Service Life Testing of Propane Vapor Regulators

Study assesses regulator performance against service life recommendations

Propane vapor regulators provide a nearly constant pressure that permits safe use of propane appliances. Millions of these regulators are now operating in field conditions worldwide in both propane and natural gas applications. While low-pressure natural gas regulators have been reported to perform effectively for more than 30 years, most propane regulator manufacturers have, until recently, recommended replacement after just 15 years.

Field experience shows that properly maintained regulators rarely exhibit major safety issues over a 15-year operational period. As a result, some major manufacturers extended this limitation to between 20 and 25 years.

Because the propane industry maintains a vested interest in equipment used to regulate propane distribution, regulators that performed satisfactorily beyond their suggested service life raised the issue of the appropriateness of the service life recommendations.

The Propane Education & Research Council (PERC) teamed with Battelle Memorial Institute and the Gas Technology Institute to determine whether scientific or engineering support exists for both the 15-year and the recently extended service life recommendations for some models. The project, *Performance, Durability, and Service Life of Propane Vapor Regulators* (**Docket 11073**), demonstrates PERC's commitment to improving safety and making propane equipment easier to use and maintain.

Project Description

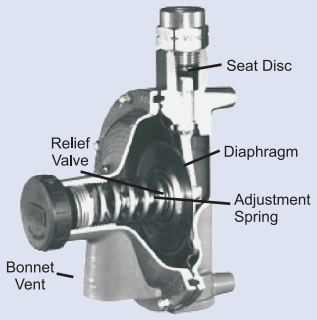
The project included the following tasks:

- A literature review to find documentation supporting the service life recommendations.
- Development of a testing protocol.
- Collection of a sample set of first-stage, second-stage, and integral two stage regulators recently removed from service.
- Performance testing to measure the impacts of age, source environment, and manufacturer on regulator performance.
- Failure analysis.

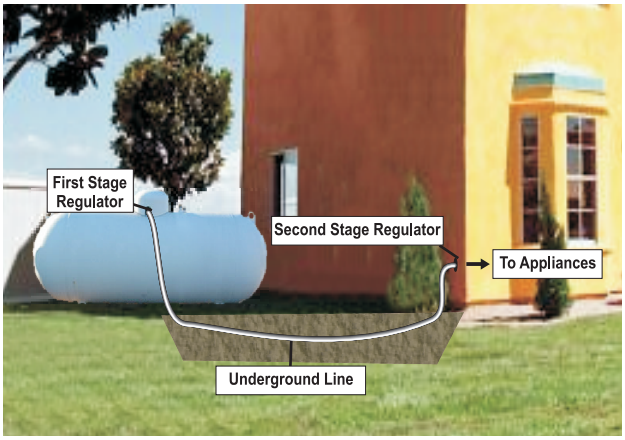
How Propane Vapor Regulators Work

Low-pressure gas regulators control the pressure to downstream equipment. A seat disk allows gas to flow through the orifice, while the diaphragm, connected to the seat disk through a linkage, moves back and forth to control downstream gas pressure.

If there is no demand for gas, the seat disc stays against the orifice and the gas flow stops, or "locks up." If too much pressure builds in the diaphragm, the relief spring compresses and diverts gas through the relief valve and out through the bonnet vent to prevent equipment damage.



Residential Propane System



Testing LP Gas Regulators

This study tested first-stage, second-stage, and integral two stage regulators collected from 49 U.S. propane marketers representing 27 states. These regulators represented a variety of manufacturers, ages, types, and service environments.

First Stage

Second Stage

Integral Two Stage

Using feedback from regulator manufacturers, equipment vendors, and industry experts, Battelle developed a testing protocol to measure the effects of regulator type, manufacturer, age, and environment on regulator performance. The protocol was based on Underwriters Laboratories Standard 144, LP Gas Regulators, which, for newly manufactured regulators, defines performance standards for leakage, flow rate, lock-up pressure, and pressure relief.

Project Implementation

The Gas Technology Institute performed the literature review for this project, while Battelle worked with the National Propane Gas Association and propane marketers to provide sample regulators. Battelle also developed the testing protocol for the sample regulators using valuable feedback from a wide range of regulatory, manufacturing, and industry experts across the United States. Tests included internal and external inspections, lock-up pressure, and pressure relief of 266 regulators. A failure analysis evaluating ten failed regulators was also performed.

Project Completion: Key Conclusions

Literature Review

- Scientific or engineering support was not found for a 15-year service life limitation.

Regulator Testing

- Regulator failure rates did not significantly increase until regulator ages were above 25 years.
- Regulator manufacturer and environment did not significantly affect regulator performance; however, warm, dry environments had a higher percentage of failures.
- Two stage regulator systems operating for 20-25 years showed no significant degradation.
- Age had little effect on the performance of first-stage regulators, and only a slight effect on second-stage regulators.

Failure Analysis

Main causes of regulator failure included the following:

- Regulator chattering and leaking through the pressure relief device (PRD).
- Leaks in the regulator body.
- Low or high PRD start-to-discharge.
- Low PRD reseat pressure.
- Failure of regulator discharge pressure to stabilize.
- PRD relief failure.

Next Steps

Further research is suggested in the following areas:

- Use and variability of plasticizers and extenders in the rubber composition of propane regulator components.
- Long-term effects of operating environment on elastomer and spring performance.
- Effects of propane contaminants and off-specification gas on propane regulator performance.

September 2006

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