Routine Inspections Play Key Role in Condition Based Maintenance

Jerry Rust	Forrest Pardue	Dick Hancock
Reliability Engineer	President	Consultant
Buzzi Unicem USA	24/7 Systems, Inc	24/7 Systems, Inc.

Buzzi Unicem is one of the world's major cement producers, and equipment reliability is an important issue at Buzzi's eleven USA plants. Due the abrasive, dusty, and hot environment in the cement making process, physical equipment inspections play a dominant role in Buzzi's reliability program. Buzzi has a comprehensive condition monitoring program using vibration analysis, oil analysis, and infrared thermography service contractors, but plant employees are very effective using sight, sound, and touch to spot random failure modes that are very common in Buzzi's operating environment.

In early 2004 a merger with Dyckerhoff AG brought the plant near Signal Mountain, Tennessee into the Buzzi Unicem USA organization. At Signal Mountain Buzzi inherited a maintenance organization with the traditional division between mechanical and electrical responsibilities. They also found that three different departments were gathering information about equipment health, without an efficient process to pull the information together for work prioritization:

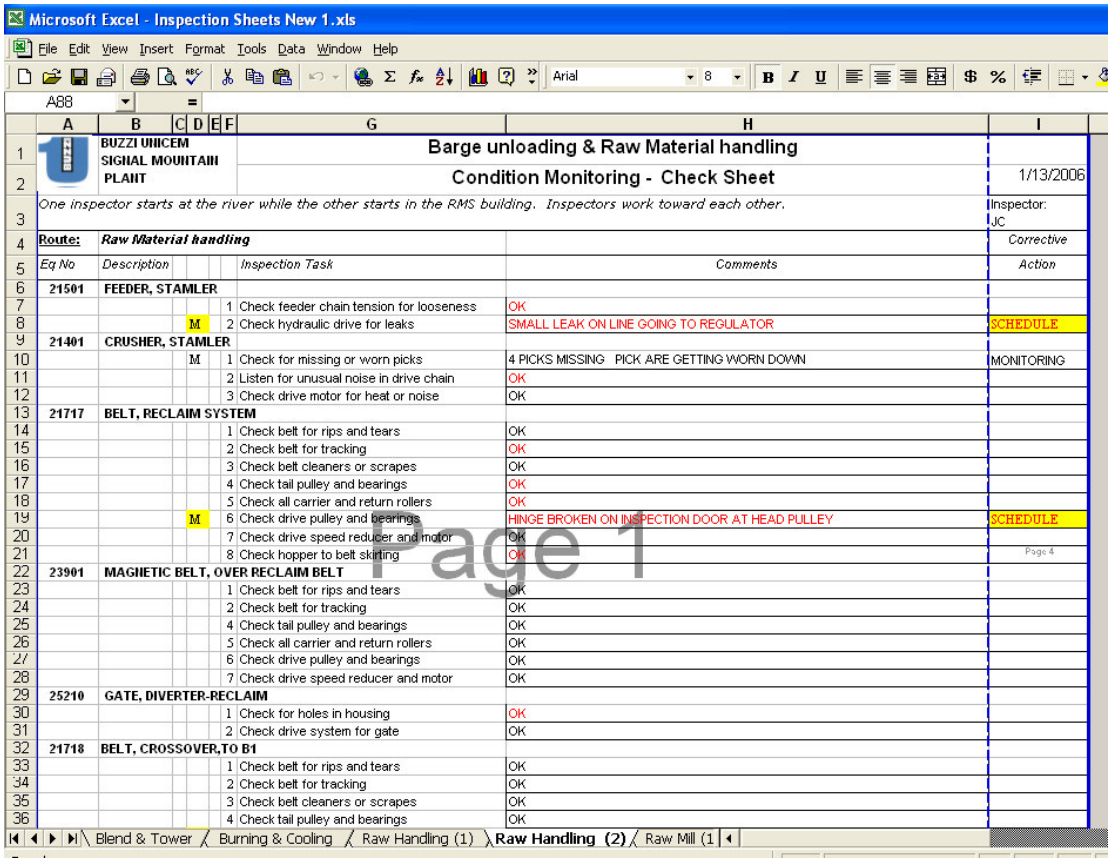
Buzzi Unicem USA's Signal Mountain, TN Plant

- Operations supervisors oversee inspections by process attendants – these include lubrication related observations, actions, & sampling.
- Electrical maintenance manages motor testing & IR thermography surveys done by service contractors, and conducts a few electrical equipment inspections.
- Mechanical maintenance directs contract vibration analysis and does weekly equipment inspections.

Jerry Rust came on board as the plant's Reliability Engineer in early 2005, and he quickly recognized that the process of capturing and using this information needed to be streamlined. Prior to his arrival, only the nine inspections set up for process attendants were documented in Microsoft Excel® spreadsheets. There were no formal definitions for the other inspections or documentation of the observations, so his first step was to create spreadsheets for the ten weekly mechanical maintenance inspection routes. These spreadsheets were printed and distributed for each inspection, with data recorded manually in the plant and later keyed into the spreadsheets.

Not surprisingly, consistency of the inspections improved significantly with the spreadsheet process, and the 'hit or miss' nature of fixing problems found through inspections also changed for the better. However, Rust realized that there were still several shortcomings:

- The spreadsheets did not have automatic alarming to quickly identify problem areas
- It was difficult to know which items in an inspection were missed
- Prioritizing and communicating work needs with maintenance planners was still erratic as they tried to evaluate the information from over a dozen weekly spreadsheets
- Pulling together failure trends and histories across all the spreadsheets was impractical
- Most importantly the manual nature of recording field observations and then keying the data into spreadsheets was very labor intensive



Microsoft Excel - Inspection Sheets New 1.xls

BUZZI UNICEM SIGNAL MOUNTAIN PLANT

Barge unloading & Raw Material handling

Condition Monitoring - Check Sheet

1/13/2006

One inspector starts at the river while the other starts in the RMS building. Inspectors work toward each other.

Inspector: JC

Route: ***Raw Material handling***

Eq No	Description			Inspection Task	Comments	Corrective Action
21501	FEEDER, STAMLER					
			1	Check feeder chain tension for looseness	OK	
		M	2	Check hydraulic drive for leaks	SMALL LEAK ON LINE GOING TO REGULATOR	SCHEDULE
21401	CRUSHER, STAMLER					
		M	1	Check for missing or worn picks	4 PICKS MISSING PICK ARE GETTING WORN DOWN	MONITORING
			2	Listen for unusual noise in drive chain	OK	
			3	Check drive motor for heat or noise	OK	
21717	BELT, RECLAIM SYSTEM					
			1	Check belt for rips and tears	OK	
			2	Check belt for tracking	OK	
			3	Check belt cleaners or scrapes	OK	
			4	Check tail pulley and bearings	OK	
			5	Check all carrier and return rollers	OK	
		M	6	Check drive pulley and bearings	HINGE BROKEN ON INSPECTION DOOR AT HEAD PULLEY	SCHEDULE
			7	Check drive speed reducer and motor	OK	
			8	Check hopper to belt skirting	OK	
23901	MAGNETIC BELT, OVER RECLAIM BELT					
			1	Check belt for rips and tears	OK	
			2	Check belt for tracking	OK	
			4	Check tail pulley and bearings	OK	
			5	Check all carrier and return rollers	OK	
			6	Check drive pulley and bearings	OK	
			7	Check drive speed reducer and motor	OK	
25210	GATE, DIVERTER-RECLAIM					
			1	Check for holes in housing	OK	
			2	Check drive system for gate	OK	
21718	BELT, CROSSOVER,TO B1					
			1	Check belt for rips and tears	OK	
			2	Check belt for tracking	OK	
			3	Check belt cleaners or scrapes	OK	
			4	Check tail pulley and bearings	OK	

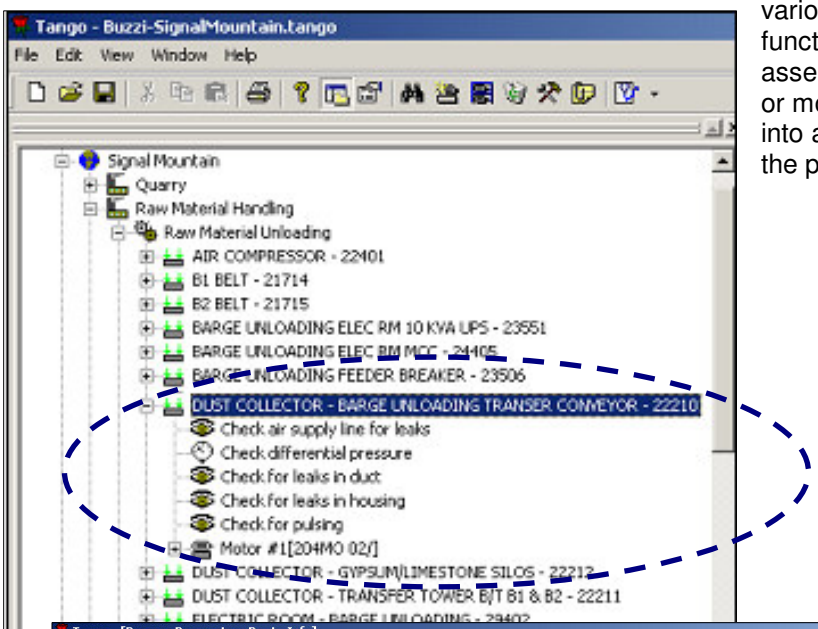
Blend & Tower | Burning & Cooling | Raw Handling (1) | Raw Handling (2) | Raw Mill (1

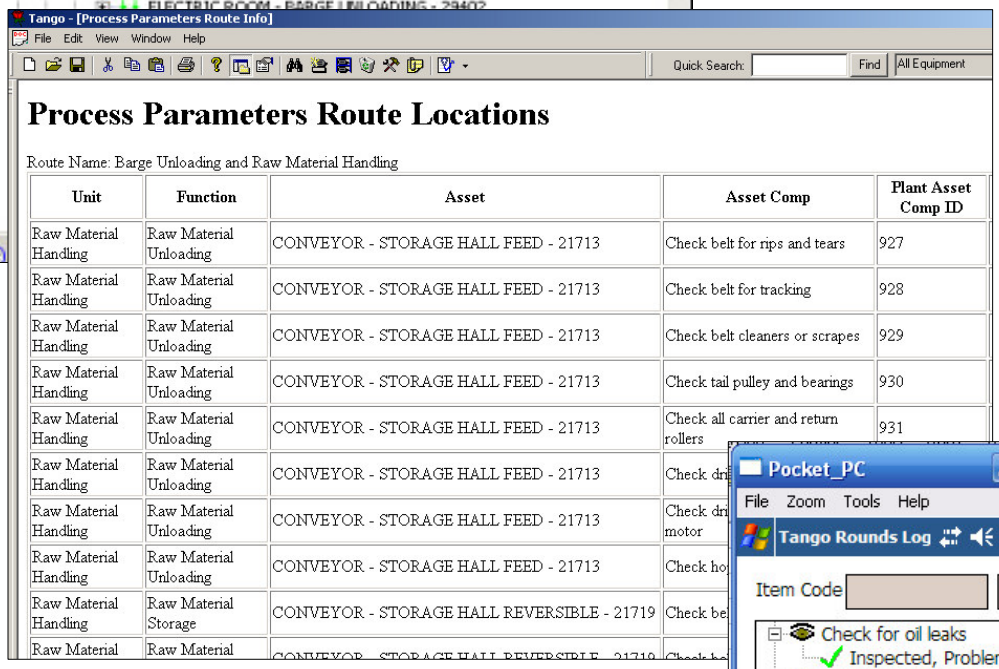
Page 1

Inspection Spreadsheet

As Rust was investigating technology for automating data collection for the spreadsheets, he learned that Buzzi's corporate office was evaluating a web-based system to integrate results for all condition monitoring technologies being used at the company's production sites. This system includes a rounds logging capability with handheld PDA's for in-plant data collection, so Rust decided to use that system. He chose to stage the implementation, starting with the ten mechanical department weekly inspections. The web-based system vendor converted the spreadsheets into routes for download into the PDA, and also set up acceptance range conditions for generating alarms on each inspection task. Two industrial grade PDA's were purchased, and two mechanics started collecting data early in 2006.

The inspection tasks are defined as a gauge reading or observation at a particular equipment location in the plant. In the database, the inspection tasks show up underneath an asset name in the location structure, as shown in the outlined area below. A group of inspection tasks on various pieces of equipment in a functional area of the plant are assembled into a route list. One or more routes are downloaded into a PDA for data collection in the plant.



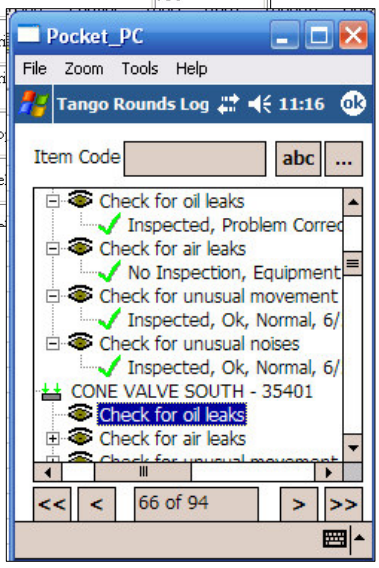


Process Parameters Route Locations

Route Name: Barge Unloading and Raw Material Handling

Unit	Function	Asset	Asset Comp	Plant Asset Comp ID
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check belt for rips and tears	927
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check belt for tracking	928
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check belt cleaners or scrapes	929
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check tail pulley and bearings	930
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check all carrier and return rollers	931
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check dri	
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check dri motor	
Raw Material Handling	Raw Material Unloading	CONVEYOR - STORAGE HALL FEED - 21713	Check ho	
Raw Material Handling	Raw Material Storage	CONVEYOR - STORAGE HALL REVERSIBLE - 21719	Check be	
Raw Material	Raw Material	CONVEYOR - STORAGE HALL REVERSIBLE - 21719	Check be	

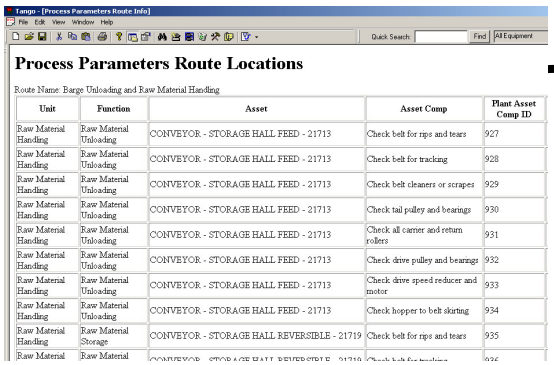
Inspection Route List for Download to PDA

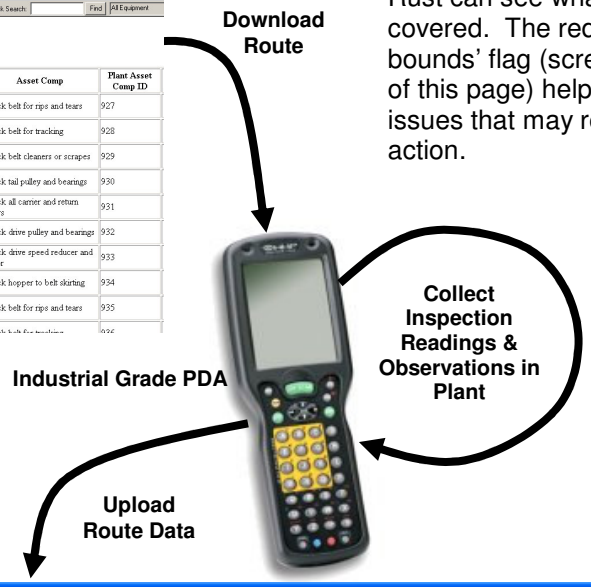


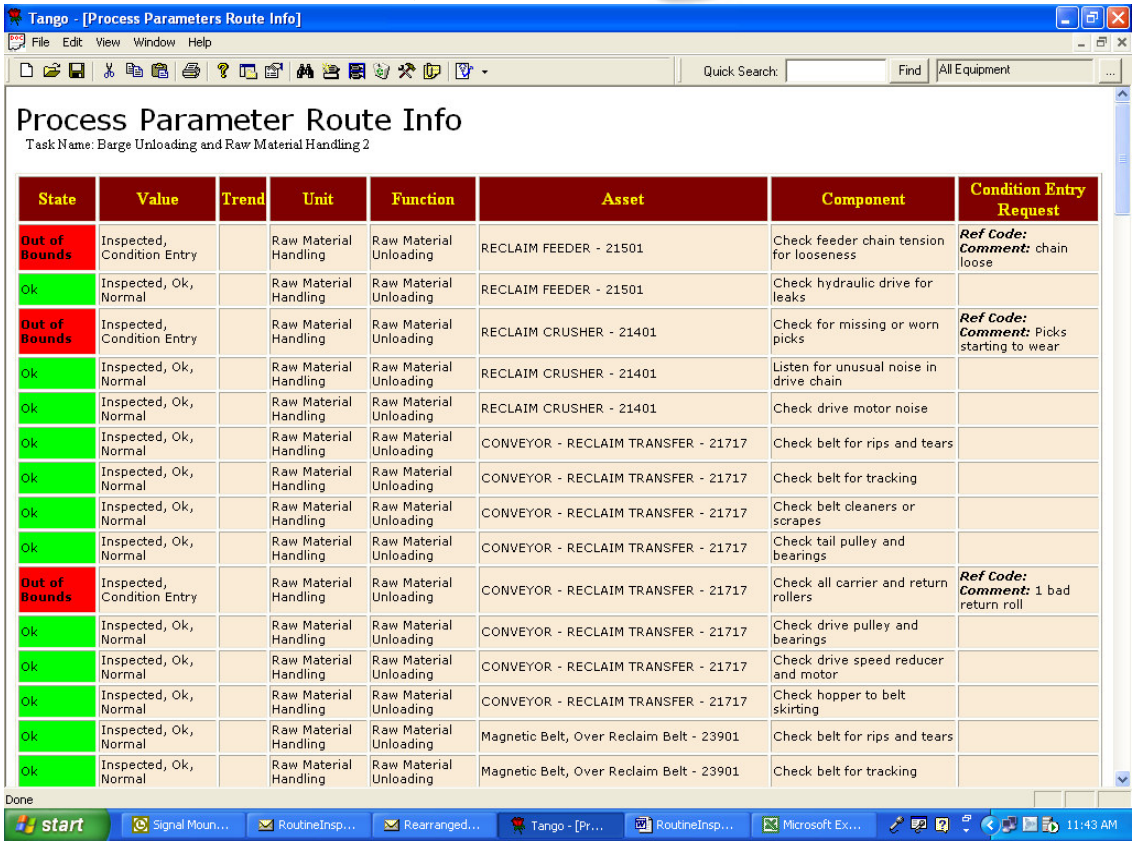
Inspection Tasks on PDA Screen

Even though data collection with the PDA is a straightforward process, one of the first lessons learned was the importance of having the correct sequence of inspection tasks appear on the screen. The technicians were used to scanning a spreadsheet printout to spot the next inspection step, and they found it awkward to scroll through a PDA screen when the items were not in the correct sequence. Rust worked with the vendor to make it easier for a route list to be re-arranged, and that solved the problem.

Inspection tasks include an acceptance range for readings and observations, so an exception report is available as soon as the PDA is uploaded to the web-hosted database. Missed inspection items are color coded, so Rust can see what was not covered. The red 'out of bounds' flag (screen at bottom of this page) helps Rust spot issues that may require further action.



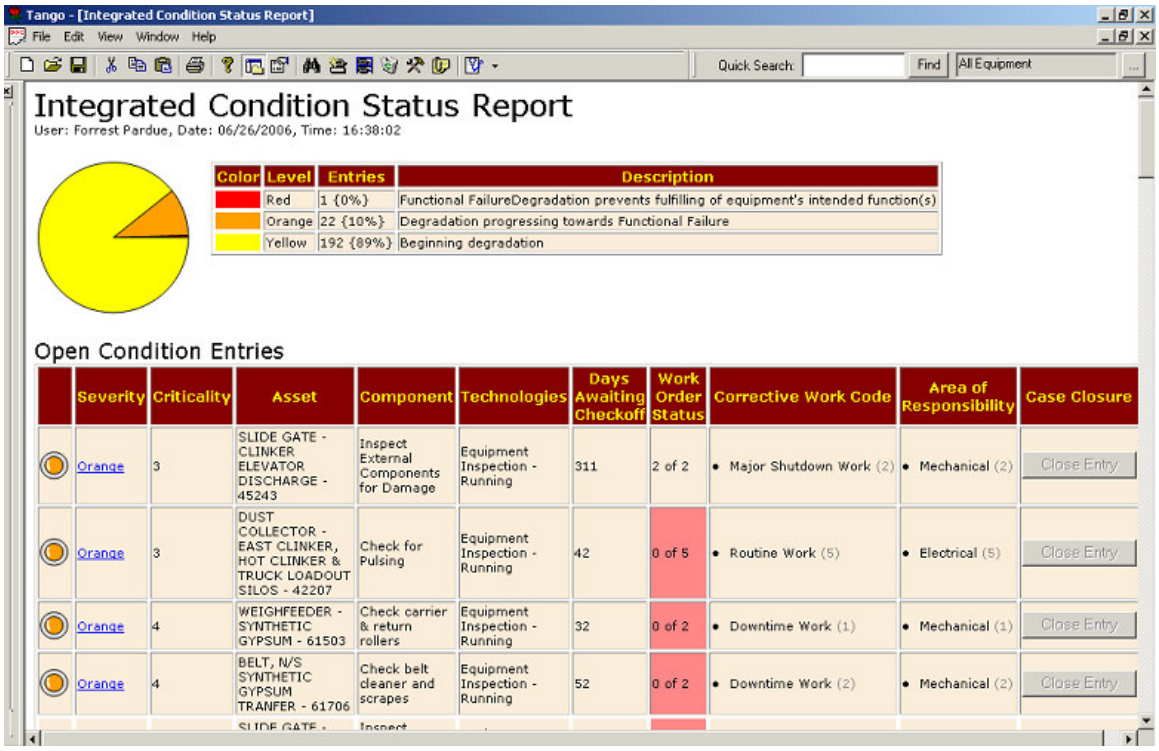




The ‘out of bounds’ items are presented in a list where Rust makes a decision about the severity of the item. For those that need a response, he creates a ‘condition entry’ that prioritizes severity based on the following three-step scale:

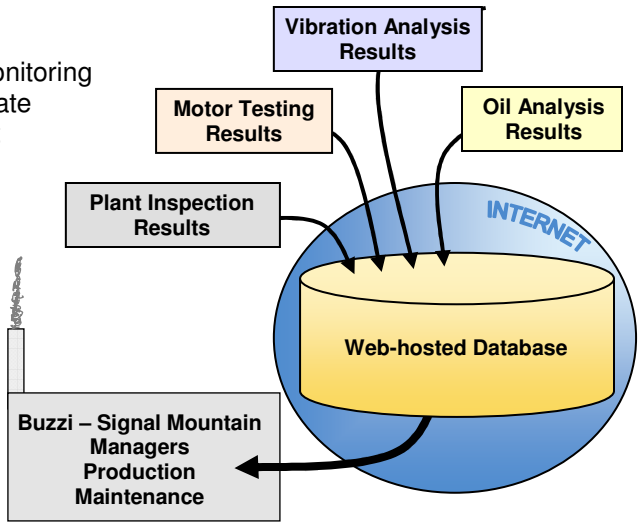
- Functional failure – degradation prevents fulfilling of equipment’s intended function(s)
- Degradation progressing towards functional failure
- Beginning degradation

As soon as these condition entries are made, other Buzzi personnel can view a report via their web browser showing all outstanding condition entries.



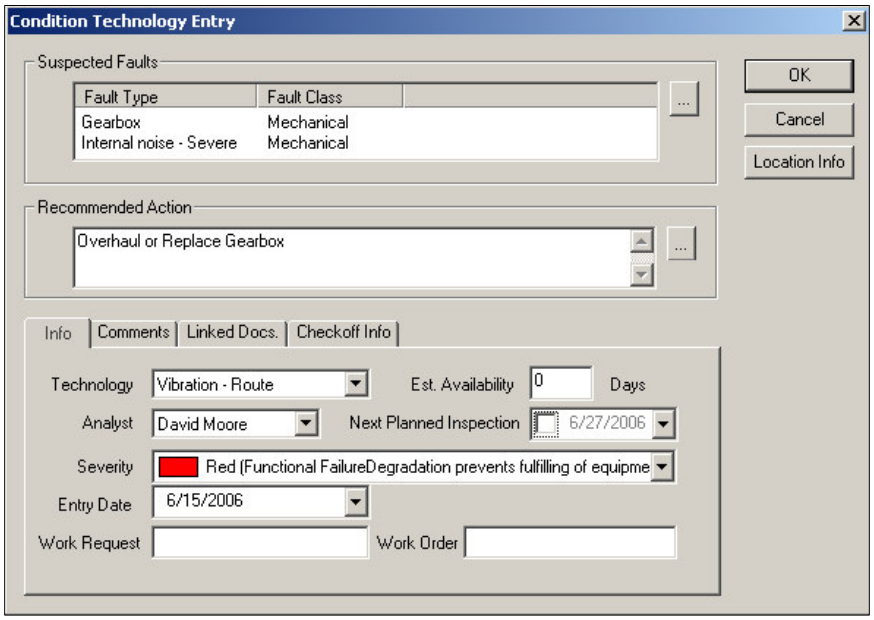
Condition Status Report with Color Coded Severity

Integrating results from different condition monitoring technologies was the focus of Buzzi’s corporate evaluation of the web-based system, so Rust also took advantage of that capability. Vibration analysis and motor testing are done at Signal Mountain by contractors who now enter results directly via the Internet, without having to cross the plant network firewalls. Plant personnel create condition entries as needed from oil analysis results sent in by the plant’s lubricant supplier.



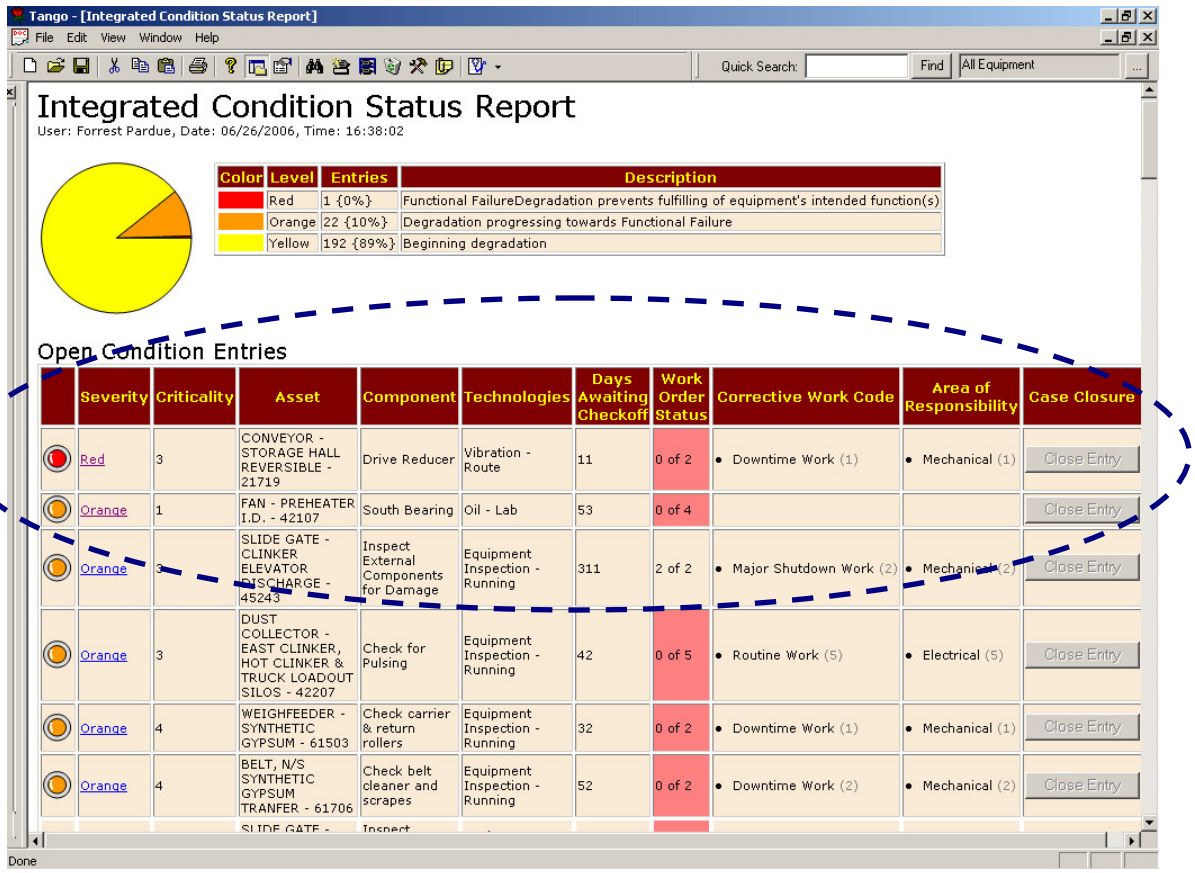
Data Entry & Retrieval via the Internet

All condition entries use the same simple process. Suspected faults are selected from a pull down menu, to force standardization of the fault descriptions. Technicians provide a concise recommended action, select one of the three severity codes, and are also able to link any documents to support their findings, such as a vibration trend plot or an IR thermography image.



Condition Entry Process

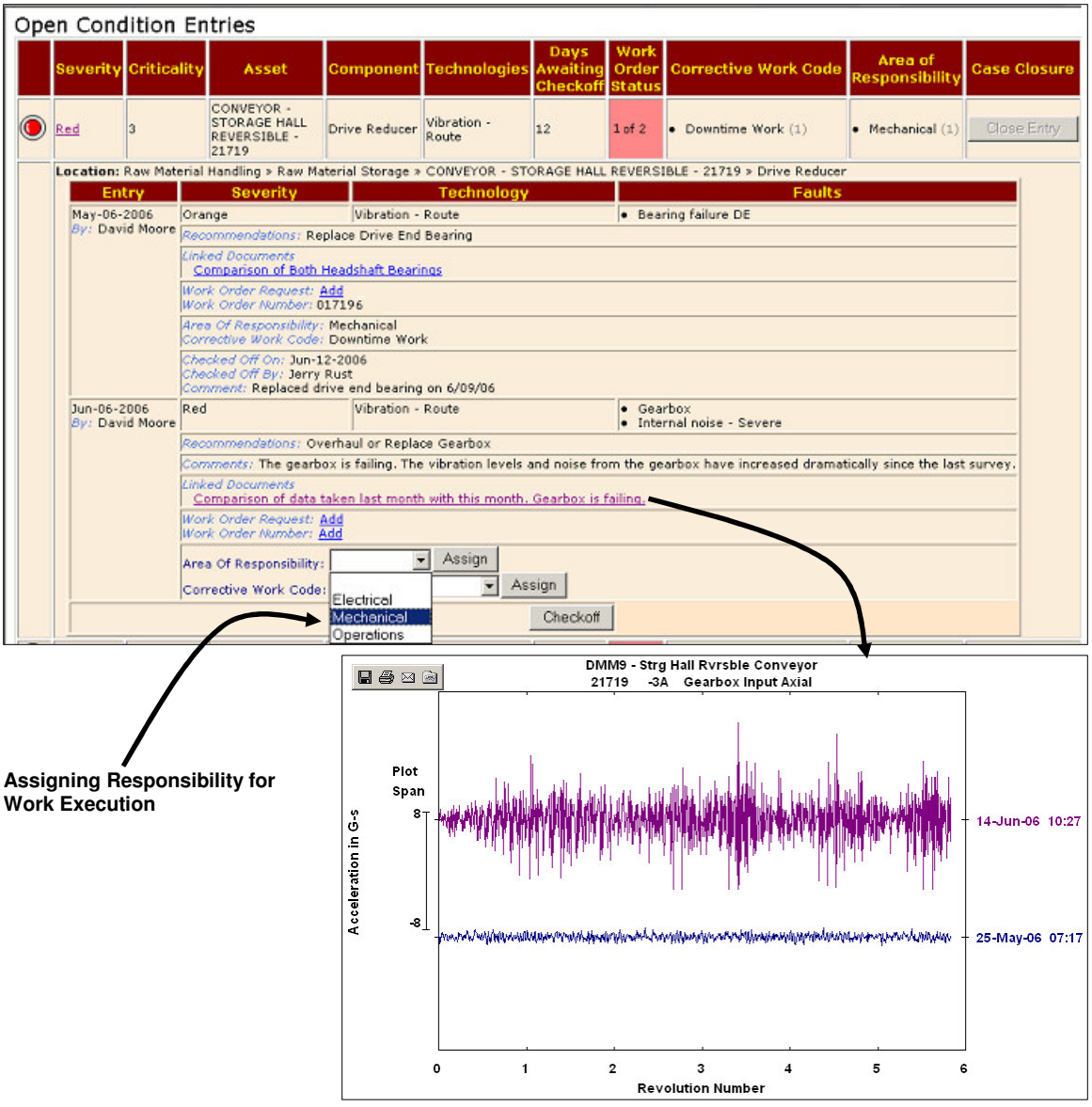
The Integrated Condition Status Report is updated as soon as the entry is completed.



Integrated Vibration, Oil, & Inspection Entries

By early spring 2006 Rust had the ten weekly mechanical inspections running with the PDA data collection system, and results were being integrated with the vibration analysis, motor testing, and oil analysis results coming from the outside contractors. At that point he began to focus on how to best use the information to make work prioritization and execution more efficient. In the existing culture at the Signal Mountain plant, work orders are entered into their CMMS system by all three departments – operations, mechanical maintenance, and electrical maintenance. They conduct a weekly meeting to schedule work based on outstanding work requests. Prior to the weekly meeting Rust evaluates the problems listed in the Integrated Condition Status Report, reviewing the findings, recommendations, and linked documents available for the asset to confirm that the severity level is accurate. He can then use the prioritized listing to help drive the most effective scheduling of resources in each area. After a couple of months he realized that he could communicate more effectively if the report he was handing out to each area was limited to items for which that area would be responsible, and if the work was also classified as emergency, routine, shut down, etc. Rust again worked with the system vendor to add capability to set those categories, and he is now able to deliver customized reports for each department at the weekly meeting.

Drilling Into Finding & Recommendation Details

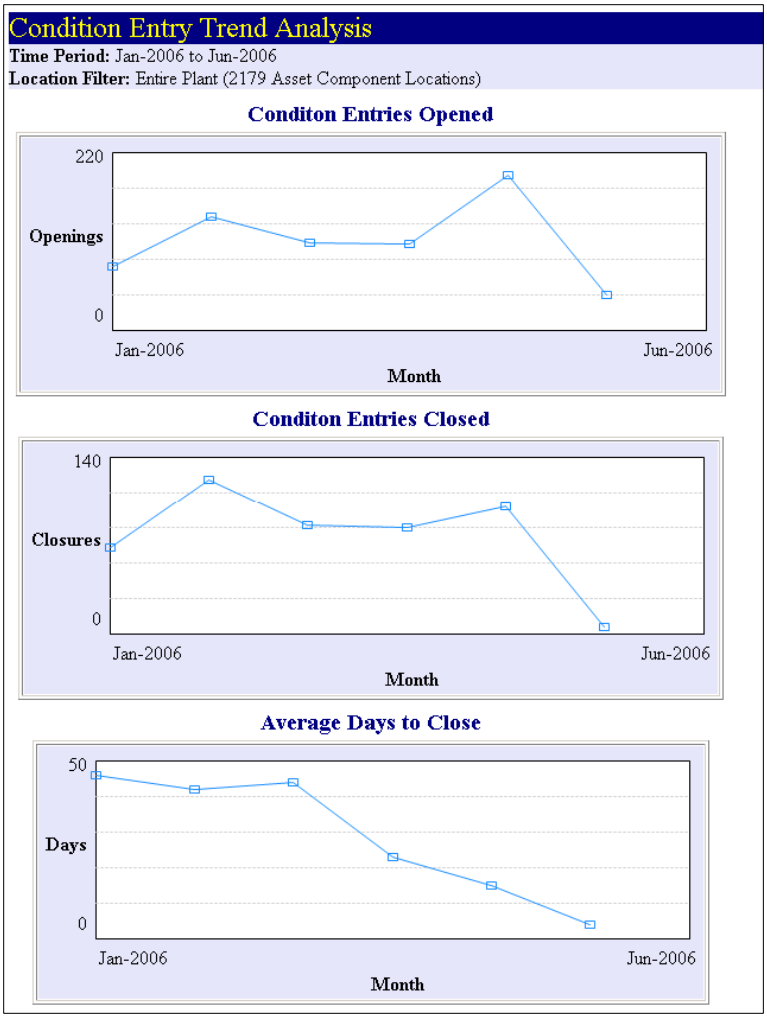


Assigning Responsibility for Work Execution

Linked Document Supporting Finding & Recommendation

As of mid-2006 the next issue facing Rust is changing the process of closing out condition entries once corrective work is done. Up to this point of the implementation he has taken care of closing out each entry after the next inspection or condition survey indicates the problem has been taken care of; he is encouraging the maintenance planners to use the interactive web-browser report instead of the paper version so that they will be able to check off entries as they close each work order.

Through the first six months of 2006 the impact of the web-based system is promising. New condition entries have averaged around 100 per month over that period, and the average time to closure has been reduced significantly at mid-year. Part of that result is probably increasing familiarity with the system, but it also indicates improved efficiency in communicating, prioritizing, and executing condition-based maintenance.



Trend Analysis of Condition Entry Closure Time: January - June, 2006

Process attendant inspections will be the next to be shifted from manual spreadsheets to PDA, and then the electrical routes once a dedicated electrical inspector is brought on board. Rust also plans to add several condition monitoring tools for use during inspection routes, such as an ultrasonic gun, a borescope, an IR spot temperature gun, and vibration pens. With results from all these technologies being integrated and distributed via their web-based system, the Signal Mountain Plant is building the template for condition-based maintenance across all Buzzi Unicem USA's sites.