Evaluating the Service Life of Propane Pressure Relief Valves

Improves safety for consumer tanks, may reduce maintenance costs

Used in millions of tanks and cylinders worldwide, pressure relief valves (PRVs) are vital safety components for any propane storage container. These spring-loaded devices open to vent excess pressure when a tank is overfilled or is exposed to high temperatures. When the pressure in the tank returns to a safe level, the pressure relief valve reseats.

Current requirements specify that all propane containers must have PRVs to prevent rupture of the container. To ensure continued safety after installation, PRVs on stationary containers are regularly inspected to ensure that there are no signs of visible damage, corrosion of operating components, or obstructions.

Manufacturers typically recommend replacing PRVs every 10 to 15 years, depending on environmental conditions and valve maintenance. Overall, service experience has shown that PRVs in consumer tanks generally have a reliable life of more than the manufacturer's recommendations.

In recent months, the California Department of Industrial Relations has considered the enforcement of manufacturers' recommendations as requirements for replacing PRVs. Because the documented number of PRV failures causing tank rupture in service is minimal, and the service life observed in the field is typically more than 10 years, these regulations could result in significant, unnecessary maintenance impacts and hazards to the propane industry and consumers.

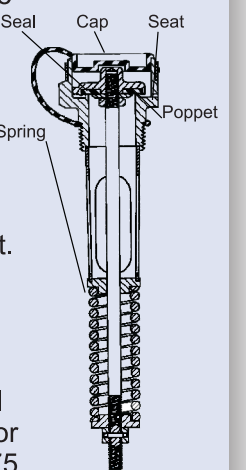
Project Description

To assess whether periodic 10-year replacement of PRVs is necessary to ensure safety, PERC initiated *Testing and Analysis of the Performance of Pressure Relief Valves for Customer Tanks* (**Docket 15203**). Battelle Memorial Institute, PERC's partner on this project, will work to achieve the following objectives:

- Evaluate the performance of PRVs that have been in service.
- Determine whether the recommended service life for PRVs can be safely extended.

How Pressure Relief Valves Work

Pressure relief valves (PRVs) prevent propane cylinder expansion or rupture in the event of excessive pressure. PRVs are held in the closed position by the force of a powerful spring-loaded valve poppet.



If the tank pressure rises above a predetermined maximum safe level (typically 250 psig for ASME tanks and 375 psig for DOT tanks), the seal opens, venting the excess pressure. While a PRV is venting excess pressure, there may be a hissing or popping sound. Once tank pressure falls below the pre-set maximum safe level, the seal closes and the valve reseats.

Pressure Relief Valve

Performance Testing

This rig, originally used to test low-pressure regulators, has been modified and used to test the performance of pressure relief valves (PRVs). The rig uses a 300-psig air compressor, supplemental compressed air from self-contained breathing apparatus (SCBA) tanks, 50-psig surge tank, automatic pressure regulator, solenoid valves, pressure transducers, a flow meter, piping and tubing, and a data acquisition system. The rig can be modified to accommodate the various PRV sizes and has the ability to monitor the PRV start-to-discharge and reseating pressure using a water seal. The automatic pressure regulator has the ability to control the pressure increase at a rate of no more than 2-psig per second to facilitate monitoring the start-to-discharge pressure.

Project Implementation

The test program includes two parts: a statistically based testing and analysis program and failure analyses of selected malfunctioning valves.

Testing and Analysis Program

The testing and analysis program includes the following activities:

- **Collecting sample relief valves.** Battelle worked with PERC and the National Propane Gas Association (NPGA) to collect 500-600 PRVs from in-service consumer tanks. The valves represent a variety of ages, service conditions, climactic conditions, and maintenance histories.
- **Documenting relief valves.** The team numbered, cataloged, photographed, and visually inspected (as directed by manufacturer guidelines) the collected valves to identify anomalies such as mechanical damage or internal debris. They then used this information to create a database on PRV integrity.
- **Developing a testing protocol.** An advisory panel of stakeholders developed a robust, defensible test protocol. The protocol is based on UL 132, *Safety Relief Valves for Anhydrous Ammonia and LP-Gas*.
- **Designing and constructing a test rig.** The team modified the test rig used in *Performance, Durability, and Service Life of Low Pressure Propane Vapor Regulators* (**Docket 11073**) to accommodate start-to-discharge and reseating testing for PRVs.
- **Testing relief valves.** Battelle is testing each PRV to measure start-to-discharge pressure and reseating pressure. Researchers will add these results to the PRV integrity database, and tabulate and analyze them against service location, service environment, and valve age.

Failure Analysis

Researchers will perform failure analyses on those valves that fail to vent or reseal appropriately during testing to determine the mechanism of failure and variables contributing to failure. Analysis tools may include nondestructive examination, optical microscopy, fractographic inspection, and infrared spectroscopy.

Researchers will tabulate the results of the valve testing and analysis and the failure analysis to determine the likelihood that periodic replacement of PRVs will improve safety.

Project Status: In Progress

If the research demonstrates that the probability of PRV failure is extremely low, then periodic replacement will be unlikely to improve safety. PERC will share the project results with NPGA and other industry representatives, who can determine if changes need to be made to existing or proposed regulations.

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