Regulator In-Testing - Quality Management and Reporting

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Introduction

The topic for this short course is Regulator In-Testing and QA Reporting. Before we get into the details, it is interesting to note that not all LDC utilities agree that the meter shop needs to in-test natural gas pressure regulators. While this is up to the individual utility management, there is a definite movement to actively verify that the product provided by the manufacturer meets the specific requirements expected by the procurement specification. The way to do this is to "Expect (QA) and Verify (QC)" which is the essence of quality management.

Bottom line is that operations that employ the best practices of QA/QC provide a measurable difference in the quality of the product. This is proven to be the case for spring-loaded pressure regulators.

The meter shop plays an important role. The fact is that the regulator manufacturers make quality products but when they know that the utility buyer in-tests to verify that the product meets specific procurement specifications they are more careful.

The presentation today will include the basics of quality management and how utility in-testing for product quality in the meter shop is coordinated with the utility engineering department and the quality control of the regulators the manufacturer provides.
The objective of this presentation is to put quality management in an understandable context and provide tools use can use. We'll also discuss the influences of regulatory and industry bodies, the relevant ANSI standards and the in-testing trends in the utility industry.

Elements of Quality Management

In general terms, quality refers to whether a product consistently meets customer established requirements, specifications, performance and safety standards.

Quality management includes three basic steps;

1. Planning
2. Quality assurance and
3. Quality control

Planning

In the utility, planning begins with forecasting and understanding the needs of the customers being served. This translates into requirements for new installations, expansions, periodic change out and repair. As well as work orders for the meter shop to assembly meter sets.

Quality Assurance (Expect)

Quality assurance reinforces that the utility is in the lead when telling the manufacturer what it expects regarding the procured products and alerts the manufacturer to potential inspections.

Quality Control (Verify)

Quality control involves the testing by the manufacturers and in-testing by the utility meter shop for performance, compliance, safety and other requirements and making sure the products meet the agreed upon standards and expected deliverable.

Quality Management in the Utility Supply Chain

A good way to begin this discussion is to review typical gas metering and regulation operations in a local distribution company (LDC) utility. Figure 1 in the appendix shows the various operations beginning with providing an adequate supply of natural gas safely to the customers via the LDC piping system.

The LDC utility is responsible for the providing natural gas safely and reliably as well as billing customers accurately. The key utility gas regulation and measurement operations to do this include:

1. Engineering planning and design (Planning);
2. Engineering standards (Assurance); and
3. Meter shop operations (Control).

Also, in the chain of operations are the manufacturers and stocking distributors that provide meters, pressure regulators and other meter set products.

Once the meters and regulators are in the utility inventory, they are available for meter set assembly in the meter shop as work orders appear. The final operation is the installation at the customer's premises. This includes observing that the gas service operates properly by checking set point and lockup before turning the service over to the customer.

Engineering Planning & Design

The engineering planning and design operation focuses on providing high performance and safe meter set solutions for the existing, new and future gas customers served.

Engineering planning anticipates the needs and requirements of the LDC operating system. The design requirements for gas regulating systems typically include:

1. Regulator/meter sets including delivery pressures and overpressure protection;
2. Piping, valves & fittings;
3. Control lines & vents; and
4. Filter & strainers.

Addendum 1 shows typical design & performance requirements for company owned gas regulating systems serving customers.

ANSI B109.4 is a "basic standard for the safe and reliable operation and the substantial and durable construction of self-operated diaphragm-type natural gas service regulators, for nominal pipe size of 1-1/4 inches and smaller with outlet pressure of 2 psig and less".

This standard includes detailed comprehensive design requirements as well as test procedures and criteria. The typical requirements shown in Addendum 1 reflect coordination with ANSI B109.4.

Engineering Standards (Quality Assurance)

The engineering standards establish the regulator design specifications and provide detailed procurement specifications for the service regulators purchased from the manufacturer including:

1. Specific required service regulator performance;
2. General manufacturer in-plant regulator testing of service regulators according to ANSI B109.4; and
3. Capacity requirements

See Addendum 2 for typical performance and capacity specifications. Manufacturers are expected to test to meet ANSI B109.4 standards; however, they may or may not comply.

Therefore, the typical procurement specification should place the manufacturer on notice that:

1. The utility reserves the right to inspect materials at any or all stages of manufacture and in-plant testing;
2. The supplier shall provide for in-plant inspection of materials and/or audits of the supplier's quality control program;

However, the only way the utility can be assured that the regulator meets the expected standards is to verify conformance by in-testing the deliverable in the meter shop.

Meter Shop Operations (Quality Control)

The typical procurement specification states that the delivered regulators may be inspected in the meter shop according to the following procedure;

1. Regulators shall be in-tested to determine conformance to the specific performance requirements (See Addendum 2);
2. Non-conformance with any requirement may be used for rejection; and
3. Rejected shipments of regulators resubmitted by the manufacturer or supplier after correction or adjustment are subject to in-test re-inspection.

Typically, in the procurement specification, the manufacturer is also notified of the following procedures to be followed if regulators are rejected:

1. A shipment failing to meet the requirements for any one of the quality characteristics is unacceptable and will be rejected;
   1.1. Rejected lots will be returned to the manufacturer for 100 percent screening, repair or replacement of defective regulators; and
   1.2. Rejected lots may be re-inspected only after the manufacturer has removed or corrected all defective units.

The scope and effectiveness of the above quality control measures, left solely to the manufacturers, is open for discussion. The best practice is to provide utility meter shop in-testing to verify and validate the deliverable.

How to Inspect Regulators for Compliance

There are a couple options;

1. In-test all regulators before placing them in inventory); and
2. In-test selected samples of the deliverable.

In-testing all the regulators may not be cost effective for larger lots. Therefore, a strategically targeted sampling plan may be used. These plans are based on comparing the percentage of regulator defects in the lot, received from the manufacturer, with the maximum allowable percent defective.

The in-test pass fail criteria is typically that of the procurement specification shown in Addendum 2.

QC In-Testing Reporting

A typical in-testing reporting procedure includes:

1. Tag an ID to each regulator
2. Assure, for each regulator model in the inventory, that it is in-tested based on its unique properties and pass/fail criteria
3. Record the pressure or other results of each performance & safety test
4. Record pass or fail for each test
5. Prepare an in-test results report
6. File and archive the report
7. Build a database of test results for regulator tracking

How to Apply Best Practice In-Testing Methods

The utility needs to determine the process to be used to assure quality and whether testing and inspection will be in the meter shop or elsewhere or a combination of both.

Meter shops have typically designed and built apparatus to in-test the performance of regulators. They vary from simple assemblies with hand clamped connections and water manometers to more sophisticated automated systems.

Along with the apparatus, over the years, the meter shops have developed spreadsheets to record results. Often, after a series of tests, the operator inputs the hand-written results into an Xcel spreadsheet and archives the report.

In working with the utility engineers and meter shop technicians over the last ten years, I have observed the need for up-graded test machines and software APPs that provide standardized test procedures, criteria and modern result recording and report archiving.

What Features Does the In-Test Apparatus Need?

1. The flexibility to apply a range of inlet pressures and back pressures and well as accurately measure the outlet pressure for all regulators in the inventory;
2. Provide backpressure to accommodate testing of IRV regulators as well as OPSO and monitor regulators;
3. Provide the proper fittings for regulators with NPT and flange connections greater than 2-in.;
4. A software App to enable the operator to view the test specifications and pass/fail conditions for each regulator in the inventory;
5. A software App to enable the operator to record, report and archive test results

Safety Factors at The Meter Set

The utilities and the manufacturers have recently provided several meter set features that promote safety. The IRV feature is a token measure to release a bit of natural gas when the regulator seat is clogged with a particle and cannot fully lockup. This feature is token in that it can release only enough gas to allow the smell to alert people to the danger and call the utility.

The over pressure shut off (OPSO) regulator provides a positive shut off solution to over pressure. Of course, the utility technician must visit the customer site to reset the OPSO after the repairs are made and service is ready to be continued.

The advent of the IRV and OPSO features of the service regulator emphasizes the need for the utility meter shop to in-test to verify performance. These tests, to determine safety compliance, simply cannot be conducted effectively in the field.

SUMMARY

The concern regarding customer safety has always been a driver in leading the manufacturers and the gas utilities to emphasize safety first.

The IRV and the OPSO features of service regulators have added needed protective measures to the meter set. These measures also add to the scope of the QA/QC process and the need for in-testing in the utility meter shop.

And again, the regulator manufacturers make quality products but when they know that the utility buyer in-tests to assure that the product meets specific procurement performance and safety specifications they are more careful

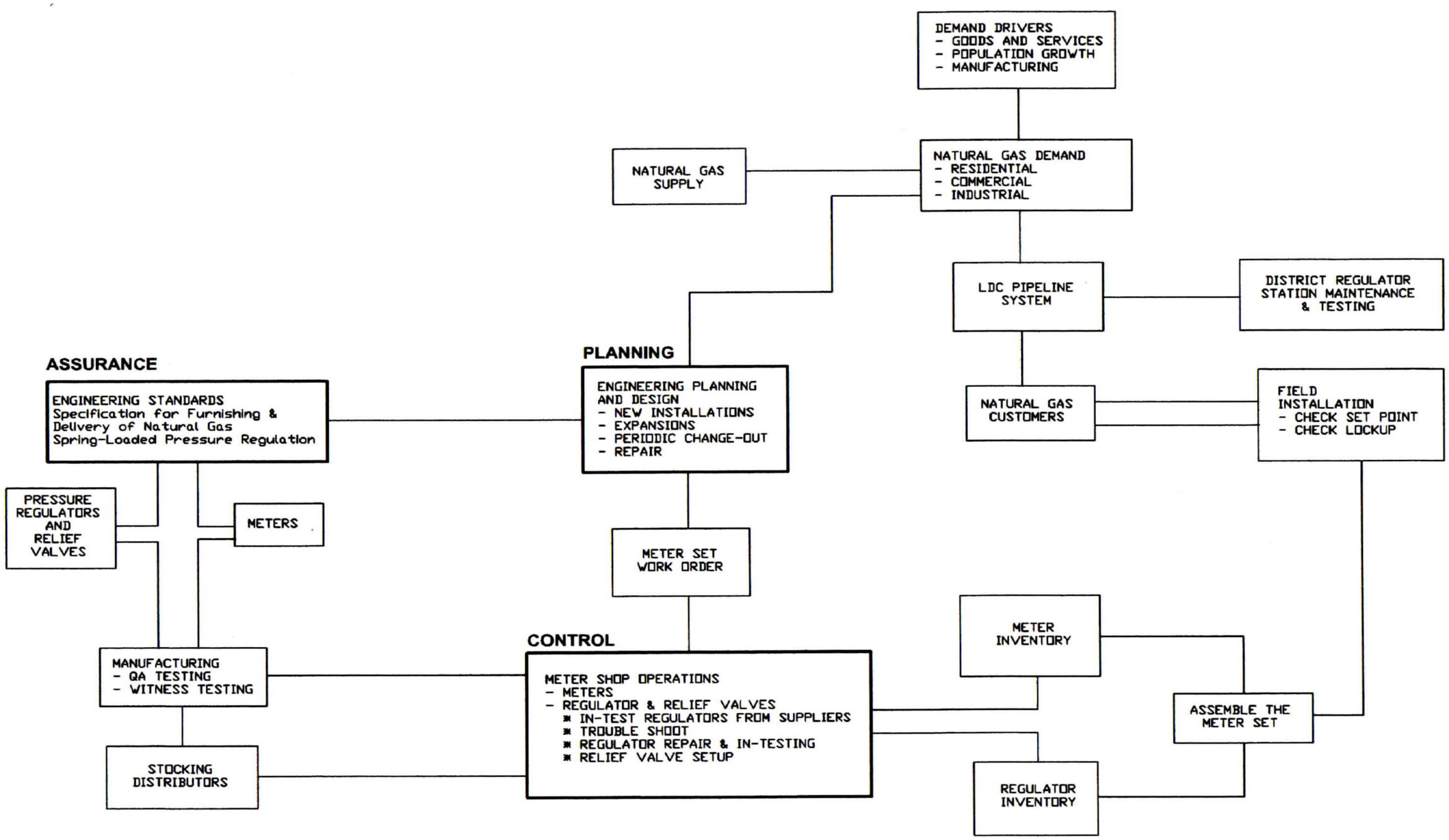
APPENDIX

Figure 1 – Gas Metering and Regulation Operations in the LDC Utility

Addendum 1 – Regulator Design Requirements (Quality Planning)

Addendum 2 – Specification for Furnishing and Delivery of Natural Gas Spring-Loaded Pressure Regulators (Quality Assurance)

FIGURE 1
GAS METERING AND REGULATION OPERATIONS IN AN LDC UTILITY



Addendum 1 - Regulator Design Requirements (Quality Planning)

1. Under flowing conditions, the service regulator must maintain gauge delivery pressure (PSIG) within:
   1.1. 1” WC, if metering at 7” WC;
   1.2. 2” WC, if metering at 14” WC; and
   1.3. 2 percent of absolute pressure, if metering at 1 psig or more. For example, a gas regulator set at 2 PSIG needs to maintain its setpoint within +/- 0.33 psi (14.73 PSIA+ 2 PSIG) x 0.02 = 0.3346 psi.

2. Lockup pressure shall not exceed:
   2.1. 10” WC for a gas delivery pressure exceeding 7” WC and less than 1 PSIG;
   2.2. 20 percent, based on PSIG for gas delivery pressure at 1 PSIG and up to 15 PSIG; and
   2.3. 3 PSIG for gas delivery pressure above 15 PSIG.

3. IRV overpressure protection required whenever;
   3.1. Inlet pressure 60 PSIG or less; and
   3.2. Outlet pressure 2 PSIG or less.

Addendum 2 – Specifications for Furnishing and Delivery of Natural Gas Spring Loaded Pressure Regulators (Quality Assurance)

1. Regulators 1-1/4” and smaller shall have an outlet set pressure at 7” WC +/- 0.5” WC with a flow of 40 SCFH using air and an inlet pressure of 50 PSIG. The regulator shall hold the set pressure after initial adjustment;

2. Regulators 1-1/2” to 2” shall have an outlet set pressure at 7” WC +/- 0.5” WC with a flow of 160 SCFH using air and an inlet pressure of 50 PSIG. The regulator shall hold the set pressure after initial adjustment;

3. The ¾” to 1-1/4” size regulator shall lock up immediately at an inlet pressure of 50 PSIG, and the lock-up pressure shall be less than 1.5” WC above the outlet set pressure with no discernible creep after 30 seconds from lock-up.

4. The 1-1/2” to 2” size regulator shall lock-up immediately at an inlet pressure of 50 PSIG, and the lock-up pressure shall be less 3” WC above the outlet set pressure with no discernible creep after 30 seconds from lock-up.

5. The ¾” to 1-1/4” size regulator shall have an internal relief device set to crack open at 10” WC +/-3” WC above the set pressure and to reseat by 5” WC above set pressure.

6. The 1-1/2” to 2” size regulator shall have an internal relief device set to crack open at 10” WC above the set pressure and to reseat by 5” WC above the set pressure.

7. Capacity tables for domestic regulators shall include flows at 1” WC droop from a 7” WC set pressure. Upon request, capacity tables shall be provided for flows at 2” WC from a 14” WC set pressure. For 1 PSIG and higher set pressures, the capacity tables shall include flows up to a droop of 2 percent of the set pressure.