AN OVERVIEW AND UPDATE OF AGA 9

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ABSTRACT

The *American Gas Association* has published (June, 1998) a recommended practice; *Report No. 9; Measurement of Gas by Multipath Ultrasonic Meters.* This paper reviews some of the key contents of A.G.A.-9 including *recommended meter performance requirements, design features, testing procedures, and installation criteria. An update for the committee work in progress for year 2001 and beyond is integrally included.* The paper addresses some of the most commonly asked questions by new users of the document.

A.G.A.-9 was drafted by the *A.G.A. Transmission Measurement Committee (TMC)* which incorporated *many of the recommendations in the GERG Technical Monograph 8 (1995)* and certain related *OIML* recommendations. After two years of technical discussions, balloting, and revisions, the document represents the consensus of several dozen metering experts in the US and Canada. They represent a cross-section of senior measurement personnel in the natural gas industry. The ISO/TC 30 standard currently being written for ultrasonic meters has mostly adapted A.G.A.-9 information and is adding various additional pieces of operating practice information, precautions and recommendations. A much larger data base now exists for performance and calibration history of USMs, including additional test data for piping, flow conditioners and valve interaction.

SELECTIVE REVIEW OF A.G.A. REPORT

Scope of Report

A.G.A.-9 was developed for *multipath* ultrasonic *transit-time* flow meters, used for the measurement of natural gas. A multipath meter is defined as one with at least two independent acoustic paths used to measure transit time difference of sound traveling upstream and downstream.

Meter Requirements: Codes and Regulations

A.G.A.-9 makes statements which are *design instructions for manufacturers* of meters. One reason this approach was taken was to ensure the end user that an ultrasonic product would be *safe* and *consistently* manufactured. Unless otherwise stated, the meters are to be suitable for use in an area which is subject to the requirements of the U.S. Department of Transportation's regulations *in 49 C.F.R. Part 192*, (Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards).

Meter Requirements: Meter Body

Manufacturers are urged to publish the overall lengths of their ultrasonic meter bodies. This is to help skid and other designers who may not be familiar with ultrasonic metering to define metering section dimensions. The meter length itself is not considered part of the approach or discharge meter tube minimum length requirements.

The inside diameter of the ultrasonic meter should be within 1% of the upstream tube's diameter.

The value of 1% was based mainly on early European studies and also work performed at the Southwest Research Institute's GRI/MRF (Gas Research Institute/ Metering Research Facility) in San Antonio, Texas.

Other meter requirements in this document include *anti-roll* devices (feet), *pressure tap location* on the meter, and *standard meter markings.*

These requirements were based on field experience and the lessons learned from other metering technologies.

Meter Requirements: Ultrasonic Transducers

Ultrasonic transducers are not common pipeline devices and many operators are unfamiliar with their properties. A.G.A.-9 includes clear *directions to the manufacturer for the specification, marking, and testing of transducer pairs.* These instructions are valuable because they will alert users as to the pertinent information that may affect the performance of the meter. A.G.A.-9 also requires that transducers be manufactured so that they may be exchanged and requires instructions for the exchange process.

Meter Requirements: Electronics

Much discussion was given to the issue of electronics and its evolution with time. The goal of the committee was to require electronics which were well tested and documented, but to allow improvements without placing a larger than necessary burden on the manufacturer. This idea is evident throughout the document but is especially relevant in the electronics and firmware sections.

The *electronics output section includes two suggested types, serial and frequency, along with a list of others.* Serial communication is suggested because the ultrasonic meter is clearly a very "smart" instrument and much of its usefulness relies on the internal information contained in the meter. The frequency output is a convenient option, especially in locations which are configured for turbine meter inputs.

A.G.A.-9 also mentions analog outputs, direction indicator, a low-flow cutoff, and volume accumulators.

Meter Requirements: Computer Programs

Since *ultrasonic meters are electronic,* the computer programs and information contained in the electronics of the meter are extremely important. *A.G.A.-9 requires that it be possible to interrogate the meter and determine its calibration parameters. It also requires that the meter be securable, so that accidental or undetectable changes can be prevented.*

Alarms and diagnostic functions are clearly addressed under the computer programs heading. These sections were difficult to compose because of the subtle differences associated with every different path configuration imaginable. The data that is required is of three main types; velocity, gas speed-of-sound and electronic failure. The velocity data is to indicate flow profile irregularities or velocity range exceptions and to calculate volume rate from average velocity times area. The speed-of-sound data is to be used as a diagnostic tool to check for erroneous transit time measurement errors. Other information is required to judge the quality of the data such as "% of accepted pulses."

Performance Requirements

The heart of A.G.A.-9 is contained in the Performance Requirements section. A.G.A.-9 separates ultrasonic meters into two categories; *smaller than 12″ and meters which are 12″ and larger.* The division was created to allow looser performance requirements for smaller meters where tolerances are more difficult to maintain. The flow regime is also divided into regions. Essentially there are *two regions, one low flow* region and *one high flow* region. The flowrate dividing them is called the transition flowrate (Qt). Manufacturers are to provide the numerical values for minimum, maximum, and transition flowrates. There is a *requirement that the maximum value be at least ten times greater than the transition flowrate.*

The maximum error allowable for an ultrasonic flow meter is ±*0.7%* for *large meters* and ±*1.0%* for *small meters.* This error expands to ±1.4% below the transition flowrate. *Within the error bands, the error curve for any individual meter may not span more than 0.7%, or one half the height of the error bounds for large meters.* This is the linearity specification written in terms of the *error curve.* The *repeatability* of the meters must be ±*0.2%* for the higher velocity range and is *doubled* for the lower. These limits specify the performance of the meter prior to the application of any flow calibration adjustment, or in other words *are a dry calibration requirement.* A.G.A.-9 was written in this fashion to provide a very clear and logical picture in which to view a meter's performance based on readily available data, the error curve. The dry calibration requirement itself was deemed necessary to discourage any haphazard construction of meters with the intention of "correcting" them in the final stages through flow calibration.

Individual Meter Testing Requirements

Individual meters are to be *tested* to strict tolerances *for leaks* and imperfections. A.G.A.-9 also specifies a *Zero-flow* Verification Test and a Flow-Calibration Test procedure (although a flow-calibration is not required). These requirements were written mainly for consistency. After flow calibration, the user is given any number of options for adjustment (within the dry calibration limits described above), however *the flow-weighted mean error method* is suggested. More sophisticated *linearization techniques* are also allowed.

Installation Requirements

A.G.A.-9 was written from the perspective of experienced gas measurement experts however each person freely admitted that they were still learning. This is evident and factually stated in the sections on installation requirements. Rather than specify numerical values for up- and down-stream pipe diameters, A.G.A.-9 requires *test-supported recommendations* from manufacturers of ultrasonic flow from an installation effect (both with and without a flow conditioner) or the meters. These recommendations can take one of two forms. The manufacturer may define an up- and down-stream *meter configuration* which will *not be biased* by more than *0.3%,* manufacturer may specify the flow profile deviation which will not bias the output of the meter by more than 0.3%. The user is also cautioned that protrusions, internal surface condition, thermowell position, valve noise, and flow conditioners may influence the meter's performance characteristics.

AGA 9 YEAR 2001 UPDATE

This document has been published exactly three years as of this writing. Currently a committee task group has identified sixteen (16) areas to be addressed. Tasks have been assigned to various committee members.

These include studying and recommending more explicit instructions for meter tube lengths, roughness and auxiliary taps, speed of sound field testing accuracy recommendations, piping elbow, flow conditioner use and basically sharpening up areas of generalities.

The reader of the A.G.A.-9 document is well advised to spend the time to read and follow examples in the appendix section. There is some very good technical information that will increase the viewer's general knowledge of UltraSonic meters.