

The Value of Reliability: How Smart Advisor Avoids Equipment Disruptions

Anyone in a plant environment understands the value of Reliability. Avoidance of equipment surprises, raw material variations, or personnel issues allows operations to run steadily and without costly interruption. Condition Based Maintenance is one tool to improve reliability in a plant.



Condition Based Maintenance (CBM)

Condition base maintenance is a program of maintenance actions that is based upon knowledge of the current operating condition of a machine. A CBM program has a data collection component that regularly records machine condition data and operating parameters. The Smart Advisor is an on-line system that analyzes and records vibration data from permanently mounted accelerometer sensors. These data are analyzed to extract and record historical trends of vibration signatures of important components of a machine. The system permits several levels of prioritized thresholds to be established for the normal operating range of these signatures, and can generate alarms when current data exceed the threshold levels. These alarms can be used to trigger further investigation or corrective maintenance action.

Armed with reliable information about the operating condition of its machinery, the maintenance department can schedule corrective actions in advance, before a problem becomes catastrophic. Maintenance planning can be more effective, inventory spares can be reduced, and unplanned downtime and attendant high costs can be reduced.

The ultimate goal of the CBM program is to maximize production uptime.

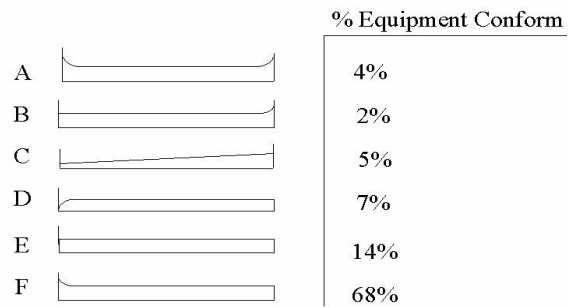
On-Line Condition Based Maintenance is One Facet of CBM

On-line Condition Based Maintenance is a key technology for insuring high reliability of critical plant equipment. These on-line systems detect upcoming failures of critical plant assets, allowing for a planned, controlled shutdown, and replacement of faulty components. On-line Condition Based Maintenance results in higher quality consistency, fewer plant breakdowns, and reduced spare inventory.

Complex Equipment Does not Fail According to Time

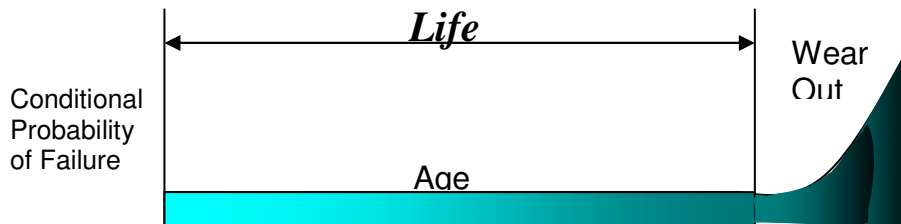
- Complex equipment lifetime is dependant on several variables
- Time of operation is not a dominant variable
- In fact for 89% of equipment, the probability of failure does not change after an initial run time
- Consequently routine scheduled maintenance will not prevent the majority of failures

Six Patterns of Failure



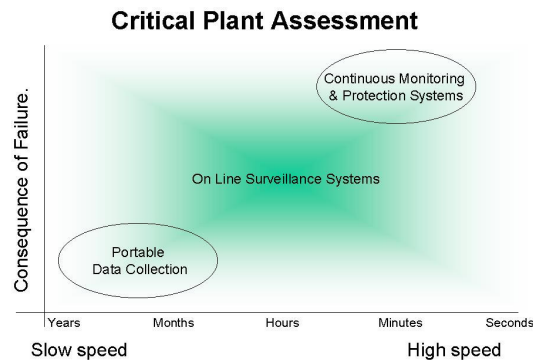
Time to Failure is the Key Variable

- CBM detects the actual presence of a impending failure
- Data sampling must be sufficiently fast to detect the problem in time to plan for replacement
- The type of CBM system used must be matched to the wear out zone



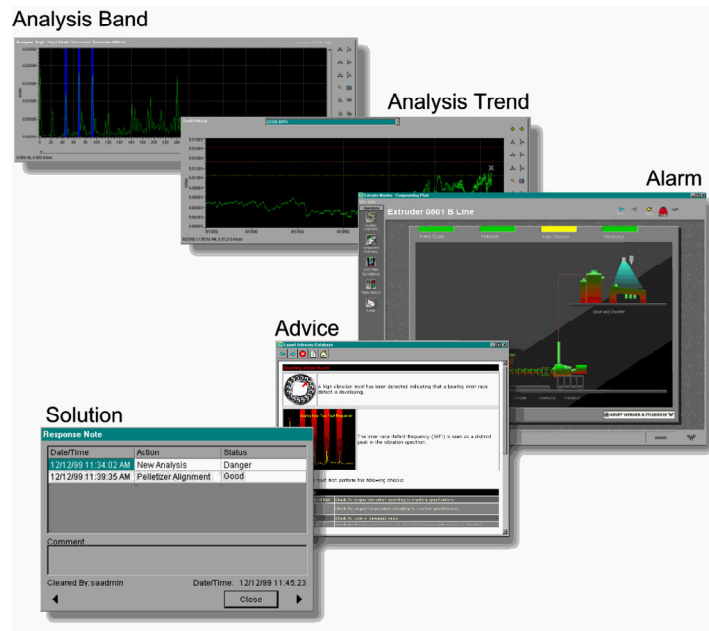
Continuous Monitoring is Necessary to Detect Issues in Time

- Portable data collectors are effective for slower speed, non-critical equipment (sample period 1-4 weeks)
- Using permanently mounted accelerometers, on-line CBM systems detect slight changes in vibration that are produced by impending equipment faults (sample period 1 hour)
- On-line systems provide time to plan



On-Line Monitoring Automatically Inspects for Impending Issues

- Automatically samples permanently mounted accelerometers
- Analyzes vibration frequencies for certain defects (inner race, outer race, imbalance, etc.)
- Trends energy for different faults
- Alarms and provides Advice to operators when a defect begins to form



On-Line CBM Results

Increased Productivity

- Reduction of unscheduled downtime
- Unexpected equipment failures require excessive downtime to repair equipment and restart the process
- On-line CBM systems detect impending failures
- Providing sufficient advanced notice to plan for an orderly shutdown
- Downtime required to repair / replace failed equipment in a planned shut is one-fifth the time required in an unscheduled repair

Decreased Equipment R&M Expense

- Detection and repair of failing piece of equipment prior to a catastrophic failure reduces expense
- Repair prior to failure often requires only a low-cost component to be replaced
- If the machine is run until this component fails, excessive collateral damage is realised
- In addition, the cost of expediting replacement parts and external supplier labour is often very expensive
- With on-line CBM, these surprise failures can be eliminated on critical plant equipment

Reduced Equipment Inventory

- Plants keep equipment spares in inventory in case a catastrophic failure occurs.



- For some equipment, installed stand-by equipment is maintained to allow a rapid substitute if equipment fails.
- With on-line CBM systems, plants will only keep parts on hand that have a longer supply cycle than the advanced warning provided from the CBM systems.

Reduced Scheduled Shutdowns

- Sometimes upcoming failures are detected immediately following a planned shutdown, and the plant is forced to schedule an additional shutdown to repair the component.
- If the upcoming failure had been detected before the shutdown, the defective component could have been replaced during the scheduled downtime.
- On-line CBM systems provide advanced monitoring algorithms, increased monitoring activity and more reliable readings as the sensors are fixed to the equipment.
- As a result, on-line CBM systems will provide very early warning of upcoming failures, allowing the repairs to be done in combination with other work.

Reduced Fixed Time Overhauls

- To avoid unexpected failures, plants often perform fixed time overhauls.
- While this is effective for some equipment, it is not for 89% of equipment at the site.
- The majority of complex equipment has an equal probability of failure for a large period of its life.
- Therefore, performing fixed time overhauls on these pieces of equipment wastes labour and replacement parts.
- On-line CBM systems detect upcoming failures when equipment has truly approached the end of its useful life.

Increased Equipment Life

- On-line CBM systems will detect small process failures like imbalance or poor lubrication.
- With the on-line warning, operators can adjust and/or care for equipment before unneeded wear occurs.
- Equipment that is properly set-up and maintained will have a longer useful life.

Reduced Catastrophic Failures

- The system projects a very professional image to external agencies with respect to the monitoring of equipment health at plants.
- Catastrophic equipment failures that cause safety and environmental hazards will be avoided.
- This will help to improve relationships with such organisations and could speed up authorisations for increased alternative fuel usage.

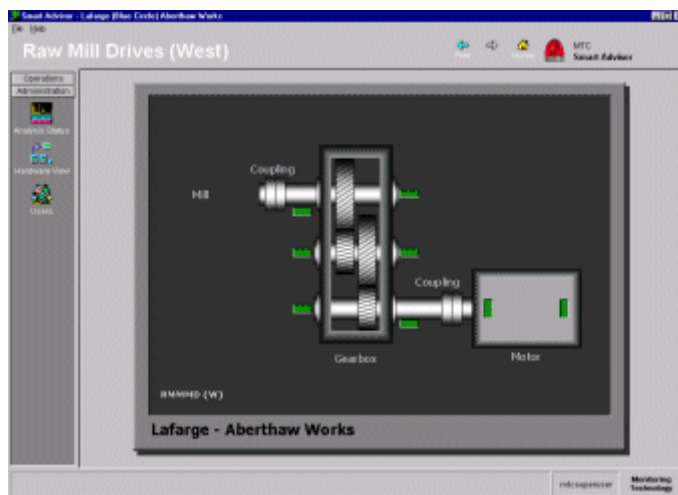
"In my more than 35 years of industry experience, there has never been any technologies implemented that have the potential to impact equipment reliability and maintenance cost in a more positive way and with the magnitude of Condition Based Monitoring. As we strive to improve in both these areas, comprehensive and well specified installations will play a very essential role."

Frank Johnson
Maintenance Manager
Lafarge Roberta, AL

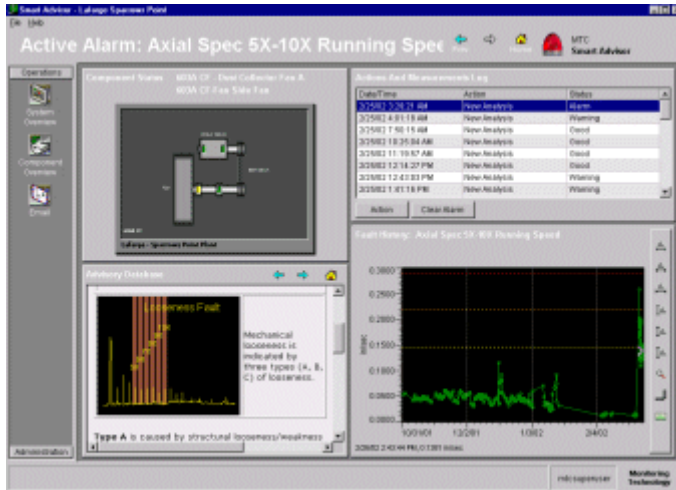
Smart Advisor was Developed for On-Line CBM

The Smart Advisor is an automatic machine and process health advisory system. It detects developing component failures such as gear and bearing fatigue, coupling faults, shaft imbalance, misalignment, and looseness. By trending the vibration at specific frequencies, the system allows operators and analysts to automatically track and monitor deteriorating equipment health. This easy-to-use, on-line system not only monitors and diagnoses various existing or impending process and machine conditions, but also offers automatic expert advice for resolution without extensive data analysis. The automatic expert advice is based on industry experience and can easily be modified on-site to conform to a plant's customary best practices.

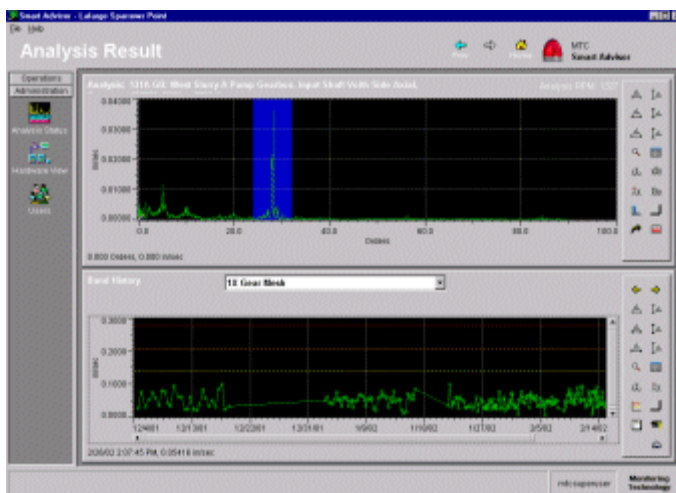
The foundation of this system is state-of-the-art digital signal processing used for precise diagnosis of the source of machine or process conditions. Production and maintenance personnel now have the ability to address problems through immediate adjustments or equipment replacement. The results include substantial cost savings and improved productivity through extended component life, reduced unscheduled downtime, and less off-quality product.



The graphical display allows operators to easily navigate through the monitored machinery. Color codes indicate the condition of the components of each machine. Double clicking on a component leads to trends of the vibration associated with specific faults.



When a fault occurs the system indicates the affected machine and component and the type of fault. Advisor text is also displayed helping the operator respond in the correct manner to the fault. The trend of the fault vibration and the notes from any previous alarms help him determine the correct course of action to correct the fault.



Analysts can review the vibration spectrum, trends, and other data computed by the system. Powerful analytical tools help him evaluate the vibration signatures.