FIELD TESTING GAS METERS BY TRANSFER PROVING

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INTRODUCTION

Transfer proving was initially developed to provide an easier and more accurate field meter proving method. Because of the capacity capabilities of transfer provers (2000 CFH to 80,000 CFH) transfer provers are utilized in meter shops where bell prover capacity is limited and allow for shop testing of the larger capacity meters.

TRANSFER TESTING SYSTEM

In the typical transfer testing system, air or gas passes through the meter under test (field meter) and then through the "Master" meter. The vacuum method of testing is basic to all commercially available provers. Atmospheric air is drawn through the field meter and prover by the blower system. Temperature and pressure differences are measured to enable correction of the data to a common base of comparison. The rotary meter transfer proving system is not affected by specific gravity or relative humidity of the flowing gas since under normal conditions no condensation or change of moisture contact would occur as the gas passes from the field meter to the master meter. It is a volumetric test in which the test time is not a critical variable. Automatic operation minimizes chances for human error, and built-in self-check features assure reliable system performance. The ROOTS Model 5 Transfer Prover System is typical of the commercially available units and will be utilized in this discussion. Other units may differ slightly in shape, size, or performance, but the base operating principles are the same.

The prover System consists of one or more rotary positive displacement master meter(s) mounted on a wheeled cart. The master meter is calibrated over a flow range of 100 to 10,000 CFH for a 10M master meter of 35 to 2,000 CFH for a 2M master meter. This range covers the testing of larger diaphragm meters as well as most rotary meters. Blowers mounted downstream of the meters are used when air is the testing medium. On air tests, the blowers discharge to atmosphere through a muffler or silencer which minimizes noise when testing in public areas or in shops where noise could be objectionable. Comprehensive tests have demonstrated compliance with OSHA regulations concerning acceptable noise levels. The connection from the field meter to the prover is made with a 25° length of flexible hose equipped with quick disconnect fittings. In addition, a cable is required for temperature, pressure, and pulser connections on a field meter.

All transfer provers are available to the gas industry compute the following formulae:

$$\%\text{ Uncorrected Proof} = \frac{\text{Master Meter Volume}}{\text{Field Meter Volume}} \times 100 \qquad \text{(Equation 1)}$$

$$\%\text{ Pressure Correction} = \frac{\text{ATM Press-Master Drop}}{\text{ATM Press – Field Press Drop}} \times 100 \qquad \text{(Equation 2)}$$

$$\%\text{ Temperature Correction} = \frac{\text{Field Meter Temp 'R}}{\text{Master Meter Temp 'R}} \times 100 \qquad \text{(Equation 3)}$$

$$\%\text{ Corr Proof} = \frac{\begin{array}{c}\%\text{Uncorr} \quad\quad \%\text{ Press} \quad \%\text{Temp Proof}\\ \text{x Corr} + 100 \text{ X Corr} + 100\end{array}}{10{,}000} \qquad \text{(Equation 4)}$$

Testing can be done automatically or manually. When testing automatically, the index or instrument is removed from the field meter and a pulser unit installed to count the output shaft revolutions. When testing a meter whose index cannot be removed, a retroreflective scanner may be utilized or a remote start-stop switch in lieu of the pulser.

The standard transfer prover operates on a 115 VAC ±10%, 47-60 Hz. Power consumption with blowers on high is approximately 1000 watts, but satisfactory operation can be obtained in the voltage range of 95 to 130 VAC. Special provers have been designed for operation on 230 VAC.

The proving system has been designed for operation by one man with a minimum of effort. A van is used for transporting the Model 5 prover. The accuracy and repeatability of the transfer prover system is related to the permanent accuracy characteristic of the rotary positive displacement master meter. For convenience, a direct readout of the proof of the field master is provided by using a simple but effective method of obtaining a master meter curve of 100% accuracy over the full working range.

The master meter incorporates a pulse unit for generating contact closures representing the flow units from the master meter. Provisions have been made in the computer software to add/subtract in extra counts required to produce a 100% accuracy curve for the master meter.

The actual preset correction necessary to linearize each specific master meter curve is determined from a factory calibration with a bell or piston prover. A chart is provided with each prover, showing the calibration curve.

OPERATION

The Model 5 Proving System consists of the master meter(s), blowers, controller, and laptop computer. Operation of the Model 5 Transfer Proving System can be broken down into five sections:

1. Powering up of the system.
2. Making field meter connections.
3. Purging the meter and leak testing.
4. Selecting and starting the test(s).
5. Running the test and saving the results.

Reasonability tests are run on the signal inputs to the controller to determine that the transducers are properly connected prior to starting a test run and that the measurements taken during a test run are within reasonable limits.

POWERING UP THE SYSTEM

This step should be performed first as it allows time for the controller to warm-up and stabilize prior to running a test.

1. Plug the line card from an AC power source into the controller.
2. Connect the laptop computer AC cord to the laptop receptacle on the controller.
3. Connect the RS232 cable between the laptop computer and controller.
4. Turn on the controller power switch and then the laptop computer.
5. Go into the Model 5 laptop computer software and verify master meter serial numbers. This ensures proper presets are loaded.

FIELD METER CONNECTION

Connections of the field meter sensors and pulser (if used) should be done next.

1. Connect the field junction box cable to the controller.

2. Install the field meter temperature sensor in, or near, the inlet port for rotary meters and at the outlet port for turbine and diaphragm meters. The tip of the sensor should be in the center of the flowing air stream. Plug the cable into the field junction box.

3. Connect the pressure lines from the field junction box to the inlet of the field meter (and outlet if rotary meter differential is to be read during testing).

4. If the field meter pulser is being used rather than the manual start/stop button, install the field meter pulser on the instrument drive platen of the field meter. Ensure that the instrument drive properly engages the pulser and that the pulser shaft is centered over the meter drive shaft. The pulser drive coupling may require adjustment to engage the

meter drive shaft. Plug the cable into the field junction box.

5. If the manual start/stop button is to be used, plug it’s cable into the field junction box instead of the pulser.

6. Connect one end of the 25 foot prover hose to the outlet of the field meter.

PURGING AND LEAK TESTING

The Model 5 Transfer Prover can be set-up to require purging of the field meter or not require purging for shop use. You can also require or not require a leak test. If a purge is required the blowers will not start for testing until the operator does a purge of the field meter.

1. Connect one end of the 25 foot prover hose to the camlock on the Model 5 silencer. The other end should be hooked to the field meter.

2. From the laptop software menu, select the purge option and run the blowers to purge the field meter.

3. Seal the inlet to the field meter, move hose from silencer to the inlet of the Master Meter and run leak test. This takes approximately 30 seconds and a pass or fail message will be displayed.

4. Identify and eliminate any leaks as they will affect the accuracy of the tests.

SELECT AND START TEST

Forty preconfigured tests can be run by simply selecting the desired tests for a particular meter. Each test can be run at three different flows and each flow can be run twice. The tests can be cascaded for more flow rates if desired. Flows are set and controlled by varying blower motor speed which reduces noise. The following items must be selected to configure for a manual test:

1. Prover Capacity (2M, 10M, 80M)
2. Test Control Mode (ID, OPTO, Manual)
3. Meter Output (UC, TC, PC, TCPC)
4. Drive Rate (What each pulse represents.)
5. Test Volume (Even multiple of drive rate.)
6. Flow Rate (Up to three flows.)
7. Base Temperature Correction (If Required.)
8. Base Pressure Correction (If required.)

RUN TEST AND SAVE RESULTS

When the operator starts the test, the computer, via the controller, will start the blowers, stabilize flow as highest rate selected and begin test. At the end of the first run, results will be displayed and the blowers will stabilize for the next run. At the completion of the tests, the operator can view any particular run. The results can be saved and/or printed. The operator will be prompted to fill in some information for the report. The layout appearance of the reports are customer configurable.

TESTING RESULTS

What is the accuracy of this testing device? Results from extensive series of tests show that the ROOTS Transfer Prover duplicated a bell prover within ±0.1% on overall average results and had a standard deviation of the less than 0.5%. The test included a large number of different types and sizes of diaphragm meters. The bell prover was in a temperature controlled environment, but the transfer prover operated in a room without temperature control. Repeatability has been found to be ±0.1%.

A warm-up period has been found to be desirable in testing diaphragm meters which have been inactive. Such meters are occasionally encountered in the meter shop testing, and a running period of a few minutes will allow enough exercise of the moving parts to restore normal meter friction and assure representative test results.

Minor variations in blower operation due to supply voltage fluctuations may occur but will vary the actual flow rate only slightly. Tests have shown that fluctuations which might have invalidated the test run by other test methods did not influence the transfer prover test results.

TEST SET-UP MODIFICATIONS

The transfer prover is an extremely versatile and flexible test device and has been used to test meters with 1,000 cubic foot drive rates, temperature compensated outputs, pressure compensated outputs, and intermittent outputs. Information concerning special test techniques or particular test problems can be obtained from the prover manufacturer.

CONCLUSION

The feasibility of using a rotary positive displacement meter transfer testing system has been clearly established. Tests have confirmed the accurate performance of the equipment. The increase in productivity, the speed of testing, the avoidance of test errors, and the savings in shop test facilities make transfer provers an attractive and economical addition to the array of meter test equipment.

The development of the portable transfer proving system with computer enhancements gives measurement personnel another useful and reliable tool for testing gas meters. The ability to test meters in the field and spot inaccurate meters and adjust them without removing the meter saves not only time but money. Although the primary usage of transfer proving has been for field testing, increasing numbers are being utilized in meter shops and provide a valuable supplement to existing test facilities.