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Revision Memo

12/01 General changes. Added description on Multivariable loops, Equipment Health Monitoring and Real Time Optimization.

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SCOPE

- ▶ This section describes some conceptual approaches and common practices available for the analysis and initial specification of controls and relevant instrumentation for process unit designs. A framework is provided to facilitate selection of manageable segments of a process unit for the purpose of analyzing control system requirements. Examples highlight instrumentation and control decisions made during process design along with related reasoning.

REFERENCES

▶ GLOBAL PRACTICES

GP 15-1-1	Instrumentation for Fired Heaters
GP 15-1-2	Instrumentation for Compressors and Drivers
GP 15-1-3	Instrumentation for Storage Tanks and Vessels
GP 15-7-3	Alarm Systems
GP 16-8-1	Instrument and Essential Services Power Supplies

DESIGN PRACTICES

DP XII-B	Flow Measurement and Control
DP XII-C	Level Measurement and Control
DP XII-D	Pressure Measurement and Control
DP XII-E	Temperature Measurement and Control
DP XII-H	Fractionator Control
DP XII-I	Boiler Controls

BACKGROUND

PROCESS DESIGNER ROLE IN AUTOMATION DESIGN

With few exceptions, new process units are equipped with a digital control system (DCS) that provides advanced control capabilities and interfaces to other systems, including management information and accounting systems and read-only interface to protective systems. The process designer can make use of these features to help achieve the basic process design objectives, such as upgrading a feedstock to increase its value, while meeting safety, environmental, minimum staffing, administrative and accounting requirements.

PURPOSES OF PROCESS CONTROL

- ▶ A major driving force behind automation is economics - to achieve the desired production safely, at the lowest cost. Process dynamics sometimes require automatic controls to make unit operations feasible in the base case. Typically, control objectives include:
- Lowering labor costs
 - Reducing or eliminating human error
 - Reducing the size and space requirements of process equipment
 - Improving product quality
 - Reducing energy consumption
 - Reducing raw material consumption
 - Elimination of product giveaway
 - Elimination of off-spec products

A process unit design rarely requires ground-breaking innovation for its basic control system. Operating experience, with a succession of previous designs of the same or similar types of units, allows the use of a "copy and modify" approach. Even in the first commercial design of a newly developed process, there is usually pilot plant experience to draw from for deciding how to control the unit (i.e., knowledge of which process variables are important and which measurement and control tools the operator needs to operate the unit effectively).

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BACKGROUND (Cont)

This section covers methods for analyzing the basic control of any portion of a unit or offsite facility which, is to be a modification of a successful previous design. Such modifications of successful designs become necessary for several reasons. Some examples of these reasons are as follows:

- Experience feedback from previous start-ups and operation.
- More or less heat integration with related units than previously.
- Changes in product quality requirements and economics due to local factors.
- Additional requirements such as advanced control applications, or provision of accounting and management information.
- Regulatory agency requirements.
- Local practices.

THE FUNCTIONS OF PROCESS CONTROL

BASIC AND COROLLARY FUNCTIONS

When modifying successful instrumentation and control systems, it is important to retain the two basic functions and the three corollary functions which are performed by process control. The two basic functions are considered basic because they are needed for plant operability. The three corollary functions are just as important but are usually considered after plant operability is established.

Basic Functions - The two basic functions are:

1. **Maintaining stability** of operating conditions at key points in the process.
2. **Providing the operator with information** on these operating conditions and the means for adjusting them.

Corollary Functions - The three corollary functions are:

1. **Automating operations** to reduce the demand for continuous operator attention as dictated by economics and management information requirements.
2. **Insuring that operations are safe** for personnel and equipment and meet all environmental or other regulatory requirements.
3. **Maintaining product quality while minimizing operating costs.**

SAFETY CONSIDERATIONS

- ◆ Control systems employ some form of fail-safe mode in the event of component / system failure or detected catastrophic event. Instrumentation and control components used in safety services have special individual and system integration requirements reflecting their potential failure modes. Hardware details are usually left to instrumentation and control specialists. The process designer in consultation with the equipment specialist normally defines the constraint conditions for keeping process equipment operations within a safe operating range. An example of such an instrument use is a centrifugal compressor low-flow cut-in, which is used to prevent machine surge. Another example is a low pressure cut-out on fuel gas to a fired heater.

CONTROL REQUIREMENTS AND METHODS

SUBDIVIDING TO SIMPLIFY ANALYSIS

Modification of the control system of a process unit requires that the unit be subdivided into pieces that are small enough and logical enough to allow effective analysis of each piece. Elaborate rules for subdividing are not necessary. An example of a subdivision into four categories is as follows:

Major Equipment Items - Fractionators, fired heaters, reactors and generators are common equipment items in this category. Major pumps and compressors are also included within this category.

Principal Circuits - Feed and product streams are the usual principal circuits, although others could qualify.

Auxiliary Circuits - These are important streams that begin and end within the unit.

Miscellaneous Circuits - These include mainly utility circuits and any other circuit which does not qualify as a principal circuit or auxiliary circuit.