Mechanalysis (India) Limited

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On-Line Machinery Condition Monitoring Diagnostics

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Synopsis

Manufacturing managers are expected to have a detailed understanding of the production processes, associated machinery and its maintenance needs to ensure plant availability. To assist in taking the optimum process decision, a wide range of objective information tools are available in the modern plant. One of the prime diagnostic techniques is vibration based machinery condition monitoring. This established method identifies machinery priorities so that maintenance can be scheduled when it is convenient to production.

This paper is directed at senior managers and non specialists who need to have a clear understanding of vibration based On-Line Condition Monitoring Diagnostics. It outlines the main aspects of the technology and terminology.

Vibration is one of industry's most effective indicators of rotating machinery performance and health. Often viewed as something mysterious and complicated, this is not so as most of us know what an Electro-Cardio-Graph (ECG) does for the human heart; fundamentally vibration on-line condition monitoring does just the same for industrial rotating machinery.

On-Line Machinery Condition Monitoring Diagnostics offers greater value over the traditional off-line portable data collection system. The quality and regularity of data obtained with respect to process variations makes the on-line system superior and essential for strategic high value machinery. This paper discusses the differences and summarises the requirements, applications and benefits of On-Line Machinery Condition Monitoring Systems. Future trends are briefly mentioned.

On-Line Machinery Condition Monitoring Diagnostics

1- Introduction

In general machinery, noise and vibration is often easily noticed. However for large machines, say greater than 25MW, Steam Turbines Electric, Generators, Compressors, Fans, Gas Turbines and Pumps etc. incipient faults are not so obvious. Shaft speed, the ratio of bearing housing mass to shaft diameter, the type of bearing, lubricating system etc all influences a machine's time to failure. To ascertain the discrete condition of complex rotating elements requires an array of sensors continuously measuring. Stored data can then be analysed in real time or viewed later.

Busy manufacturing managers are expected to have a clear understanding of a plant's processes as well as the machinery to ensure optimum availability. Amongst the wide range of tools to provide decision making information, On-Line Machinery Condition Monitoring Diagnostics offers the most responsive non invasive capability, enabling managers to schedule plant maintenance.

2 - Pioneering Condition Based Maintenance (CBM) in India

In 1974 the company commenced trading in India as a joint venture but is now 100% Indian owned. Since its inception it has been intimately connected with India's steel industry as subsidiary of Concast (India) Ltd. For over 30 years Mechanalysis (India) Ltd (MIL) (formerly IRD) pioneered condition monitoring techniques towards the zero maintenance objective in India. MIL is largely credited with training the Nation for improved productivity by optimising machinery availability through a vibration analysis programme. MIL has now evolved to become a System Integrator by global sourcing and local manufacturing a range of portable vibration instruments, protection monitors and supplying on-line multi-channel diagnostic systems.

Over the past 10 years, most leading global vendors of CBM have been swallowed up by multi-nationals who focus on their interpretation of asset management. As a result only a few 'independents' remain, dedicated to the CBM niche where innovation will continue. Machinery condition monitoring in the 21st Century is however shifting to more on-line diagnostics, intimately linked to plant processes and operations. Companies are realising that the current practice of operating a small cell in an organisation doing 'break-down' vibration analysis is costly. The trend now is towards outsourcing such services but on a more organised data acquisition programme.

MIL provides consultancy and sales support from Delhi, Kolkata, Mumbai, Baroda and Chennai. The recent remodelling of the National Service Centre, Manufacturing Works and Administration in Mumbai and new state of the art 'All India Sensor Calibration Service' reflects the commitment MIL has made to ensure customer value.

2.1 - Condition Management Solutions

The three facts of rotating machinery are:

1. All machines vibrate
2. An increase in vibration suggests a developing fault
3. Each rotating element generates its own unique vibration signal

What do these three facts and condition management solutions mean to the plant manager?

2.1.1 Condition
Maintaining machinery on condition optimises process uptime, reduces maintenance costs and increases profits.

2.1.2 Management
Is a strategy for management to be in control of events rather than the other way round. Proactive machinery plant maintenance gives management a tool for productivity gains.

2.1.3 Solutions
A range of simple and elegant integrated solutions are available to meets the needs of the user. By creating customer value to match local operating environments, the end user can reap the benefits and early returns on the investment. This can only be achieved fully by a partnership between users and suppliers on a win-win basis.

Applying the **condition management solution** approach to capital intensive industries, such as steel, is a proven formula towards zero break-down maintenance. On-Line Vibration Diagnostics is one of the technologies that will contribute to this objective.

3 - The Basics of Vibration Measurement

Vibration is the cyclic or oscillation motion of a body or component from its position of rest or its neutral position. Whenever vibration occurs there are four forces involved that determine the characteristics of vibration. They are:

1. The exciting force such as unbalance or misalignment
2. The mass of vibrating system
3. The stiffness
4. The damping characteristics

The characteristics that define vibration, and are needed to understand the behaviour of vibrating machinery, are illustrated in the figure below **(Fig1)**:

1. **Amplitude** (how much?) i.e. Displacement (microns), Velocity (mm/sec), Acceleration (g)
2. **Frequency** (how often the signal moves back and forward)
3. **Phase** (the time relationship between vibrating forces).

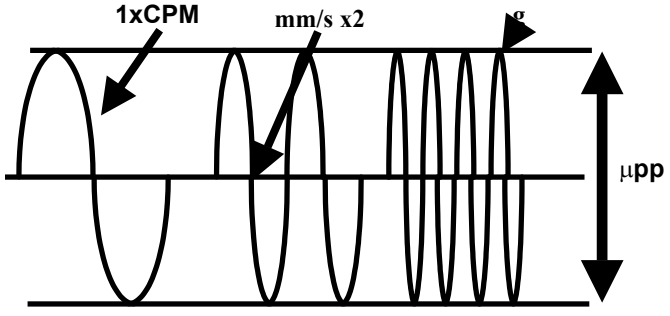


Figure 1 – Types of Vibration Measurement

For simplicity, frequencies are stated in Cycles Per. Minute or CPM as this is easier than calculating in Hz when identifying orders or harmonics of a fundamental frequency. When the three prime parameters are coupled with a machine's speed, load and effects of the process, a more precise diagnosis becomes essential for complex machinery.

When applied to case mounted sensors on rotating machinery the selected measurement unit is determined by the rotor speed or frequency of the machinery elements. A general guide is as follows:

Measurement Unit	Definition	Units	Machine Speed Range in CPM
Displacement	The total distance a mass travels back and forth as it vibrates	microns peak-peak	<600
Velocity	A measure of how fast the mass is moving back and forth.	mm/sec peak or RMS	600 - 120,000
Acceleration	The rate of change of velocity	g's	120,000
Spike Energy™	A technique for determining bearing and high speed gear meshing	gSE	Frequencies between 5kCPM - 50kCPM

3.1 - Sensor Mounting Methods

Vibration measurements are taken with portable or fixed sensors depending on the application. Like any prime measurement, the sensor's ability to transfer the optimum signal is fundamental to the success of the system. Mounting vibration sensors requires particular attention. The more difficult non contact eddy current probes are usually installed by the suppliers. Often case or surface mounted sensors (inductive velocity or accelerometers) are fitted by C&I engineers or contractors. Unless the sensors are installed to specification, the system will not deliver the protection and diagnostics required. False alarms and misleading signals are common with poorly located sensors with users often blaming the measuring instrument quite unjustifiably.

Figure 2 simply illustrates the quality of vibration data transmitted related to the method a sensor is in contact with a machine's bearing area. Establishing the optimum signal from a bearing to the outer casing may also be a trial and error exercise depending on the bearing's housing construction.

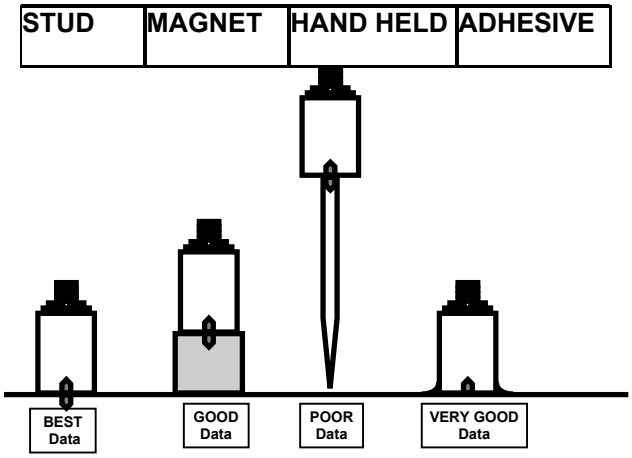


Figure 2 – Data Quality Related to Vibration Sensor Mounting Methods

In all cases, on-line permanent stud mounted sensors give the optimum performance and then in the horizontal, vertical axial positions related to the rotating shaft centreline. Advice from experienced suppliers is always advisable and worth the modest investment for site assistance.

3.2 - Vibration Analysis

Vibration can be represented in the Time or Frequency Domain that enables the analyst to identify suspect machinery elements. **Figures 3 and 4** are typical representations of the same data.

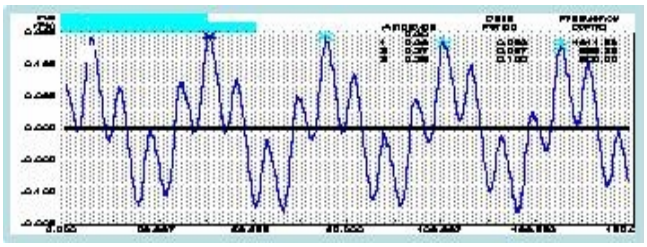


Figure 3 - Time Domain (Waveform)

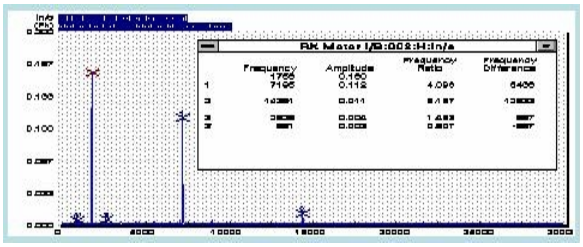


Figure 4 - Frequency Domain (FFT Vibration Spectrum)

The Time Domain format requires more skill to analyse but is indicative of repetitive vibration characteristics where complex signals illustrate a pattern. The frequency domain or vibration spectrum is easier to understand by the relationship between rotating machinery elements based on their speeds, base frequencies and associated harmonics.

3.3 - Phase a Prime Tool for Analysis

Analysis of complex vibration frequencies **(Fig.5)** can often be a technical challenge. To better understand the signal relationships and machine response, phase measurement is essential.

Phase readings (0-360 degrees) can be obtained either with a strobe light or a 1xRPM pulse from a shaft reference point. In practice phase is used as an analysis tool to pinpoint problems and is a basic need for balancing rotors in place.

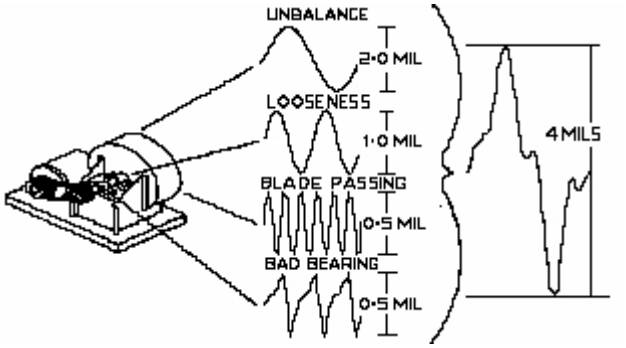


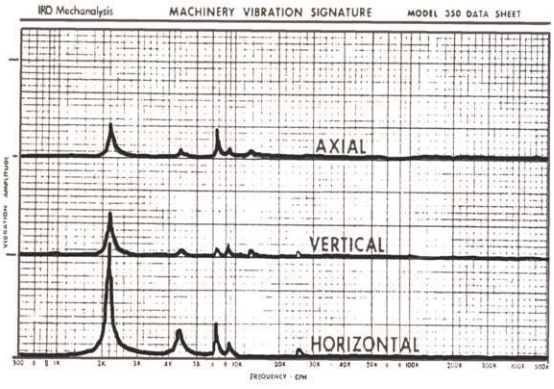
Figure 5 – Complex Vibrations

Phase is a means of determining the relative motion of two or more vibrating parts of a machine or machines, particularly the driver and driven. Phase taken at one part of a machine only has relevance when compared to other phase measurements with a common reference, i.e. the same machine train and speed.

4 - Off-Line or Portable Data Collection Systems

Prior to the development of the modern computerised portable data collector, bulky commercial vibration analysers were linked to XY or XYZ hard copy paper recorders.

Producing a machinery vibration signature **(Fig.6)** was a time consuming exercise and only a few machines could be analysed in a single day. Amplitude, Frequency, and Phase were standard measurements when most users undertook diagnostics. The main limitations were equipment portability, time taken and number of machinery



signatures. **Figure 6 – Vibration Signature on XY Recorder**
Following the onset of the powerful hand held vibration data collector with FFT (Fast Fourier Transform) and improvements over the past 20 years, signature collection became quite efficient. Most users now collect many hundreds of readings in a route and then undertake the vibration analysis at a PC remote from the machine.

Generally only vibration amplitude and frequency signals are considered for analysis. Seldom is phase used due to difficulties of capturing the rotor pulse signals on a route. As a result despite the huge technology gains in signal processing, diagnostics has not improved much in line with product developments. This limitation makes all so called 'expert systems' basic aids as a decision analysis tool for the capable user.

Other shortcomings of the portable digital data collector and digital meters are that they have numeric displays **(Fig.7)** as against the traditional analogue meters **(Fig.8)**. Vibrations are seldom stable; the digital display keeps changing unless highly damped or averaged. Over the years those new to vibration analysis have not appreciated how much information is being lost by the apparent 'new digital technology.' The moving coil analogue meter continues to present a much more representative indication of machinery vibrations, process fluctuations, peaking and even bearing rubs etc. None of this is possible with the so called 'modern' digital meter.

Figure 7 – Digital Display

Figure 8 – Analogue Display

Perhaps the most disturbing issue with off-line data collection is that samples are seldom captured more than monthly and some at even longer intervals. This makes proactive maintenance based on such practices less relevant and almost useless. In fact it has been seen at many plants that investments in portable data collectors and software are not bringing the intended returns. Instead of frequent high volume sampling the equipment is used for pre break-down emergency analysis when Operation's reports a machine is shaking itself to bits!

For strategic and high speed machines, vibration analysis can be complex and as such the portable off-line approach is quite unsuitable. Strategic machinery condition is better understood by a high rate of consistent on-line sampling of vibration, phase and operating parameters such as load, speed, temperature etc. This is illustrated in the Section 11.3 on Diagnostic System Outputs but selecting the right vibration monitoring system has to be addressed first.

5 - How to Select a Vibration Measurement System

The following summarises the questions a manager needs to ask when introducing a condition management solution for the organisation:

Objectives, Budgets, Skills, Needs

- What do you want to achieve?
- Budget for equipment & Training?
- Core competency? Knowledge level?
- Number of machines to be monitored?
- Type of machines to be monitored?
- Environment (aggressive chemicals, humidity, heat, intrinsically safe etc)?

- Integration with plant processes and maintenance systems

System Capabilities

- Off-Line Overall Vibration Level Meters (non-critical machinery)
- Data Collector / FFT Analyser (volume vibration data collection off-line)
- Real-Time Spectrum Analyser (analysis & research of complex machinery)
- On-Line Monitoring (warning, alarm & shut-down by operator decision)
- On-Line Protection (strategic & high speed requiring automatic alarm & trip)
- On-Line Diagnostics (associated with Protection System)
- Networking data (distributed to DCS and Operator Displays)
- Vibration and performance monitoring software (for machine life cycle analysis)

The most important aspect when selecting a condition monitoring system is that it must be part of an overall company strategy to improve plant availability. It must also have the commitment of executive office, operations and maintenance managers. Unless it is part of the company strategic plan, whatever system is selected, it will not return the benefits or expectations of all parties as it will be seen as a gadget and viewed in isolation of the main business activities.

6 - What is On-Line Machinery Vibration Based Diagnostics?

It is a system of integrated hardware and software measuring machinery performance 24/7 on-line in real time. It will present easily recognisable information on machine status to enable Operators to take preventative decisions. It can also be used to monitor process quality such as defective steel or paper rolls affecting the product. Raw data is continuously captured and stored so that Machinery Diagnostic Engineers can study steady-state, machinery start-up and post trip conditions in order to pinpoint incipient machinery or process faults. Not all diagnostic systems are intended for 24/7 data capture and can be moved around the plant for investigative or research purposes. This portability offering flexibility is a cost effective solution for many users, particularly OEMs.

We now need to make a more detailed comparison between off-line and on-line systems to gain a better understanding of the benefits and short comings of both on and off-line systems.

7 - Off-Line versus On-Line Data Collection Systems

The decision whether off-line or on-line is usually quite straightforward. The former is a periodic measuring system with remote analysis whereas the latter continuously measures, protects, enabling warning and shutdown alarms. Generally the off-line application **(Fig.9)** is selected due to plant layout logistics against the cost of installing and maintaining an on-line system.

Figure 9 – Periodic Vibration Data Collection

It is often assumed that the apparent lower cost of an off-line system offers more benefits. In many cases this may not be the best decision. The following comparison is not exhaustive but gives some of the issues to consider:

7.1 - Off-Line Vibration System Comparisons

Understanding the benefits limits of any system will set the expectation realistically; the table below identifies the main issues:

Positives

1. Portability
2. Unlimited readings
3. On the spot visual faults (oil leaks etc.)
4. Data Collection is relatively simple
5. Powerful analysis capability (with phase)
6. On site rotor balancing
7. Links with other NDT data
8. Non invasive
9. Establish without interfering with installed plant systems
10. Basic training takes 5 days
11. Relatively low initial investment
12. Lower cost per measurement point

Negatives

1. Taking the right reading (prone to error)
2. Limited with critical machines
3. Sensor hand held readings (case mounted)
4. Awkward taking NCPU data
5. Skilled labour intensive
6. Frequency of data vs. load changes is limited
7. False alarms due to process variables
8. Faults are only reported when looked for
9. Usually limited to amplitude & frequency measurement collection
10. Analysis will be limited without phase data
11. Often only used in fire fighting mode
12. Manpower turnover
13. Consumables: cables, battery, sensor
14. Portable instrument fatality, then no data
15. Data is seldom distributed
16. Only seen as a maintenance function
17. Rarely integrated with CMMS
18. Seldom visible to Operations
19. Re-invest every 4 years

Many Indian companies are realising that it is now more cost effective to employ a Consulting Service Company to operate its vibration based condition monitoring programme. Contract CBM has better skilled continuity compared to high staff turnover of in-house managed programmes.

The performance of on-line diagnostics systems **(Fig.10)** has improved markedly over recent years. Further, the price per measured point now makes the choice for an on-line diagnostic system a practical proposition.

The system offers high quality information and greater user value than ever. Both Operations at the Central Control Room (CCR) and Maintenance can have customised networked data available 24/7 to suit their specific requirements. Headquarters also has access to any or all data for strategic analysis purposes.

Figure 10 – On-Line Diagnostics

7.2 - On-Line Vibration System Comparisons

The following pros and cons of the On-Line Vibration System are not exhaustive but the main issues need to be appreciated as they will influence the strategic machinery condition monitoring decision.

Positives

1. High quality data available for strategic

Negatives

1. Limited number of readings to the

machinery analysis
2. Data collection automatic
3. Continuous data collection
4. Consistent data collection
5. Instant alarms machine faults
6. Amp, Freq, Phase, load collected
7. Very powerful analysis capability
8. Links with other process data
9. Data is distributed to DCS
10. Visible to Operations
11. Works with or without protection monitors
12. Basic training takes 5 days
13. Ideal for plant life assessment

number of sensors installed
2. Needs installed sensors wired to CCR
3. Economic with critical machines
4. Analysis can be complex
5. Requires skilled diagnostician
6. Cost per measurement multiple points
7. Can be high initial investment
8. Replace damaged sensors and cables

7.3 - Estimated Cost Per. Measured Point

Cost analysis is a common issue and the comparisons below are likely to generate active debate:

Assumptions: staff costs are taken as the same

Off-Line Measurement		**On-Line Monitoring**	
Hardware	Rs 9 Lakh	Hardware	Rs24 Lakh
Software	Rs10 Lakh	Software	Rs10.5 Lakh
PC	Rs 0.5 Lakh	Sensors x 800	Rs14.4 Lakh
Maintenance pa	Rs 0.5 Lakh	Maintenance pa	Rs 0.5 Lakh
TOTAL COST	**: Rs20 Lakh**	**TOTAL COST**	**: Rs49.4 Lakh**
Machines	: 50	Machines	: 50
Samples per machine	: 16	Samples per machine	: 16
Samples 2 p/month	: 1,600	Samples 24avg p/day	: 19,200
Cost/sample Rs : 1,250		**Cost/sample Rs : 257**	
Greater number of machines, low quality data needs additional tests. Operator Safety		Higher sample rate & quality, additional machine points reduces costs	

The cost comparison per point calculation can be skewed in any direction one wishes. The key message is that frequency and quality of sampling offers a greater direct return on investment than occasional readings of doubtful quality. The presence of a CBM system that is not properly managed will lull the company into a false sense of security when the reverse will be true.

8 - Criteria for Hardware & Software Selection

A guide to selecting both hardware and software is always difficult to establish but the following criteria covers the main elements.

Hardware	The Software
Proven reliability	Although just a database, it must have standard functions & features for ease of use
Flexibility for addition of on-line inputs	Defines what type of data is collected
Relative cost to machinery investment	Defines how the data is collected
Ease of use hardware & software	Records process information
Frequency & Dynamic range	Will have pre-set alarm values set that are used to

	generate reports
Measurement parameters	Distributed data available for all to view of plant condition
Operation & Display types	Data export capability for analysis of process performance
Transducer types & interface	Hard copy reports easy to generate
Phase & Speed reference inputs	Links with CMMS
Data communications	Exports data to other plant performance management reports
Number of years spares available	Number of years supported
Upgradeability	Upgradeability
Local support services with core competence	Local or web support ensures response and reduced risk
Obsolescence policy and process	Obsolescence policy and process

9 - Who Needs On-Line Condition Monitoring Systems?

Where personal and plant safety are prime concerns, protection monitoring is essential. Most high speed machines have a short time to failure; bearings fail exponentially and early indications of fault development need continuous machinery diagnostics monitoring. Periodic weekly or monthly data acquisition is not only high risk but seldom an engineering solution.

The responsible operator/owner of production plants with high speed strategic machinery will undertake a machinery risk analysis. Steam and gas turbines, high speed compressors (e.g. syngas), on-shore and off-shore high production plants etc. would be included when deciding the level of precaution necessary.

They did not have On-Line Protection Monitoring!

Figure 12 – Generator Catastrophic Failure

On-Line Condition Monitoring is essential for strategic machinery such as steam **(Fig.13)** and gas turbines, high speed machinery, compressors and even variable process machines found in steel and paper mills. Analysing rolling machinery at high speeds with confidence is only achievable with a responsive on-line data acquisition system.

Faults such as bearing rubs, sub synchronous signals, oil whirl; dynamic shaft centreline, un-balance, alignment, gear meshing etc are detected. Hydraulic and cavitation effects as well as combustion chamber characteristics, combustor imbalance and dynamics are amongst the many challenges facing engineers.

Figure 13 – Steam Turbine Rotor Reconditioned

Most of these potential machinery problems can only be identified with an array of well positioned sensors continuously collecting data at high speed for analysis on line in real-time. Correlating machinery readings with the process, such as temperature and load, completes the picture. The skills required for undertaking the diagnostics are similar to any user of off-line data collection skilled in data analysis. However, a thorough understanding of machinery dynamics is required to optimise the data presented. Most CBM equipment vendor's offer training but expertise is built upon with frequent usage.

Getting started commences with identifying the plant's needs and challenges towards the *Zero Breakdown Maintenance' Objective*. When considering the investment in the plant machinery and down time lost production, the investment to protect this by on-line machinery condition monitoring is a fraction of the possible losses. Therefore, the economic argument is usually overwhelming for on-line protection and diagnostics systems.

10 - On Line Condition Monitoring Diagnostics

The main users and applications are given in the table below**.** However, integrated steel plants and other sophisticated machinery used in aerospace, automotive and turbine production plants etc depend on high-speed vibration diagnostic systems for quality assurance and plant safety.

Applications	Power Industry Plants Monitored
Turbines	Nuclear
Pumps	Hydro
Fans	Fossil
Compressors	CCGT
Combustion Cans	Combined Cycle
Industrialised Gas Turbines	Captive Power

On-Line Applications

The fact that the strategic processes, such as nuclear power plants, use on-line diagnostic condition monitoring is indicative of the capability of the system and acceptance of the technology.

11 - Introducing Mechanalysis & Beran On-Line Systems

As part of Mechanalysis (India) Ltd 'Systems Integration' business strategy, the company has recently partnered with Beran Instruments of the UK.

The synergy of products and complementary company fit, offers Indian industry an unrivalled opportunity. MIL offers economic Protection Monitors with Alarm and Trip capability, designed and manufactured in India, with outstanding reliability.

Beran completes the picture with its highly proven and comprehensive Multi-channel Condition Monitoring Diagnostics system. These complementary condition management solutions can also be supplied individually as both products will integrate with most third party systems.

The system architecture **(Fig.14)** is outlined as follows:

Protection Monitoring System
The Mechanalysis MIL8700 machinery protection monitor with sensors offers independent alarm and trip relays for up to 16 channels per 19" rack.

On-Line Diagnostics
The Beran unit accepts the sensor signal for data capture and generates a wide range of diagnostic reports. The key features are:

User Man Machine Interface
- Easy to use and configure Software
- MS Windows-based user front end
- LAN, WAN or Dial-Up compatible

Data Handling
- Fast data capture
- Comparison of real-time data with historic
- Remote access to real-time & historic data

Effective Functionality
- Powerful alarm functions
- Automatic plant-state detection
- Expandability through modular design

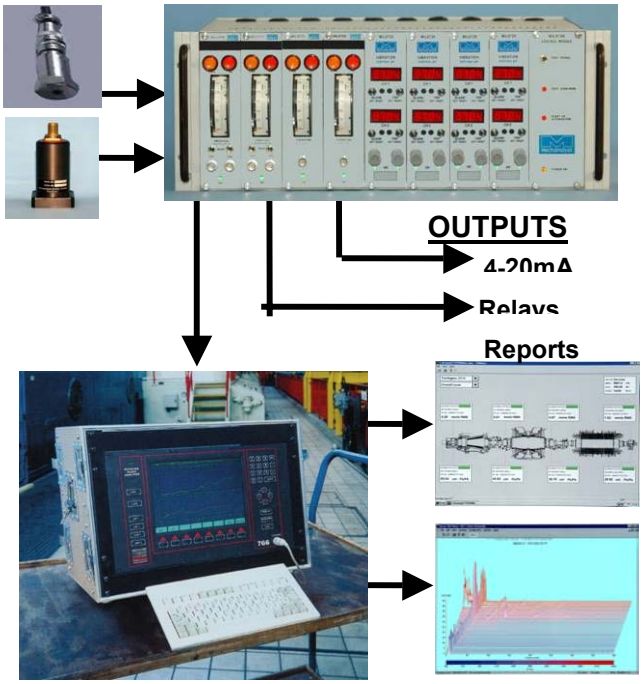


Figure 14 – MIL8700 Monitor with Beran 767 Portable Diagnostics

11.1 - Open Communications

Fully Net-workable, communications on LAN or WAN **(Fig. 15)**. The system is available on a building block arrangement. Additional units can be added as the need arises without compromising the system performance. Subsequent data acquisition devices do not require repeat software modules as that initially purchased can be extended as the system expands. Static data can be transmitted by serial link to the Beran unit thus saving wiring costs.

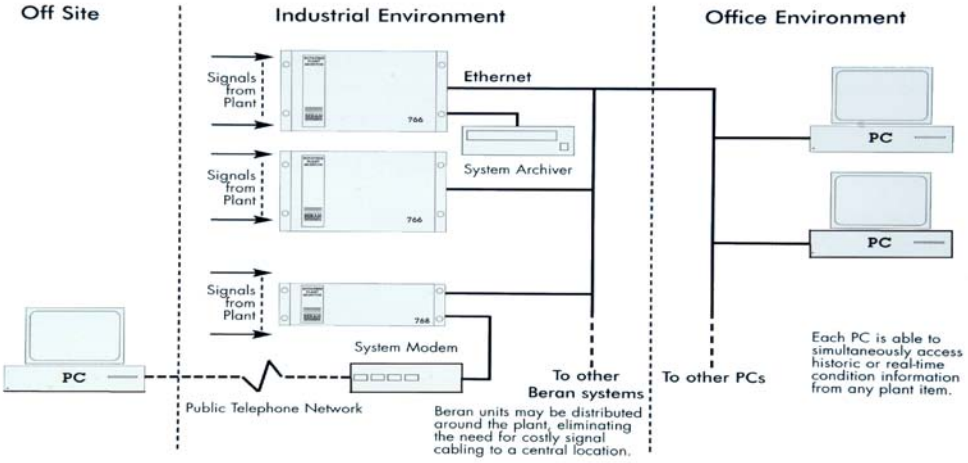
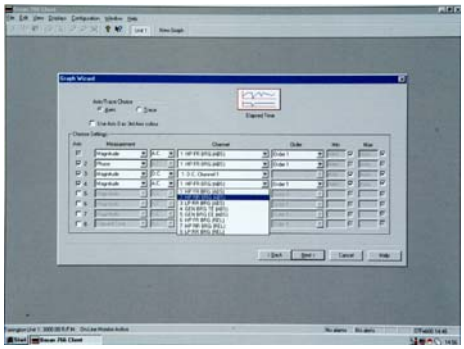


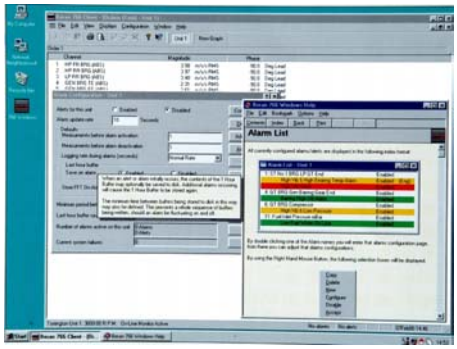
Figure 15 – Network Architecture

11.2 - System Configuration

The software will be easily recognisable by any MS Windows user with help screens and set up wizards. Operator training essential but with knowledge of machines and vibration characteristics, configuration is straight forward as seen in the screens below:



User Friendly Windows Display



Set-Up Context Sensitive Incorporates a Help Wizard

11.3 - Diagnostic Information Outputs

Customised MIMICS **(Fig. 16)** are available with Operator access to real-time or alarm log views. Operations have access to machine status reports to suit their requirements. Maintenance and Diagnostic engineers or a remote Support Services can study issues in greater depth at any time, particularly when comparing current with historical data. An important requirement of any system is that it provides decision making information and not simply data.

1. MIMICS – Customised Man Machine Interface
2. Windows Familiarity – User Friendly.
3. Context Sensitive Set-Up, incorporates a Help Wizard
4. Bar-graph/Histogram: current overall values for 16 channels
5. Single bearing order, magnitude & phase with plant load to time
6. Reconstructed Orbits across 4 bearings Waterfall
7. FFT waterfall with average historic & real-time
8. Run-up of single bearing in polar format with vector change etc.
9. Multi-plots – 3 bearings with respect to machine speed using 'Y' axis
10. FFT with zoom along 'Z' axis

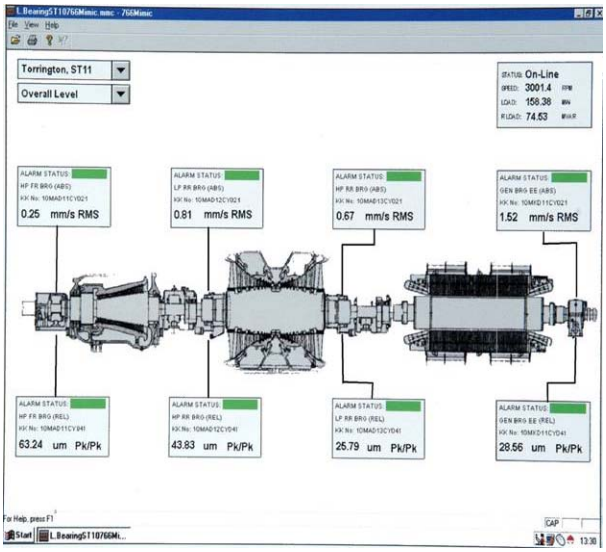
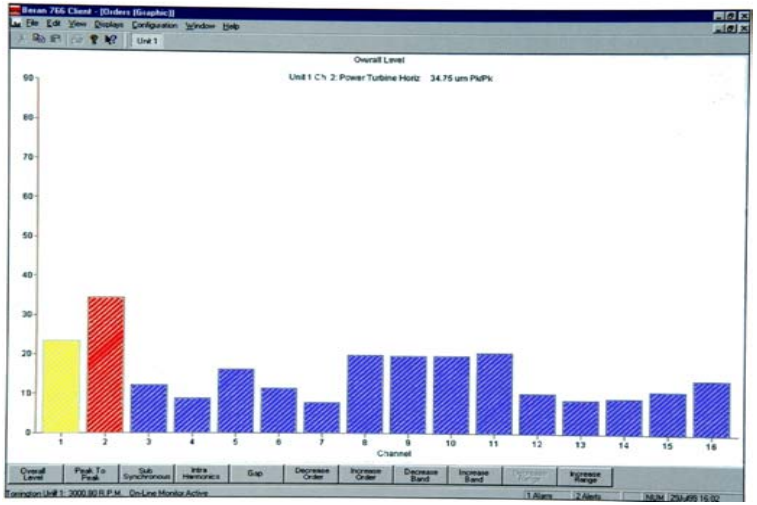


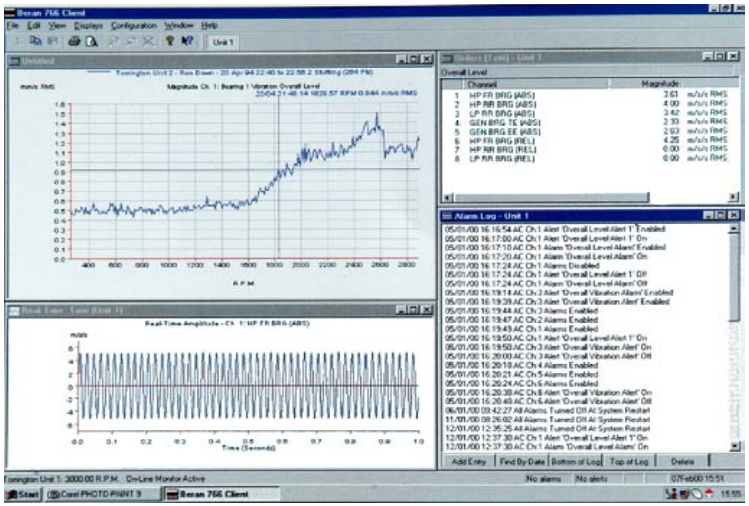
Figure 16 - Plant Operator MIMICS

It is often said a picture tells a 1000 words and the following pictures could indeed justify a 1000 words but the purpose of this paper is to expose the Manager to the variety and power of the on-line diagnostic system outputs as follows:

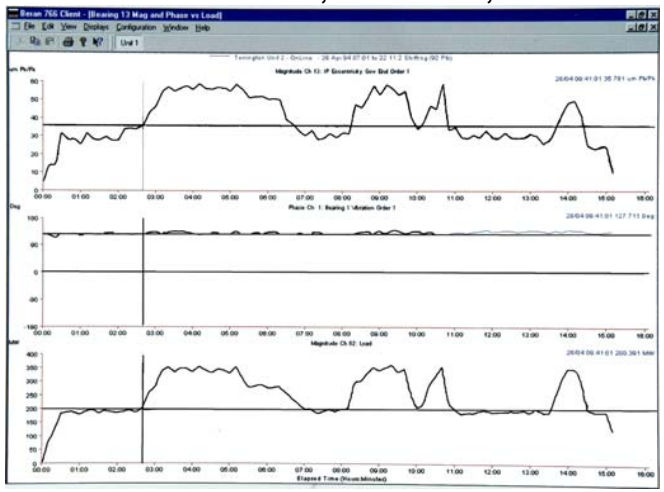
11.4 - Selected User-Definable Graph Displays



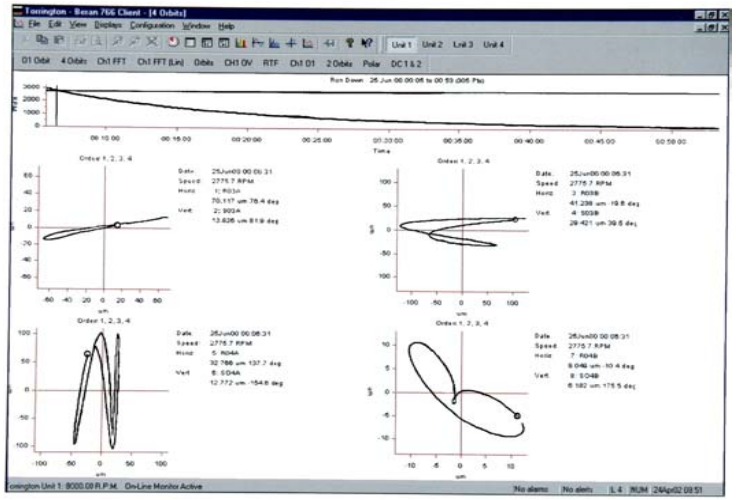
Bargraph / Histogram : current overall values for 16 channels: Blue-normal, Yellow-alert, Red-alarm



MS Windows: Tiled Displays Zoom cursors available

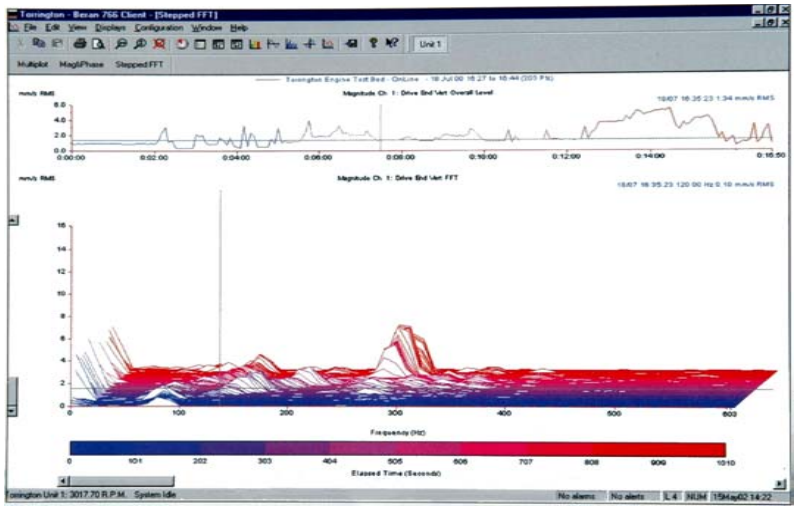


Vibration Magnitude vs Phase vs Load Relationship

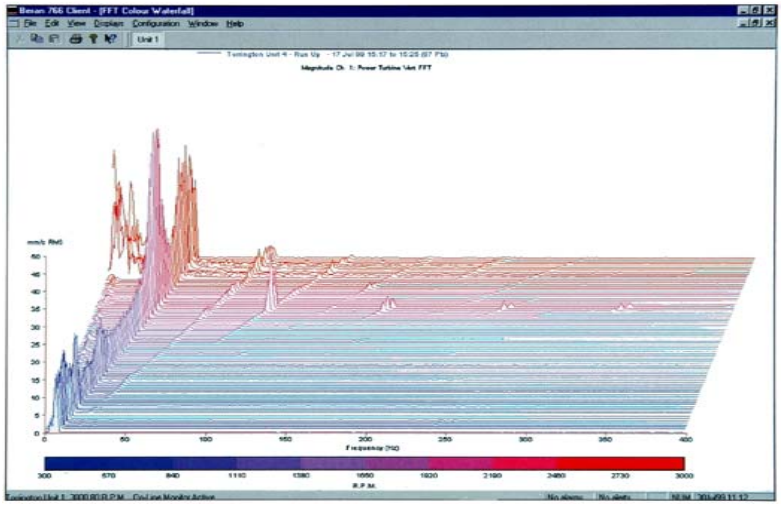


Orbits Can Be Reconstructed

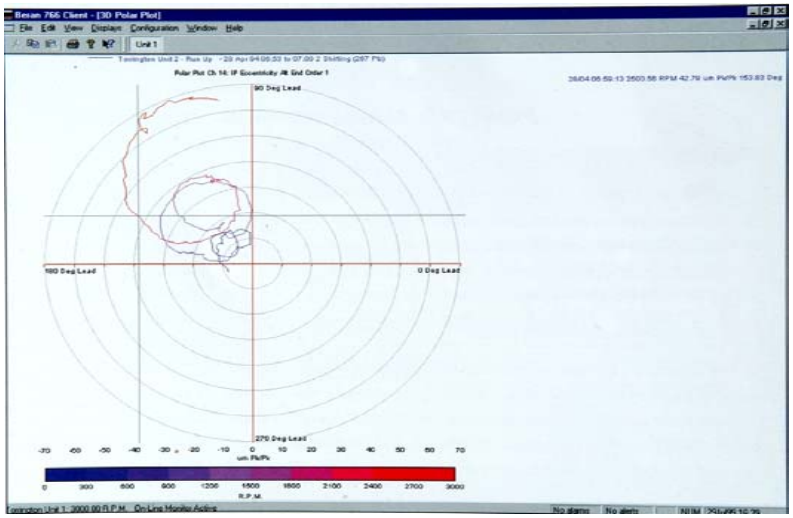
11.4 - Selected User-Definable Graph Displays cont…



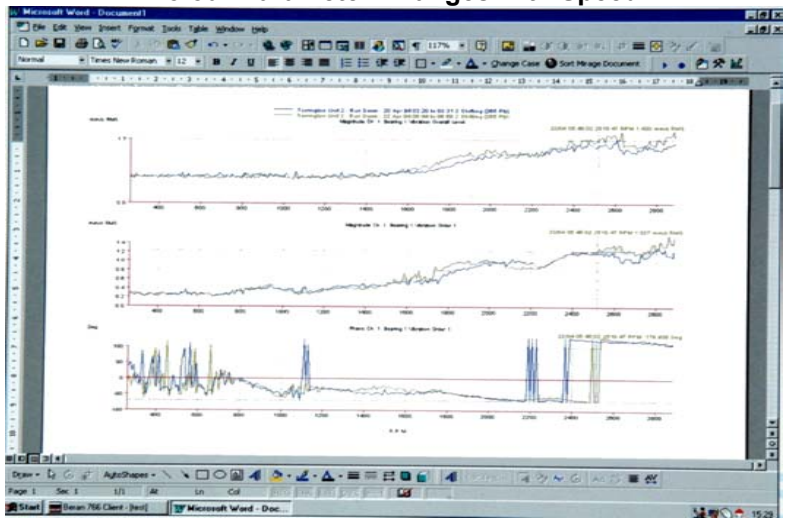
FFT with Bode Tracer



Waterfall Display
Colour Parameter Changes with Speed



Nyquist Plots
Single bearing in Polar Format



Report Generation
Export data in CSV format to Excel

12 - Global Users

All successful systems will gain global recognition and the Beran On-Line Diagnostic system is no exception. Users are diverse as Australia, Canada, Denmark, Egypt, France, Finland, Germany, Hungary, Italy, Portugal, UK and USA; India is currently under consideration. The Mechanalysis MIL8700 Protection Monitor has been in use for over 10 years with more than 230 systems in India and abroad enjoying unrivalled reliability at an economic investment.

Power Customers: Applications of over 12,500 Channels measured with in excess of 220 users in the UK alone and 20 years of continuous support speaks for itself. Other well known users are Alstom, Ansaldo, Siemens, Nuovo Pignone, David Brown, British Nuclear Energy Magnox, British Nuclear Fuels, Eon, First Hydro, EDF (France), Scottish Power, Npower, Scottish & Southern, Industries. Others are Corus Steel UK. With such a pedigree, the risk for a potential new user is minimised and expected value assured.

13 - The Benefits of On-Line Condition Monitoring Diagnostics

The benefits of on-line condition monitoring diagnostics are many. Primarily, is the greater Operator confidence in strategic machinery health and consequent increased plant availability. Advanced warning of component failure and accumulating machinery behavioural trends for optimising production and system design are readily realised. Subsidiary features of the diagnostic system are summarised:

- High quality data available for strategic machinery analysis
- Historical data can be reconstructed e.g. Orbits
- Automatic un-attended data acquisition
- Links with other process data for overall efficiency analysis
- Consistent comparable data for analysis
- Data is distributed to DCS
- Alarms machine faults instant to Operator's displays
- Amp, Freq, Phase, load collected - overcomes false alarms
- Works with protection monitors or independently
- Very powerful analysis capability – pre & trip fault review
- Ideal for plant life assessment
-

14 - Future CM Trends in Industry

Industry will continue to use the off-line vibration data collector but it will play a reduced role while remaining an economic solution. Industry is fast recognising that **On-Line Diagnostics** is more dependable and consistent. Plant life cycle analysis is a recognised tool for long term strategic planning. Operations and maintenance are converging; distributed data helps this. Remote analysis by experts operating from central or back offices will evolve as confidence is gained, even though the technology and service exist today. On-Line data offers opportunities for realistic expert analysis in time but most current systems are rule based requiring analysts to take the decisions. Mechanalysis India is at the forefront of industry trends having invested heavily to meet the future needs of the modern business manager but continuous improvement is essential.

"With Mechanalysis-On-Line Condition Monitoring Diagnostics, the Plant Manager will be in control of events rather than the other way round."

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