Reliability Information Management: What is It & Why Should You Care?

by

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Many maintenance professionals agree that there are two basic reasons for the focus on reliability in industrial plants:

- Eliminating unexpected equipment failures that can interrupt production and cause high repair costs;
- Extending the life of equipment between repairs to lower total lifecycle costs.

To accomplish these goals a plant must implement and manage many condition monitoring, lifecycle tracking, and failure analysis activities. This involves many plant employees and contractors who generate and use hundreds of pieces of information for each asset. Unfortunately many industrial organizations concentrate on the generation of condition, failure mode, and repair information. Only later does the realization come that reliability information needs to be standardized and integrated into a process that facilitates communication, accountability for action, and analysis. We believe that Reliability Information Management is the key to having accurate information available and accessible for the mitigation of unexpected failures and equipment lifecycle extension.

Why isn't the need for a Reliability Information Management process apparent for any industrial organization as they begin a reliability improvement initiative? Most who have been down that road agree that 'cultural change' is one roadblock. It is a major task to get plant stakeholders refocused from decades of reactive and interval-based maintenance strategies to predictive and proactive ones.

There's also the challenge of adopting and using condition monitoring technologies, even when they might be provided by service contractors. For example, look at the experience of Eastman Chemical Company in Kingsport, TN that was documented in a paper presented at the 2005 SMRP Conference [(1)]. That paper describes how Eastman Chemical Company began implementing several condition monitoring techniques in the mid 1980's. By the mid-90's their predictive maintenance group was well respected for its technical proficiency and was credited with preventing a significant number of production interruptions by catching equipment problems prior to failure. Yet co-presenter Mark Mitchell of Eastman Chemical Company noted that "several people within management felt there was room to improve as we still haven't achieved a condition-based maintenance culture".

Finally, good documentation takes planning, and let's face it, many organizations are ready to 'ready, shoot, aim' when making investments in new programs.

So, what kinds of reliability information are we talking about? During the 'cradle to grave' life of a piece of industrial equipment there are many 'life stages' generating information (Fig 1):

- Initial purchase documentation, including design specifications, purchase documentation, installation instructions, warranty details;

- Location at the plant – does the equipment initially go into a stores location, or into a functional service location?

- If in stores, periodic tests, inspections, or maintenance procedures may be performed; is there an auditable history of those procedures?

- If installed in a functional location, are there condition monitoring and physical inspection tasks checking the health status of the equipment?

- When repairs are needed, is information about the failure modes and root cause of failure being documented?

- Where are the documents (photographs, specifications, drawings, & reports) associated with each life cycle stage being kept?

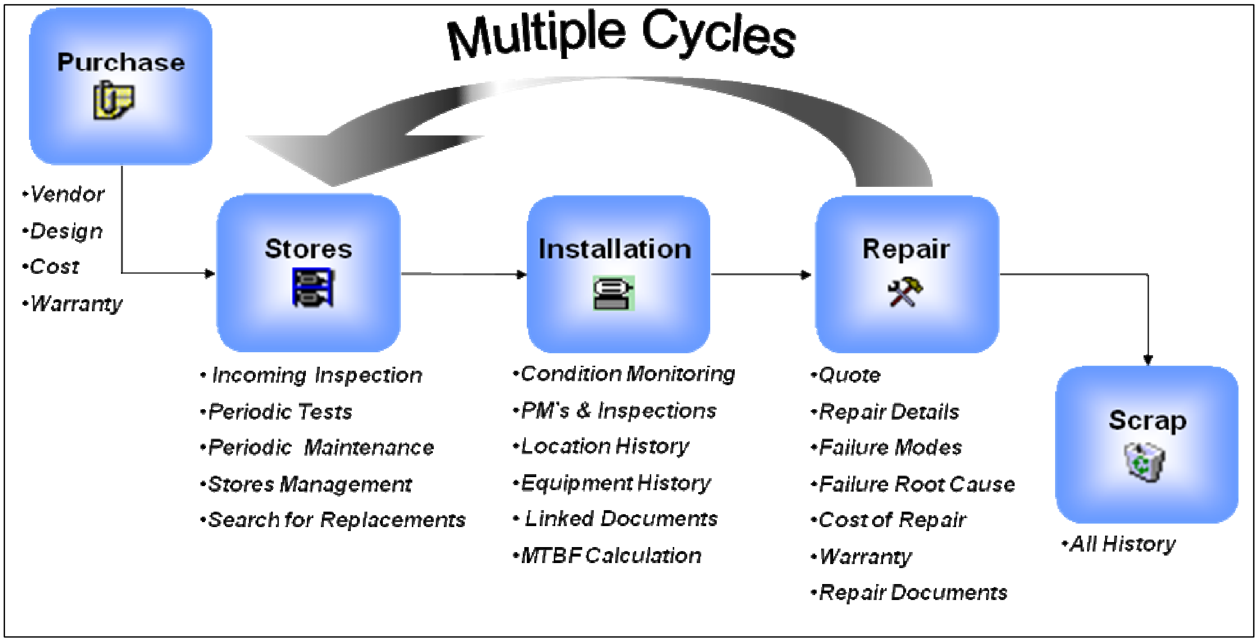


Fig. 1 – Life-cycle stages & information-producing activities for industrial equipment

How does this equipment life cycle information fit the two basic reliability improvement objectives?

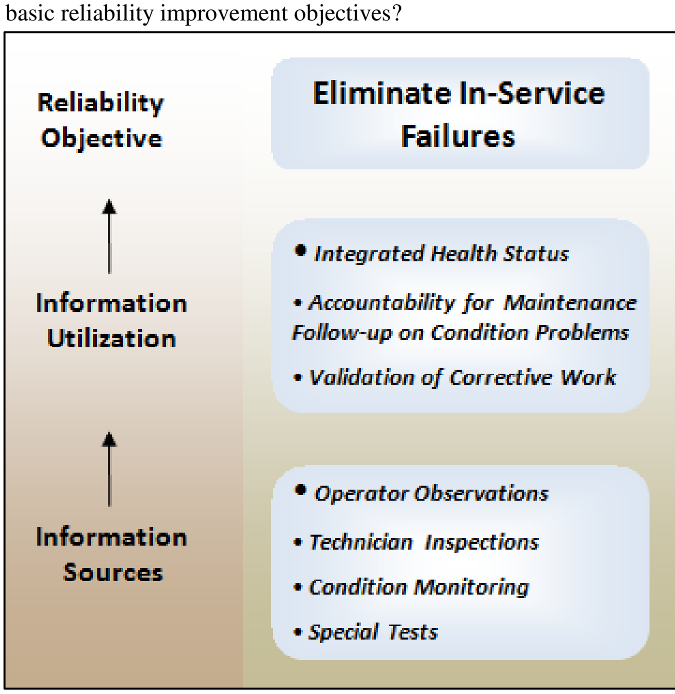


Fig. 2 – Information flow for failure mitigation to impending failures

For the elimination of unexpected failures, most plants look to 'predictive maintenance' using modern condition monitoring technologies. However, less 'high tech' activities such as operator rounds logging and mechanic inspections also produce valuable information about the condition of operating equipment – this comes from the 'installed in service' stage. Periodic tests and maintenance during the 'stores' phase also contribute. What is important is the ability to access and utilize any and all information for clues (Fig 2).

Extending life between repairs, and in fact extending the overall length of service, requires a wider range of information to feed failure analysis and root cause identification (Fig 3). It starts with knowing equipment design details, and the history for both service locations and individual pieces of equipment. Even with excellent condition monitoring technique, identification of developing failure modes is still an inexact science that should be confirmed during the repair to understand whether root causes of failure are linked to equipment design, location environment, or operational problems.

Many organizations look first to their plant's CMMS to be the master program holding all the reliability information. CMMS systems are usually strong in managing maintenance work transactions related to equipment locations, but often weak in handling condition monitoring information related to functional locations or any detail about specific pieces of equipment. This leads some plants to pursue a 'bits and bytes' transfer of data by contracting an integrator to program links between various data sources. In many cases they focus on trying to link

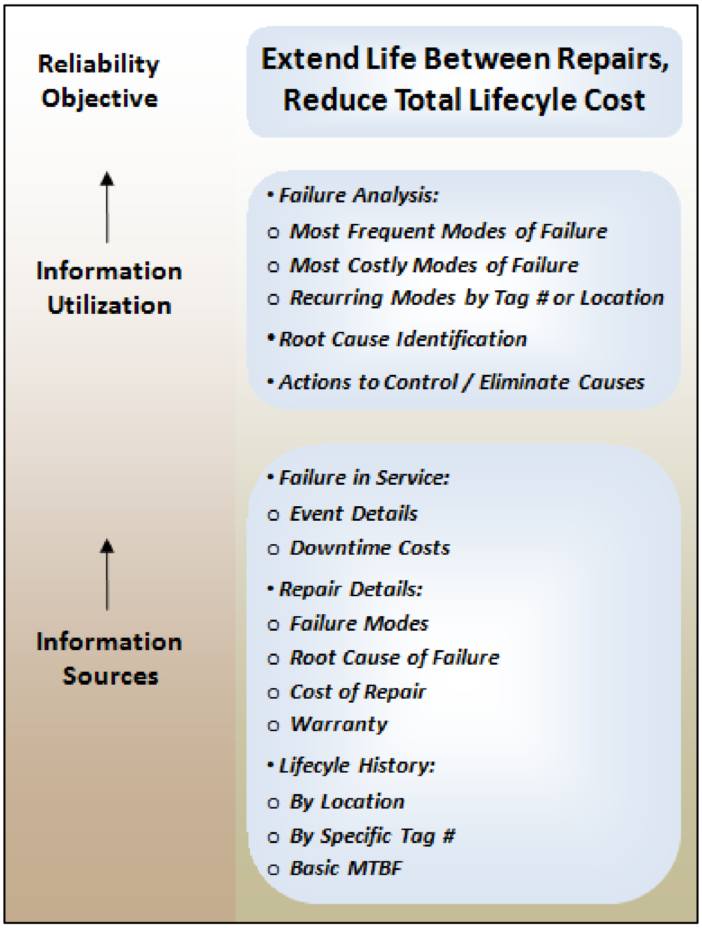


Fig. 3 – Information flow for life extension

multiple plant sources with years of historical equipment data, where non-standardized definitions for equipment and fault modes make it difficult to ensure data quality. This integration effort can certainly produce information flowing between programs, but can be costly to initiate, take significant time to implement, and be costly to maintain.

What is often overlooked is that much of the reliability information is generated outside the plant by equipment suppliers, service contractors, and repair vendors. These outside sources traditionally deliver the information via e-mail because they are not allowed direct access to a plant's IT system – yet how many plants have personnel with the time and patience to transfer e-mailed documentation into a plant database?

Eastman Chemical Company and North American Stainless are two large industrial plants who have focused on their Reliability Information Management process.

For Eastman Chemical Company, their mid-90's conclusion that they needed to create a condition-based maintenance culture resulted in the communication of equipment condition issues to a wider audience and increased accountability for appropriate response. They realized that individual condition reports from different technologies were going to different maintenance contacts for an operations area. These contacts would usually have to negotiate with their operations counterpart over the need for and scheduling of repair activity, before being able to forward a request to the maintenance planner. This resulted in delays and "dropped balls" in handling equipment problems. The key issues behind this result were:

- Few people, if anyone, had a complete picture of all known condition issues on a piece of equipment,
- Operations had very little 'buy-in' to the concept of Condition-Based Maintenance,
- The first notice maintenance managers had about 'dropped balls' was usually a call from operations after the fact.

In the late 1990's Eastman Chemical Company – Kingsport decided to improve their use of equipment condition information and drive a Condition-Based Maintenance mindset. High priority was put on making integrated condition results easily available to a wide audience of operations, maintenance, and executive managers. The communication had to be asset based rather than monitoring technology based, and it also needed to be accessible without installation of special software by users. That lead to the specification of a web browser based Integrated Condition Status Report system.

North American Stainless in Ghent, Kentucky started focusing on Reliability Information Management in late 2005. Up until that time the central reliability group e-mailed a variety of equipment condition reports to area engineers. They received feedback on planned actions and status by reply e-mails or by searching for work order history in the CMMS. With over 20 area engineers involved along with input from maintenance technicians, operations, and vendors, the high volume of e-mail and report documents could be very difficult to manage and track. Often the e-mail trail for specific issues would eventually be lost. In those cases any attempt to track maintenance response or pinpoint root causes of failure at times depended more on tribal knowledge than documented facts.

North American Stainless used a web service offered by a lubricant vendor that allowed the reliability group to store PDF reports for retrieval. While each PDF document could be searched for specific machines or mill areas, simply having a collection of PDF reports did not always provide a useable overview of critical equipment problems and status. Along with the individual PDF reports, the group was still maintaining Excel spreadsheets to help summarize information. They desired a more automated approach to reporting that allowed more interaction by all individuals involved with maintenance and reliability of assets. That experience led North American Stainless to develop its own wish-list for a web-based Reliability Information Management system early in 2008, and to consider building the system in-house.

It turned out that many of the key items on their wish-list were similar to those specified by Eastman Chemical Company years earlier:

- Show current machine health status for plant assets, based on all known results from all condition monitoring activities, including those being provided by service contractors

- Provide e-mail notification to the appropriate plant personnel when a new health problem is posted to the system

- Enforce the use of standardized fault definitions and severity descriptions across all the condition monitoring activities to improve day-to-day communications and allow meaningful reliability analysis

- Deliver a web-page dashboard display customized for each user, showing only the information for the assets in that user's area of responsibility

- Show the status of planned actions or corrective work on the dashboard display, including any status comments made by involved personnel, up to the time problems are corrected and the problem is closed

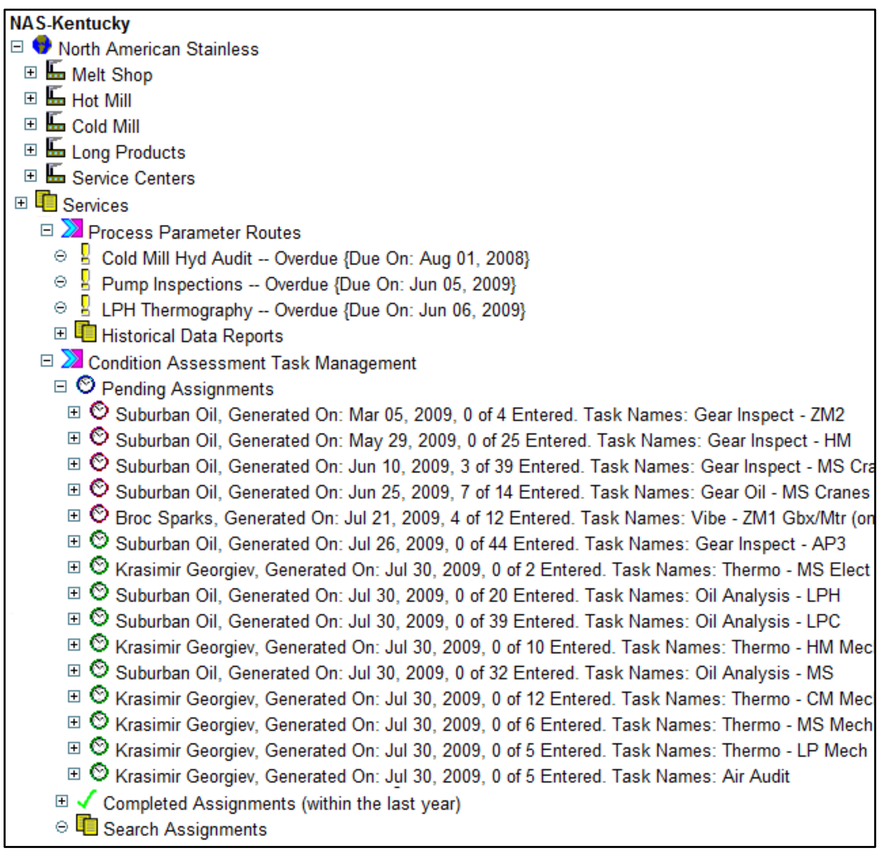
- Capture the failure mode information on each asset, including probable root causes, from repairs being done both in-house and by outside vendors

- Allow authorized users to review and report entire lifecycle history for each service location or for specific pieces of equipment

As the North American Stainless reliability team was investigating the development of a more interactive and possibly in-house website, they came across an existing Reliability Information Management web-service that had been created in response to the earlier Eastman Chemical Company specifications. They evaluated the existing system and began using it in the second half of 2008.

North American Stainless utilizes vibration analysis, ultrasonics, IR thermography, oil analysis, and gear inspections. Most of these predictive technology inspections are complete in-house, and a portion are assisted by outside vendors. They also run some monthly equipment inspections by technicians, with expectations to use handheld PDA's to automate that process. Their scheduled monitoring and inspection activities are tracked with the web-based system (Fig 4). Web browser access is controlled by authorized user names and passwords, and allows plant stakeholders to confirm that the reliability group is 'doing what we said we'd do'.

Fig. 4 – Web browser view of monitoring tasks & schedules



The in-house and service contractor technicians use various brands of monitoring hardware and software for data collection and analysis; once they have collected and analyzed the data for a specific task they use the web-based system to document their results. This is where standards for asset location names, problem severity descriptions, and fault codes are enforced. Regardless of monitoring technology or inspection, every analyst enters his results in a common web-hosted database via the Internet. For each asset covered in the monitoring task, he documents whether the asset was in good condition, has a problem, or was skipped (Fig 5).

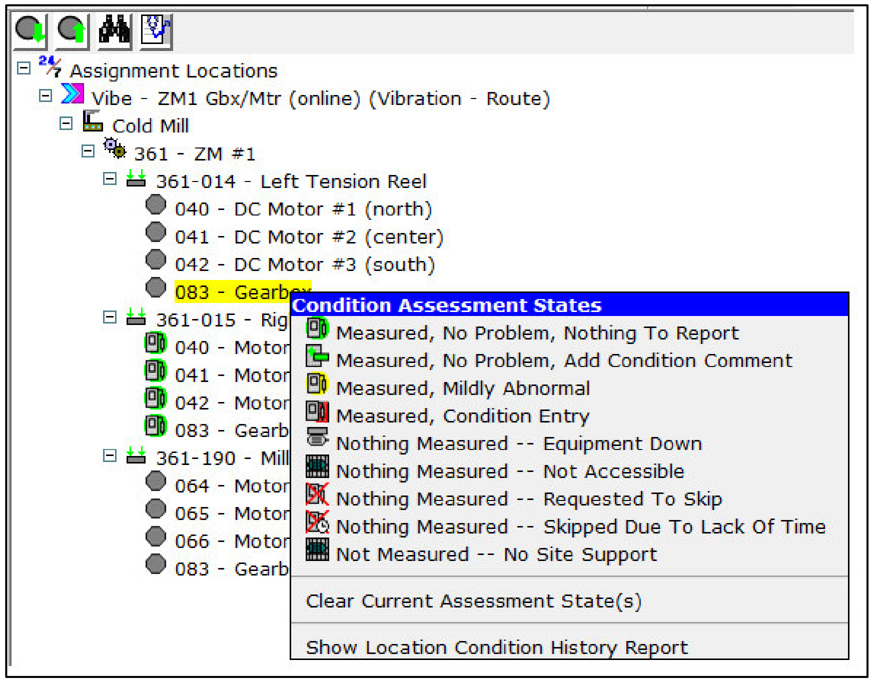


Fig 5 – Documenting asset condition states

For an asset with a detected problem, the analyst creates a condition entry and picks both the problem severity and failure mode from pull-down lists (Fig 6). He adds his recommended actions and can link multiple documents supporting the analysis, such as a vibration spectrum or infrared image.

As soon as this information has been entered, authorized users can then view the condition status for assets in their area of responsibility, via their web browser. The status dashboard shows the total number of condition issues in each category, prioritizes the display by problem severity, and shows all condition sources reporting problems on a specific asset (Fig 7). The web report is produced dynamically each time a user opens it, so the latest posted information is always shown.

To see the analyst's detailed findings, recommendations, and supporting documents the user can drill down into the condition entry; if the condition case has had more than one entry for the same problem the user can view the entire thread (Fig 8). At North American Stainless, the area engineers provide feedback to the plant stakeholders through status comments.

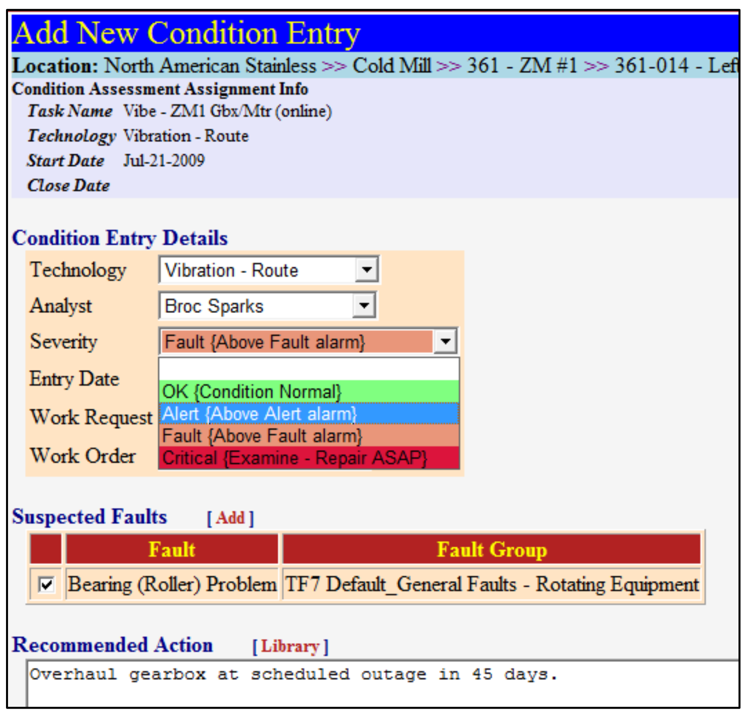
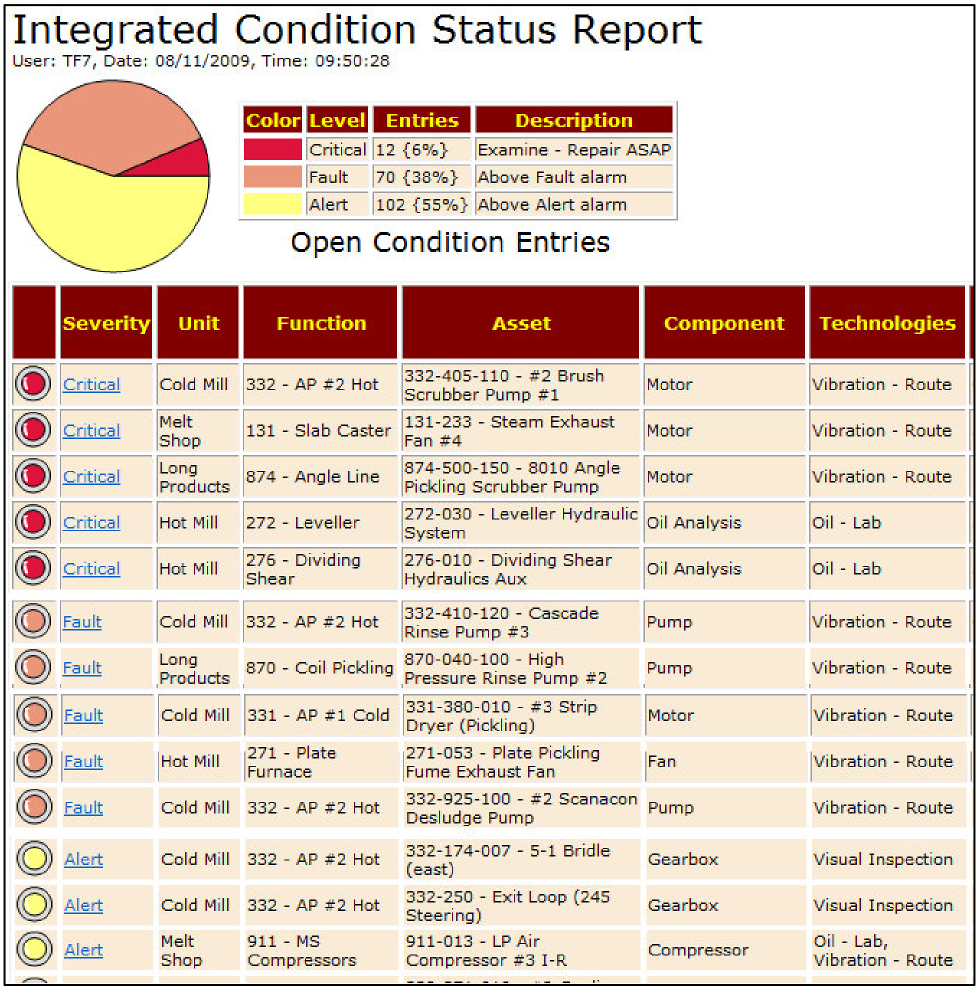


Fig. 6 – Adding condition entry details

Since the Reliability Information Management system is web based, authorized users can interact with the information. For example, North American Stainless area engineers and maintenance planners can use the integrated information on the dashboard to make decisions about opening work orders on condition-based calls, and then reference the work order numbers from their CMMS. This information can be reviewed in planning meetings with operations to fine-tune scheduling.



Integrated Condition Status Report

User: TF7, Date: 08/11/2009, Time: 09:50:28

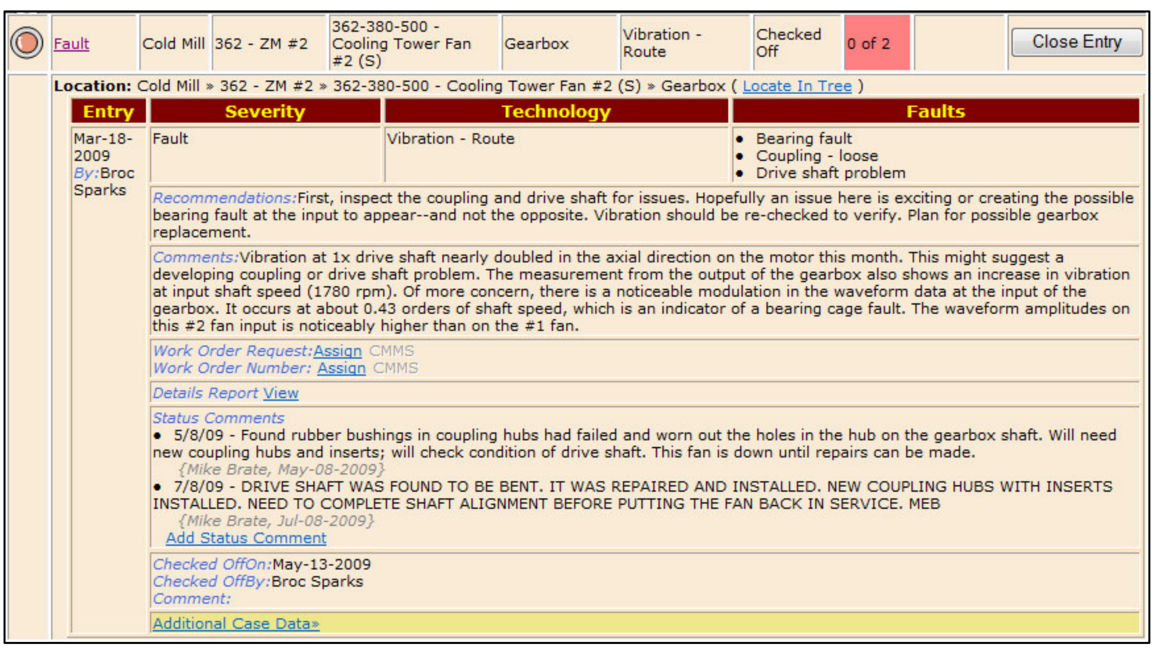
Color	Level	Entries	Description
	Critical	12 {6%}	Examine - Repair ASAP
	Fault	70 {38%}	Above Fault alarm
	Alert	102 {55%}	Above Alert alarm

Open Condition Entries

	Severity	Unit	Function	Asset	Component	Technologies
	Critical	Cold Mill	332 - AP #2 Hot	332-405-110 - #2 Brush Scrubber Pump #1	Motor	Vibration - Route
	Critical	Melt Shop	131 - Slab Caster	131-233 - Steam Exhaust Fan #4	Motor	Vibration - Route
	Critical	Long Products	874 - Angle Line	874-500-150 - 8010 Angle Pickling Scrubber Pump	Motor	Vibration - Route
	Critical	Hot Mill	272 - Leveller	272-030 - Leveller Hydraulic System	Oil Analysis	Oil - Lab
	Critical	Hot Mill	276 - Dividing Shear	276-010 - Dividing Shear Hydraulics Aux	Oil Analysis	Oil - Lab
	Fault	Cold Mill	332 - AP #2 Hot	332-410-120 - Cascade Rinse Pump #3	Pump	Vibration - Route
	Fault	Long Products	870 - Coil Pickling	870-040-100 - High Pressure Rinse Pump #2	Pump	Vibration - Route
	Fault	Cold Mill	331 - AP #1 Cold	331-380-010 - #3 Strip Dryer (Pickling)	Motor	Vibration - Route
	Fault	Hot Mill	271 - Plate Furnace	271-053 - Plate Pickling Fume Exhaust Fan	Fan	Vibration - Route
	Fault	Cold Mill	332 - AP #2 Hot	332-925-100 - #2 Scanacon Desludge Pump	Pump	Vibration - Route
	Alert	Cold Mill	332 - AP #2 Hot	332-174-007 - 5-1 Bridle (east)	Gearbox	Visual Inspection
	Alert	Cold Mill	332 - AP #2 Hot	332-250 - Exit Loop (245 Steering)	Gearbox	Visual Inspection
	Alert	Melt Shop	911 - MS Compressors	911-013 - LP Air Compressor #3 I-R	Compressor	Oil - Lab, Vibration - Route

Fig. 7 – Condition status dashboard display

Fig. 8 – Findings & recommendations, along with status comments



	Fault	Cold Mill	362 - ZM #2	362-380-500 - Cooling Tower Fan #2 (S)	Gearbox	Vibration - Route	Checked Off	0 of 2	Close Entry

Location: Cold Mill » 362 - ZM #2 » 362-380-500 - Cooling Tower Fan #2 (S) » Gearbox (Locate In Tree)

Entry	Severity	Technology	Faults
Mar-18-2009 By:Broc Sparks	Fault	Vibration - Route	• Bearing fault • Coupling - loose • Drive shaft problem

Recommendations: First, inspect the coupling and drive shaft for issues. Hopefully an issue here is exciting or creating the possible bearing fault at the input to appear--and not the opposite. Vibration should be re-checked to verify. Plan for possible gearbox replacement.

Comments: Vibration at 1x drive shaft nearly doubled in the axial direction on the motor this month. This might suggest a developing coupling or drive shaft problem. The measurement from the output of the gearbox also shows an increase in vibration at input shaft speed (1780 rpm). Of more concern, there is a noticeable modulation in the waveform data at the input of the gearbox. It occurs at about 0.43 orders of shaft speed, which is an indicator of a bearing cage fault. The waveform amplitudes on this #2 fan input is noticeably higher than on the #1 fan.

Work Order Request: Assign CMMS
Work Order Number: Assign CMMS

Details Report View

Status Comments

- 5/8/09 - Found rubber bushings in coupling hubs had failed and worn out the holes in the hub on the gearbox shaft. Will need new coupling hubs and inserts; will check condition of drive shaft. This fan is down until repairs can be made.
  {Mike Brate, May-08-2009}
- 7/8/09 - DRIVE SHAFT WAS FOUND TO BE BENT. IT WAS REPAIRED AND INSTALLED. NEW COUPLING HUBS WITH INSERTS INSTALLED. NEED TO COMPLETE SHAFT ALIGNMENT BEFORE PUTTING THE FAN BACK IN SERVICE. MEB
  {Mike Brate, Jul-08-2009}

Add Status Comment

Checked OffOn: May-13-2009
Checked OffBy: Broc Sparks
Comment:

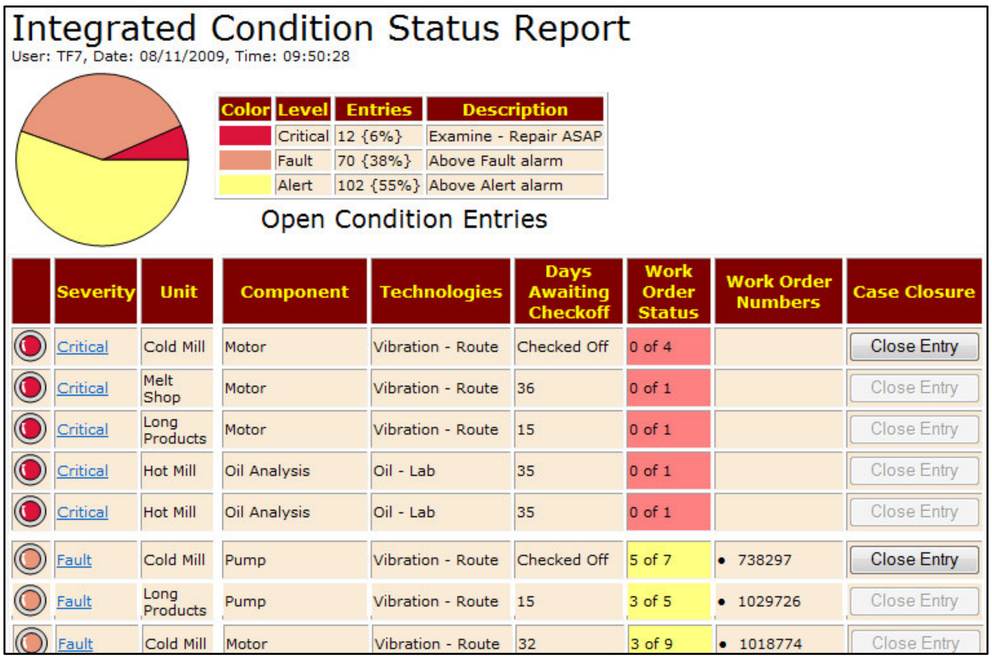
Additional Case Data»

The right hand side of the condition status dashboard shows 'Days Awaiting Checkoff', so participants in the planning meeting get a snapshot of response and work status for critical equipment issues (Fig 9). In the 2005 SMRP paper[1] Mark Mitchell at Eastman Chemical Company credited the wide and persistent visibility of condition results as one of the keys in making operations and maintenance joint owners of equipment reliability. He said that "good response to resolve condition-based maintenance issues" has become the way of life because everyone knows that "the bosses care".

At North American Stainless, Reliability Engineer Broc Sparks says he monitors the 'Days Awaiting Checkoff' and uses the information to praise good performers or enlist area maintenance managers' where response is poor.

As of mid-2009 Broc Sparks says that the web-based Reliability Information Management system has helped North American Stainless make very good progress toward the 'eliminate unexpected failures' reliability goal. He notes three contributions by the web-based system toward that success:

- Integration of monitoring results in one place, with entry being done directly by both contractors and in-house technicians
- Standardized report formats makes it easier for centralized reliability engineers & area engineers & supervisors to consume the important information
- Web-browser distribution of condition status and feed-back is building a retrievable long term history of what happened in critical equipment situations.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Open Condition Entries

	Severity	Unit	Component	Technologies	Days Awaiting Checkoff	Work Order Status	Work Order Numbers	Case Closure
	Critical	Cold Mill	Motor	Vibration - Route	Checked Off	0 of 4		Close Entry
	Critical	Melt Shop	Motor	Vibration - Route	36	0 of 1		Close Entry
	Critical	Long Products	Motor	Vibration - Route	15	0 of 1		Close Entry
	Critical	Hot Mill	Oil Analysis	Oil - Lab	35	0 of 1		Close Entry
	Critical	Hot Mill	Oil Analysis	Oil - Lab	35	0 of 1		Close Entry
	Fault	Cold Mill	Pump	Vibration - Route	Checked Off	5 of 7	• 738297	Close Entry
	Fault	Long Products	Pump	Vibration - Route	15	3 of 5	• 1029726	Close Entry
	Fault	Cold Mill	Motor	Vibration - Route	32	3 of 9	• 1018774	Close Entry

Fig. 9 – Condition-based work response indicators

When a work order is completed, the area engineers can let the central reliability group know by 'checking off' the condition entry. The reliability group can then validate the repair work with a follow-up condition survey, and close the case. At that point the condition case information is no longer included in the condition status dashboard, but becomes part of the life-cycle history for that service location and piece of equipment.

Going into the last half of 2009 North American Stainless is now starting to focus on managing the information needed to tackle the second basic reliability goal – extending life of equipment. The retrievable history of faults detected through condition monitoring is helping them pinpoint locations and fault types that need attention (Fig 10). They are now setting up their equipment repair vendors to deliver repair documentation through the same web system, linking that information to all the condition results in the same web-hosted database. That will allow the vendors to directly input design details, repair costs, and their findings on fault modes and root causes, helping confirm or modify the condition monitoring findings. The reliability group at North American Stainless knows this will help them accurately target specific equipment life extension projects, and achieve the plant reliability benefits that management expects.

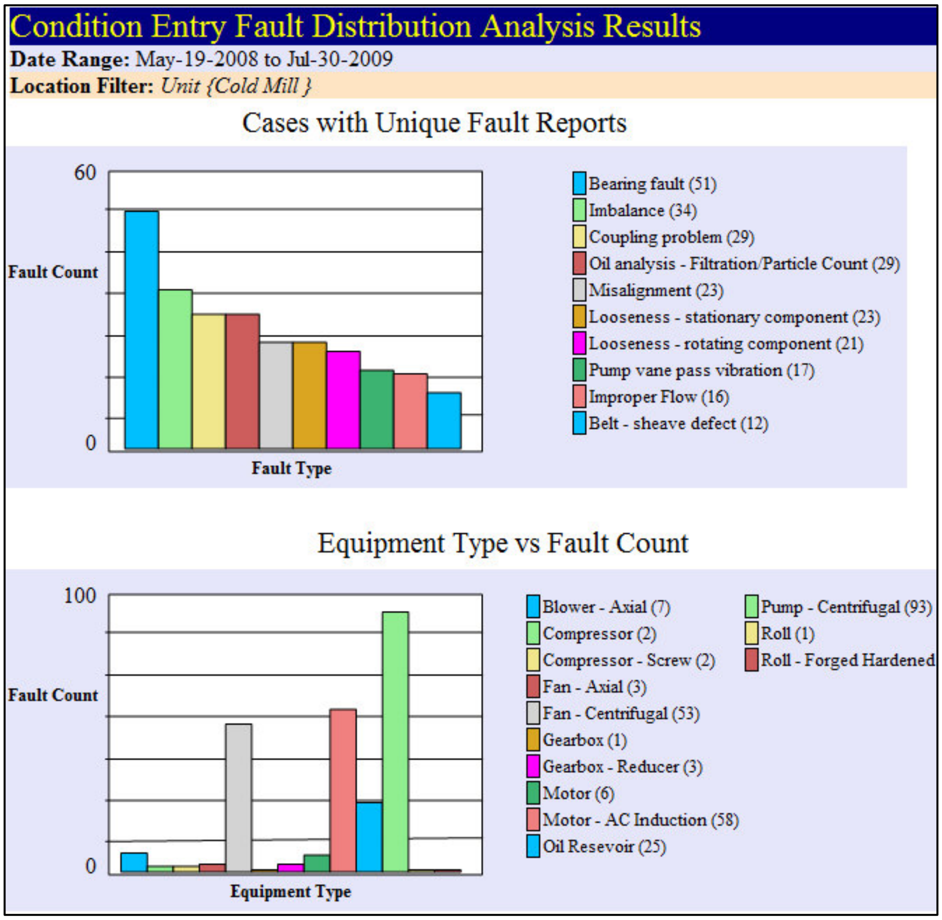

Fig. 10 – Fault history showing issues with bearing faults and centrifugal pumps in one mill area

Summary

Industrial plant organizations such as Eastman Chemical Company in Kingsport, TN and North American Stainless in Ghent, KY have recognized that technical excellence in condition monitoring and maintenance maintenance are only part of the means to achieve basic reliability goals of 1) eliminating unexpected failures and 2) extending the life of equipment. They are incorporating a process of Reliability Information Management utilizing web browser and web-hosted database technology to capture essential reliability information from plant sources and from their service contractors and repair vendors, then communicate actionable issues to a broad plant audience, and create accountability for timely maintenance follow-up.

(1) “Communication and Accountability are the Keys to Success in Condition-Based Maintenance” by Mark Mitchell & Steve Quillen of Eastman Chemical Company, Forrest Pardue & Dick Hancock of 24/7 Systems, co-presented at the 2005 SMRP Conference in St. Louis, MO