

Instrumentation Systems (Instructor-Led Training)

Course Description

This course introduces instrumentation systems to technicians new to the natural gas industry.

Course Prerequisites

- GTA Web-Based Training
 - Core WBT
 - Statistics and Uncertainty
 - Instrumentation Systems
- GTA Instructor-Led Training
 - Drawing Sets and Print Reading
 - Electric Power Fundamentals

Course Objectives

Upon completion of this course, the student will have received instruction designed to assist him/her in the following:

- Explain the purpose of instrumentation and control in the natural gas pipeline industry.
- Explain the environmental and safety concerns required for technicians working on natural gas pipeline components.
- Explain the three control variables commonly used in measurement.
- Define the terms used in instrumentation.
- Explain secondary measurement devices.
- Explain the need for calibrating instruments and control loops.
- Explain the test equipment used for instrumentation testing and calibration.
- Describe and give examples of an instrument loop.
- Describe a control loop and its use in process control.

Course Outline

1. Instrumentation and Control
2. Environmental and Safety Concerns
3. Instrumentation Units of Measurement
 - a. Pressure
 - b. Atmospheric Pressure
 - c. Absolute Pressure
 - d. Gauge Pressure
 - e. Differential Pressure
 - f. Vacuum
 - g. Head Pressure
 - h. Temperature
 - i. Fahrenheit and Celsius Scales
 - ii. Rankine and Kelvin Scales
 - i. Flow
 - i. Properties of Fluid Used to Calculate Flow
 - j. Volume
 - k. Density
 - l. Specific Gravity
 - m. Flow Rate
 - i. Volumetric Flow Rate
 - ii. Mass Flow Rate
4. Instrumentation Terms
 - a. Instrument Error
 - b. Absolute Error
 - c. Uncertainty Error
 - d. Observation Error
 - e. Zero Error
 - f. Range
 - g. Span Error

- h. Hysteresis
 - i. Linear
 - j. Non-linearity
 - k. Deadband
 - l. Accuracy
 - m. Precision
 - n. Turndown
 - o. Rangeability
 - p. Resolution
 - q. Transfer Function
 - r. Sensitivity
 - s. Calibration
 - t. Traceability
 - u. Ampere-hour and Milliampere-hour
 - v. Milliamp (mA)
 - w. Direct Current (DC)
5. Measurement Devices
- a. Manometer
 - b. Bourdon Tubes
 - c. Diaphragms
 - d. Orifice Plate
 - e. Temperature Devices
 - f. Resistance Temperature Detectors
 - g. Transmitters
 - h. Zero Suppression and Elevation
6. Calibration
- a. Good Calibration Setup
 - b. Elements of the Calibration Procedure
 - c. Input and Output Signal Span
 - d. Recalibration

- e. Accuracy in Calibration
 - i. Formula for Accuracy
 - f. Gain
 - g. Precision Process Instruments
 - h. Instrument Errors
 - i. Zero Shift and Span Error
 - j. Deadband
 - k. Hysteresis
 - l. Non-linearity
 - m. Instrument Adjustments
7. Test Equipment Used For Calibration
- a. Digital Multimeter
 - b. DC Volt Measurement
 - c. DC Milliamperes
 - d. Digital Pressure Gauge
 - e. Pressure Sources
 - f. Deadweight Tester
 - g. Current/Millivolt Source
 - h. Decade Boxes
 - i. Dry Block Calibrators
 - j. Multifunction Calibrator
 - k. Thermocouple and RTD Calibrators
 - l. HART Communicator
 - m. Smart Transmitter Overview
 - n. Advantages and Disadvantages
8. Instrument Loops
- a. Transmitters
 - b. Pressure Switches
 - c. Electromechanical Switches
 - d. Diaphragm Switches

- e. Bourdon Tube Switches
 - f. Diaphragm-Sealed Piston Switches
 - g. Piston Switches
 - h. Temperature Transmitters
 - i. Transmitter Options
 - j. Thermocouple
 - k. RTD and Advantages of RTDs
 - l. Flow Transmitters
 - m. Differential Pressure Transducer
9. Control Loops
- a. Process Control and Instrumentation Used
 - b. Control Variables
 - c. Control Elements
 - d. Feedback Control Loop
 - e. Cascade Control Loop
 - f. Feedback and Feedforward Control
 - g. Types of Automatic Control
 - h. On-Off Action
 - i. Proportional Action (Gain)
 - j. Proportional Action with Reset (Integral)
 - k. Proportional Action with Reset and Rate (Derivative)

Recommended Resources

- GTA Instrumentation Systems Participant Guide
- GTA Instrumentation Systems Instructor Presentation.
- Internet sites and textbooks related to industrial instrumentation systems.