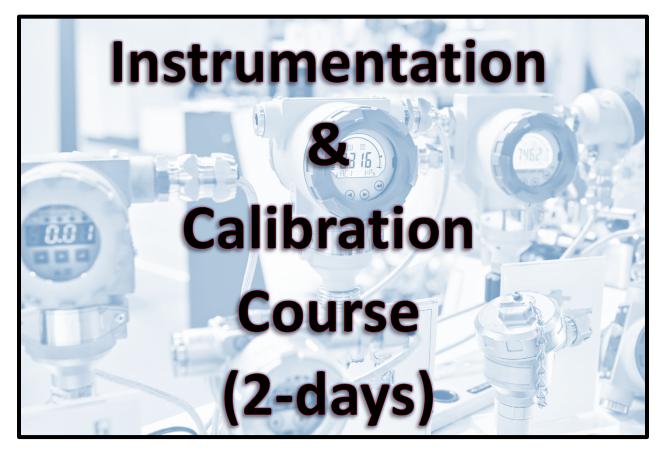# Instrumentation & Calibration

[ICAL2D]

Course Overview

Length: 2-days (16 hrs)

Hands-On: 50%

Target Audience: Personnel who work with or need to better understand industrial Instrumentation & calibration concepts (Developing Technicians, Operators, Engineers, Process Control Techs, and I&C Managers and Supervisors)

Summary Description: This course introduces students to the core fundamentals involved with modern instrumentation and calibration concepts and practices.

This course develops a fundamental understanding of the concepts required to understand and successfully maintain, calibrate, and troubleshoot common sensors, instrumentation, transmitters, and measurement systems.

This course is useful for anyone from a mechanical technician or plant operator up to senior instrumentation technicians and engineers needing to better understand the instrumentation associated with their systems. The topics presented are based on decades of expert observations of the problems and mistakes made throughout the instrumentation and controls fields.

This course includes considerable hands-on exercises and practical demonstrations, and is designed to help students gain familiarity and confidence with common instrumentation systems.

Course Agenda:

Day 1

- 4-20mA control loop and learn how to effectively test and troubleshoot analog IO problems.
- SMART transmitter concepts and operation (gain familiarity with the common functionality, mistakes, and misconceptions of SMART instrumentation and differences with older instrumentation and how it impacts maintenance programs and procedures)
- Overview of instrumentation drawings and references (loop diagrams, P&ID's, etc.)
- Introduction to calibration standards
- Calibration concepts
- Use of common I&C test equipment (Fluke Process Meters, HART Communications, etc.)
- Understanding and resolving instrumentation signal noise
- Temperature measurement basics
- Pressure measurement basics

DAY 2

- I&C calibration & maintenance programs (including common mistakes and misconceptions)
- Pneumatic and hydraulic pressure concepts (key concepts applied across the I&C field)
- Pressure measurement basics
- Level measurement basics
- DP-based level measurement concepts & issues
- Flow measurement basics
- DP-based flow measurement concepts & issues

Hands-On Exercises (only major items or topic area titles listed):

This course is over 50% hands-on training. The course is designed so that students will run into numerous real-world 'planted' problems and issues and go about resolving them. Students will see various issues and problems first-hand and will see how I&C theoretical concepts align with reality and help with solving problems.

The labs for this course are focused on the areas that are typically harder to learn and/or that are more critical and often misunderstood.

Some of the hands-on exercises for this course include:

- 4-20mA loop concepts and troubleshooting

- Smart transmitter functionality (how they are different from old analog transmitters and why they must be treated very differently).
- Transmitter damping & signal filtering labs
- RTD testing, calibration, and mistakes lab
- Thermocouple testing, calibration, and mistakes lab
- Smart transmitter configuration details (including damping, AI trim, AO trim, test outputs, fault settings, alerts/alarms, etc.
- Calibrating transmitters (and common mistakes and problems, and best practices)
- Understanding instrumentation accuracy, errors, tolerances, etc.
- Troubleshooting 4-20mA loops, transmitters, analog IO, scaling problems, etc.
- Level DP troubleshooting and configuration demos
- Flow DP troubleshooting and misconceptions demos

Student Outcomes (Course Objectives)

- Effectively test and troubleshoot analog IO loops
- Understand the 4-20mA control loop and how to effectively test and troubleshoot analog IO problems.
- Understand the operation of modern SMART transmitters and gain familiarity with the common functionality, mistakes, and misconceptions associated with them.
- Gain awareness of diagnostic capabilities of modern instrumentation and be better able to utilize it to improve plant performance and reduce downtime.
- Understand instrument and transmitter calibration concepts, including common errors, best practices for calibration programs, etc.
- Learn to utilize common instrumentation test and calibration equipment such as process meters, calibrators, and HART communicators.
- Understand typical HART communications and HART communicators & modems, usage, operation, issues, problems and solutions.
- Understand signal noise and the importance of proper signal filtering (damping) and the safety and control performance problems that incorrect filtering can cause.
- Understand typical instrumentation calibration & maintenance programs and common mistakes and problems.
- Become familiar with common process control strategies and methods.
- Understand potential process safety issues and mistakes when working with instrumentation.

Team / Organizational Benefits:

- Better recognition of common issues and faults, which enables personnel to troubleshoot more effectively, solve problems, and resolve developing issues – which reduces downtime, improves efficiency, and increases safety margins.
- Quicker recognition and correction of mistakes or problems with procedures, control functionality, or designs, resulting in problems being resolved BEFORE they cause problems.
- Improved overall operations (reduce the amount of misconception, mistakes, and assumptions that often occur in the I&C field).

- Enhanced team cohesion – Lesser skilled individuals sometimes hide their weaknesses and use other means to establish a position in the team hierarchy (vs performance). Once they develop strong fundamentals, they are able to learn; able to better communicate with team-mates; and can succeed based on merit and skills vs other approaches. Developing the underlying fundamentals often leads lower performers to shift their energy and efforts into improvement instead of other behaviors that can damage the team dynamic.
- Increased job satisfaction and team morale – Technical personnel derive great satisfaction from 'being good' at their jobs. Giving them the skills to troubleshoot and to continue growing boosts job performance and ultimately boosts retention.