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Pressure Relief Systems: The Smart Money is on Ongoing Maintenance
By David Melcher

As the economy slows and budgets tighten, plant maintenance and operations managers may be tempted to use the words “deferred” and “run-to-fail” when talking about pressure relief system maintenance. If it’s not broken, why fix it, right? While postponing maintenance activities may appear to be an easy way to stretch a budget, it can prove to be an extremely costly gamble. The smart money is on developing and following an ongoing maintenance program.

Pressure relief valves (PRVs) help ensure the reliability of equipment, help plants maximize output and help control operating costs. They also are crucial safety devices, typically serving as the last line of defense in an overpressure situation, protecting equipment, facilities, products and people.

Plant turnarounds can be time-consuming and expensive, with lost production and the cost of equipment and repairs impacting the bottom line. If pressure relief systems are not properly maintained, however, equipment can fail, resulting in unscheduled outages that can cost up to 10 times more than a turnaround – not to mention the potential for catastrophic failure.

Consider long-term costs, too. Depending on a valve’s service conditions, the initial purchase price may represent only about 20% of the valve’s cradle-to-grave cost. (1) If maintained properly, a PRV can stay in service for up to 30 years.

Add it all up, and an ongoing pressure relief system maintenance program is a small investment to make in helping ensure a facility’s reliability, profitability and safety. This article will use real-life case studies to illustrate the key components of an effective maintenance program and some of the tools that can help maintenance teams save time and money.

Proper Training of Plant Personnel

Personnel who do not understand a valve’s function cannot be expected to make it operate consistently at peak performance. Those responsible for plant maintenance and operation must be properly trained and knowledgeable in pressure relief systems and how operational decisions impact a valve’s maintenance cycle.

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For example, personnel at a power plant in North America reported that they had a boiler pressure excursion far above the level of the lowest-set safety valve in the line. None of the valves lifted during the overpressure situation. The valve manufacturer's technicians confirmed the level of the pressure excursion and checked the nameplate sets of the safety valves. They determined that a valve problem did exist.

Protocols at the facility required that in-house maintenance personnel perform all maintenance activities on the system. For 25 years, maintenance training for the staff had consisted of passing along information and experience from one person to another.

As part of the plant's established maintenance procedures, all valve calibration had been executed using a homemade device consisting of a spring with a hook on one end and a handle on the other end. The hook was connected on the end of the lifting levers of the valves. By pulling the handles with the springs attached, the valve began to release. Using a modified yardstick, the length of spring stretch was measured and used as a means to set pressure in the safety valves.

As a result, the valve manufacturer's technicians found that all of the valves on the boilers were set 30% to 35% higher than factory-set pressure limits.

To correct the problem, all safety valves were properly full-pressure actuated with appropriate set pressures. Blowdown adjustments also were made to all valves.

Look at the Big Picture

It is important to remember that a PRV is a single component of a larger system. Valves, tubing and connections – and the operating system itself – all must be working properly for the PRV to function to spec. And as any valve manufacturer or technician will attest, a problem with valve performance may not be caused by the valve; leaks, chatter, galling and valve body degradation can also be caused by problems with other elements of the system.

For example, at a power plant in Asia, a safety valve used in a steam application continually chattered. Replacement of the valve did not correct the problem; the newly installed valve was damaged and chattered during the overpressure situations.

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Technicians surveyed the system and found that the connection pipe between the drum and the safety valve measured approximately 1 meter (3 feet) and was too long to effectively support the operation of the safety valve. (See Fig. 1). At the same time, it was discovered that the inner diameter of the connection pipe measured less than the inner diameter of the valve inlet.

The combination caused the pressure to continually drop and the valve to chatter. The pipes were installed such that any safety valve integrated into the system would have the same problem.

The system was reconfigured with correctly sized inlet piping. The valve now operates as it should, opening once during an overpressure situation and remaining open until the inlet pressure is back under control.

Follow Manufacturer's Maintenance Instructions and Guidelines

Maintenance manuals exist for a reason. They are carefully prepared by valve manufacturers to ensure that users have complete and accurate information at their fingertips. Plant maintenance personnel should consult them – and an experienced valve technician – in developing and executing an ongoing maintenance program.

This was not done in the case of a power generating facility in North America. Personnel reported a boiler pressure excursion far above the level of the lowest-set safety valve in the line. None of the valves lifted during the overpressure situation.

The valve manufacturer's technician disassembled the valves for inspection and found the lower adjusting rings tightly screwed down to the bottom of each valve base. The tight assembly prevented the valves from creating a proper reaction chamber to lift the valves at set point. The adjusting rings – which the facility staff mistakenly believed to be lock nuts designed to keep the nozzles tight to the base – were the primary cause of the problem.

A secondary cause was that valve calibration was not being performed after any valve maintenance. The line of safety valves, therefore, was not able to open when the system pressure reached set pressure.

Best practices for valve maintenance were not employed at the power plant. Employees had not been adequately trained, did not follow the manufacturer's maintenance manual and did not qualify the device after maintenance.

OEM personnel recalibrated the valves by using an on-line testing device and provided additional documentation of factory specifications for the valves. The safety valves now open when required.

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Helpful Tools

When planning or executing a PRV maintenance program, plant personnel should never feel as if they are facing the task alone. In addition to support offered by the valve manufacturer and experienced repair centers, there are tools that can save time and money and help ensure maximum performance, safety and compliance. They include:

- **Facility-wide PRV audits**, during which all valves are inventoried and their condition assessed.

- **Valve maintenance and management software** for storing, evaluating and retrieving historical PRV field data. Keeping good records not only provides a clear indication of valve "health" and helps chart valve trends; it can also reduce paperwork and improve performance. A valve management software program also can be invaluable in determining the root cause of a problem and simplifying its correction.

  Valve management software also can enhance and streamline normal, ongoing maintenance activities by:
  - Improving access to critical valve data;
  - Reducing recording errors;
  - Aiding in the management of parts and spares inventory;
  - Helping manage repair workflow;
  - Contributing to the development of predictive repair dates;
  - Organizing compliance data.

- **Software that estimates appropriate maintenance intervals.** No two safety valve maintenance programs will be the same, as every valve resides in a unique environment and is set for its specific application. Even the National Board Inspection Code Section RB-8410 includes only broad recommendations – and the statement "or as determined by operating experience."

  Valve manufacturers have developed software to help estimate maintenance intervals. It is based on real-life conditions that directly affect valve safety, performance, reliability and cradle-to-grave costs, as well as changing regulations.

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Among the factors taken into account are:

- Boiler type;
- Valve type;
- Operating gap;
- Whether the valve is located indoors or outdoors;
- The part of the boiler the valve is protecting;
- Whether the boiler has gone through a start-up cycle since the valve was last maintained;
- Stack material;
- The number of known valve actuations;
- Sonic flow vibration.

It is important to remember that, while the software can generate predictive maintenance interval, it is not a finite gage. Rather, it provides a ballpark that can be used as a starting point for planning. It also is not a substitute for regular inspection and testing.

- **In-situ PRV testing devices** that allow assessment of valve performance without the need to halt production and pull the valve from service. It saves considerable time and related labor costs, taking approximately one hour per valve rather than the 10 to 12 hours per valve required for remote testing.

Pressure relief valves are an investment in reliability, efficiency and safety. It only makes sense to protect these valuable assets by making the relatively small investment needed to plan and execute an ongoing maintenance program. Key elements of such a program include proper training of maintenance and operations personnel, recognition that a malfunctioning valve may be but a symptom of a problem elsewhere in the system, adherence to the valve manufacturer's maintenance guidelines, and utilization of valve management tools offered by valve manufacturers and repair centers.

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This article is based in part on the following sources:

- "The Appropriate Design, Installation and Maintenance of Pressure Relief Valve Systems are Critical Factors in Overall System Performance," by David Melcher and William Travis. Presented at the Valve World Asia 2007 Conference & Expo, organized by KCI Publishing, Jacob Damsingel 17, NL-7201 AN Zutphen, The Netherlands.
- "Pressure Relief Valve Management Tools Save Time and Money During Plant Turnarounds while Ensuring Maximum Performance, Safety, and Compliance," by Bart Collins, Scott Smith and David Melcher. Presented at Valve World 2006 Conference & Expo, organized by KCI Publishing.
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