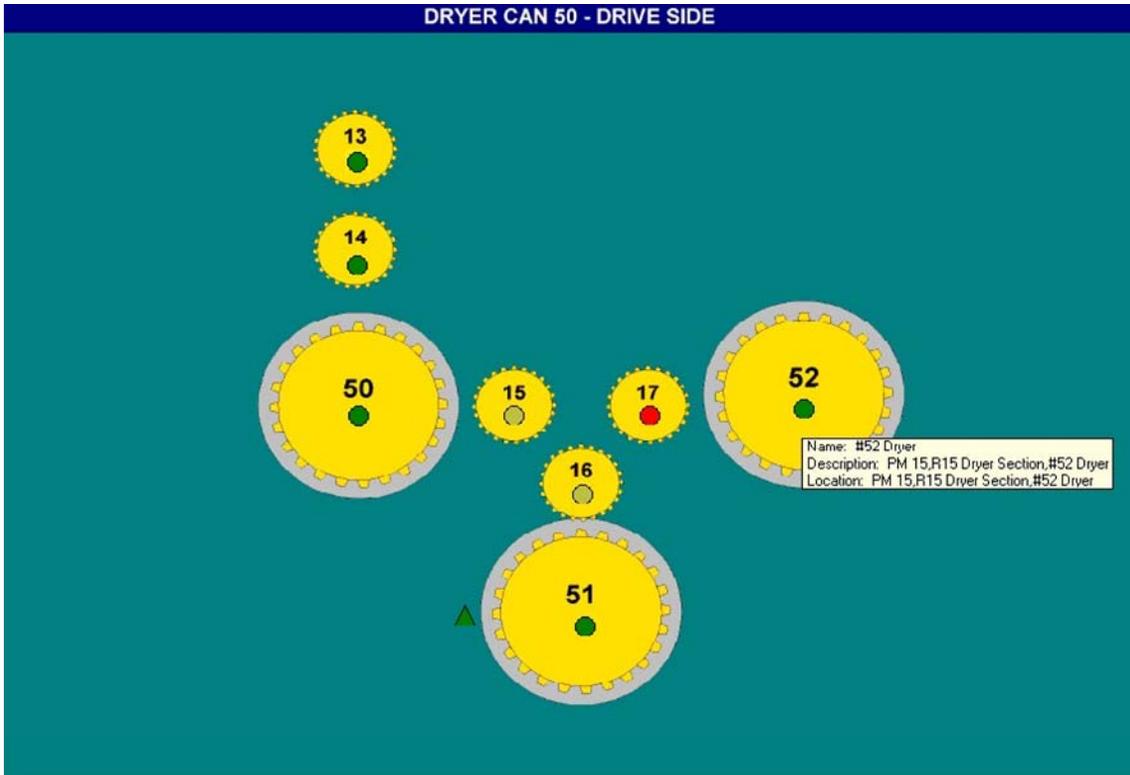


Figure 1 • Typical Operator Display

In addition to easily viewed and understood alarm conditions, information on the character of the detected fault should be made available to plant operators. Since many machine defects are frequency dependent (such as rolling element bearing defects or roll barring), one method is to display the discrete frequency alarm bands. Also, trends of vibration amplitude will provide operations personnel with an indication of fault condition and progression.

The example in Figure 2 (paper machine supercalender) shows a discrete frequency band of 300 to 500 Hz, which corresponds with know range of roll cover barring. A tool tip label on the alarm band provides operators with detailed information on the band purpose and detected fault. The associated trend plot provides a clear indication of fault progression.

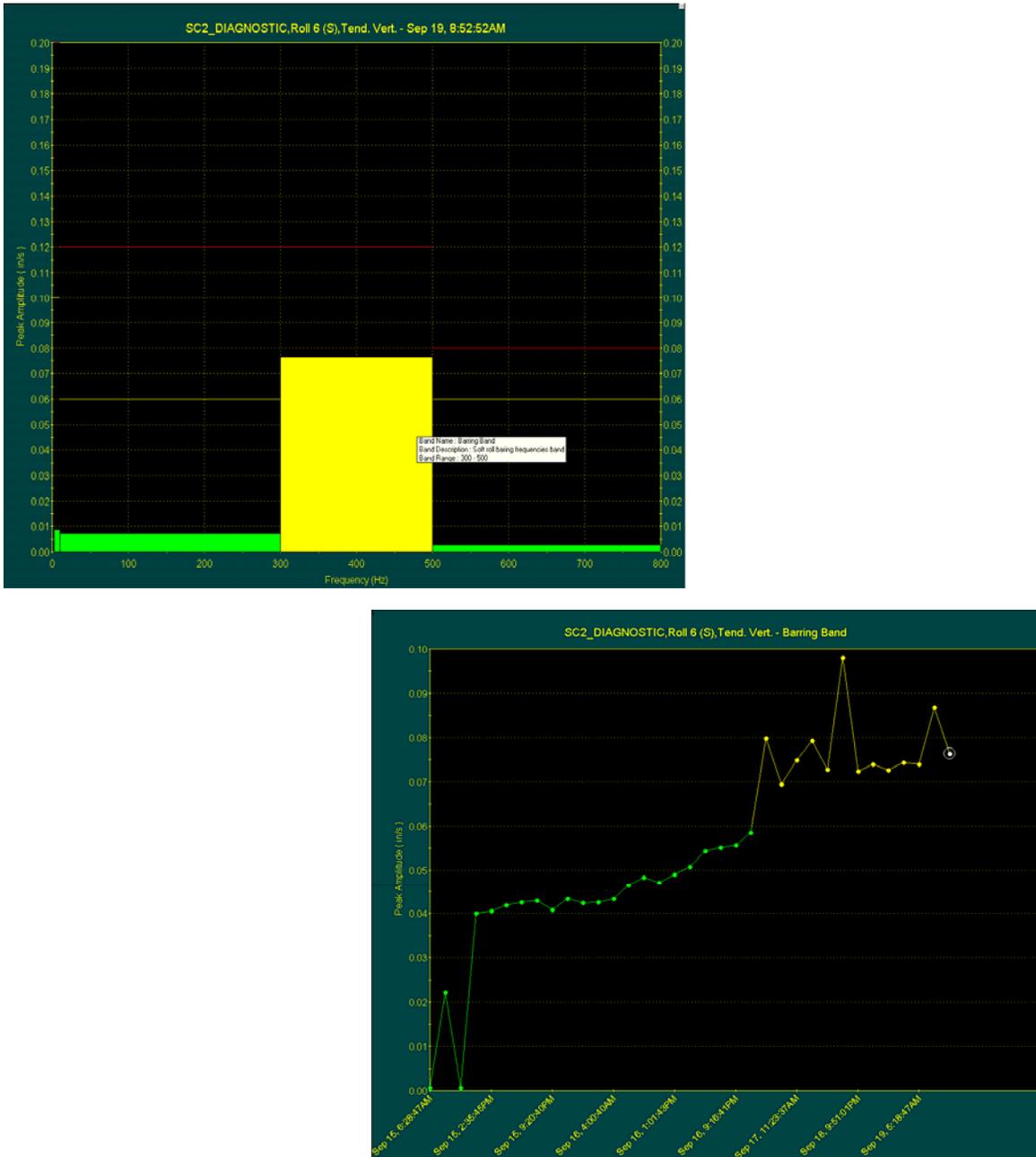


Figure 2 • Discrete Frequency Band Alarms and associated Trend Plot

Displays of alarm condition, character, and trend usually meet the routine requirements of plant operations. Machinery specialists require additional information, such as FFT spectra and Time Waveform displays. This data is required to diagnose complex machinery faults and conduct root cause failure analysis. In Figure 3, below (paper machine dryer gears), gear defects are observed in the FFT as high energy peaks at gearmesh frequency, with harmonics and running speed sidebands. Time Waveform displays contain critical information required to diagnose certain machine faults, and are especially useful for evaluating modulation and transient events.

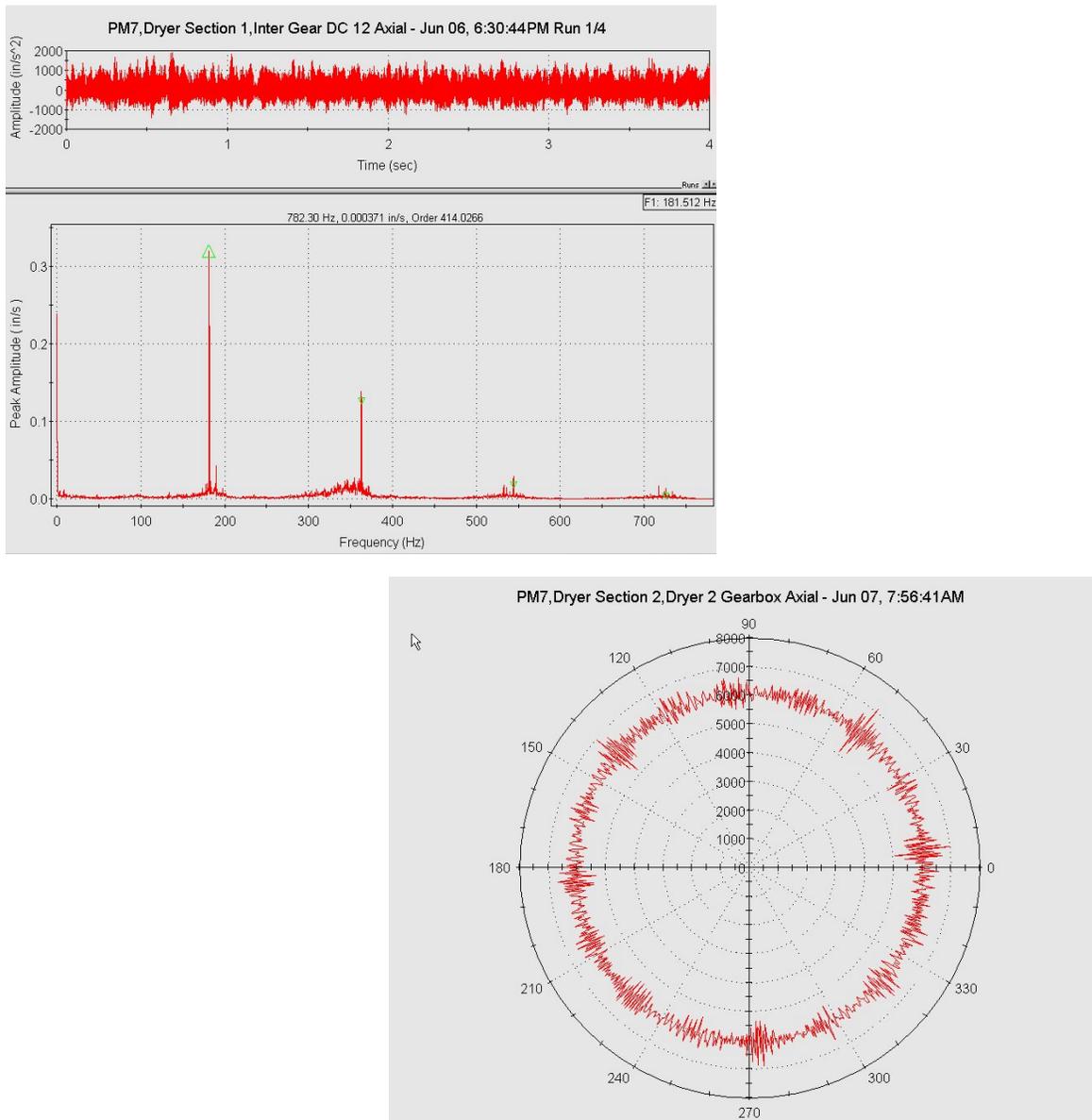


Figure 3 • FFT and Time Waveform Plots

For many installations, data displays from specialized signal processing algorithms, such as synchronous time averaging or enveloping are quite useful, and should be provided to plant operators. Advanced diagnostic features, including transfer functions, cepstrum, and kurtosis are also useful features in on-line vibration monitoring systems, however this data is of little use to operators and normally provided only to machinery specialists.

2.2 Network Distributed

As previously mentioned, the significant benefits of on-line monitoring will only be realized if “the right information is provided to the right personnel”. Therefore, distribution of data displays across plant networks is essential. This is normally achieved through multi-user database software combined with client versions of the user interface. Plant operations, maintenance, engineering, and management may simultaneously review data

from fully distributed systems. Also, fully distributable systems, combined with remote connections such as VPN (virtual private network) or modem connections, allow outside specialists to review the data.

The shift towards asset management strategies creates a requirement for a 'central repository' and standard displays or HMIs (Human Machine Interface) for all relevant data. Open database architecture, ActiveX controls, and OPC servers (*originally* OLE for Process Control) are all common methods of bringing process data and equipment condition data together. 'Open Systems' pose significant technical and business challenges. Organisations such as OSA-CMB (Open Systems Alliance for Condition Based Maintenance) and MIMOSA (Machinery Information Management Open Systems Alliance) exist to develop and define industry standards for system architectures which permit free and unconstrained sharing of information. Open systems are widely considered to be the most significant challenge / opportunity facing industry – and are critical to the wide acceptance and success of on-line vibration monitoring systems.

2.3 Hardware / Software / Engineering

Since each industrial facility has its own features, characteristics, and culture; highly configurable on-line vibration monitoring systems have the best opportunity for plant wide acceptance → use → success.

Data acquisition hardware for vibration monitoring must meet certain basic criteria. The most significant are Sampling Rate and Dynamic Range, which must be assessed to ensure compatibility with the monitoring application. Sampling rate determines available frequency resolution. For general purpose machinery monitoring, this author advises minimum sampling rate of 25 kHz (suitable for Nyquist sampling, anti-aliasing filter required). Dynamic range determines amplitude resolution, and is itself determined by the number of bits in the A/D (analog to digital) converter. This author recommends a minimum 14 bit A/D, equivalent to up to 114dB dynamic range. Other key hardware features include;

- simultaneous data acquisition (minimum 2 channels)
- integrated supply of ICP[®] sensor power
- system self-checks with operating status indicators
- programmable gain settings

In addition to data acquisition hardware, systems must utilize appropriate sensor inputs. For accelerometers, the sensor frequency response range and output range must correspond with the monitoring application. Other important hardware considerations include auxiliary sensor inputs (such as tachometers, dynamic pressure sensors, etc) environmental enclosures, and cables, each of which must suit the monitoring application and ambient conditions.

Configurable software applications are used to manage data acquisition, signal processing, data display, and data storage. Generally, system flexibility and performance increase with the degree of software configuration options, as does complexity. Two key features of system software, User Interface and Network Distribution, have already been discussed. Another important property is configurable data acquisition, based on time, process condition, and alarm condition. Signal processing, including band alarms and advanced diagnostics, may be programmed using configurable analysis 'blocks'. Figure 4, below, shows a typical interface for configuration of signal processing using analysis blocks. These systems are extremely flexible, and can be easily upgraded and/or customized.

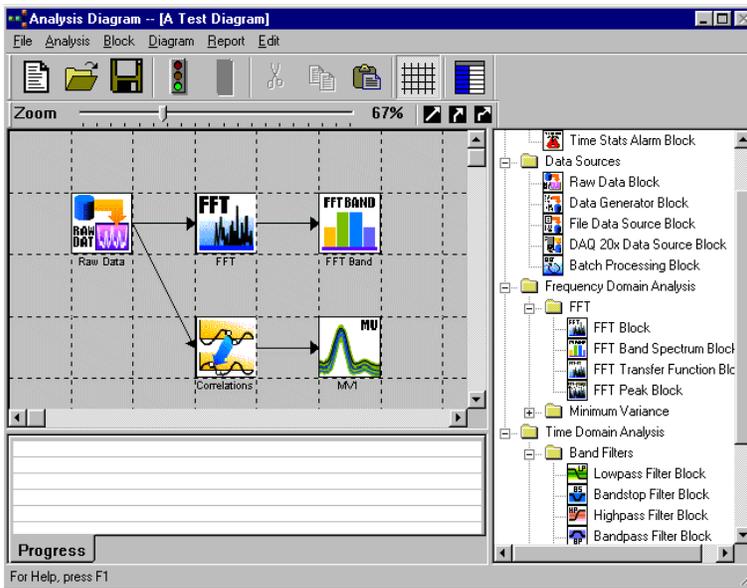


Figure 4 • Configurable Signal Processing using Analysis Blocks

The success of any on-line vibration monitoring system depends entirely on the engineering. Engineering includes all aspects of selection, installation, and configuration of hardware and software. Figure 5, below illustrates the relationship between the key system components. As monitoring systems become more flexible, open, and configurable, the importance of engineering increases.

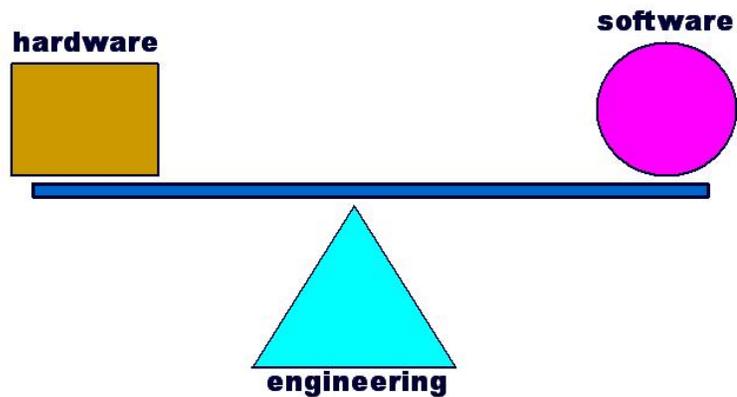


Figure 5 • Key Components of On-Line Vibration Monitoring

3. INSTALLATION EXAMPLES

3.1 StoraEnso Port Hawkesbury

In April 1998, StoraEnso commissioned its PM2, the world's fastest (95 km/h) paper machine. An integral component was 2 JANUS™ concept calenders (1500 m/min) using high temperature steel rolls and synthetic covered rolls, alternately stacked. Beginning in fall 1999, reliability issues with synthetic roll covers prompted a detailed analysis of machinery vibration using portable instruments, and subsequent installation of an on-line vibration monitoring system.

The system comprises of (5) 8 channel data acquisition units for each calender, for a total of 80 analog inputs. Figure 6, below, shows the start page of the supplied user interface.



Figure 6 • Supercalender Vibration Monitoring at StoraEnso

Round alarm bulbs indicate accelerometer locations, triangle bulbs indicate tachometer locations, and diamond bulbs on covered rolls # 3, 5, 6, and 8, indicate synchronous time averaging data acquisitions. A recent addition is sound pressure measurements, indicated by alarm bulbs at the bottom of each calender stack. Tool tips descriptions are included for all measurement locations. The data acquisition server is located in the calender control room, and displays this interface on a continuous basis.

The key measurement is the synchronous time averaging, which provides a good indicator of which roll is defective. A discrete alarm band set at 300 to 500 Hz shows that barring is present. However, since each of the covered rolls is similar in diameter, and the vibration from roll barring transmits throughout the calender stack, synchronous time averaging is required to determine which roll is barred. Data acquisition is configured so that alarms in the barring region initiate the synchronous time averaging routine. Figure 7, below, shows the FFT and Time Waveform display of a barred roll.

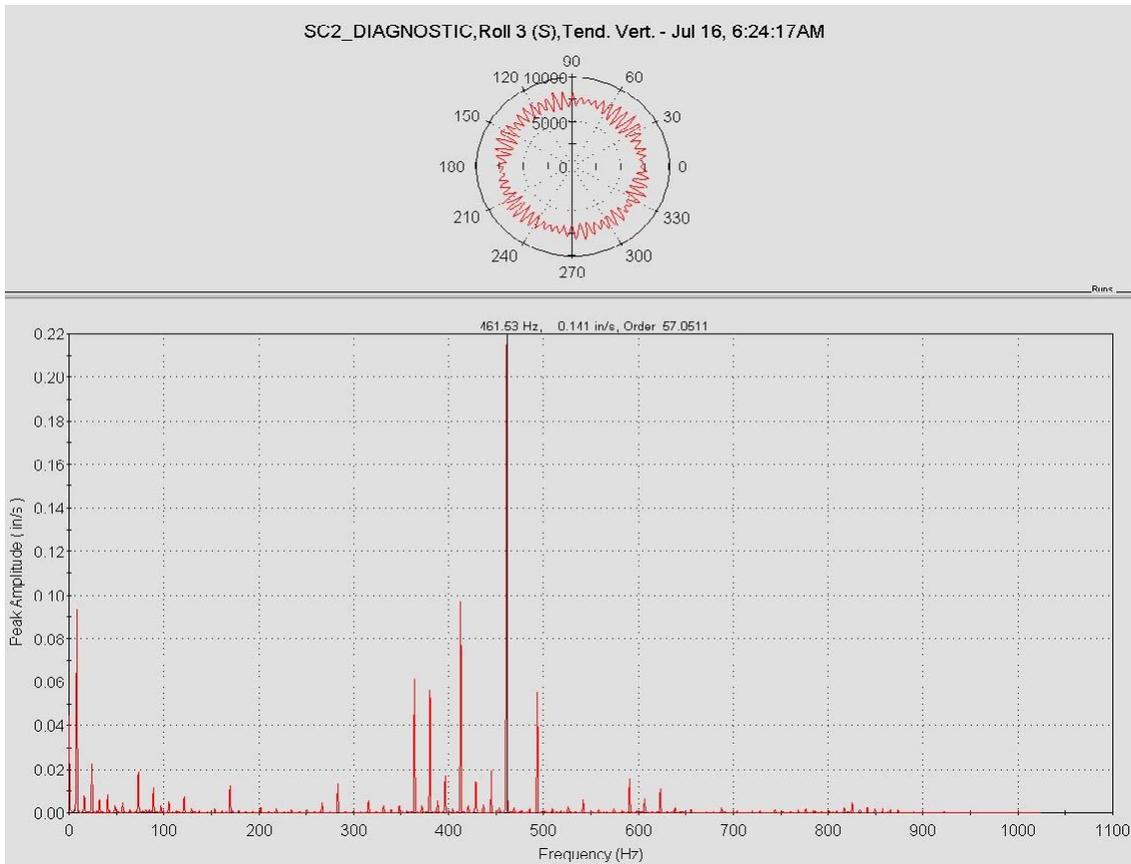


Figure 7 • Display of Synchronous Time Averaged Data at StoraEnso

StoraEnso production representatives have indicated to the author “we could not make paper without this system”.

3.2 Abitibi-Consolidated Grand Falls

Following the catastrophic failure and subsequent rebuild of dryer section gear drives on A-C Grand Falls division’s PM7, an on-line vibration monitoring system was installed. The objective of this installation was to monitor for machine faults during startup of the rebuilt gear train.

Although contracted machinery specialists were at site during the startup, a user interface was configured and distributed via the plant network to plant operations, maintenance, and engineering.

Figure 8, below, shows one of the user interfaces configured for dryer section gear train monitoring. As shown by the location of sensor alarm bulbs, vibration sensors were installed only at the intermediate pinion gears.

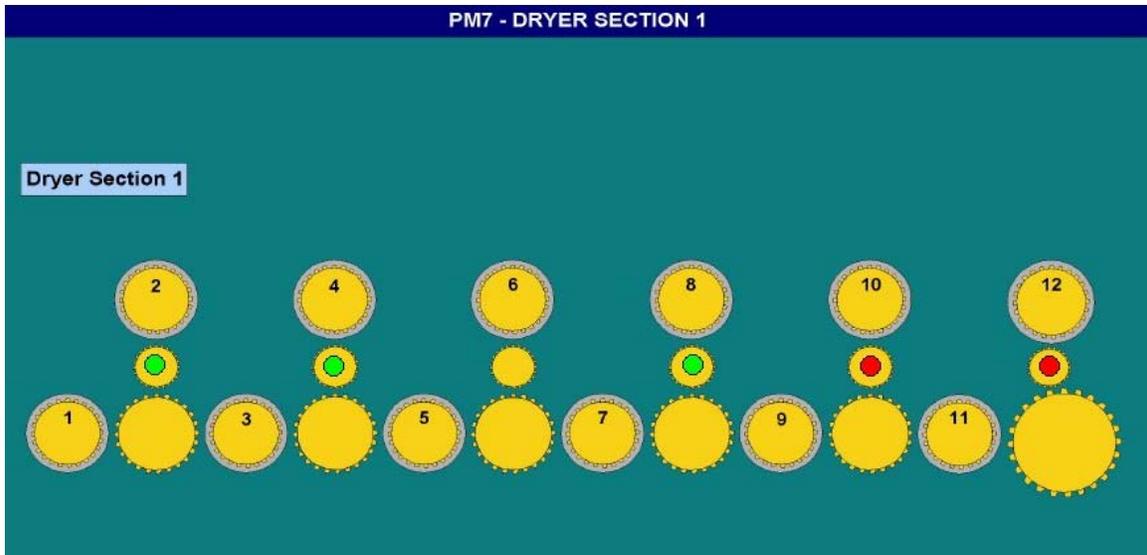


Figure 8 • Dryer Section Gear Train Monitoring at A-C Grand Falls

During the startup, a gear defect was detected. The machine was shutdown to repair the defect, preventing additional costly damage.

During subsequent monitoring and analysis by a contracted machinery specialist, a correlation between dryer condensate levels, gear load, and vibration amplitude was observed. A root cause investigation by plant engineers detected a problem with the condensate removal systems, which was subsequently repaired, resulting in a significant reduction in machinery vibration.

This system continues to be monitored via remote connection.

4. ACKNOWLEDGEMENTS and REFERENCES

This work is presented with permission of StoraEnso and Abitibi-Consolidated Inc.

Standards Developments for Condition-Based Maintenance Systems,
Michael Thurston and Mitchell Lebold, Penn State University

MIMOSA – The Golden Opportunity
John Mitchell

The Future of Machinery Monitoring Technology
SKF Condition Monitoring Technical Paper CM1012

Mike is an expert in machine condition monitoring and vibration control. He is a licensed professional engineer with over 20 years practical experience, mainly in heavy industry. Since establishing Bretech Engineering in 1989, Mike has resolved numerous vibration problems for clients in the pulp & paper, oil & gas, mining, and power generation industries. Mike has also managed the development and implementation of condition monitoring programs at various industrial and commercial facilities.



Mr Robichaud has achieved **Vibration Specialist Category IV** under ISO Standard 18436-2 and is a **Certified Maintenance and Reliability Professional** through SMRP. He serves as chair of the Canadian Advisory Committee to ISO TC108 (Mechanical Vibration and Shock) and is a member of Canadian General Standards Board Committee 48/2 on NDT and Certification of Personnel. Mike has authored and presented numerous technical papers and short courses on the subjects of vibration analysis and condition monitoring. Working closely with the Bretech Team, Mike has developed various specialized techniques, including **IN-SITU™ Roll Balancing** and **SCORE™ PdM Assessment**.





Condition Monitoring
Nondestructive Testing
Advanced Diagnostics
Engineering Services



Practical On-Line Vibration Monitoring for Papermachines

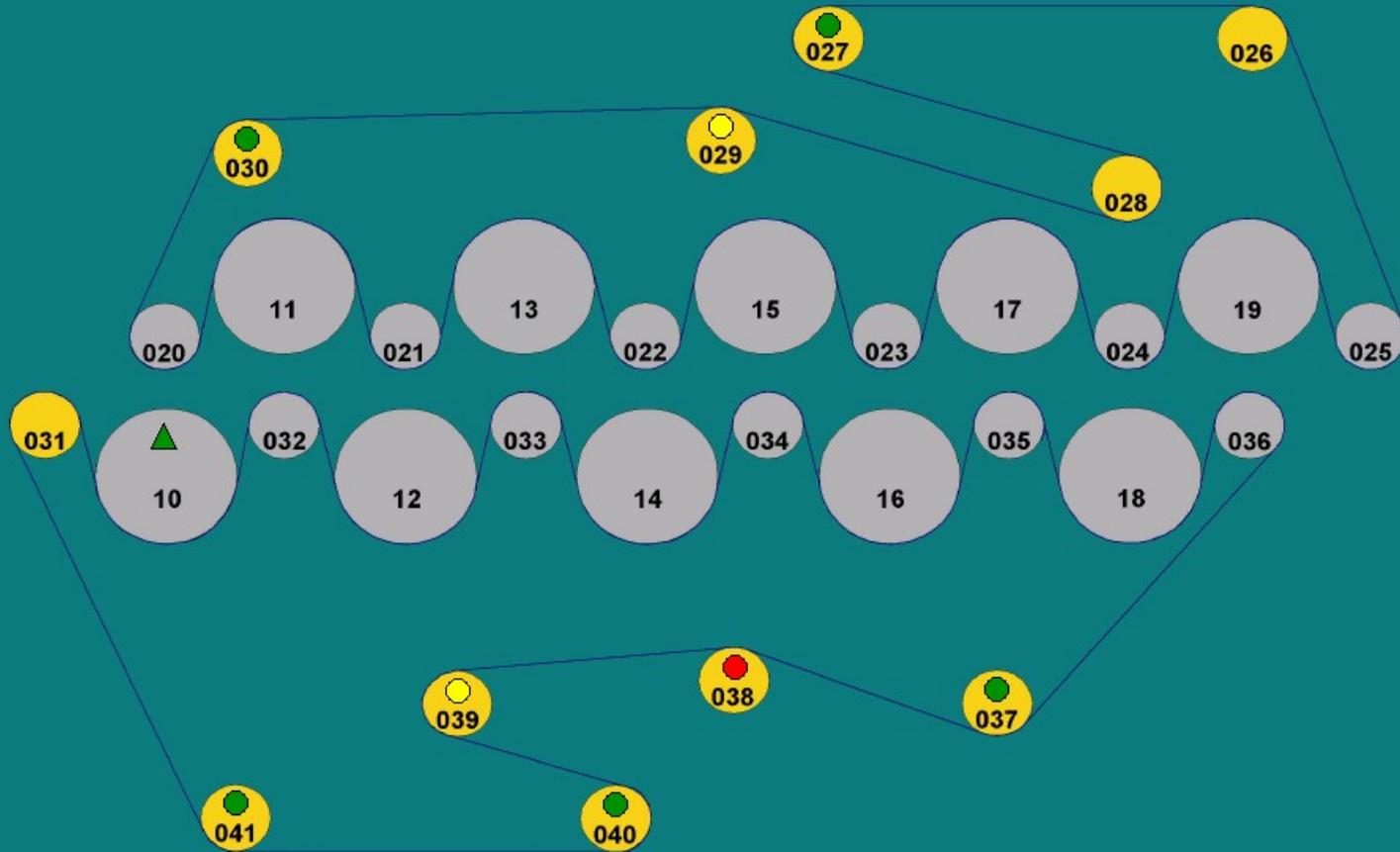
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- the strategies
- implementation

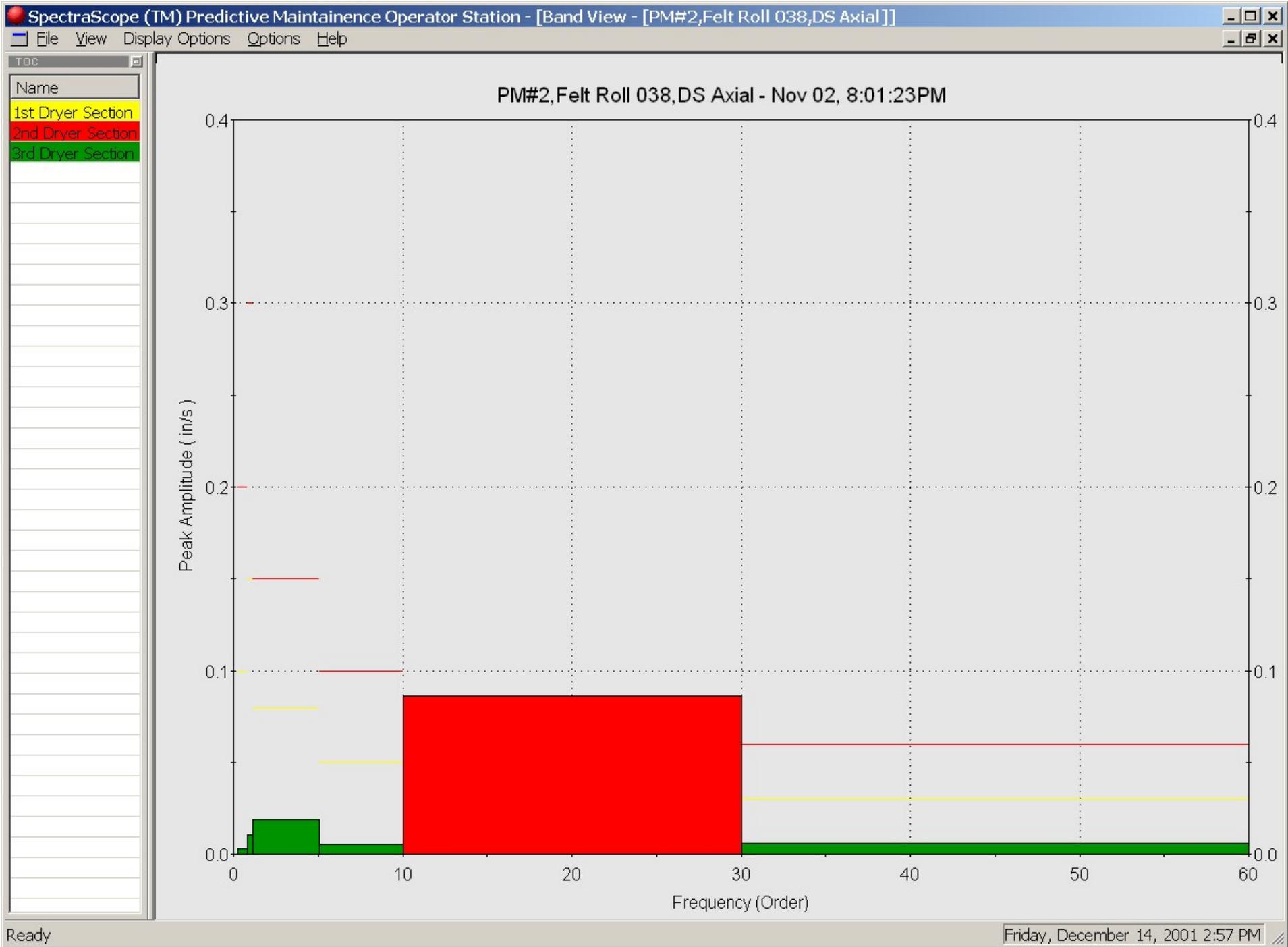
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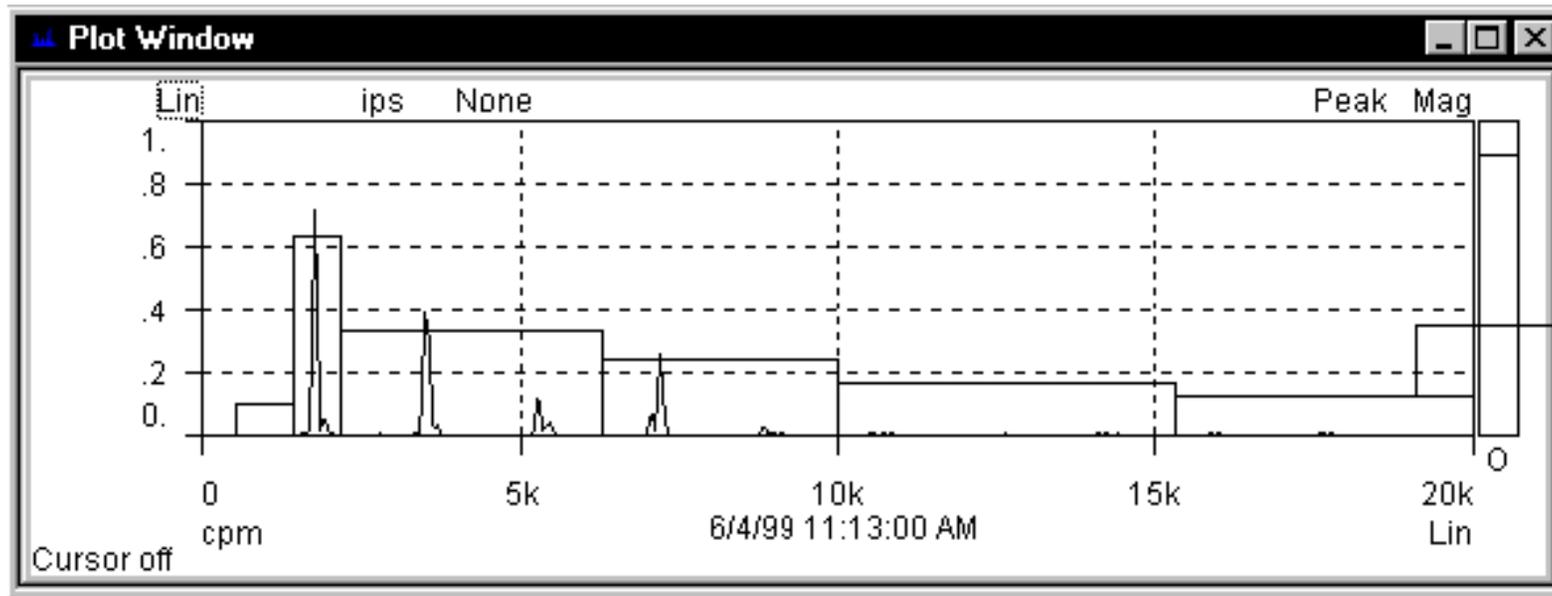
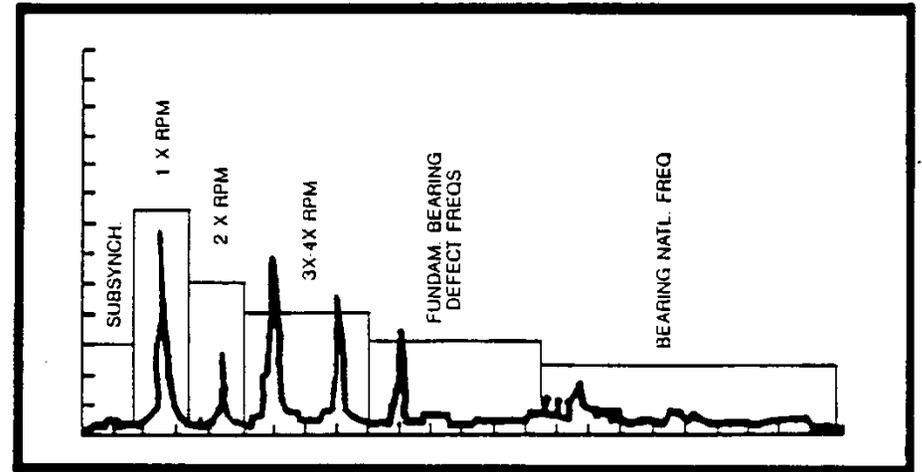
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2nd Dryer Section
3rd Dryer Section



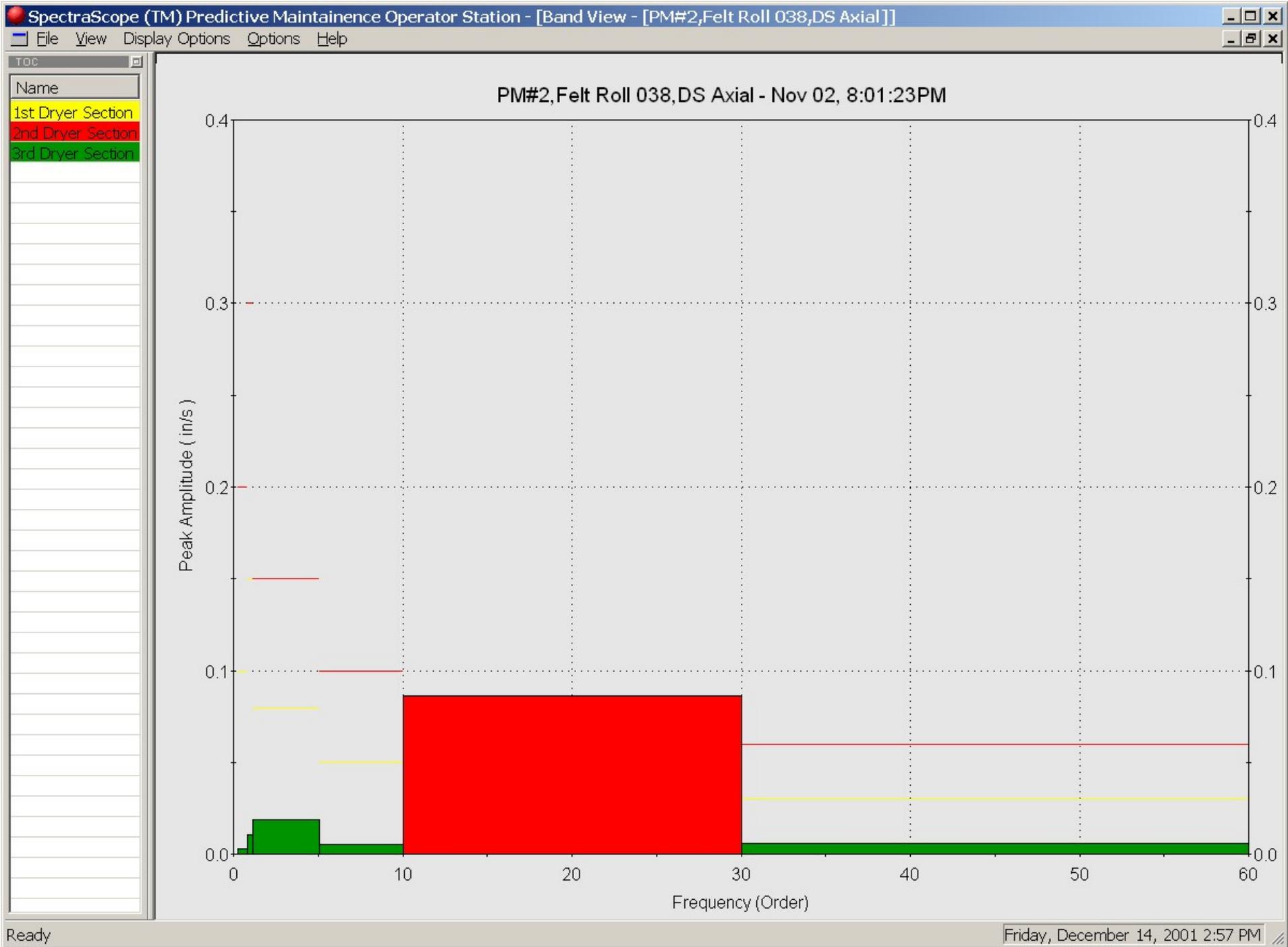
PM2 - DRYER SECTION 2



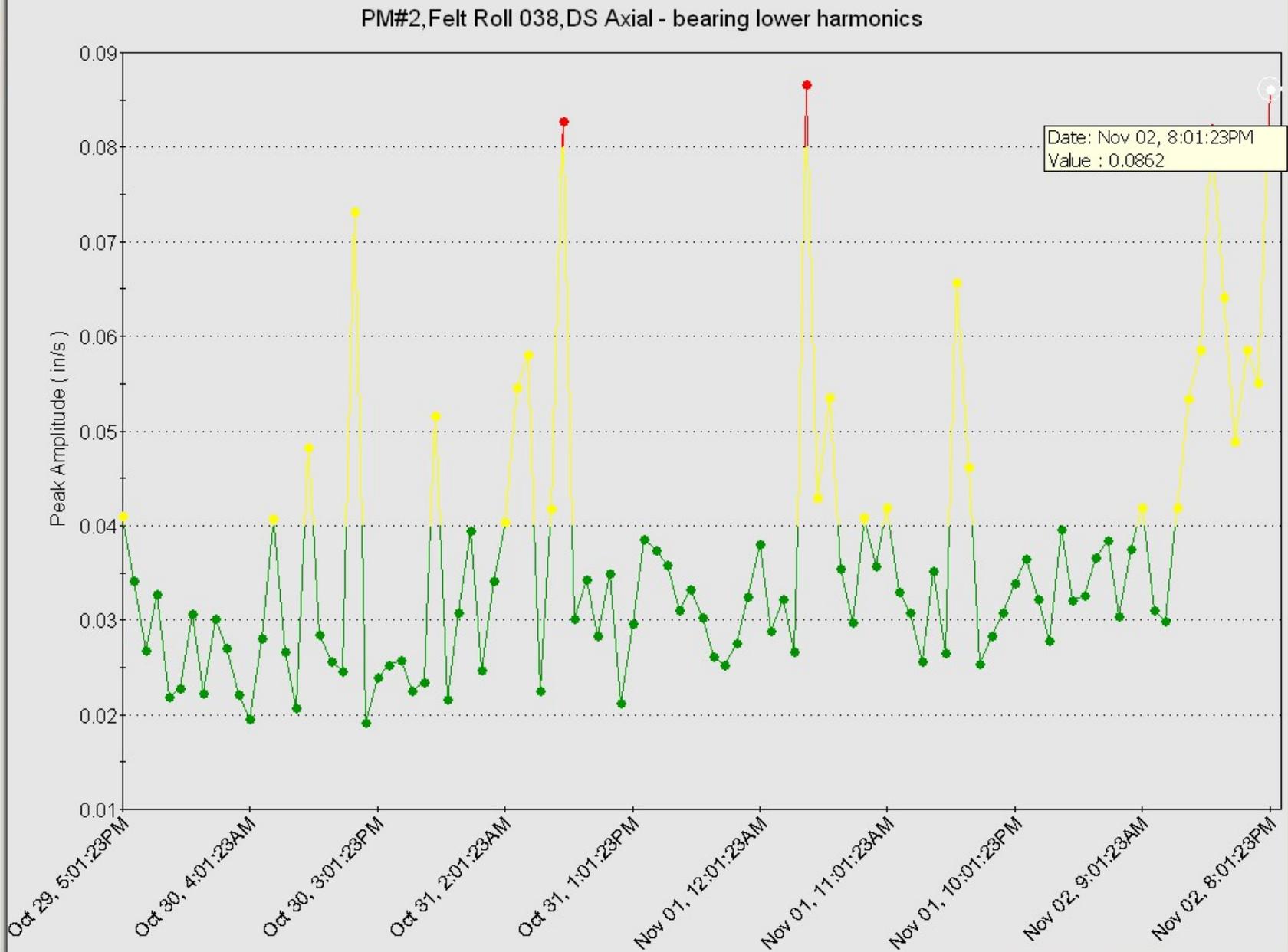




**Band alarm,
using 6 bands**

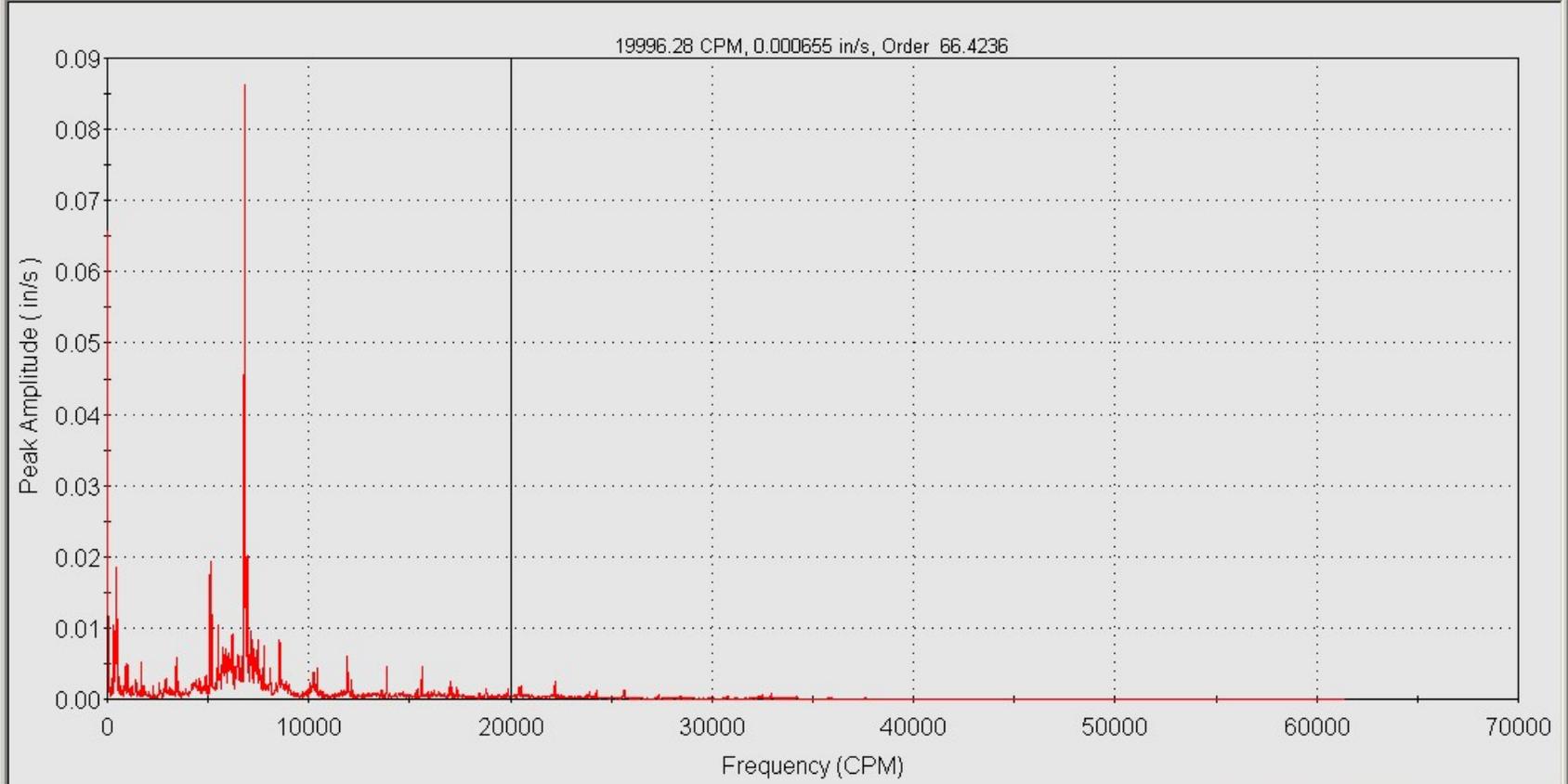
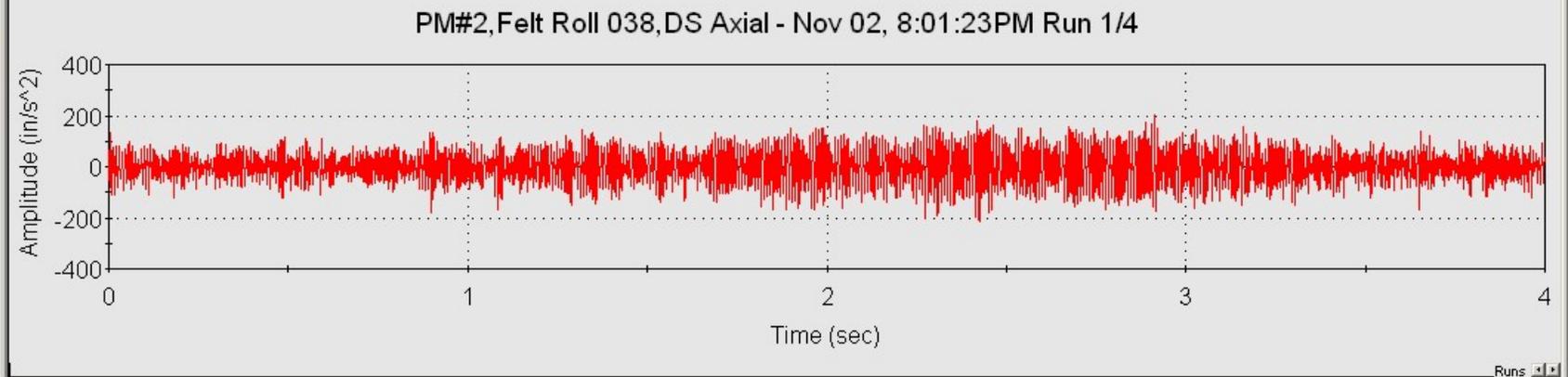


TOC
Name
1st Dryer Section
2nd Dryer Section
3rd Dryer Section



TOC

Name
1st Dryer Section
2nd Dryer Section
3rd Dryer Section



Practical On-Line Vibration Monitoring for Papermachines

Objectives

- ✓ **REDUCE or ELIMINATE UNPLANNED DOWNTIME**
- ✓ **DECREASE MAINTENANCE COSTS**

- ✓ **IMPROVE ASSET LIFE & RETURN ON CAPITAL**
- ✓ **REDUCE TOTAL COST OF OWNERSHIP**

- ✓ **INCREASE CAPACITY**

Practical On-Line Vibration Monitoring for Papermachines

→ **the tools**

hardware

software

engineering

Smart**Systems**

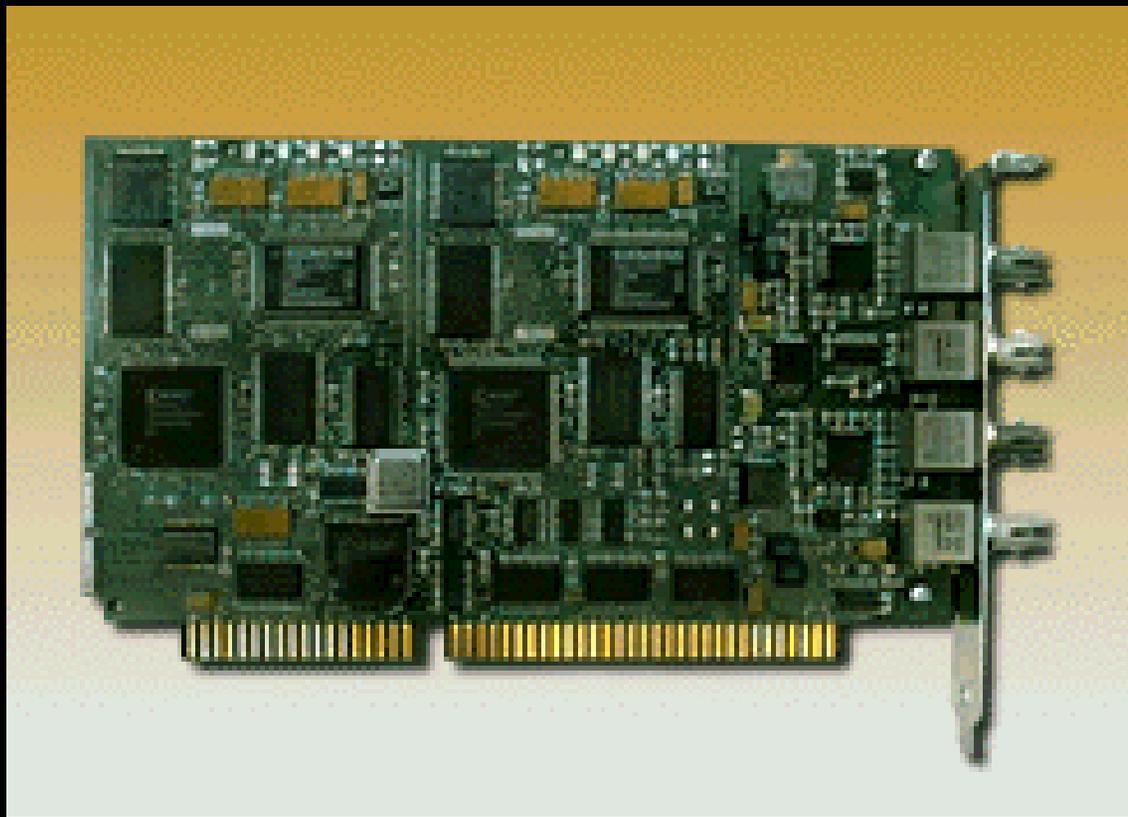
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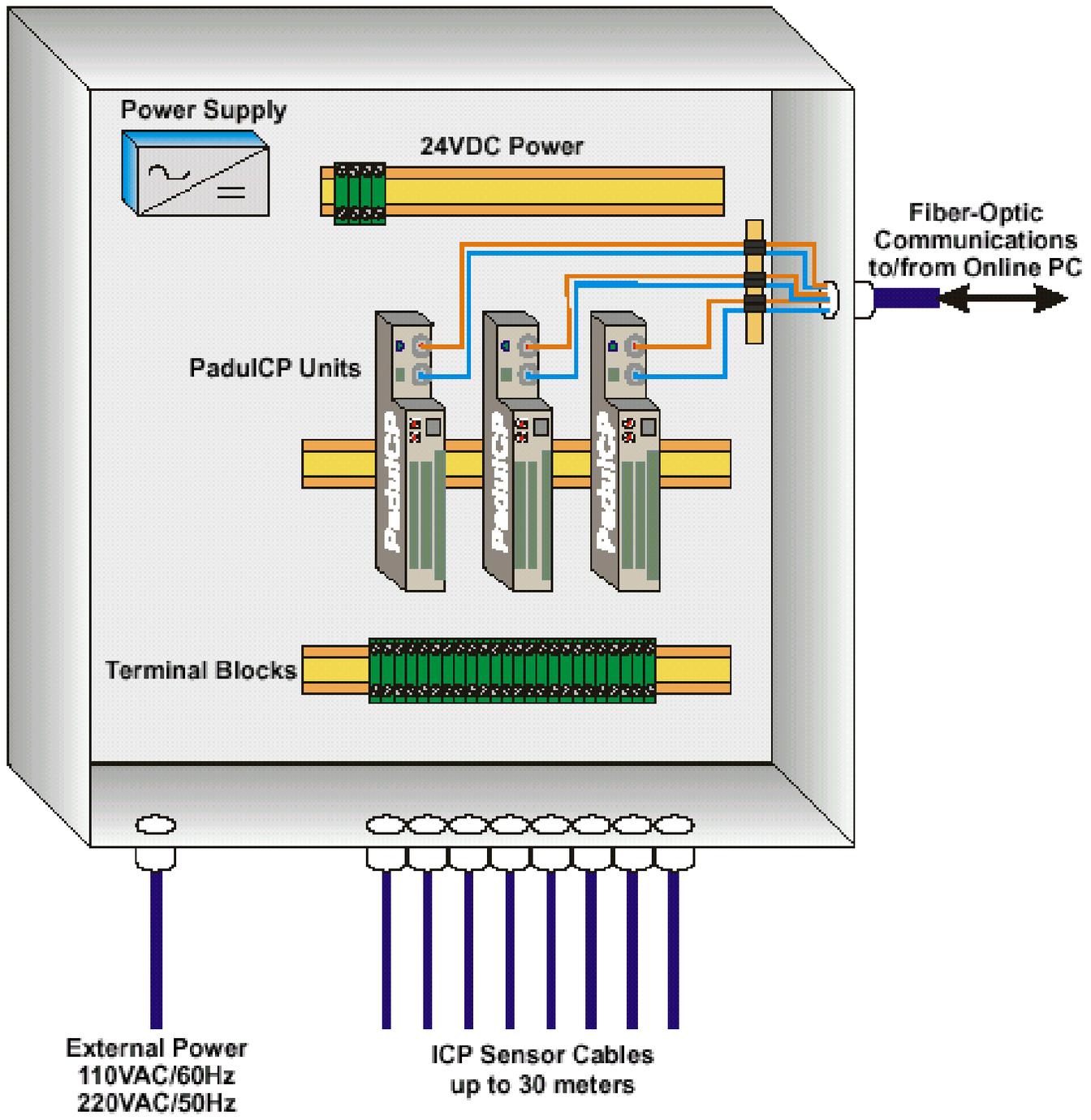
TOTAL MACHINE MONITORING SOLUTIONS™



Key Features

- ⇒ **modular**
- ⇒ **configurable**
- ⇒ **network distributed**







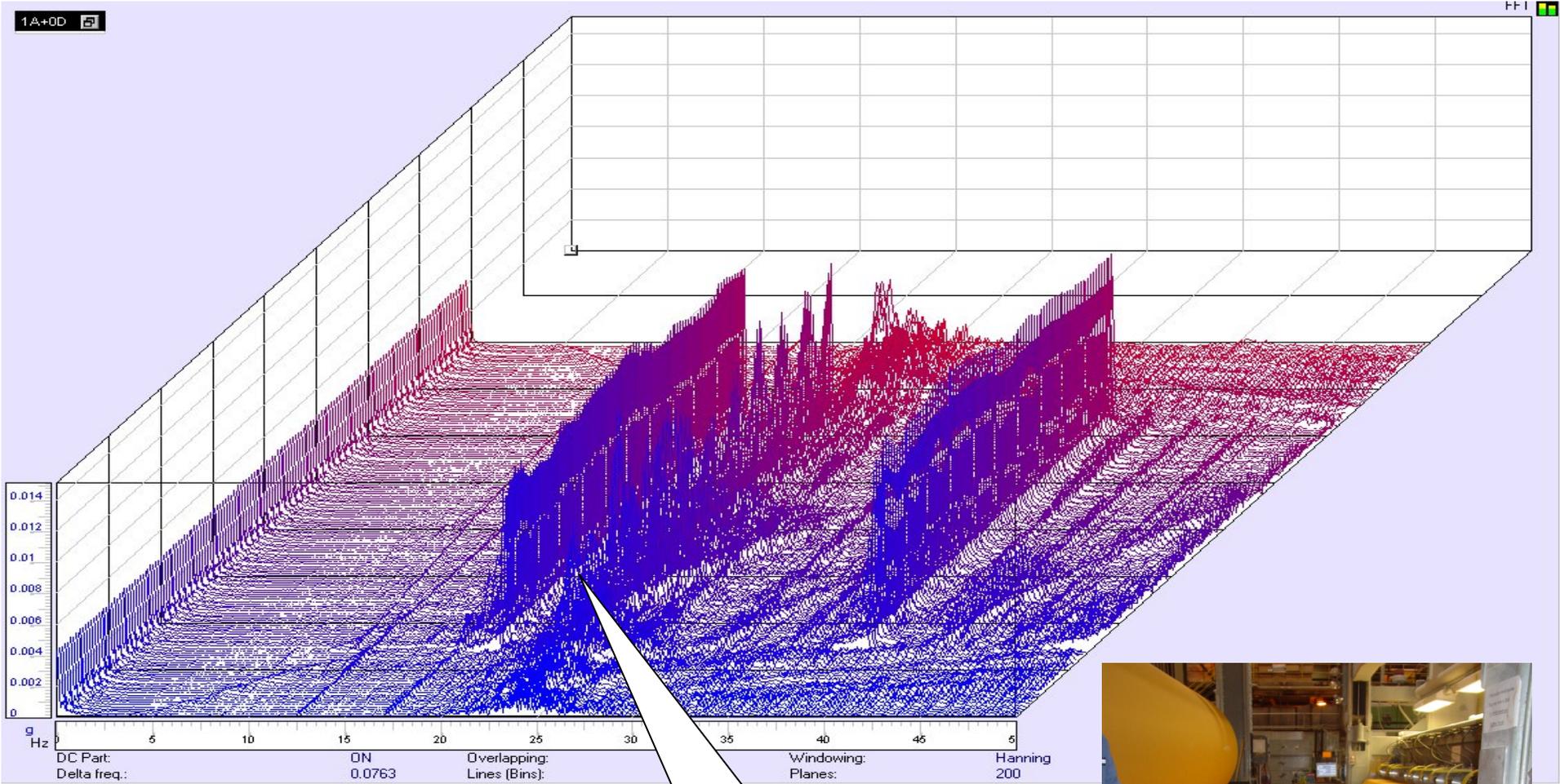
Key Features

- ⇒ **modular**
- ⇒ **configurable**
- ⇒ **network distributed**
- ⇒ **8X 14 bit A/D**
- ⇒ **up to 150 kHz sampling rate**



CM-8X Portable
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**Resonance & Beat Vibration
@ Lead In Roll & Frame**



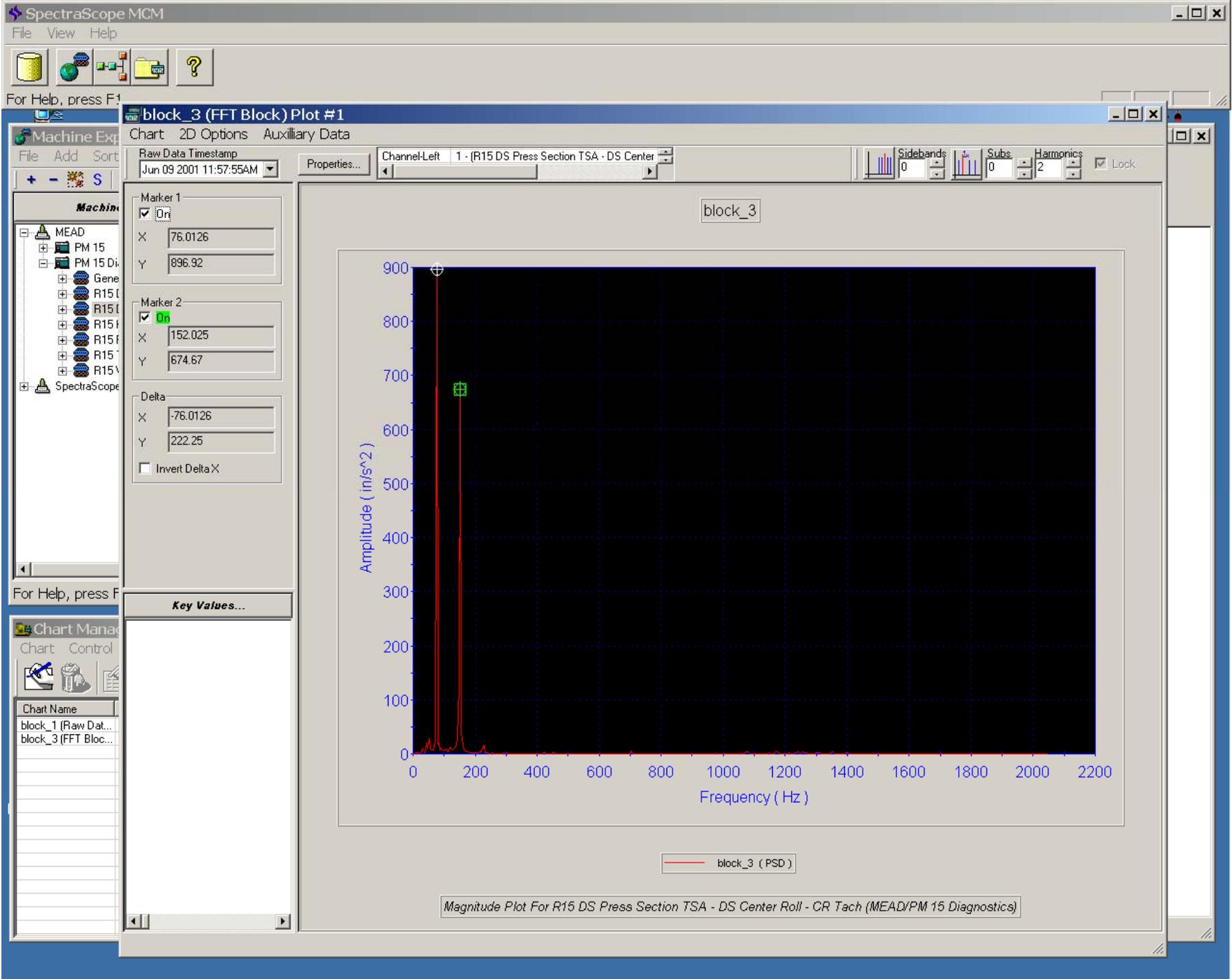
SpectraScope™



Spectral Visualization and Development ©1999

Key Features

- ⇒ **modular**
- ⇒ **configurable**
- ⇒ **network distributed**
- ⇒ **8X 14 bit A/D**
- ⇒ **up to 150 kHz sampling rate**
- ⇒ **post-processing paradigm**
- ⇒ **open database**



Practical On-Line Vibration Monitoring for Papermachines

→ the tools

→ the strategies

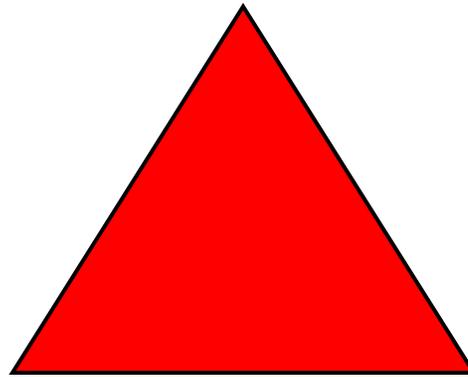
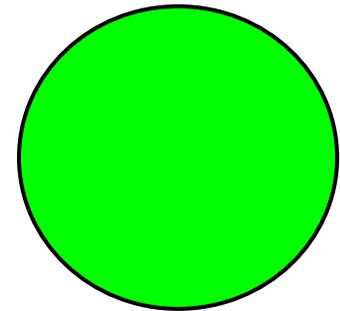
MACHINERY VIBRATION ANALYSIS

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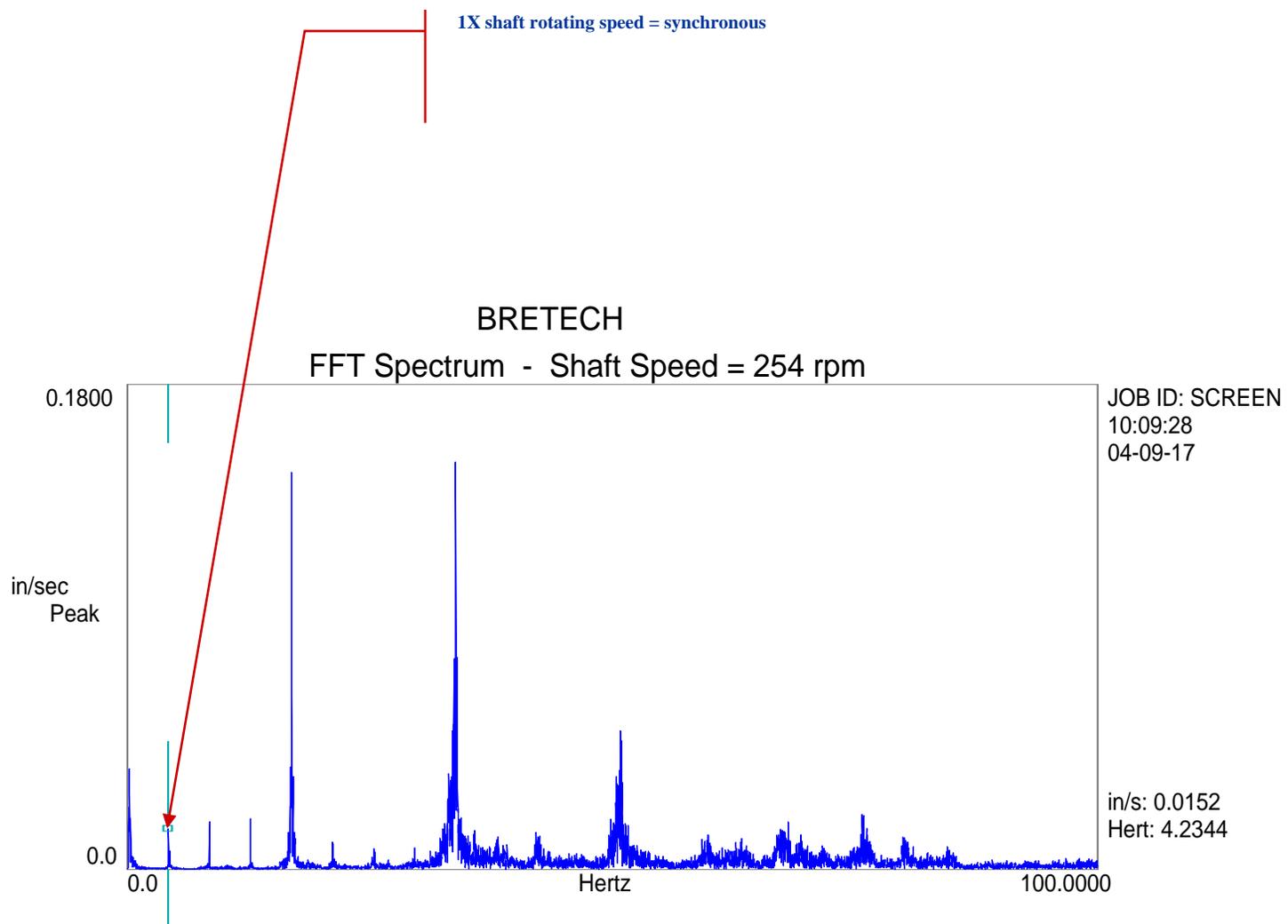
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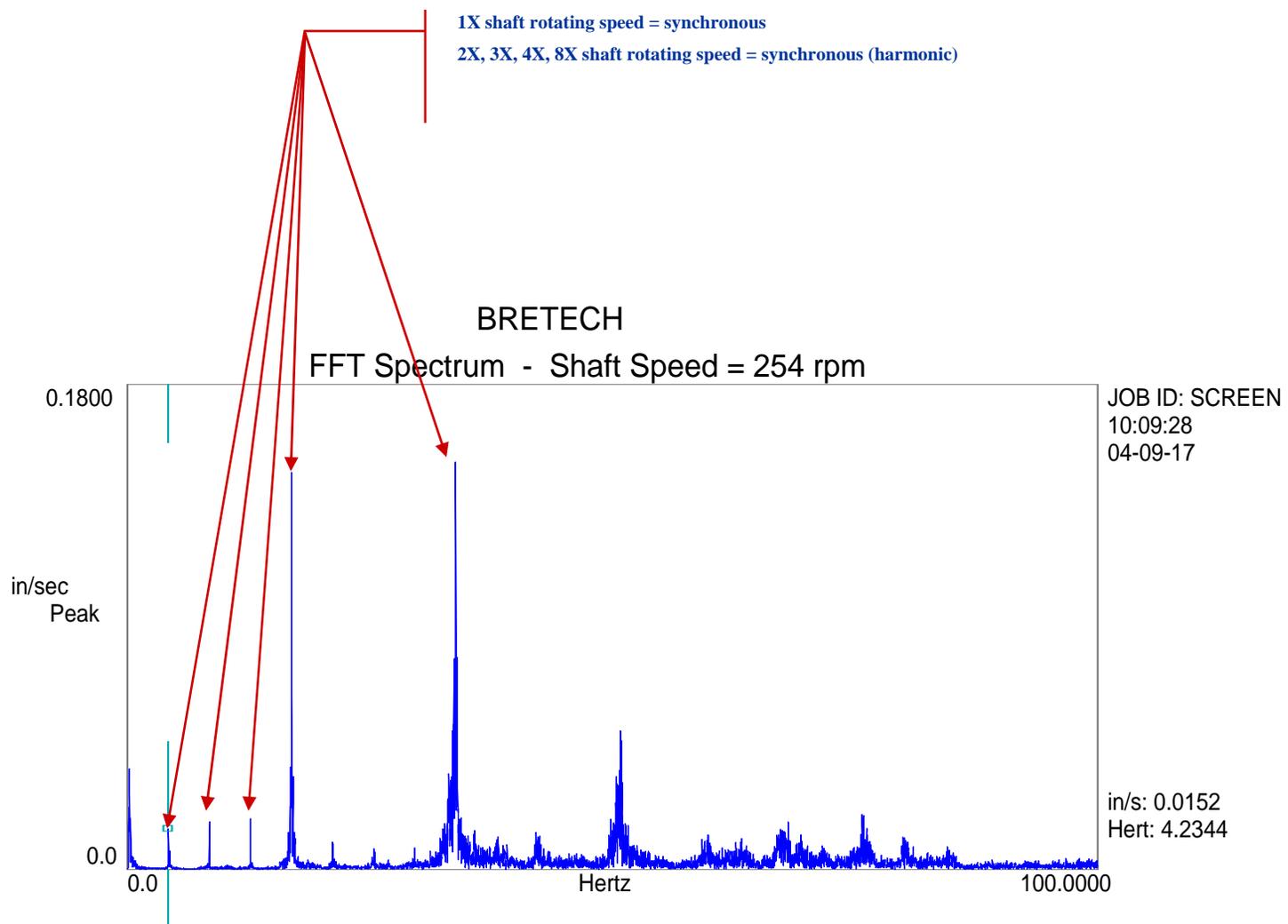


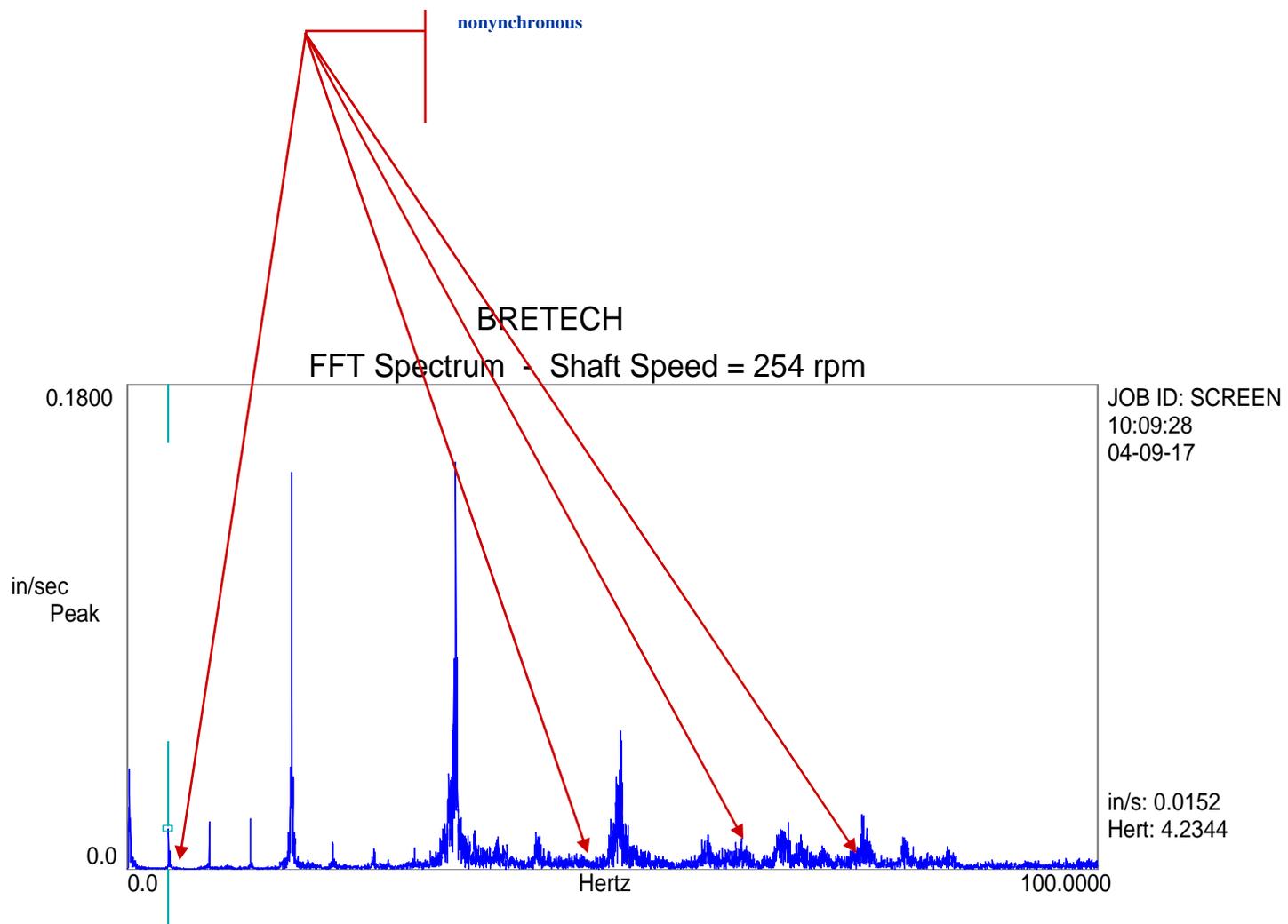
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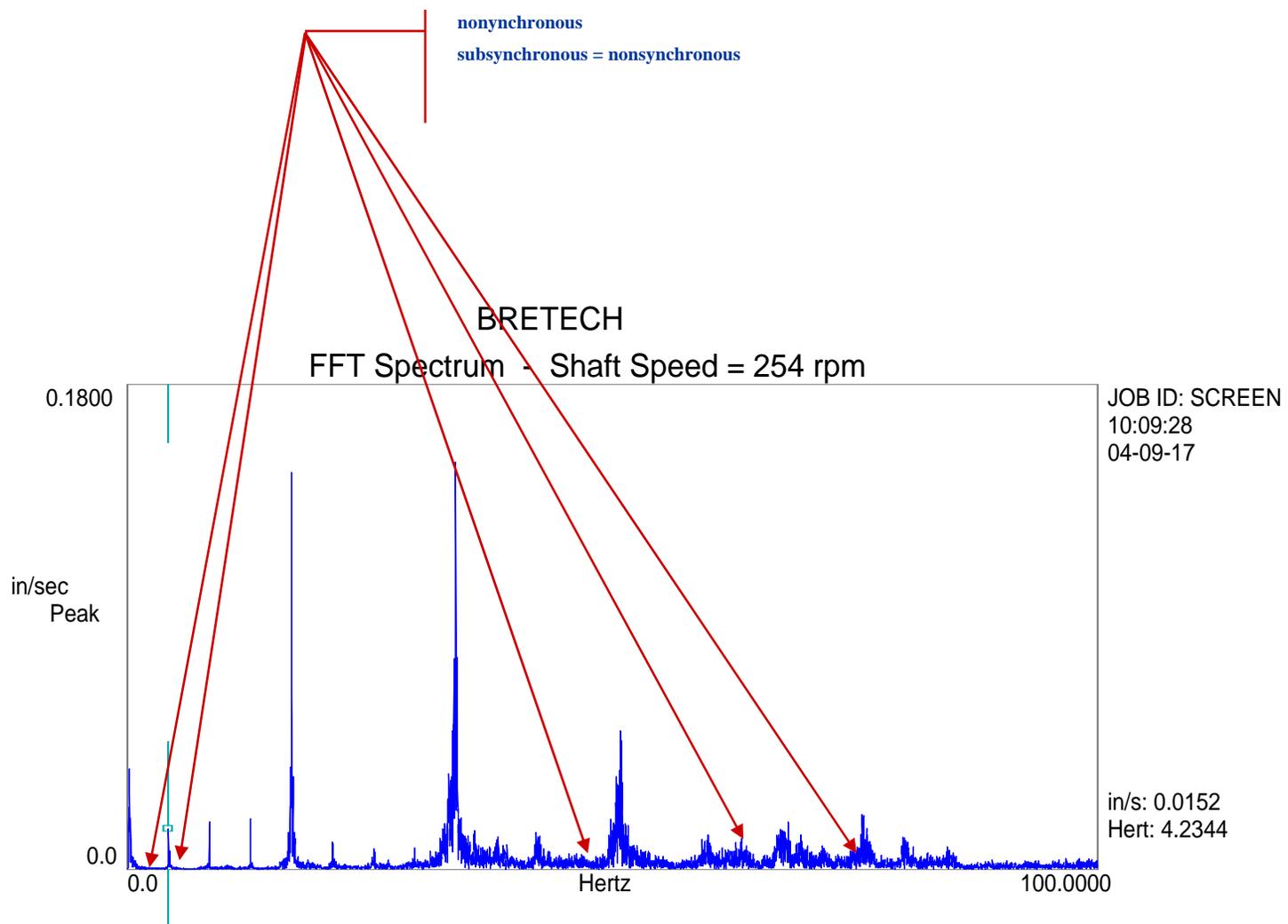


engineering

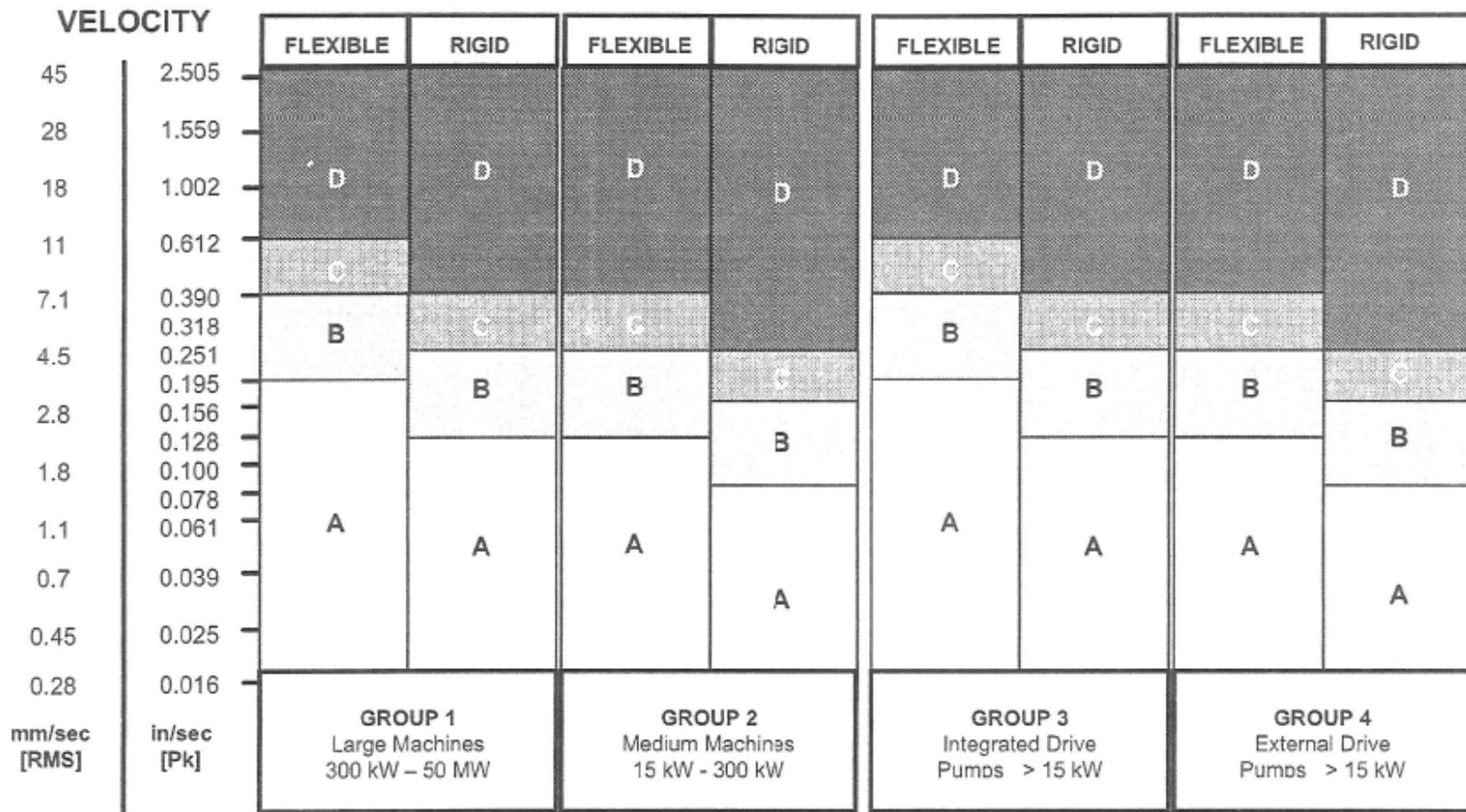






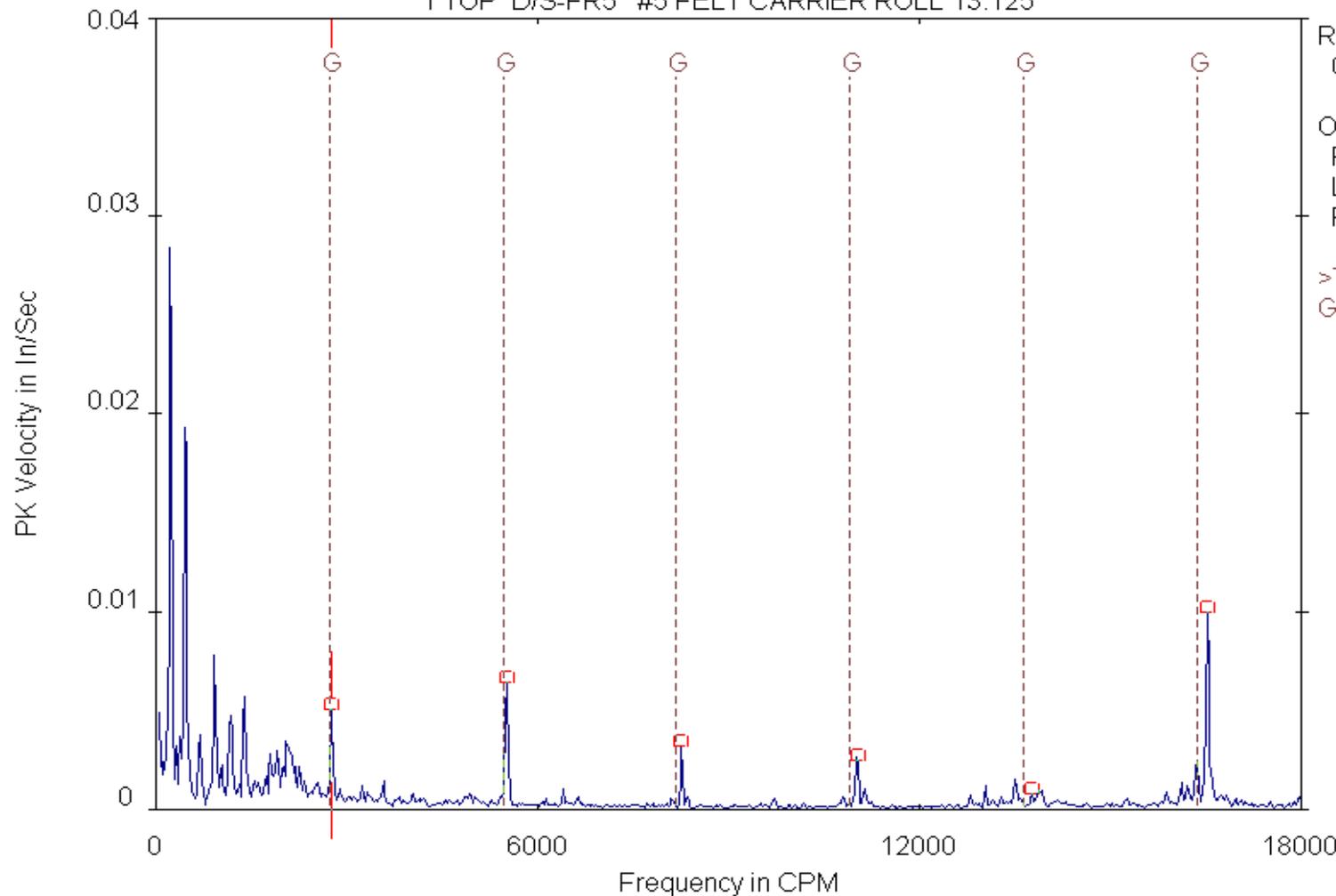


ISO 10816-3: 1998(E) VIBRATION SEVERITY for ROTATING MACHINES 120 to 15,000 RPM



A Newly Commissioned Machines
 B Unrestricted Operation
 C Restricted Operation
 D Damaging Vibration Levels

USPM - 1ST TOP FELT ROLLS-DRIVESIDE
1 TOP D/S-FR5 #5 FELT CARRIER ROLL 13.125



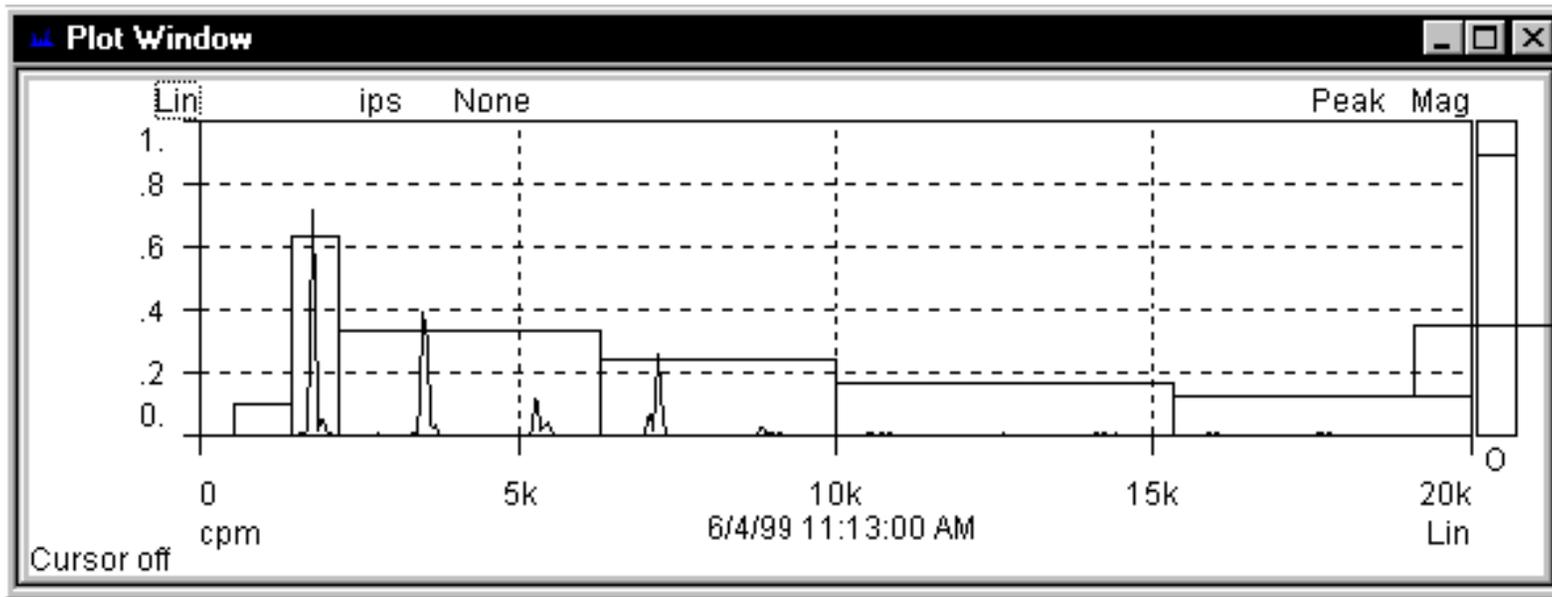
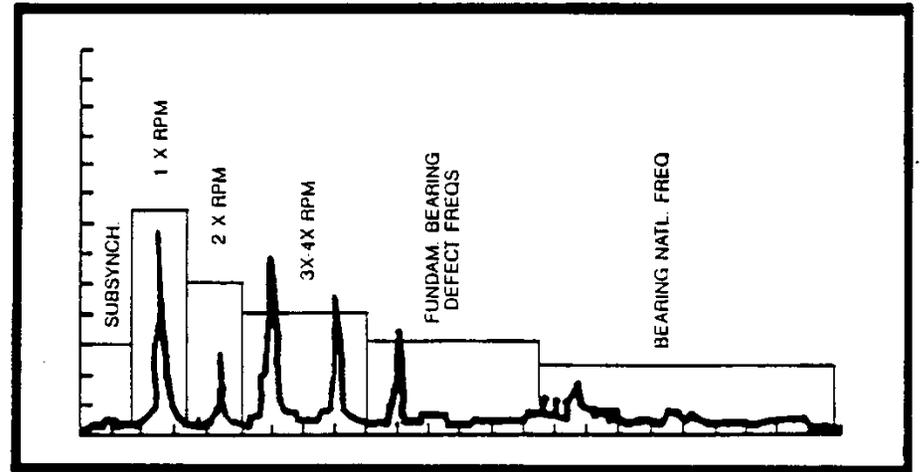
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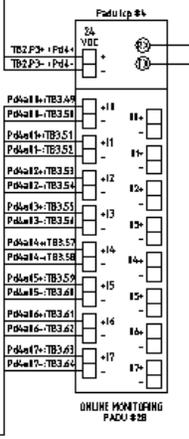
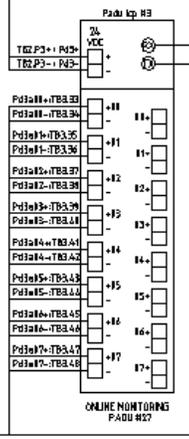
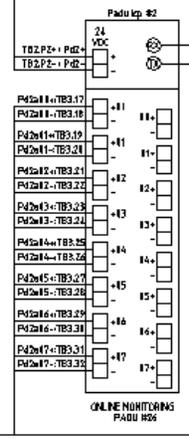
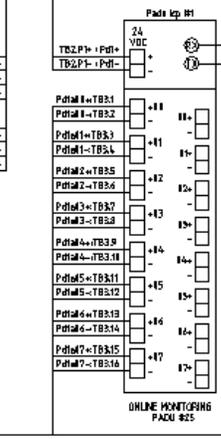
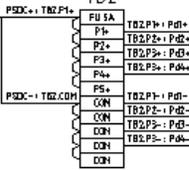
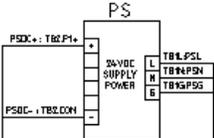
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Band alarm,
using 6 bands

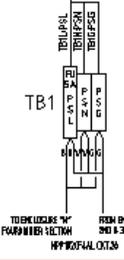
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FIBER OPTIC CABLE FROM ENCLOSURE "0" TO ENCLOSURE "1"

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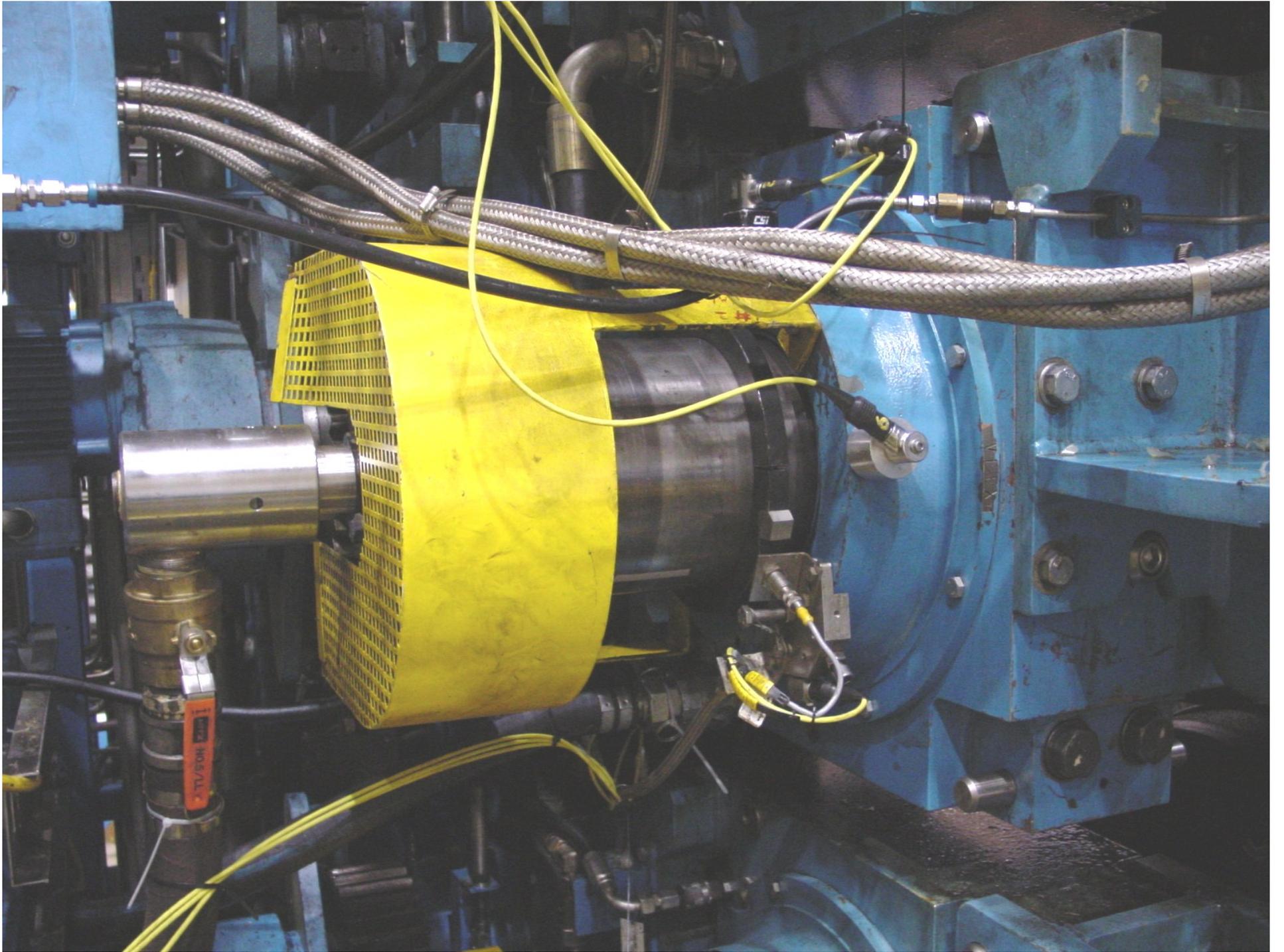
Mead Publishing Paper Division
Rumford, Maine

10V VIBRATION MONITORING SYSTEM
PRESS & GY DRYER SECTIONS
ENCLOSURE "N" - DRIVE SIDE

NO.	DATE	DESCRIPTION	BY	APP'D	DR	CHK	APP'D	SCALE	DATE	C.A.
REVISIONS										
THIS PRINT ISSUED										

JOB NO. 2019-003-B

TO ENCLOSURE "0"
FROM ENCLOSURE "1"
FROM ENCLOSURE "0"
TO ENCLOSURE "1"





Practical On-Line Vibration Monitoring for Papermachines

- the tools
- the strategies
- **implementation**



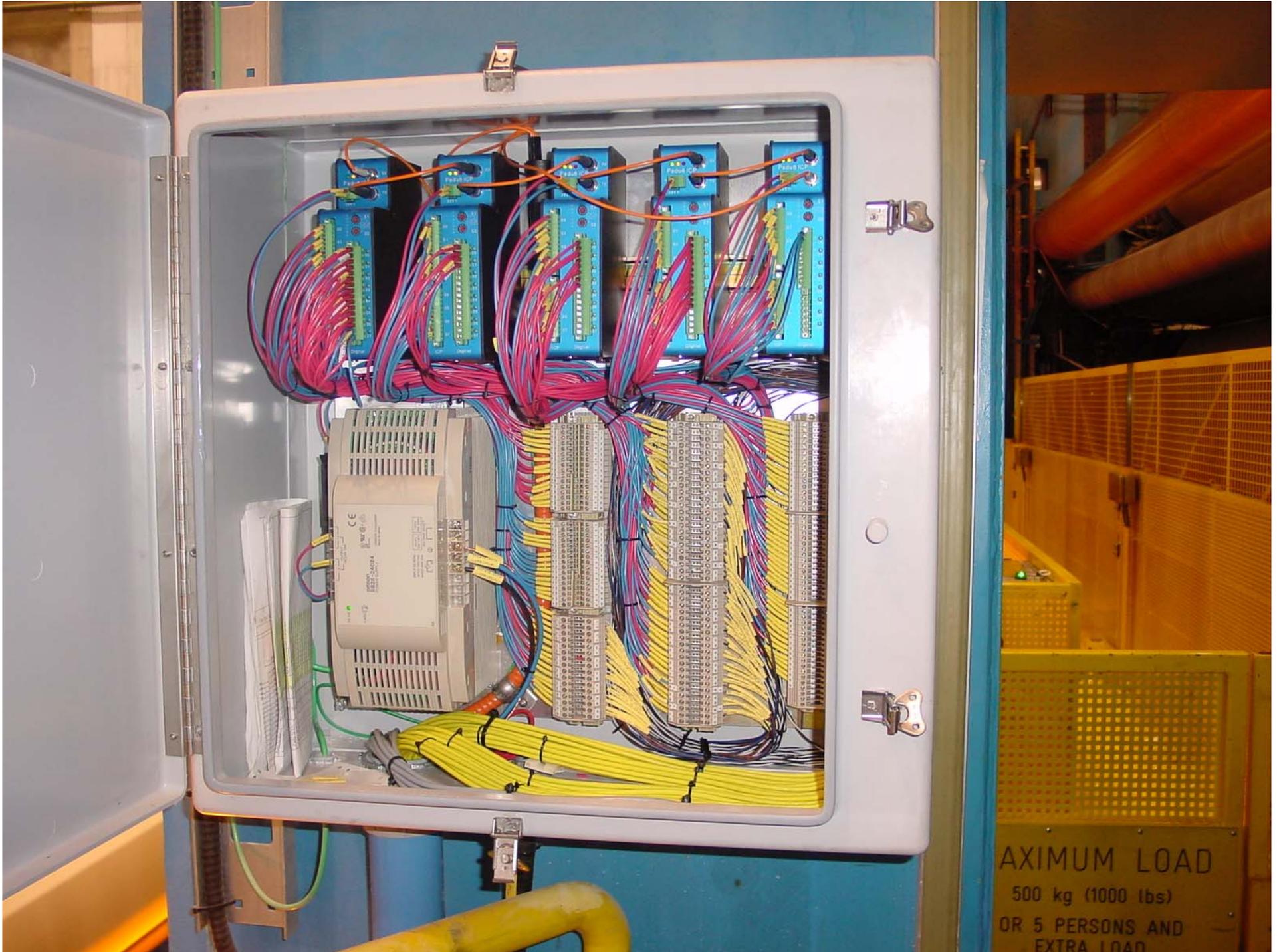


- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10



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CM-8X Vibration Monitoring System
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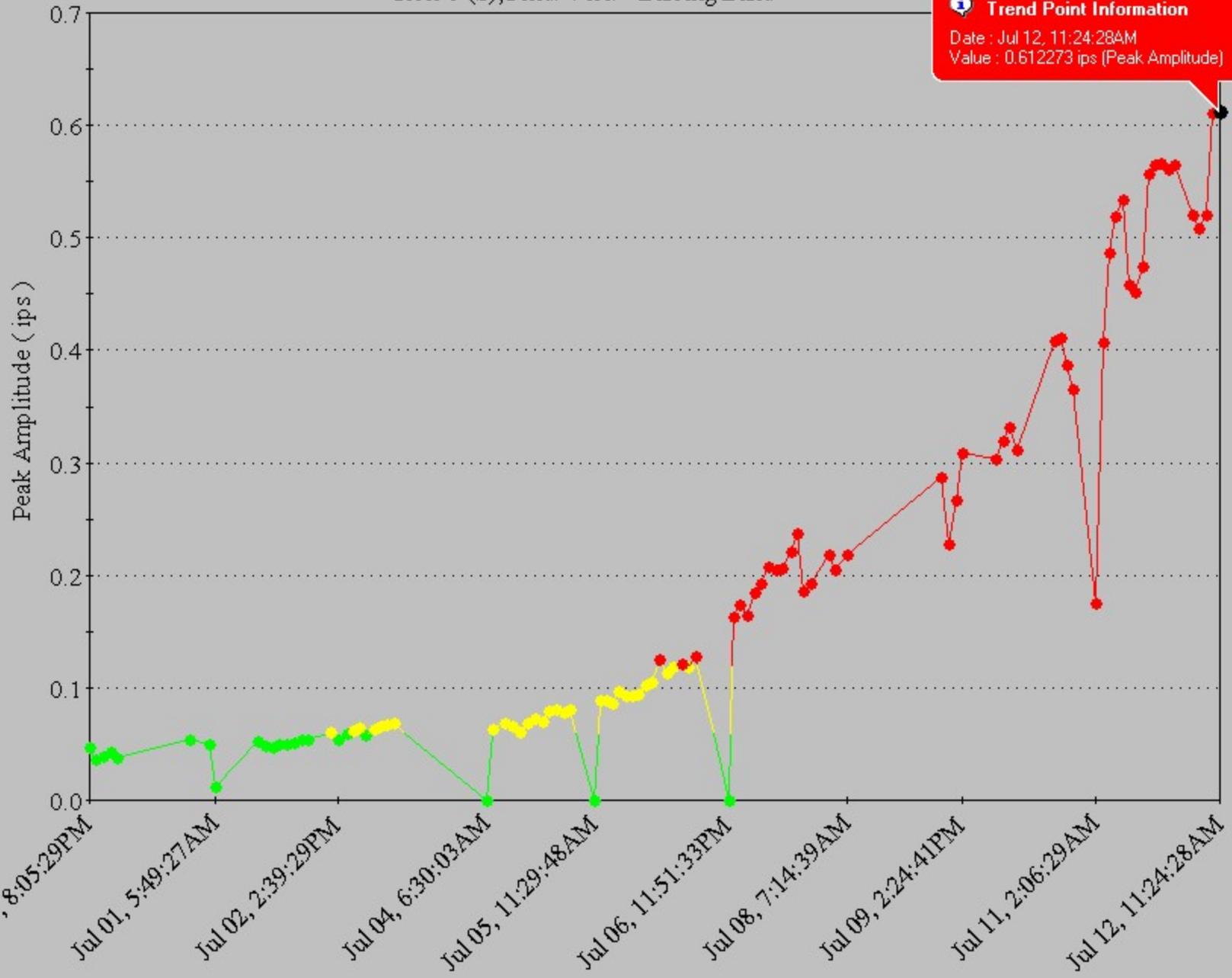


MAXIMUM LOAD
500 kg (1000 lbs)
OR 5 PERSONS AND
EXTRA LOAD

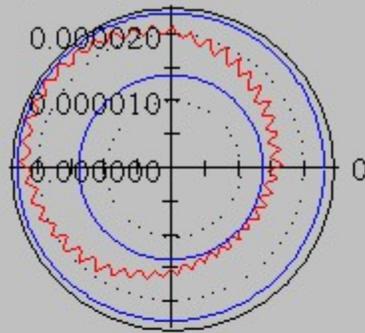


Roll 8 (S),Tend. Vert. - Barring Band

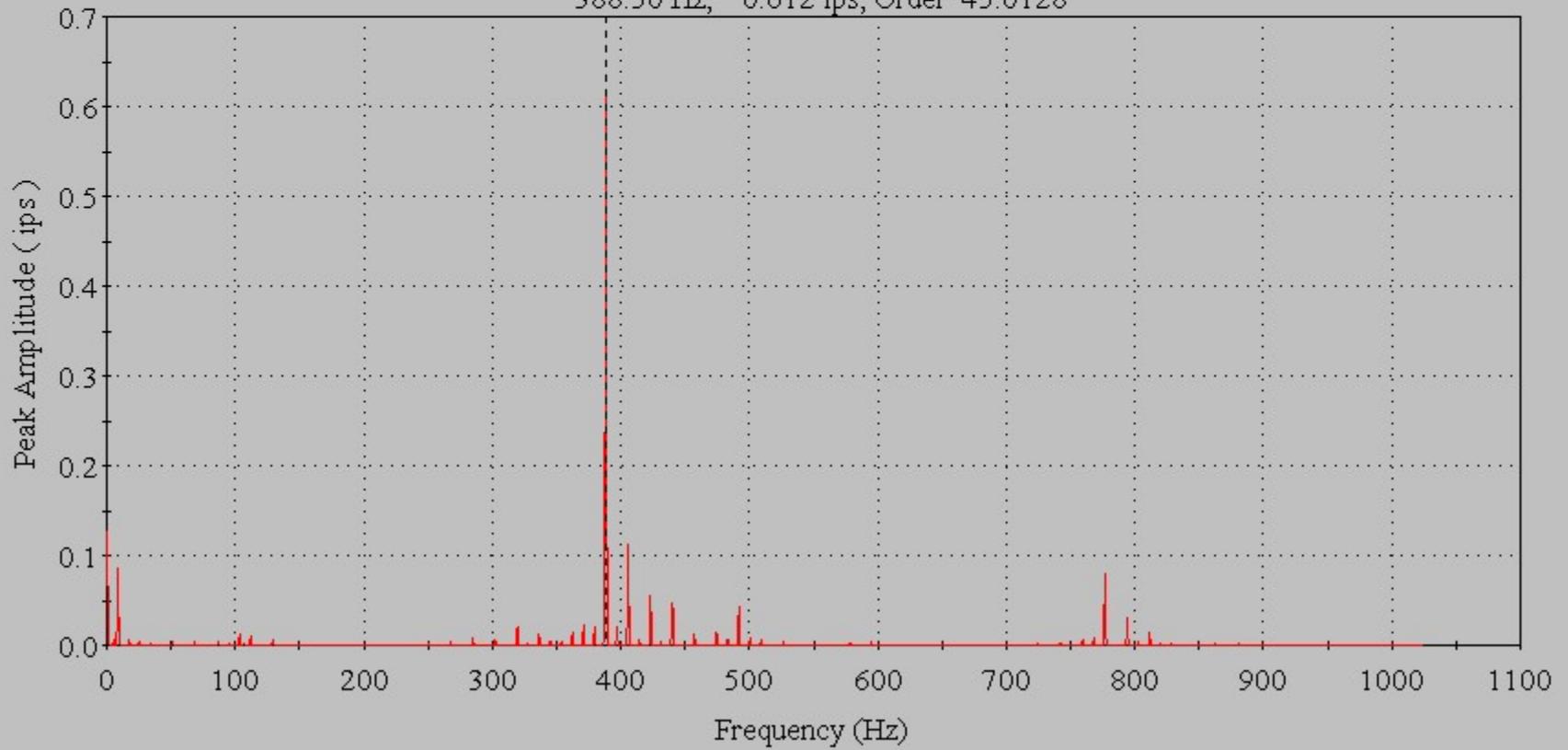
Trend Point Information
Date : Jul 12, 11:24:28AM
Value : 0.612273 ips (Peak Amplitude)

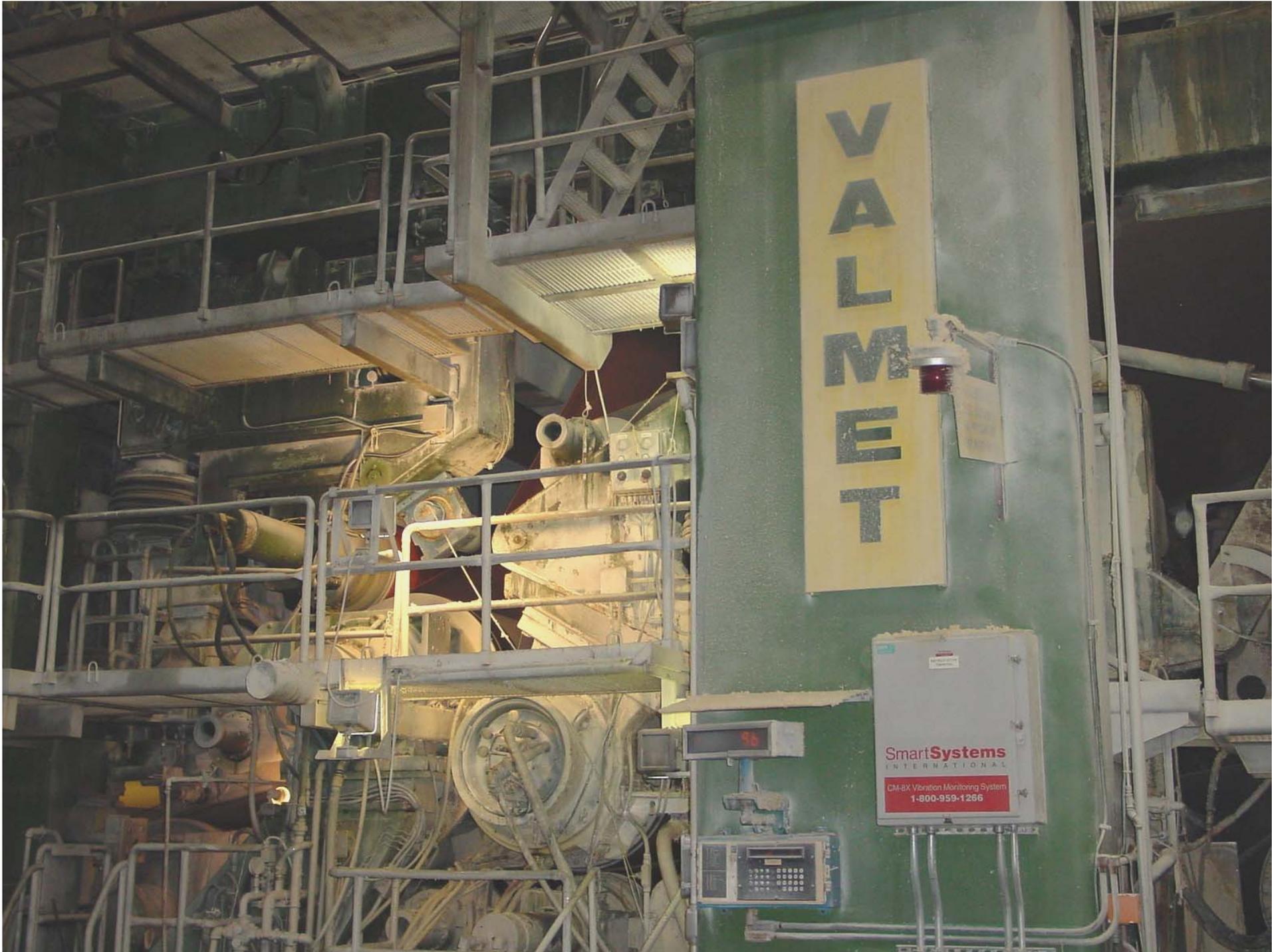


Roll 8 (S),Tend. Vert. (Jul 12, 11:24:28AM) - Polar - Amplitude (in)



388.50 Hz, 0.612 ips, Order 45.0128





VALMET

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INTERNATIONAL

CM-8X Vibration Monitoring System
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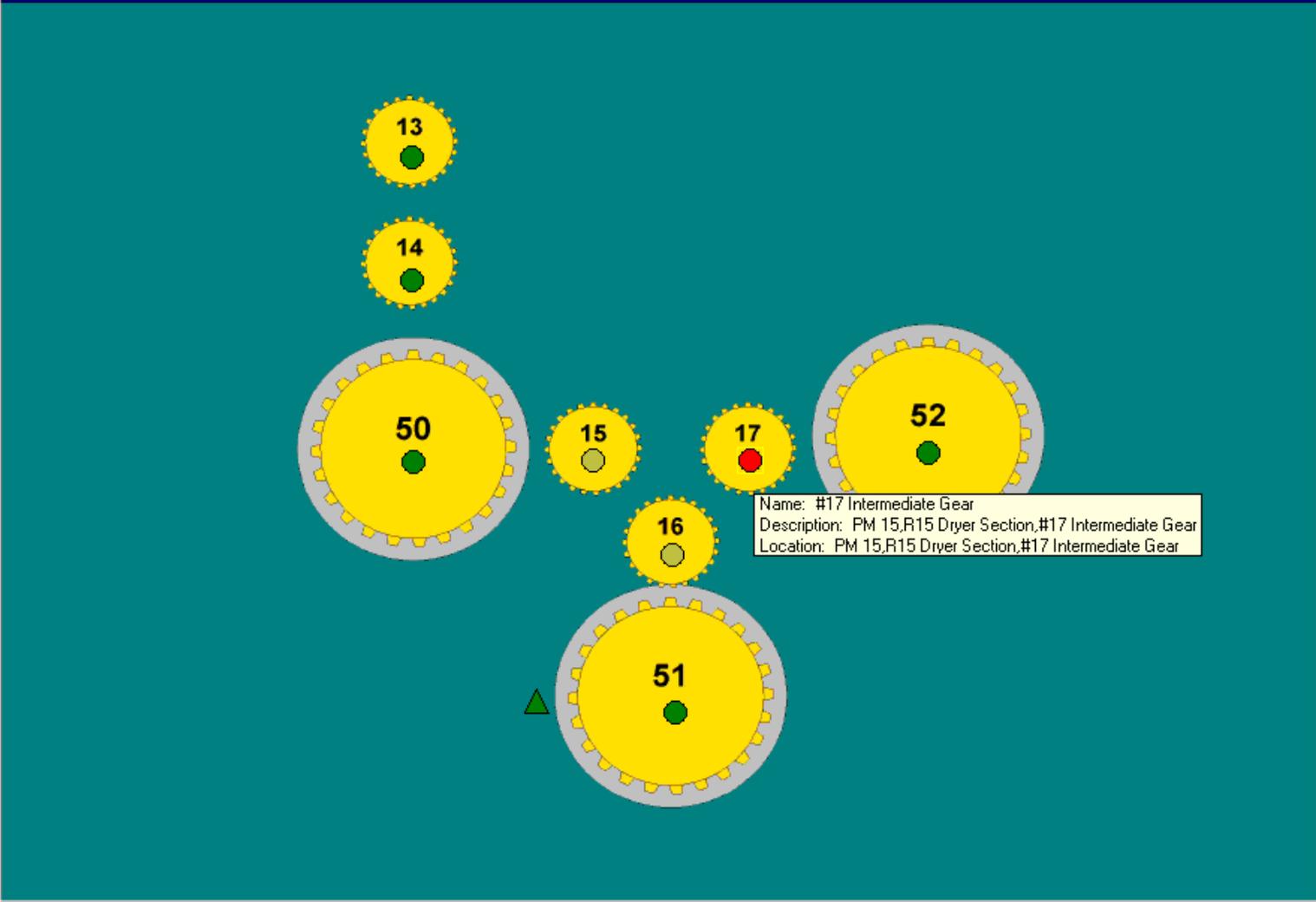
TOC

Name
Dryer 50 and Gears
Headbox
Press Section
Vacuum Pumps
1st Dryer Section
2nd Dryer Section
3rd Dryer Section
4th Dryer Section
Press Section Diagnos.



SmartSystems INTERNATIONAL

DRYER CAN 50 - DRIVE SIDE



AS5001 - pcAnywhere

SpectraScope (TM) Predictive Maintenance Operator Station - [Band View - [PM 15,R15 Dryer Section,#17 Intermediate Gear]]

File View Display Options Options Help

TOC

Name
Driver 50 and Gears
Headbox
Press Section
Vacuum Pumps
1st Dryer Section
2nd Dryer Section
3rd Dryer Section
4th Dryer Section
Press Section Diagnos.

PM 15,R15 Dryer Section,#17 Intermediate Gear - Jun 19, 3:00:27PM

Frequency (Order)	RMS Amplitude (in/s)
0 - 100	0.085
100 - 185	0.21
185 - 370	0.045

Tuesday, June 19, 2001 3:07 PM

Start SpectraScope (TM) P... 3:07 PM

AS5001 - pcAnywhere

SpectraScope (TM) Predictive Maintenance Operator Station - [Trend View - [PM 15,R15 Dryer Section,#17 Intermediate Gear]]

File View Display Options Options Help

TOC

- Name
- Driver 50 and Gears
- Headbox
- Press Section
- Vacuum Pumps
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Press Section Diagnos.

PM 15,R15 Dryer Section,#17 Intermediate Gear - 50.5X TO 100.5X

RMS Amplitude (in/s)

Date: Jun 19, 3:00:27PM
Value : 0.2091

Date/Time	RMS Amplitude (in/s)
Jun 17, 1:00:27PM	0.035
Jun 17, 1:30:27PM	0.030
Jun 17, 2:00:27PM	0.055
Jun 17, 2:30:27PM	0.035
Jun 17, 3:00:27PM	0.070
Jun 17, 3:30:27PM	0.095
Jun 17, 4:00:27PM	0.125
Jun 17, 4:30:27PM	0.115
Jun 17, 5:00:27PM	0.080
Jun 17, 5:30:27PM	0.078
Jun 17, 6:00:27PM	0.075
Jun 17, 6:30:27PM	0.115
Jun 17, 7:00:27PM	0.108
Jun 17, 7:30:27PM	0.068
Jun 17, 8:00:27PM	0.150
Jun 17, 8:30:27PM	0.090
Jun 17, 9:00:27PM	0.190
Jun 17, 9:30:27PM	0.140
Jun 17, 10:00:27PM	0.135
Jun 17, 10:30:27PM	0.088
Jun 17, 11:00:27PM	0.078
Jun 17, 11:30:27PM	0.062
Jun 18, 12:00:27PM	0.078
Jun 18, 12:30:27PM	0.088
Jun 18, 1:00:27PM	0.078
Jun 18, 1:30:27PM	0.130
Jun 18, 2:00:27PM	0.150
Jun 18, 2:30:27PM	0.135
Jun 18, 3:00:27PM	0.105
Jun 18, 3:30:27PM	0.100
Jun 18, 4:00:27PM	0.128
Jun 18, 4:30:27PM	0.208
Jun 18, 5:00:27PM	0.185
Jun 18, 5:30:27PM	0.182
Jun 18, 6:00:27PM	0.162
Jun 18, 6:30:27PM	0.148
Jun 18, 7:00:27PM	0.168
Jun 18, 7:30:27PM	0.132
Jun 18, 8:00:27PM	0.140
Jun 18, 8:30:27PM	0.230
Jun 18, 9:00:27PM	0.150
Jun 18, 9:30:27PM	0.162
Jun 18, 10:00:27PM	0.150
Jun 18, 10:30:27PM	0.230
Jun 18, 11:00:27PM	0.162

Ready

Tuesday, June 19, 2001 3:08 PM

Start SpectraScope (TM) P... 3:08 PM

AS5001 - pcAnywhere

SpectraScope (TM) Predictive Maintenance Operator Station - [Data Viewer]

File View Display Options Options Help

TOC

Name
Driver 50 and Gears
Headbox
Press Section
Vacuum Pumps
1st Dryer Section
2nd Dryer Section
3rd Dryer Section
4th Dryer Section
Press Section Diagnos

PM 15,R15 Dryer Section,#17 Intermediate Gear - Jun 19, 3:00:27PM

Amplitude (in/s²)

Time (sec)

RMS Amplitude (in/s)

Frequency (Hz)

317.05 Hz, 0.0548 in/s, Order 93.0775

Ready

Tuesday, June 19, 2001 3:10 PM

Start SpectraScope (TM) P... EN 3:10 PM

Detailed description: The image shows a software interface for predictive maintenance. The main window displays two plots. The top plot is a time-domain waveform showing vibration amplitude in in/s² over a 1.0-second interval. The amplitude fluctuates between approximately -4000 and 4000 in/s². The bottom plot is a frequency-domain spectrum showing RMS amplitude in in/s versus frequency in Hz. A prominent peak is observed at 317.05 Hz with an amplitude of 0.0548 in/s. The order of this peak is 93.0775. The interface includes a table of contents (TOC) on the left, a menu bar (File, View, Display Options, Options, Help), and a taskbar at the bottom showing the system date and time as Tuesday, June 19, 2001, 3:10 PM.





MACHINE PROFILES

- Name
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Driver 50 and Gears
- Headbox
- Press Section
- Press Section Diagnostic
- R10 1st & 2nd Press Sections
- R10 1st Dryer Section
- R10 2nd Dryer Section
- R10 3rd & 4th Press Sections
- R10 3rd Dryer Section
- R10 Fourdrinier
- TG Set 4
- Vacuum Pumps



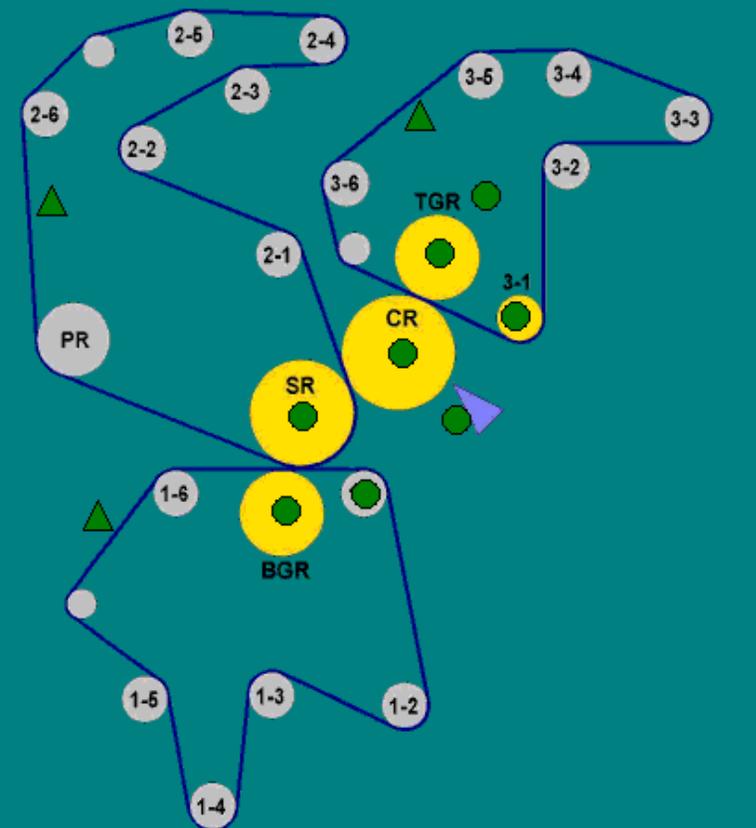
R15 PM PRESS SECTION ROLLS

TENDING SIDE

DRIVE SIDE



Bulb Information
 Name : DSTS01
 Description : PM 15,R15 Press Section,DSTS 01
 Location : R15 Press Section,DSTS 01



MACHINE PROFILES

- Name
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Driver 50 and Gears
- Headbox
- Press Section
- Press Section Diagnostic
- R10 1st & 2nd Press Sections
- R10 1st Dryer Section
- R10 2nd Dryer Section
- R10 3rd & 4th Press Sections
- R10 3rd Dryer Section
- R10 Fourdrinier
- TG Set 4
- Vacuum Pumps

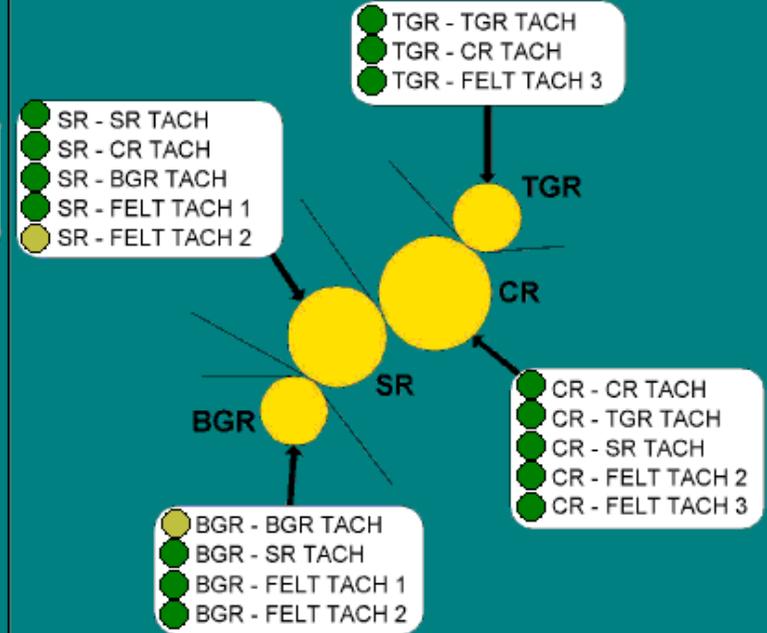
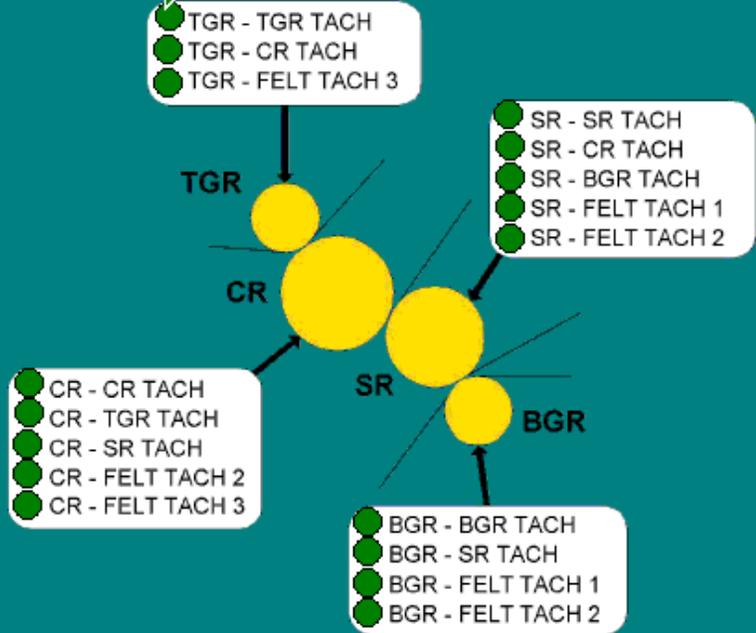


R15 PM PRESS - SYNCHRONOUS TIME AVERAGING

TENDING SIDE

DRIVE SIDE

Bulb Information
 Name : TS Top Grooved Roll - TGR Tach
 Description : PM 15 Diagnostics,R15 TS Press Section TSA,TS Top Grooved Roll - TGR Tach
 Location : R15 TS Press Section TSA,TS Top Grooved Roll - TGR Tach



TOC

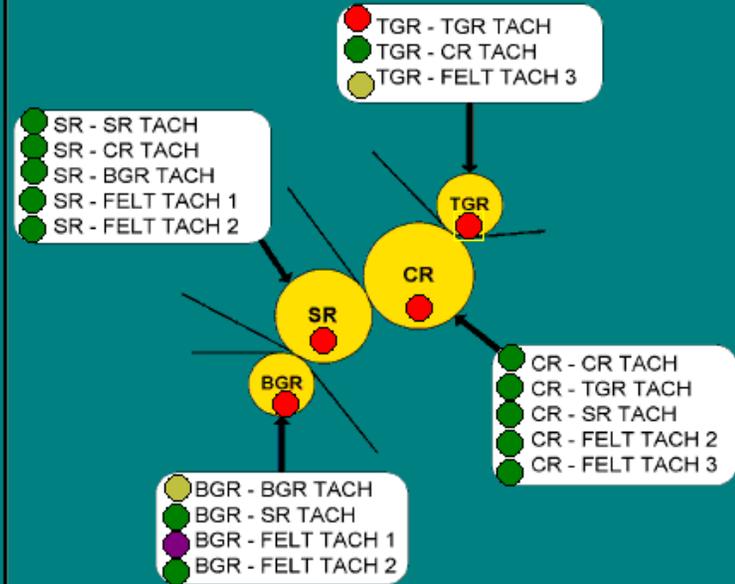
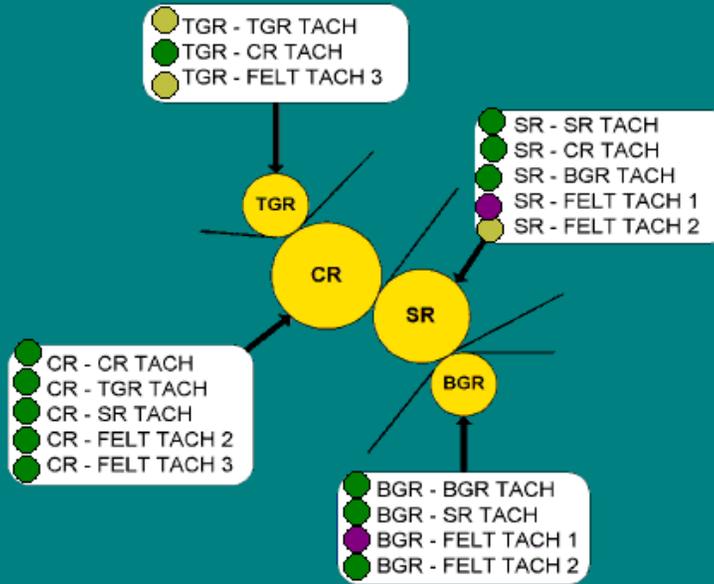
Name
Driver 50 and Gears
Headbox
Press Section
Vacuum Pumps
1st Driver Section
2nd Driver Section
3rd Driver Section
4th Driver Section
Press Section Diagnos.



R15 PM PRESS - SYNCHRONOUS TIME AVERAGING

TENDING SIDE

DRIVE SIDE



Name: DS Bottom Grooved Roll - SR Felt 2 Tach
 Description: PM 15 Diagnostics,R15 DS Press Section TSA,DS Bottom Grooved Roll - SR Felt 2 Tach
 Location: PM 15 Diagnostics,R15 DS Press Section TSA,DS Bottom Grooved Roll - SR Felt 2 Tach



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ARM READY

F5

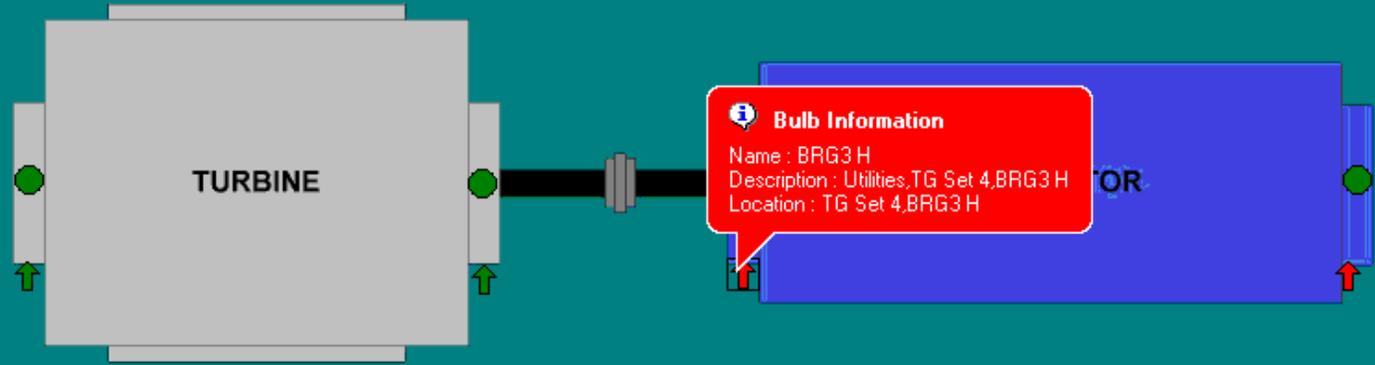
MACHINE PROFILES

- Name
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Dryer 50 and Gears
- Headbox
- Press Section
- Press Section Diagnostic
- R10 1st & 2nd Press Sections
- R10 1st Dryer Section
- R10 2nd Dryer Section
- R10 3rd & 4th Press Sections
- R10 3rd Dryer Section
- R10 Fourdrinier
- TG Set 4**
- Vacuum Pumps



TURBINE - GENERATOR SET 4

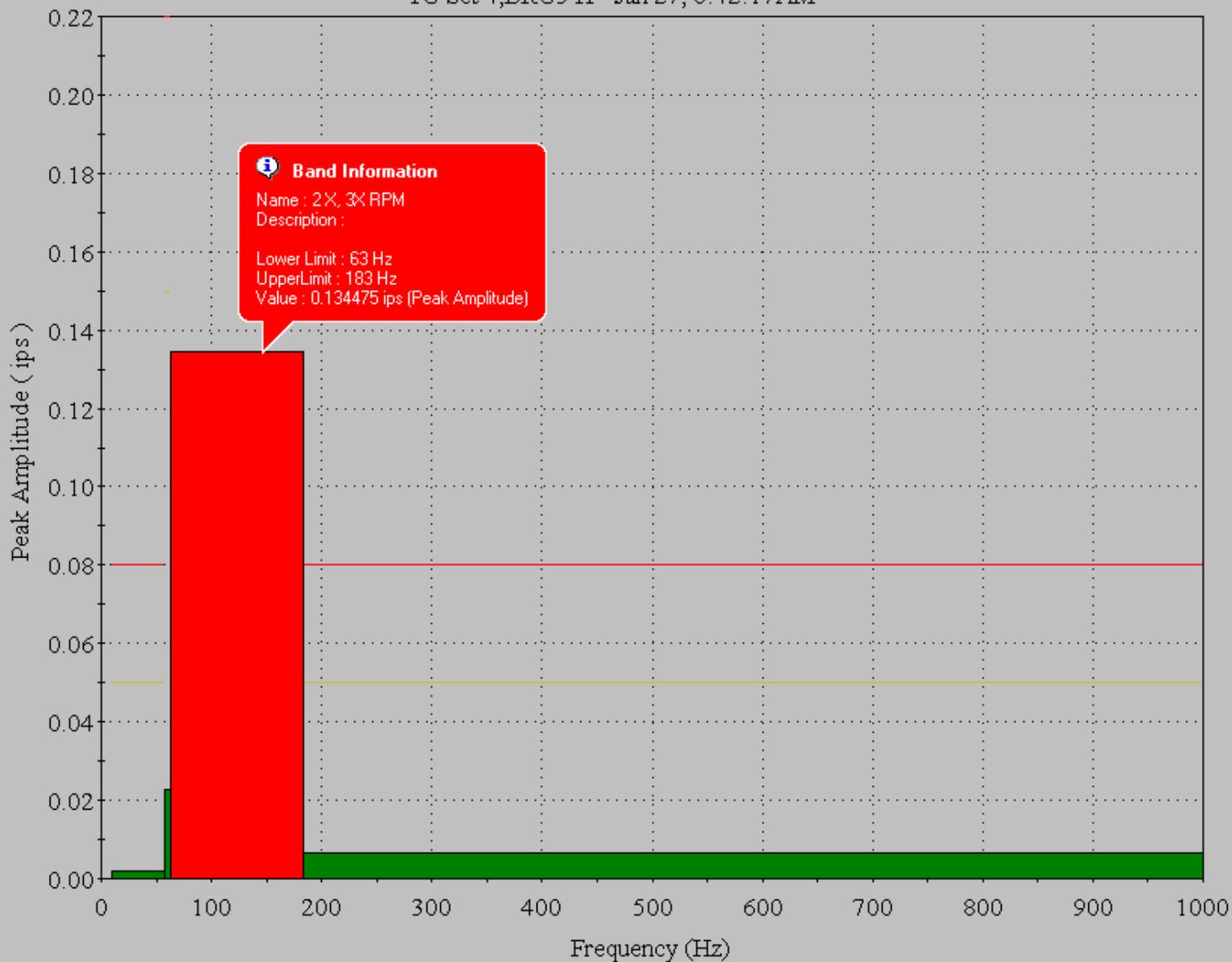
TURBINE - GENERATOR SET 4



MACHINE PROFILES

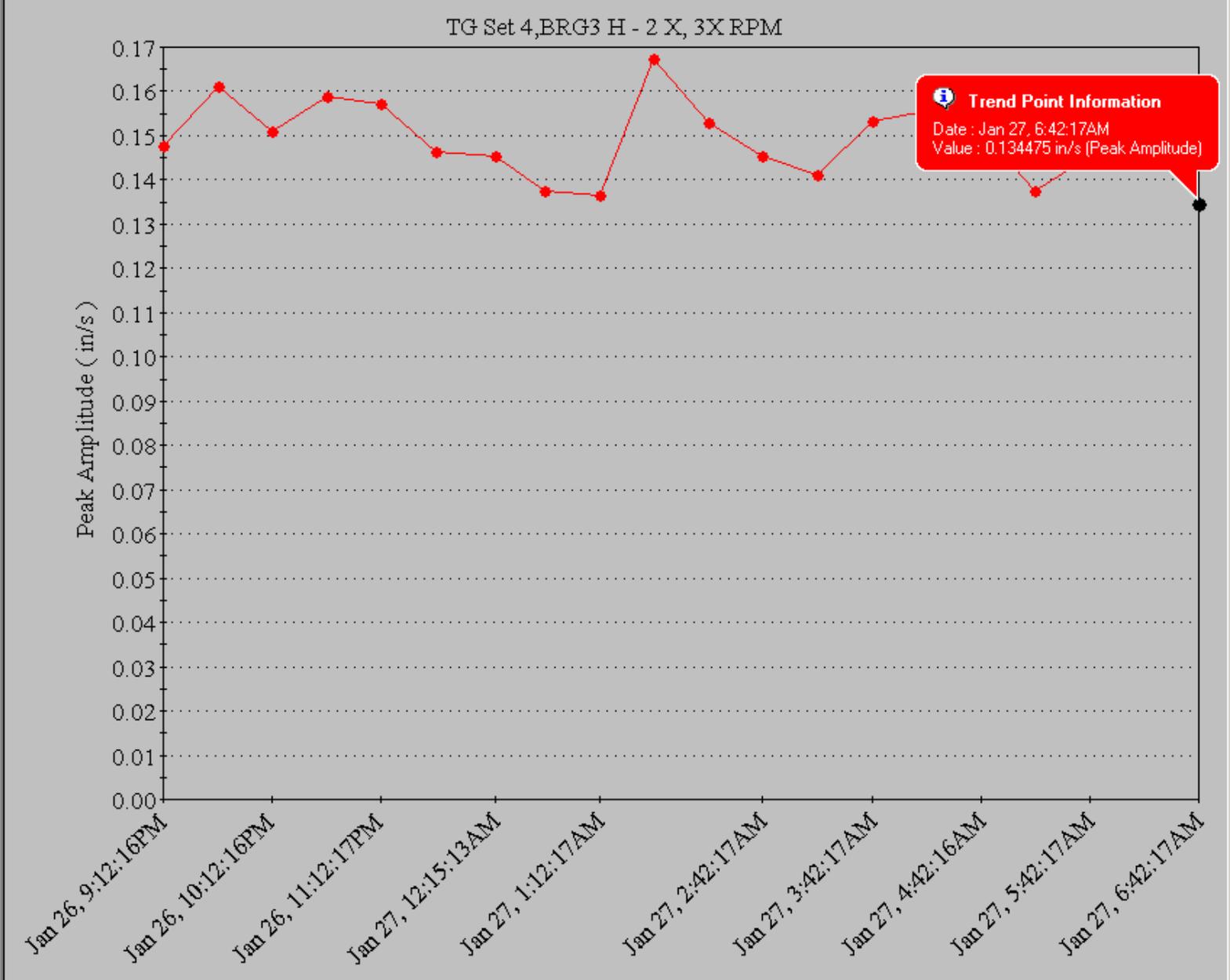
- Name
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Driver 50 and Gears
- Headbox
- Press Section
- Press Section Diagnostic
- R10 1st & 2nd Press Sections
- R10 1st Dryer Section
- R10 2nd Dryer Section
- R10 3rd & 4th Press Sections
- R10 3rd Dryer Section
- R10 Fourdrinier
- TG Set 4
- Vacuum Pumps

TG Set 4,BRG3 H - Jan 27, 6:42:17AM



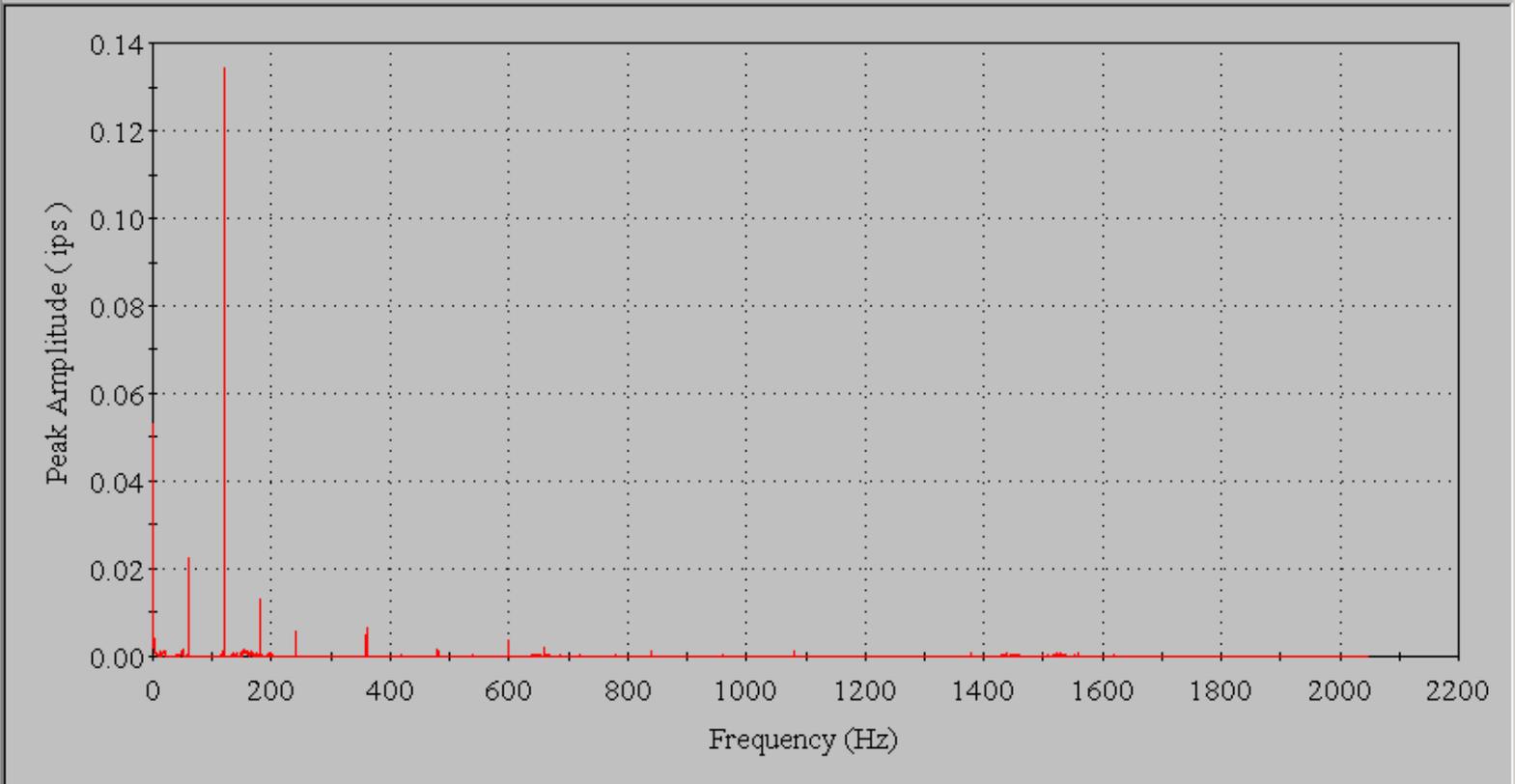
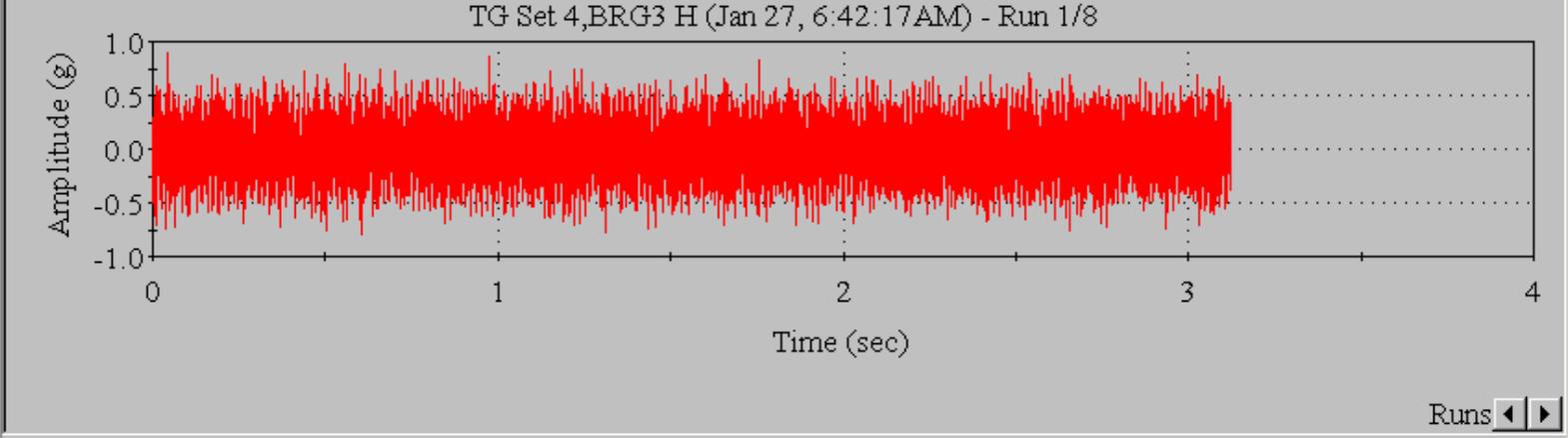
MACHINE PROFILES

- Name
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Driver 50 and Gears
- Headbox
- Press Section
- Press Section Diagnostic
- R10 1st & 2nd Press Sections
- R10 1st Dryer Section
- R10 2nd Dryer Section
- R10 3rd & 4th Press Sections
- R10 3rd Dryer Section
- R10 Fourdrinier
- TG Set 4
- Vacuum Pumps



MACHINE PROFILES

- Name
- 1st Dryer Section
- 2nd Dryer Section
- 3rd Dryer Section
- 4th Dryer Section
- Driver 50 and Gears
- Headbox
- Press Section
- Press Section Diagnostic
- R10 1st & 2nd Press Sections
- R10 1st Dryer Section
- R10 2nd Dryer Section
- R10 3rd & 4th Press Sections
- R10 3rd Dryer Section
- R10 Fourdrinier
- TG Set 4
- Vacuum Pumps

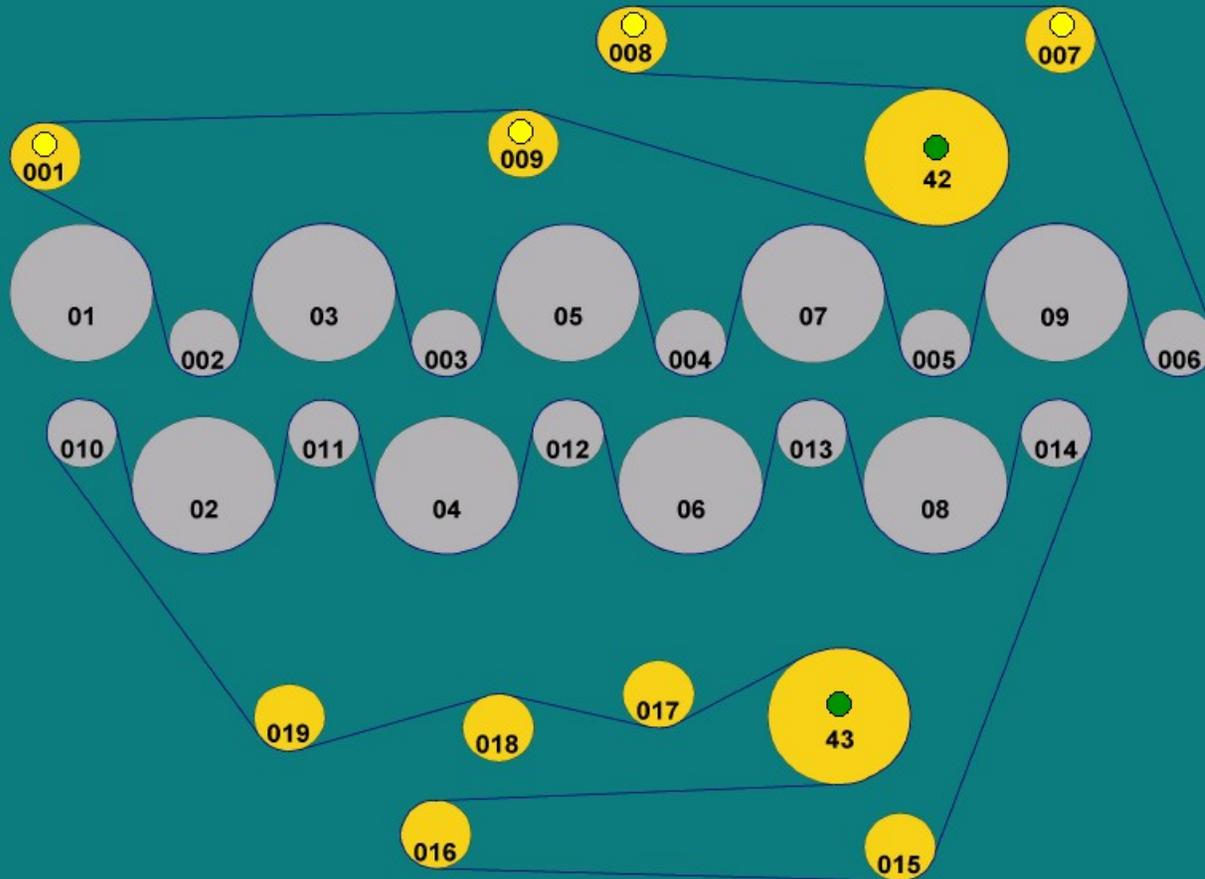


TOC

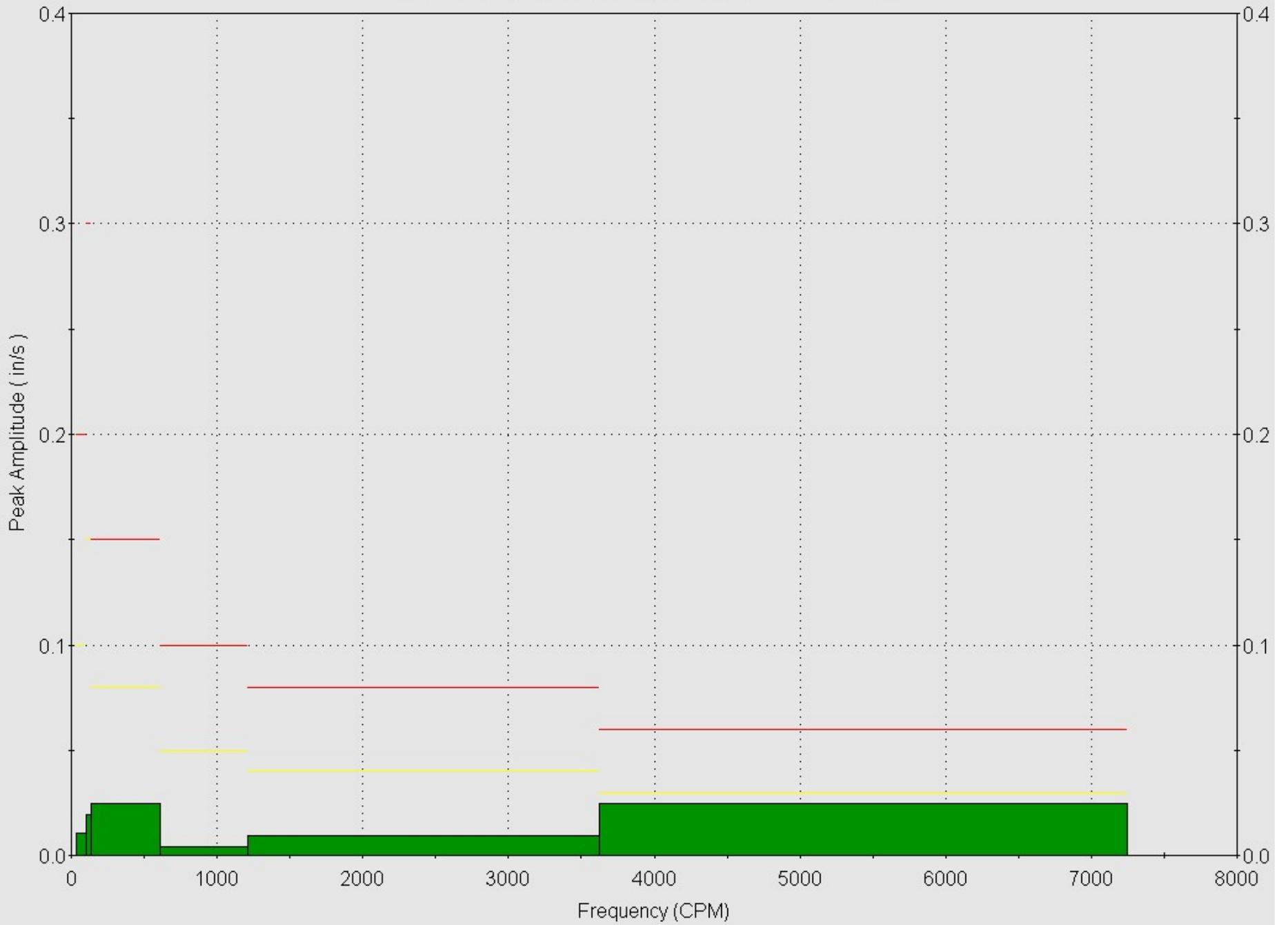
Name
1st Dryer Section
2nd Dryer Section
3rd Dryer Section



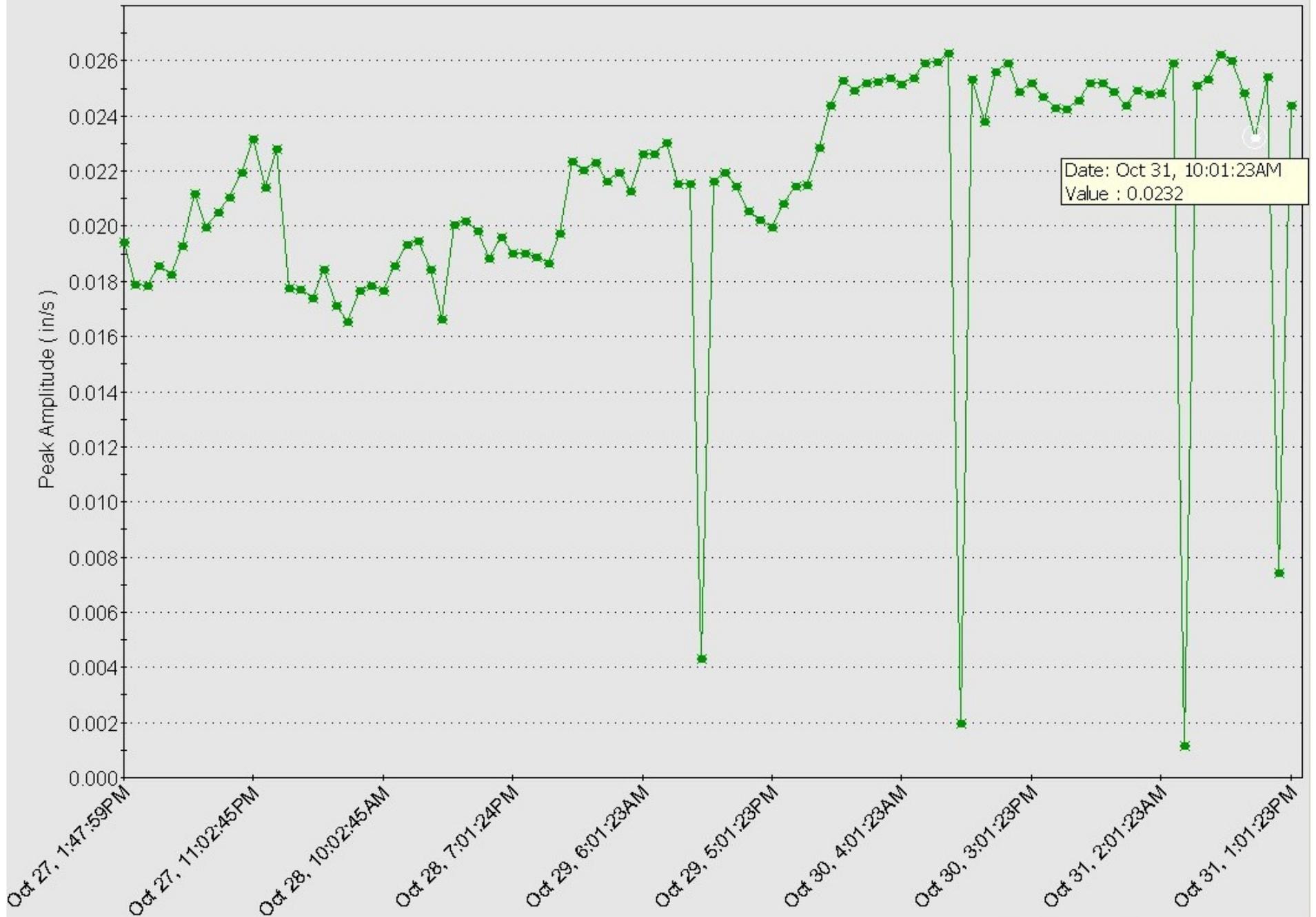
PM2 - DRYER SECTION 1



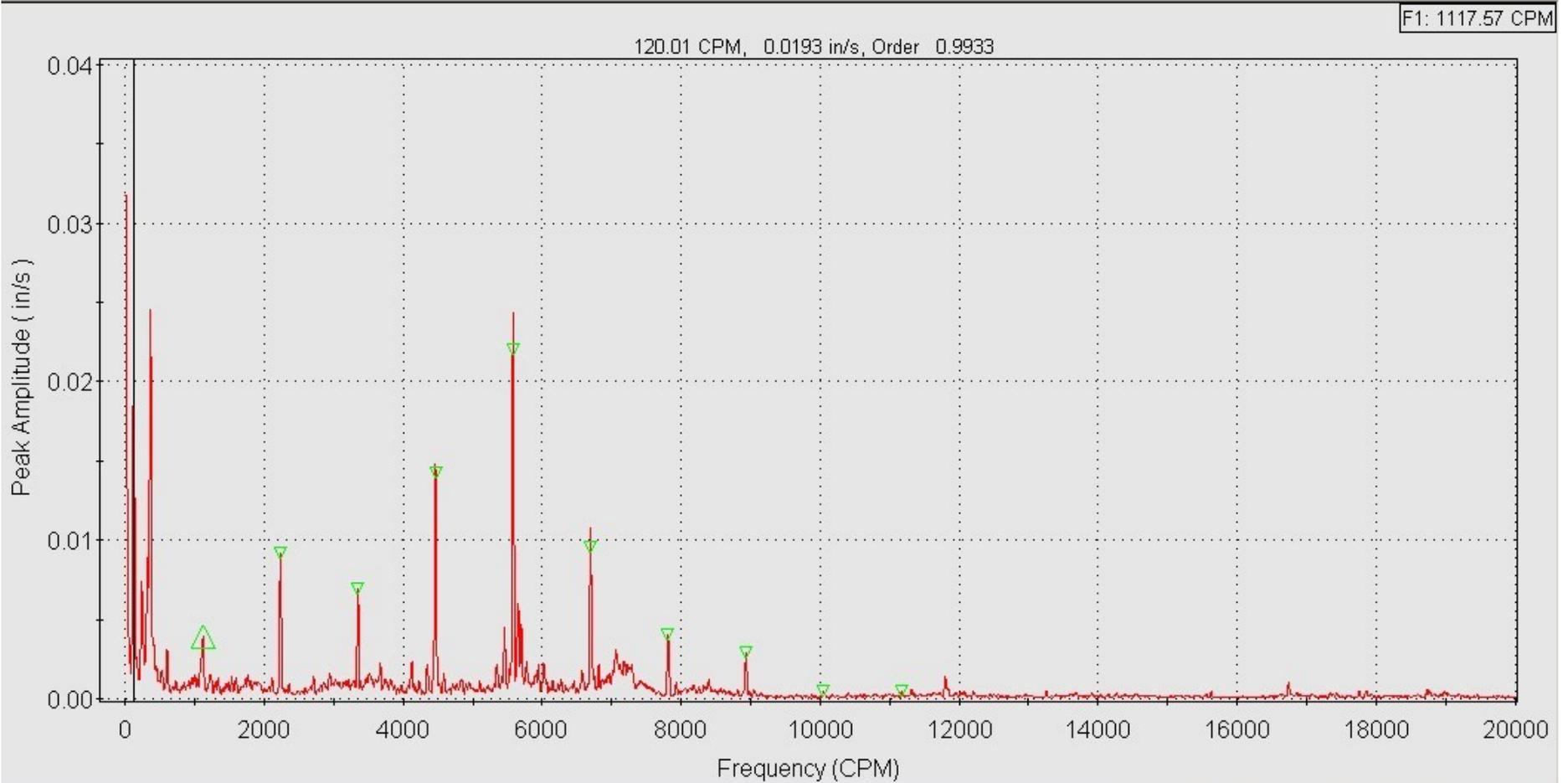
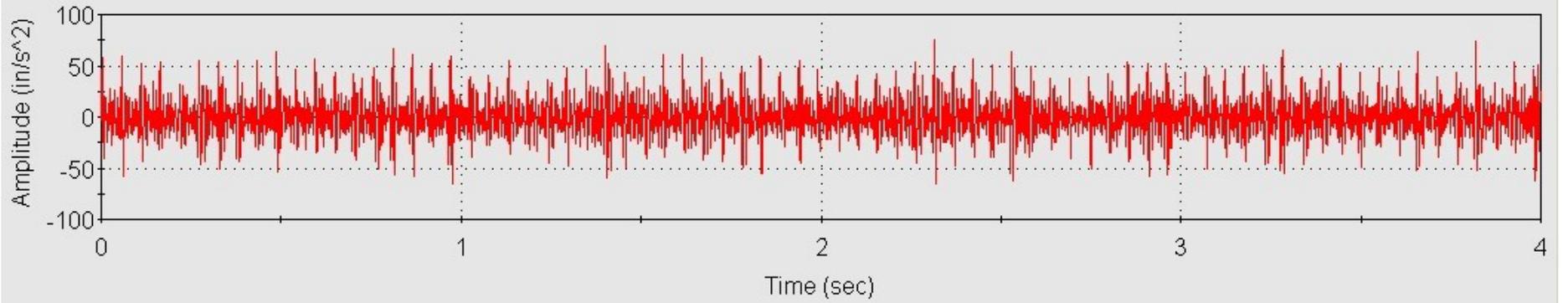
PM#2, Dryer Can 43, DS Axial - Oct 31, 1:01:23PM



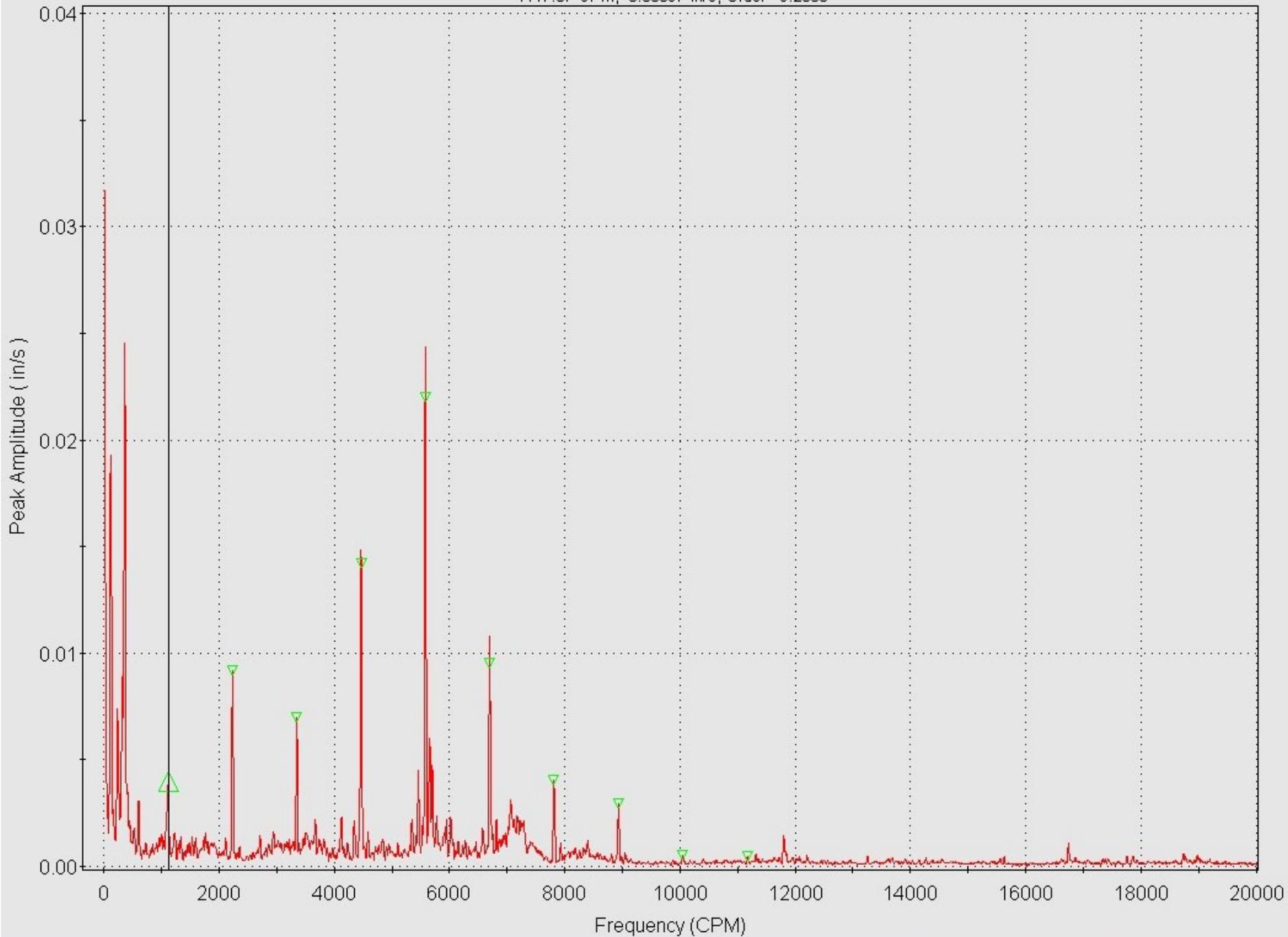
PM#2, Dryer Can 43, DS Axial - bearing upper harmonics



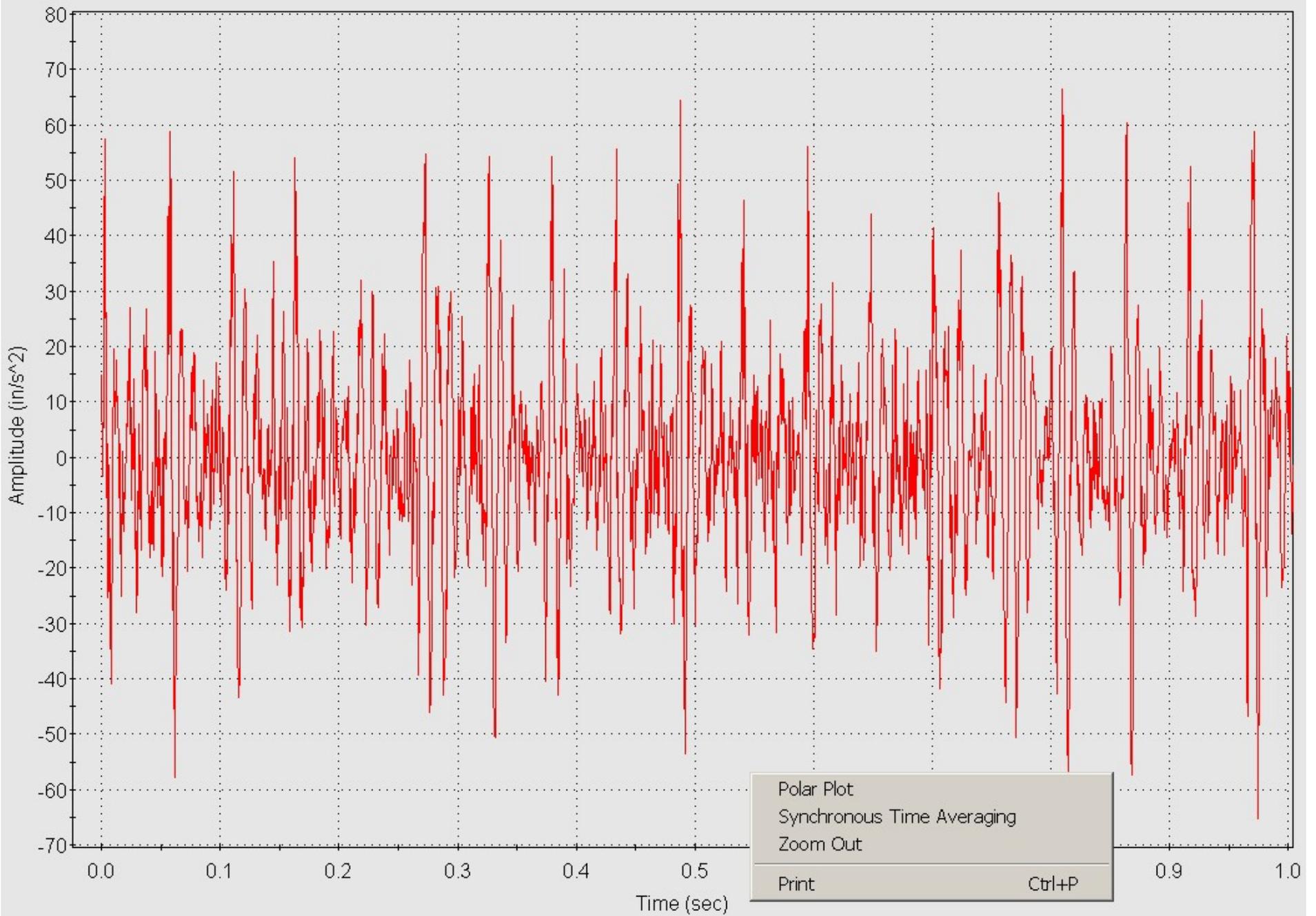
PM#2, Dryer Can 43, DS Axial - Oct 31, 1:01:23PM Run 1/4



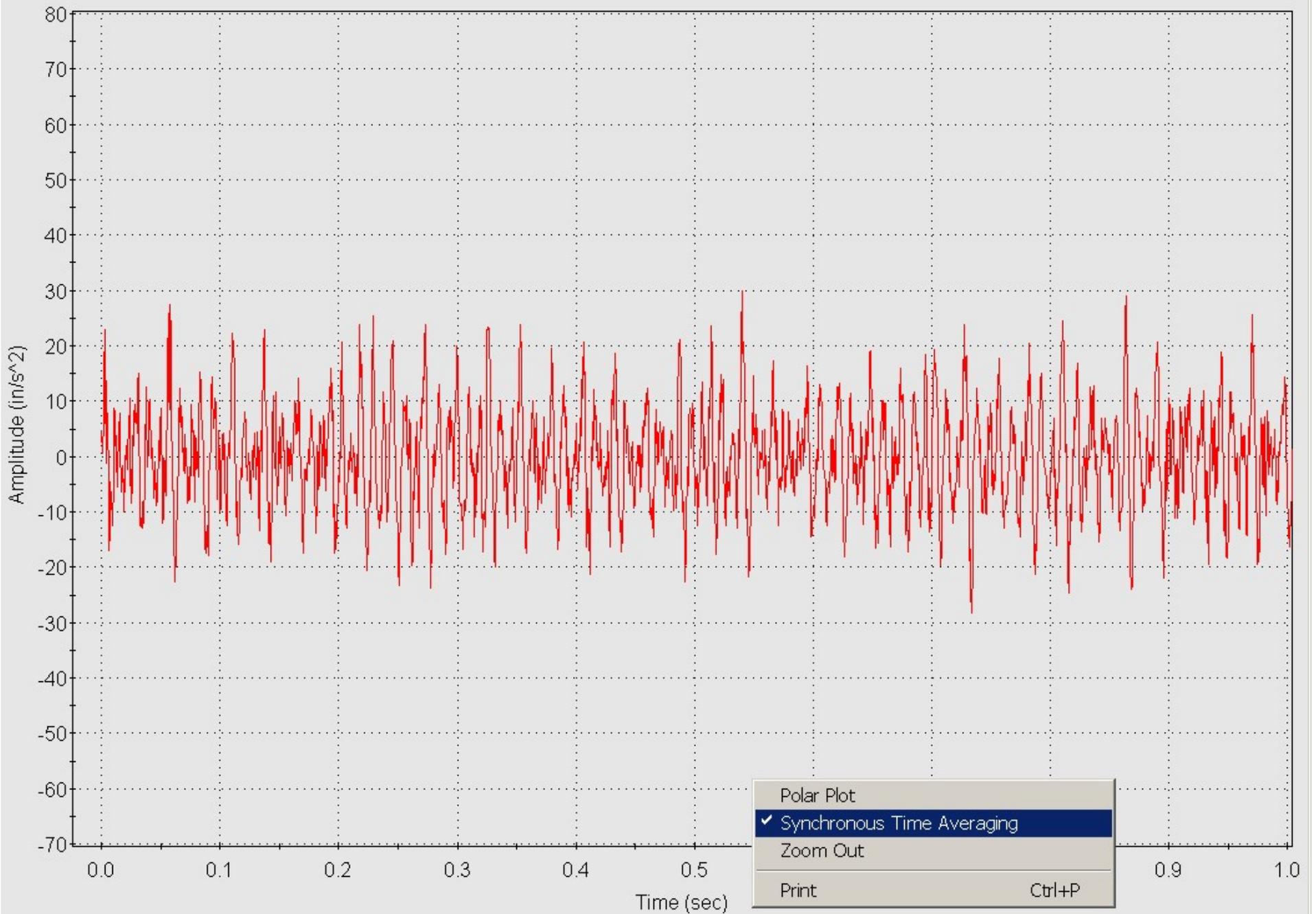
1117.57 CPM, 0.00397 in/s, Order 9.2505

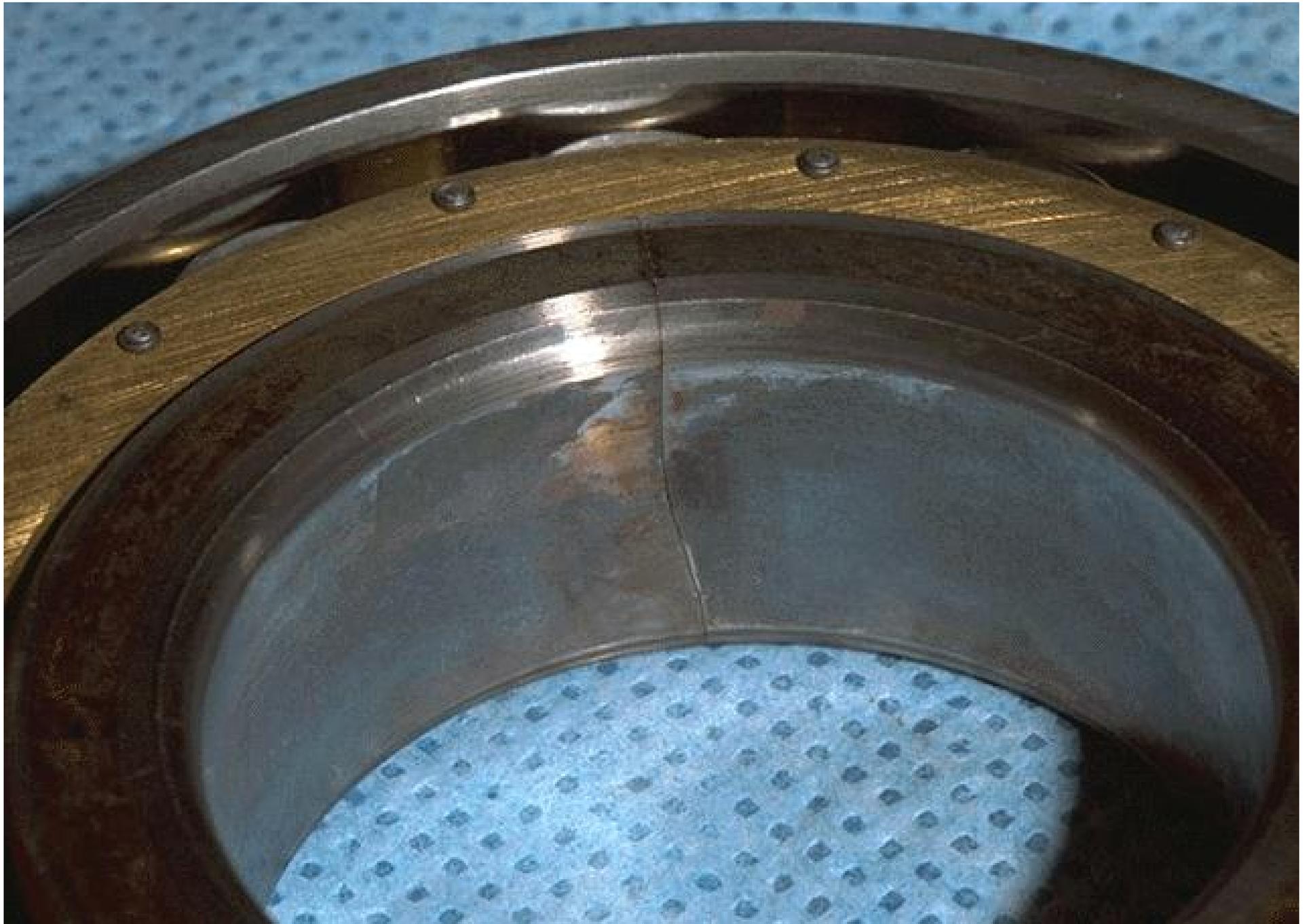


PM#2, Dryer Can 43, DS Axial - Oct 31, 1:01:23PM Run 1/4

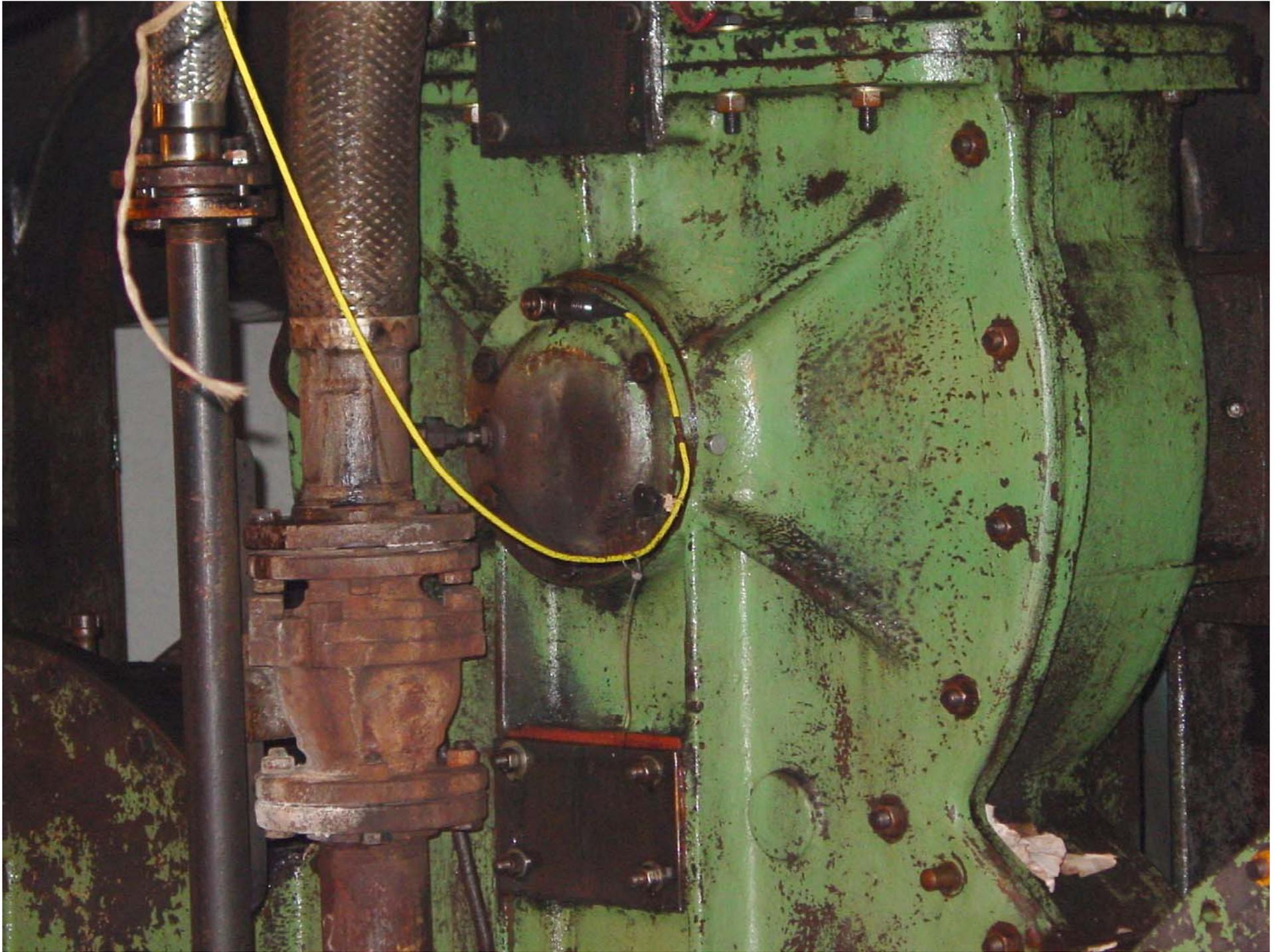


PM#2,Dryer Can 43,DS Axial - Oct 31, 1:01:23PM













Practical On-Line Vibration Monitoring for Papermachines

→ Thanks to ...



Practical On-Line Vibration Monitoring for Papermachines

→ Thank-You !

WORK SAFE

A thick, horizontal red brushstroke underline is positioned beneath the text 'WORK SAFE', extending across most of the width of the text.