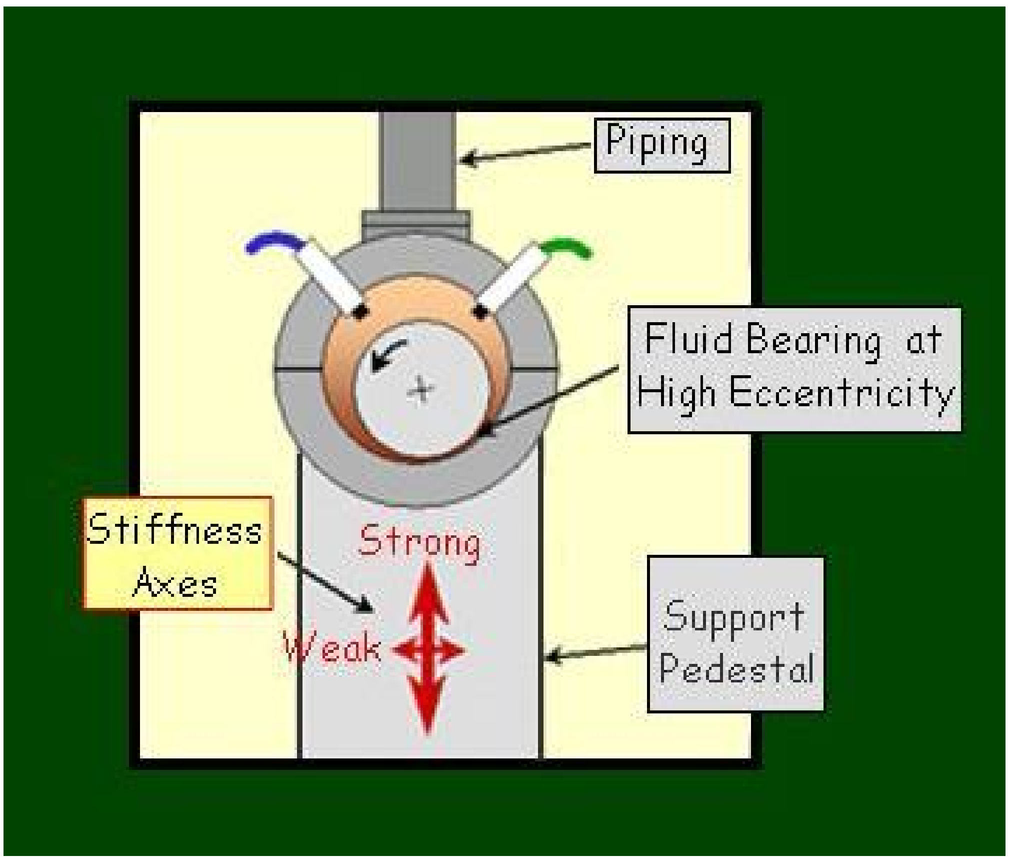
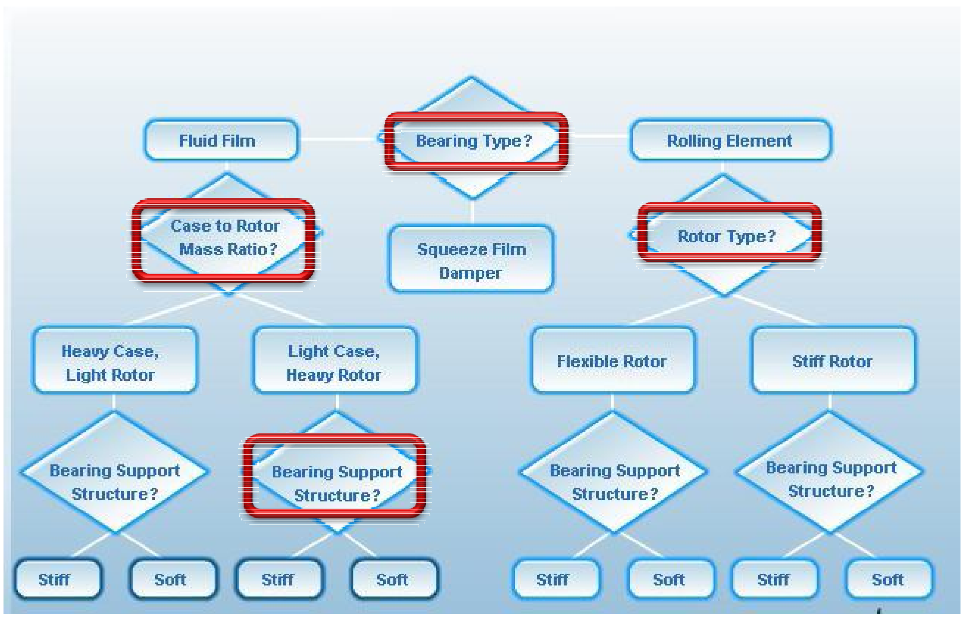
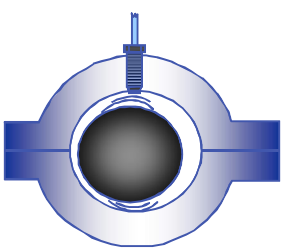
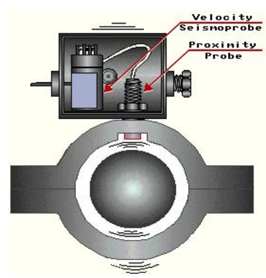
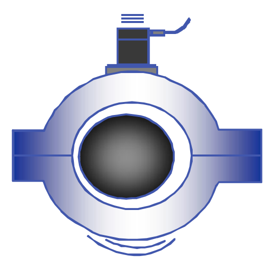

Piping
Fluid Bearing at
High Eccentricity
Stiffness
Axes
Strong
Weak
Support
Pedestal


Bearing Type?
Fluid Film
Rolling Element
Case to Rotor Mass Ratio?
Squeeze Film Damper
Rotor Type?
Heavy Case, Light Rotor
Light Case, Heavy Rotor
Flexible Rotor
Stiff Rotor
Bearing Support Structure?
Bearing Support Structure?
Bearing Support Structure?
Bearing Support Structure?
Stiff
Soft
Stiff
Soft
Stiff
Soft
Stiff
Soft

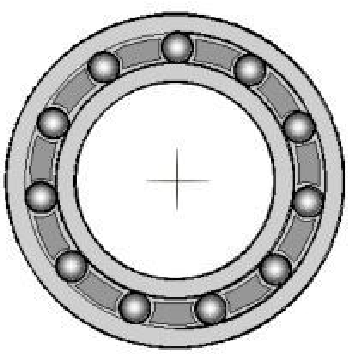


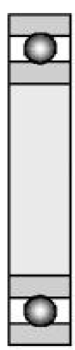

Velocity Seismoprobe
Proximity Probe



Rolling element bearing problems

- High frequency trend data is most important
- Spectral and timebase data is needed for evaluation of the failure stage
- Machine rpm is necessary
- Bearing manufacturer and part number is helpful (BE)
- Enveloping data is allways adding value and on low speed machinery it is necessary





$$ORBP = \frac{N\Omega}{120}\left(1 - \frac{d}{D}\cos\alpha\right)$$

$$IRBP = \frac{N\Omega}{120}\left(1 + \frac{d}{D}\cos\alpha\right)$$

$$FTF = \frac{\Omega}{120}\left(1 - \frac{d}{D}\cos\alpha\right)$$

$$BSF = \frac{D\Omega}{120d}\left(1 - \left(\frac{d}{D}\cos\alpha\right)^2\right)$$

N = number of elements

Ω = shaft rotation speed

d = rolling element diameter

D = pitch diameter

α = element contact angle

ORBP = Outer ring failure

IRBP = Inner ring failure

FTF = Cage failure

BSF = Roller failure

Failure Stages
Rolling Element Bearing Defects

Stage 1

> Defects located below the surface.
> Very High frequency (5KHz to ~30KHz).
> *Greasing may save the bearing*

Stage 2

> Defects appear to surface, still need a microscope to see
> HF trending still the best method
> *Enveloped Spectrum may show defects.*
> High frequency acceleration spectrum has the data at the high end too

Stage 3

> Defects become visible.
> *Vibration on Bearing Related (Prime Spike) and Rotor Region become clearly visible.*
> Replace bearing.

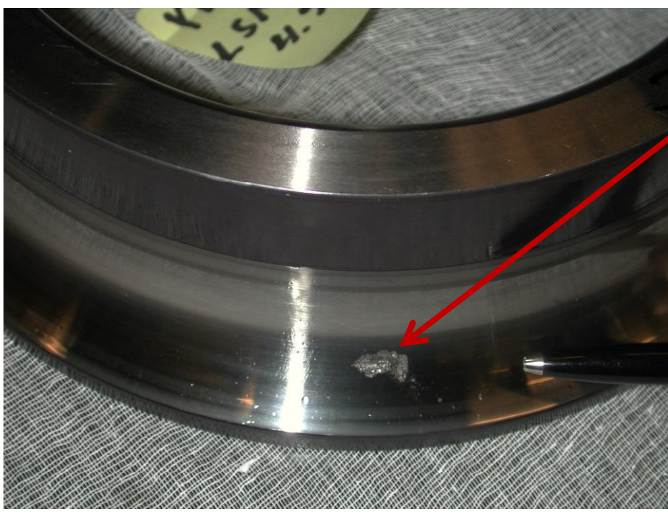
Stage 4

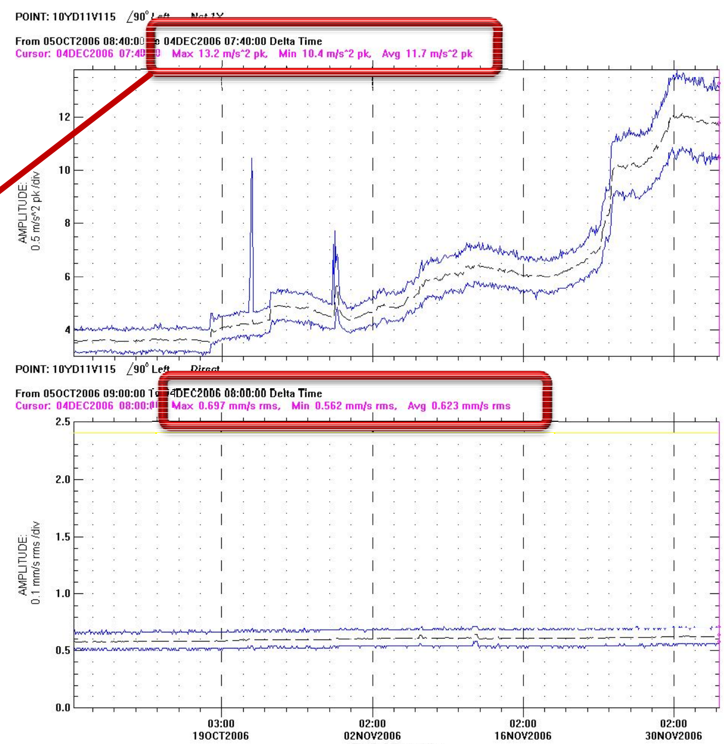
> *Defects can lead to a catastrophic failure.*
> Vibration increases in the Rotor Related Region (1/4X to 3X)
> Stop machine and fix bearing(s) and other damaged parts

Monitoring REB

Case Nuclear reactor circulation pump 1/2:

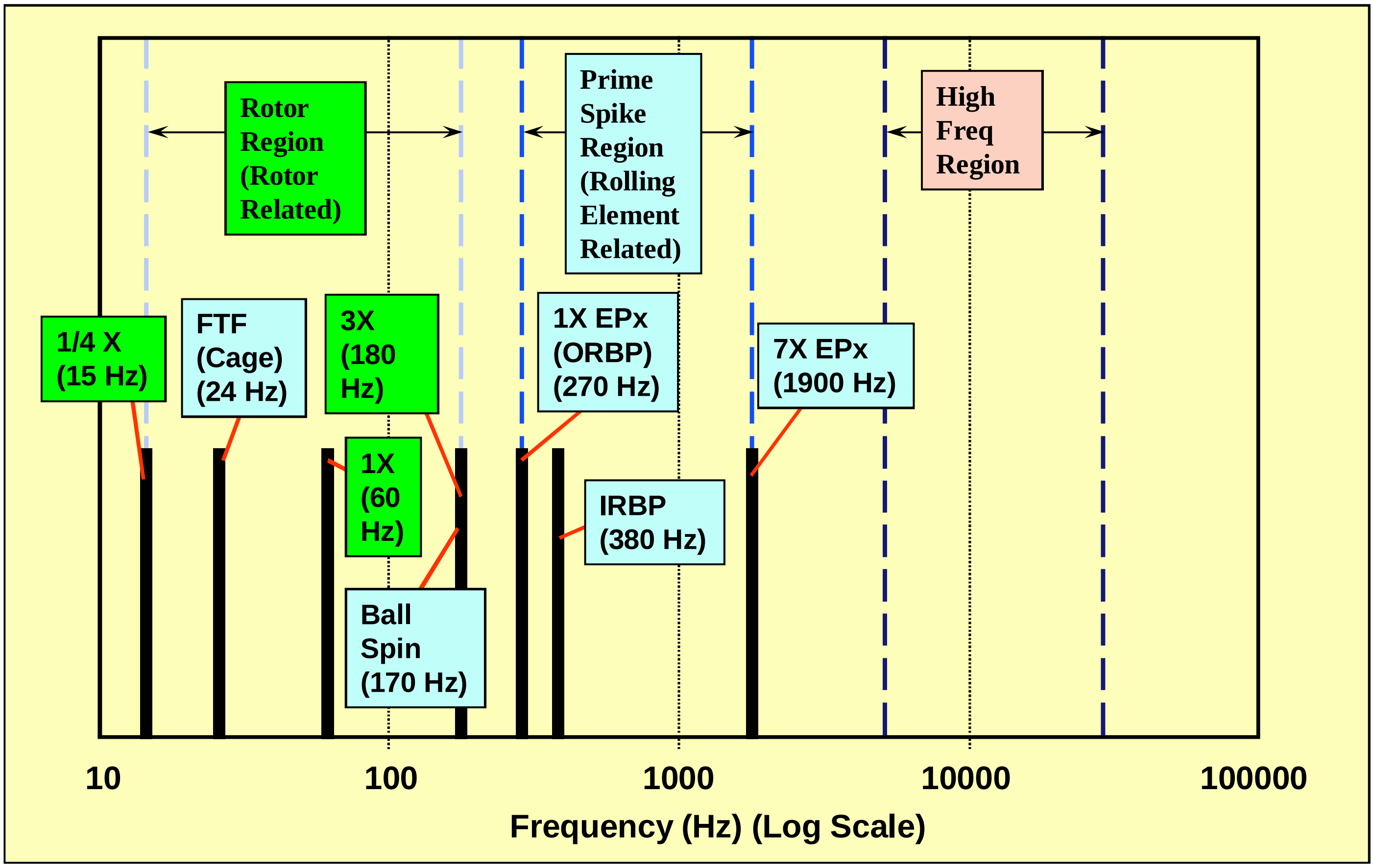
Online



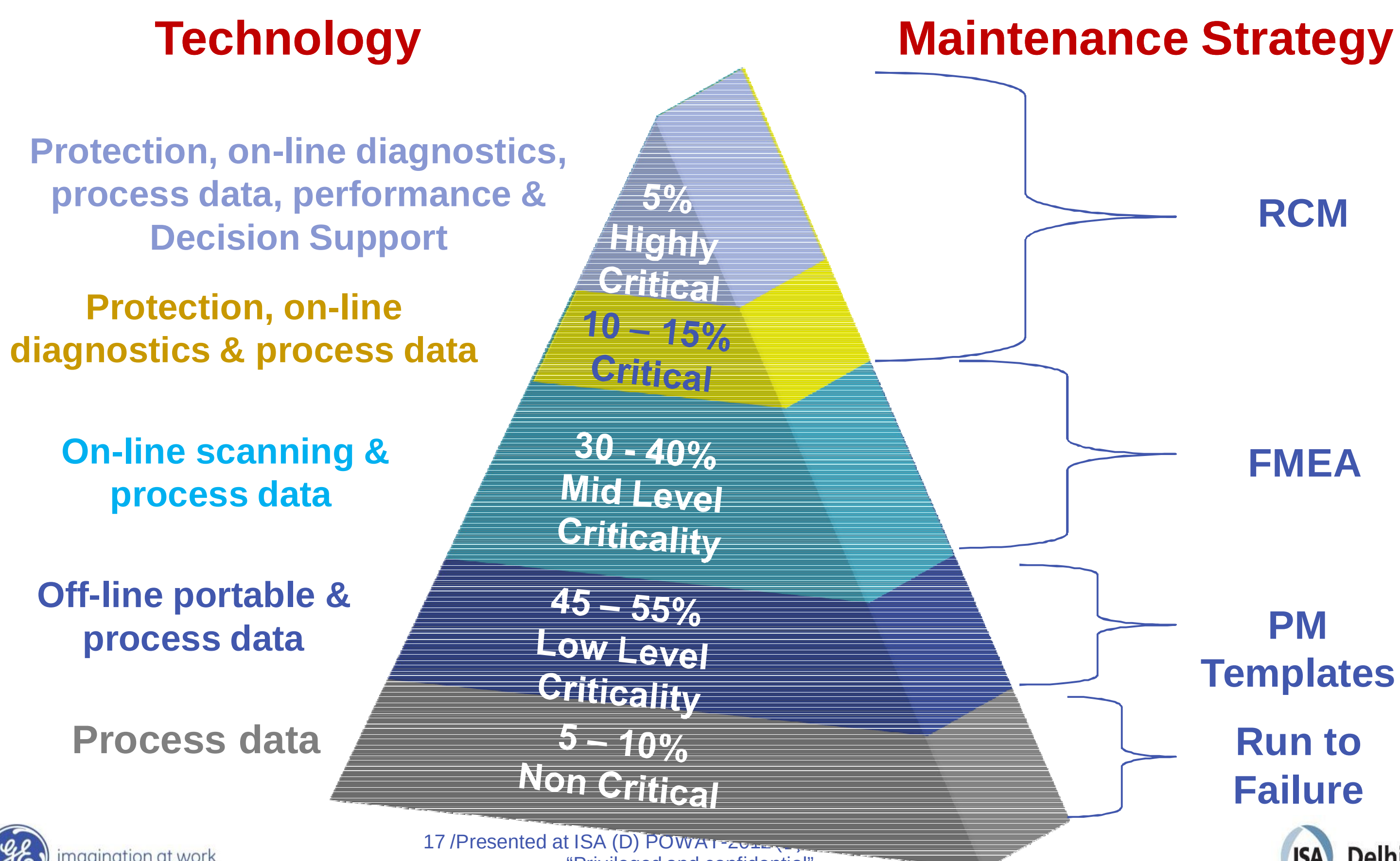


imagination at work

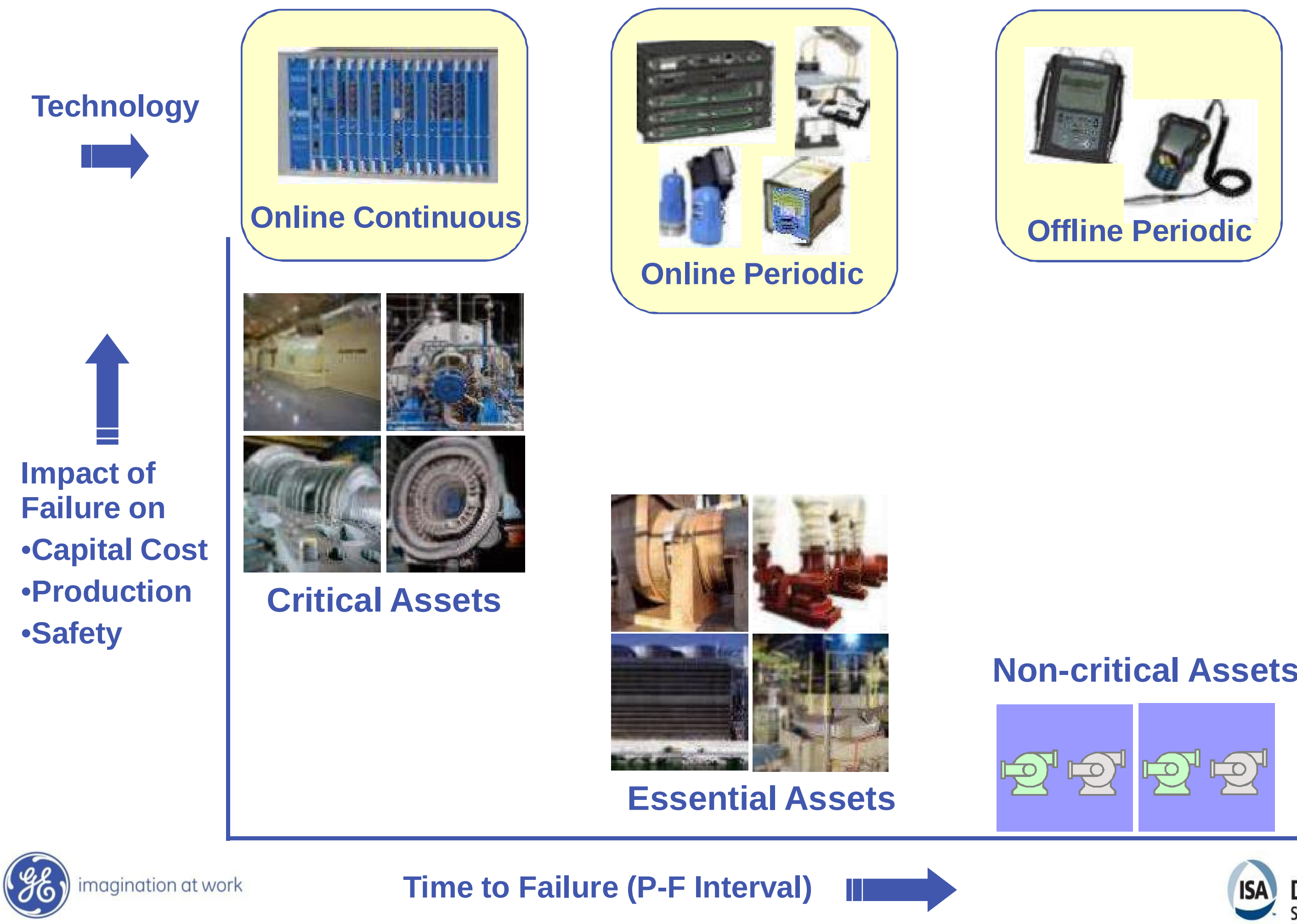
Frequencies of Interest (Example of one of the rolling element bearing frequencies)



Plant equipment criticality



Technology…appropriate to asset criticality



Predicting safe operating time

Fault types:

Start up faults, caused by faults in

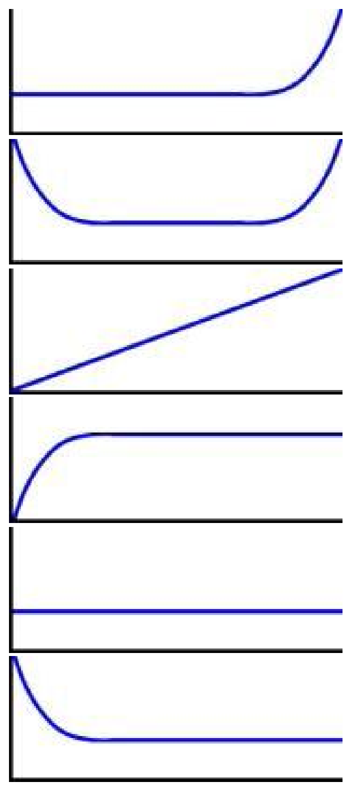
- Design
- Manufacturing
- Transportation
- Assembly
- Service
- Standby
- Startup

Random faults, caused by faults in

- Material
- External effects

Wear, caused by

- Normal wear
- Looseness
- Material degradation
- Overloading
- Environment

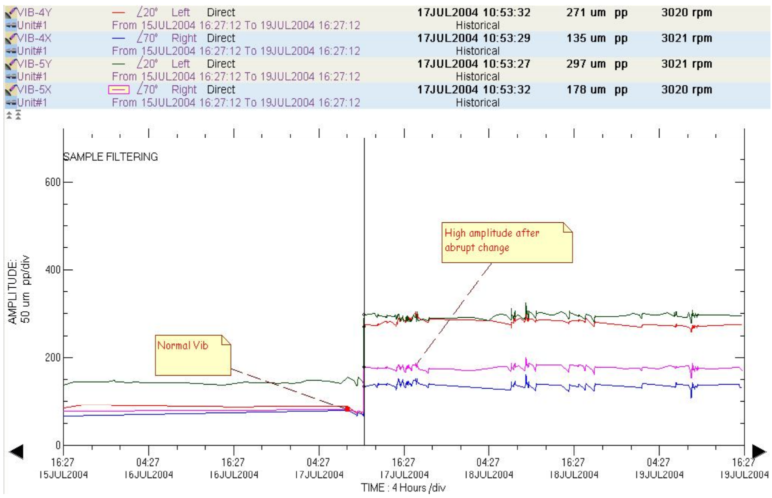


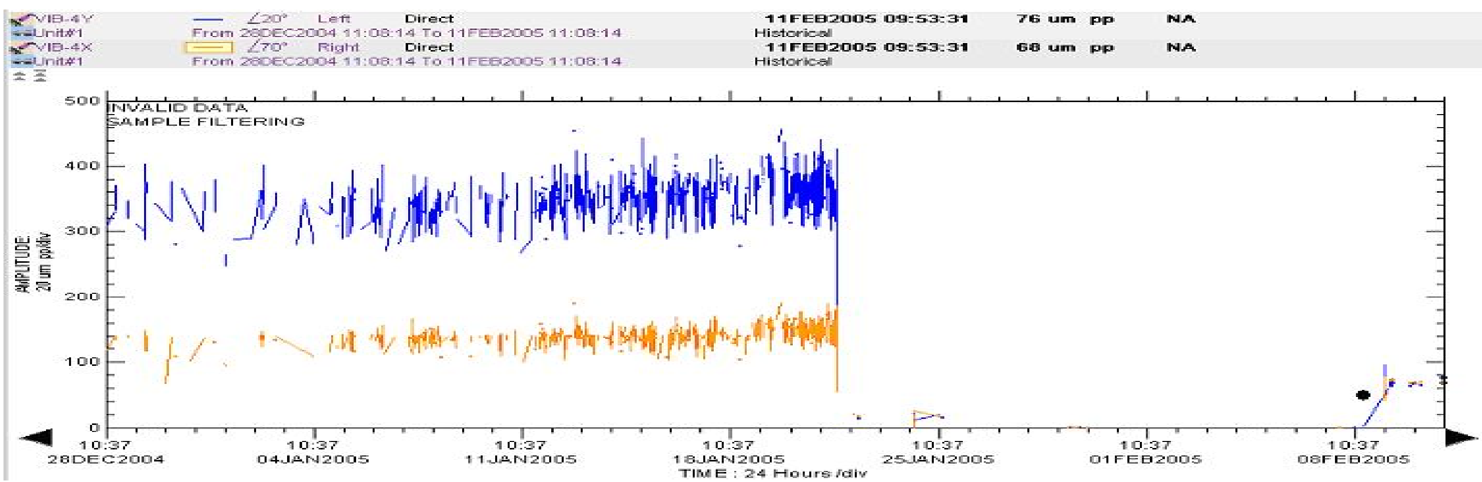
Monitor
Critically

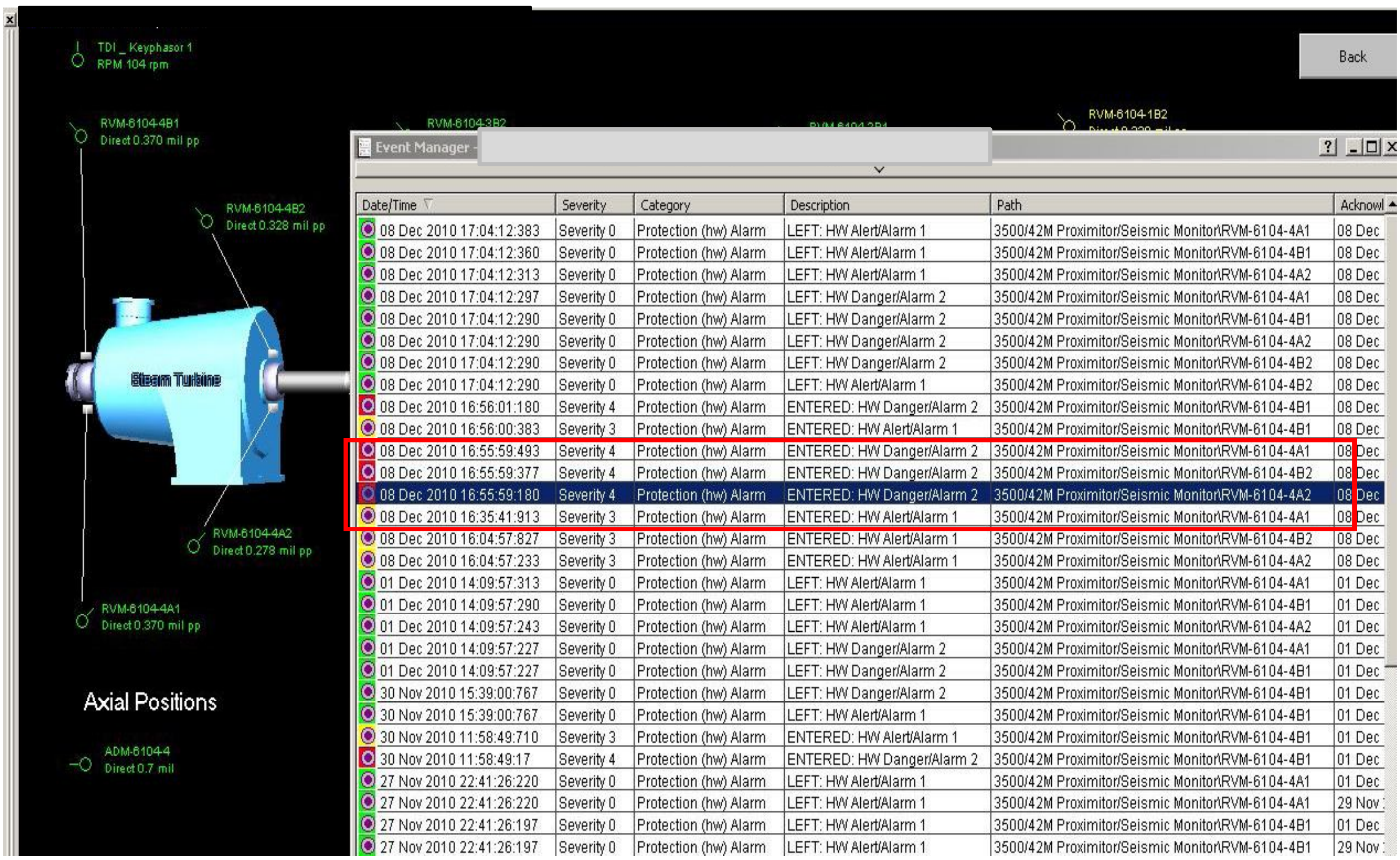
Detect
Early

Diagnose
Quick & Precise

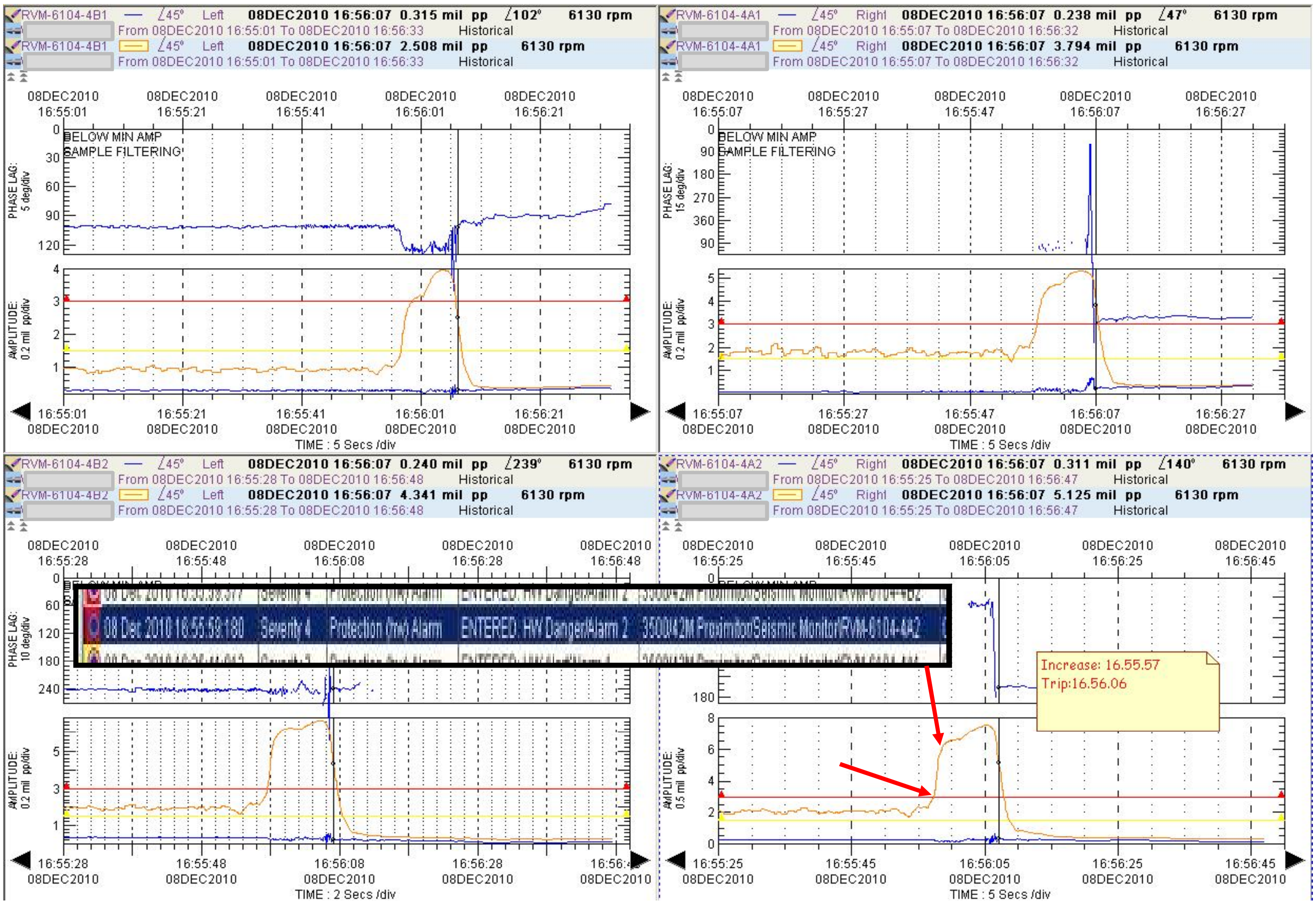
Mitigate
Risk of Operation

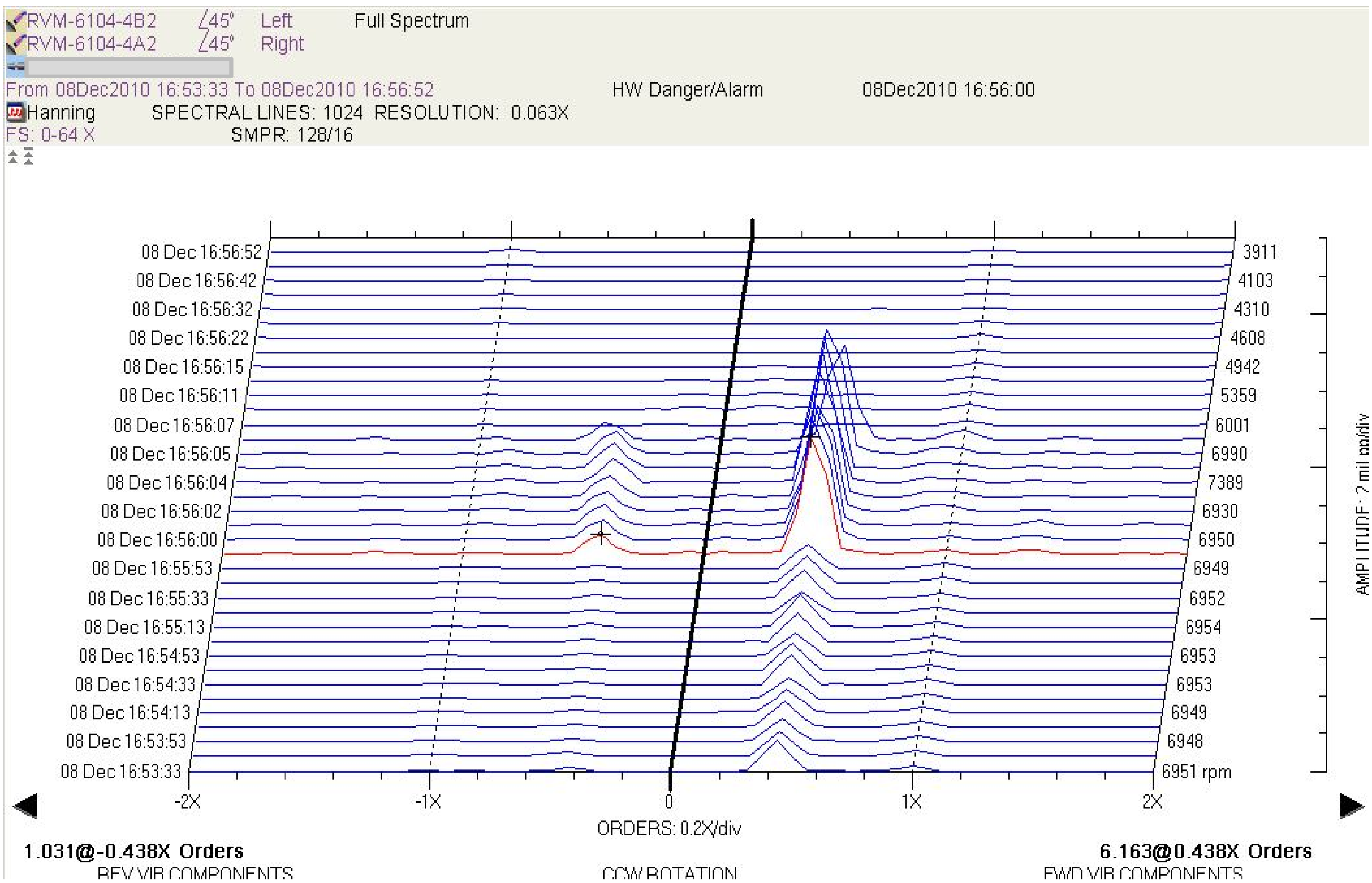

VIB-4Y Unit#1 ∠20° Left Direct From 15JUL2004 16:27:12 To 19JUL2004 16:27:12 17JUL2004 10:53:32 Historical 271 um pp 3020 rpm
VIB-4X Unit#1 ∠70° Right Direct From 15JUL2004 16:27:12 To 19JUL2004 16:27:12 17JUL2004 10:53:29 Historical 135 um pp 3021 rpm
VIB-5Y Unit#1 ∠20° Left Direct From 15JUL2004 16:27:12 To 19JUL2004 16:27:12 17JUL2004 10:53:27 Historical 297 um pp 3021 rpm
VIB-5X Unit#1 ∠70° Right Direct From 15JUL2004 16:27:12 To 19JUL2004 16:27:12 17JUL2004 10:53:32 Historical 178 um pp 3020 rpm
SAMPLE FILTERING
High amplitude after abrupt change
Normal Vib
AMPLITUDE: 50 um pp/div
TIME : 4 Hours /div

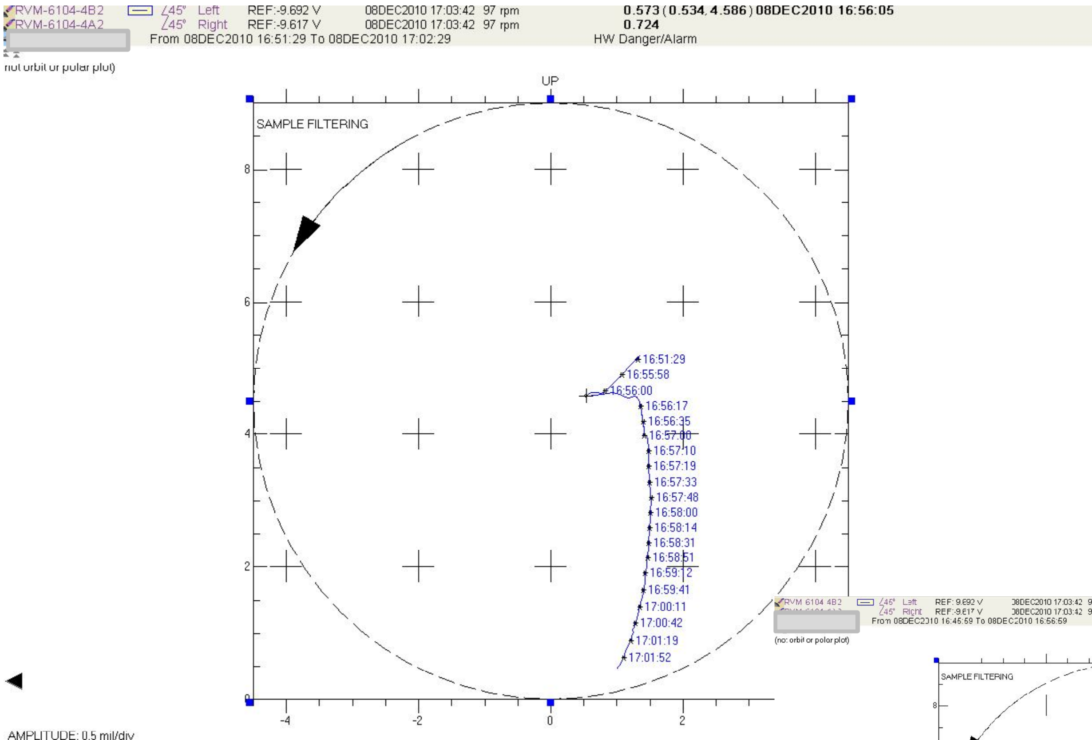

VIB-4Y Unit#1 ∠20° Left Direct From 28DEC2004 11:08:14 To 11FEB2005 11:08:14 11FEB2005 09:53:31 Historical 76 um pp NA
VIB-4X Unit#1 ∠70° Right Direct From 28DEC2004 11:08:14 To 11FEB2005 11:08:14 11FEB2005 09:53:31 Historical 68 um pp NA
INVALID DATA
SAMPLE FILTERING
AMPLITUDE: 20 um pp/div
TIME : 24 Hours /div

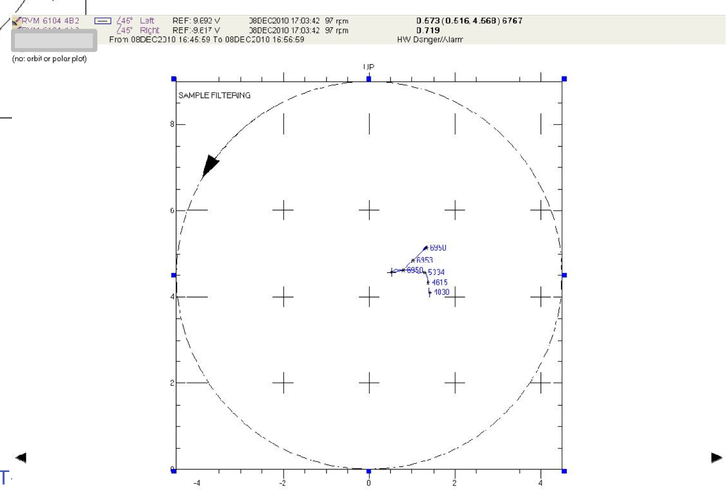


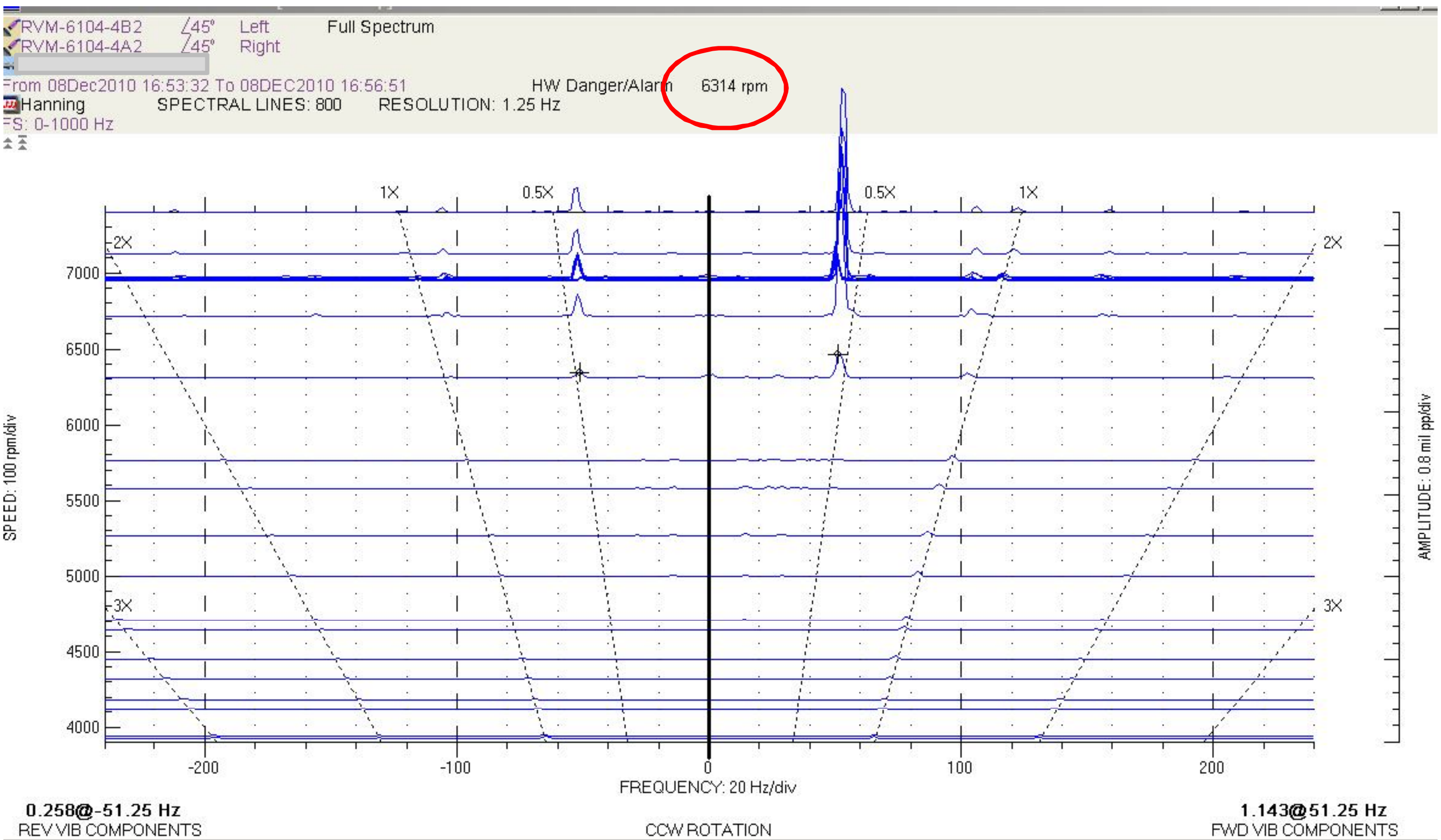
Date/Time	Severity	Category	Description	Path	Acknowl
08 Dec 2010 17:04:12:383	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	08 Dec
08 Dec 2010 17:04:12:360	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	08 Dec
08 Dec 2010 17:04:12:313	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A2	08 Dec
08 Dec 2010 17:04:12:297	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	08 Dec
08 Dec 2010 17:04:12:290	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	08 Dec
08 Dec 2010 17:04:12:290	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A2	08 Dec
08 Dec 2010 17:04:12:290	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B2	08 Dec
08 Dec 2010 17:04:12:290	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B2	08 Dec
08 Dec 2010 16:56:01:180	Severity 4	Protection (hw) Alarm	ENTERED: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	08 Dec
08 Dec 2010 16:56:00:383	Severity 3	Protection (hw) Alarm	ENTERED: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	08 Dec
08 Dec 2010 16:55:59:493	Severity 4	Protection (hw) Alarm	ENTERED: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	08 Dec
08 Dec 2010 16:55:59:377	Severity 4	Protection (hw) Alarm	ENTERED: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B2	08 Dec
08 Dec 2010 16:55:59:180	Severity 4	Protection (hw) Alarm	ENTERED: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A2	08 Dec
08 Dec 2010 16:35:41:913	Severity 3	Protection (hw) Alarm	ENTERED: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	08 Dec
08 Dec 2010 16:04:57:827	Severity 3	Protection (hw) Alarm	ENTERED: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B2	08 Dec
08 Dec 2010 16:04:57:233	Severity 3	Protection (hw) Alarm	ENTERED: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A2	08 Dec
01 Dec 2010 14:09:57:313	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	01 Dec
01 Dec 2010 14:09:57:290	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
01 Dec 2010 14:09:57:243	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A2	01 Dec
01 Dec 2010 14:09:57:227	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	01 Dec
01 Dec 2010 14:09:57:227	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
30 Nov 2010 15:39:00:767	Severity 0	Protection (hw) Alarm	LEFT: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
30 Nov 2010 15:39:00:767	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
30 Nov 2010 11:58:49:710	Severity 3	Protection (hw) Alarm	ENTERED: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
30 Nov 2010 11:58:49:17	Severity 4	Protection (hw) Alarm	ENTERED: HW Danger/Alarm 2	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
27 Nov 2010 22:41:26:220	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	01 Dec
27 Nov 2010 22:41:26:220	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4A1	29 Nov
27 Nov 2010 22:41:26:197	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	01 Dec
27 Nov 2010 22:41:26:197	Severity 0	Protection (hw) Alarm	LEFT: HW Alert/Alarm 1	3500/42M Proximitor/Seismic Monitor\RVM-6104-4B1	29 Nov


RVM-6104-4B1 ∠45° Left 08DEC2010 16:56:07 0.315 mil pp ∠102° 6130 rpm
From 08DEC2010 16:55:01 To 08DEC2010 16:56:33 Historical
RVM-6104-4B1 ∠45° Left 08DEC2010 16:56:07 2.508 mil pp 6130 rpm
From 08DEC2010 16:55:01 To 08DEC2010 16:56:33 Historical
RVM-6104-4A1 ∠45° Right 08DEC2010 16:56:07 0.238 mil pp ∠47° 6130 rpm
From 08DEC2010 16:55:07 To 08DEC2010 16:56:32 Historical
RVM-6104-4A1 ∠45° Right 08DEC2010 16:56:07 3.794 mil pp 6130 rpm
From 08DEC2010 16:55:07 To 08DEC2010 16:56:32 Historical
BELOW MIN AMP
SAMPLE FILTERING
PHASE LAG: 5 deg/div
AMPLITUDE: 0.2 mil pp/div
PHASE LAG: 15 deg/div
TIME : 5 Secs /div
RVM-6104-4B2 ∠45° Left 08DEC2010 16:56:07 0.240 mil pp ∠239° 6130 rpm
From 08DEC2010 16:55:28 To 08DEC2010 16:56:48 Historical
RVM-6104-4B2 ∠45° Left 08DEC2010 16:56:07 4.341 mil pp 6130 rpm
From 08DEC2010 16:55:28 To 08DEC2010 16:56:48 Historical
RVM-6104-4A2 ∠45° Right 08DEC2010 16:56:07 0.311 mil pp ∠140° 6130 rpm
From 08DEC2010 16:55:25 To 08DEC2010 16:56:47 Historical
RVM-6104-4A2 ∠45° Right 08DEC2010 16:56:07 5.125 mil pp 6130 rpm
From 08DEC2010 16:55:25 To 08DEC2010 16:56:47 Historical
08 Dec 2010 16:55:59.180 Severity 4 Protection (hw) Alarm ENTERED: HW Danger/Alarm 2 3500/42M Proximitor/Seismic Monitor/RVM-6104-4A2
PHASE LAG: 10 deg/div
AMPLITUDE: 0.5 mil pp/div
TIME : 2 Secs /div
TIME : 5 Secs /div
Increase: 16.55.57
Trip:16.56.06


RVM-6104-4B2 ∠45° Left Full Spectrum
RVM-6104-4A2 ∠45° Right
From 08Dec2010 16:53:33 To 08Dec2010 16:56:52
HW Danger/Alarm
08Dec2010 16:56:00
Hanning
SPECTRAL LINES: 1024 RESOLUTION: 0.063X
FS: 0-64 X
SMPR: 128/16
08 Dec 16:56:52
08 Dec 16:56:42
08 Dec 16:56:32
08 Dec 16:56:22
08 Dec 16:56:15
08 Dec 16:56:11
08 Dec 16:56:07
08 Dec 16:56:05
08 Dec 16:56:04
08 Dec 16:56:02
08 Dec 16:56:00
08 Dec 16:55:53
08 Dec 16:55:33
08 Dec 16:55:13
08 Dec 16:54:53
08 Dec 16:54:33
08 Dec 16:54:13
08 Dec 16:53:53
08 Dec 16:53:33
3911
4103
4310
4608
4942
5359
6001
6990
7389
6930
6950
6949
6952
6954
6953
6953
6949
6948
6951 rpm
-2X
-1X
0
1X
2X
ORDERS: 0.2X/div
AMPLITUDE: 2 mil pp/div
1.031@-0.438X Orders
REV VIB COMPONENTS
CCW ROTATION
6.163@0.438X Orders
FWD VIB COMPONENTS

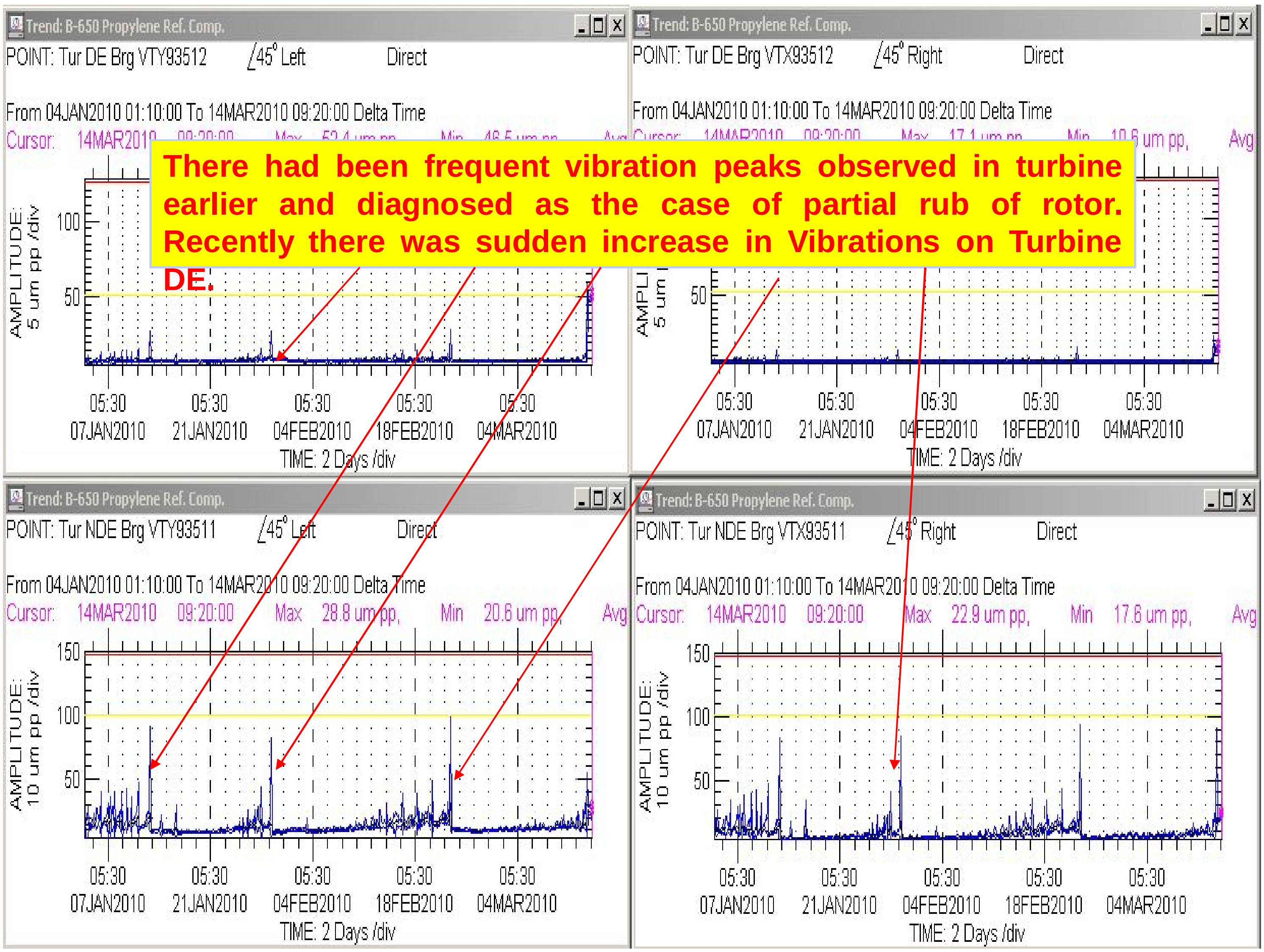

RVM-6104-4B2 ∠45° Left REF:-9.692 V 08DEC2010 17:03:42 97 rpm
RVM-6104-4A2 ∠45° Right REF:-9.617 V 08DEC2010 17:03:42 97 rpm
0.573 (0.534, 4.586) 08DEC2010 16:56:05
0.724
From 08DEC2010 16:51:29 To 08DEC2010 17:02:29
HW Danger/Alarm
UP
SAMPLE FILTERING
16:51:29
16:55:58
16:56:00
16:56:17
16:56:35
16:57:00
16:57:10
16:57:19
16:57:33
16:57:48
16:58:00
16:58:14
16:58:31
16:58:51
16:59:12
16:59:41
17:00:11
17:00:42
17:01:19
17:01:52
AMPLITUDE: 0.5 mil/div


0.573 (0.516, 4.568) 6767
0.719
HW Danger/Alarm
UP
SAMPLE FILTERING
AMPLITUDE: 0.5 mil/div

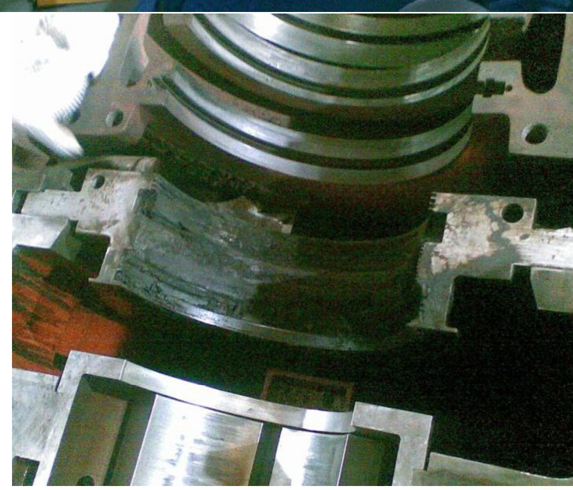


RVM-6104-4B2 ∠45° Left Full Spectrum
RVM-6104-4A2 ∠45° Right
From 08Dec2010 16:53:32 To 08DEC2010 16:56:51
HW Danger/Alarm
6314 rpm
Hanning SPECTRAL LINES: 800 RESOLUTION: 1.25 Hz
FS: 0-1000 Hz
1X
0.5X
0.5X
1X
2X
2X
3X
3X
SPEED: 100 rpm/div
AMPLITUDE: 0.8 mil pp/div
FREQUENCY: 20 Hz/div
0.258@-51.25 Hz
REV VIB COMPONENTS
CCW ROTATION
1.143@51.25 Hz
FWD VIB COMPONENTS

There had been frequent vibration peaks observed in turbine earlier and diagnosed as the case of partial rub of rotor. Recently there was sudden increase in Vibrations on Turbine DE.



NDE side Shaft Damage

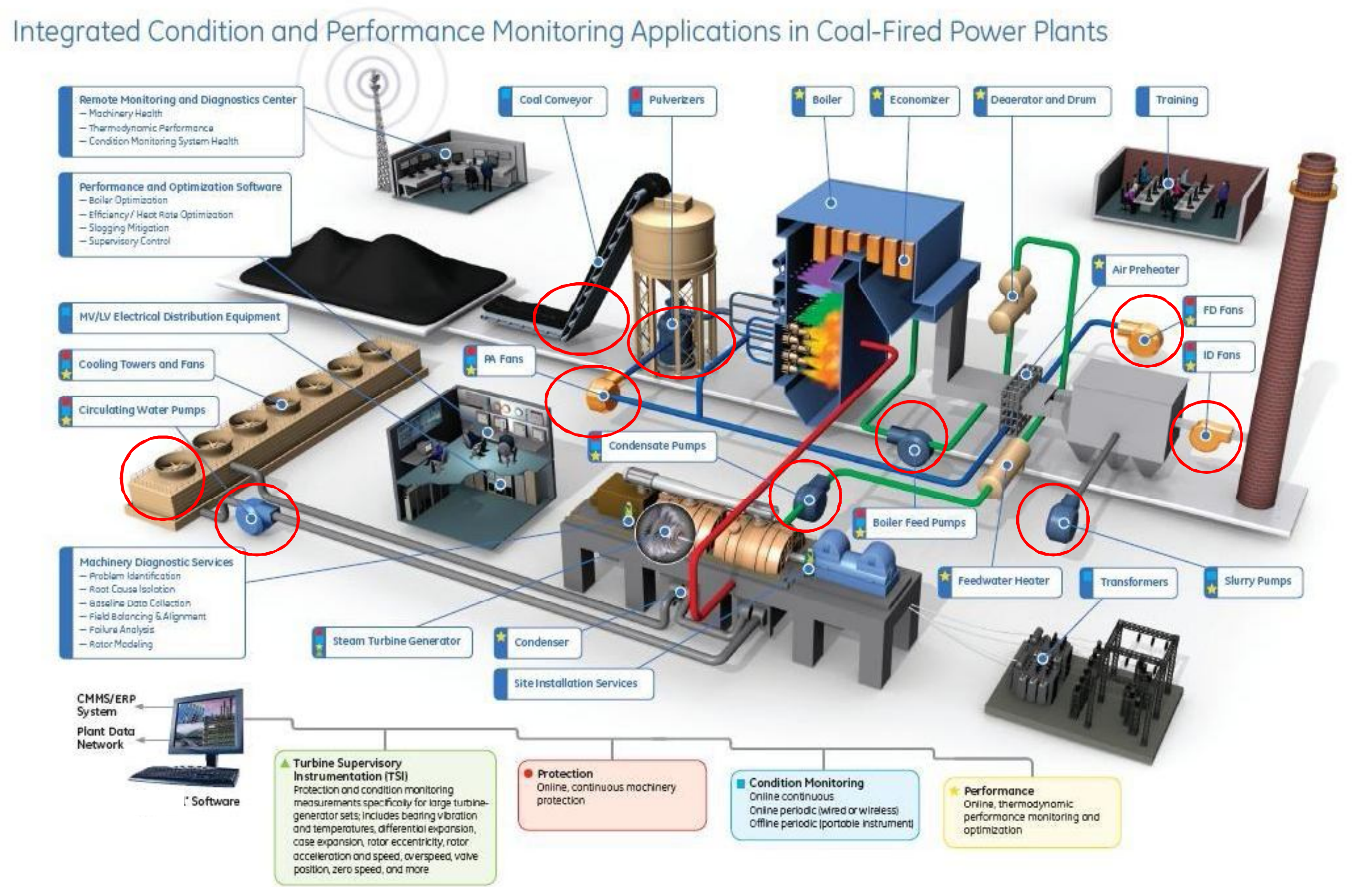


- Since Aug 2007, Turbine has been showing periodic spikes at NDE side. Machine has tripped twice on high vibration in this period.
- This is found to be due to heavy coke deposition and rubbing at NDE side oil labyrinth
- Rubbing with coke has caused deep scoring and grooving on corresponding shaft area for 100 mm width and 35 mm deep

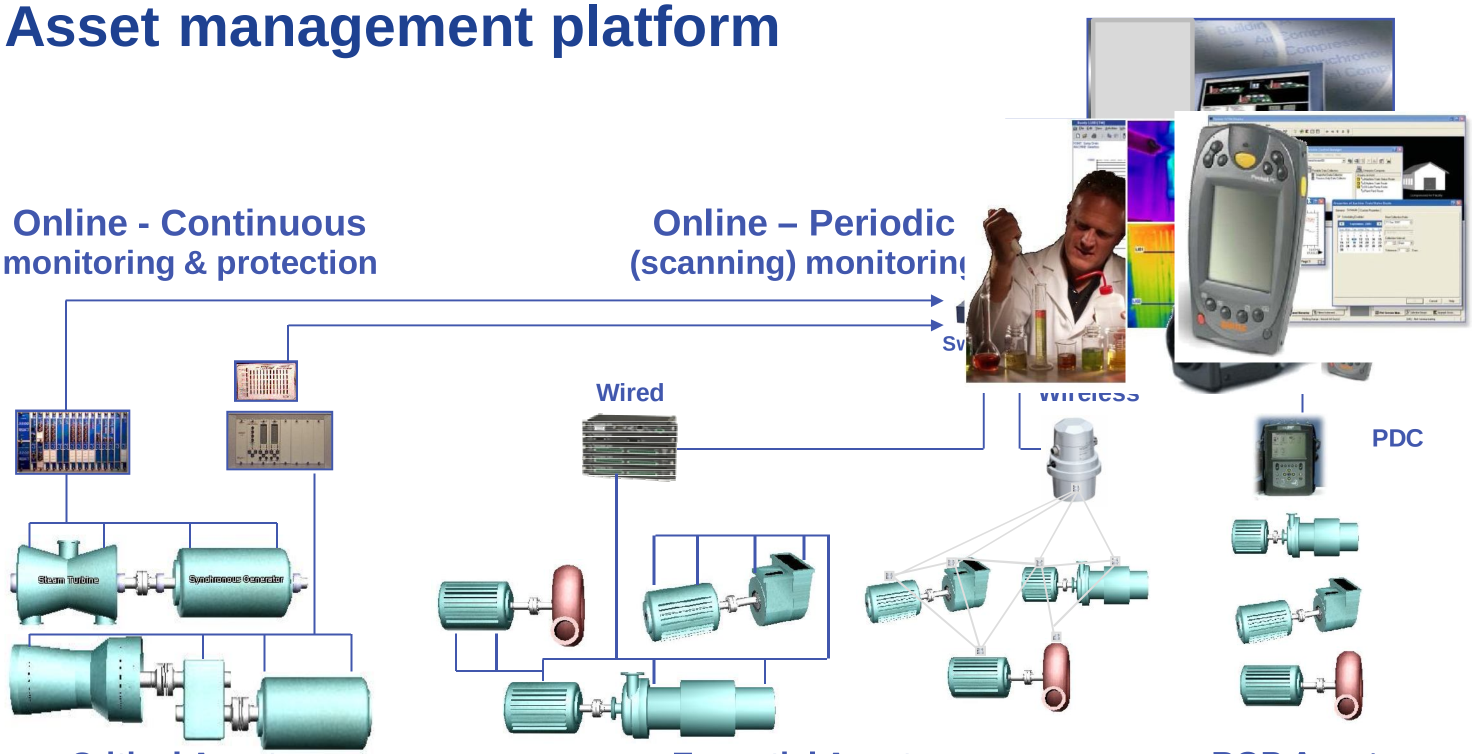
imagination at work

ISA Delhi Section

Essential Machines in Thermal Power Plant



Asset management platform



Critical Assets

- Gas Turbines
- Steam Turbines
- Generators
- Pumps
- Etc.

Essential Assets

- Fans
- Pumps
- Blowers
- Motor
- Etc.

BOP Assets

- Vibration
- Portable Devices
- Lube Oil
- Thermography
- MCA, etc…

Thank you!

Back Up

Determining Business Impact

Maintenance Strategies

Safety

> Could a machine failure cause people to be injured?

Environment

> Could a failure release hazardous materials or result in a fine by exceeding permitted levels?

Process

> Could a failure reduce production capability?

Maintenance

> Could a failure require repair work? Are parts expensive?

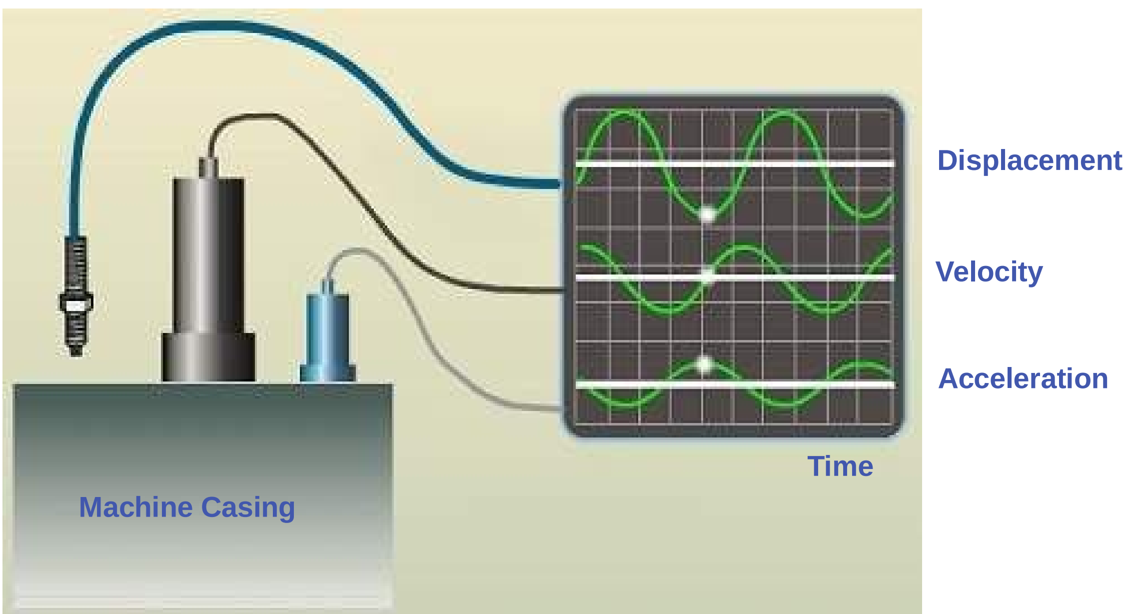
Quality

> Could a failure reduce the quality of the product being produced by the business?

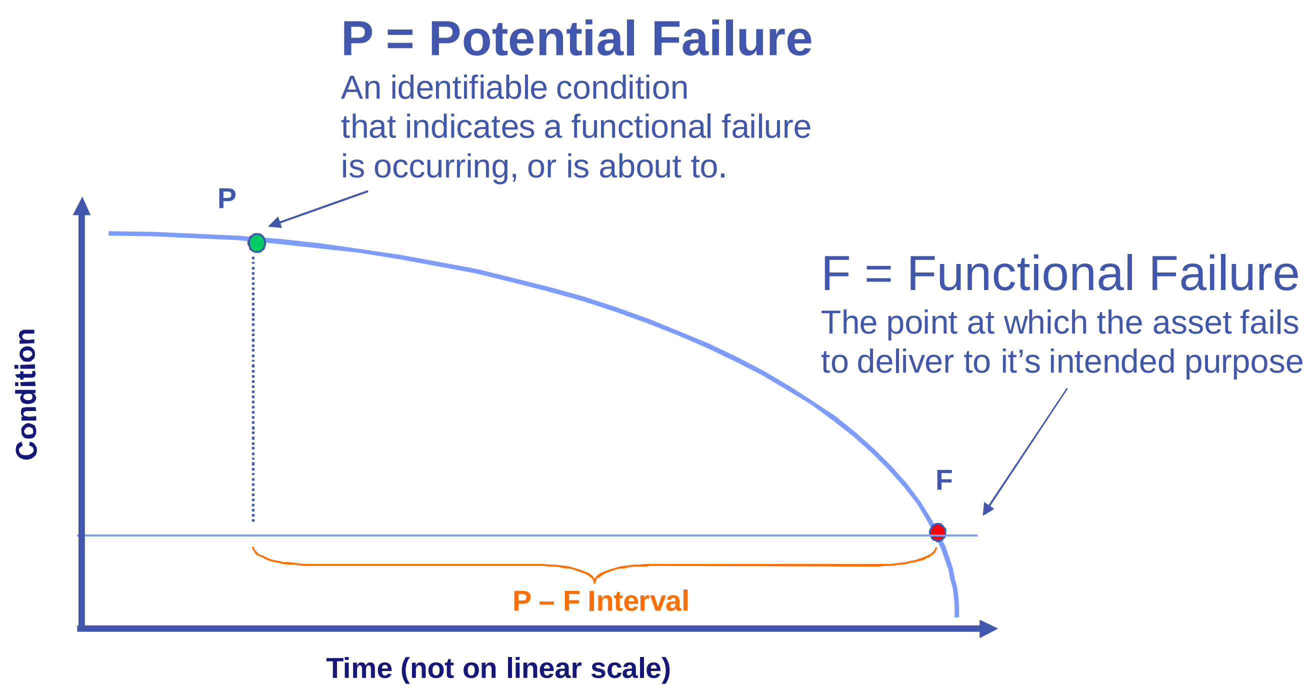
What is the FINANCIAL impact of a machine failure on the business?

Machine Casing Example

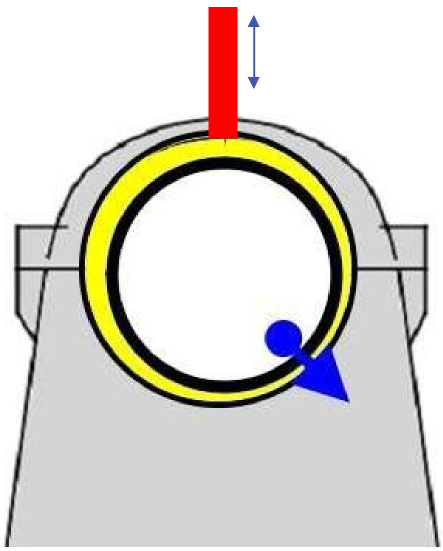
Physical Parameters



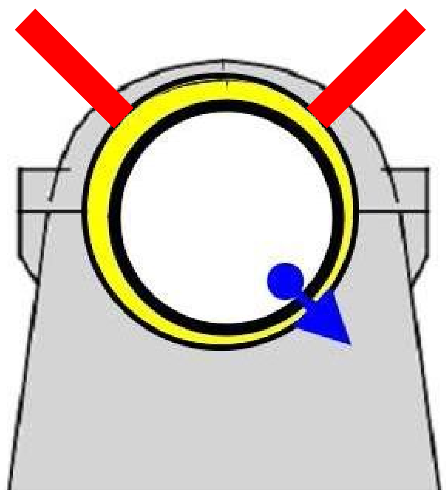
P-F interval



On essential assets P-F interval runs into numbers of days

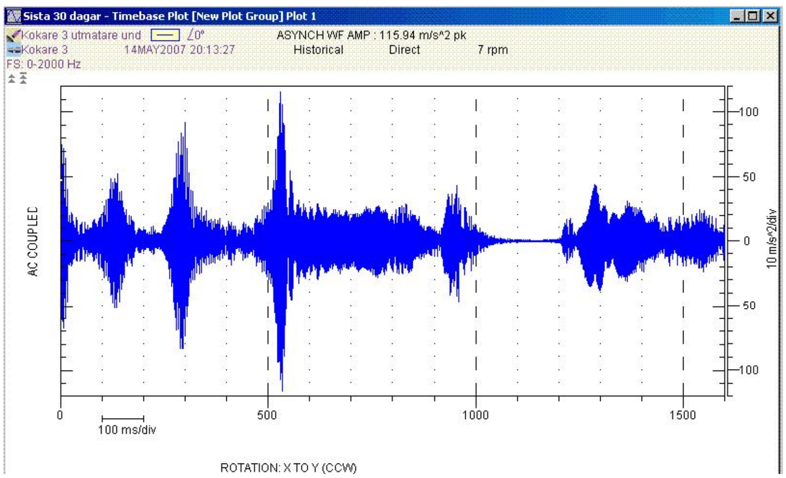


A single vibration sensor can only measure motion in one direction.



A pair of vibration sensors can measure motion in two directions at once.

Online Scanning Monitoring



Lubrication problem on a slow speed machine

- Very high acceleration peak >100 m/s2
- Clear indication of loss of lubrication

Online, scanning or portable?

Online:

- Protection is needed = failure can happen in seconds
- Operating stages vary rapidly (in seconds)
- Safety and large production losses

Scanning:

- Failure may happen too fast for PDC
- Accessibility
- Safety
- Operation stages do vary, but are not constantly changing
- Vibration data quality, especially at high frequency end
- Early problem detection
- Reduction of manpower

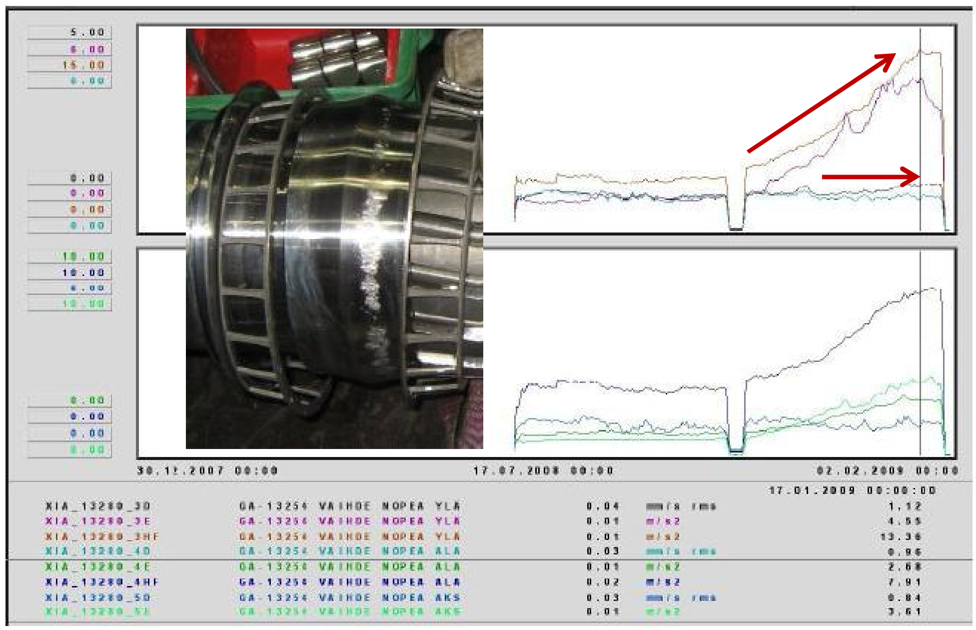
PDC:

- When failure development takes weeks
- Should allways be in place to complement online/scanning systems
- In the starting phase of a CM program usually the first system to be used
- Bedegatory constraints

Online Scanning Monitoring

Seawater pump gearbox REB failure case:

Scanning



Overhaul in Sept'08… increase in high frequency trend upward, no increase in Velocity trend

Jan'09… bearing opened and inner ring failure was observed

Predicting safe operating time

Generally *fault prediction is based on assumption that the value of the symptom is higher when the fault is more severe.*

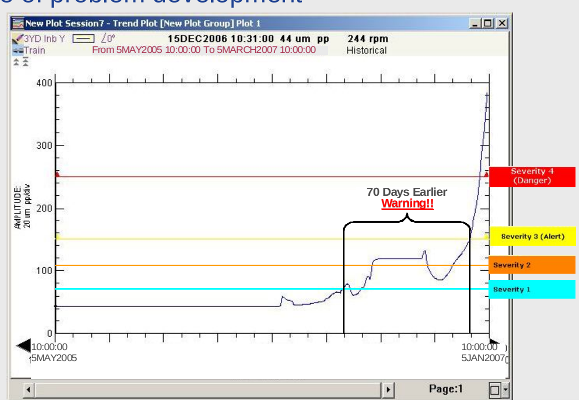
*When a failure development is recognized it may require **additional measurements** or added monitoring with same or additional technique*

Overhaul date is defined by

- > predicted danger
- > how rapid the fault development is
- > secondary failures
- > how true the danger limit is
- > failure history
- > MTBF
- > allowed failure
- > known overhaul dates
- > loss of production
- > uptime requirements
- > total costs, etc

Alarming

- Example of problem development

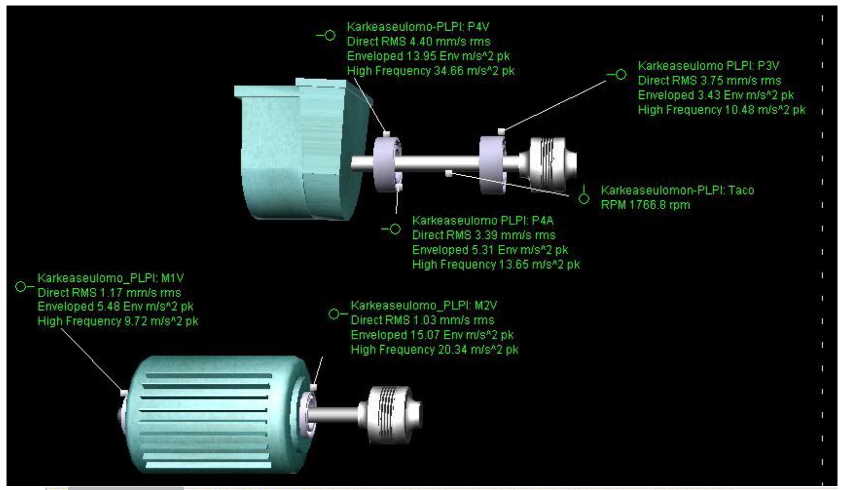


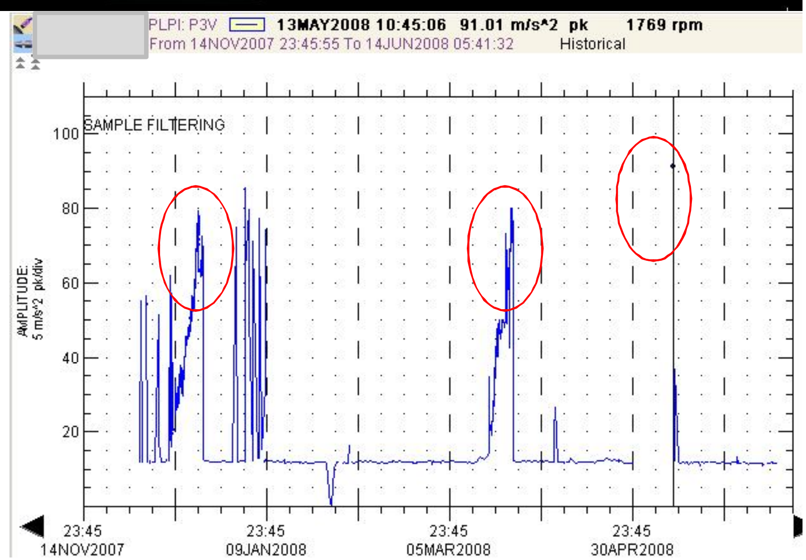
Bearing failures

Improper lubrication

Belt driven fan – DE Brg
direct input cards
Accelerometer

Problems on Fan DE
In the past several bearing failures now caught in time with HF measurement 3 times in 6 months





Selection of transducer

Selection of Monitoring System

Preparedness for Surprises

Terminology

The four main maintenance strategies are:

- Reactive Maintenance (RM)
- Preventive Maintenance (PM)
- Predictive Maintenance (PdM)
- Proactive Centered Maintenance (PCM)

Terminology

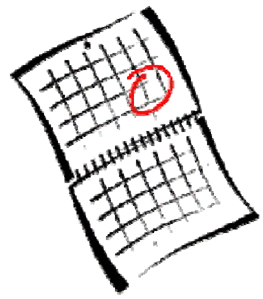
Reactive maintenance (RM):

- Maintenance performed after a failure or after an obvious, unforeseen threat of immediate failure.

- In reactive maintenance, machines are operated in a run-to-failure (RTF) mode

- Daily maintenance activities are driven by unforeseen problems from assets breaking down without detection of the impending failure.

Terminology



Preventive Maintenance (PM):

• Maintenance tasks conducted at regular, scheduled intervals based on average statistical/anticipated lifetime to avoid failure

• Includes inspection, service and/or replacement

• Intervals may be calendar or operating time.

Terminology

Predictive Maintenance (PdM):

- Maintenance based on the actual asset condition (objective evidence of need)
- Assessment data obtained from in-situ, non-invasive tests and operating & condition measurements
- Also referred to as Condition Based Maintenance (CBM).

Terminology

Proactive-Centered Maintenance (PCM):

- A program of continuous maintenance optimization
- Based on feedback from Root Cause Failure Analysis (RCFA) repairs, quantitative PM’s, PdM routines, CM systems and operations.

Terminology – other acronyms…

- **MTBE**: Mean Time Between Events
- **MTBF**: Mean Time Between Failure
- **MTBR**: Mean Time Between Repairs
- **MTTR**: Mean Time To Repair
- **MRO**: Maintenance, Repair, Overhaul
- **OEM:** Original Equipment Manufacturer
- **O&M**: Operating and Maintenance
- **ERP**: Enterprise Resource Planning

Terminology

Condition Monitoring (CM):

• The process of recording measurements that define condition without disrupting operation

• Examples are vibration, fluid & electrical characteristics and thermal gradients

• Measurements are compared to their limits.

Terminology

Reliability Centered Maintenance (RCM):

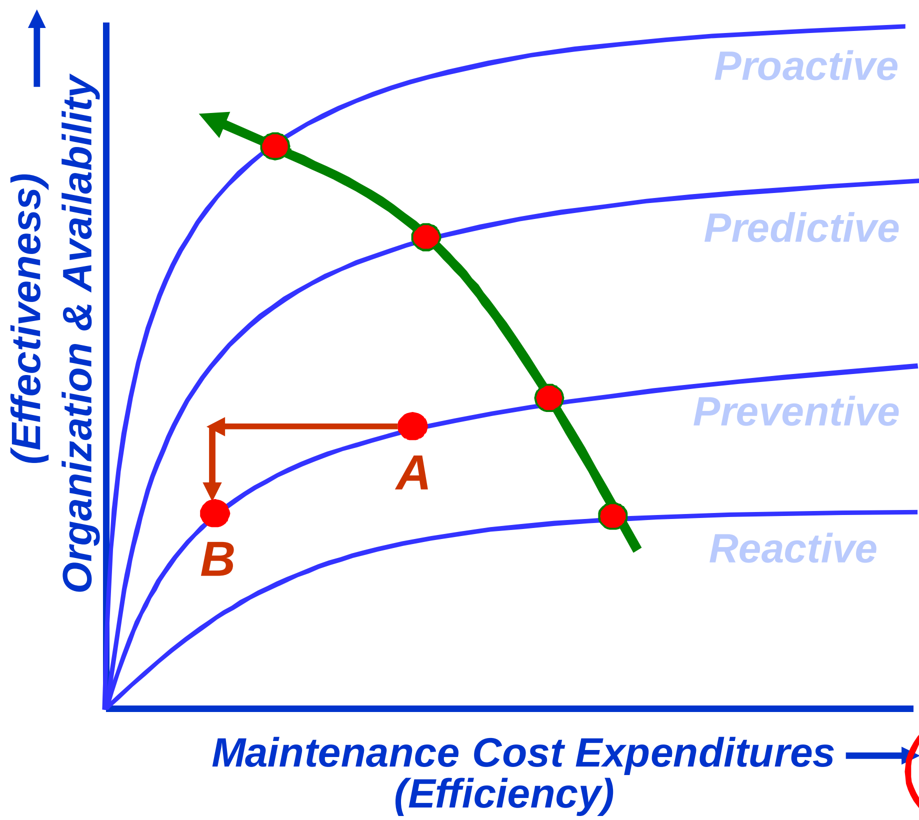
- A systematic, disciplined process to ensure safety and mission compliance that defines system boundaries and identifies system functions, functional failures, and likely failure modes for equipment and structures in a specific operating context.
- RCM develops a logical identification of the causes and effects (consequences) of system and functional failures to arrive at an efficient and effective asset management strategy to reduce the probability of failure.

Terminology

Functional Failure:

- The System is no longer capable of performing the intended function.
- For example, a pump that is designed to produce 100 gpm at 200 psi is considered to have functionally failed if it can only produce 90 gpm at 200 psi.

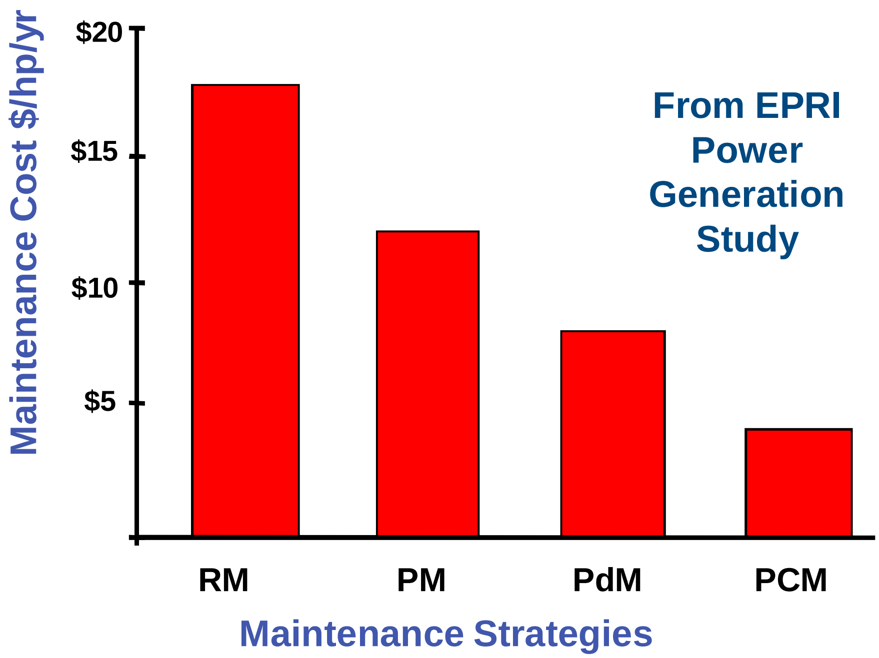
Maintenance strategies



Type of maintenance	Top Quartile	Lower Quartile
Proactive	>20%	0% >65%
Predictive	>45%	~12%
Preventive	>25% ~86%	~31%
Reactive	<10%	~55%
	100%	100%

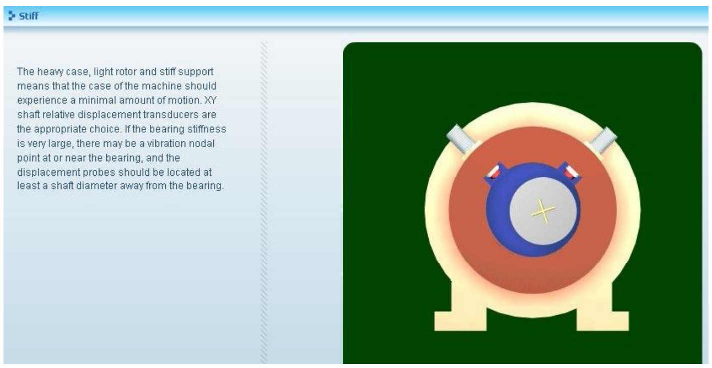
Sources:
- Society of Maintenance & Reliability Professionals Survey
- The Business Case for Reliability Robert DiStefano, John Schultz

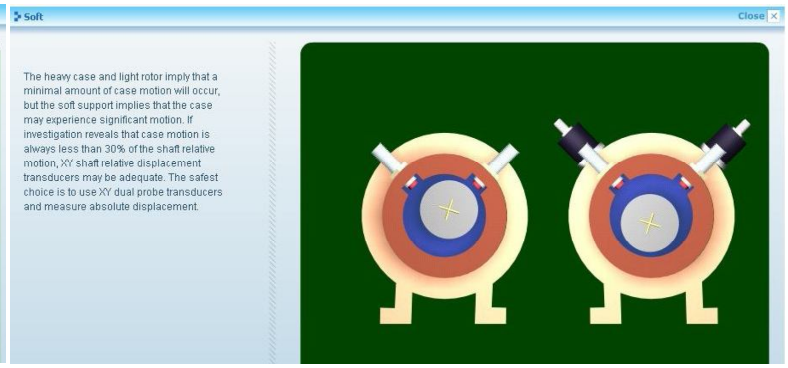
Comparative maintenance spend

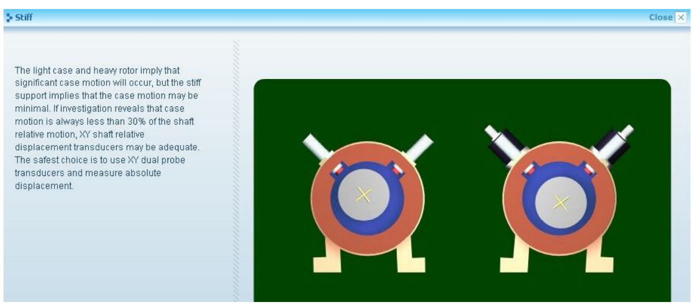


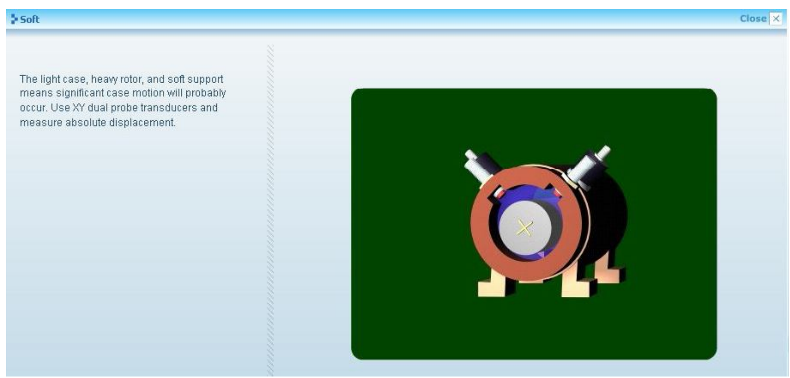
Note: This chart represents established programs

Case 1: Transducer selection for fluid film bearing considering Case to mass ratio

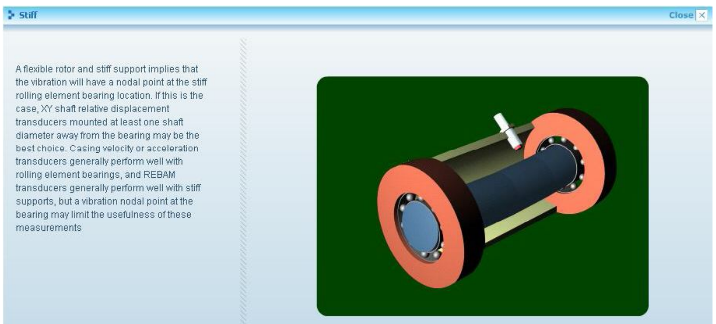


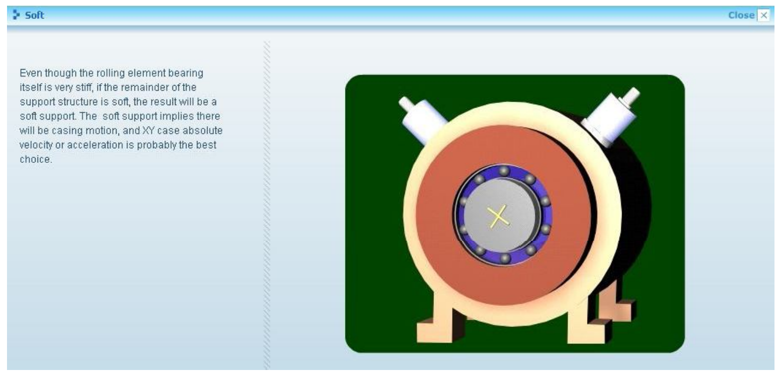


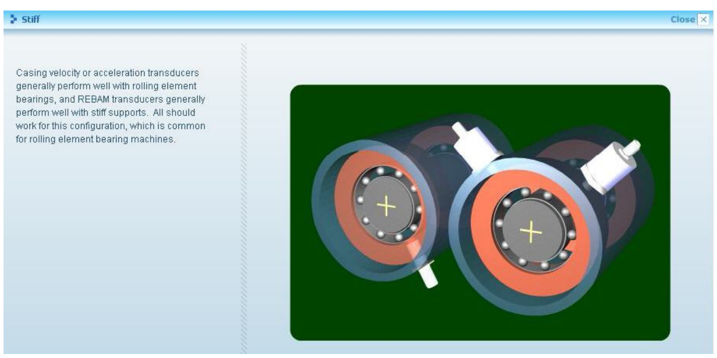


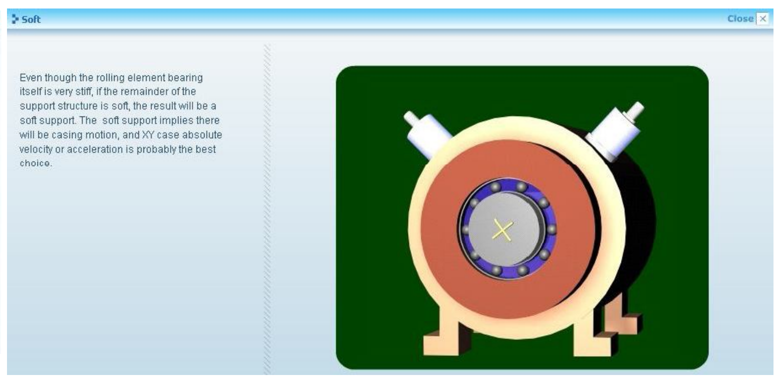


Case 2: Transducer selection for antifriction bearing considering rotor type

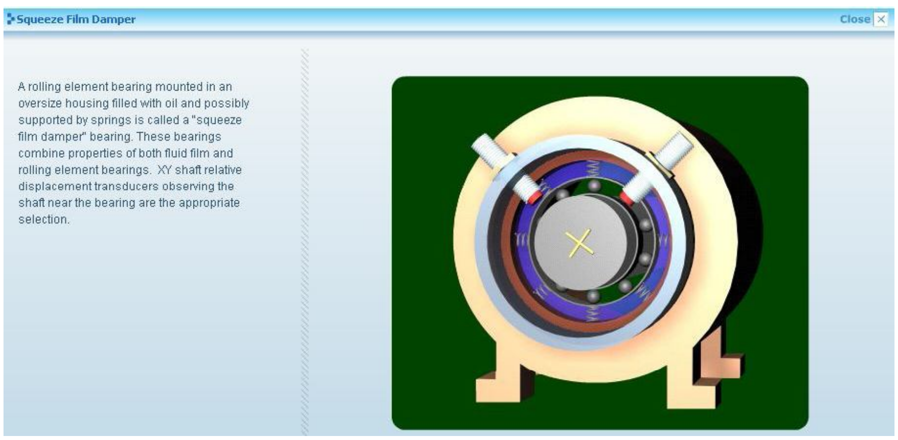








Case 3: Transducer selection for squeeze film damper bearings



Case Study – Remote Operations and Monitoring of Power Station and Managing security with remote access.

ISA Delhi Section

origin

Presentation: ISA POWAT 2012

Location: The Grand, New Delhi

Date : 13-14th Jan. 2012

Together we can make a difference.™

Overview

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- Origin – Generation portfolio
- Remote operational capability at Origin Power Stations
- Establish remote operation for Peaking Power Station
- Security measures considered and implemented
- Centralised Remote Operations – Tangible Benefits and security threats.

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origin

Origin – Generation Portfolio

Origin Energy – Company Overview

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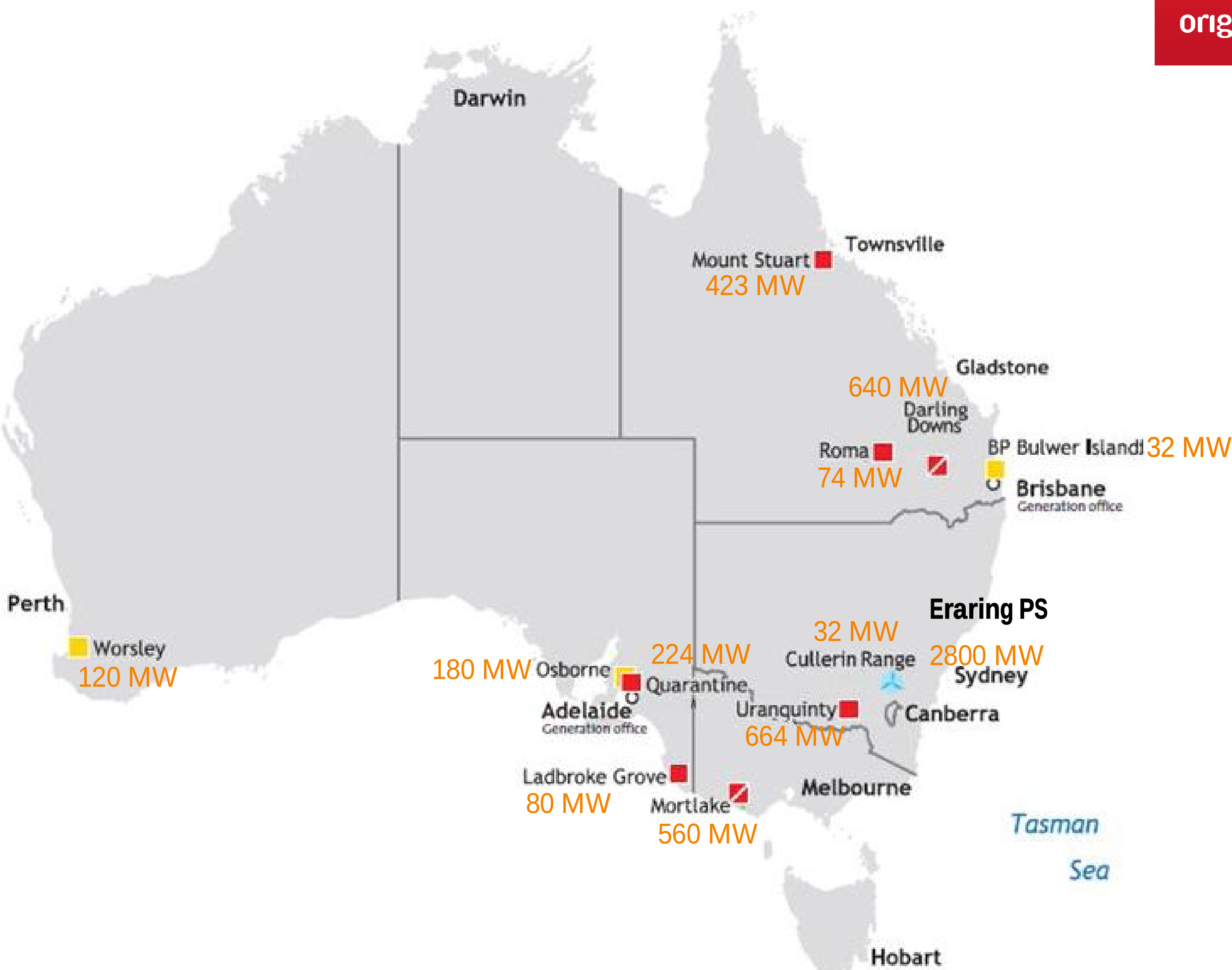
- 4500 Employees
- Major Business Units
  - Power Generation
  - Gas drilling, processing and pipeline distribution
  - Energy Trading
  - Energy Retailing
  - APLNG

One of the Australia’s largest, most diversified generators with capacity and contractual arrangements in excess of 5,800 MW.

AND Australia’s largest Energy Retailer with 4.6 million customer accounts.

Generation Portfolio



Generation portfolio

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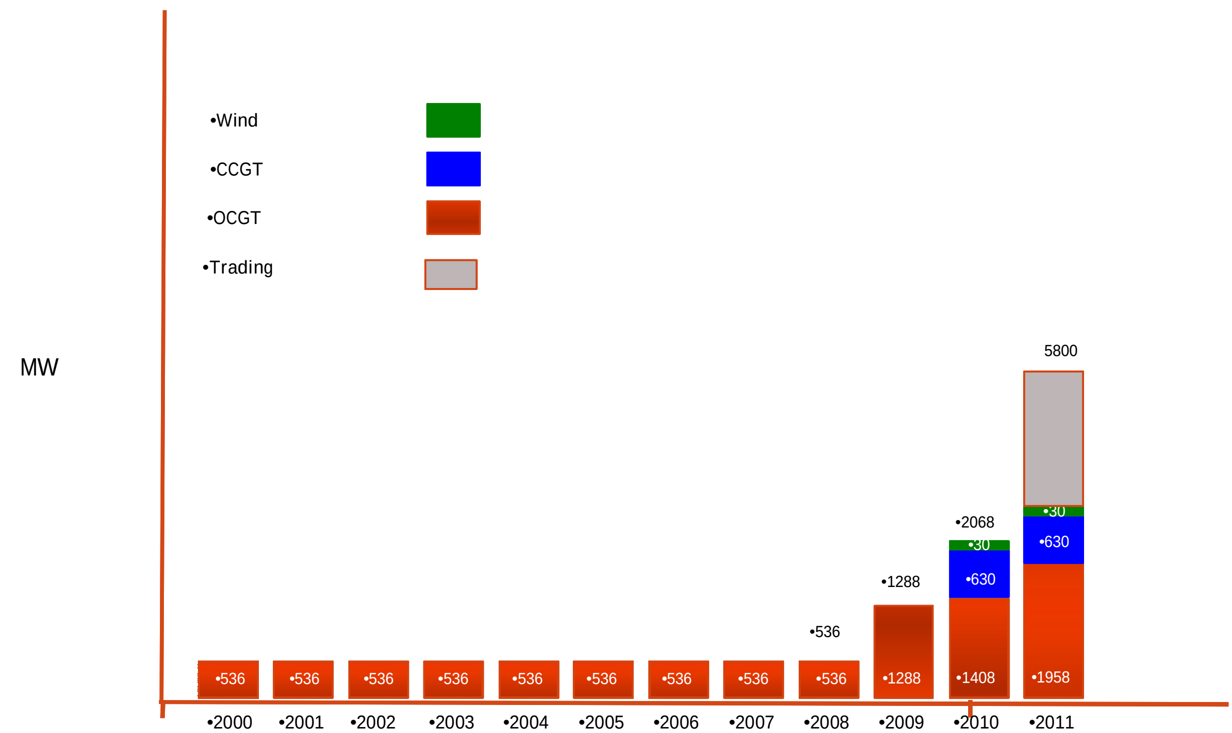

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Remote operational capability at power stations

Remote Operational Capability

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- Operated by NSPs like Powerlink and Electra-net
  - – Roma Power Station – 74 MW
  - – Ladbroke Grove Power Station – 80 MW
  - – Quarantine Power Station – 224 MW

- Operated by Origin Generation
  - – Mt Stuart Power Station *(Local operation) - 423 MW*
  - – Darling Downs Power Station *(Local operation) – 640 MW CCGT*
  - – Uranquinty Power Station *(operated by Traders – interim measure) – 664 MW*
  - – Mortlake Power Station *(will be commissioned in early 2012) – 580 MW*

Remote Operation of peaking power station

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- Uranqui
- Siemens
- Control

Remote operational Requirements

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- Minimise reaction time to have units available and run up to full load.
- Maximise opportunity to trade electricity in volatile market.
- Optimise site resources.
- Increase availability and start reliability.
- Reduced risk of human intervention and error which has potential to cause delays.
- Buildup in house capability.
- Pilot trial project to support large scale growth in future.

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Establish remote operation for peaking power station

Establish Remote Operation for Peaking Power Station

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origin

- Challenges to establish remote operation for peaking power Station.
- Overview of control system

Challenges to establish remote operation for peaking power Station.

Together we can make a difference.™

- Train Commercial traders to operate power plant:

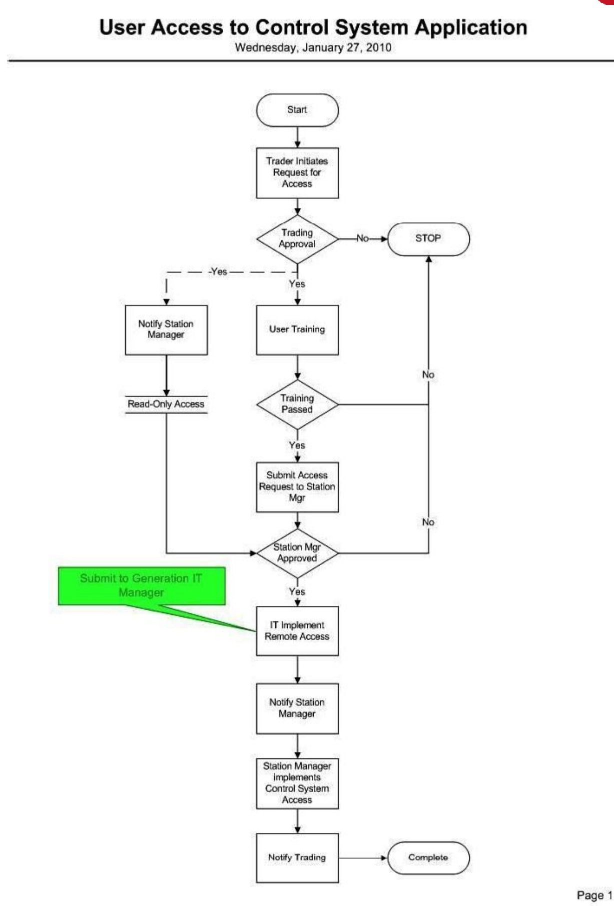
  Plant Operational Competency Model which includes:

  - Plant Operational Training package
  - Customized HMI for Traders
  - Customised and Limited DCS hands on operational training.
  - Theory and practical test.
  - Final signoff to allow unit operation from customised HMI.

Challenges to establish remote operation for peaking power Station - Contd.

Together we can make a difference.™

- User Access Control
- Operational Procedures
- Customised logic design Strategy
- Documentation
- Alarm Escalation
- Emergency Trip situation
- Alarm Standardisation



Connecting to Plant Control System (SPPA T3000) - Overview

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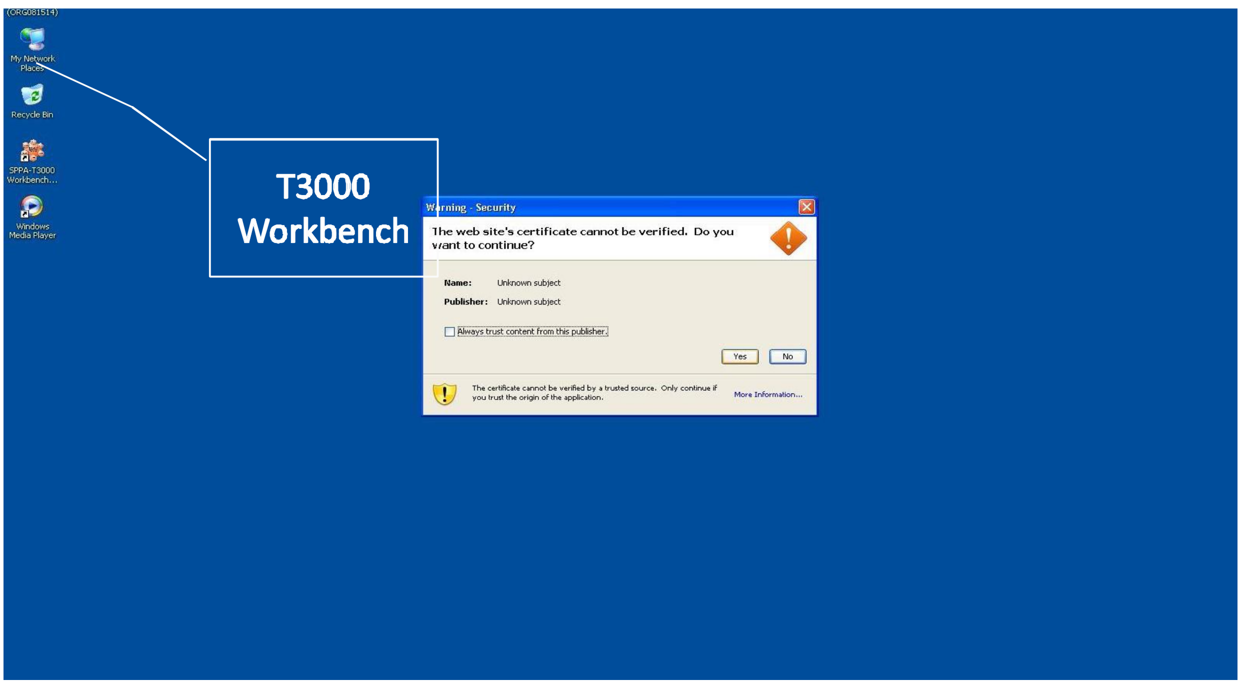
origin

- Remote desktop into Client PC meant for dedicated T3000 workbench application.
- Open SPPA T3000 workbench application
- Only Authorised users can login.



Uranquinty Control System Access

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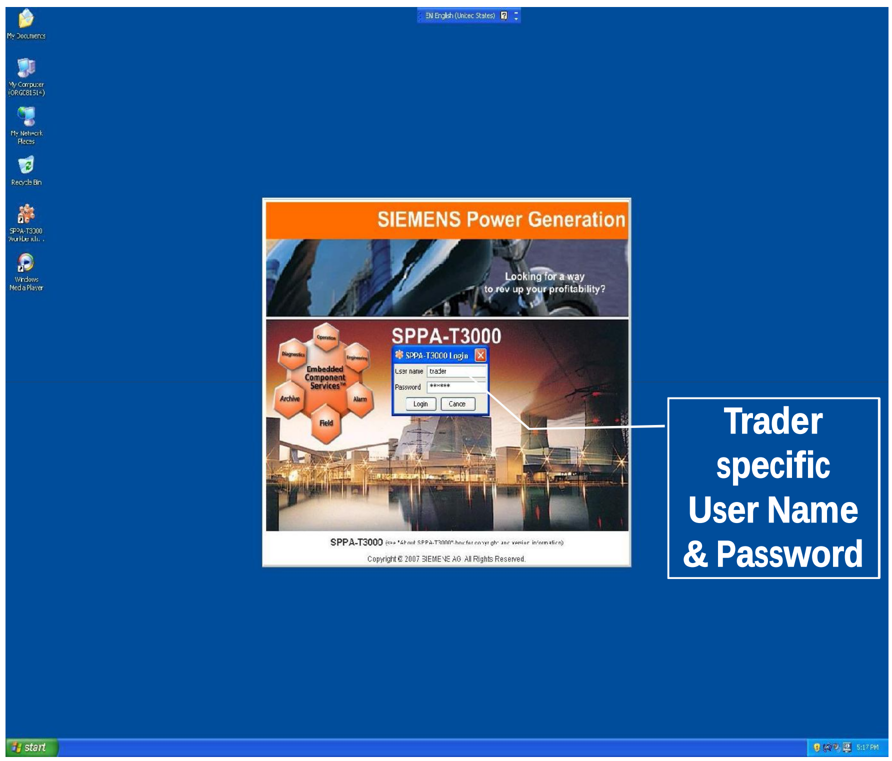
- A login will be created for all authorized members of the trading team. Type in user specific Username and Password.
- User name: Specific to each individual trader
- Password: Specific to each individual trader



Customised HMI for Traders

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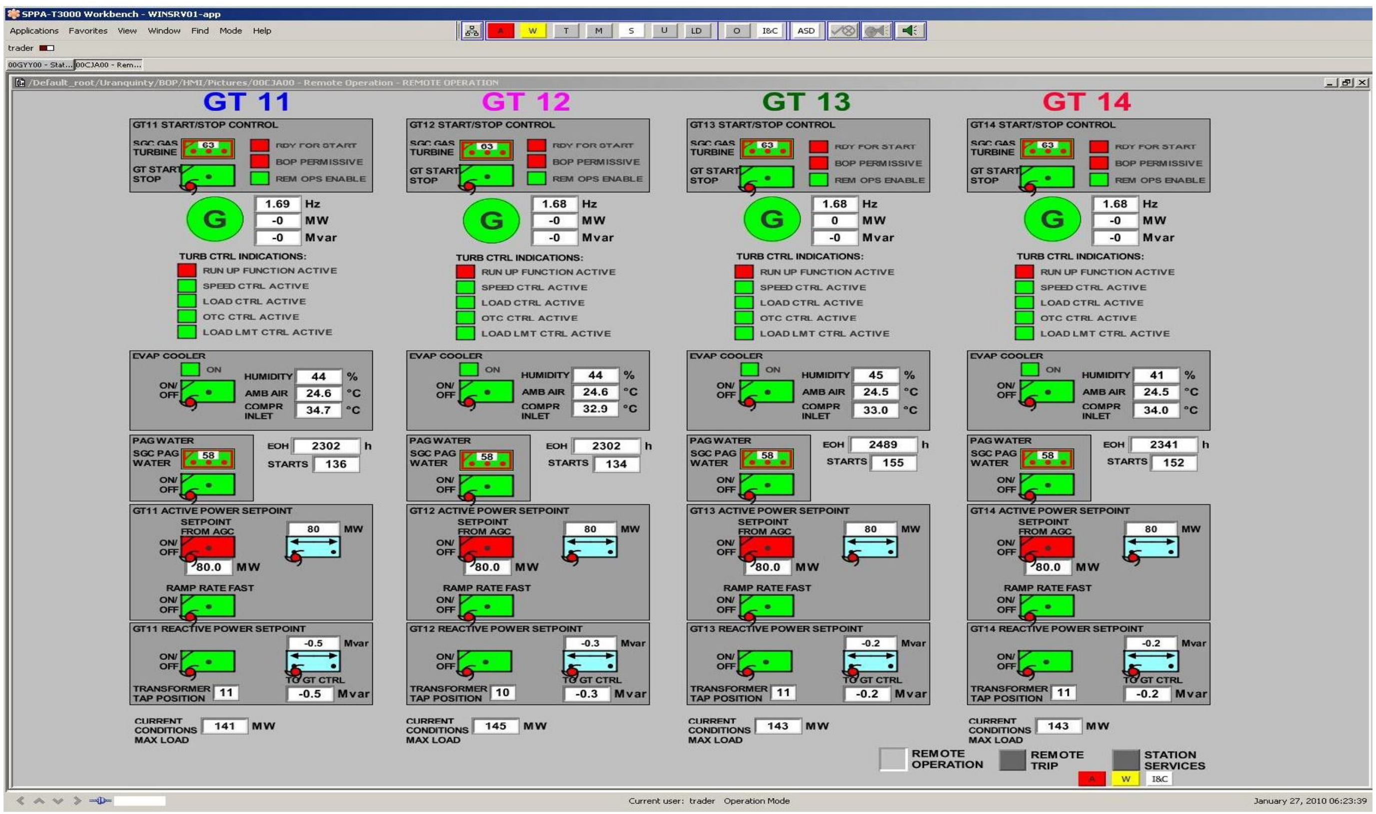
- REMOTE OPERATION Screen with all GT's at a glance for Operations and Monitoring



RED = OK, ON , Run , Open, Active. Green = Not Available, OFF, Closed.

DCS Network Architecture

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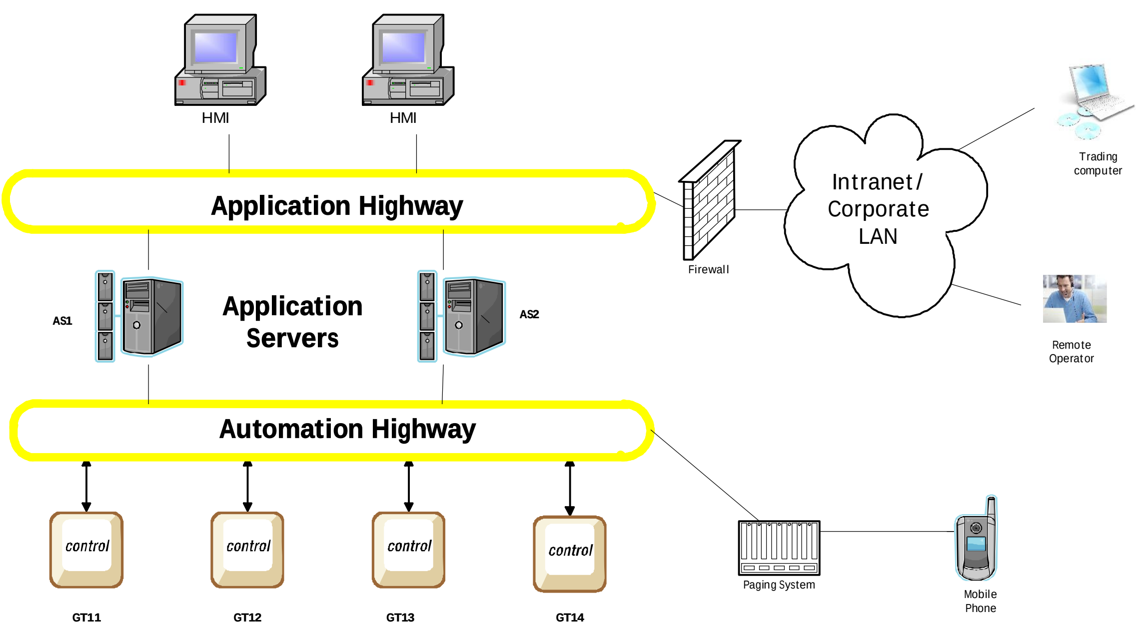
Remote Operation & Monitoring



T3000 Architecture

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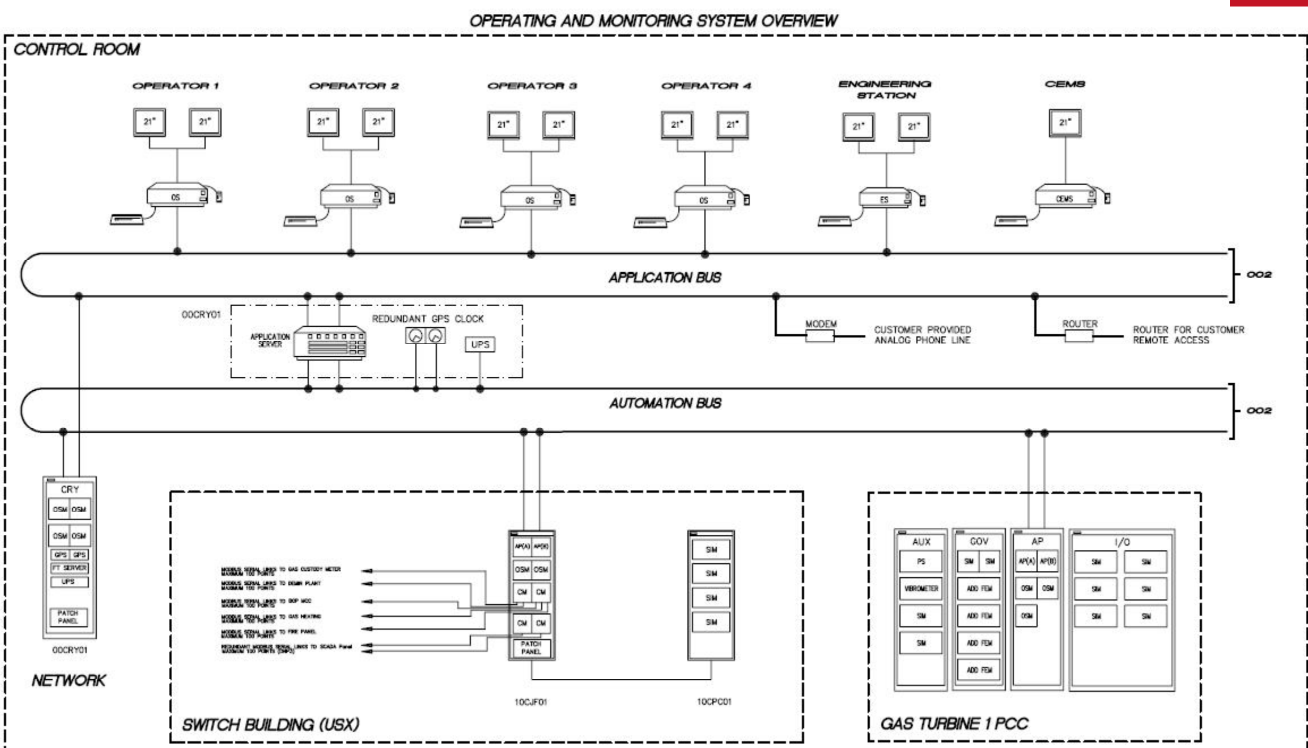

Remote Access Setup

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