



Factors in Gas Meter Station Design & Operations Short Course

Sponsored by

SGA Transmission Technical Training Committee & Southwest Research Institute® (SwRI)®

in cooperation with

The Gas Machinery Research Council

June 27 - July 1, 2005
Southwest Research Institute
San Antonio, TX



Topics:

- ◆ Natural Gas Properties
- ◆ Orifice Meters
- ◆ Ultrasonic Meters
- ◆ Turbine Meters
- ◆ Other Typical Meter Types Besides Those Listed Above
- ◆ Gas Composition Determination
- ◆ Wet Gas Technology
- ◆ Field Meter Proving
- ◆ Measurement Uncertainty Analysis

SCOPE

The Factors in Gas Meter Station Design and Operations Course will provide information that engineers, and senior field technicians with similar duties, will be able to use to design and operate natural gas flow metering facilities with the least amount of measurement. The design course includes information acquired by SwRI from R&D programs conducted for the Gas Technology Institute (GTI), the Pipeline Research Council International (PRCI), the American Petroleum Institute (API), the American Gas Association (AGA), the U.S. Department of Energy (DOE), the Gas Machinery Research Council (GMRC), and from over forty years of field service and test and calibration experience.

Those taking the course will receive information and assistance in meter station design practices, new meter research and development, meter problem identification and resolution, metering equipment calibration and verification, and gas composition and heating value determination. Throughout the course, emphasis will be placed on practical application of gas metering technology. Theoretical considerations will be presented when necessary to complement a given topic.

ABOUT THE FACILITIES

The course will be taught at the Metering Research Facility (MRF) located at Southwest Research Institute in San Antonio, Texas. Constructed in 1991, the MRF was built to improve the state of the art of natural gas flow measurement by providing a specially-designed natural gas flow calibration facility capable of simulating field operating conditions. The research program at the MRF primarily focuses on flow meter accuracy, installation effects on metering accuracy, new meter development, energy measurement, metering automation, and data acquisition and analysis. Field installation problems, such as flow pulsation effects, gas composition effects, equipment failures, and gas processing problems can also be addressed at the MRF. Students will have the opportunity to tour the MRF and see it in operation during the Gas Meter Station Design Course.

WHO SHOULD ATTEND

The course is intended for engineers employed by Operators and Manufacturers who are responsible for design and technical support of measurement facilities. Senior field and staff technicians with similar responsibilities and the ability to perform technical calculations would also benefit.

HOW TO REGISTER

You may register for this workshop by mail or fax using the registration form included. The workshop size is limited and registrations will be taken in the order they are received. The registration fee of \$1,395 includes breaks, lunch each day and all workshop materials.

HOTEL INFORMATION

The training takes place at Southwest Research Institute in San Antonio. Shuttle service to the training campus is provided each day. The shuttle will pick students up in the lobby of the Menger Hotel. The historic Menger Hotel is located at 204 Alamo Plaza in downtown San Antonio, next to the Alamo and one block from the River Walk.

You may make reservations at the Menger by calling (210) 223-4361 or (800) 345-9285. Or pick from other hotel options below.

Other hotels in the area

Holiday Inn Express Downtown (524 Saint Mary's Street; 210/354-1333)
(all suites with continental breakfast)
4-5 blocks from the Menger

Hampton Inn Downtown (414 Bowie Street; 210/225-8500)
3-4 blocks from the Menger

La Quinta (210/222-9181)
4 blocks from the Menger

Short Course Instructors

Mr. André M. Barajas is a mechanical engineer with professional interests in the areas of heat transfer, fluid dynamics, and multi-phase flow. He has over 19 years of experience in single- and multi-phase fluid flow research, including experience in hydrate formation, anti-agglomeration, and inhibition in natural gas pipeline applications. Mr. Barajas also has extensive test experience with wet-gas meters. He has also designed a multi-phase flow calibration facility for SwRI and a liquid flow calibration facility for a metrology organization in Mexico. Before joining the staff of SwRI in 1988, Mr. Barajas worked in the natural gas engineering department at the local electric and gas utilities in Austin and San Antonio, Texas. He is a registered Professional Engineer in the state of Texas.

Mr. Edgar B. Bowles, Jr. is a mechanical engineer with primary interests in fluid dynamics and heat transfer. He has experience with both analytical and experimental engineering projects. Since joining the staff at Southwest Research Institute in 1978, Mr. Bowles has been involved with a variety of projects for the oil and gas industry. In 1995, he was appointed manager of the Metering Research Facility at SwRI. In 2002, he was also given managerial responsibility for the Piping Design and Analysis Group at SwRI. That group is primarily responsible for studying flow pulsation problems associated with reciprocating compressors and pumps. He also participates in numerous national and international flow measurement standards writing committees and is author of over 80 reports and technical papers on fluid flow.

Dr. Darin L. George is a mechanical and nuclear engineer with 15 years of experience in the measurement and control of liquid, gas, and multi-phase flows. Dr. George joined the Southwest Research Institute staff in 2000, with prior work experience at Sandia National Laboratories. He is currently research project manager at the MRF for turbine flow meters, direct energy rate meters, and natural gas sampling methods. Results of this work will be incorporated into the applicable AGA or API measurement standard or recommended practice. Dr. George has authored or co-authored over 20 publications on the topics of cavitation, multi-phase flows, and flow measurement methods. He is also a registered Professional Engineer in South Carolina and Michigan.

Mr. Eric Kelner is a mechanical engineer with professional interests that include natural gas flow and quality measurement, and natural gas phase behavior and property determination. Other interests include statistical modeling of engineering system performance and engineering systems reliability. Before joining Southwest Research Institute in 1997, Mr. Kelner served as a measurement engineer for a natural gas pipeline company, and as a natural gas industry representative on several research steering committees. At SwRI, Mr. Kelner is the Leader of the Flow Measurement Group and has responsibility for the operation and maintenance of the MRF. At the MRF, he leads a team of scientists, engineers, and technicians in executing a comprehensive gas flow measurement research program funded primarily by GTI and PRCI. Technical information produced by this research program is used by gas industry standards writing groups around the world. He is a registered Professional Engineer in the state of Texas.

Mr. Robert J. McKee is a mechanical engineer with experience in dynamic analysis of piping systems, flow meters, compressors, and pumps. He has been a member of the Southwest Research Institute staff since 1977. His primary activities at SwRI have involved research on pipeline pressure losses, transient wave propagation, flow-induced vibrations, compressor performance, and fluid metering, including pulsation and other effects on meter accuracy. Mr. McKee is a past project manager for the turbine flow meter and natural gas sampling methods research programs at the MRF. Since 1999, he has served in the Plant Engineering Section at SwRI. This section primarily provides field service support for pipelines and process plants.

Dr. Thomas B. Morrow is a mechanical engineer with over 30 years of experience in fluid dynamics and heat transfer research. He worked at SwRI from 1977 to 2000 on a variety of projects, including the MRF gas measurement research program between 1987 and 2000. He performed extensive research on orifice and ultrasonic flow meters while involved with the MRF program. He retired from SwRI in 2000 to pursue a second career in teaching. In 2002, he rejoined the SwRI staff as a Technical Advisor. Since then, Dr. Morrow has managed the ultrasonic flow meter research program at the MRF. Findings from his current research will soon be incorporated in a pending revision to AGA Report No. 9 – *Measurement of Gas by Multipath Ultrasonic Meter*. Dr. Morrow has published over 50 technical papers and reports and is a registered Professional Engineer in Texas and Virginia.

FACTORS IN GAS METER STATION DESIGN AND OPERATIONS

Southwest Research Institute / Southern Gas Association

Monday, June 27, 2005

- 8:30 a.m. **I. Introduction**
- A. Welcoming remarks
 - B. Overview of the MRF program
 - C. Agenda review
- 9:15 a.m. **II. Student Pre-Test**
- 9:30 a.m. **III. Natural Gas Properties**
- A. Why are gas properties needed?
 - B. Thermodynamic state properties
 - 1. Density/compressibility factors
 - 2. Sound speed
- 10:00 a.m. *Refreshment Break*
- 10:15 a.m.
- 3. Isentropic exponent and specific heat
 - 4. Heating value
 - 5. Dew point
 - C. Transport properties
 - 1. Viscosity
 - 2. Thermal conductivity
- 11:30 a.m. *Lunch*
- 12:30 p.m. **IV. Orifice Meters - Session 1**
- A. Basic concepts
 - 1. Principles of operation
 - 2. Primary element, secondary, EFM, inferential, C_d , etc.
 - 3. Basic equations
 - B. Industry standards
 - 1. Orifice equation
 - 2. System effects
 - 3. Standard configurations
- 2:00 p.m. *Refreshment Break*
- 2:15 p.m.
- C. R&D results on system installation effects
 - 1. Upstream piping
 - 2. Flow conditioners
 - D. Preview of upcoming revision of the orifice meter standard.
 - E. Meter tube and orifice plate effects
 - 1. Surface finish
 - 2. Edge sharpness
 - 3. Beveled, un-beveled, and reversed plates
 - 4. Bent plates
 - 5. Plate eccentricity
 - 6. Importance and value of field inspection
 - F. How much do you know about good orifice meter practice?
- 4:00 p.m. **Questions and answers**
- 4:30 p.m. *Adjourn for the day*
- 6:30-8:00 p.m. *Reception*

Tuesday, June 28, 2005

- 8:30 a.m. **V. Orifice Meters - Session 2**
- G. Pulsation effects
 1. Definition of pulsation and pulsation sources
 2. Effects on the primary element
 3. Effects on the secondary system
- 10:00 a.m. *Refreshment Break*
- 10:15 a.m.
 4. Diagnosing pulsation effects
 5. Pulsation control
- H. Secondary system design and specification
- 11:45 a.m. *Lunch*
- 1:00 p.m. **VI. Ultrasonic Meters – Session 1**
- A. Introduction
 1. Characteristics
 2. Configurations
 - B. Basics of Operation
 1. Basic equations
 2. Effect of ultrasonic path location and gas inlet velocity profile
 3. Multi-path measurements
 4. Potential sources of error
- 2:30 p.m. *Refreshment Break*
- 2:45 p.m. C. Meter calibration
 1. Static calibration
 2. Flow calibration
 3. Flow calibration facilities
- D. Installation effects
 1. Bare meter performance
 2. Meter performance with flow conditioners
- 4:30 p.m. **Questions and answers**
- 5:00 p.m. *Adjourn for the day*
- 5:00-6:00 p.m. **Optional Tour of the MRF**

Wednesday, June 29, 2005

- 8:30 a.m. **VII. Ultrasonic Meters – Session 2**
- E. Effects of operating environment
 1. Line pressure
 2. Line temperature
 3. Ambient temperature
 4. Ultrasonic noise
 5. Liquid fouling
 6. Transient flow (e.g., flow pulsations)
- 10:00 a.m. *Refreshment Break*
- 10:15 a.m. F. Meter operation
 1. Interface to flow computers
 2. Health checking of meters via available software
 3. Demonstration of manufacturers' software for configuring meters
- G. Status of industry standards
 1. Overview of A.G.A. Report No. 9

2. ISO document
3. Acceptance in various countries

11:45 a.m. *Lunch*

1:00 p.m. **VIII. Turbine Meters**

- A. Principles of operation
- B. Industry standards and piping configurations
- C. System effects on meter error
 1. Line pressure and Reynolds number
 2. Pulsations
 3. Installation

2:30 p.m. *Refreshment Break*

- 2:45 p.m.
4. Secondary instrumentation systems
 5. Inspection and maintenance
 6. Meter proving
 7. Turbine meter installation design recommendations
 8. Measurement uncertainty estimates

4:30 p.m. **Questions and answers**

5:00 p.m. *Adjourn for the day*

Thursday, June 30, 2005

8:30 a.m. **IX. Other Meter Types**

- A. Positive displacement meters
 1. Rotary meter
 2. Diaphragm meter
- B. Insertion turbine meters
- C. Vortex shedding meters

10:00 a.m. *Refreshment break*

- 10:15 a.m.
- D. Coriolis meters
 - E. Averaging Pitot tube meter
 - F. Thermal mass meter
 - G. V-cone meter

11:45 a.m. *Lunch*

1:00 p.m. **X. Gas Composition Determination**

- A. Importance
- B. Gas sampling methods
 1. Spot methods
 2. Composite and on-line methods
 3. Vacuum gathering
- C. Sample handling and conditioning
- D. Gas chromatography
 1. Sample injection
 2. Sample separation in columns
 3. Sample detection
 4. Analyzing results
- E. Gas standards
- F. Quality checks and diagnostics

3:00 p.m. *Refreshment break*

3:15 p.m. **XI. Wet Gas Technology and Needs**

- A. Effects on flow meters (status report from literature)

- B. Examples of how wet gas biases the flow rate measurement
- C. Measurement technology needs
 - 1. Pipelines
 - 2. Production (onshore/offshore)

5:00 p.m. **Questions and answers**

5:30 p.m. *Adjourn for the day*

Friday, July 1, 2005

8:00 a.m. **XII. Field Meter Proving**

- A. The value
- B. The basics
- C. Prover classes
- D. Examples

8:30 a.m. **XIII. Measurement Uncertainty Analysis**

- A. The need
- B. Statistical considerations (precision)
- C. Systematic considerations (bias)
- D. Sensitivity
- E. Combined uncertainty
- F. Examples
- G. Reducing uncertainty

10:00 a.m. *Refreshment Break*

10:15 a.m. **XIV. Final Question and Answer Session**

11:15 a.m. **XV. Student post-test**

11:45 a.m. **XVI. Closing Remarks/Course Critique by Students**

12 noon *Adjourn*



Southern Gas Association/Southwest Research Institute

Course Registration Form
Factors in Gas Meter Station Design & Operations Course

June 27 - July 1, 2005

San Antonio, TX

(Please photocopy this form as necessary)

Name _____ Title _____
(include nickname for badge)

Company _____

Address _____

City _____ State _____ ZIP _____

Telephone number _____ Fax number _____

E-Mail Address _____

Brief job description _____

Length of time in company _____ Length of time in position _____

Check one: Registration fee of \$1,395 enclosed RMA

Please invoice

Credit Card

American Express

Master Card

Visa

Card # _____ Exp. _____

Signature: _____

Return to:

Debbie Krawzik

Southern Gas Association

3030 LBJ Freeway, Suite 1300 LB-60

Dallas, TX 75234

(972) 620-4012 Fax (972) 620-1613

Cancellation Policy: Refunds must be requested from SGA. For late cancellations, the following charge will be made:

- *Canceling up to two weeks before the activity will be refunded in full*
- *Canceling within two weeks of the program, 25 percent of fee*
- *Canceling within three days, no refund but substitutions may be made*