

Basic Instrument and Control Loops (Instructor-Led Training)

Course Description

This course introduces and covers identification, terminology, and calibration of some of the most commonly used instrumentation, including calibration techniques and the test equipment used.

Course Prerequisites

- GTA Web-Based Training
 - Communication and Protocols I
 - Communication and Protocols II
- GTA Instructor-Led Training
 - Instrumentation Systems

Course Objectives

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

- Explain units of measure used in instrument control loops, and define terms used for instrumentation.
- Describe common secondary devices used in instrument control loops.
- Identify methods of instrument loop calibration and the relationship between input, output, and calibration.
- Describe common test equipment used for instrument loop maintenance and calibration, and explain their use.
- Explain process control, cascade control, and feedback control, and describe four modes of control.
- Describe the operation of five different types of instrument loop controllers.

Course Outline

1. Units of Measure used in Instrument Loops and Instrument Terms
 - a. Units of Measure used in Instrument Loops
 - i. Pressure
 - ii. Temperature
 - iii. Flow
 - b. Instrument Terms
 - i. Instrument Error
 - ii. Range
 - iii. Hysteresis
 - iv. Linearity
 - v. Deadband
 - vi. Accuracy
 - vii. Precision
 - viii. Rangedown (Turndown Ratio)
 - ix. Resolution
 - x. Accuracy and Performance
 - xi. Measurement Standards
 - xii. Accuracy Ratio
2. Secondary Devices
 - a. Pressure Sensing
 - i. Manometer
 - ii. Bourdon Tubes
 - iii. Diaphragms
 - iv. Orifice Plate
 - b. Temperature Measurement
 - i. Resistance Temperature Detectors
 - ii. Thermocouple
 - c. Transmitters
 - d. Zero Suppression and Elevation

3. Instrument Loops

- a. Calibration Calculations
- b. Converting Units
- c. Determining and Calculating Accuracy
- d. Using Input and Signal Spans to Calibrate an Instrument
- e. The Importance of Recalibration
- f. Accuracy in Calibration and How to Calculate It
- g. Relationship Between Input, Output, and Calibration
 - i. The Meaning and Importance of Gain in Calibration
 - ii. The Meaning and Importance of Precision Process Instruments
- h. Zero Shift and Span Error
- i. Non-Linearity
- j. How to Recognize Instrument Errors
- k. Some Implications of Hysteresis
- l. Dead Band
- m. Elements of a Good Calibration Setup and Procedure
- n. Instrument Adjustment

4. Test Equipment

- a. Digital Multimeter
 - i. DC Volt Measurement
 - ii. DC Amperes Measurement in a Current Loop
- b. Digital Pressure Gauge
 - i. Pressure Sources
- c. Current/Millivolt Sources
- d. Temperature Baths
- e. Decade Boxes
- f. Pressure Switches
- g. Electromechanical Switches
- h. Chart Recorders
- i. Instrument Tube Fittings

- i. Swagelok Two Ferrule Tube Fitting
 - ii. Hoke Gyrolok Tube Fittings
 - iii. Parker Ferulok Tube Fittings
 - j. Instrument Tubing
 - i. Tubing Selection, Preparation, and Handling
 - ii. Visual Inspection
 - iii. Cutting
 - iv. Deburring
 - v. Cleaning
 - k. Tubing for Hazardous Gas Service
 - l. Tube Installation Guidelines
 - i. Tube Benders
 - ii. Minimum Straight Lengths
 - iii. Fitting Preparation
 - iv. Tubing Installation Practices, Supports, and Vibration
- 5. Control Loops
 - a. Process Control and Elements of Process Control
 - b. Control Variables and Control Elements
 - c. Feedback Control Loop Instruments
 - d. Primary, Measuring, Controlling, and Final Control Elements
 - e. Uses of Instrumentation in Process Control
 - f. Cascade Control
 - g. Feedback and Feedforward Control
 - h. Modes of Control
 - i. On-Off Action
 - j. Proportional Action (Gain)
 - k. Proportional Action with Reset (Integral)
 - l. Proportional Action with Reset and Rate (Derivative)
- 6. Controllers
 - a. Bristol 624 Controller

- i. Controller Operational Features
 - ii. Gain (Proportional) Adjustment
 - iii. Integral Adjustment and Derivative Adjustment
- b. Foxboro 760 and 761 Single Loop Controllers
 - c. Moore 352 Series Single Loop Digital Controller
 - d. Fisher 646 Electro-Pneumatic Transducer
 - e. Bristol 3300 RTU

Recommended Resources

- GTA Basic Instruments & Control Loops Participant Guide.
- GTA Basic Instruments & Control Loops Instructor Presentation.
- Internet sites related to industrial instrumentation and control loops.
- Textbooks or publications related to industrial instrumentation and control loops.