## 🛠️ Control & Instrumentation Valves Training – 4-Day Course

**Duration:** 4  Days (30 hours total)
**Audience:** Maintenance technicians, instrumentation engineers, commissioning teams, and operations personnel
**Delivery Mode:** Classroom + Hands-on Lab
**Standards Referenced:** ISA, IEC 60534, ANSI/FCI 70-2, API 598, ASME B31.3, ISO 5208

📅 Day 1 – Valve Fundamentals, Internals & Flow Control

### Module 1: Introduction to Control Valves (2 hrs)

- Role of control valves in process control loops

- Definitions: Cv, rangeability, shutoff class, fail-safe position

- Standards overview: ISA, IEC 60534, ANSI/FCI 70-2

- Flow characteristics: linear, equal percentage, quick opening

- Control loop integration: valve + actuator + positioner

### Module 2: Valve Types, Manifolds & Applications (2 hrs)

- Valve categories: globe, gate, ball, diaphragm, eccentric plug

- Selection criteria: media, pressure, temperature, control range

- Fail-safe positions and actuator compatibility

- Case studies: oil & gas, water treatment, power generation

- Hands-on: manifold assembly for pressure and DP transmitters

### Module 2A: Valve Cutaway Examination & Internal Component Analysis (1 hr)

- Guided disassembly of valve cutouts (globe, ball, diaphragm)

- Identification: body, bonnet, stem, seat, plug/ball/disc, packing

- Visual inspection: trim erosion, cavitation, stem wear

- Hands-on: rotate through valve cutout stations

## Module 2B: Comparative Valve Design & Application Matrix (1 hr)

| Valve Type | Flow Path | Shutoff | Throttling | Use Cases | Pros | Cons |
|---|---|---|---|---|---|---|
| Gate | Straight | Excellent | Poor | Isolation | Low ΔP | Slow actuation |
| Globe | S-shaped | Good | Excellent | Flow control | Precise | High ΔP |
| Diaphragm | Linear | Good | Moderate | Corrosives | Leak-tight | Limited range |
| Ball | Straight | Excellent | Fair | Quick shutoff | Fast | Poor throttling |
| Eccentric Plug | Offset | Very Good | Good | Slurries | Tight shutoff | High torque |

- Selection for different field and flow, pressure control applications

## Module 3: Actuators & Positioners (2 hrs)

- Pneumatic, electric, hydraulic actuators

- Smart positioners: HART, FOUNDATION Fieldbus

- Calibration and tuning basics

- Hands-on: actuator teardown and rebuild

## Module 4: Valve Sizing & Flow Calculations (1 hr)

- Cv calculation and sizing methodology

- Pressure drop, choked flow, cavitation

- ISA/IEC sizing tools and datasheets

- Lab: Cv calculation using real valve specs

**Module 5: Installation & Commissioning (2 hrs)**

- Piping layout and valve orientation

- Air supply and signal line setup

- Stroke checks and loop testing

- Hands-on: valve setup and commissioning checklist

**Module 6: Troubleshooting & Diagnostics (2 hrs)**

- Failure modes: sticking, hunting, leakage

- Diagnostic tools: handheld communicators, HART, valve signature analysis

- Hands-on: fault simulation and resolution

**Module 7: Maintenance & Overhaul (2 hrs)**

- Preventive vs. predictive maintenance

- Packing, seals, trim wear, stem inspection

- Maintenance logs and documentation

- Lab: valve teardown and rebuild

**Module 8: Safety, Compliance & Best Practices (2 hrs)**

- Lockout/tagout procedures

- API 598 leak testing

- ANSI/FCI 70-2 seat leakage classes

- Emissions control and environmental compliance

- Final assessment and Q&A

## Module 9: Fundamentals of Process Control & PID (2 hrs)

- Open-loop vs. closed-loop control

- Process dynamics: lag, dead time, time constant

- PID control theory: P, I, D actions

- Control loop components: sensor, transmitter, controller, final element

- ISA 5.1 symbols for control loops

## Module 10: PID Tuning Methods (2 hrs)

- Tuning objectives: stability, speed, robustness

- Ziegler-Nichols, Cohen-Coon, trial-and-error

- Impact of tuning on valve behavior

- Hands-on: PID simulation or loop trainer

## Module 11: Control Valve Behavior in Loops (2 hrs)

- Valve characteristics and loop gain

- Deadband, hysteresis, stiction

- Positioner dynamics and controller interaction

- Split-range and cascade control

- Hands-on: observe valve response to PID changes

## Module 12: Advanced Loop Diagnostics & Optimization (2 hrs)

- Loop performance indicators: IAE, ISE

- Trend analysis and control charts

- Valve signature analysis

- Case studies: oscillations, sluggish loops, valve chatter

- Final group exercise: diagnose and tune a simulated loop

**Module 13: Instrumentation Valve Types & Functions (2 hrs)**

- Isolation valves: needle, ball, globe

- Manifolds: 2-valve, 3-valve, 5-valve

- Bleed, vent, and equalizing valves

- Application examples: pressure, DP, level transmitters

- Hands-on: manifold configuration and installation

**Module 14: Tubing, Fittings & Leak Prevention (2 hrs)**

- Tube materials: SS316, copper, PVC

- Fitting types: compression, flare, NPT, BSP

- Ferrule installation, torque specs

- Leak testing: bubble test, pressure decay

- Hands-on: tube bending, fitting assembly, leak test

**Module 15: Best Practices & Field Tips (2 hr)**

- Mounting orientation and accessibility

- Impulse line layout: slope, elevation, traps

- Vibration mitigation

- Final checklist for commissioning instrumentation valves and fittings

- Wrap-up and Q&A

✅ Course Deliverables

- Printed workbook with schematics, datasheets, and valve cutaway diagrams

- Valve sizing calculator (Excel tool)

- PID tuning cheat sheet

- Tube bending and fitting torque chart

- Certificate of Completion (4-Day Advanced Control Valves & Instrumentation Training)