PDHonline Course E452 (4 PDH)

Process Control Systems Types & Selection

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Clifford T Johnson, PE, CSE

Intended Audience

The process industries, those industries where the primary production processes are either continuous, or occur on a batch of materials that is indistinguishable. For example, a food processing company making sauce may make the sauce in a continuous, uninterrupted flow from receipt of ingredients through packaging. Or batches may be produced depending on the cook kettle sizes but immediately combined and re-routed. In either case, there is no concept of a unit of sauce while it is being processed.

Process, Chemical, Industrial, and Instrument Control Engineers; consultants for or working in industries such as, but not limited to:

- Chemical
- Pharmaceutical
- Nuclear Processing
- Base metals
- Pulp and Paper
- Waste & Water treatment
- Synthetic Fibers
- Plastics,
- Rubber
- Textiles
- Petroleum
- ceramics
- Wood products

Many industries, such as power generation, are pre-determined to use Distributed Control Systems (DCS) because of complexity, safety concerns and the majority of analog parameters involved.

The course is not intended to cover systems that are primarily digital I/O for machine automation such as: Computer Numerical Control (CNC) or robotics.

Before you do choose a vendor ask them for a demonstration system, including controller hardware. This work upfront can save a large amount of money and lost production over the life of a system.

Review the UMV's Boiler upgrade for a typical situation that can face you. If the vendor does not offer this before taking training course on their product, I would continue looking elsewhere.

I have personally been in a situation where the client requested we use a particular vendor who I did not believe had a fully operational DCS system. The vendor insisted that the configuration could be done by the client, but, it turned out the vendor was not being truthful and charged an additional fee to do the configuration. The project cost over ran the estimated cost by a large amount, and it took many months of fixes to get to operate satisfactorily.

Benefit to Attendees

- Eliminates possible influences or objectives by peers of the type of control system that could be employed in upgrading older control systems and new systems.
- Allows closer scrutiny of all control systems that could be employed.
- Identifies the various types of control systems available
- Identifies control types for small sub systems and large systems
- Provides Management the opportunity to review and comment on operation and make constructive comments.
- Provides additional information for consultants and contractors that can eliminate future costly change orders.
- Provides quick start on developing instruction manuals for operations and technical personnel.

Course Outline

The methods for assisting with determining the types of controls and/or systems that could be employed for small to large process control systems.

- Functional Description (FD)
- Process Flow Diagram (PFD)
- Piping/Process and Instrument Diagram (P&ID)
- Instrument Index (II)

Learning Objective

- Requirements for determining the best Process Control system.
- Types of process control for use in modern manufacturing facilities.
- When to use Single Loop Controls (SLC)
- What are Supervisory Control and Data Acquisitioning Systems (SCADA).
- When Personal Computer and software control applications may be considered.
- Why a Programmable Logic Controller (PLC) should be considered.
- A new integrator Advance Process Control (APC) is now in place challenging DCS and PLC vendors.

Course Introduction

The basis of this course is my personal 50 year plus experiences in designing, installing, starting up, and maintaining a wide variety of Instrument and controls in the process industries mentioned. I had been employed by Moore Products Co and Bailey Controls Co as a Sales Engineer, and Fairchild Industrial Products as Product Manager. I then moved to Lead E&I Engineer for J.E. Sirrine Engineers and Day Engineering, I retired as Principle I&C Engineer for C T Main/Parson Engineering and accepted the position as General Manager and Chief Engineer for Control Services Co. leaving them to teach instrumentation at a local community college in the Mechatronics department where I am still an instructor and advisor. (My brief resume)

The reasons for developing this course were the discussions on the LinkedIN ISA Group discussion concerning **Functional Description** (FD) (date 10/14/2014). It was obvious that there was no agreement on what a FD was, let alone how it should be developed and used. If you search for FD on the Internet the result is "Functional Specification" which is NOT the same as an FD in my opinion. Thus I decided to develop this course to describe a FD as I have used it in past projects, and that it should be the very first document developed when contemplating selecting and executing a process control system for a new or upgrade to an existing system.

What are the advantages?

Allowing a better method for selecting the best suited Instrument & Control (I&C) for a small (Textile Dye Machine) or large process (Paper Machine). There are well over fifty suppliers of Process Controls; the top 50 were listed by *CONTROL* magazine. Click here for an analysis of a present list of DCS vendors, most of whom also provide SLCs. Although there are many providers, there are only a few actual types of controls and in my opinion that they fall into the following types:

- Single Loop Controller (SLC) Typical Digital Controller 1/4 DIN size. Includes: Infrared (IR) Configuration interface, three universal analog inputs, two loops of control and two Math Algorithms. When these are combined with fuzzy logic overshoot suppression, the result is price/performance leadership. Application flexibility is assured by the universal analog inputs, universal AC power supply, four digital inputs, a maximum of seven analog and digital outputs, Infrared, RS422/485 ModBus RTU or Ethernet 10Base-T TCP/IP.
    - Since most modern SLC offer network abilities they can be linked with a SCADA or HMI and offer the convenience of manual control (which provides confidence to operators as well as graphical representation of the process for better alarm identification)
    - SLCs provide much easier startup and Proportional-Integral-Derivative (modes of control) tuning.
    - SLCs also intrinsically offer distributed control, the same as a DCS does, but instead of being in a cabinet somewhere, they are easily reached in an emergency.
    - Linked to a SCADA they offer several advantages over a DCS, however, there is a limit to the number that a single operator can safely handle, but in many DCS systems can be used a backup control for critical loops.
- Industrial Personal Computers (IPC) that are specially designed for performing in extreme production environments while providing long life operations. Each high-efficiency industrial computer is designed to withstand extreme measures while still continuing to function at its highest capacity. These long life industrial PC systems are designed to be used in the most extreme environments and are designed to endure despite subjection to shock, moisture, oil, vibration, dust and other environmental conditions. The high-tech interior design of each industrial flat panel computer is water proof and is designed to be completely protected from external environmental forces. Reliable industrial computers have bright

TFT displays and resistant analogue touch panels. The PC is completely protected and is able to handle vibration and shock as well as other potential situations within its environment**.**

  - Primarily used for SCADA Systems as clients and servers, that I believe is really the only time it makes sense because it has the same problem which originally was reason for the introduction of the DCS.... it uses one CPU (central processing unit) and you lose everything that it is operating WHEN it crashes. The SCADA PC can crash, however, the SLCs or PLC that it is supervising continues to control.
  - Software controller that runs on your PC**.** A completely new product from Opto 22—and a Control Engineering Engineers' Choice Finalist—SoftPAC is available now. I do not recommend it except in special applications like Statistical process control.

- Supervisory Control and Data Acquisitioning System (SCADA) generally refers to an industrial computer system that monitors and supervises a remote control system by providing set points and digital signals for electrical controls. In the case of the transmission and distribution elements of electrical utilities, SCADA will monitor substations, transformers and other electrical assets. SCADA systems are typically used to control geographically dispersed assets that are often scattered over thousands of square miles. However, it is employed to be a graphical interface to most PLCs and SLCs in the market place. The SCADA does no actual control and is sometimes referred to as an HMI. It is a software application that began in the DOS days and evolved to be used on most Microsoft platforms, UNIX, and Linux as a Server and client. It communicates over ModBus as well as several proprietary busses.
- Human Machine Interfaces (HMI) presents data to a human operator who can then monitor and control the process. Data acquisition is made possible through sensors placed throughout the process or facilities. To relay data from the remotely located sensors, different hardware and software systems utilize various open communication protocols, such as OPC, to communicate data to the HMI
- Programmable Logic Relay (PLR) excels in traditional applications where multiple relays, timers and pushbuttons are used. Typical uses include, pump control and filter back wash. Can be used in conjunction with SLC to handle digital I/O and does communicate over several common networks.
- Programmable Logic Controller (PLC) is an industrial computer control system that continuously monitors the state of input devices and makes decisions based upon a custom program to control the state of output devices. Almost any process can be greatly enhanced using this type of control system. However, the biggest benefit in using a PLC is the ability to change and replicate the operation or process while collecting and communicating vital information. It is also modular, that is, you can mix and match the types of Input and Output devices to best suit your application.
  - The PLC was invented in response to the needs of the American automotive manufacturing industry primarily to replace thousands of

relays, cam timers, and drum sequencers. The big advantage was that programmable logic controllers could be reconfigured with software programming rather than rewiring control panels. The automotive industry is still one of the largest users of PLCs

  - IEC 61131-3 currently defines five programming languages for programmable control systems: function block diagram (FBD), ladder diagram (LD); structured text (ST); similar to the Pascal programming language), instruction list (IL); similar to assembly language) and sequential function chart (SFC). These techniques emphasize logical organization of operations.
  - Today the PLC is rarely installed in a Process control system without a SCADA or HMI.
  - For information on the ranking of PLC provider Click Here I am personally familiar with Allen-Bradley, Modicon, Opto-22, and Siemens.
- Distributed Control System (DCS) many agree that the beginning of the DCS started with the introduction of the Honeywell TDC 2000 in 1975. It was the first system to use microprocessors to perform direct digital control of processes as an integrated part of the system. This distributed architecture was revolutionary with digital communication between distributed controllers, workstations and other computing elements.
  - Computer-based process control systems before the TDC 2000 were mainly data collection and alarm systems with controlled done by pneumatic loop controllers and standalone electronic PID controllers.
  - The Bailey Net 90 was the next DCS to emerge in the late 70' and I was employed by them as a sales engineer for North and South Carolina. I was instrumental in selling one of the first systems outside the utility industry to Weyerhaeuser (Pulp & Paper) and Fiber Industries (PetroPak). I actually did some of the graphic programming that was pixel-by-pixel, I remember taking 30 minutes to make one circle.
  - For a DCS and PLC/SCADA - a comparison in use Click Here
  - For a DCS evaluation and selection Click Here
  - For a DCS-PLC: (7) questions to help you make the best solution Click Here
- Statistical Process Control (SPC) is a method of quality control which uses statistical methods. SPC is applied in order to monitor and control a process. Monitoring and controlling the process ensures that it operates at its full potential. At its full potential, the process can make as much conforming product as possible with a minimum (if not an elimination) of waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. Key tools used in SPC include control charts; a focus on continuous improvement; and the design of experiments.
- PAC Technologies has been used for over eight years with a few companies claiming to have invented the term. The term refers to more powerful controllers,

but the term PAC continues to be imprecise with vendors and analysts each having a different spin on the term. Wikipedia provides this definition: A (PAC) is a compact controller that combines the features and capabilities of a PC-based control system with that of a typical programmable logic controller (PLC).

- PACs are most often used in industrial settings for process control, data acquisition, remote equipment monitoring, machine vision, and motion control. Additionally, because they function and communicate over popular network interface protocols like TCP/IP, OLE for process control (OPC) and SMTP, PACs are able to transfer data from the machines they control to other machines and components in a networked control system or to application software and databases.

Course Content

Before deciding on the type of Instrument and Controls system, described previously, to be chosen I recommend developing the following to completion shown below. During engineering it is expected that many changes will be made while evolving and the control system must be determined to complete it.

- Developing a Functional Description to 90%
- Obtaining or creating a Process Flow Diagram to 80-90%
- Developing a Process/Piping & Instrument Diagram to 75%
- Creating an Instrument Index to 75%

In the past, decisions to use a particular type control system were based on past experience and other similar systems presently in operation. Obsolete systems (ten years old) should be replaced. Worries about retraining the maintenance and operations personnel must always be dealt with and given due consideration, but should not be the deciding factor. Often controls suppliers make good sales pitches, but, bear in mind they are not usually the ones that install and start up the system. A good integration firm should be considered and be part of the discussions before a firm decision is made and, as mentioned, a demonstration of the system should be given. There is a new firm making an impact on the Food and Pharmaceutical industries, PAC Technologies will do the total project and take full responsibility and may be a good choice, but it is usually a pricey one.

Taking the time to develop the four documents before discussing the project with any provider is my recommendation. The documents can be done in house or with help from a good integrator or consulting firm, but, be sure they have proper credentials such as providing documentation and references for doing like projects.

To review a **stoker coal fired boiler** control systems complete documentation package that I designed in the mid 80s (BC: Before CAD) Click Here It consists of: SAMA Logic Drawing, Drawing Index, Instrument Index, Cable Conduit Schedule, Control Panel Layout, Control Panel Terminations & components, Loop Sheets ILS-001, ILS-001A, ILS-002, ILS-003, ILS-003A, ILS-004A, ILS-004B, ILS-005, ILS-006A, and ILS006B. The package is the complete combustion and coal handling logic and control. It took two days for startup and there has never been a call back that I am aware of. SAMA logic was used instead of a P&ID which was standard for boiler projects and is still used today. The actual configuration of the Moore Products SLC was very similar to a P&ID which made configuration quite easy for an Instrument Professional.

I also helped installed and start up a Bailey Net90 DCS (Mid 80s) on a very similar boiler for major firm, The firm had made a corporate decision to use Bailey Net 90 DCS for all boiler combustion control projects and they did the configuration and design. The boiler Manufacturer did the installation and I assisted. It took several days to do the startup, but there were no serious problems, However, Bailey service was called back 2 to 3 times a month for several months to re-boot the system. The problem turned out to be the stoker's vibration caused a problem with the control modules plugged into the back plane of the PCU (Process Control Unit), and there were only (2) control modules in the combustion control system. The real problem was that the DCS was designed to be installed in an air conditioned control room free from vibration and should not have been used in a small boiler application were there was considerable vibration. The use of the DCS in this application was a bad and costly decision.

Developing a Process Control System

1 Functional Description (FD) My Definition: A written step-by-step, in outline numbered mode, created in a word processor that describes the total process with all types of ingredients, materials, and equipment required to provide the end product is the first step in determining what type of control should be used . I personally could not find a good definition for a FD. All searches of the internet that I made resulted with "Specification" which is very different. Think of the way you might direct someone to fill a bath tub to tie dye a "T" shirt, you tell them "fill the tub with water", a FD would be:

(1) Make sure tub 18 is empty and clean. If not clean call operator actuating Yellow Alarm Light AL-110R and stop program until operator cleans tub **18** and pushes Ack button **PB-110** to continue program.

(2) Set water temperature **on TIC-103** to 110 deg F and allow steam valve **TV-103** to operate.

(3) Open Fill Valve **CV-108**

(4) Close Fill Valve **CV-108** when Level Switch **LS-108** opens and turn reel motor **MR-109** on.

b Each Step should be numbered; the **bolded** information and tags would be added to the FD after the P&ID is developed to contain the instrument tags.

c The FD can be developed by an Industrial, Chemical, Process or Controls engineer who has the responsibility for the project working with management or a client. It may be for a new system or updating an old system. In any case the person creating the FD must obtain input for all departments and the management's approval.

d I do not recommend using a graphical approach for the FD except to re-enforce the written description. After the aforementioned steps are in the completion stage a Functional Specification for the actual control system chosen would be develop and may use one of the several graphical applications covered later.

e The **FD** is the document that you:

(1) Give to the developers so they know what to build,

(2) Give to the testers so they know what tests to run,

(3) Give to the stakeholders (and get them to approve) so they know what they are getting.

(4) Give to Process and Control Engineers so they can develop a Process Flow Diagram (**PFD**) and Piping and Instrument diagram (**P&ID**)

(5) Provide the potential integrators, vendors, and installers for proposal information.

f Additional **definitions** that may confused for or in addition to the **FD**.

i) **Functional design**: The specifications of the working relations between the parts of a system in terms of their characteristic actions. [Comprehensive Dictionary of Instrumentation and Control - ISA 1988]

ii) **Functional Diagram**: A diagram that represents the functional relationship among the parts of a system [Comprehensive Dictionary of Instrumentation and Control - ISA 1988]

iii) **Functional Program**: A routine or group of routines which, when considered as a whole, completes some task with a minimum of interaction of other functional programs over than to obtain data and signal completion of its task. For example, a group of routines which take data from an analog scanner and store it on a bulk storage device might be considered to be a functional program [Comprehensive Dictionary of Instrumentation and Control - ISA 1988]

iv) **Functional Requirements**: A specification of required functional behavior, operation, performance, or purpose [Comprehensive Dictionary of Instrumentation and Control - ISA 1988]

v) **Functional Specification**: does not define the inner workings of the proposed system; it does not include the specification of how the system function will be implemented. Instead, it focuses on what various outside agents (people using the program, computer peripherals, or other computers, for example) might "observe" when interacting with the system [http://en.wikipedia.org/wiki/Functional_specification]

(1) **Also**: A description of what a system (e.g. a piece of software) does or should do (but not how it should do it). The functional specification is one of the inputs to the design process. See IEEE /ANSI Std. 610.12-1990. (1999-04-07)A

g I recommend using a word processor with 2 columns, one for the **FD**, the other column for comments.

h Many industries require special treatment and have developed standards that replace or can be used as a guide in development of a **FD**

i) **Pharmaceuticals**: GAMP® 5: A Risk-Based Approach to Compliant GxP Computerized Systems.

ii) **Petroleum**: NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authority's regulations.

iii) **ANSI/ISA-S88-01-1995** is an international **standard on Batch Control** providing standard models and terminology for defining the control requirements for batch manufacturing plants.

iv) **ANSI/ISA 5.06.01-2007** **Functional Requirements:** Documentation for Control Software Applications. Includes real-time batch, discrete and continuous process automation systems. Defines regulatory, event-driven and time-driven control system actions. Encompasses both digital and analog control devices in addition to non-control actions.

i **Replacing** old or obsolete systems.

i) Spend as much time with the operations people as required to write a step-by-step description of the older systems.

ii) Break the system down by loops if not already identified.

iii) Identify actions or operations that are not performing as well as expected and identify what changes can be made to improve the operation.

iv) Complete an **FD** that contains all possible improvements.

2 **Process Flow Diagram (PFD**). A **PFD** is the fundamental representation of a process that schematically depicts the conversion of raw materials into finished products without delving into the details of how that conversion occurs. It defines the flow of material and utilities such as water and electric power; it defines the basic functional relationships between major pieces of equipment. The PFD defines the capability of a system by listing minimum, normal and maximum conditions. They include ranges of flow, pressure, temperature, and possibly some other defining parameter for that process.

i) **PFDs** are closely associated with material balances which are used to determine the raw materials and utilities needed to achieve a desired result or product. A material balance is also referred to as a mass balance. **PFD**s can provide or infer information related to an energy balance as well; as it relates to utilities needed to perform the materials conversion. A material balance in mass units is preferred; engineering calculations at this macro level are typically done in mass units rather than engineering units, that is, pounds per hour rather than gallons per minute. Project design teams use **PFD**s during this developmental stage to document the design options under study.

ii) **PFD**s are not only associated with new construction. Within an operating facility, a plant-wide design group and site management may use **PFD**s to document the requirements to produce different products or use different recipes and to provide a framework for facility optimization in support of production changes.

b There is no generally accepted industry standard available to aid in developing the PFD. ISA-5.l standard does define how instrumentation can be depicted on a PFD.

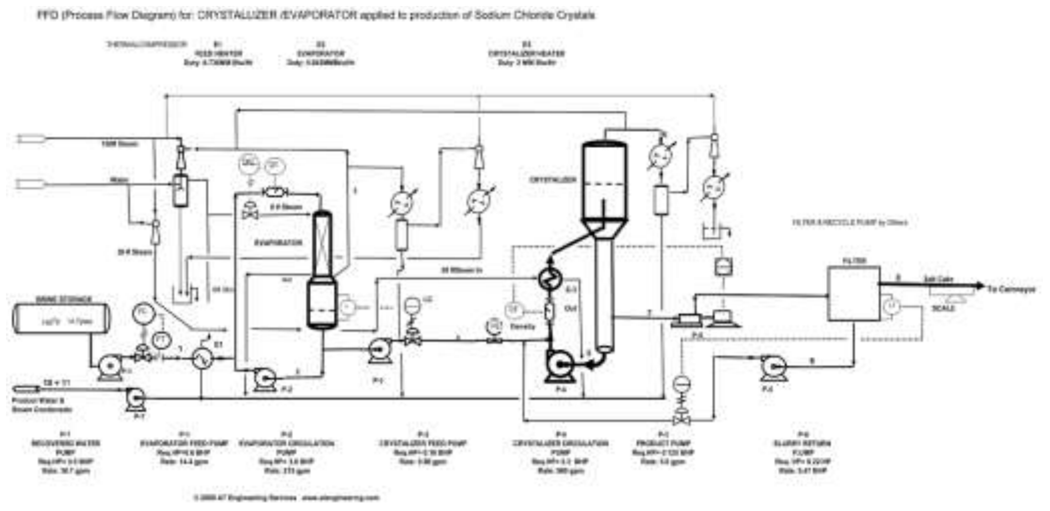
c **Minimum Detail Approach** For a **PFD** to be most effective in schematically representing the critical details of a process in the least amount of room, the entire process should be shown in as little space as practical. Only the major process steps are depicted. The intent is to simply show that a change has or will be made to a material or that a product has been modified rather than the minutiae of how that change was made. It can be something of a challenge to determine what should be shown on a PFD, but remember the PFD is a big picture schematic; there will always be a P&ID made to flesh out the details. One should err on the side of removing detail from a PFD.

d Contact the mechanical, process, and chemical departments to develop a **PFD**, it is important to complete prior to attempting to develop a control system in order that all major pieces of equipment be identified along with the complete information of processing parameters.

e Each piece of equipment must be tagged

f Each section of pipe must be numbered

g The same drawing or a separate listing must contain the process information for all the equipment and devices such as: Flow rates, Temperature ranges, Pressure requirements, Chemical makeup, etc. More examples of **PFD** and the list of symbols that are used to develop them Click Here *this is required review for quiz for PDH*.



Typical example of PFD

3 **Process/Piping & Instrument Diagram (P&ID)** The acronym "**P&ID**" is widely understood within the process industries as the name for the principal document used to define a process-the equipment, the piping and all of the control systems components. The ***Automation, Systems and Instrumentation Dictionary***, Fourth Edition defines a Piping and Instrumentation Drawing (**P&ID**) by describing its function: **P&IDs** "show the interconnection of process equipment and the instrumentation used to control the process." The fact that the **P&ID** is the principal, defining document is proven by its widespread use across most processes and industries. Once you become familiar with the "language" of the symbols and the presentation, you will come to appreciate its efficiency and simplicity in documenting salient information in an easily understandable way.

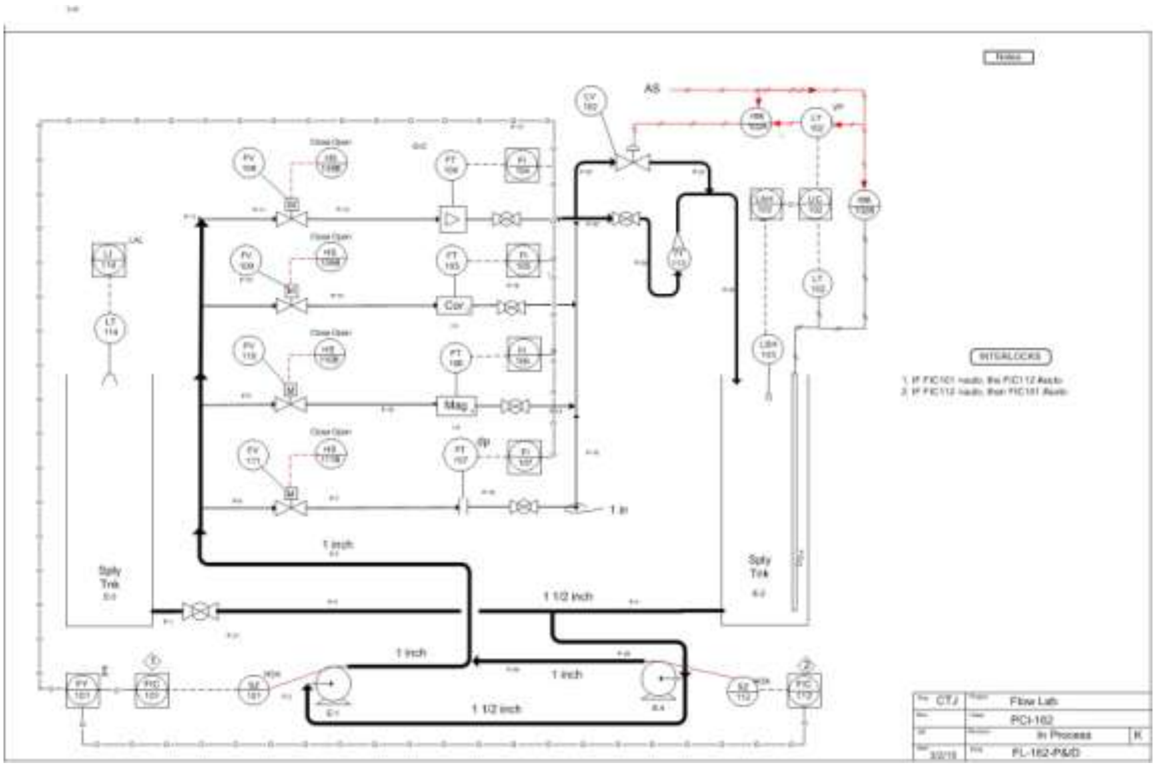
a Not withstanding the ubiquitous nature of the **P&ID**, you may experience confusion when trying to decipher unique symbols or other depictions on your drawings. The fact that confusion exists is understandable because, oddly, there is no universal standard that specifies the information that should be included on a **P&ID** or how it should be shown. Even more strangely, the meaning of the letters **P&ID** are not even universally agreed upon. You may know what the "P" stands for, or what "D" means or even what a P&ID contains, but the person in the facility down the road probably doesn't agree in every way. For instance, the "P" in P&ID may stand for Piping or Process. The "I" may refer to Instrument or Instrumentation. The "D" may mean Drawing or Diagram. **P&IDs** may even be called Flow Diagrams, which are not to be confused with the **PFD**s discussed previously. **P&IDs** are also sometimes called Flow Sheets, a term often preceded by the department that initiated or developed them, like Engineering, or Controls, or some other descriptor. For simplicity, we will refer to the document by the acronym, **P&ID**; you may define it as you wish.

b As mentioned above, there is no universal, national, or international multi-discipline standard that covers the development and content of P&IDs. However ISA Standard **ISA-d5.07.01 (2011)** is now available for the I&C Professional and, much of the Symbol and tagging is covered by **ISA-5.1** which is an excellent document that defines primary instrument and equipment based symbolism used in a P&ID then follows the method used by **ISA- 5.1** in deriving standard drawings to represent the family of equipment types with as simple a sketch as possible.

c Use the **PFD** if provided or create/developed to develop a **P&ID** with assistance from process personnel to visualize how many and types of measurements and control loops will be required

i) Use **ISA- 5.1** symbols and tags to identify devices on the **P&ID**.

ii) The Mechanical and Process discipline should be responsible for providing information to allow I&C (instrument & Controls) department to enter sizing information into the Instrument Index.



Example of P&ID

4 **Instrument Index (Database)** Information developed and maintained for process control tasks will assuredly exist in digital form, all of which can be collected in what is essentially an infinitely flexible data set **- the instrument database**. The traditional Instrument Index is simply a subset of the information available in the database. Today's instrument databases have the capability to be the primary repository and source for data rather than a copy of data generated elsewhere, which was the old method. Data can flow "out" from a single entry in a database to all other documents, rather than "in" from the documents into the database. Software programs can link directly to the database so there are no transcription errors. Some software will also identify changes to notify the user when there is a difference between the source data, the database, the application, and possibly the DCS configuration program. For example, if a suffix was added to a control valve tag after a new control valve was added to a loop, software can immediately, efficiently and accurately compare the source data to the application. The goal is always to write (and check!) the primary source data once, then use it many times.

a Identifying the "I/O" (Input/Outputs) on the **P&ID** is required. An application designed for developing a Instrument Index be should be used if the project is greater than 200 I/O or 100 loops. I recommend Aveva Instrumentation Software Application for the Instrument Index. It will enable generation of Instruments specifications, wire and cable connections through junction boxes plus provide a graphical representation of all wire and cables http://support.aveva.com/support/United_Kingdom/

b The basic Instrument Index should contain the following fields (columns), additional fields will be added after selection of the type of control system chosen

(1) "AI" (Analog Inputs) from field

(2) "AO" (Analog Outputs) to field devices such as control valves.

(3) "DI" (Digital Inputs) switches & on-off devices from field.

(4) "DO" (Digital Outputs) On-Off/Open-close valves to field.

(5) "FI" (Frequency Inputs) from field devices such as flow meters

(6) P&ID

(7) Loop Number

(8) Service

(9) Range

5 Following the **Functional Description** review and comments incorporated, the P&ID and Instrument index are about 75% developed, then selection of the type of control system can be initiated.

a The following is only a guide for your consideration; obviously there are many more factors that make for a final selection.

b Before making a firm selections of a DCS system *review the following for the quiz to get your PDHs.*

(1) DCS evaluation and selection *Click Here*

(2) DCS and PLC/SCADA - a comparison in use Click Here

(3) PLC or DCS Seven questions to help you select the best solution Click Here

6 Once the selection is made the development of the system should be made using **ANSI/ISA 5.06.01-2007** **Functional Requirements** (Some refer to this as Functional Specification) Documentation for Control Software Applications**.**

7 This course does not cover the networks and Fieldbuses that are available with all the control systems, only one does provide power for the field instruments. I personally have designed systems with ASi, ProFiBus for ABB DCS, Modbus including RS422 for several SCADAs. I prefer ASi for on-off valve operation because it is simple and connects with most PLC systems. Since I have not designed a complete system since 2006 I will refrain from commenting on the present state of the art, however, consideration for using a Fieldbus should be made if there are over a hundred control loops, it will increase costs in engineering and maintenance, especially if Foundation Fieldbus is employed. Fieldbus is quite different from a local area network. Many of us have a networks at home, but none of us have a Fieldbus in the house.

Batch Control (Number of individual batch systems)

Number		AI		AO		DI		DO	Consider
1-2	<	2	<	2	<	2	<	2	SLC With OPC HMI
1-2	<	4	<	4	<	4	<	4	SLC with SCADA
1-2	<	4	<	4	<	12	<	12	SLC , PLR, with SCADA
2 or more	<	4	<	4	<	12	<	12	SLC , PLC, with SCADA Plus recipe
2 or more	>	4	>	4	>	12	>	12	DCS or PAC

Continuous Process (Number of Systems)

Number		AI		AO		DI		DO	Consider
1	<	12	<	8	<	8	<	8	SLC with OPC HMI
1	<	12	<	8	<	12	<	12	SLC, PLR with OPC HMI
1	<	16	<	16	<	16	<	16	SLC, PLC with SCADA
1	<	24	<	24	<	48	<	48	PLC with SCADA
1	>	24	>	24	>	48	>	48	DCS or PAC

Summary

This course was meant to provide information to engineers and management that would assist them in selecting the best control system meeting their requirements and, to me, that means starting off with a good, understandable, Functional Description of the total project, not just the controls portion of the project. Everyone should now have clear understanding of the process and the I&C professionals can develop a Functional Specification for a control system that may begin on the factory floor and reach up to top management. I hope I have provided information about the various types of controls that should be considered and allow everyone involved to get their "2 cents" in. Please don't make a decision like many firms do; because controls are not like socks "one size does *NOT* fit all"

Don't forget about the cocktail party where you told a lady that you were an Instrument Engineer and she wanted to know what instrument you designed, a clarinet or tuba.