Process Control Drawings

APPENDIX

A

Drawings provide a simple visual representation of process designs and automation approaches. Since so many people are involved in the design, building, and operation of a process plant, drawing standards are essential, and the Instrument Society of America has prepared standards that are recognized in most countries and companies (ISA, 1986). The many design decisions lead to several typical levels of drawings; three common categories are

1. *Simplified*, which represents the use of measurements and calculations
2. *Conceptual*, which provides details on most calculations
3. *Detailed*, which specifies the computing resource in which each calculation is performed

Generally, simplified drawings are used in this book, and therefore, the simplified methods are presented in this appendix.

A.1 ■ IDENTIFICATION LETTERS

Abbreviations of a few letters are used to identify the measurement types and calculations performed using measured values. Each abbreviation is located in a circle or "bubble," which indicates the location of the sensor in the process. The abbreviations usually consist of two to three letters, with the first letter indicating the variable type and the subsequent letter(s) giving some information about the function performed.

Some of the more common abbreviations are presented in Table A.1. Examples of typical abbreviations are

FC	Flow control calculation
PIC	Pressure measurement indicated (displayed) for the operating personnel and used in control calculation
LAH	Level measurement used for signalling an alarm to operating personnel when the level exceeds a high limit
TS	Temperature measurement used to open/close a switch that could shut down plant operation on a dangerous condition
AC	Analyzer control calculation; the specific analysis is usually indicated just outside the bubble (e.g., ρ for density)

The symbol does not give much detail; for example, the flow measurement sensor could be an orifice plate, venturi meter, or pitot tube. Many additional details must be provided before the equipment can be selected and installed. These details are typically provided in tables, which complement drawings and are not discussed in this book.

Signals

The values of measurements or results of calculations must be transmitted between elements in a control system and ultimately to the final control element to influence the process. Many types of signals are used in a plant, and the three most common are shown in Figure A.1. The electric signal is represented by a dashed line in this book and is implemented with a 4–20 mA signal to represent measurements (e.g., 300–400 K) and final element values (e.g., 0–100% valve opening). The pneumatic signal can be used for the same purposes, and it was the dominant signal type until the 1960s. It remains in wide use today, because the power source for most valves remains air pressure; typically, the electric signal is converted to pneumatic at the valve. Finally, many signals between calculations are internal to a digital computer, and these can be represented by the symbol in Figure A.1. Since most of the methods in this book can be implemented in a variety of computing

TABLE A.1

Identification letters

	First letter	Succeeding letters	
A	Analyzer	Alarm	
F	Flow	Ratio (fraction)	
H	Hand (manual operation)		High
L	Level		Low
P	Pressure		
S	Speed	Switch	
T	Temperature	Transmitter	
Y		General computation	

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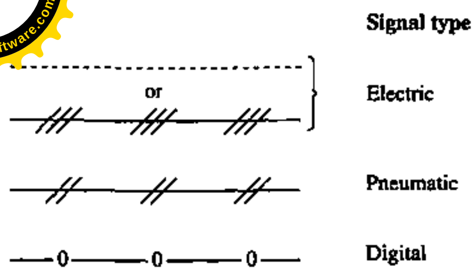

FIGURE A.1

Control signals. Reprinted by permission. Copyright ©1986, Instrument Society of America. From *Instrumentation Symbols and Identification*, ISA, 5.1-1984.

equipment, analog or digital, the electric signal transmission is used throughout. This is common practice for simplified drawings and does not preclude digital implementation of the designs.

The reader should be aware that the technology for signal transmission is changing rapidly. Soon, digital computation will be available at the sensor and final element, and most signal transmission will use digital principles. This revolution in signal transmission will not change the technology presented in this book, but it will open the door to advances in sensor diagnosis and improvements in process reliability.

Sensors

The drawing indicates the type of process variable measured and the location of the sensor. For the most part, details of the sensor physics and chemistry are not addressed in this book, because information is available in most books on fluid mechanics and heat transfer. In a few cases, some information on the sensor type is indicated in the drawing. For example, the drawings in Figure A.2 show two different types of level sensors: a differential pressure and a float.

A.2 ■ FINAL ELEMENT

The predominant final element in the process industries is the diaphragm-actuated control valve, and this is essentially the only final element considered in this book. The valve is sketched as shown in Figure A.3. When the power (air pressure) is removed from the valve, it assumes its *failure position*. Three failure positions are shown; fail open, closed, and locked (unchanged). These positions are selected for safety, as discussed in Chapter 12. The typical control valve has a relatively large unrecoverable pressure drop; thus, a butterfly valve or damper is sometimes used for control. Many valves in a process design are not automated and must be opened or closed manually; an example of such a "hand" valve is shown in the figure. Finally, an angle valve is used in this book to represent safety valves, which open without an external power source when the process pressure exceeds a specified limit.

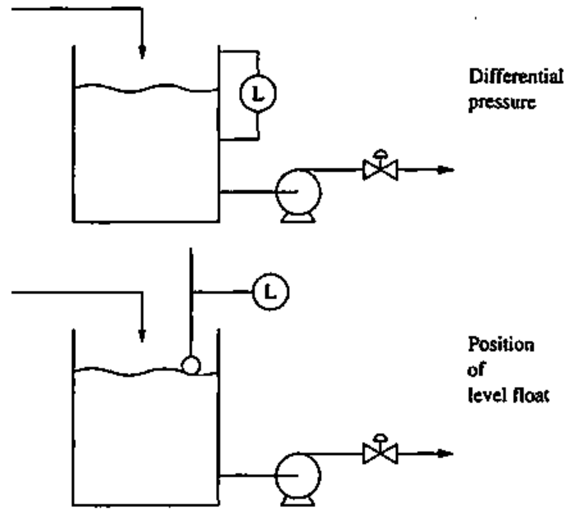

FIGURE A.2

Two-level sensors. Reprinted by permission. Copyright ©1986, Instrument Society of America. From *Instrumentation Symbols and Identification*, ISA, 5.1-1984.

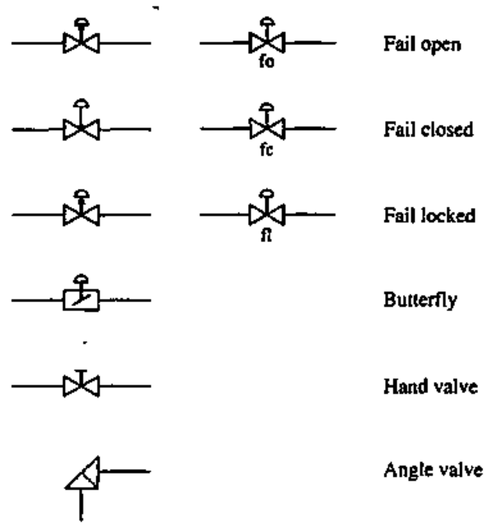

FIGURE A.3

Valve symbols. Reprinted by permission. Copyright ©1986, Instrument Society of America. From *Instrumentation Symbols and Identification*, ISA, 5.1-1984.

A.3 ■ PROCESS EQUIPMENT

Control design drawings also include a simplified sketch of the process, which is included to clarify the control strategy but not to provide sufficient detail to build the process equipment. Some of the process schematic symbols are given in Figure A.4.

These elements are combined in the process drawing. An example is given in Figure A.5. The feed flow is maintained at the desired value using flow control, and the liquid level is controlled by adjusting the flow leaving the drum. The

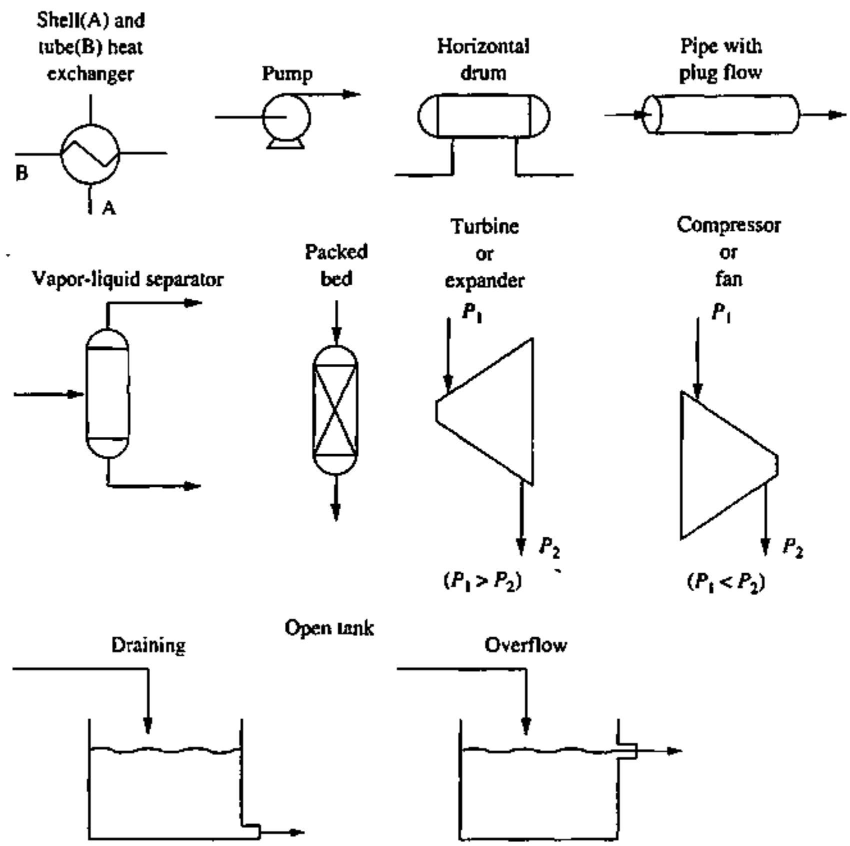

FIGURE A.4

Process schematics. Reprinted by permission. Copyright ©1986, Instrument Society of America. From *Instrumentation Symbols and Identification*, ISA, 5.1-1984.

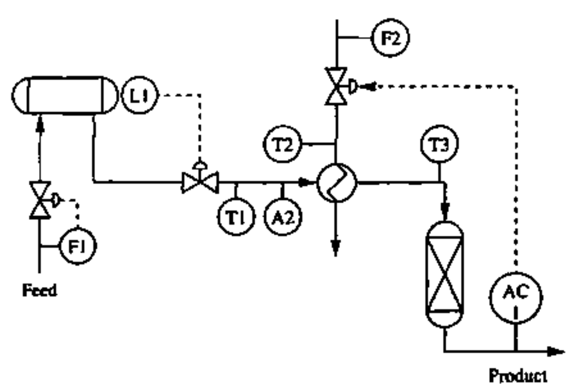

FIGURE A.5

Example process drawing with instrumentation.

reactor effluent concentration is controlled by adjusting the heating medium valve opening. The bed temperature is measured and used to provide an alarm to the operating personnel when the temperature exceeds a specified value. Finally, the other sensors are used for display to operating personnel. Each sensor is numbered to allow unambiguous reference.

REFERENCE

Instrument Society of America, *Instrumentation Symbols and Identification*, ISA 5.1-1984, Research Triangle Park, NC, 1986.