

FACTORS IN GAS METER STATION DESIGN AND OPERATIONS
Southwest Research Institute / Southern Gas Association

DAY 1

- 08:30 a.m. I. Introduction
A. Welcoming remarks
B. Overview of the MRF program
C. Agenda review
- 09:00 a.m. II. Student Pre-Test
- 09:15 a.m. III. Natural Gas Properties
A. Why are gas properties needed?
B. Thermodynamic state properties
1. Density/compressibility factors
2. Sound speed
- 09:45 a.m. Refreshment Break
- 10:00 a.m. 3. Isentropic exponent and specific heat
4. Heating value
5. Dew point
C. Transport properties
1. Viscosity
2. Thermal conductivity
- 11:00 a.m. Natural Gas Properties Class Problem (& Solution Discussion)
- 11:30 a.m. Lunch Break
- 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
- 01:30 p.m. Orifice Flow Calculation Class Problem (& Solution Discussion)
- 02:00 p.m. Refreshment Break
- 02:20 p.m. C. System installation effects
1. Upstream piping
2. Flow conditioners
D. System operational effects
1. Meter tube and orifice plate
2. Choice of secondary instrumentation
3. Importance and value of field inspection
- 03:30 p.m. Refreshment Break
- 03:45 p.m. Orifice Meter Sizing Class Problem (& Solution Discussion)
- 04:30 p.m. Class Discussion of Key Questions Related to Orifice Meter Sizing and Design
- 04:45 p.m. Adjourn for the day
- 06:30 p.m. Reception (1 to 2 hours at a local restaurant)

Day 2

- 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
 - 4. Diagnosing pulsation effects
 - 5. Pulsation control
- 10:00 a.m. Refreshment Break
- 10:15 a.m. Orifice Meter Pulsation Class Problem (& Solution Discussion)
- 11:15 a.m. H. Secondary system design and specification
- 11:45 a.m. Lunch Break
- 12:45 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
- 02:15 p.m. Refreshment Break
- 02:35 p.m. Ultrasonic Flow Meter Class Problems (& Solution Discussion)
- 03:15 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
- 04:15 p.m. Class Discussion of Key Questions Related to Ultrasonic Meter Sizing and Design
- 05:00 p.m. Adjourn for the day
- (05:00 p.m. Optional One-Hour Tour of the MRF)

Day 3

- 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)
- 09:45 a.m. Refreshment Break
- 10:00 a.m. Ultrasonic Flow Meter Class Sizing and Design Problem (& Solution Discussion)
- 11:00 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 AGA Report No. 9
 - 2. ISO document
 - 3. Acceptance in various countries
- Noon Lunch Break
- 01:00 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
- 02:30 p.m. Refreshment Break
- 02:50 p.m. 4. Secondary instrumentation systems
- 5. Inspection and maintenance
 - 6. Meter proving
 - 7. Turbine meter installation design recommendations
 - 8. Measurement uncertainty estimates
- 04:15 p.m. Turbine Flow Meter Class Problem (& Solution Discussion)
- 05:00 p.m. Adjourn for the day

Day 4

- 08:30 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
- 11:15 a.m. “Other” Flow Meter Class Problems (& Solution Discussion)
- Noon Lunch Break
- 01:00 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
- 02:30 p.m. Refreshment Break
- 02:50 p.m. Class Discussion of Key Questions Regarding Gas Composition Determination
- 03:15 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
- 04:00 p.m. XII. Field Meter Proving
- A. The value
 - B. The basics
 - C. Prover classes
 - D. Examples
- 04:45 p.m. Adjourn for the day

Day 5

- 08:30 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
- 09:15 a.m. Refreshment Break
- 09:30 a.m. XIV. Summative Design/Selection/Sizing Problem (& Solution Discussion)
- 11:00 a.m. XV. Student post-test
- 11:15 a.m. XVI. Closing Remarks/Course Critique by Students
- 11:30 a.m. Adjourn for the day