DISTRIBUTED CONTROL SYSTEMS (DCS)

Course Objective

After completion of this course, the attendees should be able to:

- Understand the architecture and operation of a DCS
- Specify and design a simple DCS, including sizing, network layout, and consoles
- Select the best DCS offering from several vendors
- Understand ergonomic issues
- Appreciate good alarm strategies
- Understand the basic concepts of Advanced Process Control schemes

Who Should Attend

This course is intended for engineers and managers who are responsible for the selection and implementation of Distributed Control Systems, the application of Advanced Process Control systems, and control system revamps in older plants. Personnel in technical positions who want to know more about DCS installations and projects will also benefit from this course.

Course Description

The course covers the practical application of Distributed Control Systems (DCS) in continuous process plants.

The past 15 years have witnessed lower costs and increased power of small digital computers, the emergence of the Internet, and a growing use of non-proprietary network technologies. This has changed the mix of process control products on the market, both in terms of hardware and software. In particular, new “smart” field transmitters have been developed that connect to the DCS via digital networks. The course describes how these new technologies work and how they can be used to advantage.

With the increased computing power has also come more acceptance of Advanced Process Controls (APC) as a “standard” function in a DCS. The various APC technologies available today are briefly discussed.

The way the operator interacts with his processes has also changed over the past 25 years. The first DCS installations were commissioned in the mid-1970s and came with Video Display Unit (VDU) consoles that replaced wall-sized control boards. Ergonomics emerged as a “new” science that deals with the Human Machine Interface (HMI) and the issues that arise with alarm systems and annunciation of alarms in general.

As the course unfolds, a practical design exercise is woven through the lectures. A hydro-desulphuriser unit is used as a framework to size and lay out a typical DCS installation. A Simplified Flow Plan (SFP) forms the basis of the Input/Output (I/O) instrument counts and DCS sizing, while a Plot Plan provides an opportunity to determine cabinet locations and network topologies.

Course Logistics

The course is presented in a suitable venue of the client’s choice, using a laptop computer and a digital projector. Attendees receive a Course Book of approximately 300 pages and a folder with Course Notes. Knowledge of Higher Mathematics is useful to understand the details of the various equations in the book. Attendees will need to bring a laptop computer that has a spreadsheet and a presentation program such as Excel and PowerPoint. Equivalent programs may also be used. These software tools are needed while doing the exercises to document the various instrumentation and control loop counts and types. The presentation tool is useful for presenting results to the attendees and the instructor.

Course Outline

The course is designed to last four full days of about 5 to 6 instructional hours per day and one half day to wrap up. This half day will be an opportunity for Questions and Answers among all attendees and to interact in a group context. Interaction is encouraged during the course and discussion is catalyzed by the design exercise that will be used in the course. Although the Course Book contains a large body of material about instrumentation and regulatory control systems, the emphasis of this course is on the application of Distributed Control Systems. Good process control practices and examples will be provided using proven control techniques. Some discussion about loop tuning will also be included. For more information about areas that are not discussed in detail during the lectures, attendees may refer to the Course Book.

The course outline follows below.

- Control Loop Elements
  - Process Control Symbols
  - Line Types
  - Common Terminology
- Sensors
  - Temperature, Flow, Pressure, Composition
- Signal Transmission Methods
  - Analog, Digital
- Controller Technologies
  - Pneumatic Analog PID Controller
  - Electronic Analog PID Controller
  - Analog Control Loop Issues
  - Digital Controller
  - Analog to Digital Converter
  - Digital to Analog Converter
  - Analog Input/Output Sub-System
  - Digital Control with 1st Generation Mainframe Controllers
  - Historical Perspective
  - Digital Stand-Alone Controller
  - Anti-Surge Controller
  - 2nd Second Generation Mainframe Controllers
- Control valves
  - Communication to/from Control Valves
  - Final Control Element or Control Valve
  - Control Valve Features
  - Installed Valve Characteristics
  - Globe Valve with Linear Action
  - Typical Actuator
  - Push-down to Close Valve Body
  - Conventional Butterfly Disk
  - Segmented Ball
- Networking
  - Signal Transmission
  - Physical Network Structures

- Logical Network Structures
- Communication Standards
- Field Communications
- Fieldbus Operation

- Distributed Control Systems
  - Overview
  - Functions
  - Logical layout
  - Where used
  - How well utilized
  - Capital/Expense costs
  - Cost of Maintenance
  - Programmable Logic Controller – brief overview
  - Supervisory Control and Data Acquisition System – brief overview
  - DCS, PLC and SCADA compared
- DCS Hardware & Software Internals
  - Traditional Process Controllers
  - Architecture of Controllers
  - Programming
  - Timing of Control Actions
  - Software Structures
  - Connecting Controllers
  - Redundancy
- Human Machine Interfaces
  - Interface Categories
  - Indicators and Keyboards aka “Process Window”'
  - From dials to LCD panels
  - Multiple Video Displays
  - Screen Design Tools
  - Recorders and Loggers
  - Recorders and Trend Displays
  - Loggers and Data Archiving
  - Ergonomic Requirements in Control Rooms
  - Control Room Design
  - Operator Consoles in the Field
- Alarm Management
  - Key Requirements
  - Alarm System Functions
  - Selection of Alarm Limits – a scientific approach
  - Web Seminar showing Newest Tool Kit for Alarm Limit Calculations
- DCS Vendor Selection
  - Common metrics
  - Decision Matrix
  - Other approaches

- Advanced Process Control
  - Process Dynamics
  - Feedback Control
  - Feed forward Control
  - Cascade Control
  - Inferential Control

Exercises

- Exercise 1 – Design of a control loop and its components
- Exercise 2 – Design of a compressor control scheme of real machine
- Exercise 3 – HC Gas/Liquid recovery platform problem
- Exercise 4 – Heat exchanger control loop design
- Exercise 5 – Control System Design & DCS Layout for hydro-desulphuriser unit. Based on simplified flowsheet of process with most control loops already drawn. Includes review of existing controls, modification and addition of loops, building an I/O Database, routing of data highways to field shelters and control room. This challenging exercise will take about 8 hours over 2 days or more if needed.
- Exercise 6 – Preparation of brief Functional Specification of DCS designed in Exercise 5. Presentation of results of Exercise 5 to all students and instructor.
- Exercise 7 – Loop tuning practice

What the DCS Course does not offer

This course does not offer detailed material about the structure of the various databases, alarm annunciation techniques or ergonomic issues. Attendees will not learn how to configure screens, control schemes and control algorithms. The various vendors of DCS hardware and software provide the system specific training courses needed for operators, technologists and engineers who will design, use, implement and maintain the systems on a daily basis.

Course Duration

~ 4-1/2 days

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