

## Diagnostic Technologies Drive Smarter Turnarounds

Written by Wally Vahlstrom, P.E., and Jeff W. Jostad Emerson Process Management  
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**Knowledge is mighty powerful stuff when it comes to planned outages.**

During advance planning for maintenance turnarounds, some decisions are based more on estimating the condition of key assets than actual knowledge. That can be very costly. Control valves, for example, are frequently scheduled for overhaul with no factual information on their condition. In fact, up to 40% of installed valves may not need this level of maintenance. Experience has shown that much better results can be obtained using valve diagnostics than with the common "tear-apart-and- inspect" method, which can be a very expensive way to go.

For example, after six months of "planning," one Midwestern operation recently contracted to rehabilitate 100 control valves—*with no preliminary information on their condition*. After the turnaround began, 32 more undiagnosed control valves were added to the list. All 132 valves had to be removed, transported to a nearby shop, disassembled and repaired according to what the technicians found inside. Many of these valves could have been repaired and/or adjusted without ever removing them from the plant, but poor planning and the surprise addition of 32 more valves resulted in a final cost that was more than four times the original bid.

But control valves represent just one class of plant equipment where the use of a relatively new diagnostic technology can have a significant positive impact on turnarounds by giving maintenance managers valid information on which to base their plans. Electrical power systems are another such area.

In the past, the only way most plants had to determine the condition of medium- and high-voltage systems was by offline testing—*which can't be performed prior to the turnaround*. This makes it difficult to proactively plan and identify the specific scope of work in advance. With

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new online diagnostic tests, however, good information on the condition of electrical equipment is available well before the turnaround starts.

Outage planning based on *actual knowledge*, not guesses, is what our company refers to as "smart turnarounds." Pre-outage testing or evaluation of essential assets yields predictive diagnostics well in advance. Better information enables the turnaround team to work smarter, avoiding those unexpected issues that cause more work than can be done in the allotted time and with available resources, resulting in schedule and cost overruns.

Optimum results can be achieved only through effective planning in order to meet such critical objectives as:

- Completion in the shortest time and lowest cost possible
- Improved equipment performance for higher yields
- Reduced energy costs
- Maintaining highest levels of safety

### **Diagnostics for planning**

A thorough evaluation of production assets is the first step in any smart turnaround. Most maintenance managers have lists of equipment they know is damaged or performing poorly. Certain widely recognized diagnostic techniques—*such as vibration profiles on rotating machinery*—are also commonly used in compiling turnaround lists. Still, the true condition of some systems has been difficult to ascertain. Thus, decisions regarding their maintenance have traditionally relied on a combination of judgment, severity of the service and history. In light of ever-smarter technologies, this situation is rapidly changing.

### **Control-valve diagnostics...**

Digital valve controllers (DVCs) have led to the ability to generate vast amounts of information regarding the valves to which these devices are mounted—*and the ability to position these valves precisely and quickly*. When that data is accessed and evaluated using recently developed flowscanner technology, the knowledge gained can be of tremendous value in turnaround planning. If flowscanning is applied in advance of a turnaround, experience shows that about a third of all valves DO NOT need to be pulled, saving on removal and installation as well as overhaul costs.

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Initially, a portable flowscanning device would be connected directly to a control valve in the field for inline testing against manufacturers' specifications. With DVCs, however, technicians were able to access more extensive diagnostics through software in a laptop computer hooked up to one control valve at a time. This has allowed a never-before-possible means of looking into control valves to reveal conditions not visually apparent.

Today, the ability to see the health of control valves is even easier. Take, for example, the AMS Suite: Intelligent Device Manager predictive maintenance software. It allows access to valve diagnostic data via a plant's distributed control system. Users can gather current information on the condition of valves throughout the facility without ever leaving the comfort and safety of the control room or instrument shop. Diagnostics obtained in this way are stored in a comprehensive database of all valves and presented in a logical series of screens. This field-generated information is critical for predicting the maintenance needs of smart valves at any time, but especially prior to a turnaround. A criticality factor can also be applied, indicating the importance of each piece of equipment to the production system so that priority attention can be given to the most important assets.

### ***Electrical-system diagnostics...***

Industrial power distribution systems are more susceptible to deterioration than many people realize—and the probability of an electrical failure increases if maintenance is deferred. Most people also aren't fully aware of how many technologies are available to provide accurate information on the condition of electrical equipment prior to a turnaround. These include, among others, infrared thermography to determine "hot" spots while equipment is energized; analysis of the condition and dielectric properties of transformer oils; and ultrasonics testing to find corona and other invisible problems within an electrical system. Online partial discharge testing (OLPD) is one of the newer methods available to help maintenance managers determine the condition of their electrical systems so that cost-effective plans can be made for a coming outage.

OLPD is most beneficial in facilities that cannot be shut down for offline testing. These tests can be performed while the equipment is energized with no disruption of the power supply—and *without causing any damage.*

A partial discharge is an electrical fault that does not bridge the entire space between two electrodes. With power cables, partial discharge might be a streamer or arc across a gap in the insulation, either external or internal to the cable. Such a discharge may occur in several places, but an insulation void is most common. It can also occur at a contaminant or at the tip of a well-developed water tree. Defects, installation errors and deterioration in cables and

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terminations often cause growing levels of partial discharge prior to failure.

Partial discharges emit heat, sound, light and electromagnetic waves. Utilizing RF signatures, OLPD tests measure the characteristics of insulation as a means of assessing a cable system's condition. Electromagnetic waves produced by the partial discharges are utilized to produce graphic images of insulation deterioration, leading to an awareness of cable system weakness not available from any other source. This knowledge makes it possible to plan for component or cable replacement or repair at the least disruptive time (see [Sidebar](#) ).

Online testing is conducted under actual operating conditions, temperatures, voltage stresses and vibration levels. For critical, round-the-clock operations, this type of non-destructive testing is the best way to identify partial discharge activity. Only a few minutes are needed to test each point of attachment, so a large number of tests can be done rather quickly and easily. Partial discharge signals are captured by special monitoring software and each asset is automatically assigned a "criticality" level based on the magnitude and number of PD pulses per power cycle.

The scope of OLPD test technology now extends beyond cable testing to include switchgear and other electrical equipment employed by major power users—*and even power providers*. New services encompass both online (while equipment is energized) and offline testing, periodic monitoring of selected electrical assets and other methods to identify potential trouble spots in order to prevent unexpected, costly outages.

### Turnaround services

Above all, turnaround managers want to finish on time and within budget, as these are the parameters management uses to measure the success (or failure) of the undertaking. As Case #2 in the accompanying [Sidebar](#) shows, such objectives are reachable by following a proven process based on predictive diagnostics in the hands of turnaround specialists.

Once the scope of work has been clearly defined and a schedule adopted, the next step is determining the resources needed to execute the plan. This is followed by allocating the parts, materials, labor, and test and repair equipment required to complete the turnaround. Execution is then a matter of making sure the right people and equipment are staged so the turnaround proceeds according to schedule.

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After the turnaround is complete and the plant successfully restarted, it's time to review the entire process to identify areas for improvement. A final comprehensive report details tasks performed, equipment rebuilt or replaced and labor utilization—*plus recommendations for future maintenance requirements.*

Depending on the initial condition and criticality of each asset, monitoring may be needed in the future—

*from monthly to semi-annually to once every two or three years.*

### **The value of sooner than later**

It is impossible to efficiently execute a plant or unit turnaround without thorough advance planning based on good knowledge of the condition of the assets affected during the turnaround. That means making full use of available diagnostic tests, which should be included in turnaround budgeting. The cost can be more than paid for from the savings that will be realized by having inside knowledge of your assets' condition, sooner than later. **MT**

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## **How Smarter Turnarounds Have Saved Money**

### **Case #1...**

*Many of the 270 control valves in the hydrocarbon-processing unit of a major Texas refinery had performance issues that needed to be addressed during an upcoming turnaround. Although some repairs had already been scheduled, the site's control-valve asset manager chose to conduct a thorough assessment of all 270 valves in the unit. By stroking these valves using flowscanner technology and comparing the results with benchmark studies, he was able to*

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*advise the turnaround planners which valves were most in need of overhaul, allowing them to prioritize the repairs. About a third of the valves were found to be in good condition and not pulled during the turnaround.*

*In one case, a failed valve travel sensor was identified and an unplanned shutdown was avoided—saving the facility an estimated \$625,000 in repairs and lost productivity. Since the sensor was repaired, this critical valve has continued to operate without incident.*

*The refinery's control-valve asset manager has become an effective force in the facility, regularly monitoring diagnostics generated by the DVCs and working proactively to eliminate systemic failures. Savings of more than \$1 million annually have been attributed to the efforts of this manager and the predictive maintenance environment he established.*

### **Case #2...**

*After roughly 14 years without a comprehensive overhaul, the power distribution system at a major Southeastern pulp and paper mill was long overdue. In fact, planning was underway for a cold-mill outage when a 500 MCM primary-feed cable failed, completely shutting down the 40-year-old facility for a day—at a cost of more than a million dollars in downtime.*

*That cable failure brought home the need to periodically test, clean and repair the site's distribution systems, but with production straining just to keep up with orders, minimal time was available for such a project. Finally, management allotted 24 hours for an electrical maintenance outage.*

*During that 24-hour period, the 13.8 kv power distribution system to the entire mill was taken offline, given routine preventive maintenance, cleaned and reconfigured. A complete overhaul was performed on more than 148 substations and four 13.8 kv buses. In addition, seven 13.8 kv primary switches were changed, seven 700 MCM cables were split from the utility, three mill 500 MCM cables spliced, mill black-start capabilities installed and five 13.8 kv breakers, including all phases, were re-terminated.*

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*This concentrated project took planning and extreme effort by more than 135 highly qualified technicians and electricians from Emerson's Electrical Reliability Services business along with 75 mill personnel. In return, mill management is confident there will be no more unexpected million-dollar blackouts.*