FIELD INSPECTION AND CALIBRATION OF MEASUREMENT INSTRUMENTS

George E. Brown III

Reliant Energy – Entex

210 W. Larissa, Jacksonville, Texas 75766

INTRODUCTION

Timely, diligent field testing and calibration of gas volume recording and correcting instruments ensure that measurement information fairly represents actual volumes.

The instruments save a company capitol and operating costs because they can record or integrate volumes at pressures and temperature above the normal pressure-base conditions specified in contracts for volume calculation. This allows the company to use smaller and fewer meters.

Recording and correcting instruments normally are connected to positive displacement, rotary and turbine meters in lieu of a direct reading/compensating index. The compensating instruments include:

- Volume and pressure/temperature recording gauges
- Mechanical pressure/temperature volume correctors
- Electronic pressure/temperature volume correctors
- Electronic flow computer

TEST FREQUENCY

How often should recording and correcting instrumentation be field inspected and calibrated? Generally, every time the meters are tested.

Company policies for test scheduling usually are based on contractual obligations and average measured volumes. Large volume deliveries dictate monthly, quarterly and semiannual inspections. Devices that handle smaller quantities might be scheduled annually or every four years.

Another scheduling factor is instrument type and age and the type and age of the meter to which it is connected. Older mechanical devices require more frequent attention than electronic units. For this reason, high reliability meters, such as rotary and turbine, should not be paired with high-maintenance mechanical instruments. A 20-year-old volume and pressure recording gauge mounted on a diaphragm meter, might be scheduled for quarterly inspections. Conversely, an electronic corrector, connected to a rotary meter, may require only semi-annual testing. Whatever the case, when an inspection schedule has been determined, it should be documented and monitored to ensure timely and valid testing procedures.

BASIC TEST PROCEDURE

Basic instrument proving procedure is simulating all conditions the device was designed for, and testing for accuracy at several points. Pressure and temperature responses should be checked at a minimum, maximum, 25%, 50% and 75% of instrument scale.

For indexes and counters, meter input responses should be checked for value, coding and operation. When the device is a volume and pressure/temperature recording gauge, volume cycle value and operation also should be tested.

For electronic instrument tests, scaleable unit configuration values such as inputs, outputs, ranges, calculation parameter and audit trail definitions should be verified during each inspection.

TEST EQUIPMENT

The most important piece of instrument test equipment is the inspector's eyes. Many measurement errors can be avoided by a thorough visual inspection of an instrument. Close attention to details will ensure utmost equipment accuracy and will find potential device failures before they occur. The remaining test equipment requirements can vary, depending on whether the instrument is mechanical or electronic. Following is a minimum list of typical items required for testing both instrument types.

MECHANICAL TEST DEVICES

- Deadweight tester
- +/- 1/4% accuracy test gauge of suitable range
- 0.5°F accuracy Yellowback measurement thermometer
- Device to simulate meter output

Electronic test units

- Pressure source—usually compressed air or nitrogen—and optional precision pressure regulator
- Electronic pressure gauge, 0.1% accuracy
- Digital voltmeter, 4 1/2 digit
- Digital thermometer, 0.1°F accuracy
- Device to simulate and count meter output revolutions

CALIBRATING MECHANICAL DEVICES

Process inputs on most mechanical measurement instruments consist of some form of the standard four-bar linkage (Fig. 1). Inputs include pressure, temperature, volume integration and volume cycle measurements. Basic linkage operation is the same for all types, with differences in the amount and direction of linkage travel.

Since mechanical wear is inevitable, linkage adjustment eventually will be needed to maintain acceptable accuracy. These adjustments commonly called zero, span and linearity. Zero is minimum scale, span is maximum scale and linearity is set to ensure output equals input at all points between zero and span. Product manufacturers provide maintenance manuals with diagrams and instructions for adjusting their equipment (Fig. 2).

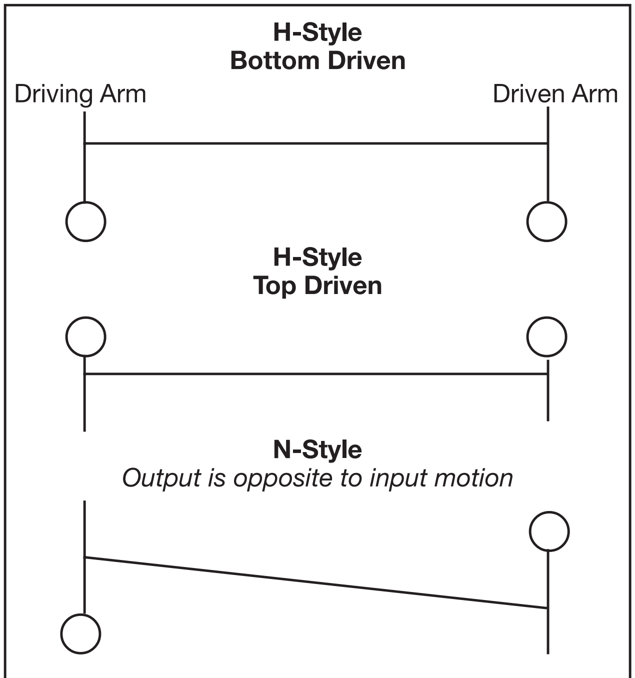
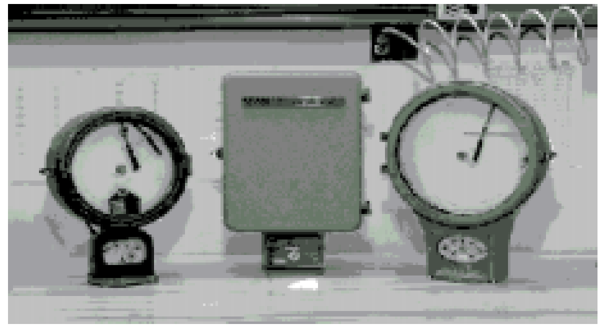


FIGURE 1. Mechanical linkage styles

Instruments should also be checked for repeatability since excessive wear on mechanical parts will induce errors caused by slack or slippage in the mechanism. Once the inputs are calibrated, the inspector must test the indexes or odometer counters for proper operation and, equally important, proper coding of volume increments.



Final inspection is accomplished by applying test values to the inputs and simulating meter flow by rotating the input drive equal to a sufficient test volume. The inspector then calculates what the instrument's output should be and determines accuracy by making comparisons. Percentages of error will appear inflated at lower pressure and lower test volumes. In these circumstances, it is wiser to deal with larger test volumes rather than be confused by percentages. Again, the manufacturer's instructions provide best recommendations for dealing with this situation.

The final inspection described above also is usually performed as an initial inspection before calibrations are performed. Initial inspection results generally are used for billing adjustments.

CALIBRATING ELECTRONIC DEVICES

Basic procedures for calibrating process inputs on electronic instrumentation are similar to that for mechanical devices except there is no four-bar linkage.

Instead, calibration changes are made with a voltmeter and adjusting, "tweaking," zero/span potentiometers either manually, or electronically by using software in a hand-held or laptop computer connected to the unit's serial

communication port. Linearity usually is accomplished in the computer or transmitter's EPROM. A few transmitters have a potentiometer adjustment for this function.

Meter connection to an electronic volume corrector is made directly to the hand-hole plate and these devices have a mechanical counter to back up the digital uncorrected counter. Uncorrected counters should be compared to ensure that input pulses to the calculation circuit are correct. If the y are not close to the same value, a pulse-switch problem exists. This leads to volume under recording or under correcting.

Flow computers are connected to the meter via a remote pulser, which sometimes is backed up by an index or sandwiched between the meter output and a volume and pressure/temperature recording gauge. In either case, mechanical counters need to be inspected for operation and volume coding to make sure their setup matches the specified measurement configuration for the site. Initial and final testing procedures are identical to those for mechanical instruments. All "found" and "left" conditions should be properly documented on the appropriate test forms to validate the completed inspection.

CONCLUSION

Only the most common inspection and calibration procedures have been covered in this article because special applications, such as volume controlled nomination loops, tube switching and alarms, normally are tailored to specific measurement requirements.

Acceptable accuracy limits are not mentioned because company policies and equipment tolerances will vary somewhat. Measurement instrument inspectors must obtain this information from company and manufacturer sources. Whatever the instrument, the inspector's primary goal is to ensure that recorded volumes represent actual volumes as accurately as is humanly possible. As technological advances bring new and more sophisticated products to the industry, it is increasingly evident that measurement perfection is a goal yet to be attained.

George E. Brown III