NUCLEAR POWER PLANTS – I & C

by

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Nuclear Power Plants

- Steady increase in energy requirements (primarily electricity)
- Greater awareness of need to address global warming
- No single technology can meet electricity demands and reduce production of “greenhouse” gases
- Nuclear power plants must play a significant role
  - Maintain existing and develop new cost-effective electricity generating plants

International NPP Scenario 1/2

- 30 countries have 436 operating NPPs producing 372 GWe.
- Number of NPP units under construction is 44 representing 38 GWe total electrical capacity
- Number of NPP units planned in major countries (USA - 31, China - 25, Japan - 9, Russia - 6, Korea - 5)
- NPP operating licence beyond 60 *(requires I&C modernization)*

International NPP Scenario 2/2

- 61 more countries interested in launching new NPP have requested support from IAEA on what they need to do to have nuclear power (Africa 20, Latin America 12, Asia Pacific 20, Europe and FSU 9).
- *(All new plants based on digital I&C and HSI technology)*

Current Nuclear Regime in India

- Indigenous Program
  - Safeguarded Reactors
  - Unsafeguarded Reactors
- Program to import reactors
  - (Safeguarded) nuclear parks
    - Negotiations under way

Imports for use in Nuclear Facilities

- Safeguarded Facilities
  - Unrestricted imports permitted
- Unsafeguarded Facilities
  - End Use Issues

- Focus on indigenization

NPP Capacities in India

- PHWR Program
  - 18 operating NPPs (capacity 4460 MWe), 1 under construction (220 MWe)
  - 4 plants (700 MWe each) launched, 6 under launch
- LWR Program (Imported)
  - Five major nuclear parks (up to 10GWe each)
- LWR Program (Indigenous)

Nuclear Industry

- Heavily Regulated Industry (in every country)
  - Regulatory permissions required at each stage of design, construction and operation

I&C in Nuclear Industry

- Rapid advances take place in electronics *(better efficiency, reliability, lower costs)*
- However, there is a time gap between **introduction** and **usage** of new technologies because of i) long lead times, and, ii) conservative attitudes in the nuclear industry
- Nuclear industry had a long lean period so most plants are of 60s and 70s vintage (except in India, China, France)

I&C Technologies

- Sense, Regulate, Protect
- Plant I&C implemented in a layered configuration:
  - Field Instrumentation
  - Field Communication
  - Process Monitoring and Control Systems
  - Human System Interface

I&C - Emerging Technologies

- Field Instrumentation
  - Smart Transducers
  - MEMS based technologies
- Field Communication
  - Digital fieldbus (wired)
  - Digital (wireless)

Digital I&C – Emerging Technologies

- Improved accuracy of computation, reduction of panel instrumentation, absence of drift, self diagnostics ……

- However, issues with complex devices (modern processors, FPGA, CPLD)
- Issues of Verification and Validation
  - Extensive documentation
  - Exhaustive Reviews

HSI - Emerging Technologies

- Provides superior operator interface with introduction of soft screen displays (and often, controls)
- Operator Support Systems
  - Intelligent aids to reduce workload and likelihood of human errors
- Computerized Procedures

Digital I&C in TAPP-3,4, KG-3,4 RAPP-5,6

- All major Control, Monitoring, Test & Surveillance and Operator Information functions are CBS.
- Some protection functions use microprocessors
- Information from these systems and from stand alone controllers & recorders sent to a Computerized Operator Information System (COIS) through Gateways
- Information from COIS sent over VSAT to HQ

Support Issues for Digital I&C 1/2

- Systems are required to be supported for their life span
- Changes are required due to:
  - Operational feedback
  - Regulatory requirements
  - Hardware obsolescence

Original developers move on to other challenges

Support Issues for Digital I&C 2/2

- Operating stations of differing vintage to be supported in-house
- Implementation of the system for the same function varies with station reflecting the state of the art at that time
- Large variety of prototypes are required Leads to high resource requirements: Cost, Space, Manpower

Design Considerations for future 1/2

- Control Rooms need to be made compact with view to:
  - Ease Operation and Monitoring
  - Improve Communication between operators
  - Provide seated operation (effective in enhancing team work)
- Information has to be structured at plant, system and component level
- Introduce Operator Support functions, particularly prioritized Alarm Reporting

Design Considerations for future 2/2

- Use of DCS is virtually integral to design of Compact Control Room
  - Replaces autonomously operating functionally distributed systems, reduction of display screens
  - Complete overview of plant processes
  - Reduction in cabling, networking, terminations
- Large Display Panel allows faster operator assessment of situation

SCHEME-2 (3-D VIEW)

Thank you

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SINTROL
Dust control with a difference

Saving money by dust monitoring after ESPs

in coal fired power stations

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ISA (D) POWAT 2010
May 28 - 29, 2010, Mumbai

Introduction

Dust removing

Regulations – environment

Loss of (expensive) product

Dust monitor is your eyes

Understand how changing process conditions influence on ESP operation

Optimise power usage

Optimise hammering

Changing from coal grade A to coal grade B

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Problems with dust monitors

Optical dust monitors have been used after ESPs

High maintenance costs

Replacement of the light-source even twice a year

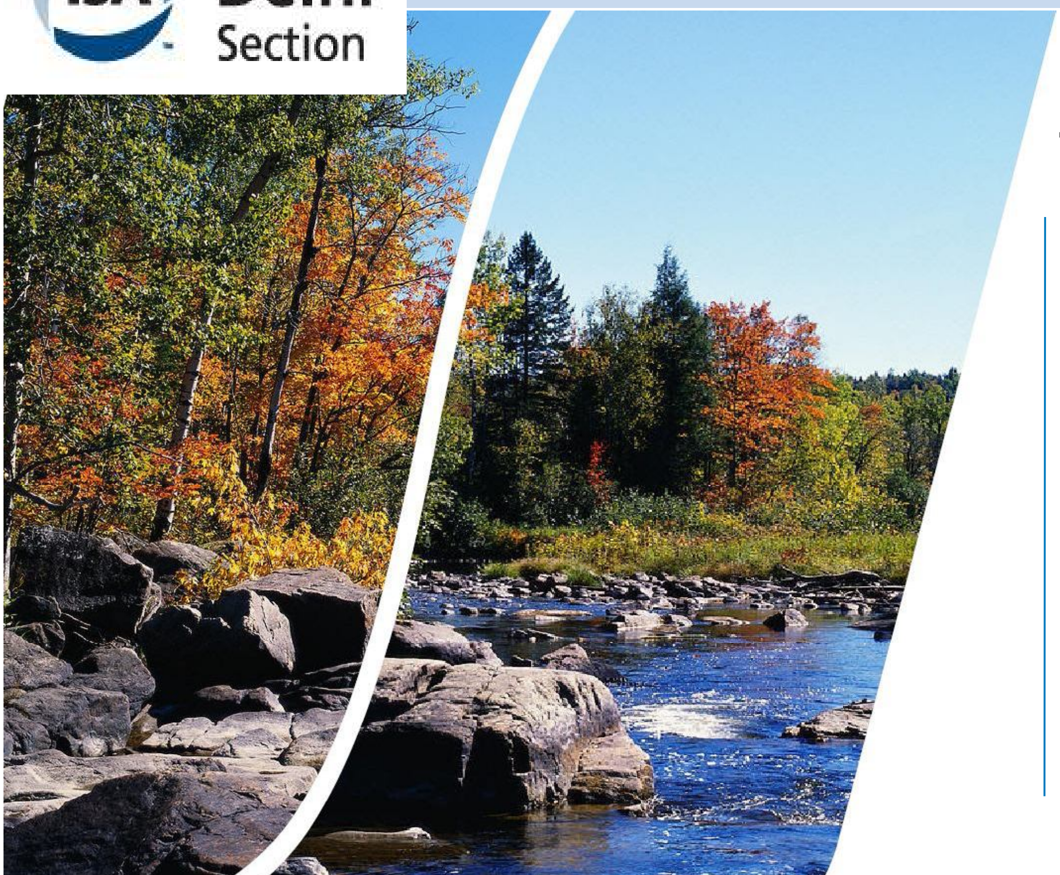
Vibration: optics & electronics

Clean dry air for purging: compressed air not available & ambient air too dirty

SINTROL

Dust monitors

Optical	Triboelectric / electrodynamic
High investment costs	Less expensive
High maintenance costs	Maintenance usually low
Low usability due to lack of maintenance	Unreliable measurement – non-working



ESPY – solution to the problem

Target of project:

Reduce investment costs to a minimum

Reduce maintenance costs to a minimum

Reliable measurement – availability 365 days

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Chose triboelectric technology

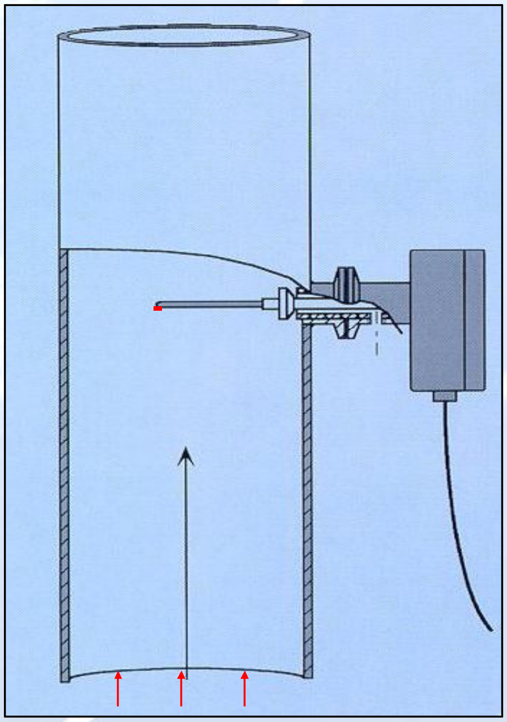
Problems to be solved:

Influence of the electromagnetic field

Influence of the dust build-up on the probe

Influence of the charged particles

Why measure dust?



Measuring principale

When solid particles impact an isolated metal probe, or pass nearby, they emit a charge to the probe

The charge is amplified and converted output signal proportional to dust concentration

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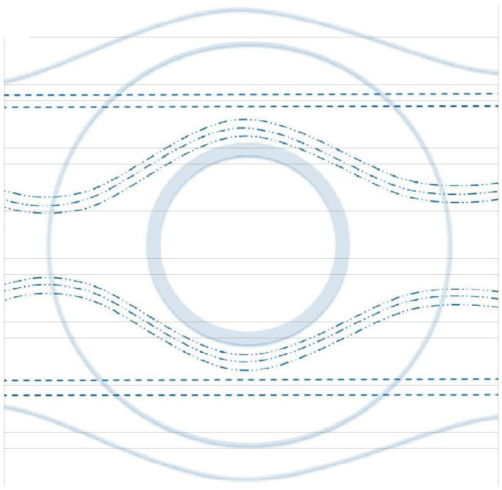
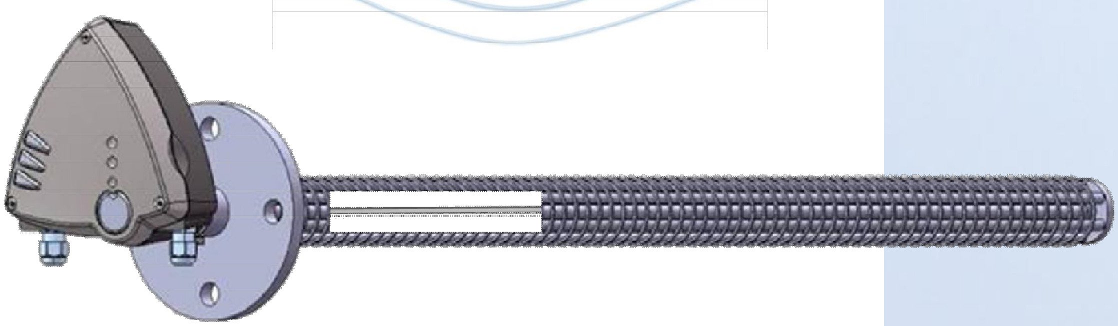
Solution for electromagnetic field





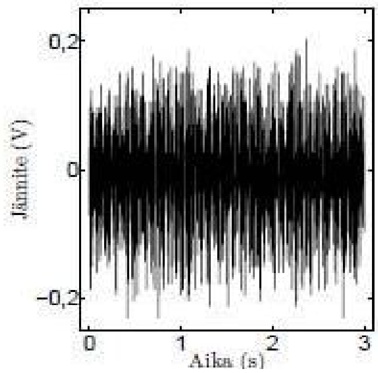
Farady cage

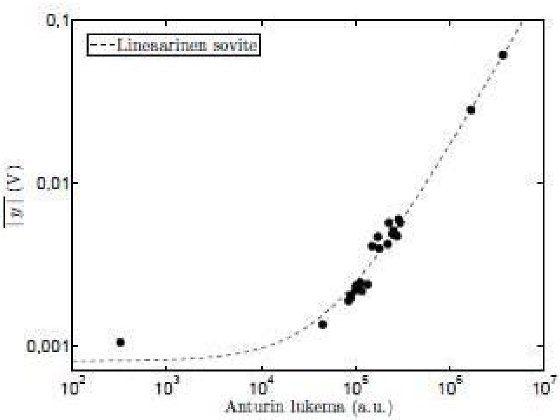
Solution for dust build up

Build up creates maintenace demand.

Coating the probe

Solution for charged particles

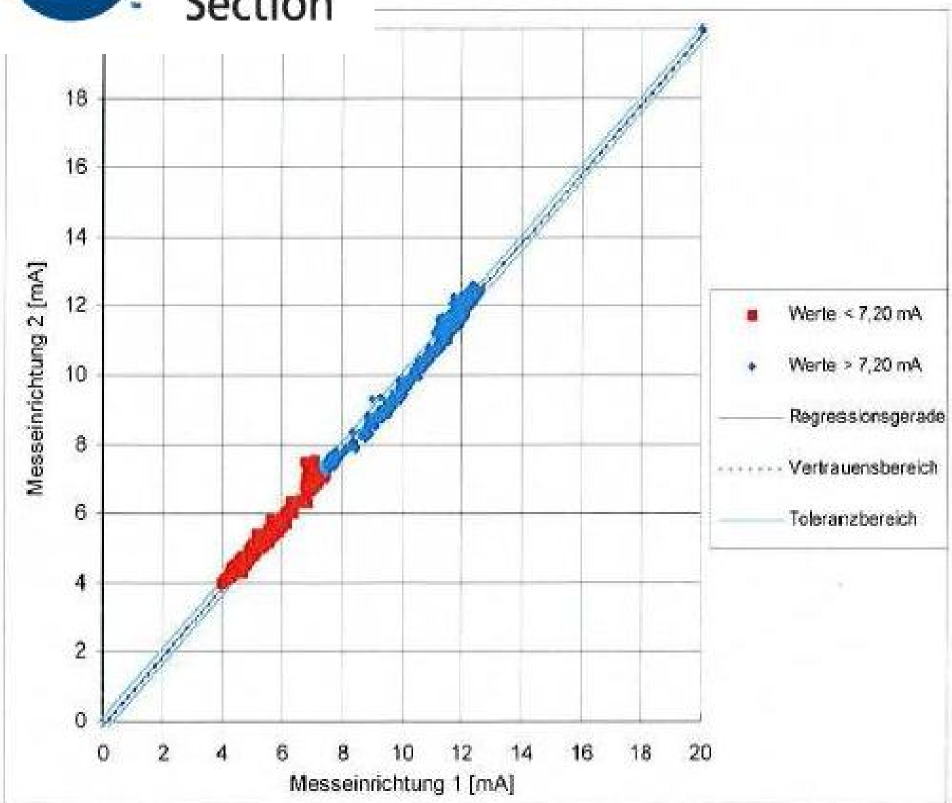




- Separating signals into AC and DC components and noise suppression
- Finding algorithm how to remove noise from the instrument signal

Also solved drift and affect of other changing process parameters

Results



- Designed for rugged and demanding applications
- Reliable and accurate readings after ESP

Know the dust removing process!

Application examples – case 1

Coal fired power plant in Hebei

Process parameters:

T = 130 C
p = 530 Pa
Dust = 83 mg/m3
L = 500 mm
Dia = 5m
Distance = 6m from ESP
After the fan

One ESP supplier supplied 4 Sintrol ESPYs to this coal fired power plant. All four units have operated without a problem since installation.

Application examples – case 2

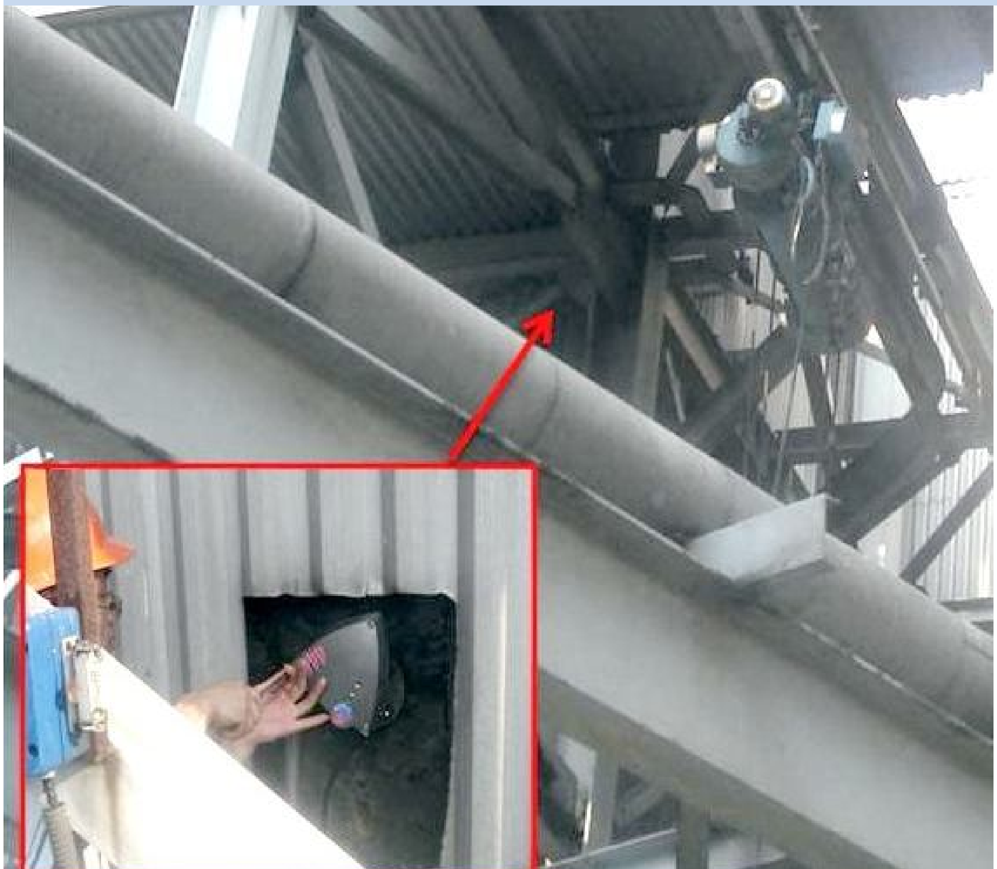
Coal fired power plant in Henan

Process conditions:

T = 95 C
p = -180 Pa
Dust = 70 mg/m3
L = 500 mm
Dia = 4.25 m
Distance = 10 m after ESP
After the fan

Earlier they used optical monitors which did not work. They replaced them with ESPY dust monitors which have worked without problems since installation.

Application examples – case 3



Coal fired power plant in Jiangxi

Process parameters:

T = 120 C
P = -220 Pa
Dust = 65 mg/m3
L = 500 mm
Dia = 5 m
Distance = 4 m after ESP
In front of the fan

The customer bought optical monitors in the beginning. After a short time, they stopped working. The customer installed Sintrol ESPY and has not had any problems since installation.

Application examples – case 4

Yuzhong power station

Maintenance interval was 3 days

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Summary from over 200 installations

Optical	Sintrol ESPY
6000 € + a few days	3000 € + a few hours
Maintenace interval even a few days	Maintenance interval 1 year
Usability <300 – 365 days	Usability 365 days
Accuracy good	Accuracy good

Variable cost savings

Prof. Feng Zaolin, South China University of Technology:

Optimizing the ESP operation by using Sintrol ESPY customer could:

- Save up to 20% of electricity used in the ESP (540.000 RMB)
- Decrease dust emissions by 50% (saving 187.000 RMB)

The power plant could save: 727 000 RMB (106.000 USD)!

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Conclusions

Reduce the investment costs by >50%

Reduce the maintenace costs by up to 95%

Know the process 365 days!

Tremendous reduction of variable costs!

Easy life....

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ESPY – a unique solution

And the power plant will enjoy an environmentally-friendly image and a good reputation among the surrounding residents and neighbors!

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Thank you!

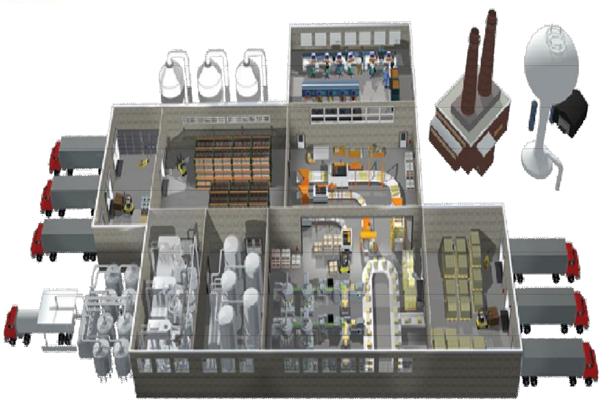
Empowering 'Power' with Automation

Controller Based Monitoring – An Integrated Approach Towards Condition Monitoring

Anup Sharma
Rockwell Automation

- **ISA (D) POWAT 10 May 28-29, 2010, Mumbai**

Asset Reliability is the key for plant wide optimization..



- Production and manufacturing optimization is not solely about reliable controls and drives, and seamless instrumentation.
- It is also about reliable machinery capable of operating to desired and expected capacity.
- These machineries are the engines that drive production; and they need to be equally optimized and properly maintained.
- To understand better these machinery behaviors, a condition monitoring program is typically implemented.

Be it Manufacturing or a Production Area

Condition Monitoring is an Integral Part of any Asset Reliability Program

Condition Monitoring is an Integral Part of any Asset Reliability Program

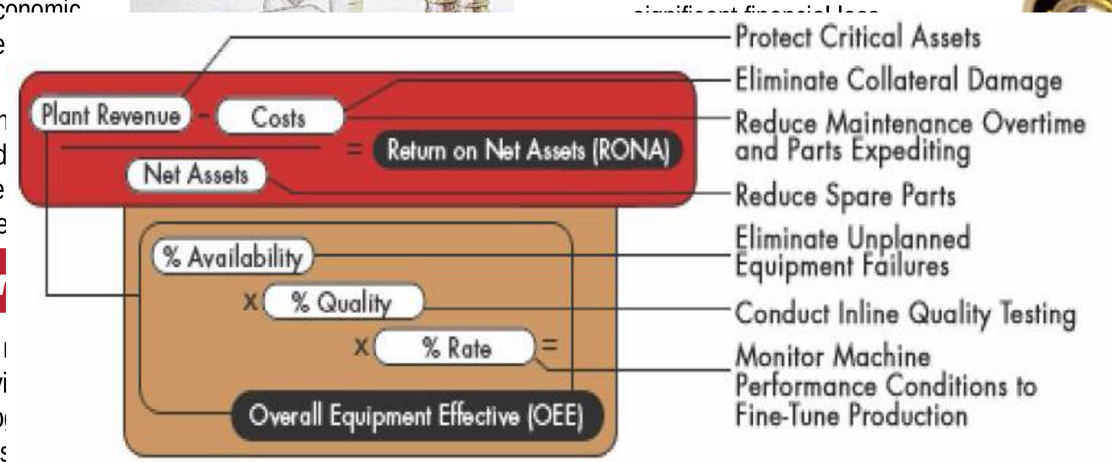
Motivations for applying Condition Monitoring

Machinery Protection

- Machinery failure could cause severe economic loss or pe injury
- Protection mandated insurance requireme

Production Assurance

- Reduce unscheduled downtime
- Unplanned outages can result in



Pr

- Reduce by applyi technolo problems rather than replacing parts on schedule or waiting for failure

random sample testing – or by monitoring the process for abnormal behavior, such as mill chatter, or for excessive vibration or movement

Condition Monitoring - it works

Sydney WATER: "10% - 15% reduction in maintenance costs"

CALPINE: "In 2004… cost avoidance… directly related to the application of predictive maintenance exceed $1.5M"

intel: "...the program helped the company avoid estimated lost-production costs of more than $1.4M in 2002 alone."

The benefits and return are well documented

Published Documented Savings by End-User – Genesis Power

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LISTEN. THINK. SOLVE.

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Predictive Maintenance Strategy Helps Genesis Energy Maximize Output and Meet Growing Demand

Energy supplier's predictive maintenance strategy targets critical equipment to ensure optimal availability

Solutions

Intelligent Motor Control through Allen-Bradley® XM® modules for continuous monitoring and protection

Rockwell Software Emonitor family of products to leverage plant floor data to improve overall equipment effectiveness

Rockwell Software Maintenance Automation Control Center (RSMACC) for gathering, analyzing, and managing control system information for better maintenance decisions

Rockwell Automation support contract and commissioning services for ease of integration into existing systems for reduced downtime

Results

Reduction in reactive maintenance — reactive maintenance is now only 10 percent of all maintenance activities

Increased predictive maintenance activities — predictive maintenance now accounts for 60 percent of all maintenance activities

Extended operating life of capital assets

Increased uptime of power production equipment

Genesis Energy generates its power through a thermal power station and five remote hydro plants. To keep plants running without interruption, Genesis decided to develop a maintenance strategy to maximize asset performance.

Background

Because of its remote location, New Zealand is forced to produce electricity locally. Legally, power providers must stay online or purchase energy from other suppliers at the current price to make up the short fall, facing financial penalties for any major production interruption. The demand for electricity continues to increase, keeping pace with the growth of the country's industrial sector and population.

Challenge

Genesis Energy is New Zealand's largest provider of electricity. Genesis primarily generates power through a thermal power station and five remote hydro plants. Equipment failures can force Genesis to purchase energy from other suppliers, costing the company between $40,000 and $1 million per day, so optimizing the electricity generation process became an essential business goal.

The remote location of Genesis Energy's hydro plants posed another challenge. If a failure occurs at one of these plants, it can take up to six hours for an engineer to arrive on-site and assess the situation. In some cases, production at the facility could be down for days before the problem would be corrected.

To leverage available information on production assets, Genesis Energy utilized Rockwell Software Maintenance Automation Control Center (RSMACC).

Solutions

To keep their plants running without interruption, Genesis Energy decided to develop a maintenance strategy to maximize asset performance. In developing its maintenance strategy, Simon Hurricks, machine dynamics engineer for Genesis Energy, and a group of maintenance personnel, sought to incorporate a mix of predictive, preventive and reactive maintenance activities that corresponded to the criticality of the equipment, the failure modes and the costs associated with failure.

The company partnered with Rockwell Automation to implement a reliability-centered maintenance program, which can assist in predicting and preventing failures from occurring and ultimately extend the life of capital assets – increasing the company's overall profit margins.

To accommodate the hydro plants' remote locations, Hurricks selected the Allen-Bradley® XM® modules from Rockwell Automation, for continuous monitoring and protection. He selected the XM Series for its remote diagnostic and real-time data capabilities, and its ease of integration into Genesis' existing architecture.

By connecting the XM modules to the Genesis Ethernet networks through a dedicated vibration local area network (LAN), Hurricks and his team were able to analyze data from these distant plants and identify problems far in advance of a failure. The time normally spent driving to the individual plants to gather vibration readings could be better used for other maintenance activities. On the hydro plant equipment alone, the XM system collected more than 800 points of data in a fraction of the time it would normally take to manually collect the same information.

The company also upgraded its network from analog to digital for more cost-effective remote analysis. A server installed at the main facility communicates to the XM modules via a wide area network, and the data in the modules is downloaded according to a predetermined schedule.

The newly installed predictive technology enables Genesis Energy to identify potential failures before the problem affects productivity or performance of equipment. To further leverage the available information on its production assets, Genesis Energy utilized the Rockwell Software Emonitor family of products, as well as Rockwell Software Maintenance Automation Control Center (RSMACC).

Emonitor provides Genesis with a suite of integrated maintenance data functions, enabling them to make informed decisions that optimize uptime, reduce inventory, cut production and maintenance costs, and improve overall equipment effectiveness. With RSMACC, Genesis Energy can centrally manage their automated production environment. Genesis can also secure access to its control system, track users' actions, manage asset configuration files, and in the event of disaster, recover operating asset configuration files.

Through a services contract with Rockwell Automation, local software and support engineers configured the software and integrated it with Genesis' existing system. Using the new equipment and software, Genesis can now track progression of faults and schedule convenient repairs.

To complement the increased predictive maintenance activities in their overall maintenance strategy, Genesis implemented a preventive maintenance program, using traditionally predictive techniques — vibration and oil analysis, thermal imaging and ultra-sound signature analysis — to monitor various parameters on a strict schedule.

"Using a combination of maintenance practices, we can more accurately target the work that needs to be done during the annual shutdown," said Hurricks.

Results

"With the trending data we collect with the XM system, we can strategically make corrections or change out equipment," Hurricks said. "This allows us to make more effective use of our time during a shutdown."

Using this strategic approach to maintenance, Genesis now only performs reactive maintenance on non-critical equipment with low replacement costs. "With 70 maintenance personnel covering six major energy production facilities, we have to prioritize our activities," explains Hurricks. "We've calculated that the capital expense of replacing non-critical equipment when it fails is evenly balanced against the cost of implementing a predictive or preventive program for this equipment."

By increasing predictive and preventive maintenance and limiting reactive maintenance activities, Genesis is now able to keep their plant at optimal production levels. This mix enables Genesis Energy to extend the life of its capital assets and keep New Zealand up and running.

The results mentioned in this story are specific to Genesis Energy's use of Rockwell Automation products in conjunction with other products. Specific results may vary for other customers.

Condition Monitoring – Industry Acceptance

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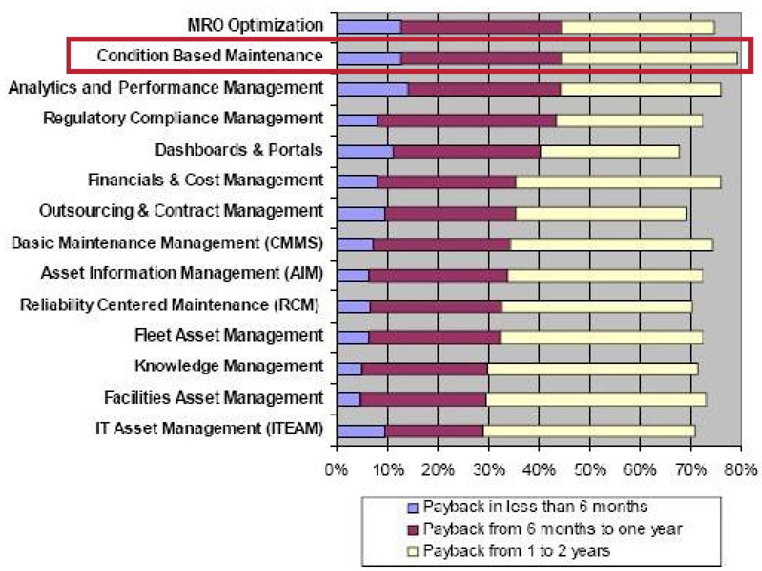
ARC INSIGHTS Rapid Payback Asset Management Solutions

INSIGHT# 2006-38ECMP
AUGUST 24, 2006

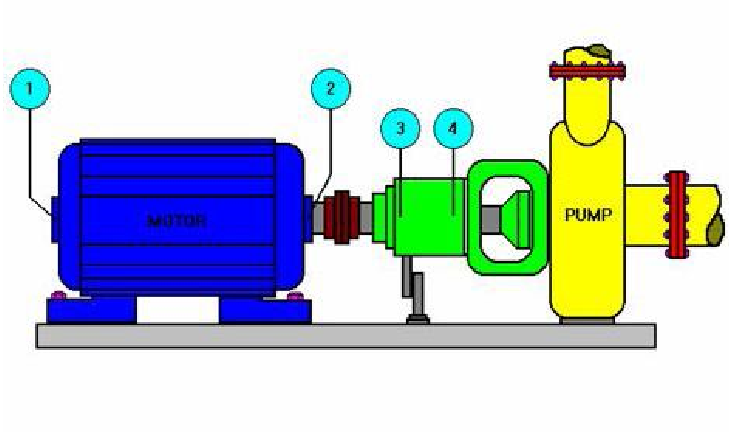
The top three asset management solutions with the greatest occurrence of a Rapid Payback include Analytics & Performance Management (APM), Condition Based Maintenance (CBM), and MRO Optimization for managing and purchasing spare parts inventory.



75% of Condition Monitoring Systems (CbM) show Payback in less than 2 years

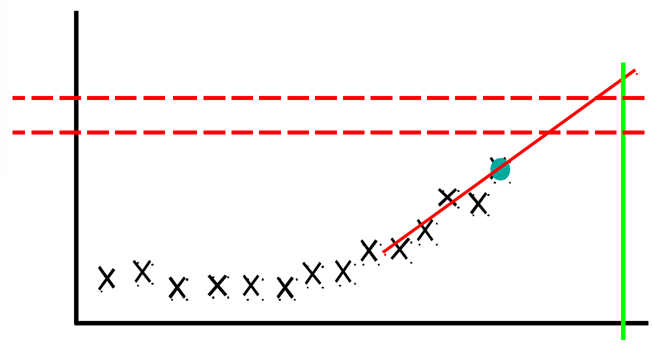
What is Condition Monitoring?

- Condition Monitoring is the collection and trending of parameters which change when machine condition begins to **degrade.**



- Physical characteristics are identified that collectively indicate the current condition of the machine.
- Each of these characteristics is measured, analyzed, and recorded so that trends can be recognized.

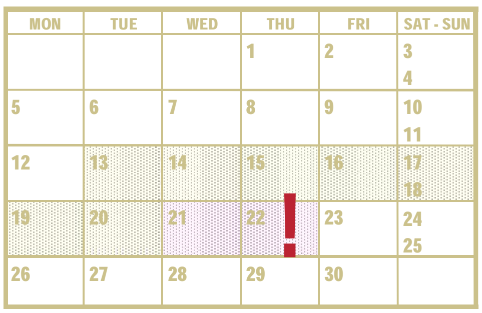
- The goal is to identify changes in the condition of a machine that will indicate some potential failure.



Example: Vibration level increasing with time.

What is the Value of Condition Monitoring?

How do you identify equipment failures today?

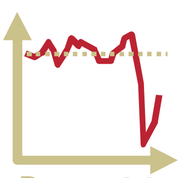


Late

- *Line Shuts Down*
- *Process Alarm*
- *Operators See an Issue*
- *Noise Increases*
- *Temperature Rise*

Early ← *Condition Monitoring*

What's the cost of a late warning?



Productivity
- *Downtime*
- *Product Quality*
- *Collateral Damage*

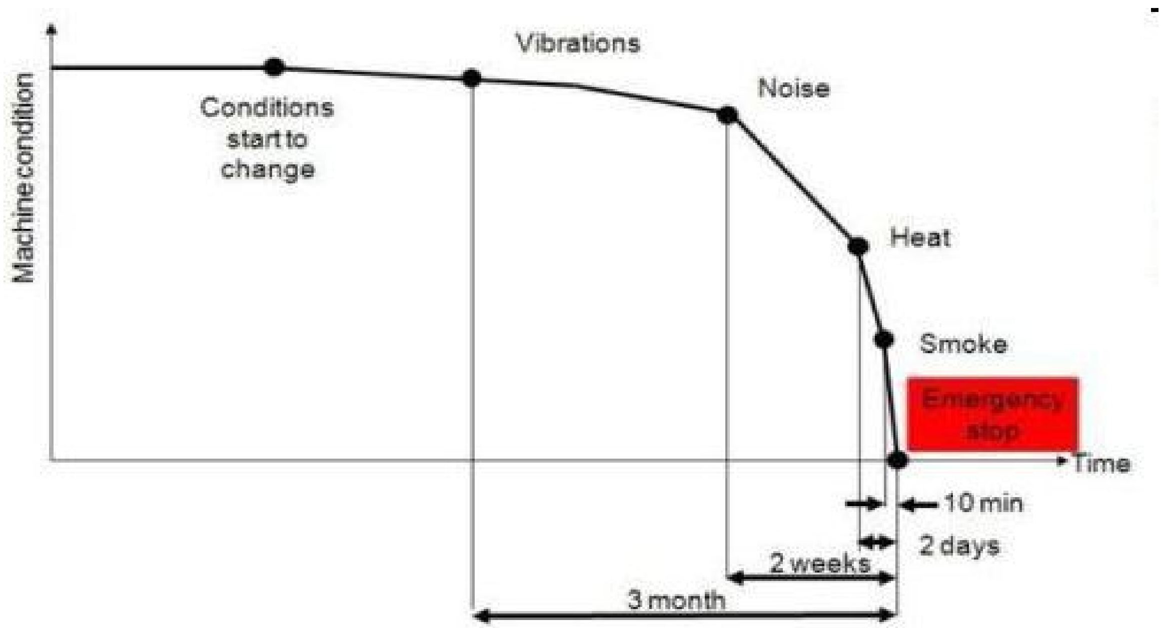
Expenses
- *Inventory*
- *Overtime*
- *Expediting*

Organization
- *Safety*
- *Reliability*
- *Credibility*

Enable your Operations to drive better Maintenance, Quality & Reliability

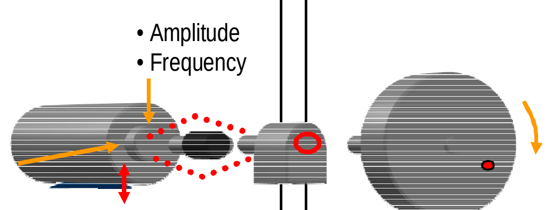
Vibration

Vibrations are the first warning sign that a machine is prone to failure ...



Common Machine Defect Frequencies

Defect	Common Fault Frequency
Unbalance	1 X RPM
Misalignment	2 X RPM
Blade / Vane Pass	BPF = # of vanes/blades x RPM
Gear Mesh Frequency	GMF = # of Gear Teeth X gear RPM
Bearing Defect Frequencies	Depends on bearing



Y axis only	---	Looseness
1x RPM	---	Imbalance
2x RPM	---	Misalignment
>4x RPM	---	Bearing

System can track 4 independent bands and Fault Frequencies

Condition Monitoring: Traditional -or- Integrated

- Machinery Protection and Condition Monitoring are essential for:
  - Operational continuity
  - Regulatory compliance
  - Protection & Safety
  - Maintenance & Reliability
- Traditionally these are separate and isolated disciplines

- Protection and CM are merged in an Integrated Architecture

TRADITIONAL

DCS	Protection	CBM

INTEGRATED ARCHITECTURE

Integrated Architecture Vision

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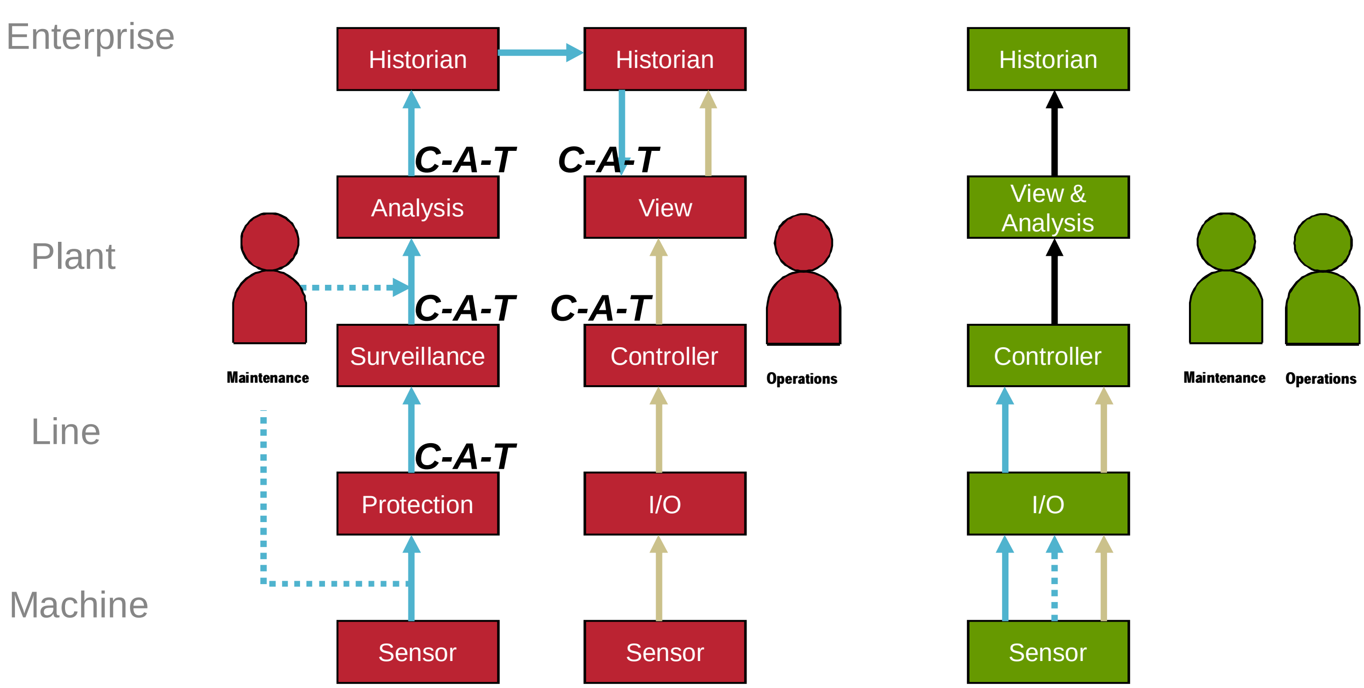
Traditional Solution
"Isolated Reliability"

Integrated Architecture
"Operations Centered"



Duplication of Configuration, Alarming, & Trending vs. Integrated Solution

Traditional Server Based Solution

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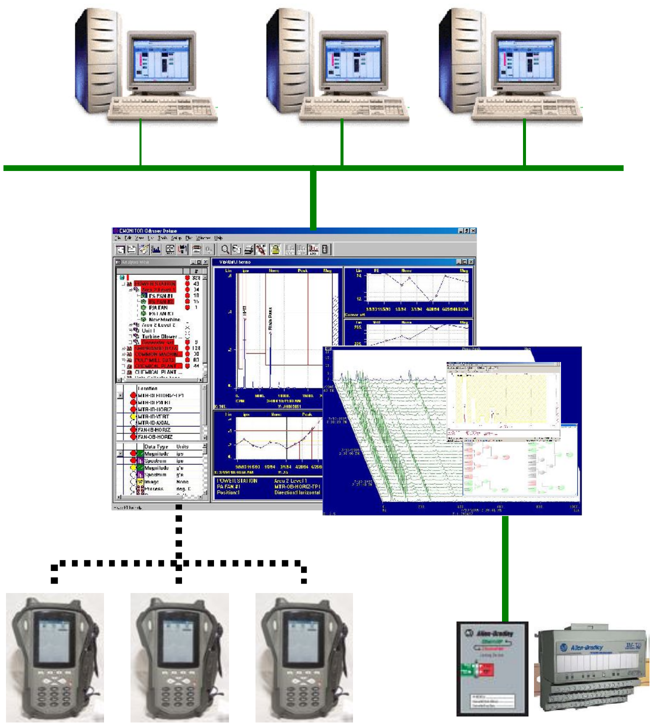
Traditional predictive maintenance systems require highly trained vibration analysts to periodically gather and analyze the data. Results are highly dependent on the ability of the analyst and the frequency of the data collection.



- Asset Management software is the center of the system
  - Intelligent Advisory sends alarms and notifications
  - Operators log into stand alone analysis workstation to access data, analyze data, and understand recommendations
  - Traditionally optimized for off line remote analysis
  - Uses IT infrastructure, servers and computers
  - Often not integrated with control system architecture

Controller Based Solution

- Two Levels of Intelligence
  - Routine diagnostics, alarms and trends via Controller
  - Full analysis workstation available in parallel
  - Operators receive notifications directly from control system
  - Pre-packaged machine displays improve ease of use
  - Combined w/ production data
  - Uses plant floor infrastructure for increased reliability

The Integrated solution collects data multiple times a day, analyzes using programmed rule sets and converts it to actionable diagnostic messages. This eventually takes away the burden of manually collecting and analyzing data. Both operations and maintenance personnel can be informed about specific pending machinery problems before they cause unplanned downtime.

Achieving Real-time Condition Monitoring - Simple to Complex Data, BoP to TSI Application

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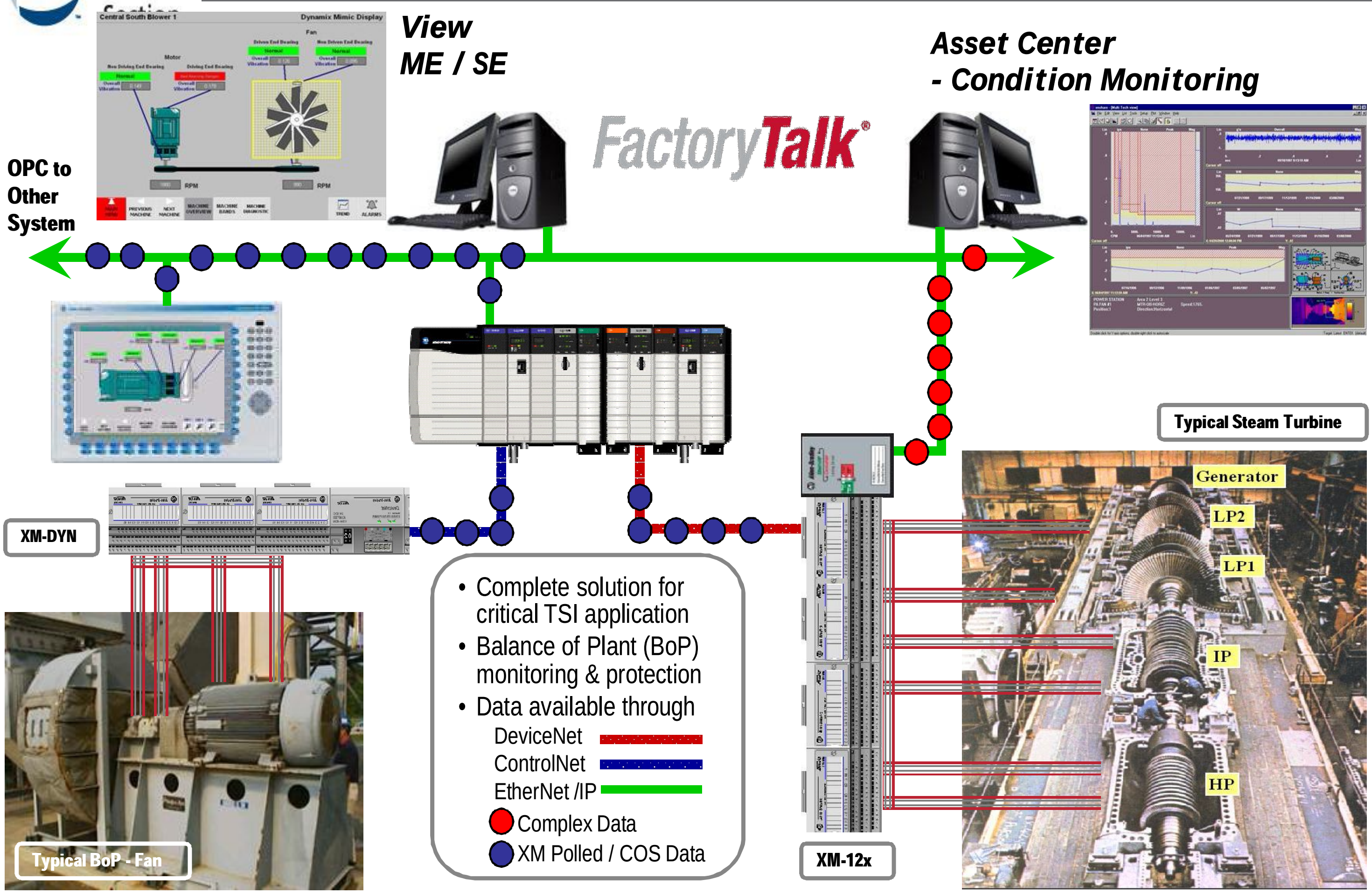
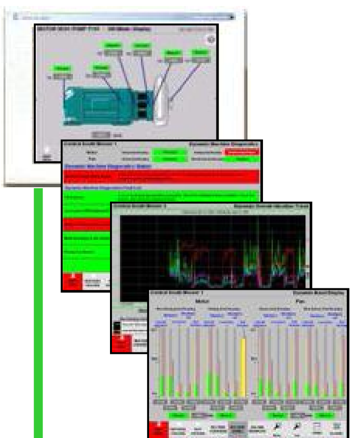
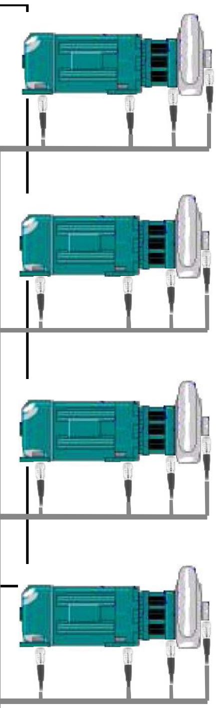


Integrated Surveillance Panels

HMI



- Sequential system
  - Single set of Vibration module,
  - Controller connects sensors to Vibration Module
  - For each machine, Controller loads new configuration and retrieves data set
  - Problem analysis rules sets executed
- Operator Interface
  - View diagnostics and alarms
  - Track and trend data for all machines
  - Configured by Add-On-Instructions



Controller & Vibration Hardware

Sensors wired to Controller for sequencing Vibration

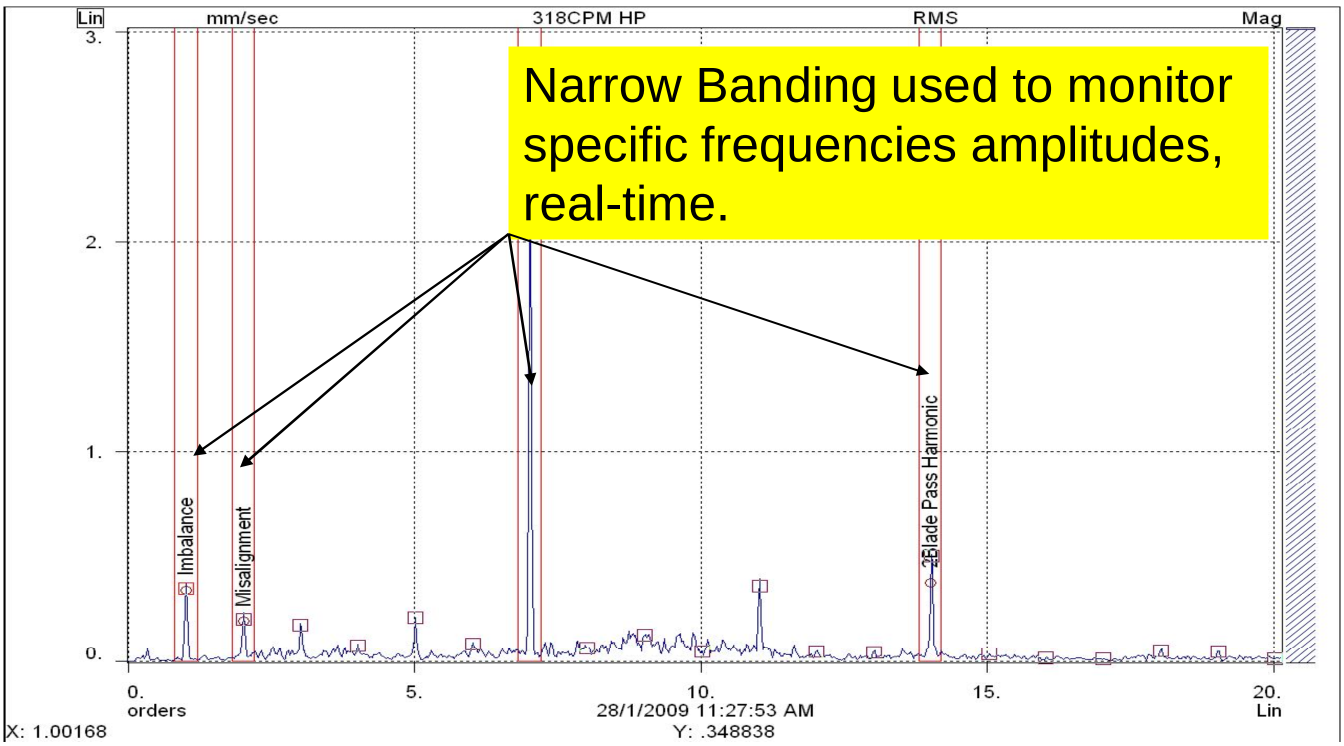
Operations-centered; Process-centric analysis

In the correct format, data can be shared and utilized real-time anywhere & not limited to vendor specific software

Vibration Data that can be shared are typically of two types:

- An Overall Measurement – the sum of the energy over a specific band of frequencies, or the difference between the minimum and maximum values of an unfiltered time waveform.
- A Discrete Measurement – A measure of the vibration magnitude (or phase) at a specific frequency, or, if from a time waveform, then the same as an Overall, but from a filtered time waveform.

Narrow Banding / Discreet Measurement



First Level Automated Diagnostics

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Most machinery problems can be addressed with basic "if then" statements.

- Machinery Unbalance
  - If 1x rpm is >.300 in/sec = WARNING Unbalance
  - If 1xrpm is >.450 in/sec = DANGER Unbalance
- Blade Pass
  - If 5x rpm is >.200 in/sec = WARNING Blade Pass
  - If 5x rpm is >.300 in/sec = DANGER Blade Pass

Integrated Condition Monitoring allows Funcational Access to Controller--

1 Machinery Profiles

- Stored settings to define frequency bands and alarms for common machine types
- Allows for basic changes to the configuration from FactoryTalk View or RSLogix
- Not required for direct or fixed monitoring, required for sequential monitoring

2 Intelligent Advisory

- Translates monitoring data into actionable descriptions for common failure modes
- Connects information from multiple channels and is customizable for specific machines

3 Trending

- Establishes baseline values
- Stores values at desired intervals and averages for day, week, month & year summaries

4 Sequencing

- Manages multiple machinery profiles and the sequencing intervals
- Sequence dwell function allows continuous monitoring of one channel which pauses data gathering for the system

Multi-level and Multi-purpose Visualization

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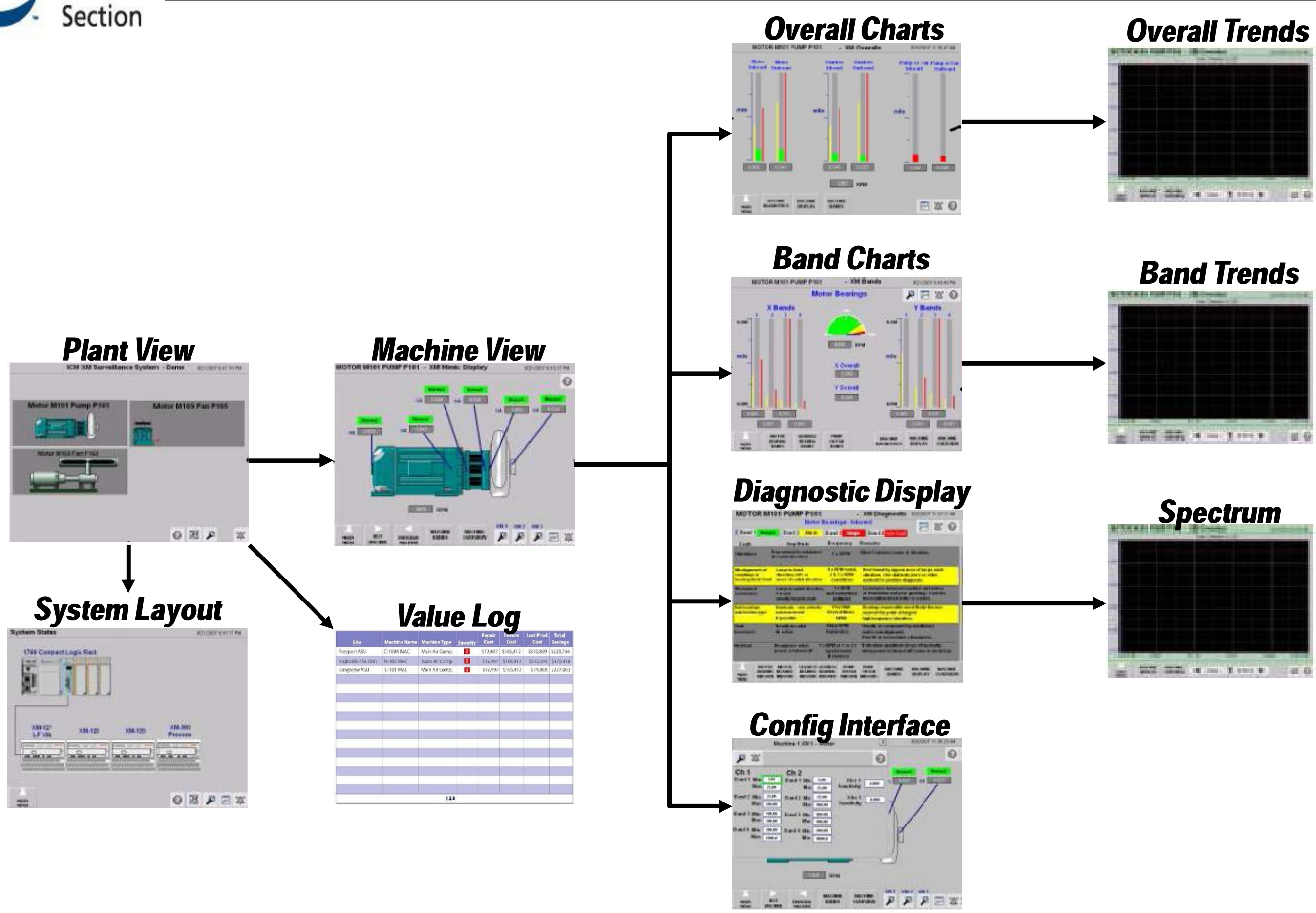
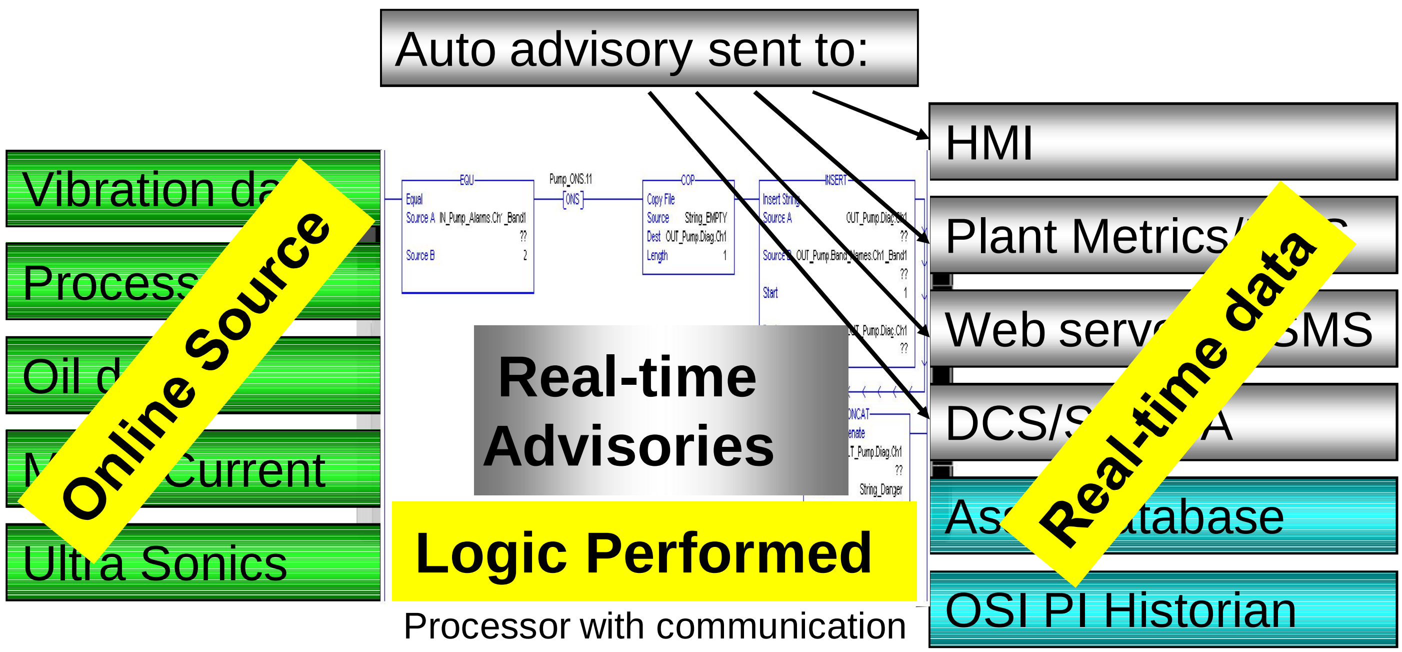
Empowering 'Power' with Automation



Real-time Integration with Automation Controls

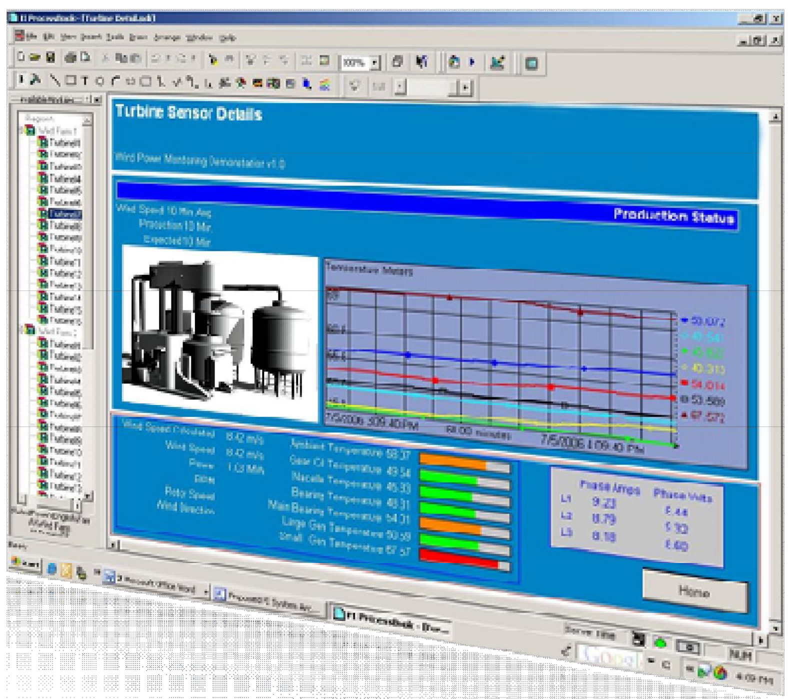
Empowering 'Power' with Automation



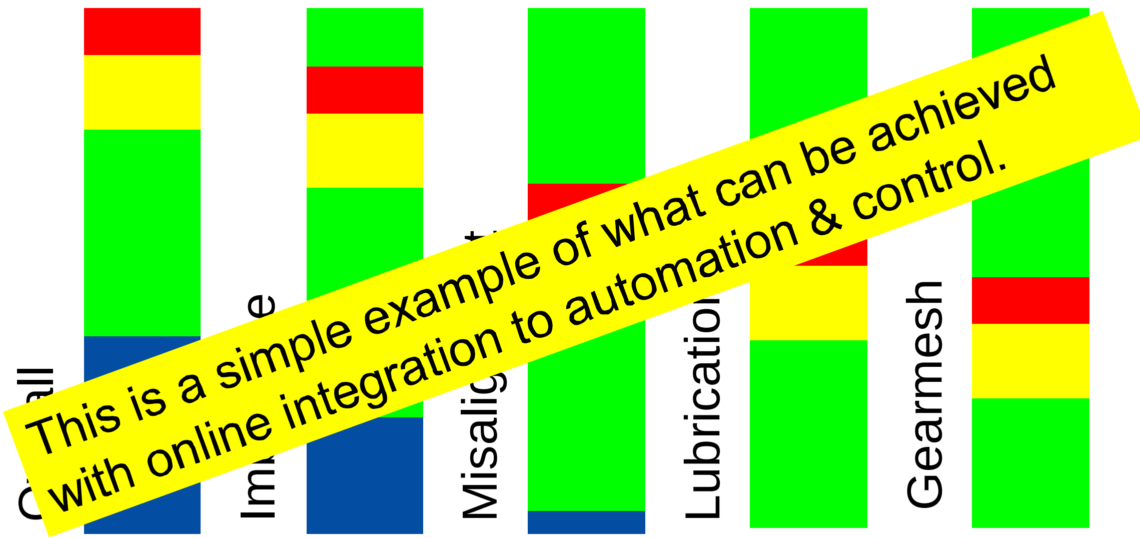
Processor with communication and input cards

Historian, Trending & Visualization

- Trending of historical data at Operator Interface
- Trends from days, months and years
- Correlation of multiple processes and condition monitoring can be achieved



Operator Visualization with Embedded Knowledge



Danger High Gearmesh Vibration Present

Action: Sending SMS to Maint. Department

Fault Diagnostics and Band Displays

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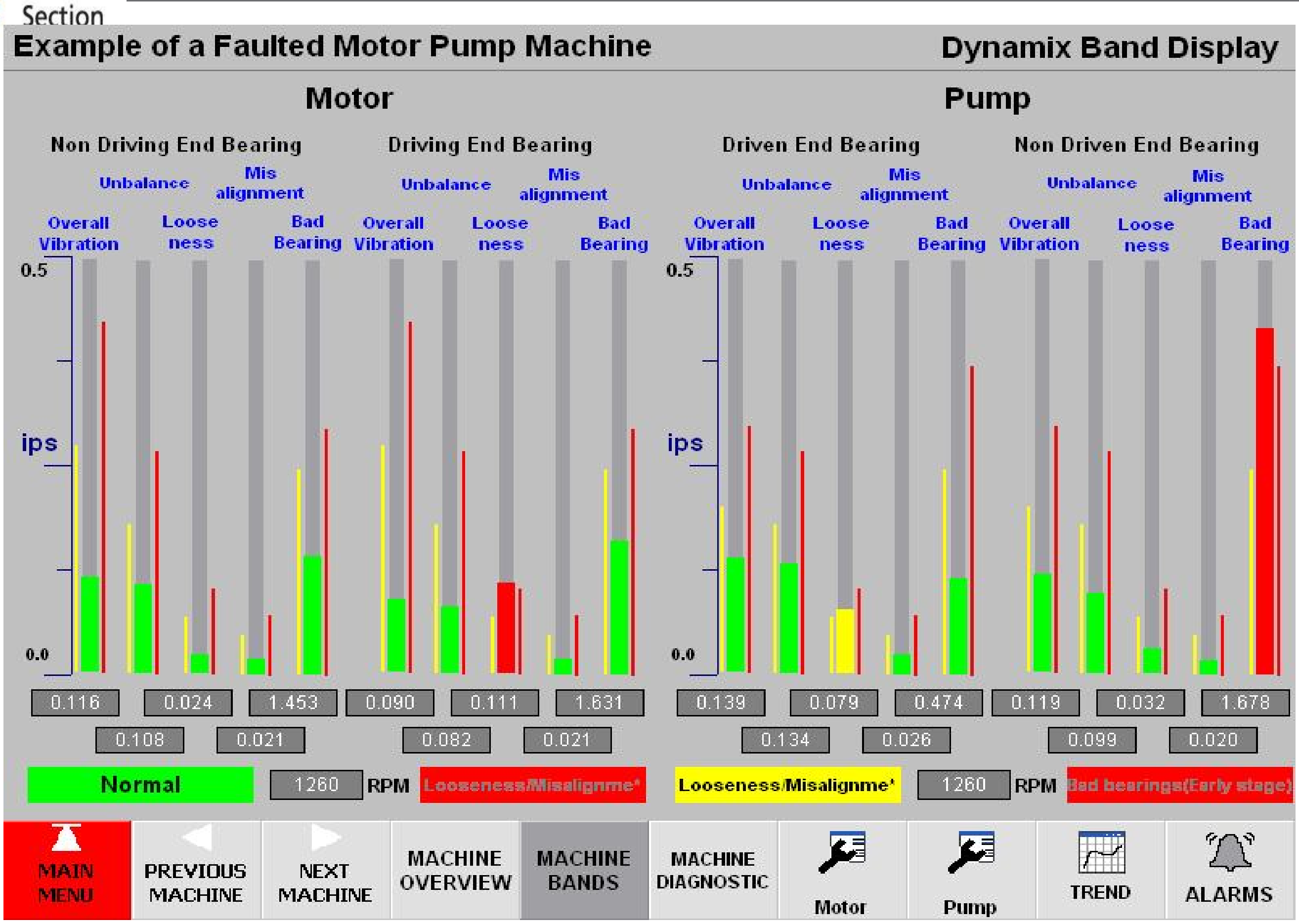

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Narrow Banding / Discreet Measurement

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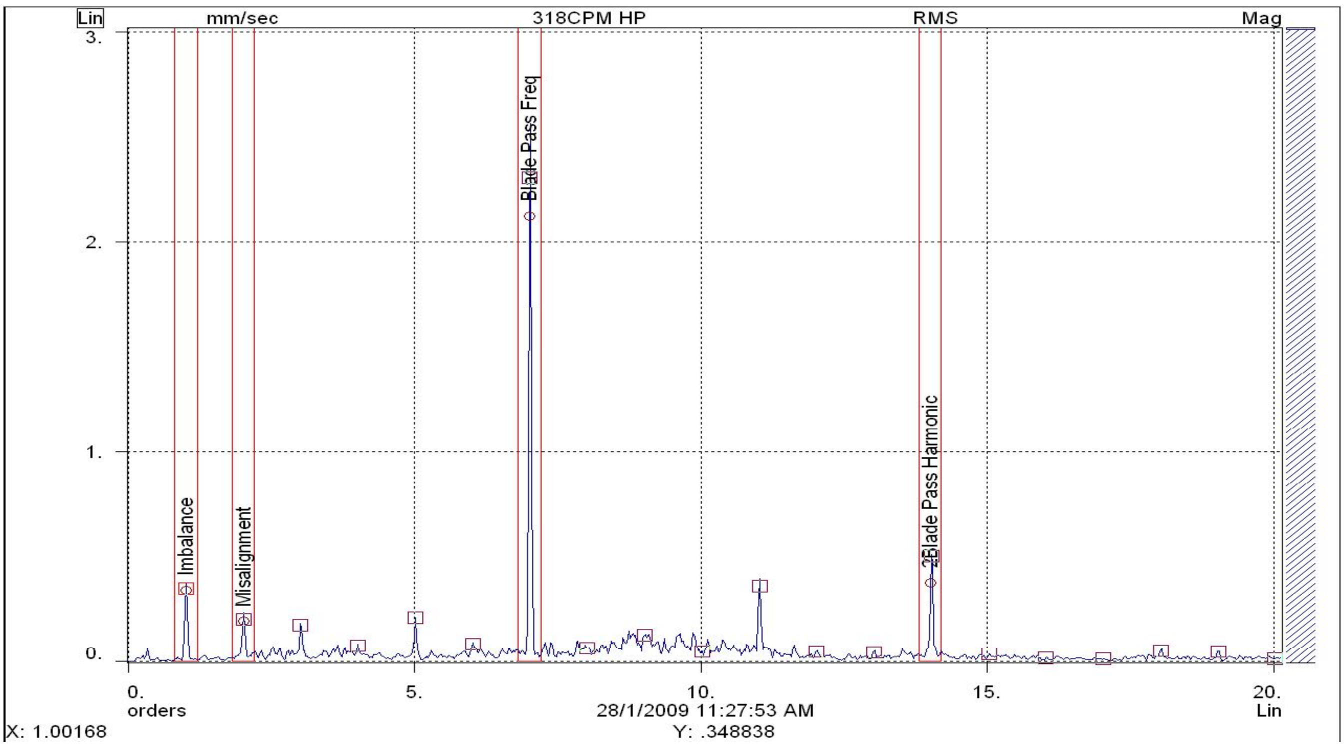

Machine Diagnostics in Plain English

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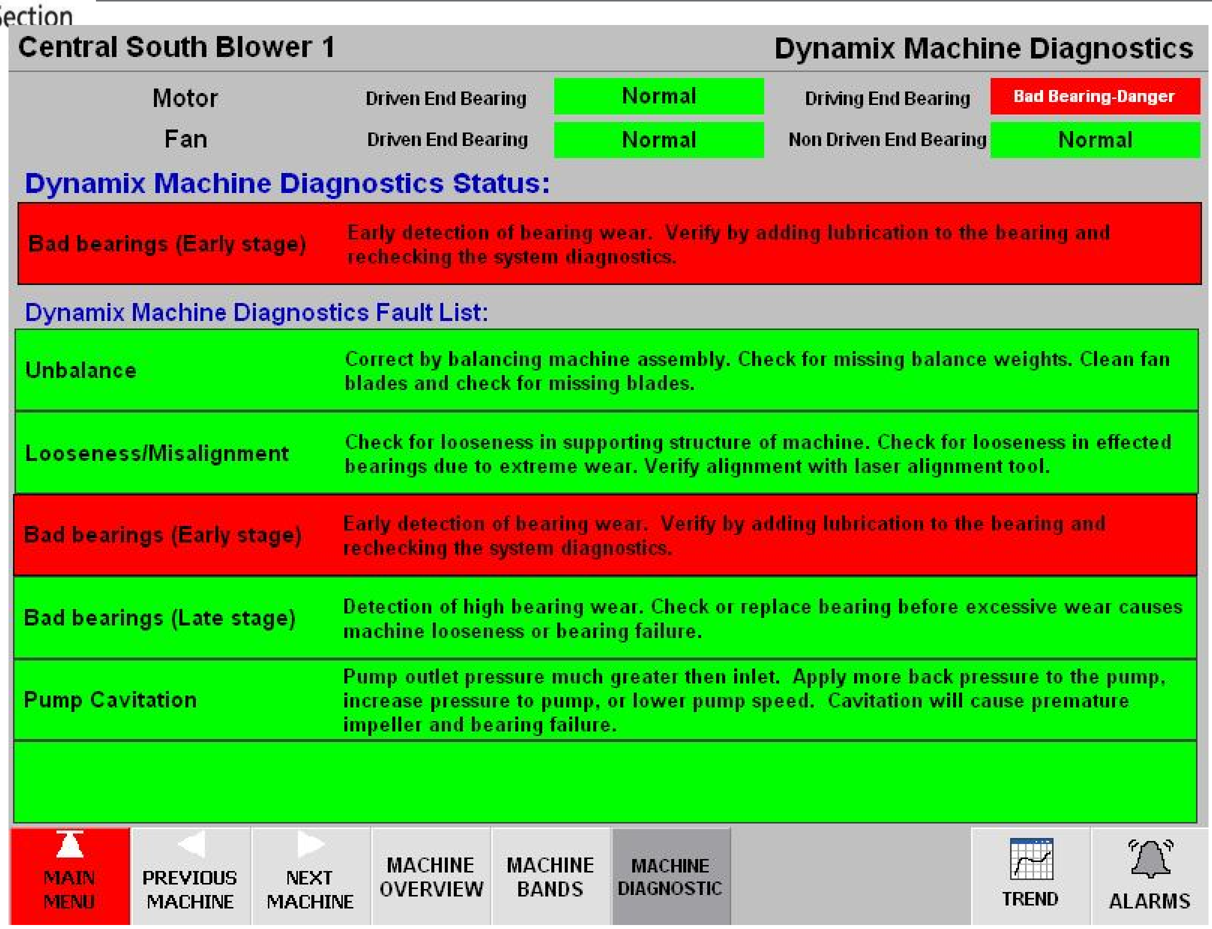

Information Flow enabling Operation Interface & Access to Condition Monitoring

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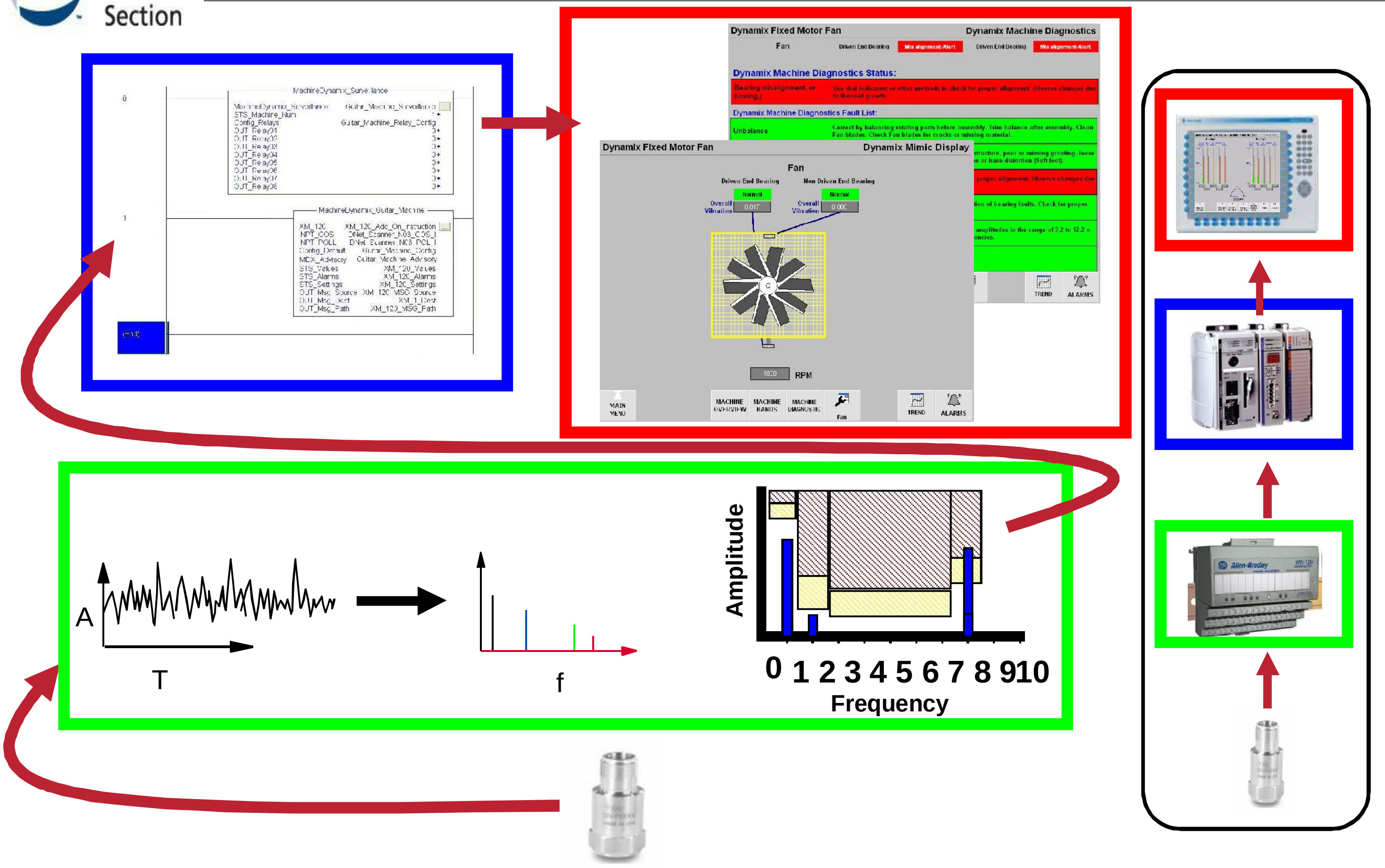
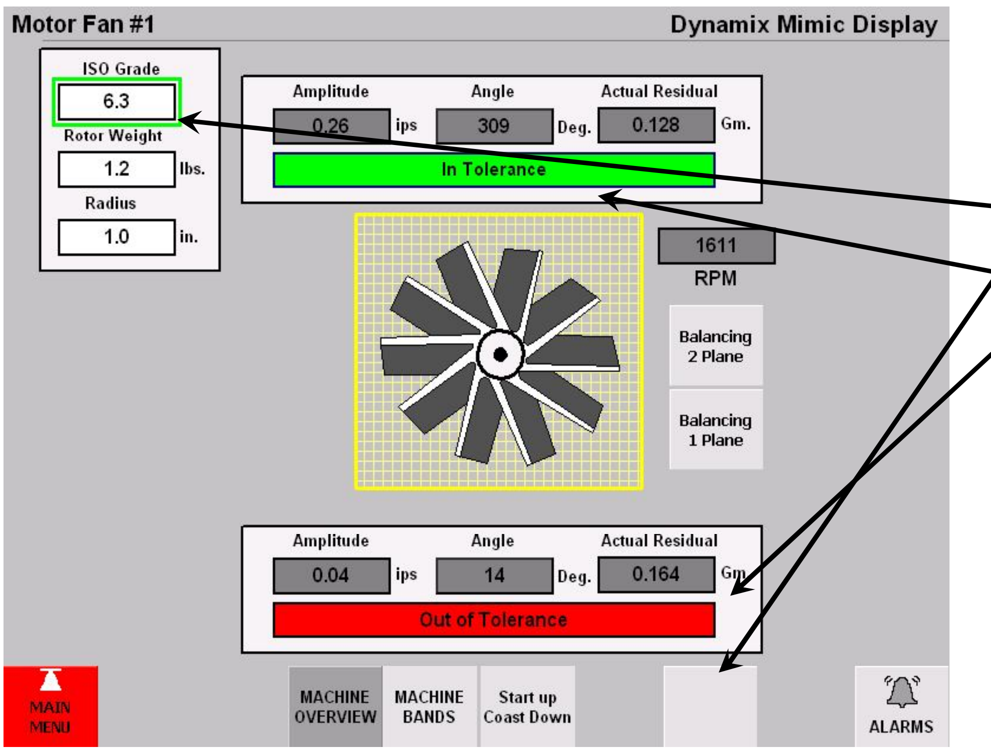
Empowering 'Power' with Automation



Dynamic Balancing



ISO Standards

Tolerance Indicators

Residual Unbalance

Alarm Indicators

Accomplishing truly, an Intelligent Approach

Optimises plant performance by combining:

- Control and Protection with Advanced Networking and Diagnostic Capabilities of Integrated Architecture to…

Thank You

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APM 3DLevelScanner™

Changing the market from level to volume

Subject: "Innovative 3D Technology-- changing the market from level to volume. Providing accurate & continuous Volume & Mass measurement of material inside the tank/bin"

Author: Mr Ofir Perl, CEO, A.P.M Automation Solutions Ltd. Israel

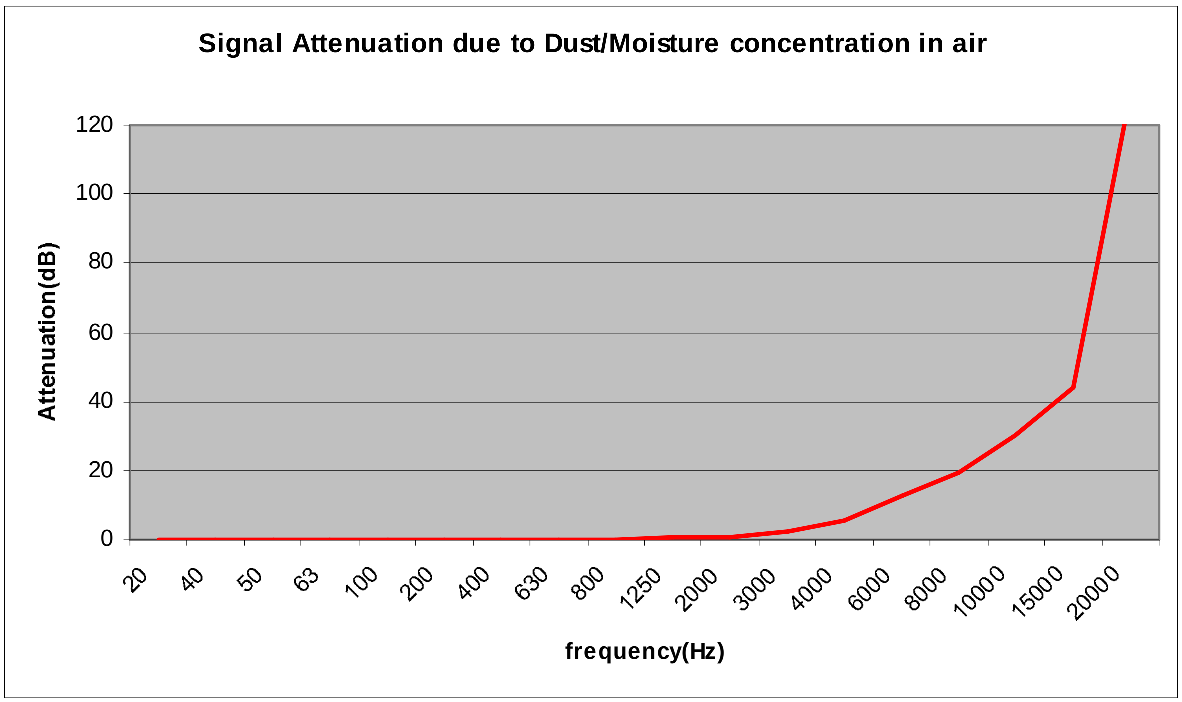
Overview

- What we do
  - Providing accurate & continuous Volume & Mass measurement of material inside the tank/bin
  - Let's understand the world we live in & what is the problem that exists with today's technologies?
- Where is the innovation
- How is the innovation reached technologically
  - How does it work
  - How accurate is it
- What value this innovation brings
- Where this technology can be applied
- Where this technology is applied in India

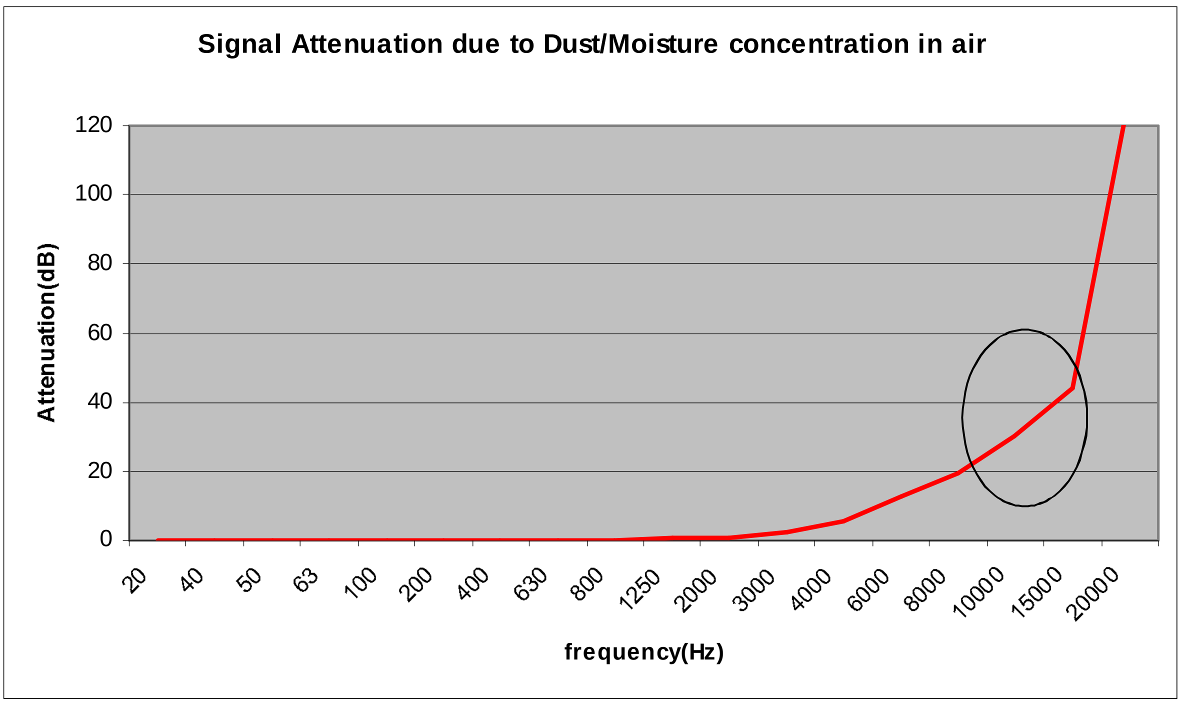
How does it work

- Dust Penetrating
- Accurate Volume Measurement

How does it work – Cont.

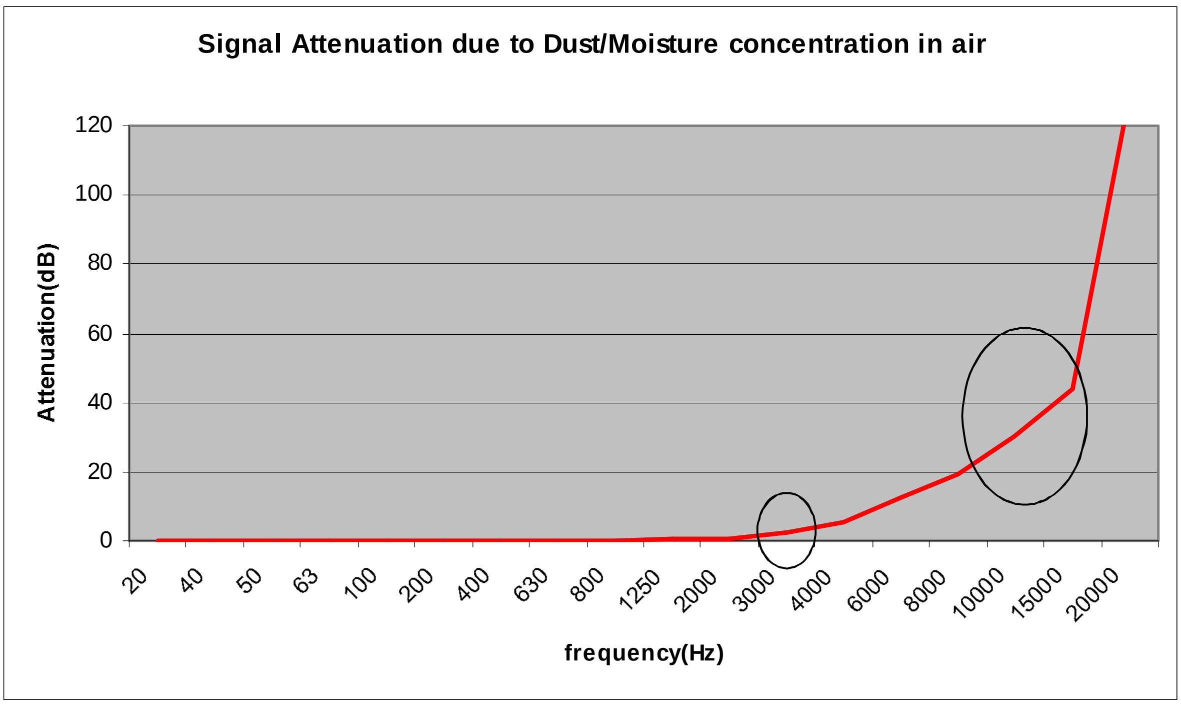


How does it work – Cont.



- 3 db loss is loss of 50% of signals energy

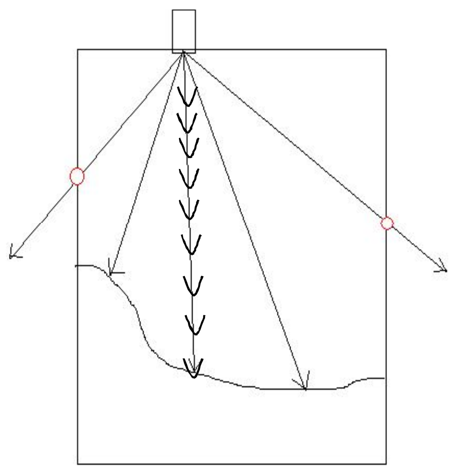
How does it work – Cont.



- At 3-4 KHz signal looses only 2-3 dB

How does it work – Cont.

How do standard sensors (radar/ultrasonic/etc.) operate?

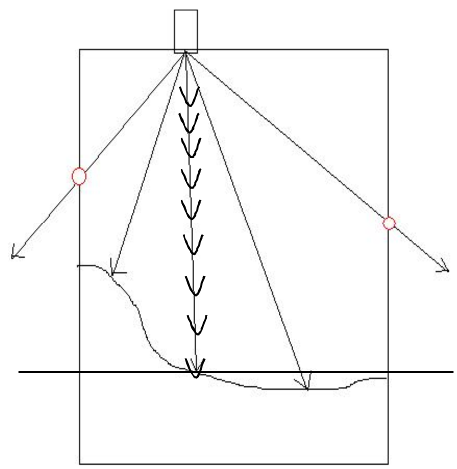


Beam Angle vs. frequency

Standard Time of flight technology is not enough

How does it work – Cont.

How do standard sensors (radar/ultrasonic/etc.) operate?



Beam Angle vs. frequency

Standard Time of flight technology is not enough

How does it work – Cont.

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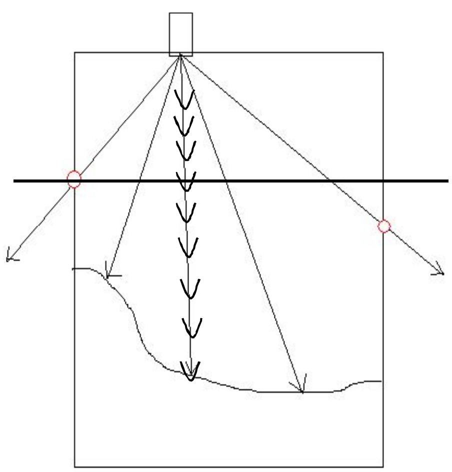
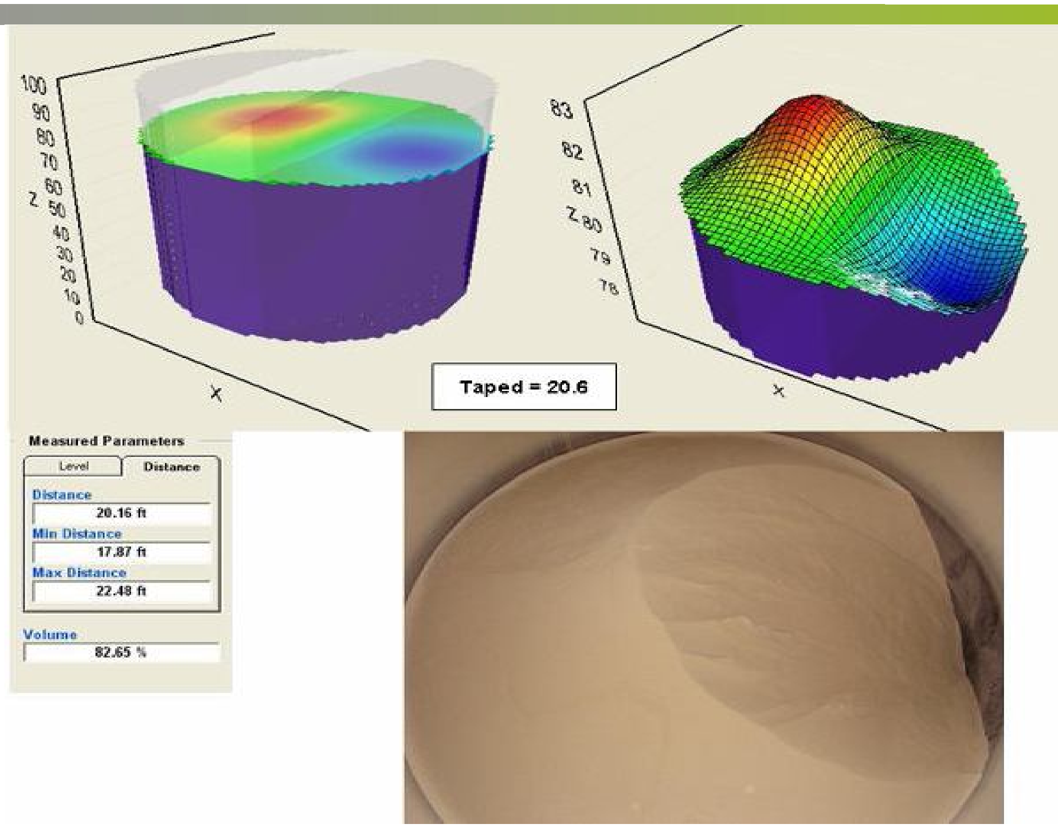


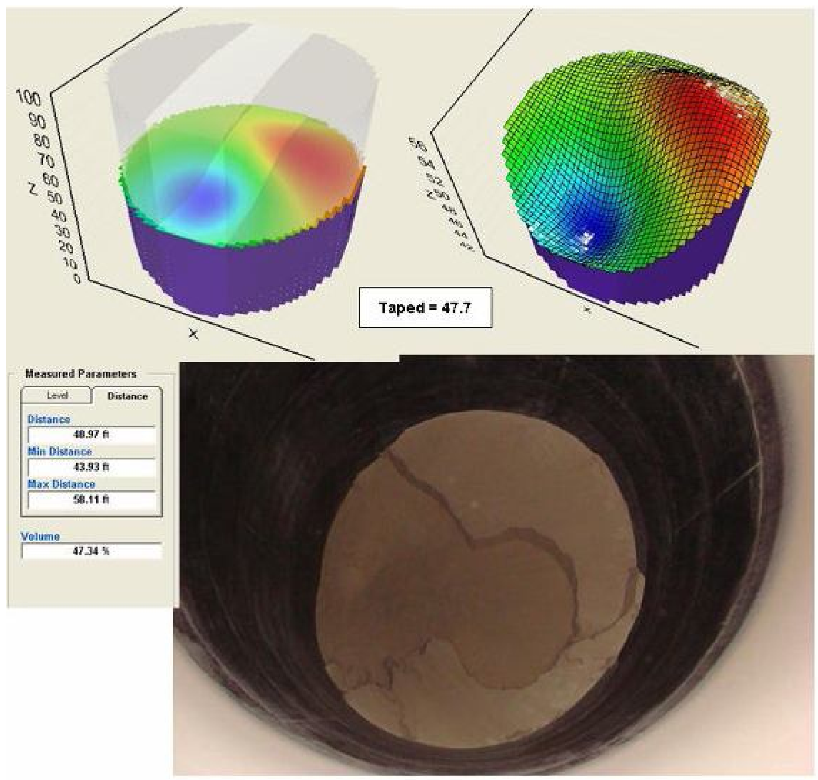
Beam Angle vs. frequency

Standard Time of flight technology is not enough

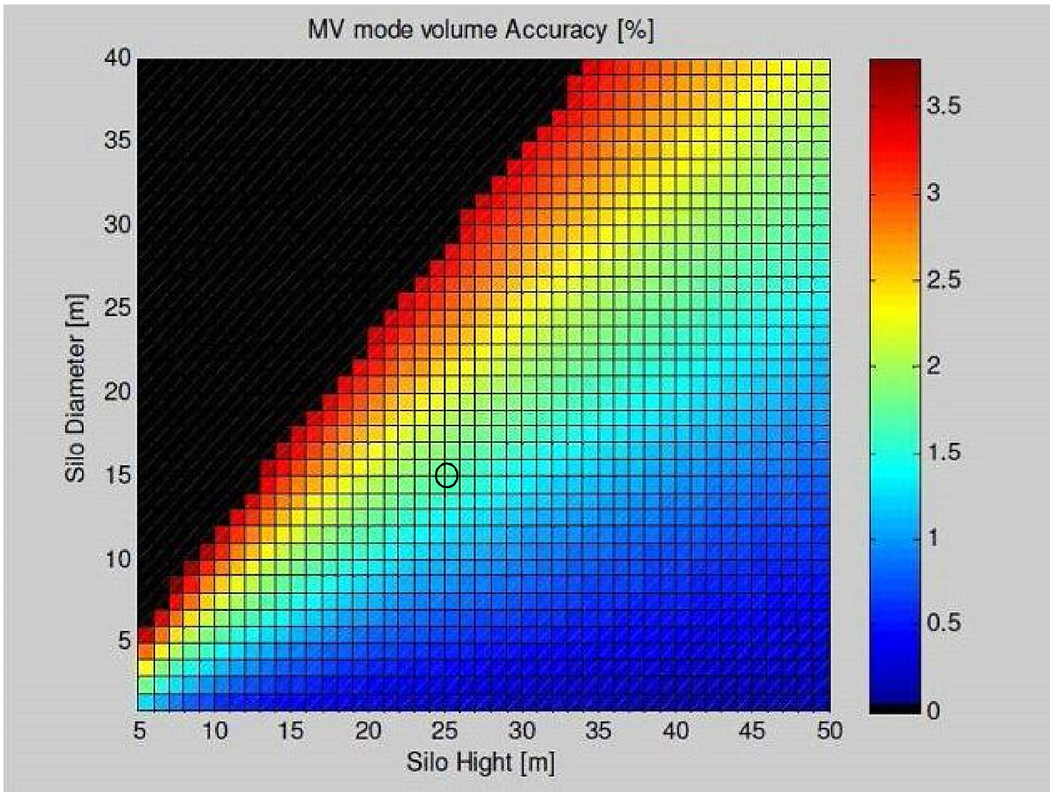
Profile - Example



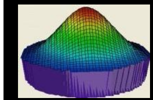
Profile - Example

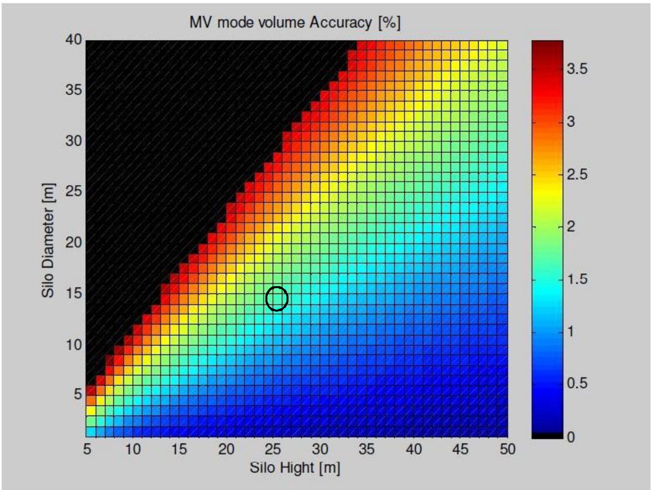


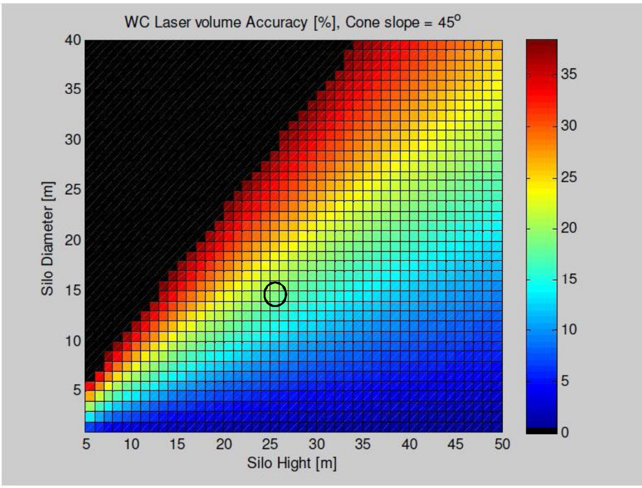
How accurate is it?



How accurate is it?

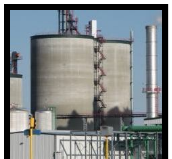


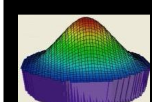




Applications

- Power stations - fly ash, coal, limestone
- Plastics - plastic pellets and powder
- Cement
- Chemicals - Aerosil, calcium carbonate, potash, etc.
- Steel - iron pellets, dust foundry, etc.
- Ceramics
- Tobacco
- Food - grains, flour, sugar, animal food





Where this technology is applied in India together with our partner EIP

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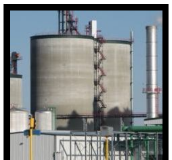
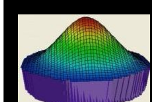
	Project/Customer	Application	Remarks
1)	**PSEB – Ropar TPS**	**Fly ash silo**	**Working since April 09**
2)	**HPGCL – Yamuna Nagar**	**Fly ash silo**	**Working since Aug. 09**
3)	**HZL-CPP-Chanderia**	**Fly ash Silo**	**Working since Dec.09**
4)	**HZL-CPP-Zawar**	**Fly ash silo**	**Working since June 09**





Where this technology is applied in India together with our partner EIP

ISA Delhi Section

	Project/Customer	Application	Remarks
5)	**Aditya Cement**	**Various stick materials**	**Working since May 09 and replaced with Radar**
6)	**Madras Cement**	**Cement silo**	**Working since Nov.09**
7)	**Glow Power-Thailand**	**Fly ash silo**	**Working since Oct 09**