

## Improving Control Valve Performance

*By Fabian C. Gonzalez, Flowserve Corporation*

The increasing demand on facilities to improve profitability has driven many plant managers to prioritize maintenance activities while striving to increase plant output. Historically, refineries, chemical plants and power plants have focused on achieving cost savings through capital and personnel reductions, and improving output by reducing unplanned downtime. While many plant managers struggle with the apparent paradox these two frequently conflicting goals create, improving control valve performance can help make both objectives a reality.

Traditionally, improving the availability (process uptime) of a control valve requires *increasing* planned and corrective maintenance activities in order to maintain peak performance. Many facilities try to reverse this problem by moving towards condition-based strategies that adjust maintenance workload in response to actual control valve health. This strategy is based on the assumption that such “proactive” maintenance activities are far more cost effective than “reactive” activities – a fact supported by a recent article in *Factory Maintenance*, which states that emergency maintenance can cost “four to 10 times as much as proactive preventive maintenance solutions.”

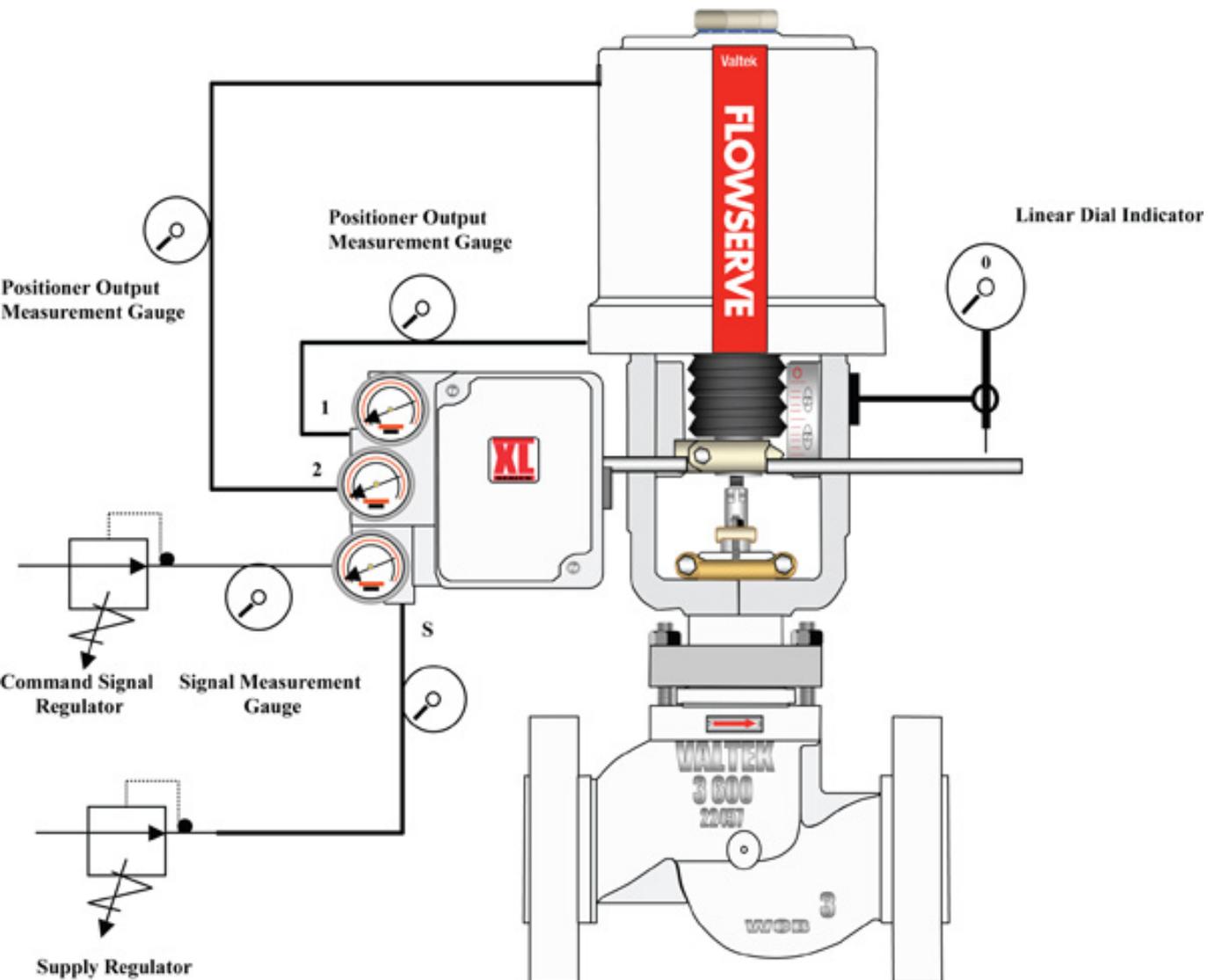
However, realizing the benefits of a proactive maintenance strategy for control valves also depends on one other critical assumption that is often overlooked – the assumption that plant operations and maintenance staff are able to obtain an accurate, real-time picture of control valve health that can be translated into tangible actions that will keep the unit in peak performance. “Diagnostics” is a popular buzzword for solutions that provide this data, but often fall short of the ideal for two key reasons.

**Conventional Control Valve Diagnostic Methods** First, valve and instrumentation diagnostics have traditionally required off-line performance testing, which can be costly. Checking and maintaining each valve in a facility can also be a time-intensive process. In addition, the accuracy of the resulting data could vary due to both the equipment and the skill of the technician performing the test.

To understand the current level of technology used to evaluate the performance of control valves, it is important to look at how this testing has been performed historically. Equipment for performing valve and instrumentation testing in the past typically consisted of a high-resolution pressure regulator, a zero to 30 pounds per square inch (psig) pressure gauge (0.25 percent accuracy), and a linear dial indicator. (See Figure 1.)

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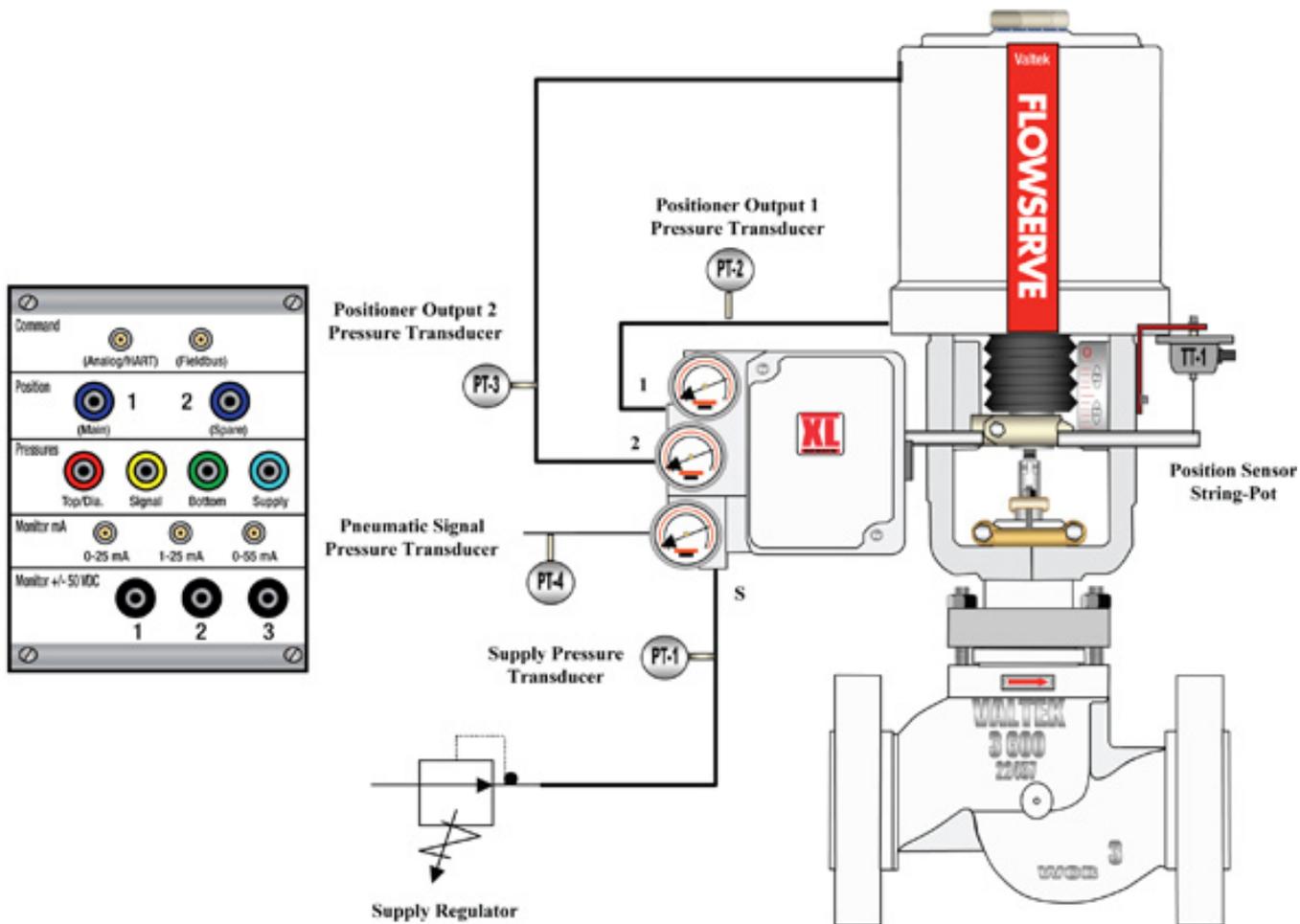
**Figure 1. Conventional valve-diagnostics measurement equipment.**

Traditionally, the equipment was precalibrated for the specific operating range (for example, three to 15 psig, or six to 30 psig) and the high-resolution pressure regulator was used to simulate the control command signal over the operating range, using the pressure gauge as a measurement point. The dial indicator would provide a valve position at the specified signal range.

This procedure was performed in both operating directions — signal to close and signal to open — starting at 50 percent of valve displacement. Three consecutive full cycles were performed in order to report and calculate repeatability and hysteresis, plus dead band, which is the maximum difference for the same input between the upscale and downscale output values during a full range. The test data was then plotted and analyzed for performance. The resulting “valve signature” provides a fingerprint of the specific control valve and its associated instruments and accessories. Data captured during these valve diagnostic tests provides useful information about valve performance degradation. (See Figure 2)

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**Figure 2. Typical application of valve field-diagnostics equipment.**

However, this diagnostic procedure is time consuming, and requires that the valve be taken “off-line” (in other words, the process shut down), which results in reduced output from the plant. In addition, the accuracy of the data results relied on the measurement equipment and the skill of the technician performing the test.

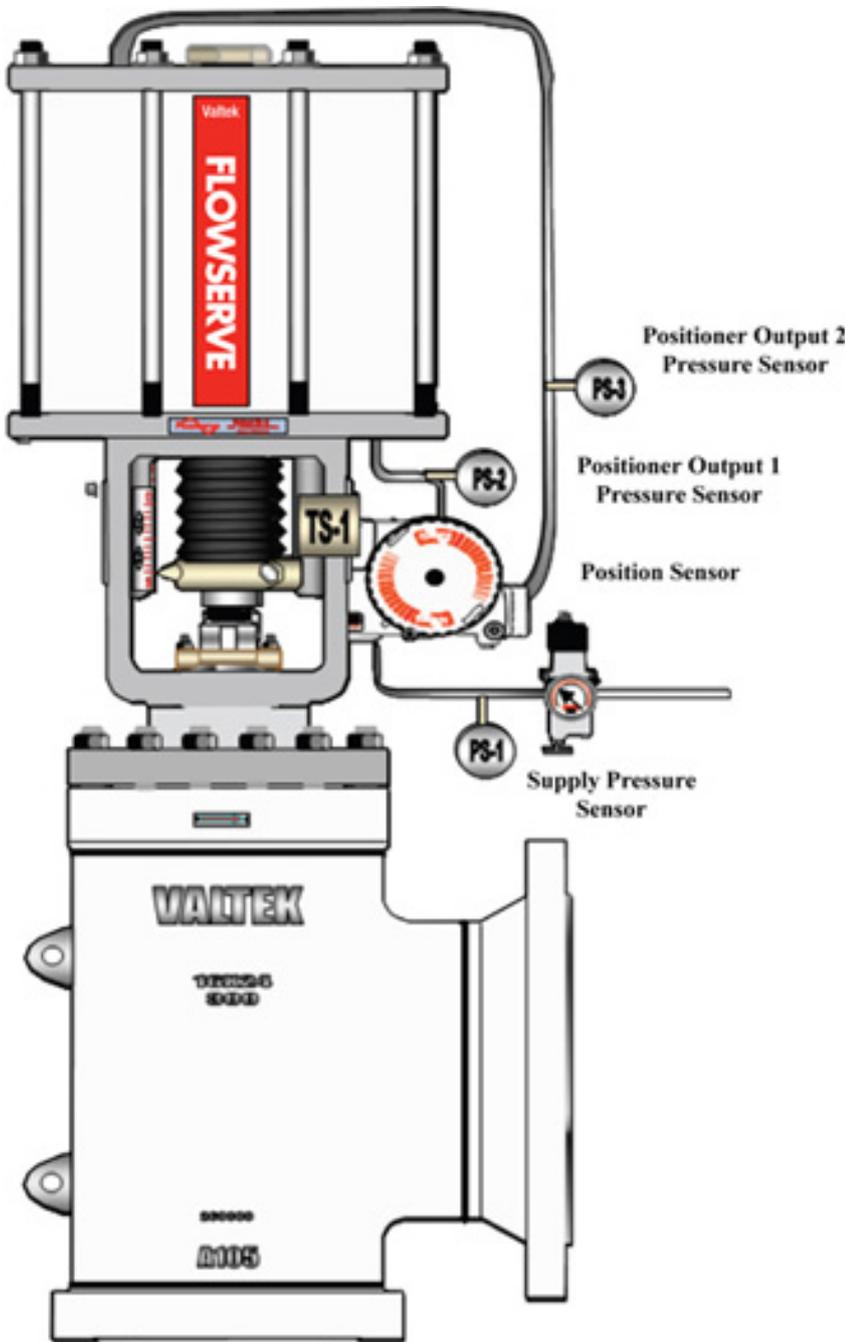
Because of the complexity of mechanical components and instrumentation associated with different valve designs and accessories, the interpretation of diagnostic data into specific maintenance actions is both a science and an art. It is therefore highly dependent on the experience and knowledge of the individual technician.

The overall aim is to conduct “proactive” maintenance that is cheaper than corrective actions while being more effective at preventing unplanned downtime. Translating diagnostic data into actionable maintenance advice that meets these goals frequently requires a detailed level of knowledge about why the valve was designed the way it was, how it was built, how it “should” perform under the specific process conditions, and what behavior should be deemed “normal” as a result. While the International Society for Automation (ISA) has played a role in defining standards for the performance of control valves and general instrumentation, providing fundamental guidelines in performing valve-related diagnostics, these guidelines can only provide part of the full picture of control valve health without the specific knowledge and experience of the original equipment manufacturer (OEM).

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For example, field diagnostics have limitations in identifying nonconforming issues, such as whether the valve is leaking across the seat, whether there is adequate seat force, or why a particular valve might be high maintenance. Some of these areas can be quickly resolved, such as whether there is adequate seat force. Calculating seat load ( $F_s$ ) is a function of force, based on actuator-effective area ( $A_f$ ) multiplied by applied-loading pressure ( $P_s$ ), and spring final ( $P_f$ ) and actuator spring rate in the other direction. However, this analysis requires specific knowledge of the actual control valve hardware being used, such as the physical size of the valve actuator and the stiffness of springs installed. Additionally, a generic algorithm for seat load confirms only that force is being applied, while the actual physical surface finish and mating-contact angle of the trim components will determine whether the control valve will provide a satisfactory shut-off under that seat load against process pressure. The physical design of the trim (plug orifice or pressure balanced) must also be considered.



### **Figure 3. Flowserve Logix 3000 Series digital valve positioner sensors.**

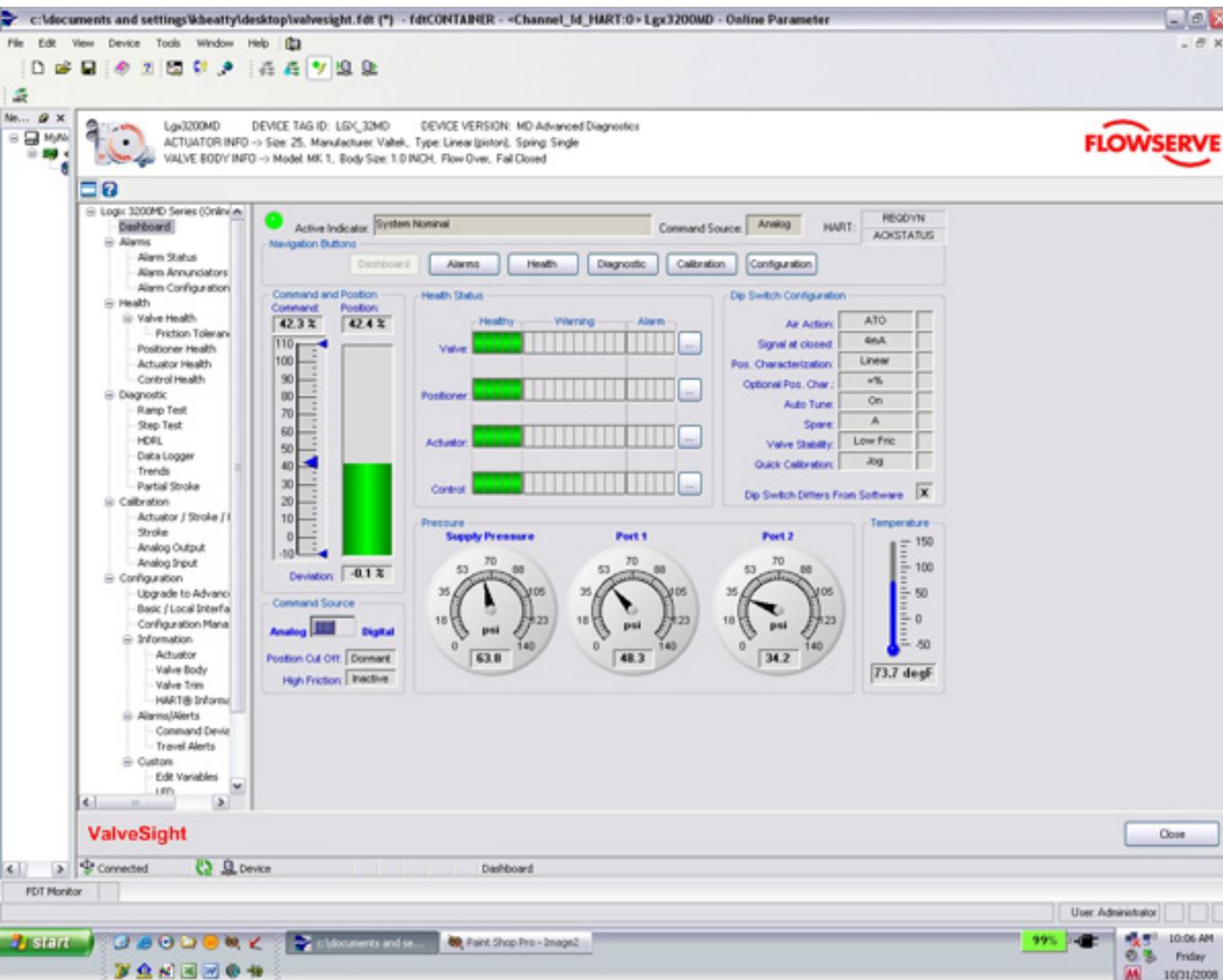
The reality for many plant operations today is that large staffs of experienced, knowledgeable maintenance staff have been replaced by a fewer personnel with less experience with the wide array of configurations, sizes, and trim designs of modern control valves. In addition, many modern facilities have turned to “asset management” software to perform the arduous task of collecting, analyzing, and archiving the vast amount of data that is generated from control valve diagnostic tools. While these tools perform a valuable function in helping plants plan and prepare for turnarounds, they are no substitute for the knowledge and experience of a control valve technician since they are frequently provided by a vendor other than the valve OEM, and therefore are often of little help in day-to-day maintenance management.

**Finding The Right Answers** Valve diagnostic and asset management tools have evolved to the point where they have become a useful ally to plant operations and maintenance staff. These tools now capitalize on best practices of data management, valve identification, and online and offline valve diagnostic techniques. In the best examples, these solutions are integrated into the control valve positioner and operate in real-time collecting data constantly, thus reducing the need to take the valve off-line to generate a signature. (See Figure 3). These state-of-the-art tools improve valve performance, leading to significant decreases in downtime and valve-related maintenance costs.

More importantly, the latest generation of diagnostic tools that can be obtained from the control valve OEM are based on the manufacturer’s extensive history in the design, manufacture, operation, and maintenance of the valve. In some cases, these tools can come very close to capturing the “art and science” of control valve diagnostics that only an experienced control valve technician can bring.

Without the information provided by these latest field diagnostic solutions, facilities could spend time and money performing unnecessary preventive maintenance while still suffering from high levels of unplanned downtime.

It is common for valves to require only simple mechanical adjustments or instrument recalibration, according to suppliers and end users using advanced valve diagnostics. (See Figure 4) For example, an average three-inch globe-style valve can cost approximately \$4,600 (USD). The cost of replacing the valve can be much higher than taking the old valve offline, repacking it with new gaskets and packing rings, then reinstalling it. The trick becomes knowing when this will be sufficient to maintain performance.



**Figure 4. Flowserve ValveSight®, a next-generation diagnostics software, features an intuitive dashboard-inspired user interface.**

Because they are provided by the valve manufacturer, the new generation of diagnostic tools has the ability to analyze a valve-signature-response curve and identify any inconsistencies or pattern/trend deviations, such as excessive friction caused by packing or guiding components, high hysteresis and dead band, nonlinear response, mechanical maladjustments, low friction induced by packing wear, and potential limit-cycling and out-of-calibration instruments.

These analytical approaches improve the accuracy of field diagnostics while making the process less intrusive, reducing the amount of time it takes to perform diagnostics because the valve is kept in service. This process saves facilities both the labor and lost-productivity costs associated with equipment downtime. These solutions provide advanced notice of impending problems, giving plant operators time to take action to minimize or eliminate downtime.

Because they are provided by the valve manufacturer, next-generation control valve diagnostic tools can provide guidance and recommendations by identifying the potential root cause of the problem. This further saves facilities time and money by allowing operators to quickly address the cause of the issue, as well as understand the correct maintenance procedure, spare parts, and special tools that

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may be required to correct the problem.

**State-Of-The-Art OEM Diagnostics Save Time, Money** In conclusion, while control valve diagnostic solutions have a great potential for improving plant profitability, realizing the full potential benefits is frequently jeopardized by solutions that fail to collect meaningful real-time diagnostic data and/or translate it into actionable maintenance advice based on the unique combination of valve design and service conditions. Fortunately for end users, the current generation of tools available from valve OEMs have made tremendous progress in closing these gaps.

Best-in-class diagnostic solutions from valve OEMs overcome the traditional shortcomings of solutions from 3rd-party “software” vendors by leveraging the knowledge and experience of the valve manufacturer to enhance the analysis of control valve performance, as well as the resulting identification of actionable maintenance advice to restore the device to peak performance. In so doing, these solutions are better positioned to help plants realize the original promise of asset management strategies aimed at increasing process output without increasing maintenance costs or manpower.

For more information about asset management solutions for valves, please visit [www.flowserve.com](http://www.flowserve.com) [1].

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