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Instrumentation Symbols and Identification

ISA–The Instrumentation, Systems, and Automation Society

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

Preface

This preface is included for information and is not a part of ISA-5.1-1984 (R1992).

This standard has been prepared as part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709, Telephone (919) 549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to U.S.A. users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, which has been published by the Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1982, and future revisions will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards that ISA develops.

The information contained in the preface, footnotes, and appendices is included for information only and is not a part of the standard.

The instrumentation symbolism and identification techniques described in the standard accommodate the advances in technology and reflect the collective industrial experience gained since the publication of Recommended Practice RP5.1 in 1949.

This revision attempts to strengthen the standard in its role as a tool of communication in the process industries. Communication presupposes a common language; or, at the very least, it is facilitated by one. The standard offers the foundation for that common language.

When integrated into a system, the symbols and designations presented here form a concise, dedicated language which communicates concepts, facts, intent, instructions, and knowledge about measurement and control systems in the process industries.

This document is a consensus standard rather than a mandatory one. As such, it has many of the strengths and the weaknesses of consensus standards. Its primary strength is that it can be used in widespread, interdisciplinary ways. Its weakness is generally that of not being specific enough to satisfy the special requirements of particular interest groups.

The symbols and identification contained in ISA-5.1 have evolved by the consensus method and are intended for wide application throughout the process industries. The symbols and designations are used as conceptualizing aids, as design tools, as teaching devices, and as a concise and specific means of communication on all types and kinds of technical, engineering, procurement, construction, and maintenance documents.

In the past, the standard has been flexible enough to serve all of the uses just described. In the future, it must continue to do so. To this end, this revision offers symbols, identification, and definitions for concepts that were not previously described; for example, shared display/control, distributed control, and programmable control. Definitions were broadened to accommodate the fact that, although similar functions are being performed by the new control systems, these functions are frequently not related to a uniquely identifiable instrument; yet they still must be conceptualized and identified. The excellent SAMA (Scientific Apparatus Makers Association) method of functional diagramming was used to describe function blocks and function designators. To help the batch processing industries, where binary (on-off) symbolism is extremely useful, new binary line symbols were introduced and first-letter *Y* was selected to represent an initiating variable which could be categorized as an event, presence, or state. In general, breadth of application as opposed to narrowness has been emphasized.

The ISA Standards Committee on Instrumentation Symbols and Identification operates within the ISA Standards and Practices Department, with William Calder III as vice president. The persons listed below served as members of or advisors to the SP5.1 committee. The SP5.1 committee is deeply appreciative of the work of previous SP5.1 committees and has tried to treat their work with the respect it deserves. In addition, this committee would like to acknowledge the work of the SP5.3 committee in developing ISA-5.3, "Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems." The key elements of ISA-5.3 have been incorporated into ISA-5.1, and it is the Society's intent to withdraw ISA-5.3 after publication of this revision of ISA-5.1.

The following people served as members of ISA Committee SP5.1, which prepared this standard:

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G. Wilbanks	The Rust Engineering Company

*Member Emeritus

The following people served as members of ISA Committee SP5:

NAME	COMPANY
D. E. Rapley, Chairman	Stearns Catalytic Corporation
R. C. Greer	Bailey Controls Company
D. G. Kempfer	Standard Oil Company of Ohio
R. H. Kind	El Paso Natural Gas Company
R. Mulley	Fluor Engineers, Inc.
T. J. Myron	The Foxboro Company

This standard was approved for publication by the ISA Standards and Practices Board in September 1984.

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G. Platt*	Bechtel Power Corporation
J. R. Williams*	Stearns Catalytic Corporation

*Director Emeritus

Contents

1 Purpose

The purpose of this standard is to establish a uniform means of designating instruments and instrumentation systems used for measurement and control. To this end, a designation system that includes symbols and an identification code is presented.

2 Scope

2.1 General

2.1.1 The procedural needs of various users are different. The standard recognizes these needs, when they are consistent with the objectives of the standard, by providing alternative symbolism methods. A number of examples are provided for adding information or simplifying the symbolism, as desired.

2.1.2 Process equipment symbols are not part of this standard, but are included only to illustrate applications of instrumentation symbols.

2.2 Application to industries

2.2.1 The standard is suitable for use in the chemical, petroleum, power generation, air conditioning, metal refining, and numerous other, process industries.

2.2.2 Certain fields, such as astronomy, navigation, and medicine, use very specialized instruments that are different from the conventional industrial process instruments. No specific effort was made to have the standard meet the requirements of those fields. However, it is expected that the standard will be flexible enough to meet many of the needs of special fields.

2.3 Application to work activities

2.3.1 The standard is suitable for use whenever any reference to an instrument or to a control system function is required for the purposes of symbolization and identification. Such references may be required for the following uses, as well as others:

- Design sketches
- Teaching examples
- Technical papers, literature, and discussions
- Instrumentation system diagrams, loop diagrams, logic diagrams
- Functional descriptions
- Flow diagrams: Process, Mechanical, Engineering, Systems, Piping (Process) and Instrumentation
- Construction drawings
- Specifications, purchase orders, manifests, and other lists

- Identification (tagging) of instruments and control functions
- Installation, operating and maintenance instructions, drawings, and records

2.3.2 The standard is intended to provide sufficient information to enable anyone reviewing any document depicting process measurement and control (who has a reasonable amount of process knowledge) to understand the means of measurement and control of the process. The detailed knowledge of a specialist in instrumentation is not a prerequisite to this understanding.

2.4 Application to classes of instrumentation and to instrument functions

The symbolism and identification methods provided in this standard are applicable to all classes of process measurement and control instrumentation. They can be used not only to describe discrete instruments and their functions, but also to describe the analogous functions of systems which are variously termed "shared display," "shared control," "distributed control," and "computer control."

2.5 Extent of functional identification

The standard provides for the identification and symbolization of the key functions of an instrument. Additional details of the instrument are better described in a suitable specification, data sheet, or other document intended for those requiring such details.

2.6 Extent of loop identification

The standard covers the identification of an instrument and all other instruments or control functions associated with it in a loop. The user is free to apply additional identification — by serial number, unit number, area number, plant number, or by other means.

3 Definitions

For the purpose of understanding this standard, the following definitions apply. For a more complete treatment, see ISA-51.1 and the ISA-75 series of standards. Terms italicized in a definition are also defined in this section.

***Accessible**:* A term applied to a device or *function* that can be used or be seen by an operator for the purpose of performing control actions, *e.g., set point* changes, auto-manual transfer, or on-off actions.

***Alarm**:* A device or *function* that signals the existence of an abnormal condition by means of an audible or visible discrete change, or both, intended to attract attention.

It is not recommended that the term *alarm switch* or *alarm* be used to designate a device whose operation is simply to close or open a circuit that may or may not be used for normal or abnormal interlock, start-up, shutdown, actuation of a *pilot light* or an *alarm* device, or the like. The first device is properly designated as a level *switch*, a flow *switch*, *etc*., because "switching" is what the device does. The device may be designated as an *alarm* only if the device itself contains the *alarm function*. [See also Table 1, note (13).]

Assignable: A term applied to a feature permitting the channeling (or directing) of a signal from one device to another without the need for switching, patching, or changes in wiring.

Auto-manual station: Synonym for *control station*.

Balloon: Synonym for *bubble*.

Behind the panel: A term applied to a location that is within an area that contains (1) the *instrument panel*, (2) its associated rack-mounted hardware, or (3) is enclosed within the *panel. Behind the panel* devices are not *accessible* for the operator's normal use, and are not designated as *local* or front-of-*panel-mounted*. In a very broad sense, *"behind the panel"* is equivalent to "not normally *accessible* to the operator."

Binary: A term applied to a signal or device that has only two discrete positions or states. When used in its simplest form, as in "*binary* signal" (as opposed to "analog signal"), the term denotes an "on-off" or "high-low" state, *i.e*., one which does not represent continuously varying quantities.

Board: Synonym for *panel*.

Bubble: The circular symbol used to denote and identify the purpose of an *instrument* or *function*. It may contain a tag number. Synonym for *balloon*.

Computing device: A device or *function* that performs one or more calculations or logic operations, or both, and transmits one or more resultant output signals. A *computing device* is sometimes called a computing *relay*.

Configurable: A term applied to a device or system whose functional characteristics can be selected or rearranged through programming or other methods. The concept excludes rewiring as a means of altering the configuration.

Controller: A device having an output that varies to regulate a controlled variable in a specified manner. A *controller* may be a self-contained analog or *digital instrument*, or it may be the equivalent of such an *instrument* in a shared-control system.

An automatic *controller* varies its output automatically in response to a direct or indirect input of a measured *process variable*. A manual *controller* is a *manual loading station*, and its output is not dependent on a measured *process variable* but can be varied only by manual adjustment.

A *controller* may be integral with other functional elements of a control *loop*.

Control station: A *manual loading station* that also provides switching between manual and automatic control modes of a control *loop*. It is also known as an *auto-manual station*. In addition, the operator interface of a *distributed control system* may be regarded as a *control station*.

Control valve: A device, other than a common, hand-actuated ON-OFF valve or self-actuated check valve, that directly manipulates the flow of one or more fluid process streams.

It is expected that use of the designation "hand *control valve*" will be limited to hand-actuated valves that (1) are used for process throttling, or (2) require *identification* as an *instrument*.

Converter: A device that receives information in one form of an instrument signal and transmits an output signal in another form.

An *instrument* which changes a sensor's output to a standard signal is properly designated as a *transmitter*, not a *converter*. Typically, a temperature element *(TE)* may connect to a *transmitter (TT)*, not to a *converter (TY)*.

A *converter* is also referred to as a *transducer*; however, "*transducer*" is a completely general term, and its use specifically for signal conversion is not recommended.

Digital: A term applied to a signal or device that uses *binary* digits to represent continuous values or discrete states.

Distributed control system*:* A system which, while being functionally integrated, consists of subsystems which may be physically separate and remotely located from one another.

Final control element: The device that directly controls the value of the manipulated variable of a control *loop*. Often the *final control element* is a *control valve*.

Function: The purpose of, or an action performed by, a device.

Identification: The sequence of letters or digits, or both, used to designate an individual *instrument* or *loop*.

***Instrument**:* A device used directly or indirectly to measure and/or control a variable. The term includes *primary elements, final control elements, computing devices,* and electrical devices such as annunciators, *switches*, and pushbuttons. The term does not apply to parts (e.g., a receiver bellows or a resistor) that are internal components of an *instrument.*

Instrumentation: A collection of *instruments* or their application for the purpose of observation, *measurement*, control, or any combination of these.

Local: The location of an *instrument* that is neither in nor on a *panel* or console, nor is it mounted in a control room. *Local instruments* are commonly in the vicinity of a *primary element* or a *final control element.* The word "field" is often used synonymously with *local*.

Local panel: A *panel* that is not a central or main panel. *Local panels* are commonly in the vicinity of plant subsystems or sub-areas. The term *"local panel instrument"* should not be confused with "*local instrument*."

Loop: A combination of two or more *instruments* or control *functions* arranged so that signals pass from one to another for the purpose of *measurement* and/or control of a *process variable*.

Manual loading station: A device or *function* having a manually adjustable output that is used to actuate one or more remote devices. The station does not provide switching between manual and automatic control modes of a control *loop* (*see controller* and *control station*). The station may have integral indicators, lights, or other features. It is also known as a manual station or a manual loader.

Measurement: The determination of the existence or the magnitude of a variable.

Monitor: A general term for an *instrument* or *instrument* system used to measure or sense the status or magnitude of one or more variables for the purpose of deriving useful information. The term *monitor* is very unspecific — sometimes meaning analyzer, indicator, or *alarm. Monitor* can also be used as a verb.

***Monitor light**:* Synonym for *pilot light*.

***Panel**:* A structure that has a group of *instruments* mounted on it, houses the operator-process interface, and is chosen to have a unique designation. The *panel* may consist of one or more sections, cubicles, consoles, or desks. Synonym for *board*.

***Panel-mounted**:* A term applied to an *instrument* that is mounted on a *panel* or console and is *accessible* for an operator's normal use. A *function* that is normally *accessible* to an operator in a *shared-display* system is the equivalent of a discrete *panel-mounted* device.

Pilot light: A light that indicates which of a number of normal conditions of a system or device exists. It is unlike an *alarm* light, which indicates an abnormal condition. The *pilot light* is also known as a *monitor light*.

***Primary element**:* Synonym for *sensor.*

***Process**:* Any operation or sequence of operations involving a change of energy, state, composition, dimension, or other properties that may be defined with respect to a datum.

Process variable: Any variable property of a *process*. The term *process variable* is used in this standard to apply to all variables other than *instrument* signals.

Program: A repeatable sequence of actions that defines the status of outputs as a fixed relationship to a set of inputs.

Programmable logic controller: A *controller*, usually with multiple inputs and outputs, that contains an alterable *program*.

Relay: A device whose *function* is to pass on information in an unchanged form or in some modified form. *Relay* is often used to mean *computing device*. The latter term is preferred.

The term *"relay"* also is applied specifically to an electric, pneumatic, or hydraulic *switch* that is actuated by a signal. The term also is applied to *functions* performed by a *relay*.

Scan: To sample, in a predetermined manner, each of a number of variables intermittently. The *function* of a scanning device is often to ascertain the state or value of a variable. The device may be associated with other *functions* such as recording and alarming.

Sensor: That part of a *loop* or *instrument* that first senses the value of a process variable, and that assumes a corresponding, predetermined, and intelligible state or output. The *sensor* may be separate from or integral with another functional element of a *loop*. The *sensor* is also known as a detector or *primary element*.

Set point: An input variable that sets the desired value of the controlled variable. The *set point* may be manually set, automatically set, or programmed. Its value is expressed in the same units as the controlled variable.

Shared controller: A *controller*, containing preprogrammed algorithms that are usually *accessible, configurable,* and *assignable*. It permits a number of *process variables* to be controlled by a single device.

Shared display: The operator interface device (usually a video screen) used to display *process* control information from a number of sources at the command of the operator.

Switch: A device that connects, disconnects, selects, or transfers one or more circuits and is not designated as a *controller*, a *relay*, or a *control valve*. As a verb, the term is also applied to the *functions* performed by *switches*.

Test point: A *process* connection to which no *instrument* is permanently connected, but which is intended for the temporary or intermittent connection of an *instrument*.

Transducer: A general term for a device that receives information in the form of one or more physical quantities, modifies the information and/or its form, if required, and produces a resultant output signal. Depending on the application, the *transducer* can be a *primary element, transmitter, relay, converter* or other device. Because the term *"transducer"* is not specific, its use for specific applications is not recommended.

Transmitter: A device that senses a *process variable* through the medium of a sensor and has an output whose steady-state value varies only as a predetermined *function* of the *process variable*. The *sensor* may or may not be integral with the *transmitter*.

4 Outline of the identification system

4.1 General

4.1.1 Each instrument or function to be identified is designated by an alphanumeric code or tag number as shown in Figure 1. The loop identification part of the tag number generally is common to all instruments or functions of the loop. A suffix or prefix may be added to complete the identification. Typical identification is shown in Figure 1.

	TYPICAL TAG NUMBER
TIC 103	- Instrument Identification or Tag Number
T 103	- Loop Identification
103	- Loop Number
TIC	- Functional Identification
T	- First-letter
IC	- Succeeding-Letters
	EXPANDED TAG NUMBER
10-PAH-5A	- Tag Number
10	- Optional Prefix
A	- Optional Suffix
Note: Hyphens are optional as separators	

Figure 1 — Tag numbers

4.1.2 The instrument loop number may include coded information, such as plant area designation. It is also possible to set aside specific series of numbers to designate special functions; for instance, the series 900 to 999 could be used for loops whose primary function is safety-related.

4.1.3 Each instrument may be represented on diagrams by a symbol. The symbol may be accompanied by a tag number.

4.2 Functional identification

4.2.1 The functional identification of an instrument or its functional equivalent consists of letters from Table 1 and includes one first-letter (designating the measured or initiating variable) and one or more succeeding-letters (identifying the functions performed).

4.2.2 The functional identification of an instrument is made according to the function and not according to the construction. Thus, a differential-pressure recorder used for flow measurement is identified by *FR*; a pressure indicator and a pressure-actuated switch connected to the output of a pneumatic level transmitter are identified by *LI* and *LS*, respectively.

4.2.3 In an instrument loop, the first-letter of the functional identification is selected according to the measured or initiating variable, and not according to the manipulated variable. Thus, a control valve varying flow according to the dictates of a level controller is an *LV*, not an *FV*.

4.2.4 The succeeding-letters of the functional identification designate one or more readout or passive functions and/or output functions. A modifying-letter may be used, if required, in addition to one or more other succeeding-letters. Modifying-letters may modify either a first-letter or succeeding-letters, as applicable. Thus, *TDAL* contains two modifiers. The letter *D* changes the measured variable *T* into a new variable, "differential temperature." The letter *L* restricts the readout function *A*, alarm, to represent a low alarm only.

4.2.5 The sequence of identification letters begins with a first-letter selected according to Table 1. Readout or passive functional letters follow in any order, and output functional letters follow these in any sequence, except that output letter *C* (control) precedes output letter *V* (valve), *e.g.*, *PCV*, a self-actuated control valve. However, modifying-letters, if used, are interposed so that they are placed immediately following the letters they modify.

4.2.6 A multiple function device may be symbolized on a diagram by as many bubbles as there are measured variables, outputs, and/or functions. Thus, a temperature controller with a switch may be identified by two tangent bubbles — one inscribed *TIC-3* and one inscribed *TSH-3*. The instrument would be designated *TIC/TSH-3* for all uses in writing or reference. If desired, however, the abbreviation *TIC-3* may serve for general identification or for purchasing, while *TSH-3* may be used for electric circuit diagrams.

4.2.7 The number of functional letters grouped for one instrument should be kept to a minimum according to the judgment of the user. The total number of letters within one group should not exceed four. The number within a group may be kept to a minimum by:

1) Arranging the functional letters into subgroups. This practice is described in Section 4.2.6 for instruments having more than one measured variable or input, but it may also be used for other instruments.

2) Omitting the *I* (indicate) if an instrument both indicates and records the same measured variable.

4.2.8 All letters of the functional identification are uppercase.

4.3 Loop identification

4.3.1 The loop identification consists of a first-letter and a number. Each instrument within a loop has assigned to it the same loop number and, in the case of parallel numbering, the same first-letter. Each instrument loop has a unique loop identification. An instrument common to two or more loops should carry the identification of the loop which is considered predominant.

4.3.2 Loop numbering may be parallel or serial. Parallel numbering involves starting a numerical sequence for each new first-letter, *e.g., TIC-100, FRC-100, LIC-100, AI-100*, *etc*. Serial numbering involves using a single sequence of numbers for a project or for large sections of a project, regardless of the first-letter of the loop identification, *e.g., TIC-100, FRC-101, LIC-102, AI-103, etc*. A loop numbering sequence may begin with 1 or any other convenient number, such as *001, 301* or *1201*. The number may incorporate coded information; however, simplicity is recommended.

4.3.3 If a given loop has more than one instrument with the same functional identification, a suffix may be appended to the loop number, *e.g., FV-2A, FV-2B, FV-2C*, *etc*., or *TE-25-1, TE-25-2*, *etc*. However, it may be more convenient or logical in a given instance to designate a pair of flow transmitters, for example, as *FT-2* and *FT-3* instead of *FT-2A* and *FT-2B*. The suffixes may be applied according to the following guidelines:

1) An uppercase suffix letter should be used, *i.e., A, B, C, etc*.

2) For an instrument such as a multipoint temperature recorder that prints numbers for point identification, the primary elements may be numbered *TE-25-1, TE-25-2, TE-25-3*, *etc*., corresponding to the point identification number.

3) Further subdivisions of a loop may be designated by serially alternating suffix letters and numbers. (*See* Section 6.9R(3).)

4.3.4 An instrument that performs two or more functions may be designated by all of its functions. For example, a flow recorder *FR-2* with a pressure pen *PR-4* may be designated *FR-2/PR-4*. A two-pen pressure recorder may be *PR-7/8*, and a common annunciator window for high and low temperature alarms may be *TAHL-21*. Note that the slash is not necessary when distinctly separate devices are not present.

4.3.5 Instrument accessories such as purge meters, air sets, and seal pots that are not explicitly shown on a diagram but that need a designation for other purposes should be tagged individually according to their functions and should use the same loop identification as the instrument they directly serve. Application of such a designation does not imply that the accessory must be shown on the diagram. Alternatively, the accessories may use the identical tag number as that of their associated instrument, but with clarifying words added. Thus an orifice flange union associated with orifice plate *FE-7* should be tagged *FX-7*, but may be designated *FE-7 FLANGES*. A purge meter associated with pressure gauge *PI-8* may be tagged *PI-8 PURGE*. A thermowell used with thermometer *TI-9* should be tagged *TW-9*, but may be tagged *TI-9 THERMOWELL*.

The rules for loop identification need not be applied to instruments and accessories that are purchased in bulk quantities if it is the user's practice to identify these items by other means.

4.4 Symbols

4.4.1 The examples in this standard illustrate the symbols that are intended to depict instrumentation on diagrams and drawings. Methods of symbolization and identification are demonstrated. The examples show identification that is typical for the pictured instrument or functional interrelationships. The symbols indicating the various instruments or functions have been applied in typical ways in the illustrations. This usage does not imply, however, that the applications or designations of the instruments or functions are restricted in any way. No inference should be drawn that the choice of any of the schemes for illustration constitutes a recommendation for the illustrated methods of measurement or control. Where alternative symbols are shown without a statement of preference, the relative sequence of symbols does not imply a preference.

4.4.2 The bubble may be used to tag distinctive symbols, such as those for control valves, when such tagging is desired. In such instances, the line connecting the bubble to the instrument symbol is drawn close to, but not touching, the symbol. In other instances, the bubble serves to represent the instrument proper.

4.4.3 A distinctive symbol whose relationship to the remainder of the loop is easily apparent from a diagram need not be individually tagged on the diagram. For example, an orifice flange or a control valve that is part of a larger system need not be shown with a tag number on a diagram. Also, where there is a primary element connected to another instrument on a diagram, use of a symbol to represent the primary element on the diagram is optional.

4.4.4 A brief explanatory notation may be added adjacent to a symbol or line to clarify the function of an item. For instance, the notations *3-9 psig* and *9-15 psig* adjacent to the signal lines to two valves operating in split range, taken together with the symbols for the failure modes, allow complete understanding of the intent. Similarly, when two valves are operated in a diverting or mixing mode from a common signal, the notations *3-15 psig* and *15-3 psig*, together with the failure modes, allow understanding of the function.

4.4.5 The sizes of the tagging bubbles and the miscellaneous symbols shown in the examples are the sizes generally recommended; however, the optimum sizes may vary depending on whether or not the finished diagram is to be reduced in size and depending on the number of characters that are expected in the instrument tagging designation. The sizes of the other symbols may be selected as appropriate to accompany the symbols of other equipment on a diagram.

4.4.6 Aside from the general drafting requirements for neatness and legibility, symbols may be drawn with any orientation. Likewise, signal lines may be drawn on a diagram entering or leaving the appropriate part of a symbol at any angle. However, the function block designators of Table 3 and the tag numbers should always be drawn with a horizontal orientation. Directional arrowheads should be added to signal lines when needed to clarify the direction of flow of information. The judicious use of such arrowheads, especially on complex drawings, will often facilitate understanding of the system.

4.4.7 The electrical, pneumatic, or other power supply to an instrument is not expected to be shown unless it is essential to an understanding of the operation of the instrument or the loop.

4.4.8 In general, one signal line will suffice to represent the interconnections between two instruments on flow diagrams even though they may be connected physically by more than one line.

4.4.9 The sequence in which the instruments or functions of a loop are connected on a diagram should reflect the functional logic or information flow, although this arrangement will not necessarily correspond to the signal connection sequence. Thus, an electronic loop using analog voltage signals requires parallel wiring, while a loop using analog current signals requires series interconnections. However, the diagram in both instances should be drawn as though all the wiring were parallel, to show the functional interrelationships clearly while keeping the presentation independent of the type of instrumentation finally installed. The correct interconnections are expected to be shown on a suitable diagram.

4.4.10 The degree of detail to be applied to each document or sketch is entirely at the discretion of the user of the standard. The symbols and designations in this standard can depict both hardware and function. Sketches and technical papers will usually contain highly simplified symbolism and identification. Process flow diagrams will usually be less detailed than engineering flow diagrams. Engineering flow diagrams may show all in-line components, but may differ from user to user in the amount of off-line detail shown. In any case, consistency should be established for each application. The terms *simplified, conceptual,* and *detailed* as applied to the diagrams of 6.12 were chosen to represent a cross section of typical usage. Each user must establish the degree of detail that fulfills the purposes of the specific document or sketch being generated.

4.4.11 It is common practice for engineering flow diagrams to omit the symbols of interlock-hardware components that are actually necessary for a working system, particularly when symbolizing electric interlock systems. For example, a level switch may be shown as tripping a pump, or separate flow and pressure switches may be shown as actuating a solenoid valve or other interlock devices. In both instances, auxiliary electrical relays and other components may be considered details to be shown elsewhere. By the same token, a current transformer sometimes will be omitted and its receiver shown connected directly to the process — in this case the electric motor.

4.4.12 Because the distinctions between shared display/shared control and computer functions are sometimes blurred, in choosing symbols to represent them the user must rely on manufacturers' definitions, usage in a particular industry, and personal judgment.

5 Tables

The purpose of Section 5, Tables, is to define certain of the building blocks of the identification and symbolic representation system used in this standard in a concise, easily-referenced manner.

Table 1, Identification Letters, together with the Notes for Table 1, define and explain the individual letter designators used as functional identifiers in accordance with the rules of Section 4.2, Functional Identification.

Table 2, Typical Letter Combinations, attempts to facilitate the task of choosing acceptable combinations of identifying letters.

Table 3, Function Blocks - Function Designations, is an adaptation of the SAMA (Scientific Apparatus Manufacturers Association) method of functional diagramming. Two basic uses are found for these symbols: as stand-alone function blocks on conceptual diagrams, or as flags which designate functions performed by bubbles on more detailed drawings. A third use is a combination of the first two and is found in shared control systems where, for instance, the measured variable signal line enters a square root function block that is drawn adjacent to a shared controller.

Two omissions will be noted: The SAMA symbol for *Transfer* and that for an *Analog Signal Generator*. Since the ultimate use of ISA-5.1 symbolism usually requires identification to be associated with a symbol, it is advisable to use the *HIC* (manual loader) bubble for an analog signal generator and an *HS* (hand switch) with or without a relay bubble for a transfer function.

5.1 Notes for Table 1

1) A "user's choice" letter is intended to cover unlisted meanings that will be used repetitively in a particular project. If used, the letter may have one meaning as a first-letter and another meaning as a succeeding-letter. The meanings need to be defined only once in a legend, or other place, for that project. For example, the letter *N* may be defined as "modulus of elasticity" as a first-letter and "oscilloscope" as a succeeding-letter.

2) The unclassified letter *X* is intended to cover unlisted meanings that will be used only once or used to a limited extent. If used, the letter may have any number of meanings as a first-letter and any number of meanings as a succeeding-letter. Except for its use with distinctive symbols, it is expected that the meanings will be defined outside a tagging bubble on a flow diagram. For example, *XR-2* may be a stress recorder and *XX-4* may be a stress oscilloscope.

3) The grammatical form of the succeeding-letter meanings may be modified as required. For example, "indicate" may be applied as "indicator" or "indicating," "transmit" as "transmitter" or "transmitting," *etc*.

4) Any first-letter, if used in combination with modifying letters *D* (differential), *F* (ratio), *M* (momentary), *K* (time rate of change), *Q* (integrate or totalize), or any combination of these is intended to represent a new and separate measured variable, and the combination is treated as a first-letter entity. Thus, instruments *TDI* and *TI* indicate two different variables, namely, differential-temperature and temperature. Modifying letters are used when applicable.

5) First-letter *A* (analysis) covers all analyses not described by a "user's choice" letter. It is expected that the type of analysis will be defined outside a tagging bubble.

6) Use of first-letter *U* for "multivariable" in lieu of a combination of first-letters is optional. It is recommended that nonspecific variable designators such as *U* be used sparingly.

7) The use of modifying terms "high," "low," "middle" or "intermediate," and "scan" is optional.

8) The term "safety" applies to emergency protective primary elements and emergency protective final control elements only. Thus, a self-actuated valve that prevents operation of a fluid system at a higher-than-desired pressure by bleeding fluid from the system is a back-pressure-type *PCV*, even if the valve is not intended to be used normally. However, this valve is designated as a *PSV* if it is intended to protect against emergency conditions, *i.e.*, conditions that are hazardous to personnel and/or equipment and that are not expected to arise normally.

The designation *PSV* applies to all valves intended to protect against emergency pressure conditions regardless of whether the valve construction and mode of operation place them in the category of the safety valve, relief valve, or safety relief valve. A rupture disc is designated *PSE*.

9) The passive function *G* applies to instruments or devices that provide an uncalibrated view, such as sight glasses and television monitors.

10) "Indicate" normally applies to the readout—analog or digital—of an actual measurement. In the case of a manual loader, it may be used for the dial or setting indication, *i.e.*, for the value of the initiating variable.

11) A pilot light that is part of an instrument loop should be designated by a first-letter followed by the succeeding-letter *L*. For example, a pilot light that indicates an expired time period should be tagged *KQL*. If it is desired to tag a pilot light that is not part of an instrument loop, the light is designated in the same way. For example, a running light for an electric motor may be tagged *EL*, assuming voltage to be the appropriate measured variable, or *YL*, assuming the operating status is being monitored. The unclassified variable *X* should be used only for applications which are limited in extent. The designation *XL* should not be used for motor running lights, as these are commonly numerous. It is permissible to use the user's choice letters *M, N* or *O* for a motor running light when the meaning is previously defined. If *M* is used, it must be clear that the letter does not stand for the word "motor," but for a monitored state.

12) Use of a succeeding-letter *U* for "multifunction" instead of a combination of other functional letters is optional. This nonspecific function designator should be used sparingly.

13) A device that connects, disconnects, or transfers one or more circuits may be either a switch, a relay, an ON-OFF controller, or a control valve, depending on the application.

If the device manipulates a fluid process stream and is not a hand-actuated ON-OFF block valve, it is designated as a control valve. It is incorrect to use the succeeding-letters *CV* for anything other than a self-actuated control valve. For all applications other than fluid process streams, the device is designated as follows:

- A switch, if it is actuated by hand.

- A switch or an ON-OFF controller, if it is automatic and is the first such device in a loop. The term "switch" is generally used if the device is used for alarm, pilot light, selection, interlock, or safety.

- The term "controller" is generally used if the device is used for normal operating control.

- A relay, if it is automatic and is not the first such device in a loop, *i.e.*, it is actuated by a switch or an ON-OFF controller.

14) It is expected that the functions associated with the use of succeeding-letter *Y* will be defined outside a bubble on a diagram when further definition is considered necessary. This definition need not be made when the function is self-evident, as for a solenoid valve in a fluid signal line.

15) The modifying terms "high," and "low," and "middle" or "intermediate" correspond to values of the measured variable, not to values of the signal, unless otherwise noted. For example, a high-level alarm derived from a reverse-acting level transmitter signal should be an *LAH*, even though the alarm is actuated when the signal falls to a low value. The terms may be used in combinations as appropriate. (*See* Section 6.9A.)

16) The terms "high" and "low," when applied to positions of valves and other open-close devices, are defined as follows: "high" denotes that the valve is in or approaching the fully open position, and "low" denotes that it is in or approaching the fully closed position.

17) The word "record" applies to any form of permanent storage of information that permits retrieval by any means.

18) For use of the term "transmitter" versus "converter," see the definitions in Section 3.

19) First-letter *V*, "vibration or mechanical analysis," is intended to perform the duties in machinery monitoring that the letter *A* performs in more general analyses. Except for vibration, it is expected that the variable of interest will be defined outside the tagging bubble.

20) First-letter *Y* is intended for use when control or monitoring responses are event-driven as opposed to time- or time schedule-driven. The letter *Y*, in this position, can also signify presence or state.

21) Modifying-letter *K*, in combination with a first-letter such as *L, T,* or *W*, signifies a time rate of change of the measured or initiating variable. The variable *WKIC*, for instance, may represent a rate-of-weight-loss controller.

22) Succeeding-letter *K* is a user's option for designating a control station, while the succeeding-letter *C* is used for describing automatic or manual controllers. (*See* Section 3, Definitions.)

Table 1 — Identification Letters

	FIRST-LETTER (4)		**SUCCEEDING-LETTERS** (3)		
	MEASURED OR INITIATING VARIABLE	**MODIFIER**	**READOUT OR PASSIVE FUNCTION**	**OUTPUT FUNCTION**	**MODIFIER**
A	Analysis (5,19)		Alarm		
B	Burner, Combustion		User's Choice (1)	User's Choice (1)	User's Choice (1)
C	User's Choice (1)			Control (13)	
D	User's Choice (1)	Differential (4)			
E	Voltage		Sensor (Primary Element)		
F	Flow Rate	Ratio (Fraction) (4)			
G	User's Choice (1)		Glass, Viewing Device (9)		
H	Hand				High (7, 15, 16)
I	Current (Electrical)		Indicate (10)		
J	Power	Scan (7)			
K	Time, Time Schedule	Time Rate of Change (4, 21)		Control Station (22)	
L	Level		Light (11)		Low (7, 15, 16)
M	User's Choice (1)	Momentary (4)			Middle, Intermediate (7,15)
N	User's Choice (1)		User's Choice (1)	User's Choice (1)	User's Choice (1)
O	User's Choice (1)		Orifice, Restriction		
P	Pressure, Vacuum		Point (Test) Connection		
Q	Quantity	Integrate, Totalize (4)			
R	Radiation		Record (17)		
S	Speed, Frequency	Safety (8)		Switch (13)	
T	Temperature			Transmit (18)	
U	Multivariable (6)		Multifunction (12)	Multifunction (12)	Multifunction (12)
V	Vibration, Mechanical Analysis (19)			Valve, Damper, Louver (13)	
W	Weight, Force		Well		
X	Unclassified (2)	X Axis	Unclassified (2)	Unclassified (2)	Unclassified (2)
Y	Event, State or Presence (20)	Y Axis		Relay, Compute, Convert (13, 14, 18)	
Z	Position, Dimension	Z Axis		Driver, Actuator, Unclassified Final Control Element	

NOTE: Numbers in parentheses refer to specific explanatory notes in Section 5.1.

5.3

Table 2 — Typical Letter Combinations

		Controllers				Readout Devices		Switches and Alarm Devices*			Transmitters									
First-Letters	Initiating or Measured Vaiable	Recording	Indicating	Blind	Self-Actuated Control Valves	Recording	Indicating	High**	Low	Comb	Recording	Indicating	Blind	Solenoids, Relays, Computing Devices	Primary Element	Test Point	Well or Probe	Viewing Device, Glass	Safety Device	Final Element
A	Analysis	ARC	AIC	AC		AR	AI	ASH	ASL	ASHL	ART	AIT	AT	AY	AE	AP	AW			AV
B	Burner/Combustion	BRC	BIC	BC		BR	BI	BSH	BSL	BSHL	BRT	BIT	BT	BY	BE		BW	BG		BZ
C	User's Choice																			
D	User's Choice																			
E	Voltage	ERC	EIC	EC		ER	EI	ESH	ESL	ESHL	ERT	EIT	ET	EY	EE					EZ
F	Flow Rate	FRC	FIC	FC	FCV, FICV	FR	FI	FSH	FSL	FSHL	FRT	FIT	FT	FY	FE	FP		FG		FV
FQ	Flow Quantity	FQRC	FQIC			FQR	FQI	FQSH	FQSL			FQIT	FQT	FQY	FQE					FQV
FF	Flow Ratio	FFRC	FFIC	FFC		FFR	FFI	FFSH	FFSL						FE					FFV
G	User's Choice																			
H	Hand		HIC	HC						HS										HV
I	Current	IRC	IIC			IR	II	ISH	ISL	ISHL	IRT	IIT	IT	IY	IE					IZ
J	Power	JRC	JIC			JR	JI	JSH	JSL	JSHL	JRT	JIT	JT	JY	JE					JV
K	Time	KRC	KIC	KC	KCV	KR	KI	KSH	KSL	KSHL	KRT	KIT	KT	KY	KE					KV
L	Level	LRC	LIC	LC	LCV	LR	LI	LSH	LSL	LSHL	LRT	LIT	LT	LY	LE		LW	LG		LV
M	User's Choice																			
N	User's Choice																			
O	User's Choice																			
P	Pressure/ Vacuum	PRC	PIC	PC	PCV	PR	PI	PSH	PSL	PSHL	PRT	PIT	PT	PY	PE	PP			PSV, PSE	PV
PD	Pressure, Differential	PDRC	PDIC	PDC	PDCV	PDR	PDI	PDSH	PDSL		PDRT	PDIT	PDT	PDY	PE	PP				PDV
Q	Quantity	QRC	QIC			QR	QI	QSH	QSL	QSHL	QRT	QIT	QT	QY	QE					QZ
R	Radiation	RRC	RIC	RC		RR	RI	RSH	RSL	RSHL	RRT	RIT	RT	RY	RE		RW			RZ
S	Speed/Frequency	SRC	SIC	SC	SCV	SR	SI	SSH	SSL	SSHL	SRT	SIT	ST	SY	SE					SV
T	Temperature	TRC	TIC	TC	TCV	TR	TI	TSH	TSL	TSHL	TRT	TIT	TT	TY	TE	TP	TW		TSE	TV
TD	Temperature, Differential	TDRC	TDIC	TDC	TDCV	TDR	TDI	TDSH	TDSL		TDRT	TDIT	TDT	TDY	TE	TP	TW			TDV
U	Multivariable					UR	UI							UY						UV
V	Vibration/Machinery Analysis					VR	VI	VSH	VSL	VSHL	VRT	VIT	VT	VY	VE					VZ
W	Weight/Force	WRC	WIC	WC	WCV	WR	WI	WSH	WSL	WSHL	WRT	WIT	WT	WY	WE					WZ
WD	Weight/Force, Differential	WDRC	WDIC	WDC	WDCV	WDR	WDI	WDSH	WDSL		WDRT	WDIT	WDT	WDY	WE					WDZ
X	Unclassified																			
Y	Event/State/Presence		YIC	YC		YR	YI	YSH	YSL				YT	YY	YE					YZ
Z	Position/Dimension	ZRC	ZIC	ZC	ZCV	ZR	ZI	ZSH	ZSL	ZSHL	ZRT	ZIT	ZT	ZY	ZE					ZV
ZD	Gauging/Deviation	ZDRC	ZDIC	ZDC	ZDCV	ZDR	ZDI	ZDSH	ZDSL		ZDRT	ZDIT	ZDT	ZDY	ZDE					ZDV

Note: This table is not all-inclusive.
*A, alarm, the annunciating device, may be used in the same fashion as S, switch, the actuating device.

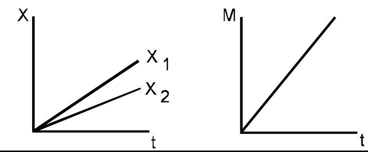
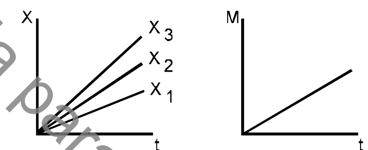
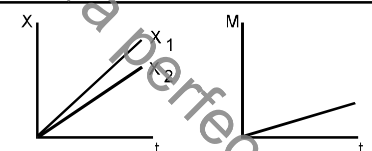
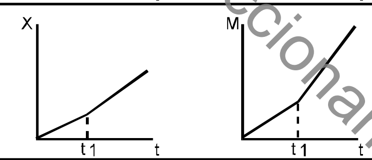
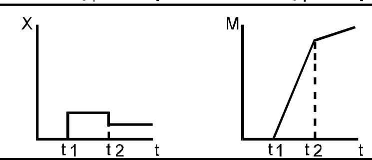
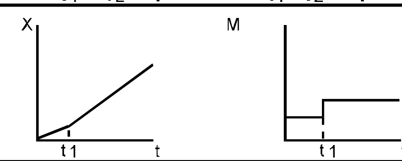
**The letters H and L may be omitted in the undefined case.

Other Possible Combinations:

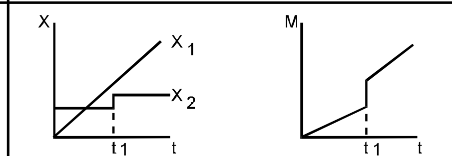
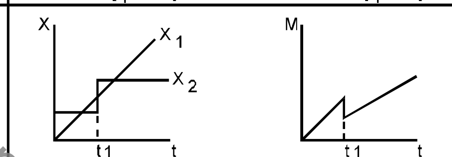
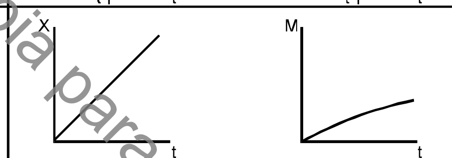
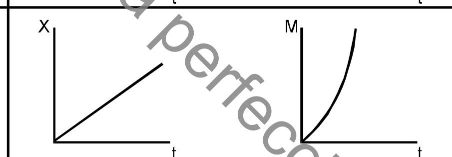
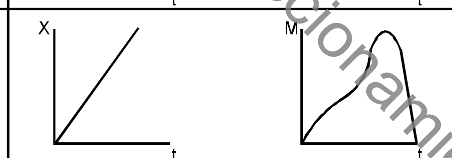
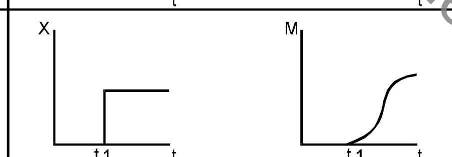
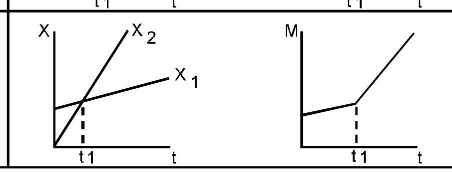
FO	(Restriction Orifice)	PFR	(Ratio)
FRK, HIK	(Control Stations)	KQI	(Running Time Indicator)
FX	(Accessories)	QQI	(Indicating Counter)
TJR	(Scanning Recorder)	WKIC	(Rate-of-Weight-Loss Controller)
LLH	(Pilot Light)	HMS	(Hand Momentary Switch)

Table 3 — Function Blocks - Function Designations

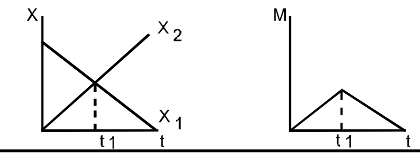
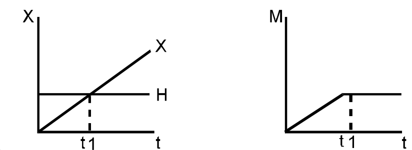
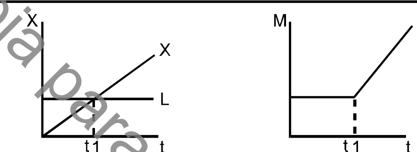
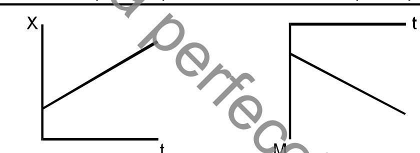
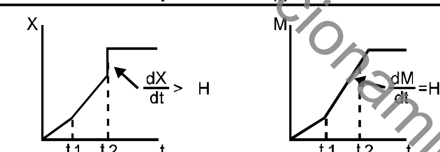
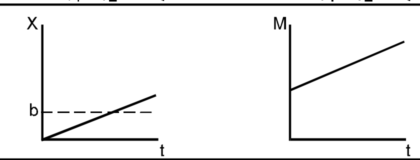
THE FUNCTION DESIGNATIONS ASSOCIATED WITH CONTROLLERS, COMPUTING DEVICES, CONVERTERS AND RELAYS MAY BE USED INDIVIDUALLY OR IN COMBINATION (ALSO, SEE TABLE 1, NOTE 14.). THE USE OF A BOX AVOIDS CONFUSION BY SETTING OFF THE SYMBOL FROM OTHER MARKINGS ON A DIAGRAM AND PERMITS THE FUNCTION TO BE USED AS A STAND-ALONE BLOCK ON CONCEPTUAL DESIGNS.

NO	FUNCTION	SYMBOL	MATH EQUATION	GRAPHIC REPRESENTATION	DEFINITION
1	SUMMING	$\boxed{\Sigma}$	$M = X_1 + X_2 + \ldots + X_n$		THE OUTPUT EQUALS THE ALGEBRAIC SUM OF THE INPUTS. (THE INPUTS MAY BE LABELED WITH POSITIVE OR NEGATIVE SIGNS).
2	AVERAGING	$\boxed{\Sigma/_n}$	$M = \dfrac{X_1 + X_2 + \ldots + X_n}{n}$		THE OUTPUT EQUALS THE ALGEBRAIC SUM OF THE INPUTS DIVIDED BY THE NUMBER OF INPUTS.
3	DIFFERENCE	$\boxed{\Delta}$	$M = X_1 - X_2$		THE OUTPUT EQUALS THE ALGEBRAIC DIFFERENCE OF THE TWO INPUTS.
4	PROPORTIONAL	$\boxed{K}$ $\boxed{1:1}$ $\boxed{2:1}$	$M = KX$		THE OUTPUT IS DIRECTLY PROPORTIONAL TO THE INPUT. IN THE CASE OF A VOLUME BOOSTER, "K" MAY BE REPLACED BY 1:1 FOR INTEGER GAINS, 2:1, 3:1, ETC., MAY BE SUBSTITUTED FOR K.
5	INTEGRAL	$\boxed{\int}$	$M = \dfrac{1}{T_I} \int X dt$		THE OUTPUT VARIES IN ACCORDANCE WITH BOTH MAGNITUDE AND DURATION OF THE INPUT. THE OUTPUT IS PROPORTIONAL TO THE TIME INTEGRAL OF THE INPUT.
6	DERIVATIVE	$\boxed{^d/_{dt}}$	$M = T_D \dfrac{dX}{dt}$		THE OUTPUT IS PROPORTIONAL TO THE RATE OF CHANGE (DERIVATIVE) OF THE INPUT.

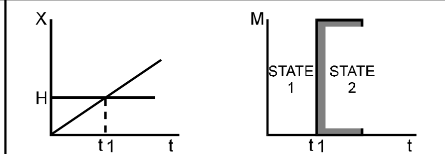
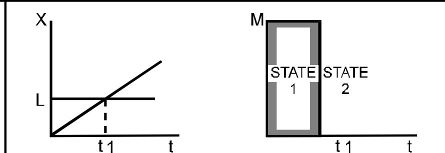
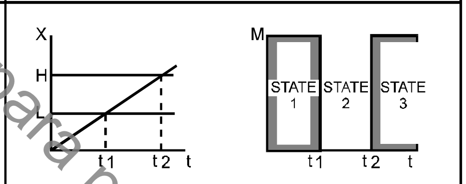
5.4 Table 3 — Continued

NO	FUNCTION	SYMBOL	MATH EQUATION	GRAPHIC REPRESENTATION	DEFINITION
7	MULTIPLYING	X	$M = X_1 X_2$		THE OUTPUT EQUALS THE PRODUCT OF THE TWO INPUTS.
8	DIVIDING	÷	$M = \frac{X_1}{X_2}$		THE OUTPUT EQUALS THE QUOTIENT OF THE TWO INPUTS.
9	ROOT EXTRACTION	$\sqrt[n]{\ }$	$M = \sqrt[n]{X}$		THE OUTPUT EQUALS THE ROOT (I.E., CUBE ROOT, FOURTH ROOT, 3/2 ROOT, ETC.) OF THE INPUT. IF n IS OMITTED, A SQUARE ROOT IS ASSUMED.
10	EXPONENTIAL	X^n	$M = X^n$		THE OUTPUT EQUALS THE INPUT RAISED TO A POWER (I.E., SECOND, THIRD, FOURTH, ETC.).
11	NONLINEAR OR UNSPECIFIED FUNCTION	f (X)	M = f (X)		THE OUTPUT EQUALS SOME NONLINEAR OR UNSPECIFIED FUNCTION OF THE INPUT.
12	TIME FUNCTION	f (t)	M = Xf (t) M = f (t)		THE OUTPUT EQUALS THE INPUT TIMES SOME FUNCTION OF TIME OR EQUALS SOME FUNCTION OF TIME ALONE.
13	HIGH SELECTING	>	$M = \begin{cases} X_1 \text{ FOR } X_1 \geq X_2 \\ X_2 \text{ FOR } X_1 \leq X_2 \end{cases}$		THE OUTPUT IS EQUAL TO THE GREATER OF THE INPUTS.

5.4 Table 3 — Continued

NO	FUNCTION	SYMBOL	MATH EQUATION	GRAPHIC REPRESENTATION	DEFINITION
14	LOW SELECTING	$<$	$M = \begin{cases} X_1 \text{ FOR } X_1 \leq X_2 \\ X_2 \text{ FOR } X_1 \geq X_2 \end{cases}$		THE OUTPUT IS EQUAL TO THE LESSER OF THE INPUTS.
15	HIGH LIMITING	$\not>$	$M = \begin{cases} X \text{ FOR } X \leq H \\ H \text{ FOR } X \geq H \end{cases}$		THE OUTPUT EQUALS THE INPUT OR THE HIGH LIMIT VALUE WHICHEVER IS LOWER.
16	LOW LIMITING	$\not<$	$M = \begin{cases} X \text{ FOR } X \geq L \\ L \text{ FOR } X \leq L \end{cases}$		THE OUTPUT EQUALS THE INPUT OR THE LOW LIMIT VALUE WHICHEVER IS HIGHER.
17	REVERSE PROPORTIONAL	$-K$	$M = -KX$		THE OUTPUT IS REVERSELY PROPORTIONAL TO THE INPUT.
18	VELOCITY LIMITER	$\not\vee$	$\frac{dM}{dt} = \frac{dX}{dt} \begin{cases} \frac{dX}{dt} \leq H \text{ AND} \\ M = X \end{cases}$ $\frac{dM}{dt} = H \begin{cases} \frac{dX}{dt} \geq H \text{ OR} \\ M \neq X \end{cases}$		THE OUTPUT EQUALS THE INPUT AS LONG AS THE RATE OF CHANGE OF THE INPUT DOES NOT EXCEED A LIMIT VALUE. THE OUTPUT WILL CHANGE AT THE RATE ESTABLISHED BY THIS LIMIT UNTIL THE OUTPUT AGAIN EQUALS THE INPUT.
19	BIAS	$+$ $-$ $\pm$	$M = X \pm b$		THE OUTPUT EQUALS THE INPUT PLUS (OR MINUS) SOME ARBITRARY VALUE (BIAS).
20	CONVERT	*/*	OUTPUT = f (INPUT)	NONE	THE FORM OF THE OUTPUT SIGNAL IS DIFFERENT FROM THAT OF THE INPUT. * E - VOLTAGE I - CURRENT P - PNEUMATIC A - ANALOG B - BINARY * H - HYDRAULIC O - ELECTROMAGNETIC, SONIC R - RESISTANCE (ELECT.) D - DIGITAL

5.4 Table 3 — Continued

NO	FUNCTION	SYMBOL	MATH EQUATION	GRAPHIC REPRESENTATION	DEFINITION
21	SIGNAL MONITOR	** H	STATE 1 $X \leq H$ STATE 2 (ENERGIZED OR ALARM STATE) $X > H$		THE OUTPUT HAS DISCRETE STATES WHICH ARE DEPENDENT ON THE VALUE OF THE INPUT. WHEN THE INPUT EXCEEDS (OR BECOMES LESS THAN) AN ARBITRARY LIMIT VALUE THE OUTPUT CHANGES STATE.
		** L	STATE 1 (ENERGIZED OR ALARM STATE) $X < L$ STATE 2 $X \geq L$		
		** HL	STATE 1 (FIRST OUTPUT M_1 ENERGIZED OR ALARM STATE) $X < L$ STATE 2 (BOTH OUTPUTS INACTIVE OR DE-ENERGIZED) $L \leq X \leq H$ STATE 3 (SECOND OUTPUT M_2 ENERGIZED OR ALARM STATE) $X > H$		

THE VARIABLES USED IN THE TABLE ARE:

- b - ANALOG BIAS VALUE.
- $\frac{d}{dt}$ - DERIVATIVE WITH RESPECT TO TIME.
- H - AN ARBITRARY ANALOG HIGH LIMIT VALUE.
- $\frac{1}{T_1}$ - INTEGRATING RATE.
- L - AN ARBITRARY ANALOG LOW LIMIT VALUE.
- M - ANALOG OUTPUT VARIABLE.
- n - NUMBER OF ANALOG INPUTS OR VALUE OF EXPONENT.
- t - TIME
- T_D - DERIVATIVE TIME.
- X - ANALOG INPUT VARIABLE.
- $X_1, X_2, X_3, \ldots\ldots, X_n$ - ANALOG INPUT VARIABLE (1 TO N IN NUMBER).
- * - TABLE 1 LETTER DESIGNATORS.

NOTE: THE SQUARE MAY BE USED AS A FLAG

I-O	ON-OFF
REV	REVERSE ACTION

THIS TABLE HAS BEEN MODIFIED FROM SAMA PMC 22-11-1981 WITH PERMISSION OF THE COPYRIGHT HOLDER, SCIENTIFIC APPARATUS MAKERS ASSOCIATION. COPIES OF PMC 22-11-1981 ARE AVAILABLE FROM ISA, 67 ALEXANDER DR., RESEARCH TRIANGLE PARK, NC 27709; TELEPHONE (919) 549-8411.

6 Drawings

6.1 Cautionary notes

1) If a given drawing, or set of drawings, uses graphic symbols that are similar or identical in shape or configuration and that have different meanings because they are taken from different standards, then adequate steps must be taken to avoid misinterpretation of the symbols used. These steps may be to use caution notes, reference notes, comparison charts that illustrate and define the conflicting symbols, or other suitable means. This requirement is especially critical in cases where symbols taken from different disciplines are intermixed and their misinterpretation might cause danger to personnel or damage to equipment.

2) The titles *Simplified Diagrams, Conceptual Diagrams* and *Detailed Diagrams* of Section 6.12 were chosen to represent a cross section of symbol usage, not any particular generic document. (*See* 4.4.10 for a more complete discussion.)

3) The line symbols of Section 6.2 offer "user's choice" alternative electrical symbols and optional binary symbols. The subsequent examples use one consistent set of these alternatives and apply the binary options. This was done for consistency of appearance of the standard.

It is recommended that the user choose either the dashed line electrical symbol or the triple cross hatch symbol and apply it consistently. The optional binary (on-off) symbols are available for those applications where the user finds it necessary to distinguish between analog and binary signals. If, in the user's judgment, the application does not require such differentiation, the reverse slash may be omitted from on-off signal line symbols. Consistency is recommended on a given set of documents.

6.2 Instrument line symbols

ALL LINES TO BE FINE IN RELATION TO PROCESS PIPING LINES.

(1) INSTRUMENT SUPPLY *
OR CONNECTION TO PROCESS

(2) UNDEFINED SIGNAL

(3) PNEUMATIC SIGNAL **

(4) ELECTRIC SIGNAL

(5) HYDRAULIC SIGNAL

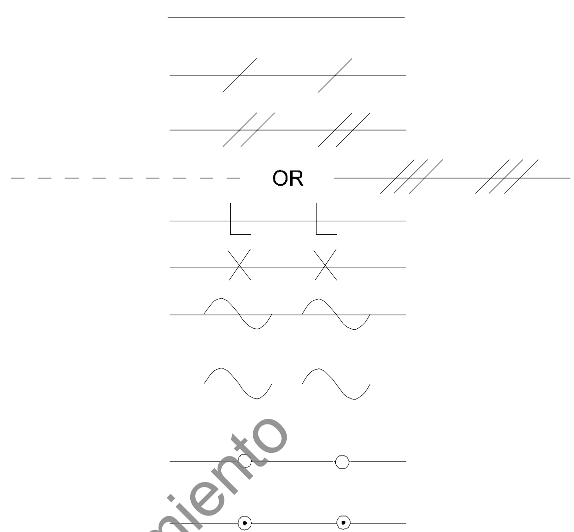
(6) CAPILLARY TUBE

(7) ELECTROMAGNETIC OR SONIC SIGNAL ***
(GUIDED)

(8) ELECTROMAGNETIC OR SONIC SIGNAL ***
(NOT GUIDED)

(9) INTERNAL SYSTEM LINK
(SOFTWARE OR DATA LINK)

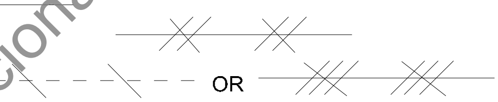
(10) MECHANICAL LINK



OPTIONAL BINARY (ON-OFF) SYMBOLS

(11) PNEUMATIC BINARY SIGNAL

(12) ELECTRIC BINARY SIGNAL



NOTE: 'OR' means user's choice. Consistency is recommended.

* The following abbreviations are suggested to denote the types of power supply. These designations may also be applied to purge fluid supplies.

AS - Air Supply
IA - Instrument Air } Options
PA - Plant Air
ES - Electric Supply
GS - Gas Supply

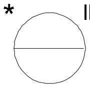
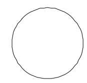
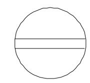
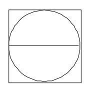
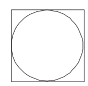
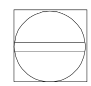
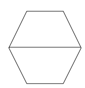
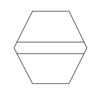
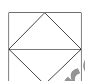
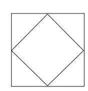
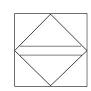
HS - Hydraulic Supply
NS - Nitrogen Supply
SS - Steam Supply
WS - Water Supply

The supply level may be added to the instrument supply line, e.g., AS-100, a 100-psig air supply; ES-24DC, a 24-volt direct current power supply.

** The pneumatic signal symbol applies to a signal using any gas as the signal medium. If a gas other than air is used, the gas may be identified by a note on the signal symbol or otherwise.

*** Electromagnetic phenomena include heat, radio waves, nuclear radiation, and light.

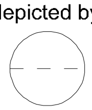
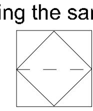
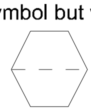
6.3 General instrument or function symbols

	PRIMARY LOCATION ***NORMALLY ACCESSIBLE TO OPERATOR	FIELD MOUNTED	AUXILIARY LOCATION ***NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS	1 * IP1** 	2 	3 
SHARED DISPLAY, SHARED CONTROL	4 	5 	6 
COMPUTER FUNCTION	7 	8 	9 
PROGRAMMABLE LOGIC CONTROL	10 	11 	12 

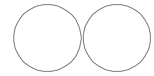
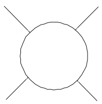
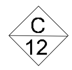
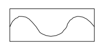
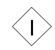
* Symbol size may vary according to the user's needs and the type of document. A suggested square and circle size for large diagrams is shown above. Consistency is recommended.

** Abbreviations of the user's choice such as IP1 (Instrument Panel #1), IC2 (Instrument Console #2), CC3 (Computer Console #3), etc., may be used when it is necessary to specify instrument or function location.

*** Normally inaccessible or behind-the-panel devices or functions may be depicted by using the same symbol but with dashed horizontal bars, i.e.

6.3 General instrument or function symbols (contd.)

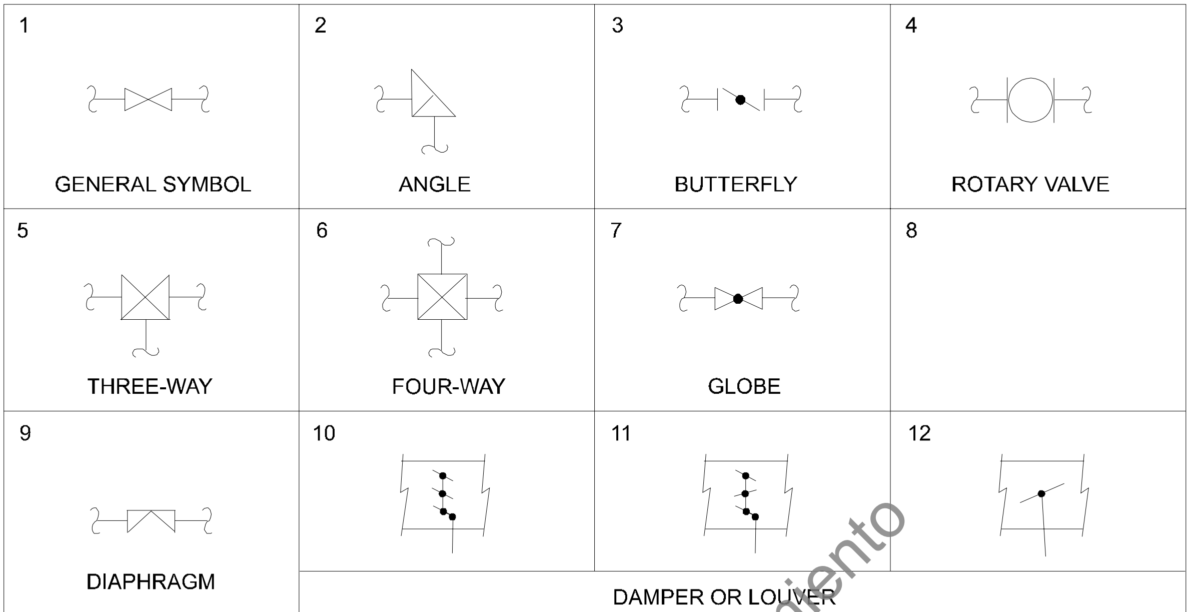
13	14  6TE 2584-23 INSTRUMENT WITH LONG TAG NUMBER	15  INSTRUMENTS SHARING COMMON HOUSING *
16  PILOT LIGHT	17  C 12 PANEL MOUNTED PATCHBOARD POINT 12	18 **  P PURGE OR FLUSHING DEVICE
19 **  R REST FOR LATCH-TYPE ACTUATOR	20  DIAPHRAGM SEAL	21 ** ***  I UNDEFINED INTERLOCK LOGIC

* It is not mandatory to show a common housing.

** These diamonds are approximately half the size of the larger ones.

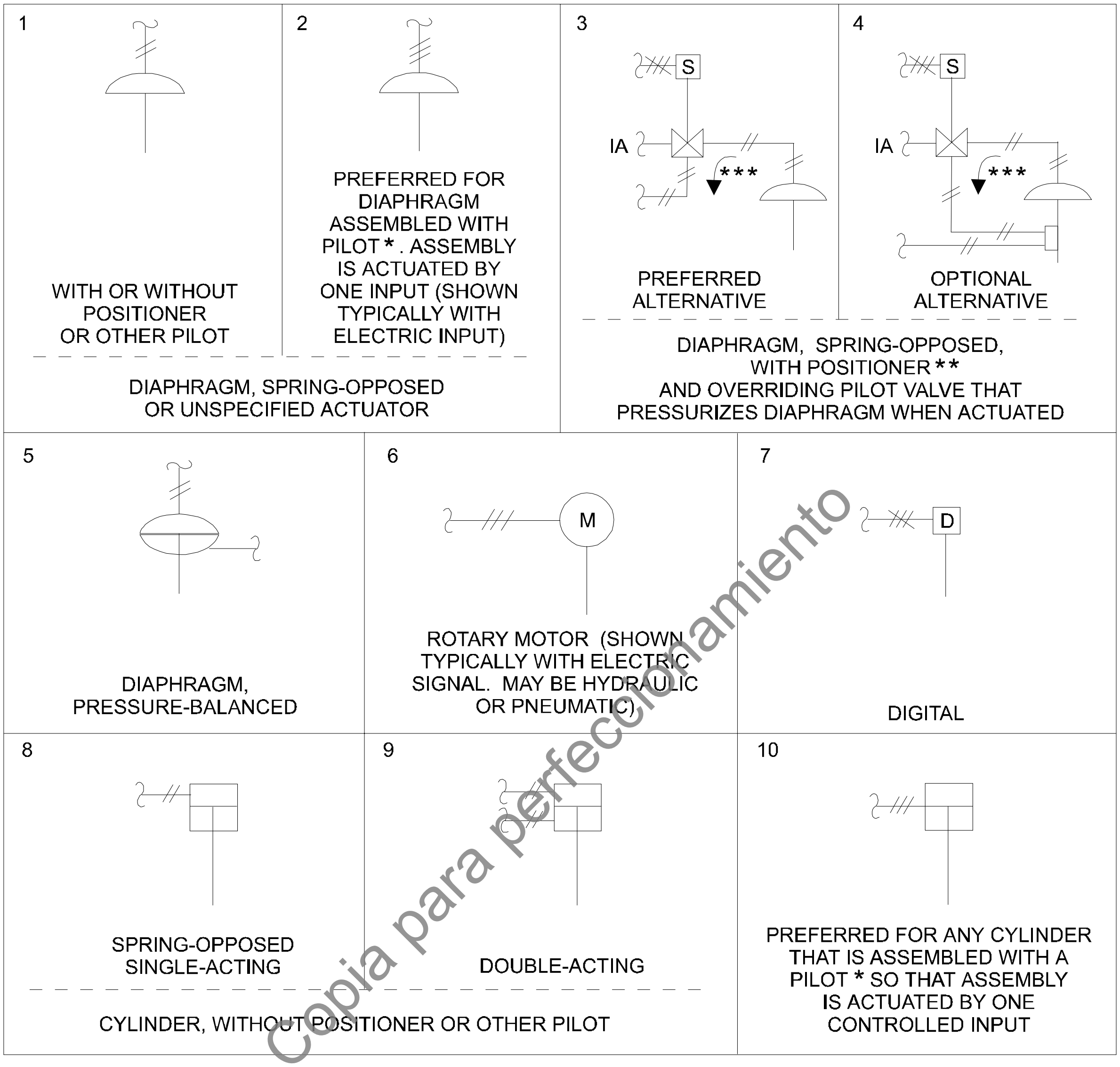
*** For specific logic symbols, see ANSI/ISA Standard S5.2.

6.4 Control valve body symbols, damper symbols



Further information may be added adjacent to the body symbol either by note or code number.

6.5 Actuator symbols

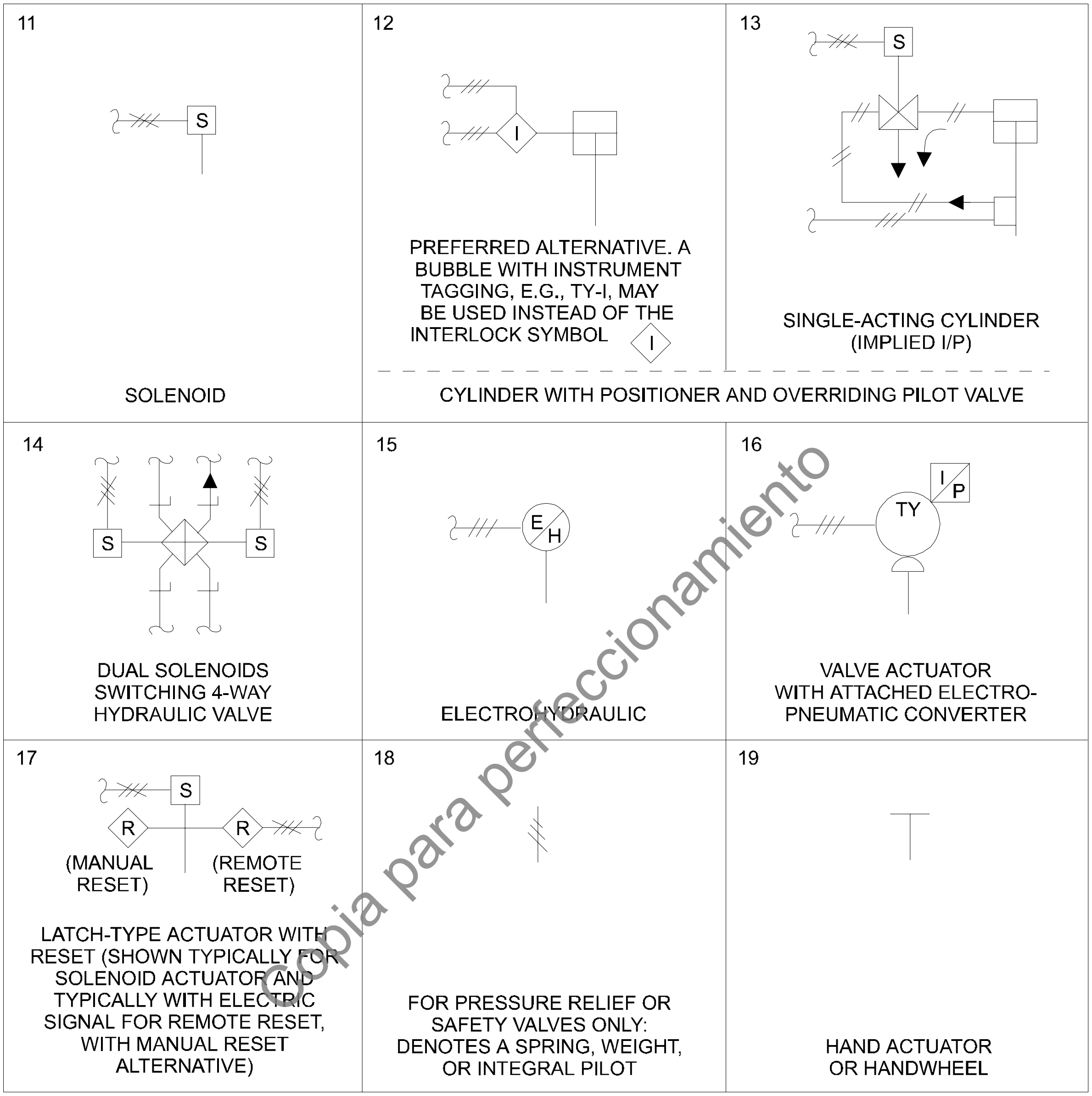


* Pilot may be positioner, solenoid valve, signal converter, etc.

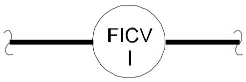
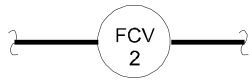
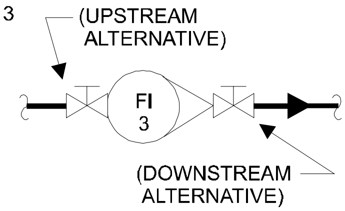
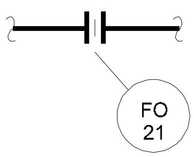
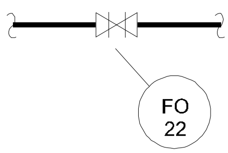
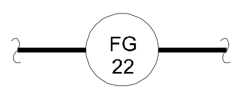
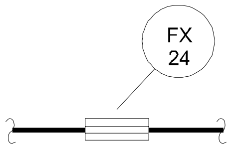
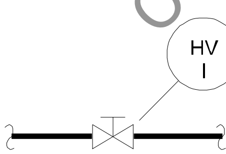
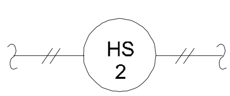
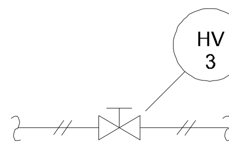
** The positioner need not be shown unless an intermediate device is on its output. The positioner tagging, ZC, need not be used even if the positioner is shown. The positioner symbol, a box drawn on the actuator shaft, is the same for all types of actuators. When the symbol is used, the type of instrument signal, i.e., pneumatic, electric, etc., is drawn as appropriate. If the positioner symbol is used and there is no intermediate device on its output, then the positioner output signal need not be shown.

*** The arrow represents the path from a common to a fail open port. It does not correspond necessarily to the direction of fluid flow.

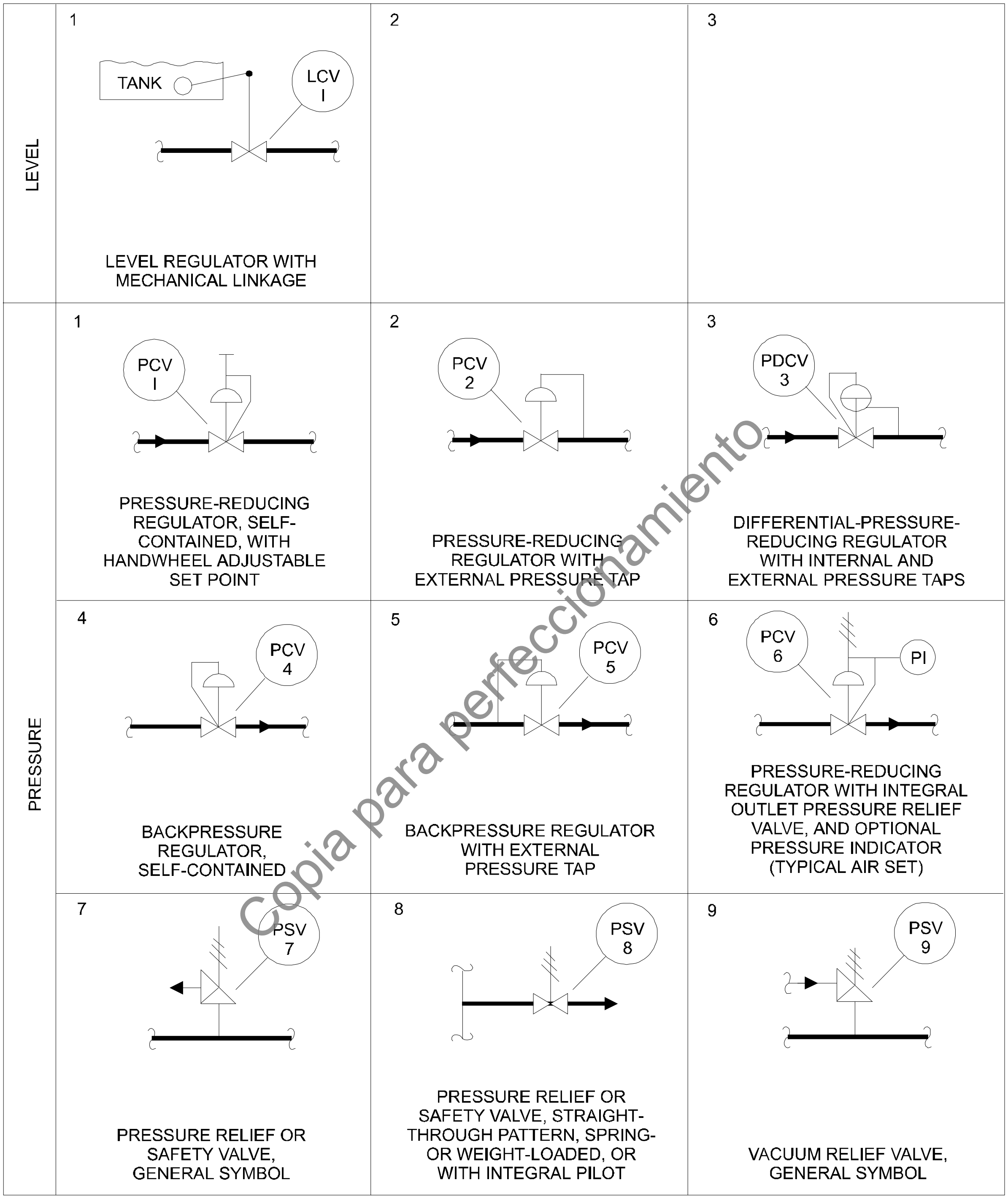
6.5 Actuator symbols (contd.)



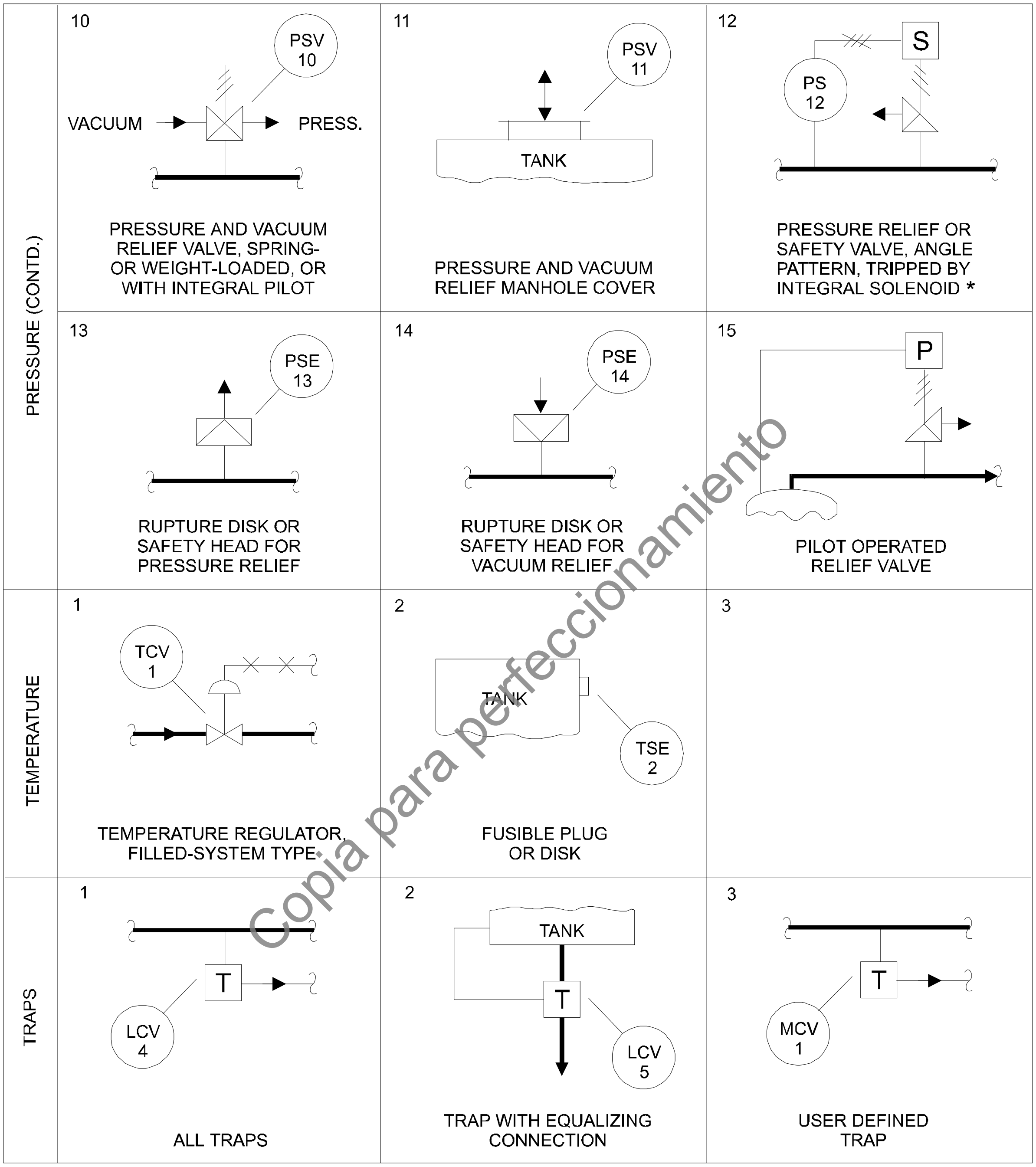
6.6 Symbols for self-actuated regulators, valves, and other devices

FLOW	1  AUTOMATIC REGULATOR WITH INTEGRAL FLOW INDICATION	2  AUTOMATIC REGULATOR WITHOUT INDICATION	3  INDICATING VARIABLE AREA METER WITH INTEGRAL MANUAL THROTTLE VALVE
	4  RESTRICTION ORIFICE (ORIFICE PLATE, CAPILLARY TUBE OR MULTI-STAGE TYPE, ETC.) IN PROCESS LINE	5  RESTRICTION ORIFICE DRILLED IN VALVE (INSTRUMENT TAG NUMBER MAY BE OMITTED IF VALVE IS OTHERWISE IDENTIFIED)	6  FLOW SIGHT GLASS, PLAIN OR WITH PADDLE WHEEL, FLAPPER, ETC.
	7  FLOW STRAIGHTENING VANE (USE OF TAG NUMBER IS OPTIONAL. THE LOOP NUMBER MAY BE THE SAME AS THAT OF THE ASSOCIATED PRIMARY ELEMENT)	8	9
HAND	1  HAND CONTROL VALVE IN PROCESS LINE	2  HAND-ACTUATED ON-OFF SWITCHING VALVE IN PNEUMATIC SIGNAL LINE	3  HAND CONTROL VALVE IN SIGNAL LINE

6.6 Symbols for self-actuated regulators, valves, and other devices (contd.)

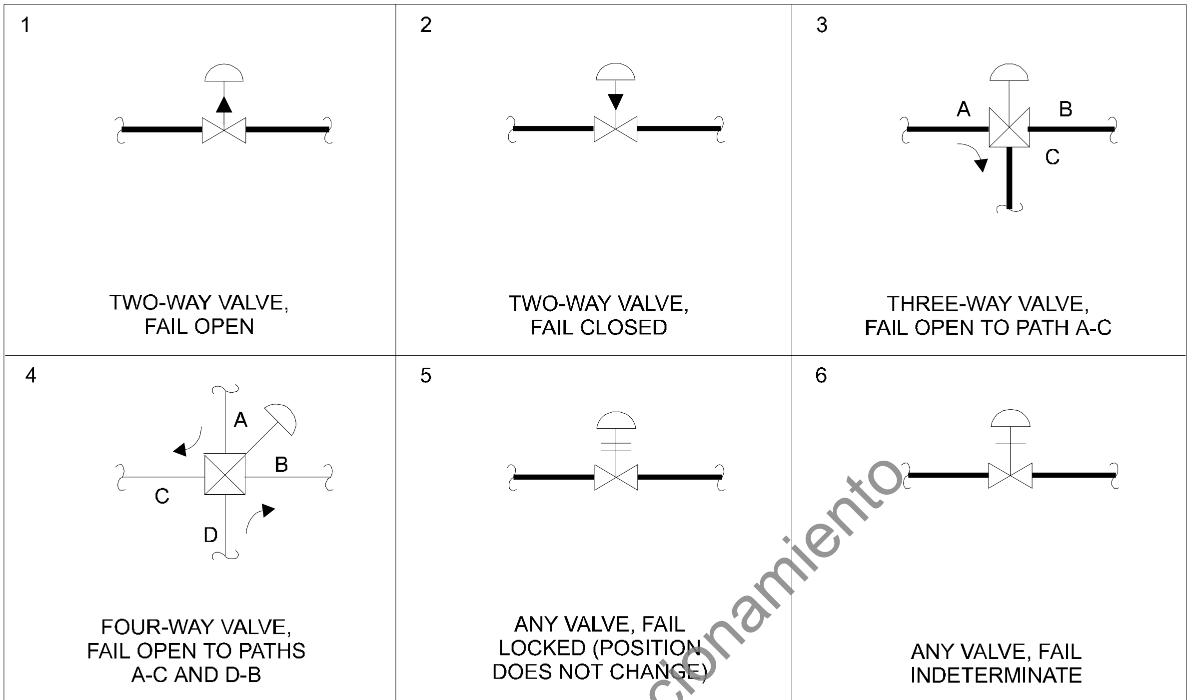


6.6 Symbols for self-actuated regulators, valves, and other devices (contd.)



* The soleniod-tripped pressure relief valve is one of the class of power-actuated relief valves and is grouped with the other types of relief valves even though it is not entirely a self-actuated device.

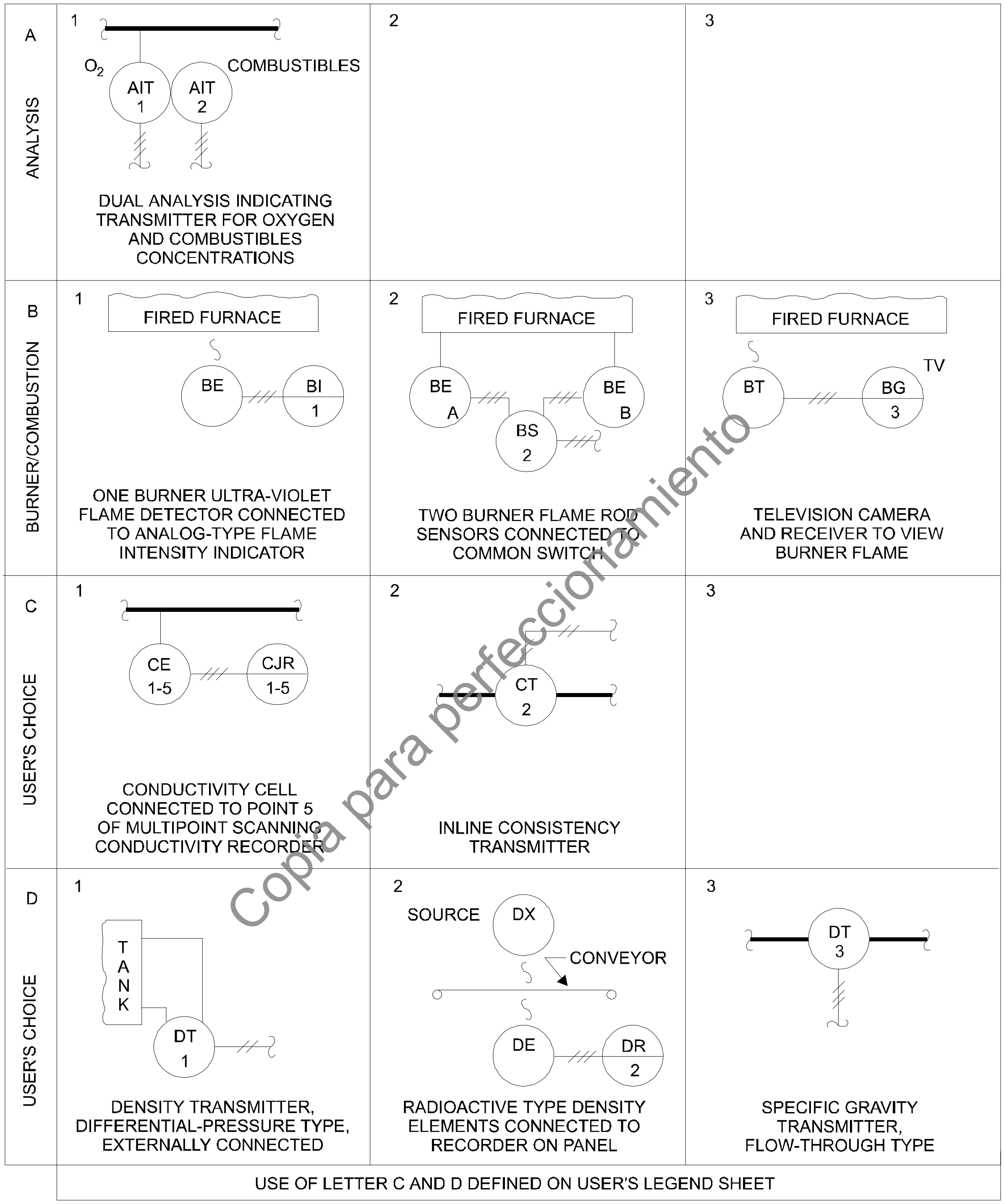
6.7 Symbols for actuator action in event of actuator power failure (shown typically for diaphragm-actuated control valve).



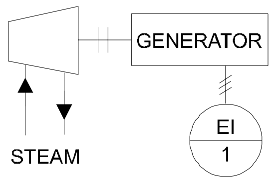
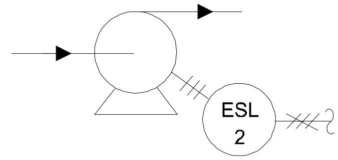
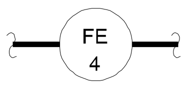
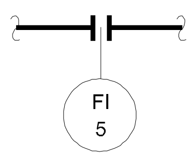
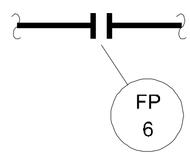
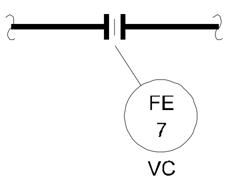
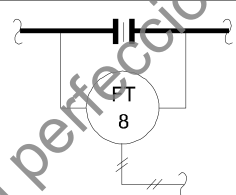
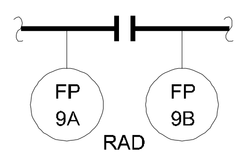
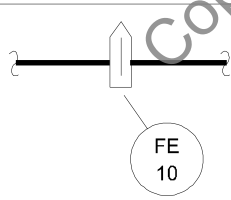
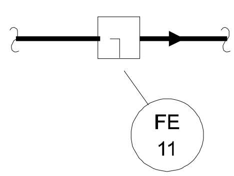
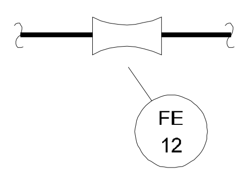
The failure modes indicated are those commonly defined by the term, "shelf-position." As an alternative to the arrows and bars, the following abbreviations may be employed:

FO - Fail Open
FC - Fail Closed
FL - Fail Locked (last position)
FI - Fail Indeterminate

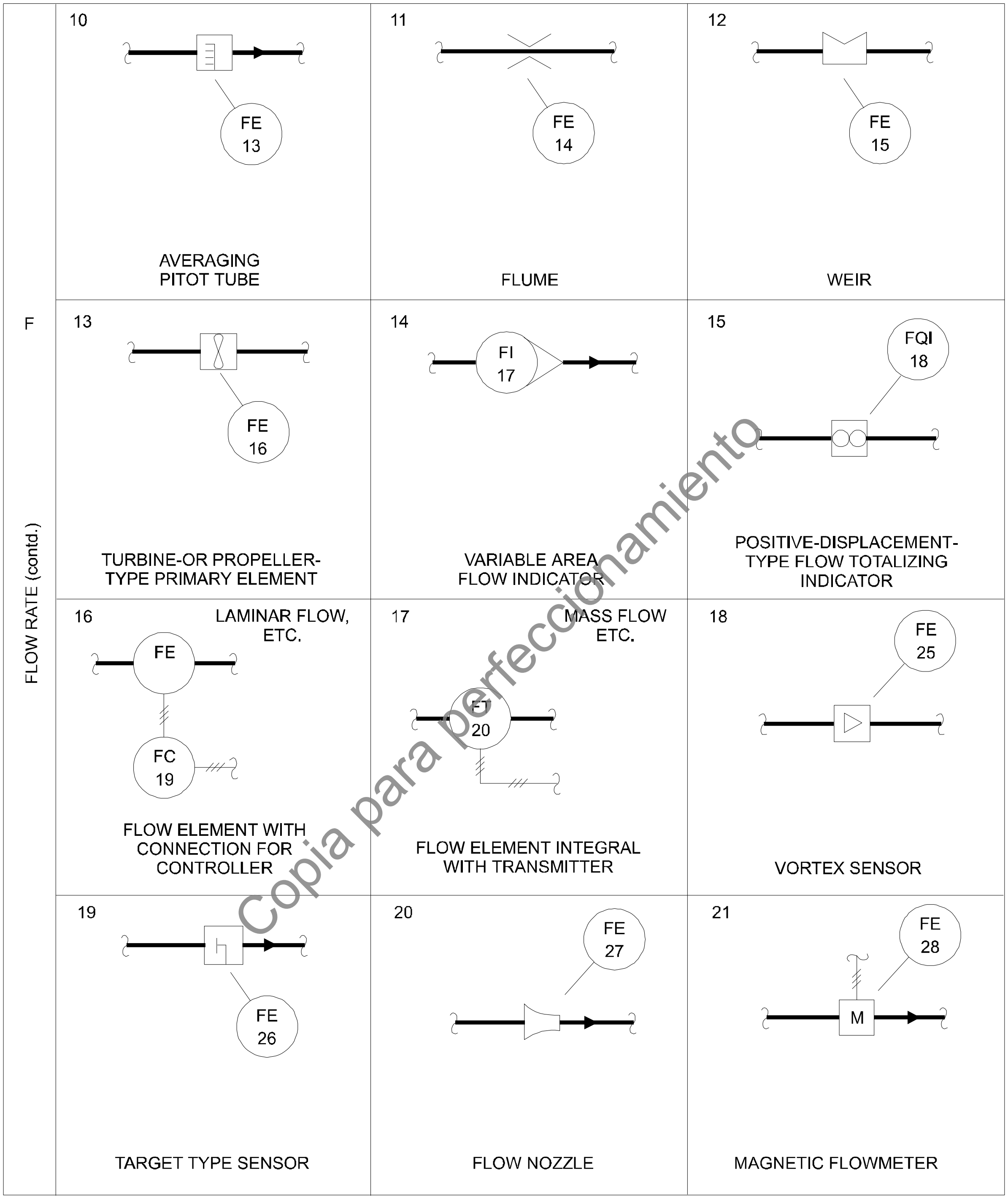
6.8 Primary element symbols



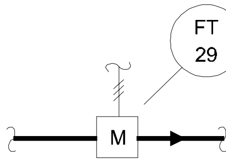
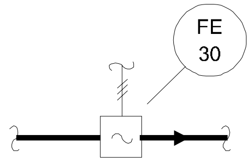
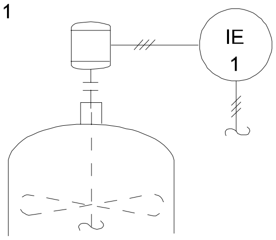
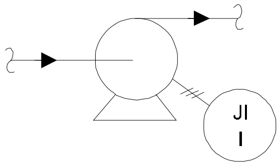
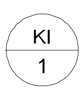
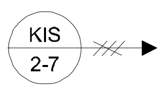
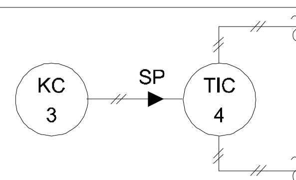
6.8 Primary element symbols (contd.)

	1	2	3
E VOLTAGE	 INDICATING VOLTMETER CONNECTED TO TURBINE-GENERATOR	 LOW-VOLTAGE SWITCH CONNECTED TO PUMP MOTOR	
F FLOW RATE	 GENERAL SYMBOL THE WORDS LAMINAR, ETC., MAY BE ADDED	 ORIFICE PLATE WITH FLANGE OR CORNER TAPS CONNECTED TO DIFFERENTIAL-PRESSURE TYPE FLOW INDICATOR	 FLANGE OR CORNER TAP TEST CONNECTIONS WITHOUT ORIFICE PLATE
	4  ORIFICE PLATE WITH VENA CONTRACTA TAPS	5  ORIFICE PLATE WITH VENA CONTRACTA, RADIUS, OR PIPE TAPS CONNECTED TO DIFFERENTIAL-PRESSURE-TYPE FLOW TRANSMITTER	6  RADIUS TAP TEST CONNECTIONS WITHOUT ORIFICE PLATE
	7  ORIFICE PLATE IN QUICK-CHANGE FITTING	8  SINGLE PORT PITOT TUBE OR PITOT-VENTURI TUBE	9  VENTURI TUBE

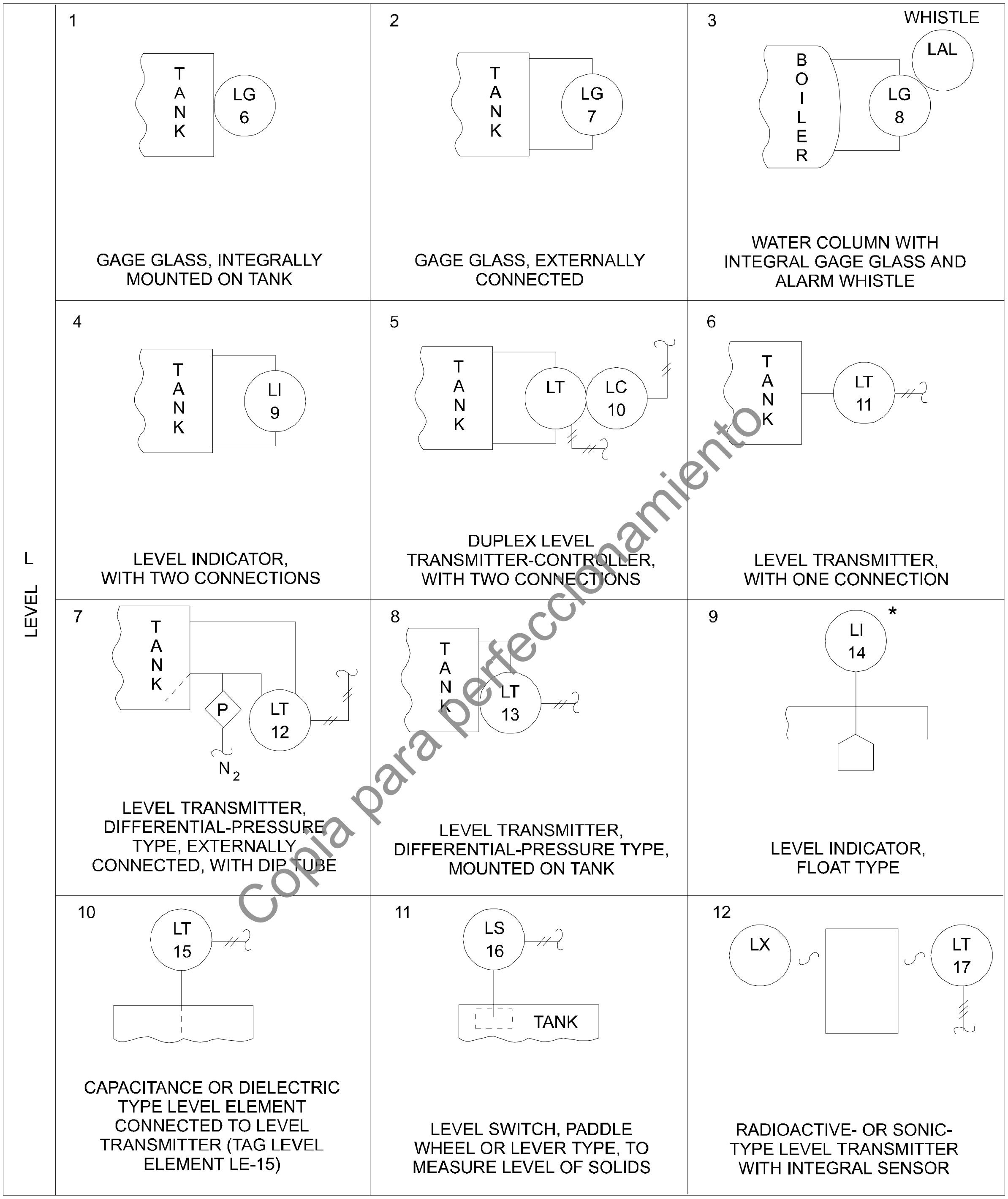
6.8 Primary element symbols (contd.)



6.8 Primary element symbols (contd.)

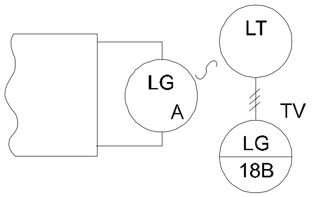
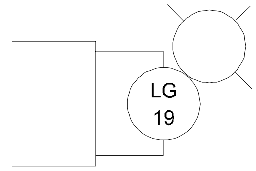
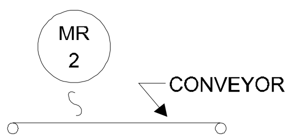
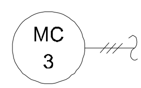
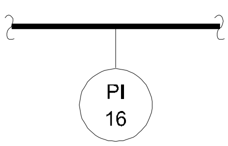
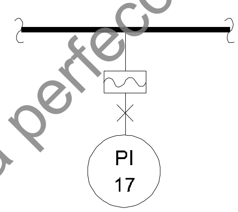
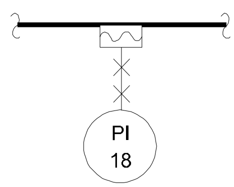
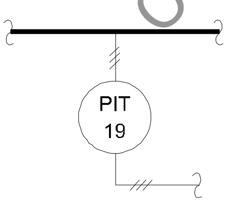
F FLOW RATE (CONTD.)	22  MAGNETIC FLOWMETER WITH INTEGRAL TRANSMITTER	23  SONIC FLOWMETER "DOPPLER" OR "TRANSIT TIME" MAY BE ADDED	24
I CURRENT	1  CURRENT TRANSFORMER MEASURING CURRENT OF ELECTRIC MOTOR	2	3
J POWER	1  INDICATING WATTMETER CONNECTED TO PUMP MOTOR	2	3
K TIME OR TIME-SCHEDULE	1  CLOCK	2  MULTIPOINT ON-OFF TIME SEQUENCING PROGRAMMER POINT 7	3  TIME-SCHEDULE CONTROLLER, ANALOG TYPE, OR SELF-CONTAINED FUNCTION GENERATOR

6.8 Primary element symbols (contd.)

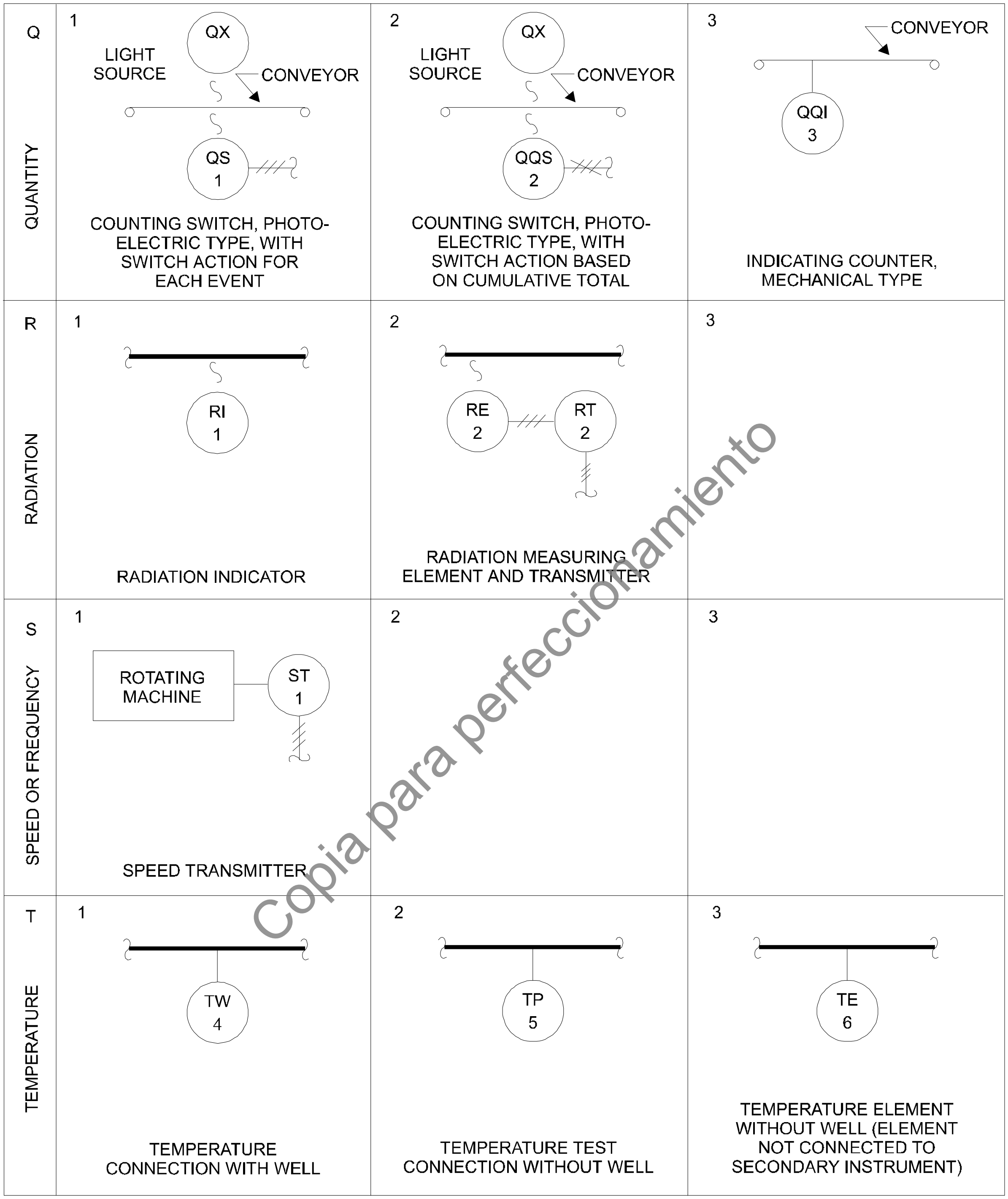


* Notations such as "mounted at grade" may be added.

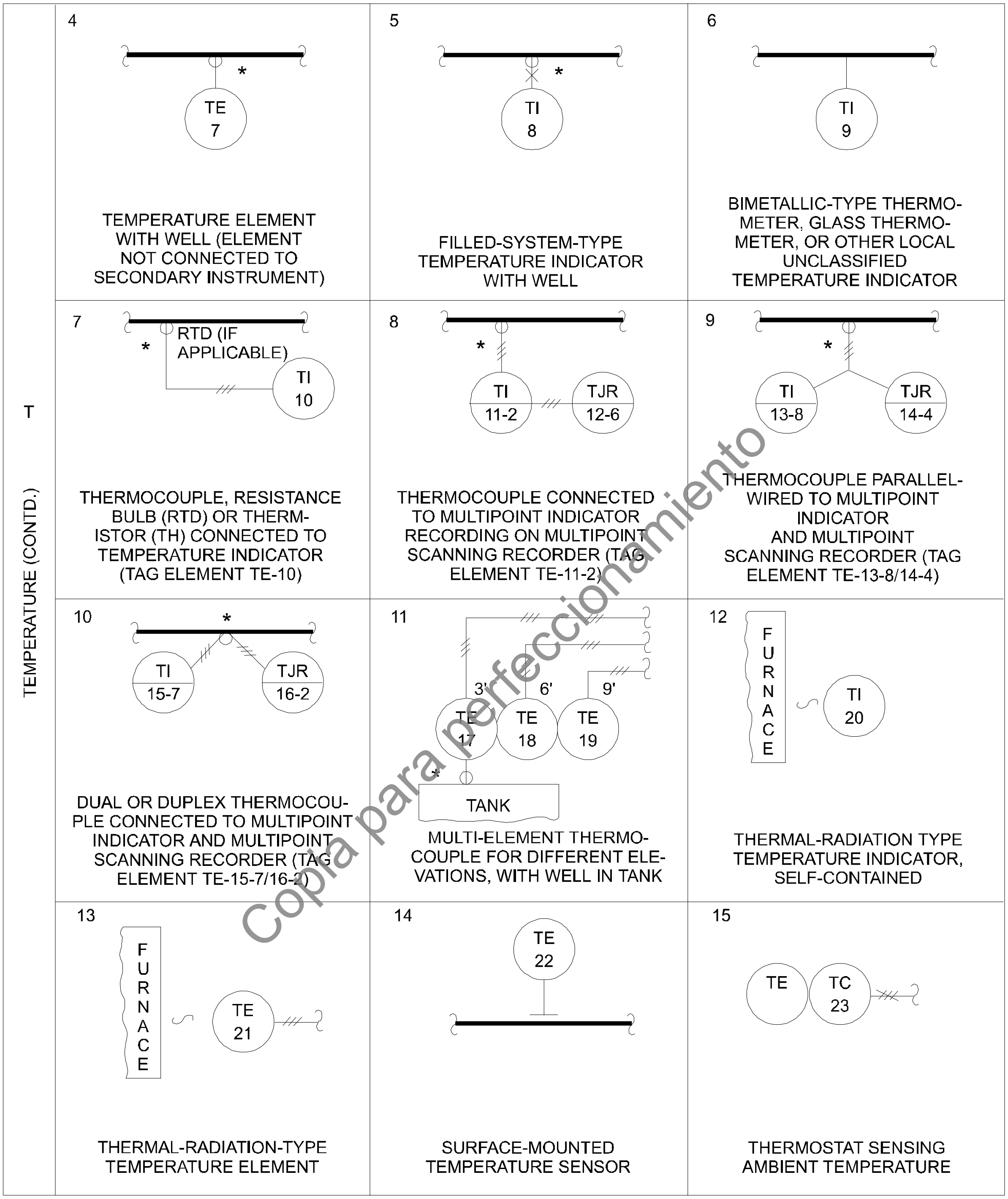
6.8 Primary element symbols (contd.)

L LEVEL (CONTD.)	13  REMOTE VIEWING OF GAGE GLASS BY USE OF TELEVISION	14  LEVEL GLASS WITH ILLUMINATOR	15
M USER'S CHOICE	1  MOISTURE RECORDER (IF THERE IS A SEPARATE PRIMARY ELEMENT, IT SHOULD BE TAGGED ME-2)	2  SELF-CONTAINED HUMIDITY CONTROLLER IN ROOM	
	USE OF LETTER M TO BE DEFINED IN USER'S LEGEND		
P PRESSURE OR VACUUM	1  PRESSURE INDICATOR, DIRECT-CONNECTED	2  WITH PRESSURE LEAD LINE	3  LINE-MOUNTED
		PRESSURE INDICATOR CONNECTED TO DIAPHRAGM SEAL WITH FILLED SYSTEM	
	4  PRESSURE ELEMENT, STRAIN-GAGE TYPE, CONNECTED TO PRESSURE INDICATING TRANSMITTER (TAG STRAIN GAGE PE-19)	5	6

6.8 Primary element symbols (contd.)

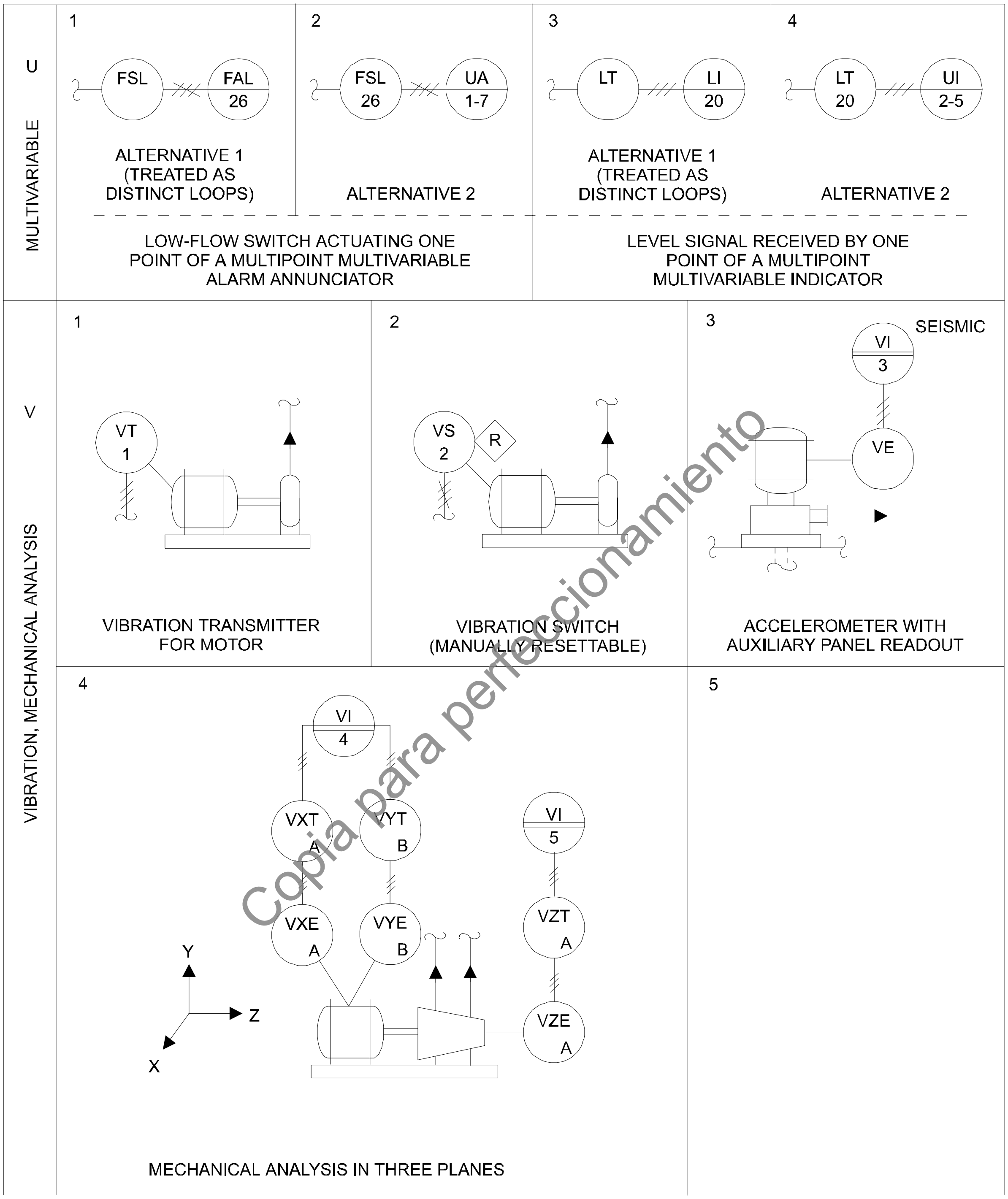


6.8 Primary element symbols (contd.)

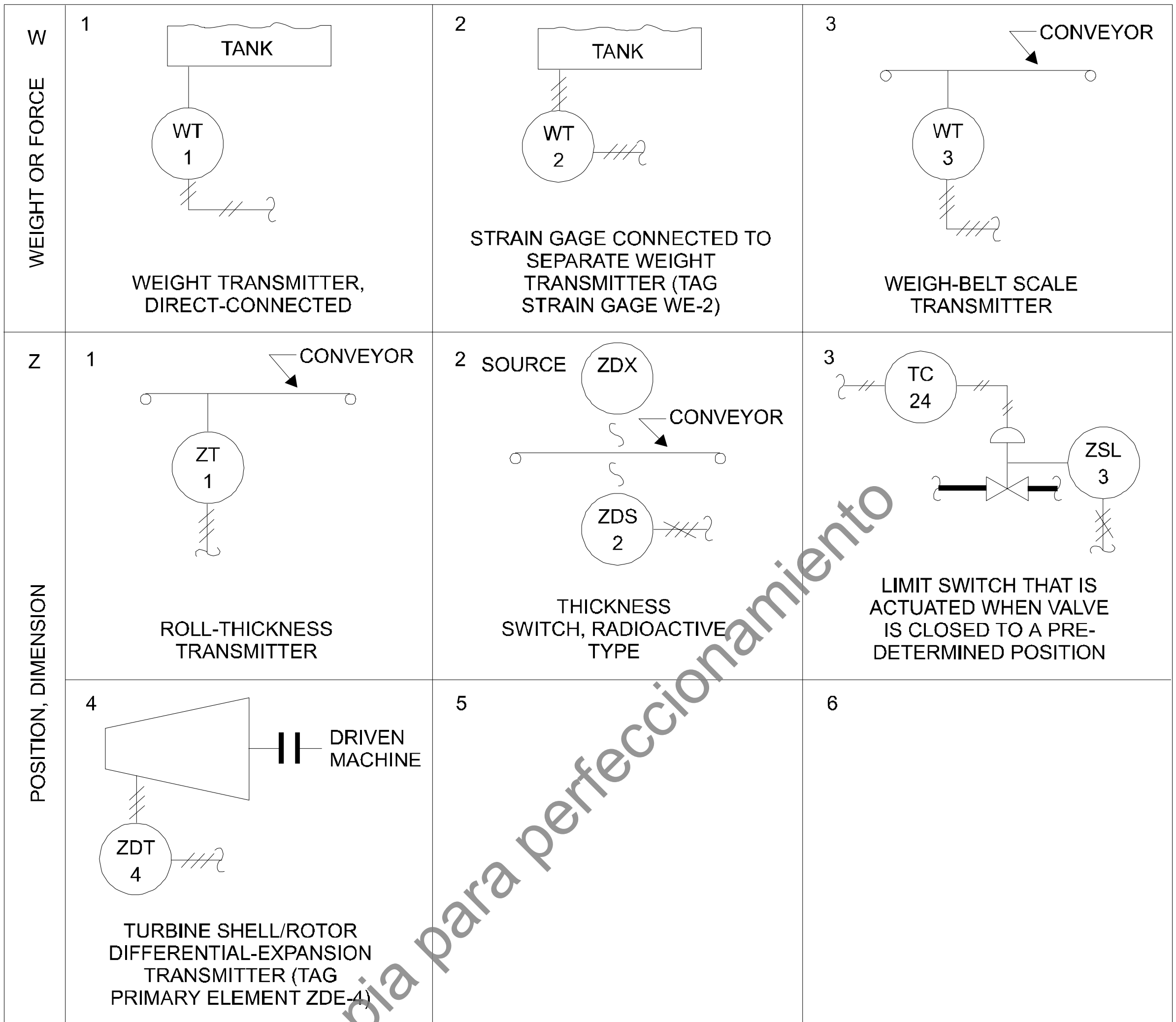


* Use of the thermowell symbol is optional. However, use or omission of the symbol should be consistent throughout a project.

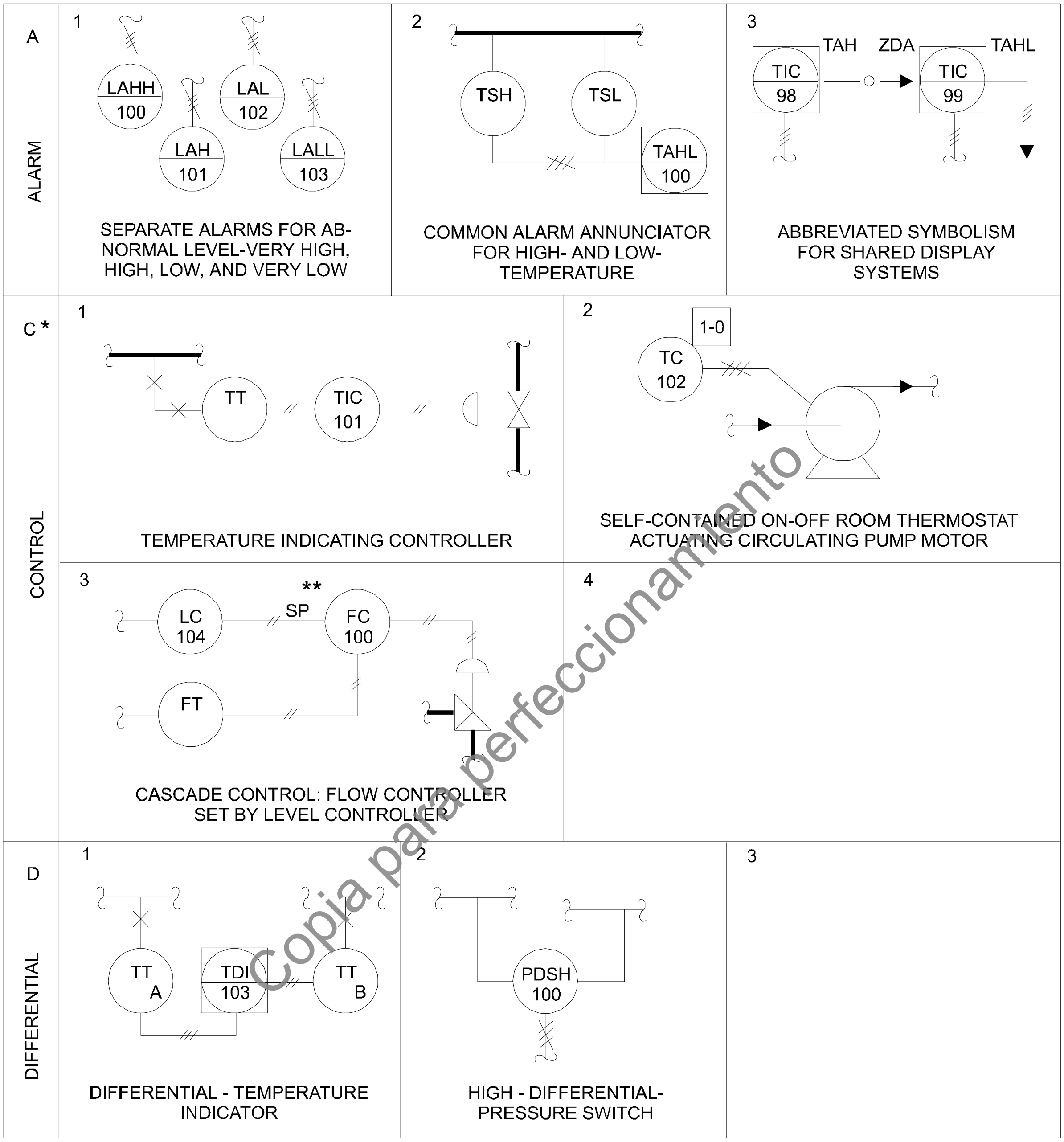
6.8 Primary element symbols (contd.)



6.8 Primary element symbols (contd.)



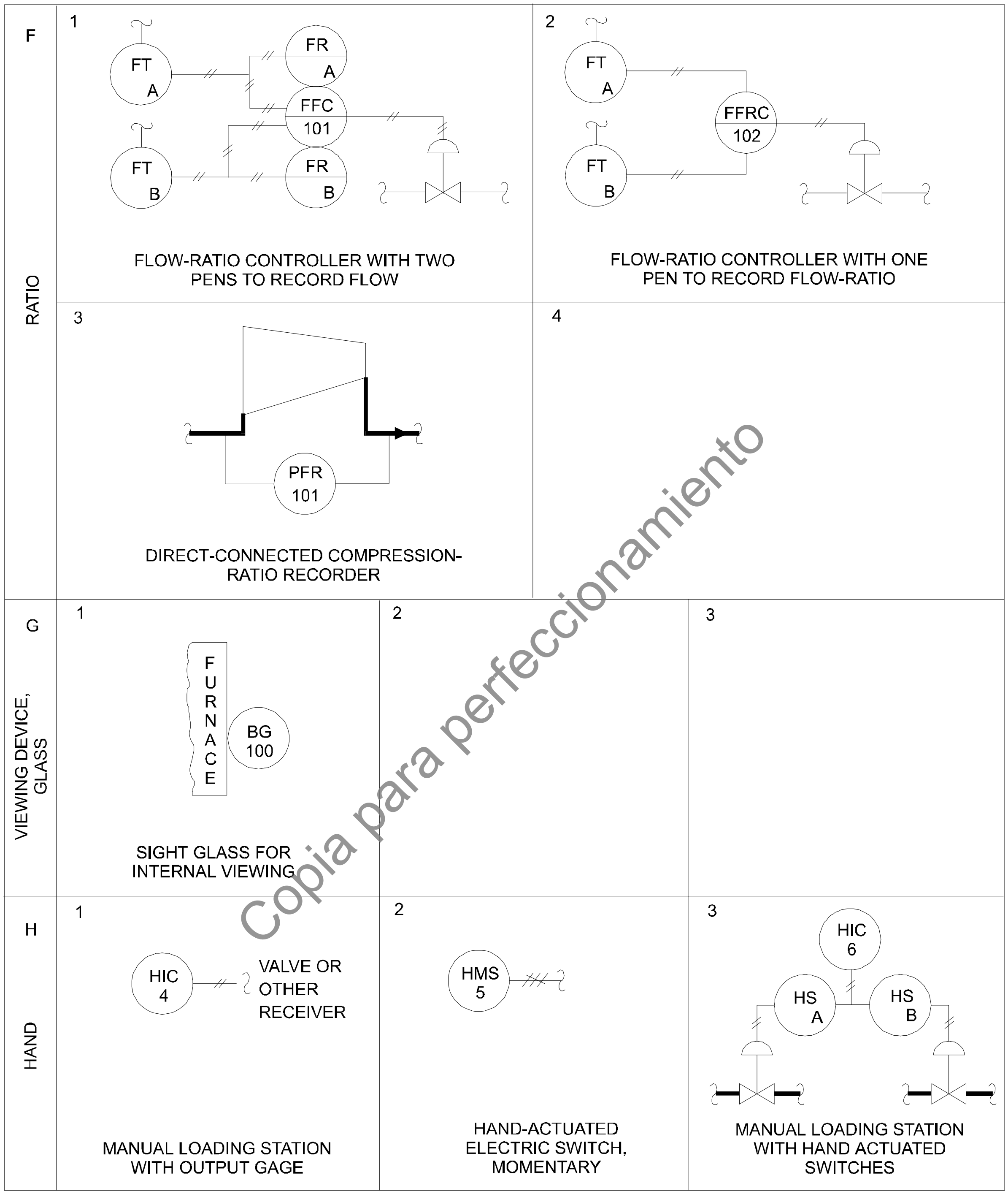
6.9 Examples — functions



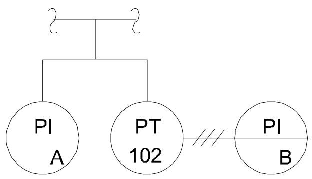
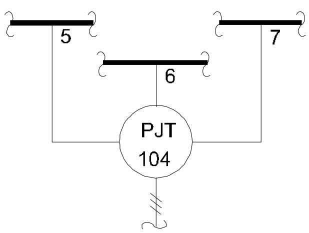
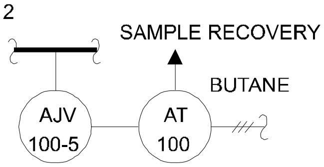
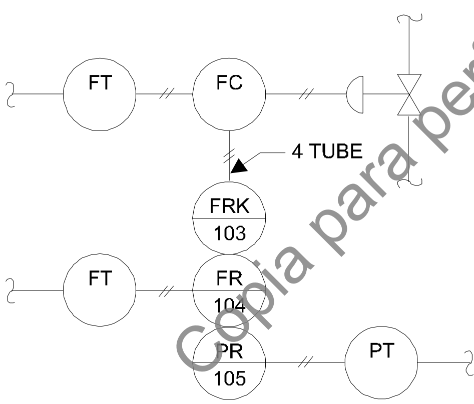
* It is expected that control modes will not be designed on a diagram. However, designations may be used outside the controller symbol, if desired, in combinations such as $\boxed{\%}$, $\boxed{\int}$, $\boxed{\text{1-0}}$.

** A controller is understood to have integral manual set-point adjustment unless means of remote adjustment is indicated. The remote set-point designation is SP.

6.9 Examples — functions (contd.)



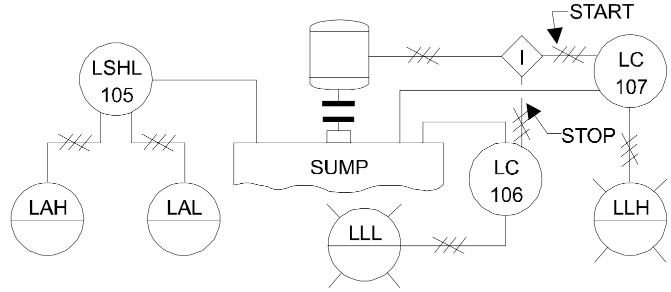
6.9 Examples — functions (contd.)

	1	2	3
I INDICATE	 LOCAL PRESSURE INDICATOR AND PRESSURE TRANSMITTER WITH COMMON TAP AND PANEL-MOUNTED PRESSURE INDICATOR		
J SCAN	 PRESSURE-SCANNING TRANSMITTER CONNECTED TO PROCESS POINTS 5,6,7	 SAMPLE LINE CONNECTED TO BUTANE-CONCENTRATION TRANSMITTER THROUGH EXTERNAL SAMPLE-SCANNING VALVE	
K CONTROL STATION	 RECORDING FLOW CONTROL STATION PANEL MOUNTED, WITH ADDITIONAL FLOW AND PRESSURE PENS, AND LOCAL CONTROLLER		

6.9 Examples — functions (contd.)

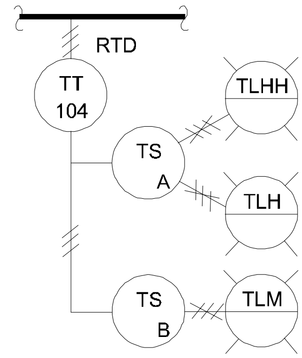
L — LIGHT OR LOW

1



DIFFERENTIAL-GAP CONTROL OF SUMP LEVEL THROUGH STARTING AND STOPPING SUMP PUMP BY LC-107 AND LC-106 THAT ALSO ACTUATE HIGH- AND LOW-LEVEL PILOT LIGHTS. HIGH- AND LOW-LEVEL ALARMS ARE ACTUATED BY LSHL-105

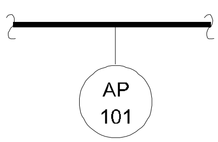
2



PILOT LIGHTS TO SIGNAL THAT TEMPERATURE HAS RISEN TO INTERMEDIATE, HIGH, AND VERY HIGH VALUES

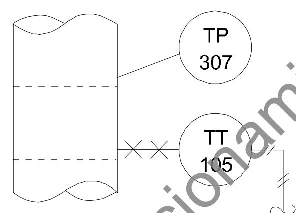
P — POINT

1



ANALYSIS TEST SAMPLE POINT

2

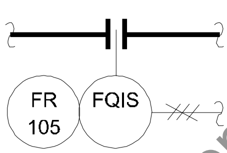


DISTILLATION COLUMN WITH CONNECTION FOR ALTERNATIVE LOCATION OF SENSOR

3

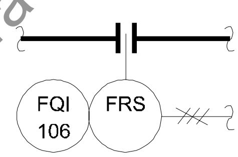
Q — INTEGRATE OR TOTALIZE

1



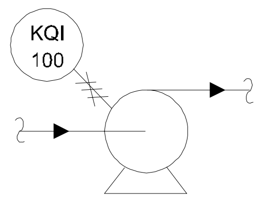
DIFFERENTIAL-PRESSURE-TYPE FLOW METER WITH (1) RECORDING OF FLOW RATE, (2) INDICATION OF INTEGRATED FLOW, AND (3) SWITCH ACTUATED BY INTEGRATED FLOW.

2



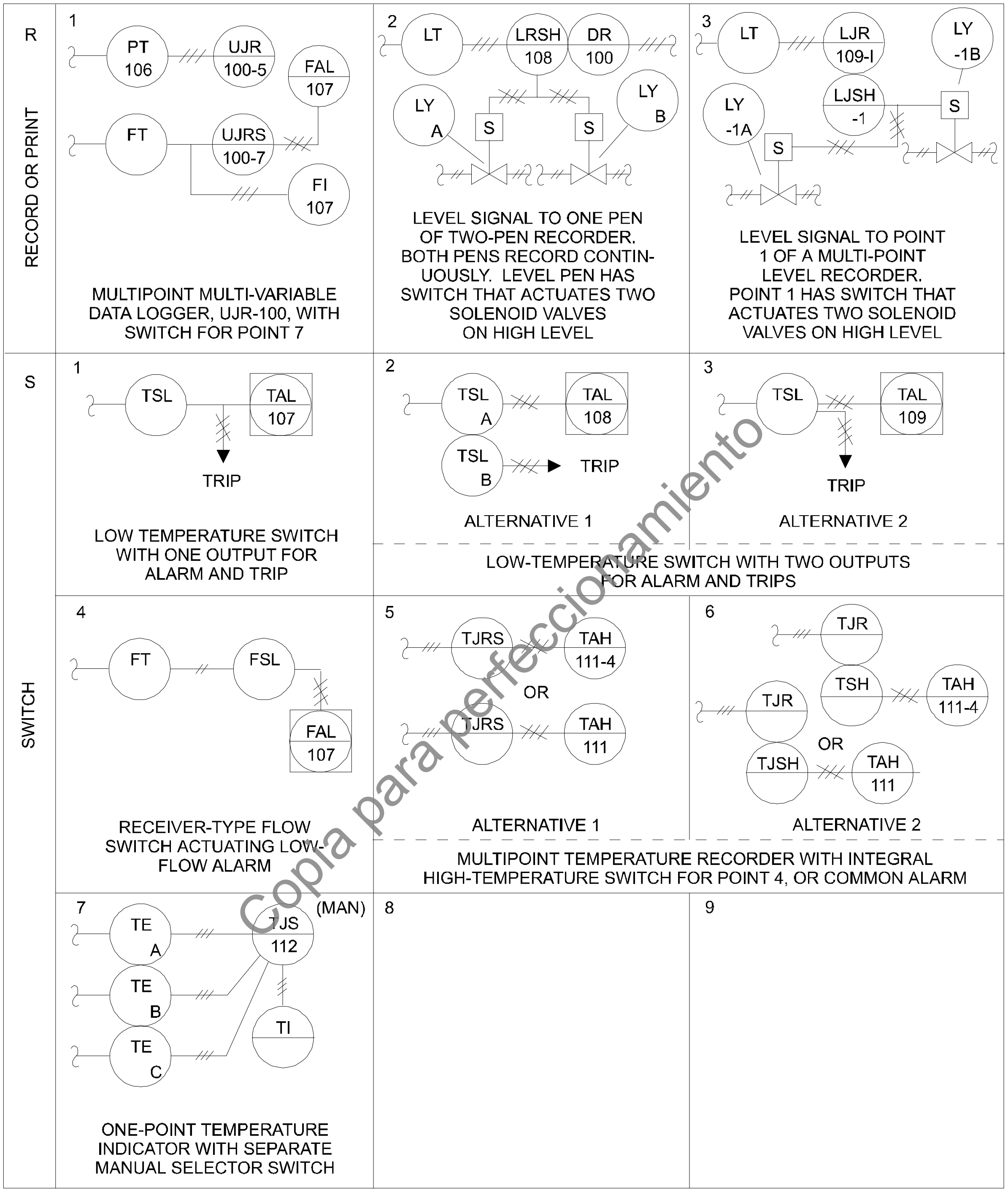
DIFFERENTIAL-PRESSURE-TYPE FLOW METER WITH (1) RECORDING OF FLOW RATE, (2) INDICATION OF INTEGRATED FLOW, AND (3) SWITCH ACTUATED BY FLOW RATE.

3

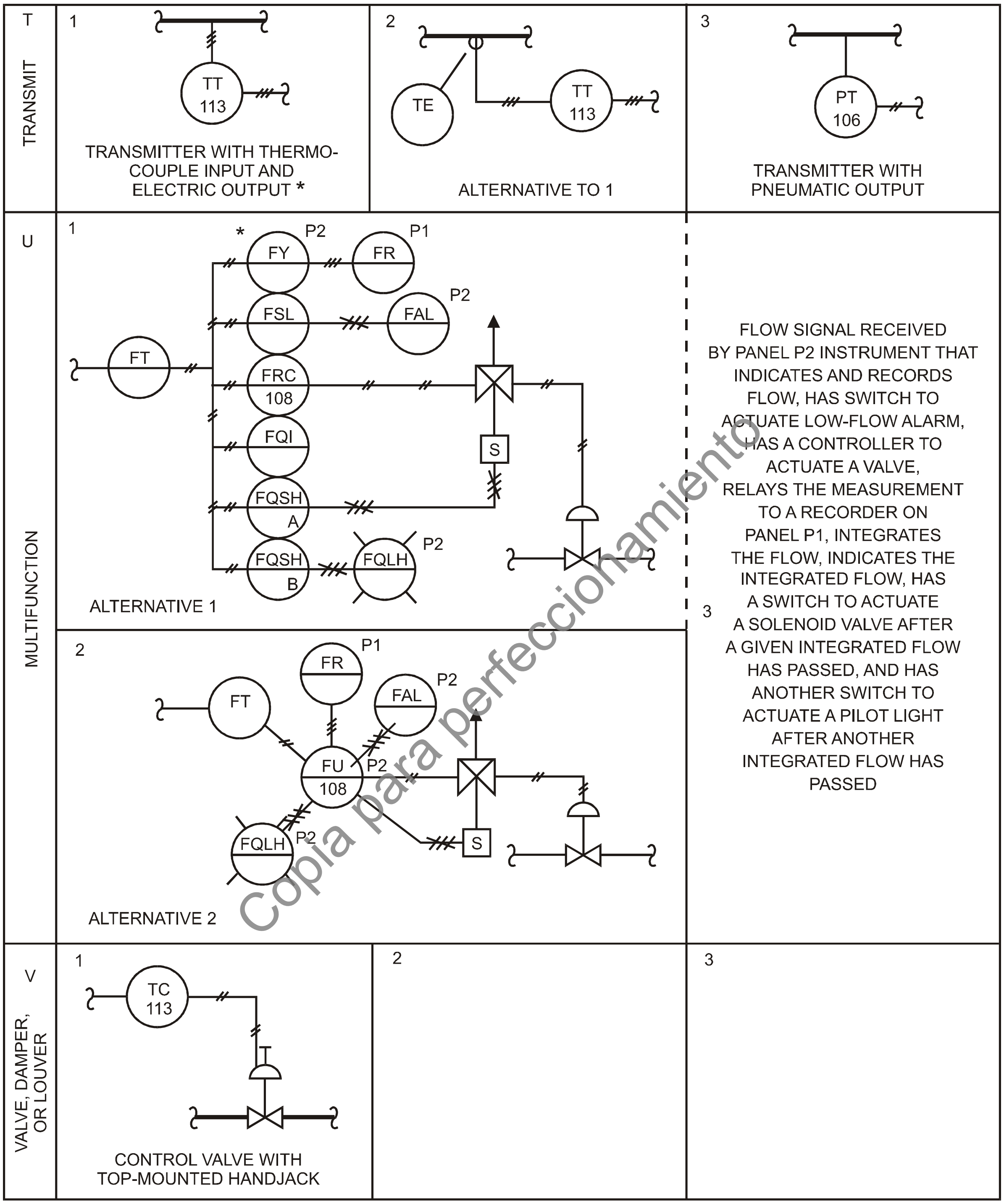


RUNNING-TIME TOTALIZER CONNECTED TO PUMP MOTOR

6.9 Examples — functions (contd.)

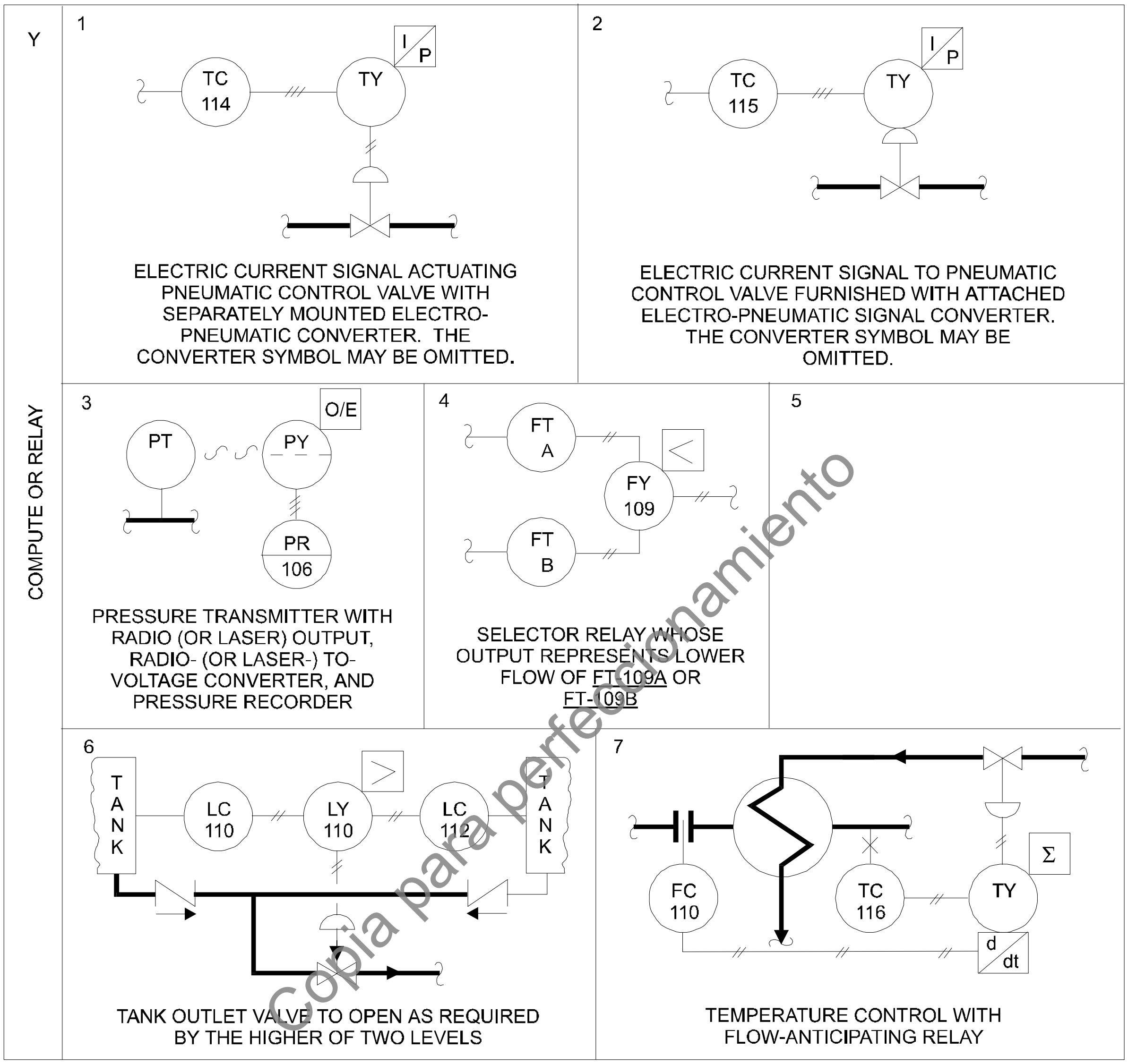


6.9 Examples — functions (contd.)



* See definition of converter versus transmitter.

6.9 Examples — functions (contd.)

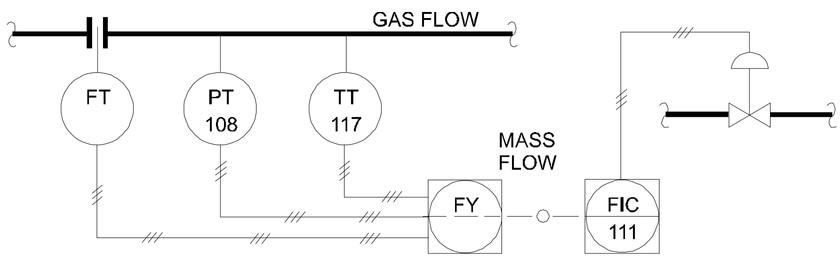


6.9 Examples — functions (contd.)

Y

COMPUTE OR RELAY (contd.)

8

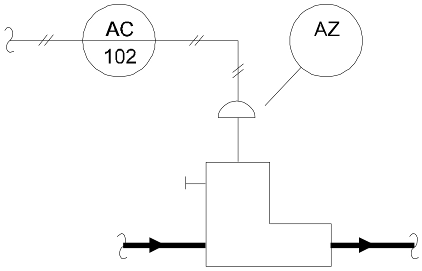


MASS-FLOW COMPUTATION PERFORMED BY MASS-FLOW COMPUTING RELAY FY-111 HAVING LINEAR INPUTS FOR PRESSURE AND TEMPERATURE AND A NON-LINEAR INPUT FOR FLOW

Z

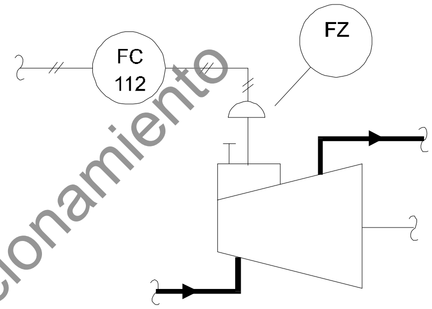
DRIVE, ACTUATE, OR UNCLASSIFIED FINAL CONTROL ELEMENT

1



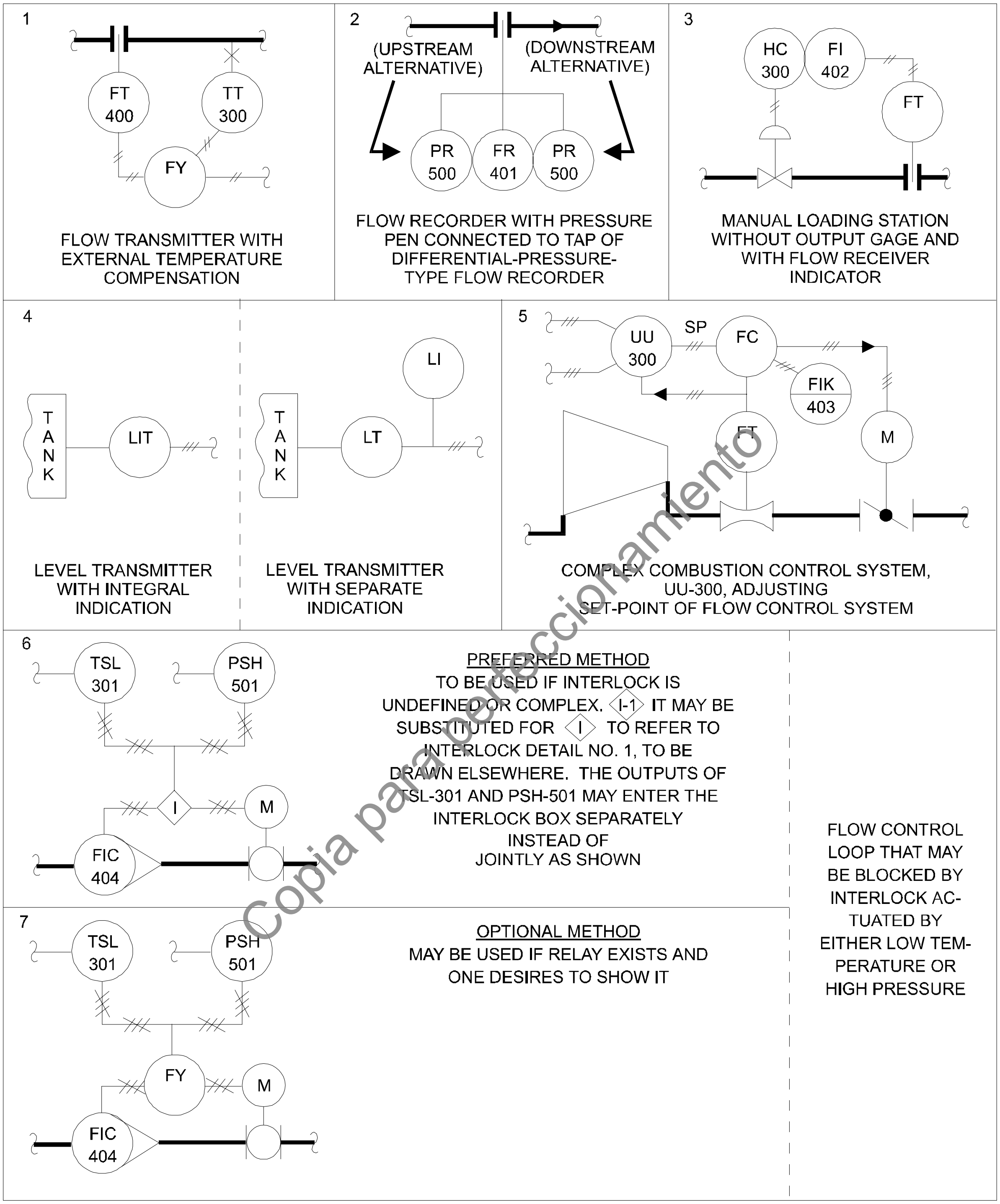
PROPORTIONING PUMP WITH AUTOMATIC AND MANUAL STROKE CONTROL

2



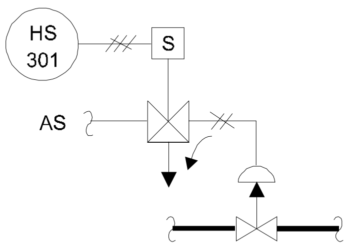
TURBINE WITH AUTOMATIC AND MANUAL SPEED CHANGER

6.10 Examples — miscellaneous combinations



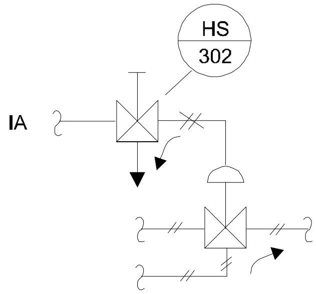
6.10 Examples — miscellaneous combinations (contd.)

8



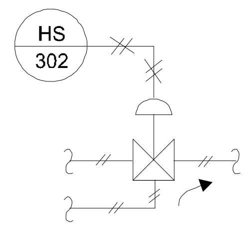
SOLENOID PILOT VALVE
ACTUATED BY HAND SWITCH

9



ALTERNATIVE 1

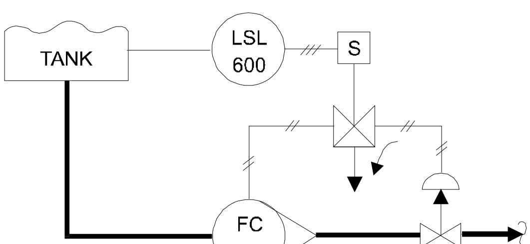
10



ALTERNATIVE 2

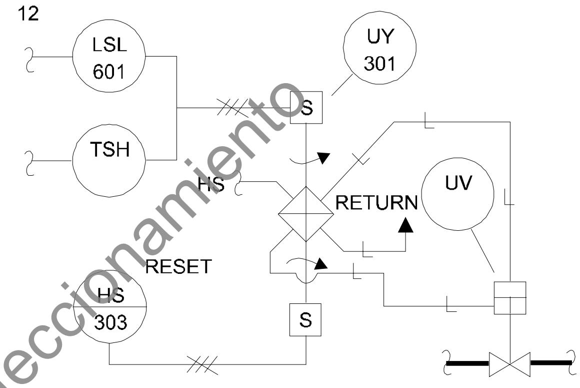
PNEUMATIC PILOT VALVE ACTUATED BY
REMOTE HAND SWITCH

11



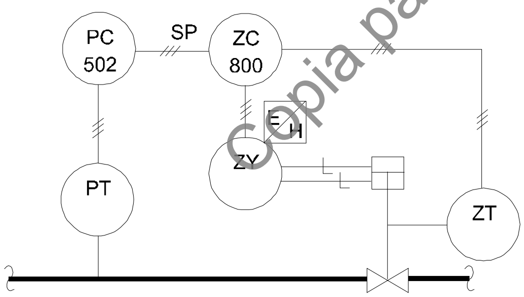
FLOW CONTROL LOOP WITH LOW-LEVEL
INTERLOCK ACTUATED BY LEVEL SWITCH
THE SOLENOID MAY BE TAGGED FY-405

12



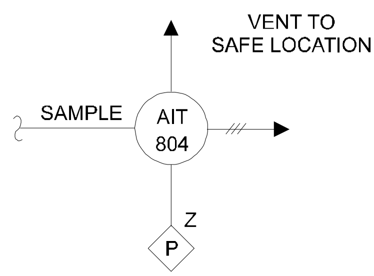
PISTON-ACTUATED ON-OFF VALVE TO CLOSE
ON LOW LEVEL OR HIGH TEMPERATURE AND
TO BE REOPENED BY PUSHBUTTON RESET
OF DOUBLE-COIL SOLENOID VALVE

13



PRESSURE CONTROLLER ACTING THROUGH
SERVO-VALVE ACTING AS VOLTAGE-TO-
HYDRAULIC CONVERTER TO MODULATE
DOUBLE-ACTING-CYLINDER-ACTUATED
CONTROL VALVE HAVING POSITIONING
SYSTEM

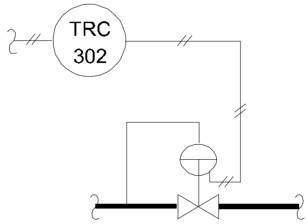
14



SAFETY PURGING
(Z TYPE)

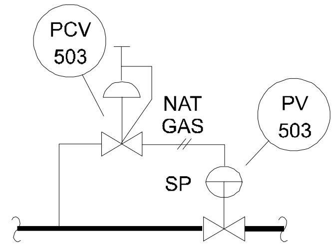
6.10 Examples — miscellaneous combinations (contd.)

15



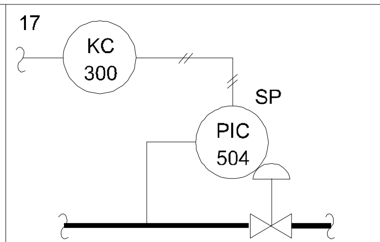
PRESSURE-BALANCED VALVE

16



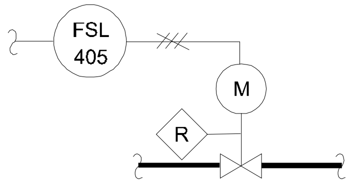
SELF-ACTUATED NATURAL GAS PRESSURE REGULATOR WITH REMOTE SET-POINT ADJUSTMENT

17



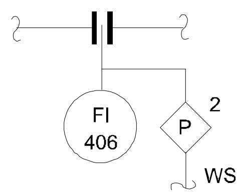
TIME-SCHEDULE CONTROLLER VARYING SET-POINT OF VALVE-MOUNTED PRESSURE CONTROLLER (TAG VALVE ASSEMBLY PIC/PV-504)

18



VALVE THAT UNLATCHES OR LATCHES WHEN TRIPPED AND RE-QUIRES HAND ACTUATION OF VALVE-MOUNTED RESET MECHANISM

19



DIFFERENTIAL-PRESSURE TYPE FLOW INDICATOR WITH WATER PURGE* FOR BOTH LEADS (DENOTED BY NUMBER 2)

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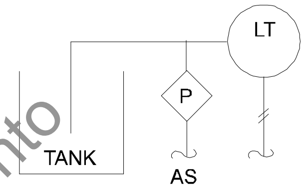
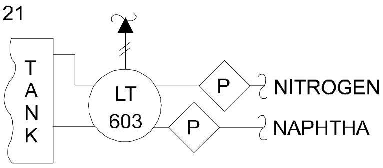


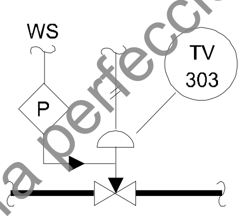
LEVEL TRANSMITTER FOR OPEN TANK WITH DIP TUBE AND AIR PURGE *

21



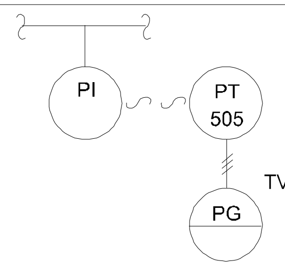
DIFFERENTIAL-PRESSURE TYPE LEVEL TRANSMITTER WITH GAS AND LIQUID PURGES *

22



CONTROL VALVE WITH WATER-SEALED* STUFFING BOX. VALVE CLOSES ON AIR FAILURE

23



TELEVISION VIEWING OF PRESSURE GAGE

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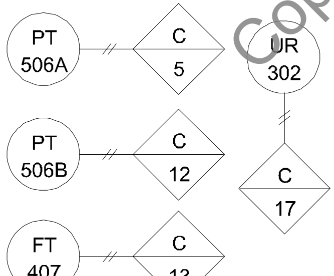

ONE-POINT RECORDER WITH PATCHBOARD INPUT CONNECTION

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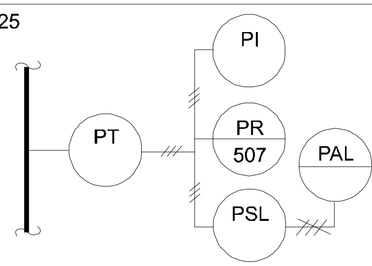

ELECTRIC OUTPUT OF TRANSMITTER CONNECTED TO MORE THAN ONE RECEIVER, REGARDLESS OF TYPE OF ELECTRIC SIGNAL

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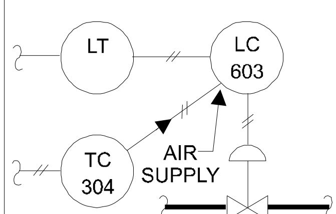
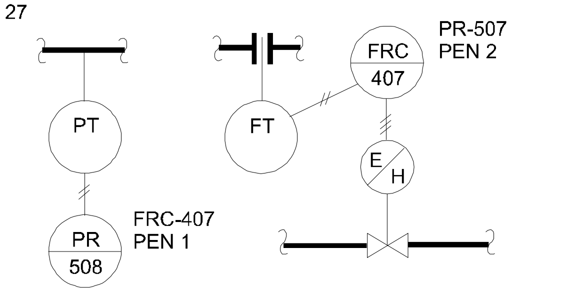


TEMPERATURE CONTROLLER OUTPUT ACTING AS AIR SUP-PLY FOR LEVEL CONTROLLER

* The purge fluid supplies may use the same abbreviations as the instrument power supplies.

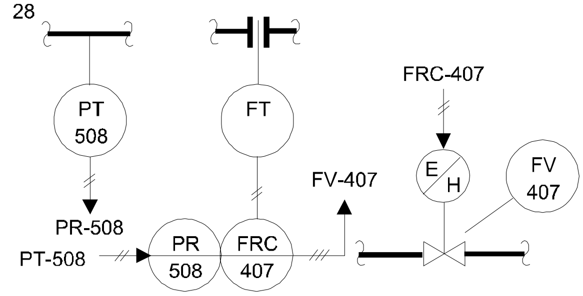
6.10 Examples — miscellaneous combinations (contd.)

27



ALTERNATIVE 1

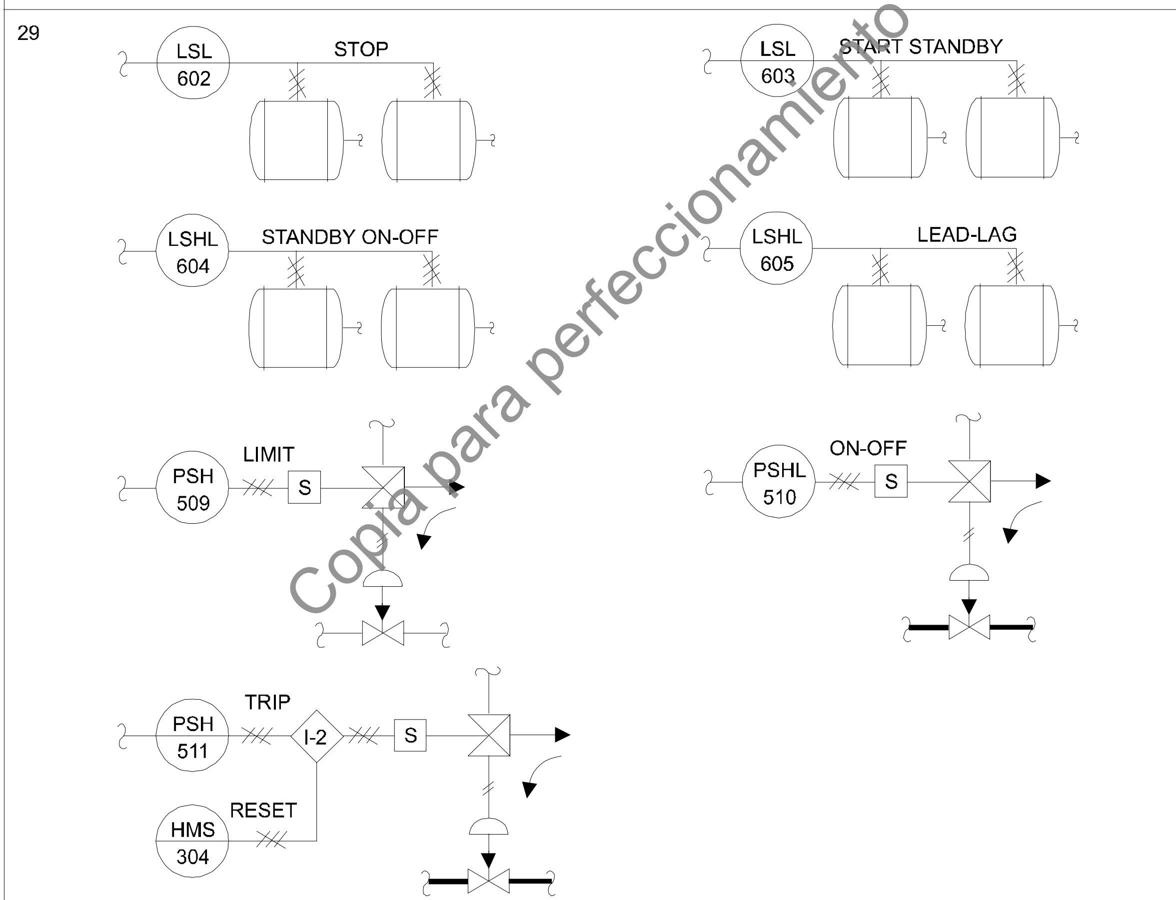
28



ALTERNATIVE 2

INTERRELATED INSTRUMENTS WHOSE SYMBOLS ARE SCATTERED ON DIAGRAM. (A MULTI-POINT INSTRUMENT, SUCH AS A DATA LOGGER, THAT IS DESIGNATED WITH POINT NUMBERS ON A DIAGRAM IS NOT EXPECTED TO HAVE THE SYMBOLS FOR THE VARIOUS POINTS TIED OR REFERENCED TOGETHER). PEN ASSIGNMENTS NEED NOT BE SHOWN ON A DIAGRAM IF IT IS THE USER'S PREFERENCE TO SHOW THEM IN AN INDEX.

29



THE JUDICIOUS USE OF WORDS CAN CLARIFY DESIGN INTENT

6.10 Examples — miscellaneous combinations (contd.)

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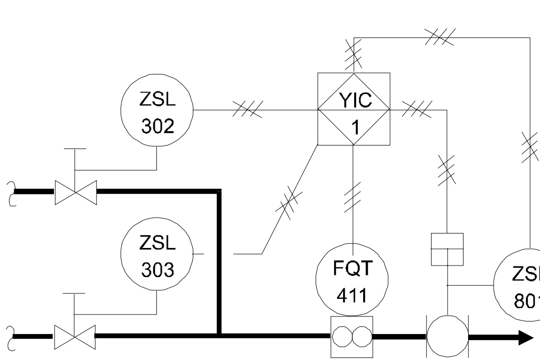

ALTERNATIVE 1

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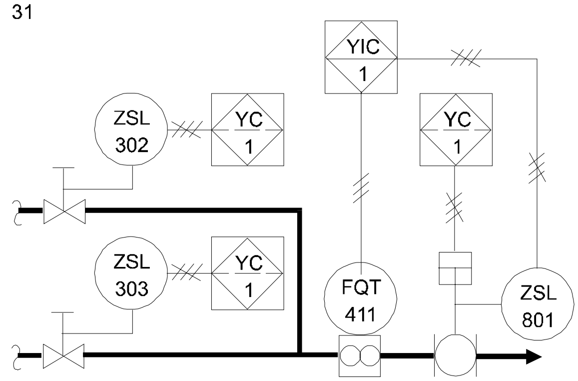

ALTERNATIVE 2

PROGRAMMABLE CONTROLLER SCHEME. ALTERNATIVE 2 ALLOWS MORE DEFINITION OF WHICH SIGNALS ARE ACCESSIBLE TO THE OPERATOR

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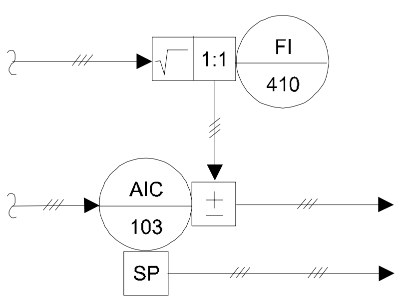
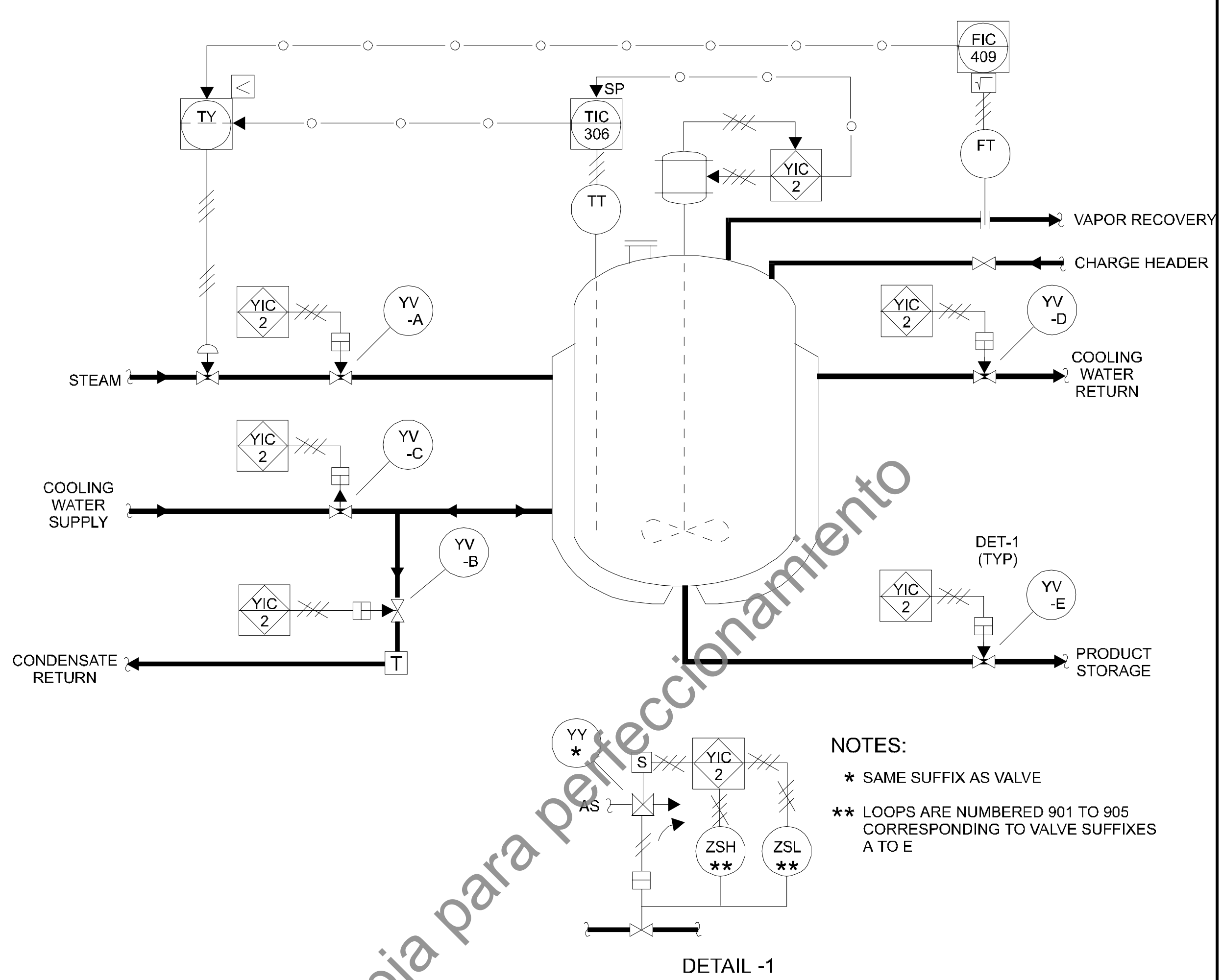


INDIVIDUAL INSTRUMENTS WITH INTEGRAL FUNCTION BLOCKS: SQUARE ROOT EXTRACTION, 1:1 FEED BOOST, FEED FORWARD BIAS ON CONTROLLER OUTPUT, SETPOINT OUTPUT SIGNAL

33

6.11 Example — complex combinations

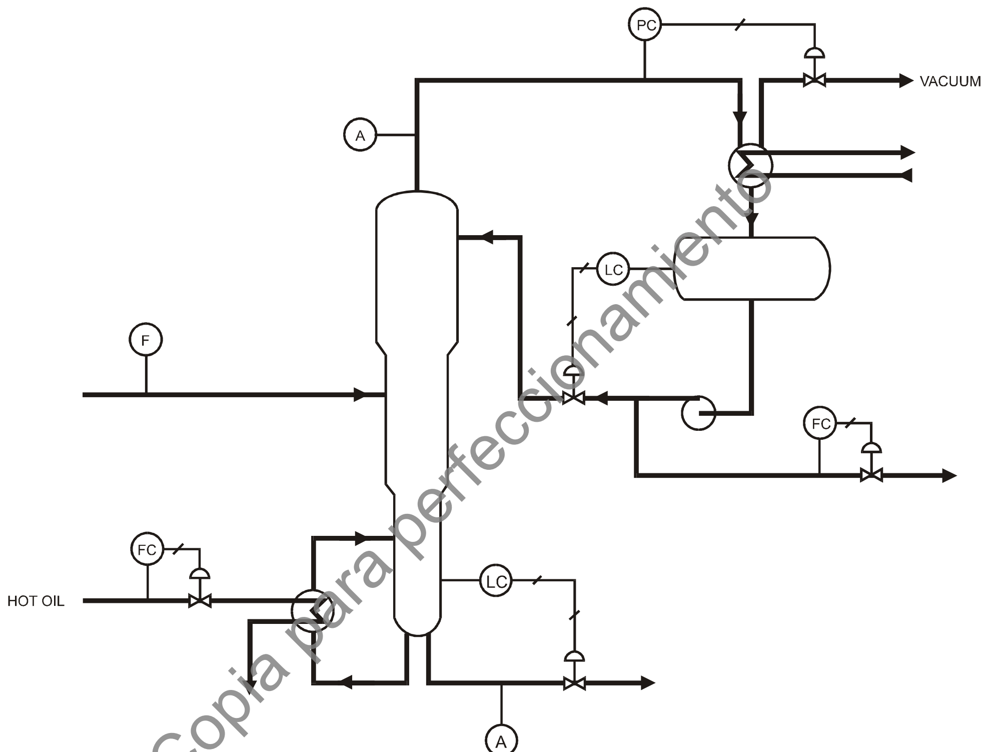
1



Example of complex batch kettle control involving both shared display/control and programmable logic control. The purpose of this drawing is to allow a general understanding of the control scheme and to define and identify the connection components. Detailed understanding would be obtained from the study of other documents.

6.12 Example — degree of detail*

1 TYPICAL SYMBOLISM FOR SIMPLIFIED DIAGRAMS

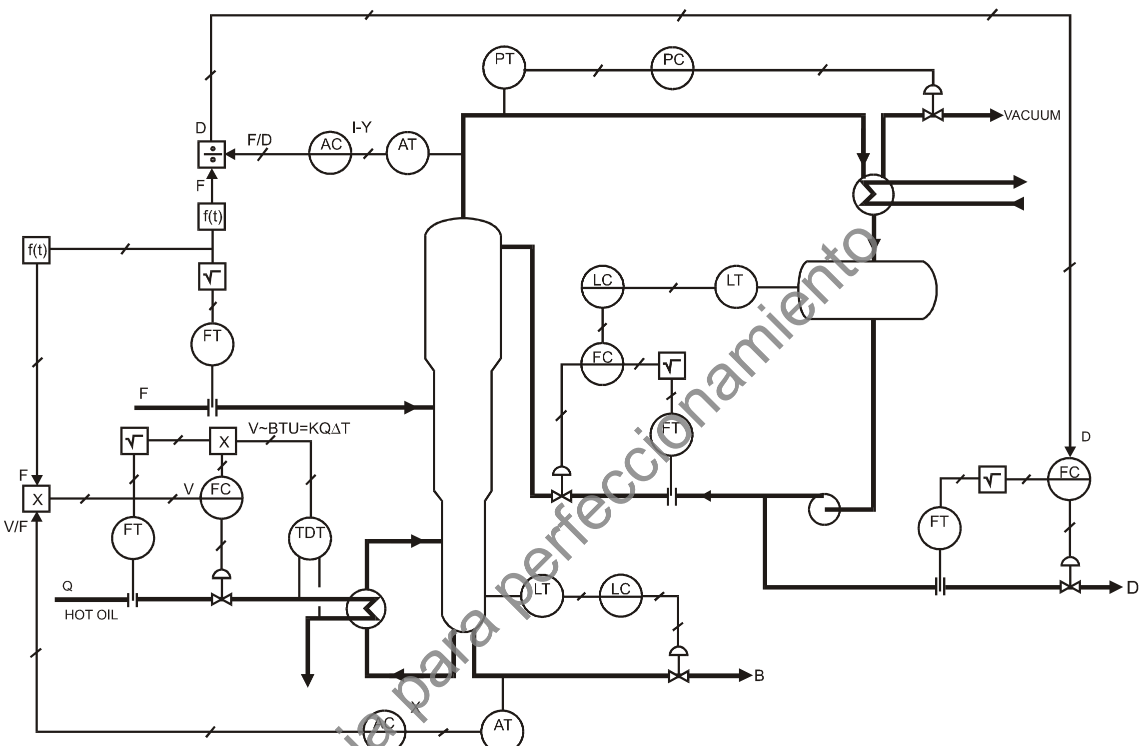


Simplified symbolism and abbreviated identification used to define the principal points of measurement and control interest.

* SEE SECTION 4.4 FOR DISCUSSION

6.12 Example — degree of detail (contd.)*

2 TYPICAL SYMBOLISM FOR CONCEPTUAL DIAGRAMS

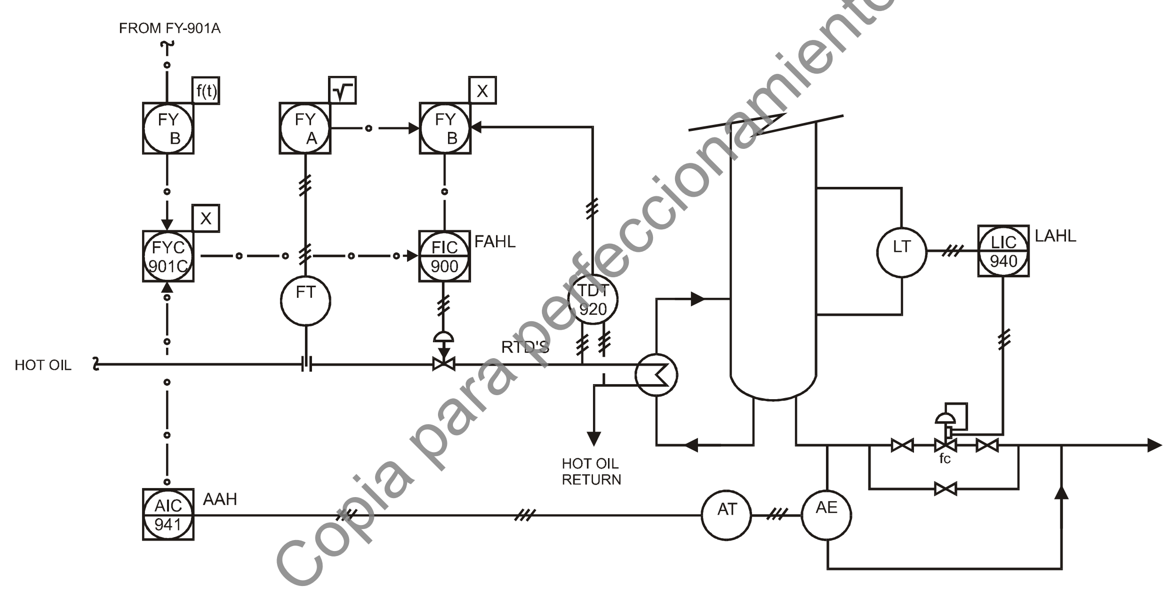


Functionally oriented symbolism and abbreviated identification used to develop control concepts without concern for specific hardware.

* SEE SECTION 4.4 FOR DISCUSSION

6.12 Example — degree of detail (contd.)*

3 TYPICAL SYMBOLISM FOR DETAILED DIAGRAMS



DETAILED SYMBOLISM AND MORE COMPLETE IDENTIFICATION USED TO DESCRIBE THE CONTROL SYSTEM WHEN TYPE OF HARDWARE AND KINDS OF SIGNALS HAVE BEEN CHOSEN.

* SEE SECTION 4.4 FOR DISCUSSION

Index

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American National Standard

Binary Logic Diagrams for Process Operations

ISA-S5.2 — Binary Logic Diagrams for Process Operations

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

Preface

This preface is included for informational purposes and is not part of Standard ISA-S5.2.

This Standard has been prepared as a part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709, Telephone (919) 549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA Standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, which has been published by the American Society for Testing and Materials as ANSI designation Z210.1 (ASTM E380-76, IEEE Std. 286-1975), and further revisions, will be the reference guide for definitions, symbols, abbreviation, and conversion factors.

It is the Policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA Standards. Participation in the ISA Standards making process by an individual in no way constitutes endorsement by the employer of that individual of ISA or any of the Standards which ISA develops.

The system described in this Standard is intended to meet the needs of people who are concerned with the operation of process systems. The guide for the Standard was American National Standards Institute (ANSI) Standard Y32.14.1973, Graphic Symbols for Logic Diagrams, which the committee attempted to follow so far as practical for the intended users of the ISA Standard.

The Committee also referred to National Electric Manufacturers Association Standards ICS 1-102, Graphic Symbols for Logic Diagrams, whose symbols bear resemblance to those of the ANSI Standard, and ICS 1-103, Static Switching Control Devices, which may eventually be supplanted by ICS 1-102. Reference was also made to National Fluid Power Association Recommended Standard T.3.7.68.2, Graphic Symbols for Fluidic Devices and Circuits. In addition, numerous other industrial standards were reviewed.

The following people served on the 1976 SP5.2 Committee:

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Roy Lazar	Carnation Company

Frank Mehle (deceased)	Procon Incorporated, Pacific Operation
Gary L. Pierce	Shell Oil Company
Chuck Simms	Fisher Controls Company
John Vance	United Process Control Systems
Robert Woo	Los Angeles Department of Water & Power

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The 1976 edition of this Standard was approved by the ISA Standards and Practices Board in November, 1975.

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J. R. Williams*	Stearns-Rogers, Inc.

*Director Emeritus

Contents

1 Purpose

1.1 The purpose of this Standard is to provide a method of logic diagramming of binary interlock and sequencing systems for the startup, operation, alarm, and shutdown of equipment and processes in the chemical, petroleum, power generation, air conditioning, metal refining, and numerous other industries.

1.2 The Standard is intended to facilitate the understanding of the operation of binary systems, and to improve communications among technical, management, design, operating, and maintenance personnel concerned with the systems.

2 Scope

2.1 The Standard provides symbols, both basic and non-basic, for binary operating functions. The use of symbols in typical systems is illustrated in appendices.

2.2 The Standard is intended to symbolize the binary operating functions of a system in a manner that can be applied to any class of hardware, whether it be electronic, electrical, fluidic, pneumatic, hydraulic, mechanical, manual, optical, or other.

3 Use of symbols

3.1 By using the symbols designated as "basic," logic systems may be described with the use of only the most fundamental logic building blocks. The remaining symbols, not basic, are more comprehensive and enable logic systems to be diagrammed more concisely. Use of the non-basic symbols is optional.

3.2 A logic diagram may be more or less detailed depending on its intended use. The amount of detail in a logic diagram depends on the degree of refinement of the logic and on whether auxiliary, essentially non-logic, information is included.

As an example of refinement of detail: A logic system may have two opposing inputs, e.g., a command to open and a command to close, which do not normally exist simultaneously; the logic diagram may or may not go so far as to specify the outcome if both the commands were to exist at the same time. In addition, explanatory notes may be added to the diagram to record the logic rationale.

Non-logic information may also be added, if desired, e.g., reference document identification, tag numbers, terminal markings, etc.

In these ways, the diagram may provide the level of detail appropriate, for example, for communication between a designer of pneumatic circuits and a designer of electric circuits, or may provide a broad-view system-description for a plant manager.

3.3 The existence of a logic signal may correspond physically to either the existence or the non-existence of an instrument signal, depending on the particular type of hardware system and the circuit design philosophy that are selected.* For example, a high-flow alarm may be chosen to be actuated by an electric switch whose contacts open on high flow; on the other hand, the high-flow alarm may be designed to be actuated by an electric switch whose contacts close on high flow. Thus, the high-flow condition may be represented physically by the absence of an electric signal or by the presence of the electric signal. The Standard does not attempt to relate the logic signal to an instrument signal of any specific kind.

3.4 A logic symbol that is shown in Section 4 with three inputs — *A*, *B*, and *C* — is typical for the logic function having any number of two or more inputs.

3.5 The flow of intelligence is represented by lines that interconnect logic statements. The normal direction of flow is from left to right, or top to bottom. Arrowheads may be added to the flow lines wherever needed for clarity, and shall be added to lines whose flow is not in a normal direction.

3.6 A summary of the status of an operating system may be put in the diagram wherever it is deemed useful as a reference point or landmark in the sequence.

3.7 There may be misunderstanding of binary logic statements involving devices that are not recognizable as inherently having only two specific alternative states. For example, if it is stated that a valve is not closed, this could mean either (a) that the valve is open fully, or (b) that the valve is simply not closed, namely, that it may be in any position from almost closed to wide open. To aid accurate communication between writer and reader of the logic diagram, the diagram should be interpreted literally. Therefore, possibility (b) is the correct one.

If a valve is an open-close valve, then, to avoid misunderstanding, it is necessary to do one of the following:

1) Develop the logic diagram in such a way that it says exactly what is intended. If the valve is intended to be open, then it should be so stated and not be stated as being not closed.

2) Have a separate note specifying that the valve always assumes either the closed or the open position.

By contrast, a device such as a motor-driven pump is either operating or stopped, barring some special situations. To say that the pump is not operating usually clearly denotes that it has stopped.

The following definitions apply to devices that have open, closed, or intermediate positions. The positions stated are nominal to the extent that there are differential-gap and dead band in the instrument that senses the position of the device.

Open position: a position that is 100-percent open.

Not-open position: a position that is less than 100-percent open. A device that is not open may or may not be closed.

Closed position: a position that is zero-percent open.

*In process operations, binary instrument signals are commonly either ON or OFF. However, as a more general case, logic systems exist that make use of binary hardware having signals with two alternate real values, e.g., +5 volts and –3 volts. In *positive logic*, the more positive signal, +5 volts, represents the existence of a logic condition, e.g., *pump stopped*. In *negative logic*, the less positive signal, –3 volts, represents the existence of a logic condition of *pump stopped*.

Not-closed position: a position that is more than zero-percent open. A device that is not closed may or may not be open.

Intermediate position: a SPECIFIED position that is greater than zero- and less than 100-percent open.

Not-at-intermediate position: a position that is either above or below the SPECIFIED intermediate position.

For a logic system having an input statement that is derived inferentially or indirectly, a condition may arise that will lead to an erroneous conclusion. For example, an assumption that flow exists because a pump motor is energized may be false because of a closed valve, a broken shaft, or other mishap. Factual statements, that is, statements based on positive measurements that a certain condition specifically exists or does not exist, are generally more reliable.

3.8 A process operation may be affected by loss of the power supply* to memories and to other logic elements. In order to take such operating eventualities into account, it may therefore be necessary to consider the effect of loss of power to any logic component or to the entire logic system. In such cases, it may be necessary to enter power supply or loss of power supply as logic inputs to a system or to individual logic elements. For memories, the consideration of power supply may be handled in this manner or as shown in Sections 4.7b, c, and d.

By the same token, it may be necessary to consider the effect of restoration of power supply.

Logic diagrams do not necessarily have to cover the effect of logic power supplies on process systems but may do so for thoroughness.

3.9 It is recommended, for clarity, that a single time-function symbol, as appropriate, be used to represent each time function in its entirety. Though not incorrect, the representation of a complex or uncommon time function by using a time-function symbol in immediate sequence with a second time-function symbol or with a NOT symbol should be avoided (see Section 4.8).

3.10 Process instrument symbols and designations follow ISA Standard S5.1-1973 (American National Standards Institute Standard Y32.20-1975), "Instrumentation Symbols and Designations." However, these symbols are included for illustrative purposes, only, and are not part of Standard S5.2.

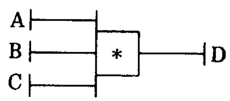
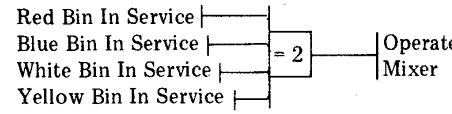
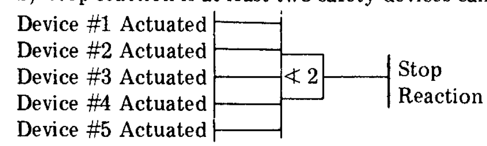
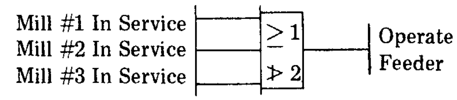
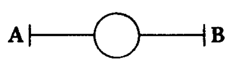
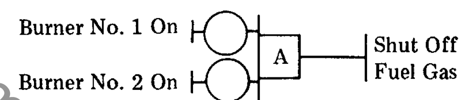
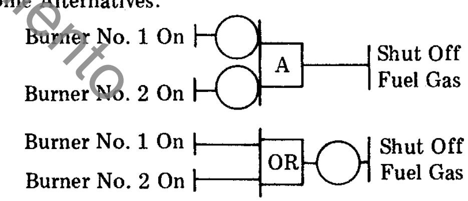
3.11 If a drawing, or set of drawings, uses graphic symbols that are similar or identical to one another in shape or configuration and that have different meanings because they are taken from different standards, then adequate steps shall be taken to avoid misinterpretation of the symbols used. These steps may be to use caution notes or reference notes, comparison charts that illustrate and define the conflicting symbols, or other suitable means. This requirement is especially critical if the graphic symbols used, being from different disciplines, represent devices, conductors, flow lines, or signals whose symbols, if misinterpreted, may result in danger to personnel or damage to equipment.

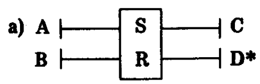
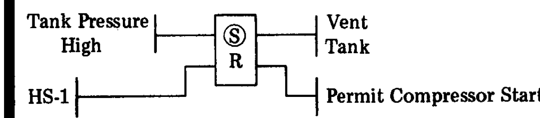
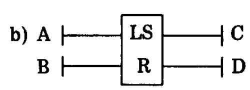
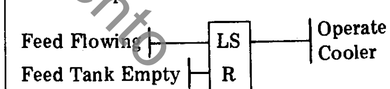
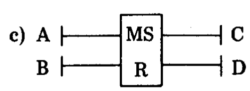
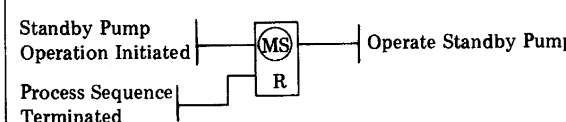
4 Symbols

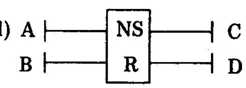
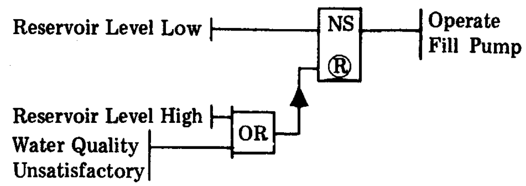
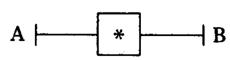
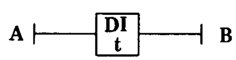
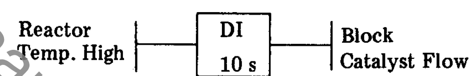
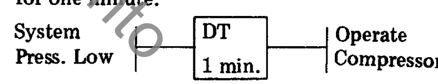
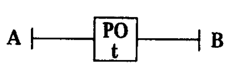
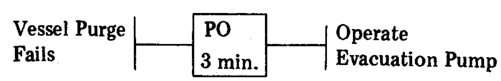
The symbols for diagramming binary logic are defined as follows:

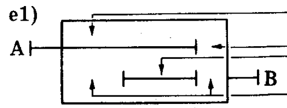
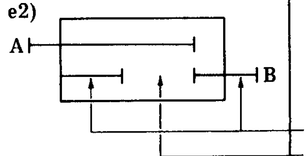
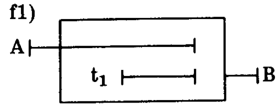
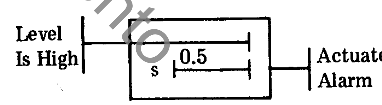
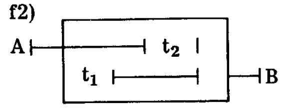
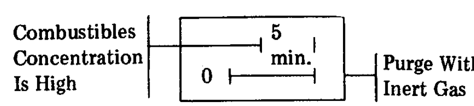
*The term *power supply* covers the energizing medium, whether it be electric, pneumatic, or other.

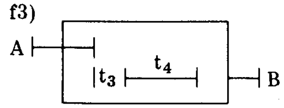
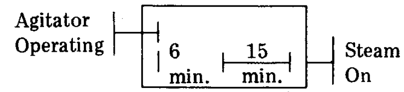
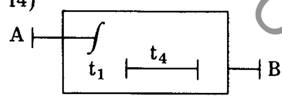
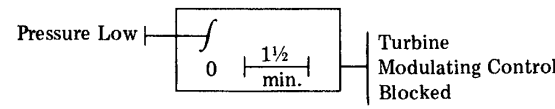
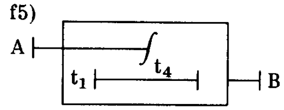
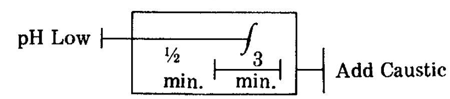
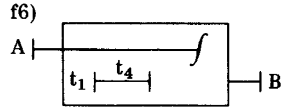
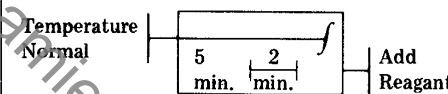
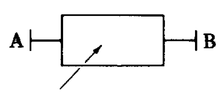
FUNCTION	SYMBOL	DEFINITION	EXAMPLE
4.1 INPUT	Statement of Input Alternatively: Statement of Input Initiating instrument or device number, if known	An input to the logic sequence	The start position of a hand switch *HS-1*, is actuated to pro input to start a conveyor. Alternative diagrams: a) HS-1 Start Conveyor Manually b) HS 1 Start Conveyor Manually
4.2 OUTPUT	Statement of Output Alternatively: Statement of Output Operated instrument or device number, if known	An output from the logic sequence.	An output from the logic sequence commands valve *HV-2* t Alternative diagrams: a) Open Valve HV-2 b) Open Valve HV 2
4.3 AND BASIC	A, B, C → A → D	Logic output D exists if and only if all logic inputs A, B, and C exist.	Operate pump if suction tank level is high and discharge val is open. Tank Level High, Valve Open → A → Operate Pump
4.4 OR BASIC	A, B, C → OR → D	Logic output D exists if and only if one or more of logic inputs A, B, and C exist.	Stop compressor if cooling water pressure is low or bearing temperature is high. Water Pressure Low, Bearing Temperature High → OR → Stop Compressor

FUNCTION	SYMBOL	DEFINITION	EXAMPLE
4.5 QUALIFIED OR	 *Internal details represent numerical quantities (see "Definition").	Logic output D exists if and only if a specified number of logic inputs A, B, and C exist. Mathematical symbols, including the following, shall be used, as appropriate, in specifying the number: a. $=$ equal to b. $\neq$ not equal to c. $<$ less than d. $>$ greater than e. $\nless$ not less than f. $\ngtr$ not greater than g. $\leq$ less than or equal to [equivalent to f] h. $\geq$ greater than or equal to [equivalent to e]	a) Operate mixer if two, and only two, bins are in service.  b) Stop reaction if at least two safety devices call for stop.  c) Operate materials feeder if at least one and no more than two mills are in service. 
4.6 NOT	BASIC  **The *NOT* symbol may be drawn tangent to an adjacent logic symbol.**	**Logic output B exists if and only if logic input A does not exist.**	Shut off fuel gas if burners no. 1 and no. 2 are not on.  Some Alternatives: 

FUNCTION	SYMBOL	DEFINITION	EXAMPLE
4.7 MEMORY (Flip-Flop) BASIC	 *Output *D* shall not be shown if it is not used.	S represents *set memory* and R represents *reset memory.* Logic output *C* exists as soon as logic input *A* exists. *C* continues to exist, regardless of the subsequent state of *A*, until the memory is reset, i.e., terminated by logic input *B* existing. *C* remains terminated regardless of the subsequent state of *B*, until *A* causes the memory to be set. Logic output *D*, if used, exists when *C* does not exist, and *D* does not exist when *C* exists.	If tank pressure becomes high, vent tank and continue venting, regardless of pressure, until venting is stopped by manual actuation of hand switch, HS-1, provided that the pressure is not high. If the venting is stopped, a compressor may be started. 
		Input-Override Option If inputs *A* and *B* exist simultaneously, and if it is desired to have *A* override *B*, then *S* should be encircled, i.e., Ⓢ ; if *B* is to override *A*, then *R* should be encircled, i.e., Ⓡ. *Loss-Of-Power-Supply Option* The unmodified letter *S* denotes that *no consideration* has been given to the action of the memory on loss of the logic power supply. See paragraphs 4.7 b, c, and d, below, and 3.8.	
	 (See Appendix C)	Similar to definition of symbol (a) except that the memory shall be *lost* in the event of loss of the logic power supply.	If feed begins to flow, the cooler shall operate until the feed tank is empty. In the event of loss of the logic power supply, the cooler shall not operate 
(cont'd)		Similar to definition of symbol (a) except that the memory shall be *maintained* in the event of loss of the logic power supply.	If standby pump operation is initiated, the pump shall operate, even on loss of the logic power supply, until the process sequence is terminated. The pump shall operate if start and stop commands exist simultaneously. 

FUNCTION	SYMBOL	DEFINITION	EXAMPLE
4.7 (cont'd)	d) 	Similar to definition of symbol (a) except that *after consideration* it is deemed *not significant*, so far as the process is concerned, whether the memory is maintained or lost in the event of loss of power supply.	If reservoir level is low, operate fill pump until either level is high or water quality is unsatisfactory. It is not significant to the process what happens to the pump on loss of the logic supply. If start and stop commands are simultaneous, the pump shall stop. 
4.8 TIME ELEMENT	a)  *For functional details, see the following (also see Section 3.9):	Logic output *B* exists with a time relationship to logic input *A* as specified.	
BASIC	b)  (Delay Initiation of output)	**The continuous existence of logic input *A* for time *t* causes logic output *B* to exist when *t* expires. *B* terminates when *A* terminates.**	If reactor temperature exceeds a high limit continuously for 10 seconds, block catalyst flow. Resume flow when temperature does not exceed the limit. 
BASIC	c)  (Delay Termination of output)	**The existence of logic input *A* causes logic output *B* to exist immediately. *B* terminates when *A* has terminated and has not again existed for time *t*.**	If system pressure falls below a low limit, operate compressor at once. Stop the compressor when pressure is not low continuously for one minute. 
BASIC (cont'd)	d)  (Pulse Output)	**The existence of logic input *A*, regardless of its subsequent state, causes logic output *B* to exist immediately. *B* exists for time *t* and then terminates.**	If vessel purge fails for any period of time, operate evacuation pump for 3 minutes and then stop the pump. 

FUNCTION	SYMBOL	DEFINITION	EXAMPLE
4.8 (cont'd)	A generalized method for diagramming all time functions is outlined as follows. The symbols that are defined are intended to be illustrative but are not all-inclusive.		
	e1) 	Input logic state exists. Input logic state does not exist. Output logic state exists. Output logic state does not exist. The time at which the logic input A is initiated is represented by the left-hand edge of the box. Passage of time is from left to right and is usually shown unscaled. The logic output B always begins and ends in the same state within the time-element box. More than one output may be shown, if required.	
	e2) 	The timing of logic may be applied to either the existence state or the non-existence state, as applicable. Output logic state exists. Output logic state does not exist.	
	f1) 	The continuous existence of logic input A for time t_1 causes logic output B to exist when t_1 expires. B terminates when A terminates.	Avoid nuisance alarms on high level by actuating alarm only if level remains high continuously for 0.5 second. The alarm signal terminates when there is no high level. 
(cont'd)	f2) 	The continuous existence of logic input A for time t_1 causes logic output B to exist when t_1 expires. B terminates when A has been terminated continuously for time t_2.	Purge immediately with inert gas when combustibles concentration is high. Stop the purge when concentration is not high continuously for 5 minutes. 

FUNCTION	SYMBOL	DEFINITION	EXAMPLE
4.8 (cont'd)	f3) 	The termination of logic input A and its continuous non-existence for time t_3 cause logic output B to exist when t_3 expires. B terminates when either (1) B has existed for time t_4, or (2) A again exists, whichever occurs first.	Steam is turned on for 15 minutes beginning 6 minutes after agitator has stopped except that the steam shall be turned off if the agitator restarts. 
	f4) 	The existence of logic input A, regardless of its subsequent state, causes logic output B to exist when time t_1 expires. B exists for time t_4 and then terminates.*	If pressure dips to low value momentarily, block modulating control of turbine immediately, maintain for 1½ minutes, then release turbine to modulating control. 
	f5) 	The continuous existence of logic input A for time t_1 causes logic output B to exist when t_1 expires. B exists for time t_4, regardless of the state of A, and then terminates.*	If pH is low continuously for ½ minute, add caustic for 3 minutes. 
	f6) 	The continuous existence of logic input A for time t_1 causes logic output B to exist when t_1 expires. B terminates when either (1) B has existed for time t_4, or (2) A terminates, whichever occurs first.*	If temperature is normal continuously for 5 minutes, add reagent for 2 minutes except that reagent shall not be added if temperature is abnormal. 
	*For symbols f4, f5, and f6, the action of logic output B depends on how long logic input A is in continuous existence, up to the line break for A. Beyond the break in A, the state of A is not significant to the completion of the B sequence. If it is desired to have a B time segment, e.g., t_1, go to completion only if A exists continuously, then A must be drawn beyond that segment. If A is drawn past the beginning but not beyond the end of a time segment, then the segment will be initiated and go to completion regardless of whether A exists only momentarily or longer.		
4.9 SPECIAL	 Statement of Special Requirements	Logic output B exists with a relationship to logic input A as specified in the statement of special requirements. The statement may cover a logic function not otherwise specified in this standard or a logic system that is further defined elsewhere.	

5 Bibliography

American National Standards Institute Standard Y32.14-1973, Graphic Symbols for Logic Diagrams (Two-State Devices).

American National Standards Institute Standard X3.5-1970, Flowchart Symbols and Their Usage in Information Processing.

International Electrotechnical Commission Recommendation, Publication 117-15, 1972, Binary Logic Elements.

National Electric Manufacturers Association Standard ICS 1-102, Graphic Symbols for Logic Diagrams.

National Electric Manufacturers Association Standard ICS 1-103, Static Switching Control Devices.

National Fluid Power Association Standard T.3.7.68.2, Graphic Symbols for Fluidic Devices and Circuits.

Appendix A General application example

A.1 Introduction

This example uses a representative process whose instruments are denoted by the symbols of ISA-S5.1-1973, (ANSI Y32.20-1975.) The process equipment symbols are included only to illustrate applications of instrumentation symbols. The example is not a part of Standard S5.2.

A.2 Simplified flow diagram

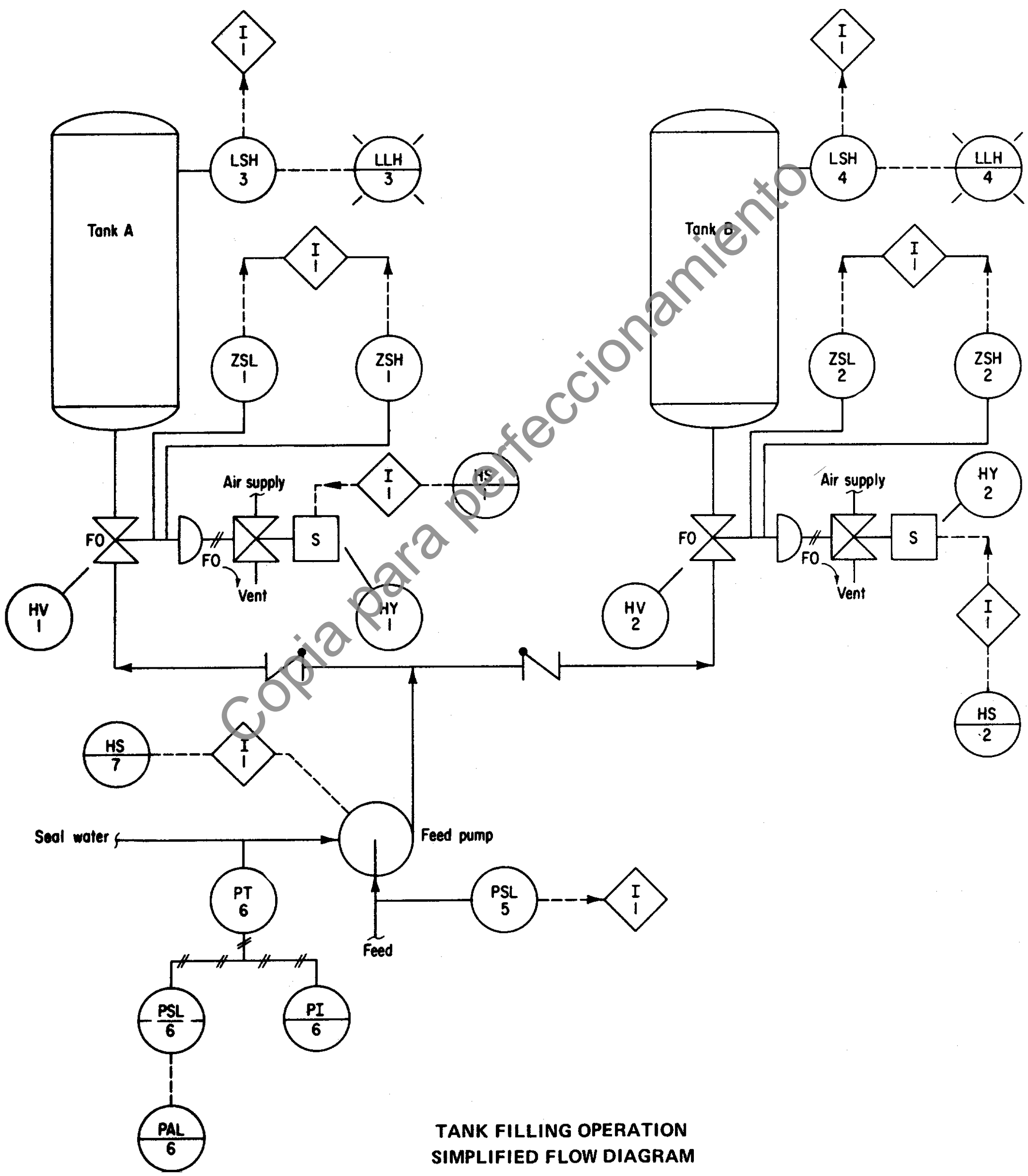


Figure A.1 — Tank filling operation simplified flow diagram

A.3 Word description

A.3.1 Pump start

Feed is pumped into either tank *A* or tank *B*. The pump may be operated manually or automatically, as selected manually on a local maintained-output selector switch, *HS-7*, which has three positions: *ON*, *OFF*, and *AUTO*. When the pump is operating, red pilot light *L-8A* is on; when not operating, green pilot light *L-8B* is on. Once started, the pump continues to operate until a stopping command exists or until the control power supply is lost.

The pump may be operated manually at any time provided that no trouble condition exists: The suction pressure must not be low; the seal water pressure must not be low; and the pump motor must not be overloaded and its starter must be reset.

In order to operate the pump automatically, all the following conditions must be met:

A.3.1.1 Board-mounted electric momentary-contact hand switches, HS-1 and HS-2, start the filling operation for tanks A and B, respectively. Each switch has two positions, START and STOP. START de-energizes the associated solenoid valves, HY-1 and HY-2. De-energizing a solenoid valve causes it to go to the fail-safe position, i.e., to vent. This depressurizes the pneumatic actuator of the associated control valves, HV-1 and HV-2. Depressurizing a control valve causes it to go to the fail-safe position, i.e., to open. The control valves have associated open-position switches, ZSH-1 and ZSH-2, and closed-position switches, ZSL-1 and ZSL-2.

The STOP position of switches HS-1 and HS-2 causes the opposite actions to occur so that the solenoid valves are energized, the control valve actuators are pressurized, and the control valves close.

If starting circuit power is lost, the starting memory is lost and the filling operation stops. The command to stop filling can override the command to start filling.

To start the pump automatically, either control valve HV-1 or HV-2 must be open and the other control valve must be closed, depending on whether tank A or tank B is to be filled.

A.3.1.2 The pump suction pressure must be above a given value, as signalled by pressure switch PSL-5.

A.3.1.3 If valve HV-1 is open to permit pumping into tank A, the tank level must be below a given value, as signalled by level switch LSH-3, which also actuates a board-mounted high-level pilot light, LLH-3. Similarly, high-level switch, LSH-4, permits pumping into tank B, if not actuated, and actuates pilot light LLH-4, if actuated.

A.3.1.4 Pump seal water pressure must be adequate, as indicated on board-mounted receiver gage, PI-6. This is a non-interlocked requirement that depends on the operator's attention before he starts the operation. Pressure switch, PSL-6, behind the board, actuates board-mounted low-pressure alarm, PAL-6.

A.3.1.5 The pump drive motor must not be overloaded and its starter must be reset.

A.3.2 Pump stop

The pump stops if any of the following conditions exists:

A.3.2.1 While pumping into a tank, its control valve leaves the fully-open position, or the valve of the other tank leaves its fully-closed position, provided that the pump is on automatic control.

A.3.2.2 The tank selected for filling becomes full, provided that the pump is on automatic control.

A.3.2.3 The pump suction pressure is continuously low for 5 seconds.

A.3.2.4 The pump drive motor is overloaded. It is immaterial to the process logic whether or not the memory of the pump motor overload is retained on loss of power in this system because the maintained memory that operates the pump is defined as losing memory on loss of power, and this by itself will cause the pump to stop. However, an existing motor-overload condition prevents the motor starter from being reset.

A.3.2.5 The sequence is stopped manually through HS-1 or HS-2. If stop and start commands for pump operation exist simultaneously, then the stop command overrides the operate command.

A.3.2.6 The pump is stopped manually by HS-7.

A.3.2.7 The pump seal water pressure is low. This condition is not interlocked, and requires manual intervention to stop the pump.

A.4 Logic diagram

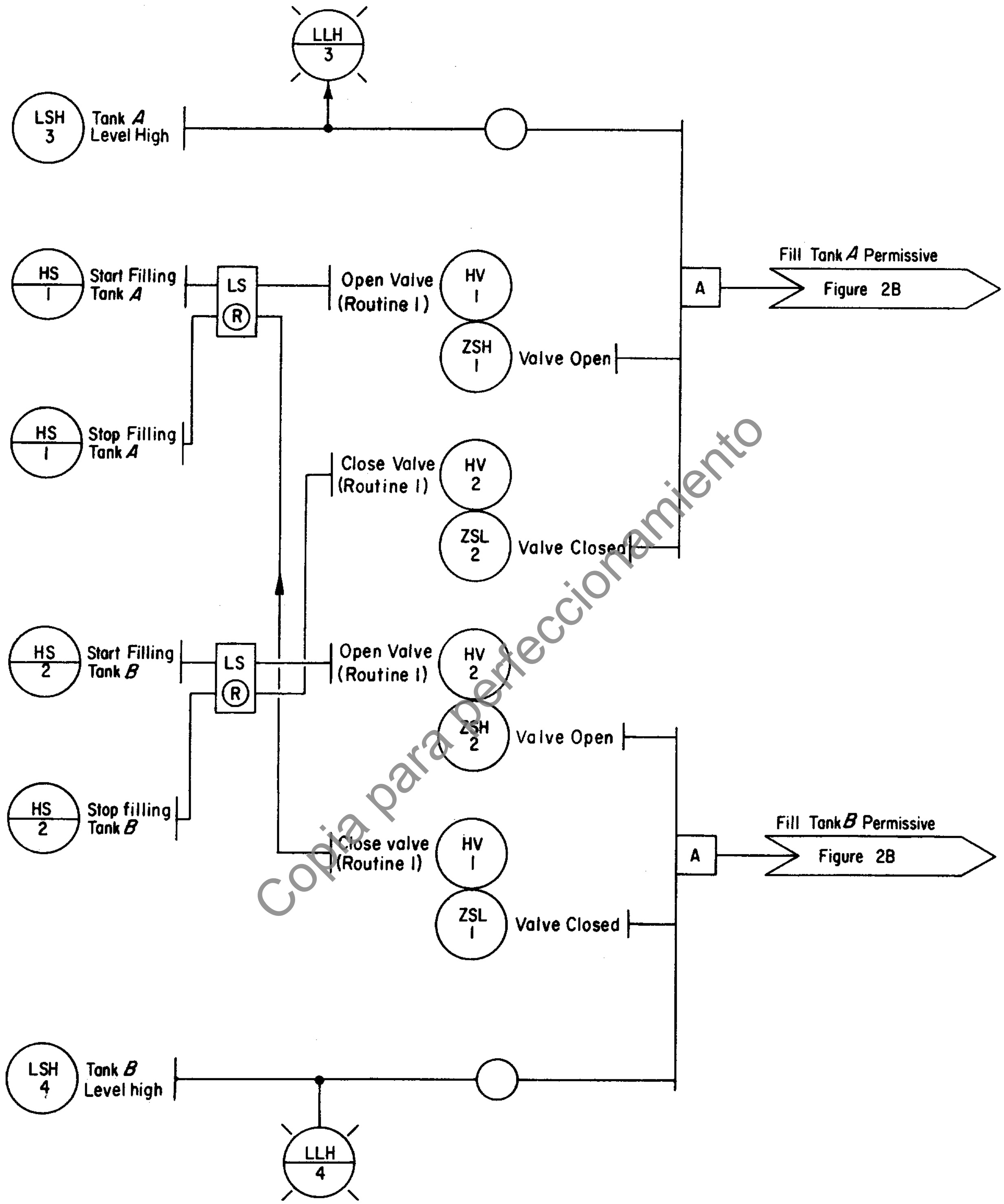
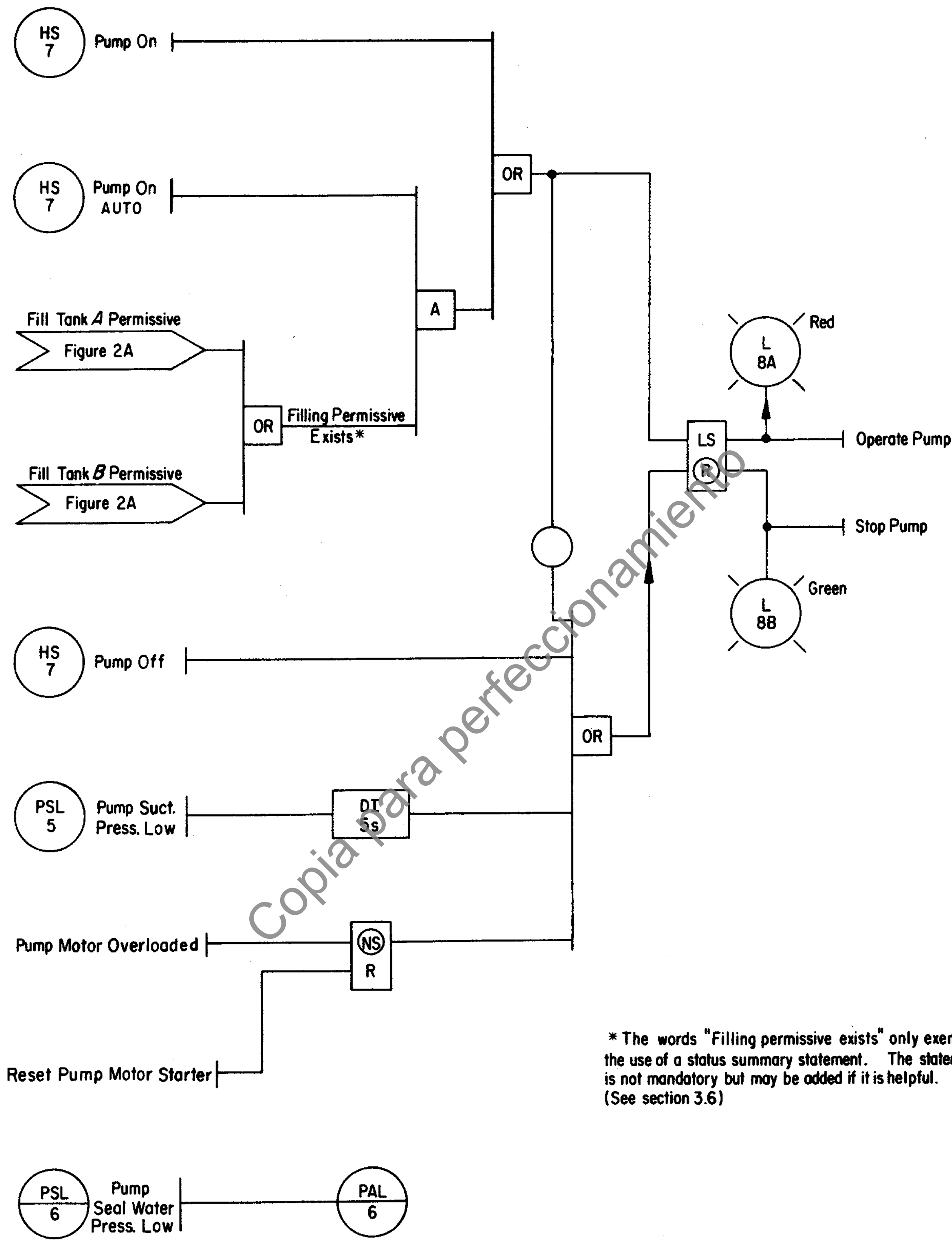


Figure A.2A — Tank filling operation interlock 1 logic diagram — part I



* The words "Filling permissive exists" only exemplify the use of a status summary statement. The statement is not mandatory but may be added if it is helpful. (See section 3.6)

Figure A.2B — Tank filling operation interlock 1 logic diagram — part II

		Solenoid Valve	Control Valve	
		HY-1	HV-1	
		HY-2	HV-2	
			Actuator	Port
Operation	Open Valve	De-Energized	Vented	Open
	Close Valve	Energized	Pressurized	Closed

The information stated in this figure is required if detailed design work is to be done. The information may be presented in any other convenient form.

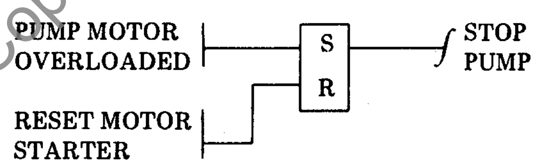
Description Of Valve Actuation Scheme

Figure A.2C — Tank filling operation interlock 1 routine 1

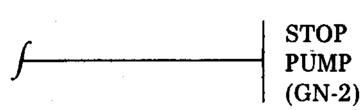
Comments on the logic diagram for Interlock 1:

1) The diagram may be simplified by using general notes (GN) for a project, especially for repetitive items. For example, the operating light for the pump may be omitted from the diagram by using a general note that states: "All pumps have red and green pilot lights to denote that the pump motors are operating or not operating, respectively," thus,

As another example, the motor lockout detail



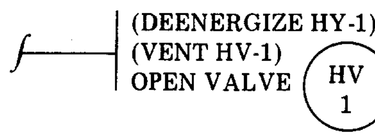
will commonly be simplified by referring to a general note that states: "The motor starter locks out when tripped," thus:



2) The memory function that keeps the pumps in operation may be but is not necessarily provided by a circuit breaker for the pump motor. The other maintained-memory functions in the diagram may be provided by pneumatic or electric latching relays or other types of hardware. This illustrates the essentially hardware-free nature of the operational logic portion of the diagram and the emphasis on logic function.

3) The logic diagram emphasizes the operating logic of the process by not detailing the system mechanism for opening and closing the control valves. Thus, this information is provided by means of Routine 1, which may apply to similar hardware of an entire project as well as to Interlock 1. However, if it is desired to make the diagram more self-contained by including hardware functions, this can be done as follows, using an excerpt from the diagram as an example:

Alternative:



Appendix B Complex time-element example

B.1 Word description

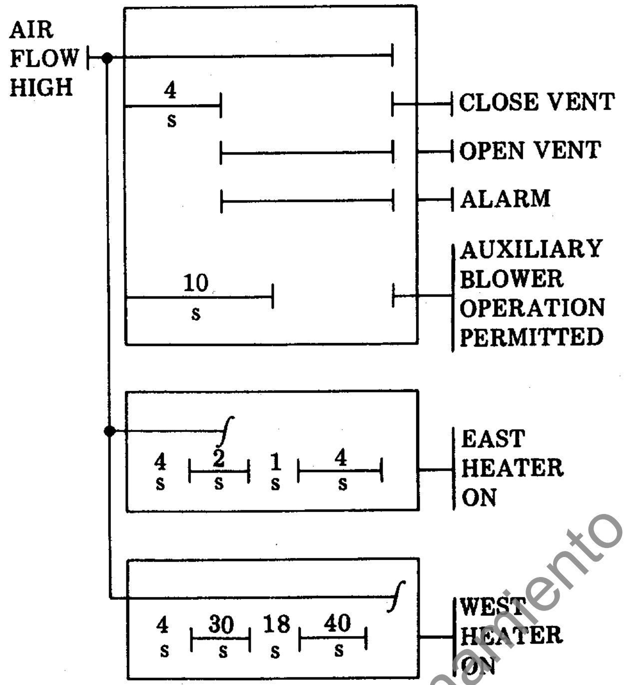
Assume a process operation, as follows:

If air flow becomes high and is so sustained for 4 seconds, then open vent, actuate alarm, and initiate heating by east and west heaters. If heating by east heater is initiated, the heater goes on for 2 seconds, off for one second, and on again for 4 seconds, regardless of whether the air flow remains high while this is occurring. If heating by west heater is initiated, then heater goes on for 30 seconds, off for 18 seconds, and on for 40 seconds, but only if the air flow remains high while this is occurring.

If high flow of air is sustained for 10 seconds, stop the auxiliary blower if it is running.

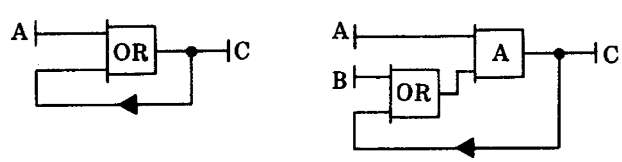
When air flow is no longer high, close the vent, permit the auxiliary blower to be restarted and the alarm to be reset.

B.2 Logic diagram



Appendix C Loss of power supply for memory

Section 4.7b indicates how to symbolize memories that are lost in the event of loss of power supply. The use of a logic feedback to symbolize a memory is deprecated. Thus, the following symbolisms shall not be used:



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STANDARD

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Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems

Approved 30 June 1982

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Preface

This preface is included for informational purposes and is not part of ISA-5.3-1983.

This Standard has been prepared as a part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static but should be subject to periodic review. Towards this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, North Carolina 27709, telephone 919-549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA Standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Towards this end this Department will endeavor to introduce SI and SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide,* which has been published by the American Society for Testing and Materials as ANSI designation Z210.1 (ASTM E380-76. IEEE Std. 268-1975), and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

The systems referenced in this Standard are based on advances in control systems technology since the publication of ISA-5.1, "Instrumentation Symbols and Identification." During recent years, technology has evolved in terms of microprocessor-based systems presently manufactured by many companies as "Distributed Control Systems."

These systems may include components identified as "computers" as distinct from the integral processor, which derives the various functions of the system. The computer component may be integrated into the overall system, via the communication link, or it may be a stand-alone computer.

In attempting to implement these systems, the need for supplementary symbolism has become apparent.

The symbols defined in ISA-5.3 are intended to complement those of ISA-5.1, "Instrumentation Symbols and Identification," for use on flow diagrams. In this way, the integration of distributed controllers and process computers into the more traditional instrument systems — analog, binary, and digital — can be depicted clearly on flow diagrams and other documents to give an overall and comprehensive picture of how process variables are measured and controlled.

Distributed control systems appear to be similar to each other; however, they are so diverse in philosophy that there must be a generic way to document their application.

The second printing of ISA-5.3, dated April 1983, was published to correct errors in the original 1982 edition. The definition for communication link, Section 3, has been corrected and an omitted abbreviation, C.R.T., added. Minor clarifications were also made to the Appendix A artwork.

The ISA Standards Committee on Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems, SP5.3, operates within the ISA Standards and Practices Department, Dr. Thomas J. Harrison, Vice President. The persons listed below served as members of the SP5.3 Committee.

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Contents

1 Purpose

The purpose of this standard is to establish documentation for that class of instrumentation consisting of computers, programmable controllers, minicomputers and micro-processor based systems that have shared control, shared display or other interface features. Symbols are provided for interfacing field instrumentation, control room instrumentation and other hardware to the above. Terminology is defined in the broadest generic form to describe the various categories of these devices.

It is not the intent of this standard to mandate the use of each type symbol for each occurrence of a generic device within the overall control system. Such usage could result in undue complexity in the case of a Piping and Instrument Drawing (P&ID). If, for example, a computer component is an integral part of a distributed control system, the use of the computer symbol would normally be an undesirable redundancy. If, however, a separate general purpose computer is interfaced with the system, the inclusion of the computer symbol may provide the degree of clarity needed for control system understanding.

This standard attempts to provide the users with defined symbolism and rules for usage, which may be applied as needed to provide sufficient clarity of intent. The extent to which these symbols are applied to various types of drawings remains with the users. The symbols may be as simple or complex as needed to define the process.

2 Scope

This standard satisfies the requirements for symbolically representing the functions of distributed control/shared display instrumentation, logic, and computer systems. The instrumentation is generally composed of field hardware communication networks and control room operator devices. This standard is applicable to all industries using process control and instrumentation systems.

No effort will be made on the flow diagram to explain the internal construction, configuration, or method of operation of this type of instrumentation, logic and computer systems. Personnel needing to understand flow diagrams must have a basic understanding of the total system in order to correctly interpret the diagram. The type of computation or the use of the process variable within a program is not indicated except in those cases where the process variable is an integral part of the control strategy. In applications where all instrument system data base information is available to the computer via the communication link, the depiction of the computer interconnections is optional in order to conserve space on flow diagrams.

2.1 Application to work activities

This standard is intended for use whenever any reference to an instrument is required. Such references may be required for the following uses as well as others:

Flow diagrams, process and mechanical;

Instrumentation system diagrams;

Specifications, purchase orders, manifests, and other lists;

Construction drawings;

Technical papers, literature, and discussions;

Tagging of instruments; and

Installation, operation, and maintenance instructions, drawings, and records.

2.2 Relationship to other ISA standards

This standard complements ISA-5.1, "Instrumentation Symbols and Identification," for symbols and formats representing functional identification codes. For clarification of examples, a limited amount of ISA-5.1 symbology has been included in this document.

2.3 Relationship to other standards

Where applicable, definitions not included in Section 3 are in accordance with ANSI X3/TR-1-77, "American National Dictionary for Information Processing," and/or ISA-5.1.

3 Definitions and abbreviations

Accessible—A system feature that is viewable by and interactive with the operator, and allows the operator to perform user-permissible control actions, e.g., set point changes, auto-manual transfers, or on-off actions.

Assignable—A system feature that permits an operator to channel (or direct) a signal from one device to another, without the need for changes in wiring, either by means of switches or via keyboard commands to the system.

Communication link—The physical hardware required to interconnect devices for the purpose of transmitting and/or receiving data.

Computer control system—A system in which all control action takes place within the control computer. Single or redundant computers may be used.

Configurable—A system feature that permits selection through entry of keyboard commands of the basic structure and characteristics of a device or system, such as control algorithms, display formats, or input/output terminations.

C.R.T.—Cathode Ray Tube

Distributed control system—That class of instrumentation (input/output devices, control devices and operator interface devices) which in addition to executing the stated control functions also permits transmission of control, measurement, and operating information to and from a single or a plurality of user-specifiable locations, connected by a communication link.

I/O—Input/Output

Shared controller—A control device that contains a plurality of pre-programmed algorithms which are user retrievable, configurable, and connectable, and allows user defined control strategies or functions to be implemented. Control of multiple process variables can be implemented by sharing the capabilities of a single device of this kind.

Shared display—The operator interface device used to display signals and/or data on a time shared basis. The signals and/or data, i.e., alphanumeric and/or graphic, reside in a data base from where selective accessibility for display is at the command of a user.

Software—Digital programs, procedures, rules, and associated documentation required for the operation and/or maintenance of a digital system.

Software link—The interconnection of system components or functions via software or keyboard instruction.

Supervisory set point control system—The generation of set point and/or other control information by a computer control system for use by shared control, shared display or other regulatory control devices.

4 Symbols

4.1 General

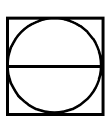
Standard instrumentation symbols as shown in ISA-5.1 are retained as much as possible for flow diagram use, but are supplemented as necessary by the new symbols in Sections 4.2 through 4.6. Symbol size should be consistent with ISA-5.1, Section 3. The symbol descriptions listed to the right of each symbol are intended as guidelines for applications, and are not intended to be all inclusive. The symbol may be used if one or more of the descriptions apply. Shared signal lines can be expressed by the symbol for a system link (See Section 4.6.1.).

4.2 Distributed control/shared display symbols

Advances in control systems brought about by microprocessor based instrumentation permit shared functions such as display, control and signal lines. Therefore, the symbology defined here should be "Shared Instruments," which means shared display and/or shared control. The square portion of this symbol, as shown in paragraphs 4.2.1 through 4.2.3 has the meaning of shared type instrument.

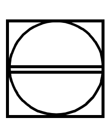
4.2.1 Normally accessible to operator

Indicator/Controller/Recorder or Alarm Points—usually used to indicate video display.



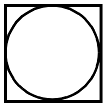
1) Shared display.
2) Shared display and shared control.
3) Access limited to communication link.
4) Operator Interface on communication link.

4.2.2 Auxiliary operator's interface device



1) Panel mounted—normally having an analog faceplate—not normally mounted on main operator console.
2) Can be a backup controller or manual station.
3) Access may be limited to communication link.
4) Operator interface via the communication link.

4.2.3 Not normally accessible to operator



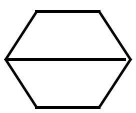
1) Shared blind controller.
2) Shared display installed in field.
3) Computation, signal conditioning in shared controller.
4) May be on communication link.
5) Normally blind operation.
6) May be altered by configuration

4.3 Computer symbols

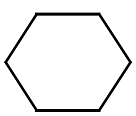
The following symbols should be used where systems include components identified as "computers," as distinct from an integral processor, which drive the various functions of a "distributed control system." The computer component may be integrated with the system via the data link, or it may be a stand-alone computer.

4.3.1 Normally accessible to operator

Indicator/Controller/Recorder or Alarm Point— usually used to indicate video display.



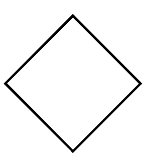
4.3.2 Not normally accessible to operator



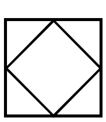
1) Input/Output interface.
2) Computation/Signal conditioning within a computer.
3) May be used as a blind controller or a software calculation module.

4.4 Logic and sequential control symbols

4.4.1 General symbol—For undefined complex interconnecting logic or sequence control. (Also see ISA-5.1).

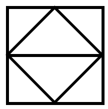


4.4.2 Distributed control interconnecting logic controller with binary or sequential logic functions.



1) Packaged programmable logic controller, or digital logic controls integral to the distributed control equipment.
2) Not normally accessible by the operator.

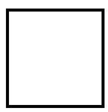
4.4.3 Distributed control interconnecting logic controller with binary or sequential logic functions.



1) Packaged programmable logic controller, or digital logic controls integral to the distributed control equipment.
2) Normally accessible to the operator.

4.5 Internal system function symbols

4.5.1 Computation/Signal conditioning



1) For block identification refer to ISA-5.1, Table 2 "Function Designations for Relays."
2) For extensive computational requirements, use designation "C." Explain on supplementary documentation.
3) Used in conjunction with function relay bubbles per ISA-5.1.

4.6 Common symbols

4.6.1 System link

1) Used to indicate either a software link or manufacturer's system supplied connections between functions.
2) Alternatively, link can be implicitly shown by contiguous symbols.
3) May be used to indicate a communication link at the user's option.

4.7 Recorders and other historical data retention

4.7.1 Conventional hard-wired recording devices such as strip chart recorders shall be shown in accordance with ISA-5.1. (Refer to Appendix A.2.2. of this standard.)

4.7.2 For assignable recording devices use Symbol 4.2.1.

4.7.3 Long term/mass storage of a process variable by digital memory means such as tape, disc, etc., shall be depicted in accordance with 4.2 or 4.3 of this standard, depending on the location of the device.

5 Identification

For purposes of this standard, identification codes shall be consistent with ISA-5.1, with the following additions.

5.1 Software alarms

Software alarms may be identified by placing ISA-5.1, Table 1, letter designators on the input or output signal lines of the controls, or other specific integral system component. See Section 6 Alarms of this standard.

5.2 Contiguity of symbols

Two or more symbols can adjoin to express the following means in addition to those shown in ISA-5.1:

1) Communication among the associated instruments, e. g.,
   - Hard wiring
   - Internal system link
   - Backup
2) Instrument integrated with multiple functions, e.g.,
   - Multipoint recorder
   - Control valve with integrally mounted controller.

The application of contiguous symbols is a user option.

If the intent is not absolutely clear, contiguous symbols should *not* be used.

6 Alarms

6.1 General

All hard-wired standard devices and alarms, as distinct from those devices and alarms specifically covered in this standard, shall be shown in accordance with ISA-5.1, Table 1.

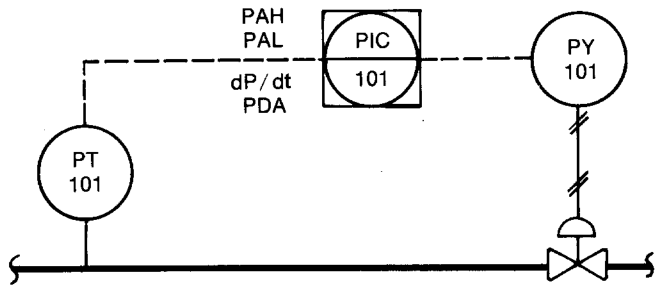
The examples in paragraph 6.2 illustrate principles of the methods of symbolization and identification. Additional applications that adhere to these principles may be devised as required. The location of the alarm identifiers is left to the discretion and convenience of the user.

6.2 Instrument system alarms

6.2.1 Multiple alarm capability is provided in most systems. Alarms covered by this standard should be identified as shown by the examples in 6.2.2 and 6.2.3.

6.2.2 Alarms on measured variables shall include the variable identifiers, i.e.:

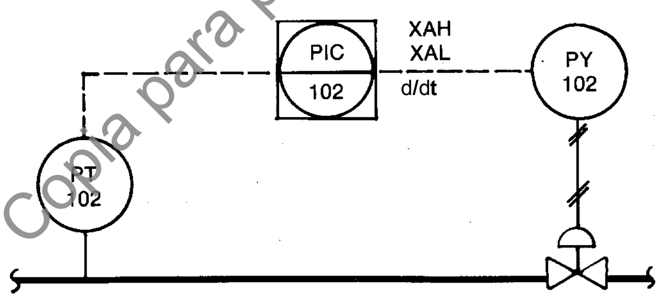
Pressure:	PAH	(High)
	PAL	(Low)
	dP/dt	(Rate of change)
	PDA	(Deviation from set point)



Example 6.2.2

6.2.3 Alarms on controller output shall use the undefined variable identifier X, i.e.:

XAH	(High)
XAL	(Low)
d/dt	(Rate of change)



Example 6.2.3

Appendix A — Examples

A.1 Examples of use

A.1.1 The following figures illustrate some of the various combinations of symbols presented in this standard and ISA-5.1. These symbols may be combined as necessary to fulfill the needs of the user.

A.1.2 Controllers located in the diagram main information line are to be considered the primary controllers. All devices outside the main line provide a backup or secondary function.

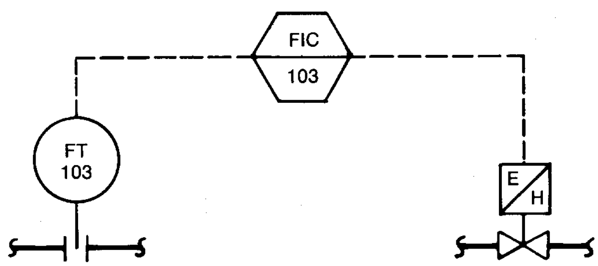


Figure A1. Computer Control—No Backup - Shared Display

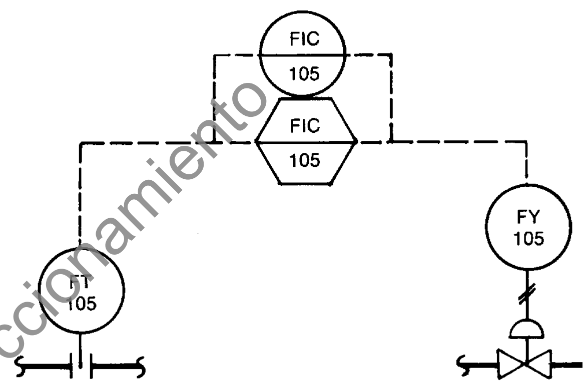


Figure A2. Computer Control—With Analog Backup

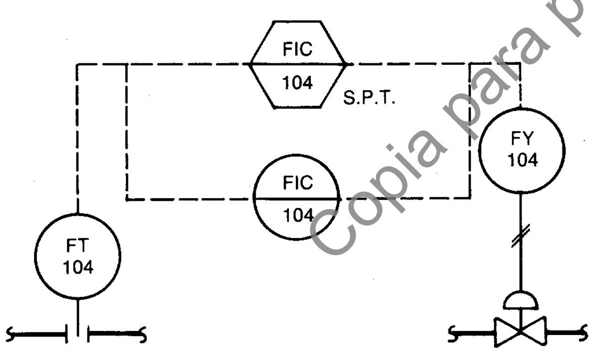


Figure A3. Computer Control—Full Analog Backup Through Set Point Tracking (SPT)

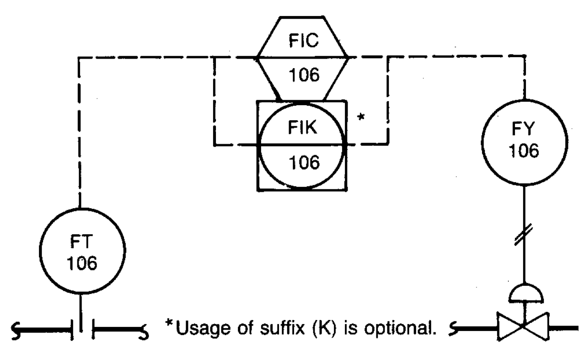


Figure A4. Computer Control-Full Backup from Distribute Control Instrumentation. Computer Uses Instru ment System Communication Link

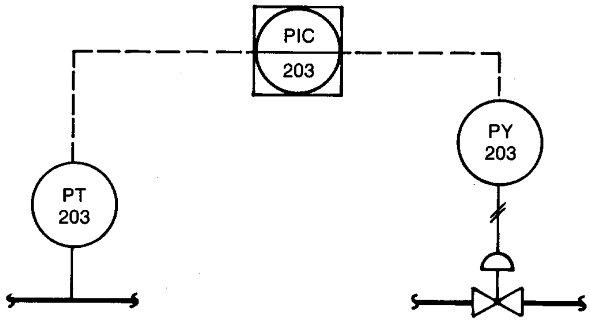


Figure A5. Shared Display/Shared Control—No Backup

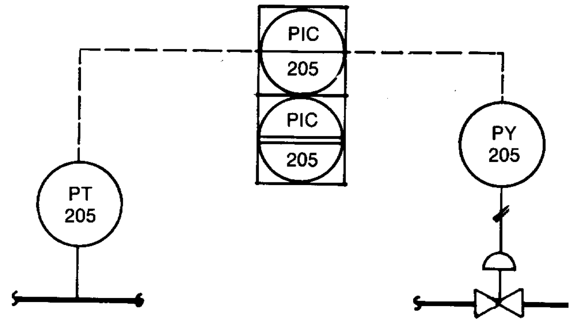


Figure A6. Shared Display/Shared Control—With Auxilia
Operator's Interface Device

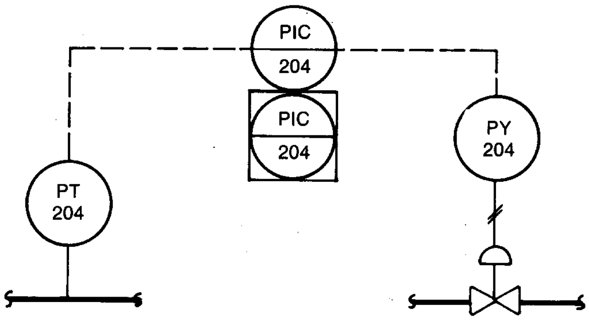


Figure A7. Analog Control—Interfaced with Shared Display. Shared Control Backup

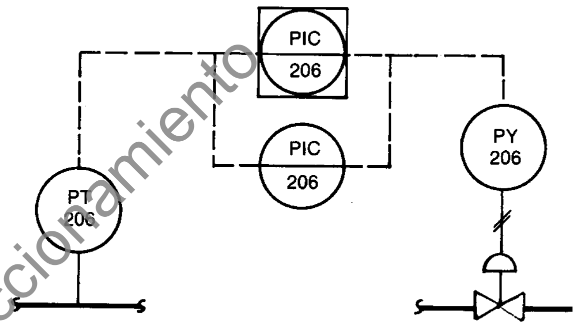


Figure A8. Shared Display/Shared Control—With Analc
Controller Backup

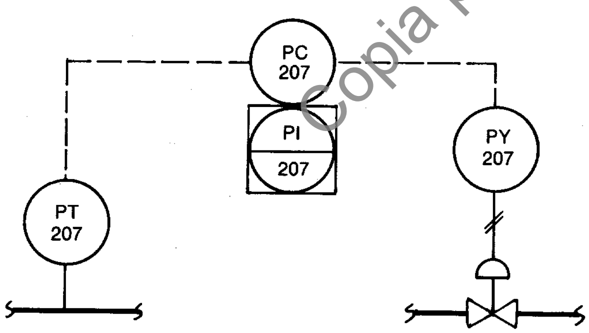


Figure A9. Analog Control—Blind Controller. Shared Display

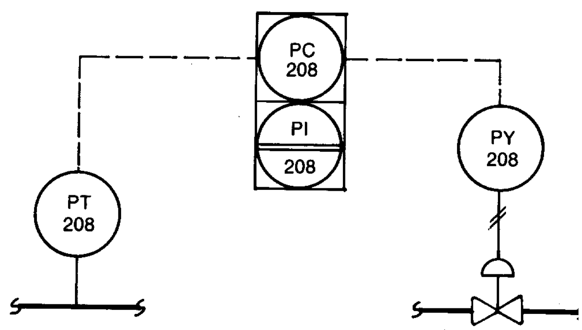


Figure A10. Blind Shared Control—With Auxiliary Operator:
Interface Backup

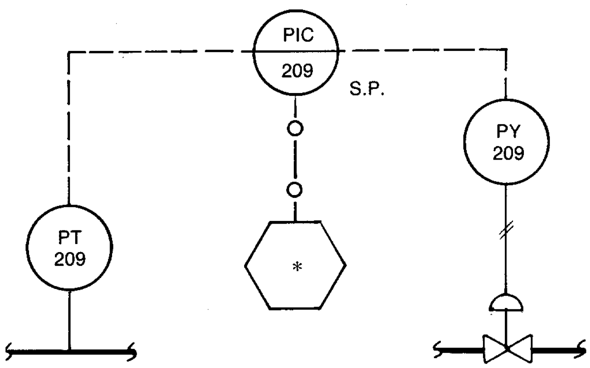


Figure A11. Supervisory Set Point Control—Analog Controller with Conventional Faceplate. Computer Supervisory Set Point via Communication Link

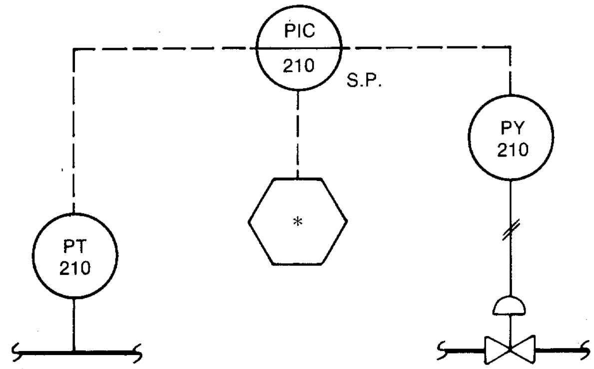


Figure A12. Supervisory Set Point Control—Analog Controller Complete with Conventional Faceplate. Computer Supervisory Set Point Hardwired.

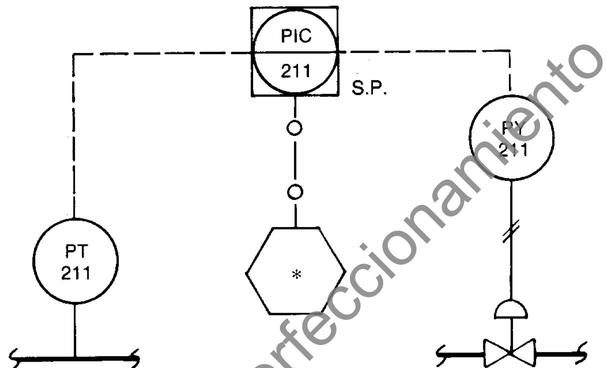


Figure A13. Supervisory Set Point Control—Shared Display Shared Control with Full Computer Access via the Communication Link

*User identification is optional

A.2 Typical Flow Diagrams

A.2.1 Figure A.14 combines the basic symbols of this standard in a simplified drawing. It is intended to provide a hypothetical example and to stimulate the user's imagination in the application of symbolism to this equipment. Figure A.14 is arranged in the following manner:

1) Volumetric fuel and air flows provide inputs for combustion system firing rate and fuel air ratio via distributed control instrumentation. Set points for both rate and ratio can be computer generated.

2) Combustion air and gas pressures are monitored by pressure switches which control the gas safety shutoff valve via UC-600 "distributed control interconnecting logic."

3) Material moisture content is measured, dry weight of the input material is calculated, and feed rate is controlled by MT-300 and WC-301. Discharged material moisture content is read by MT-302. At this point, firing rate and/or feed rate could be controlled by the Distributed Control System (DCS) instrumentation or by the computer taking other process variables into consideration.

4) British thermal unit (Btu) analysis (AT-97) is input to the computer system to generate feed forward control adjusting firing rate, in Btu/hr. The set point is calculated by the computer, based on feed rate, weight, and moisture content.

5) Internal system links are shown for selected computer input/output, while the firing rate and ratio set points are implied. Shown in the same manner, the links between the calculation modules and the controllers are implied by contiguous symbols, while the wild flow to the ratio control is shown in the system link symbol.

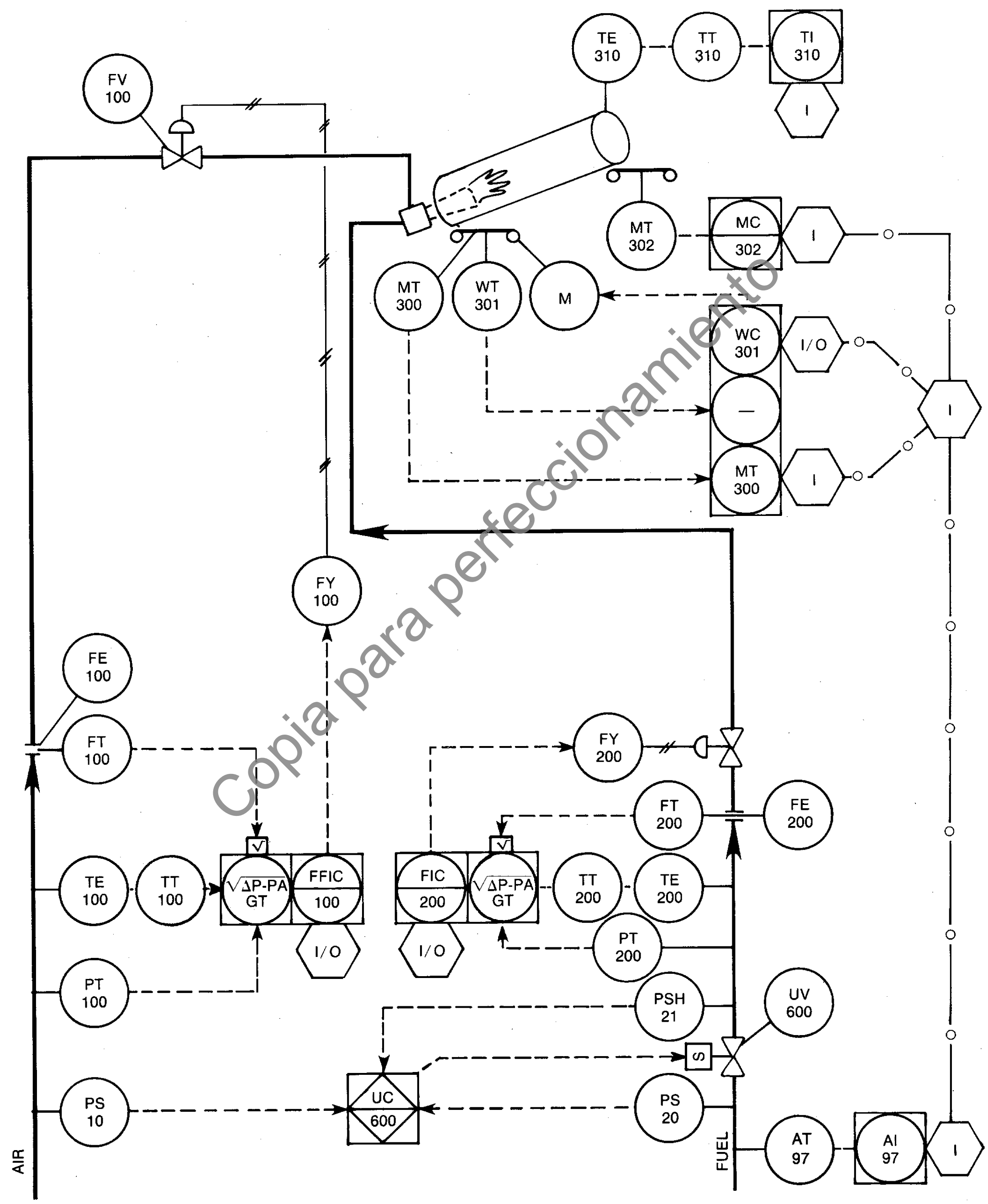
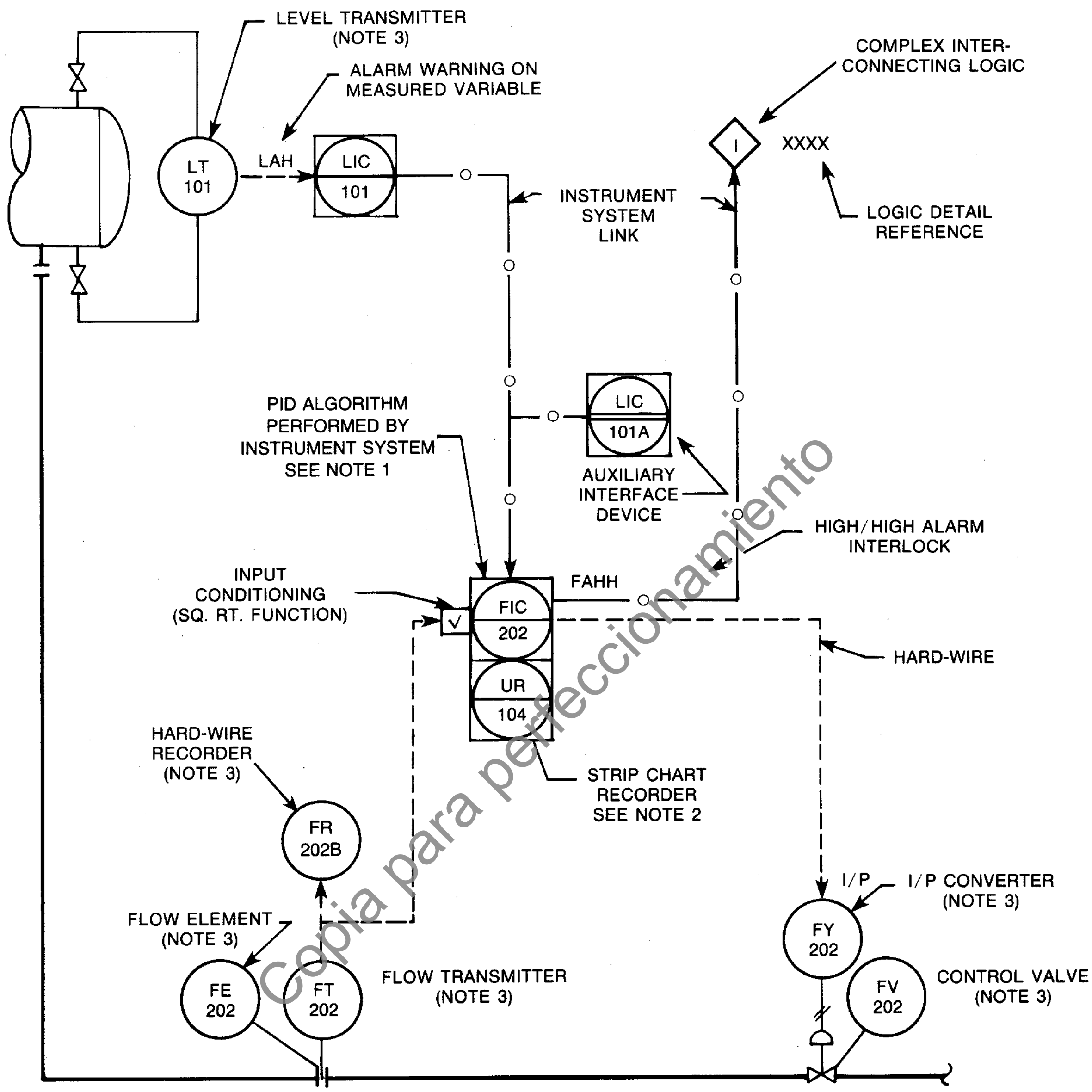


Figure A.14 — Example — simplified drawing

A.2.2 Figure A.15 combines the symbols to depict a cascade loop with alarms. Notes are added on the diagram itself for clarification purposes only.



Notes: Shared Display
1. Display/adjustments on console. Communication via data link.
2. Located in console. Signal selected from instrument system data base.
3. Field mounted.

Figure A.15 — Typical flow diagram—cascade control loop

Developing and promulgating technically sound consensus standards, recommended practices, and technical reports is one of ISA's primary goals. To achieve this goal the Standards and Practices Department relies on the technical expertise and efforts of volunteer committee members, chairmen, and reviewers.

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ISA
Attn: Standards Department
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, NC 27709

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STANDARD

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Instrument Loop Diagrams

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ISA–The Instrumentation, Systems, and Automation Society

ISA-5.4-1991
Instrument Loop Diagrams

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

Preface

The information contained in the Preface and Forward is for information only and is not a part of the standard.

This standard is prepared as part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but must be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and request that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P. O. Box 12277, Research Triangle Park, NC 27709. Telephone (919) 549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to U.S.A. users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will try to introduce SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, published by the Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1982, and future revisions will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employers of the individual, of the ISA, or of any of the standards that ISA develops.

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Foreword

Instrument loop diagrams are suitable for general use throughout industry. It is important to consider their value for design, construction, checkout, start-up, operation, maintenance, rearrangement, and reconstruction. Benefits can include reduction in engineering costs, improved loop integrity and purchasing accuracy, and easier maintenance troubleshooting.

An instrument loop diagram can be effective on any size project from one or two loops up to large and complex installations. It can present on one sheet all the information or references to the information needed for installation, checkout, start-up and maintenance. Without the use of an instrument loop diagram, that information is spread among many other documents and is not readily available. Updating this single diagram to "as built" status is more easily achieved than updating the variety of other documents.

This standard does not mandate the style and content of instrument loop diagrams, but rather it is a consensus concerning their generation. As such, it has the same strengths and weaknesses as other consensus standards. Its primary strength is that the format and content guidelines apply to the majority of instrumentation applications. Its weakness is that it is not specific enough to satisfy the special requirements of particular interest groups.

The ISA Standards Committee on Instrument Loop Diagrams operates within the ISA Standards and Practices Department. This committee is appreciative of the work of previous SP5.4 committees and has tried to treat their work with respect. This committee would like to acknowledge the work of the SP5.1 committee in developing ISA-5.1, Instrumentation Symbols and Identification. One of our major goals has been to have the ISA 5.4 standard conform to the revised 5.1 standard.

Contents

1 Purpose

1.1 Provide guidelines. This standard will provide guidelines for the preparation and use of instrument loop diagrams in the design, construction, start-up, operation, maintenance, and modification of instrumentation systems.

1.2 Assist understanding. This standard will assist the understanding of instrument loop diagrams and improve communications among technical, non-technical, management, design, construction, operating, and maintenance personnel.

2 Scope

2.1 Additional information for individual loop. This standard establishes minimum required information and identifies additional optional information for a loop diagram for an individual instrumentation loop. This loop is typically part of a process depicted on the class of engineering drawings referred to as Piping and Instrument Drawings (P&IDs).

2.2 Suitability. This standard is suitable for use in the chemical, petroleum, power generation, air conditioning, metal refining, and many other industries.

2.3 Specialty fields. Certain fields, such as astronomy, navigation, and medicine, use very specialized instruments that are different from the conventional industrial process instruments. No specific effort to have this standard meet the requirements of those fields has been made. However, this standard is flexible enough to meet many of the needs of specialty fields.

3 Applications

3.1 Serve many purposes. Loop diagrams serve many purposes. Several of these stated below are in the chronology of project development.

3.2 Design

1) Illustrate control philosophy and confirm the completeness of submitted data

2) An extension of P&IDS, which show the components and accessories of the instrument loop, connections between devices, and identification of component action

3) The specification of instrument hardware items and a means of communicating requirements to vendors

3.3 Construction

1) Panel instrumentation interconnections and checkout diagram

2) Instrumentation installation references and special requirements

3) Instrumentation interconnections

4) Instrumentation loop checkout

5) Inspection and documentation

3.4 Start-up

1) Pre-start-up commissioning and calibration

2) Training tool and aid

3.5 Operation

1) Communication medium between operations, maintenance, and engineering personnel

2) Training device for operations

3.6 Maintenance

1) Troubleshooting

2) Routine calibration

3) Preventative and corrective maintenance tool

3.7 Modification

1) Rearrangement

2) Reconstruction

3) Enhancement

4 Definitions

This standard is an extension of the communications defined by ISA-5.1, “Instrumentation Symbols and Identification”, and the definitions of that standard therefore apply. The guidelines of this standard cover the content of a loop diagram drawing, and it does not produce any new definitions for that presentation process.

5 Content

5.1 General. The instrument loop diagram is a composite representation of instrument loop information. It contains all associated electrical and piping connections and should contain all of the information needed to accommodate the intended uses. Classified below are minimum requirements and some established options that can be used to match the desired uses.

5.2 Minimum content requirements. As a minimum, an instrument loop diagram shall contain the information covered below.

1) Identification of the loop and loop components shown on the P&IDS. Other principal components of the loop to be shown and identified under ISA-5.1, “Instrumentation Symbols and Identification”.

2) Word description of loop functions within the title. If not adequate, use a supplemental note. Identify any special features or functions of shutdown and safety circuits.

3) Indication of the interrelation to other instrumentation loops, including overrides, interlocks, cascaded set points, shutdowns and safety circuits.

4) All point-to-point interconnections with identifying numbers or colors of electrical cables, conductors, pneumatic multitubes, and individual pneumatic and hydraulic tubing. This identification of interconnections includes junction boxes, terminals, bulkheads, ports, and grounding connections.

5) General location of devices such as field, panel, auxiliary equipment, rack, termination cabinet, cable spreading room, I/0 cabinet, etc.

6) Energy sources of devices, such as electrical power, air supply, and hydraulic fluid supply. Identify voltage, pressure, and other applicable requirements. For electrical sources, identify circuit or disconnect numbers.

7) Process lines and equipment sufficient to describe the process side of the loop and provide clarity of control action. Include what is being measured and what is being controlled.

8) Actions or fail-safe positions (electronic, pneumatic, or both) of control devices such as controllers, switches, control valves, solenoid valves, and transmitters (if reverse-acting). These are to be identified in accordance with ISA-5.1, “Instrumentation Symbols and Identification”.

5.3 Optional content information. Additional information needs to be considered for its effectiveness in accommodating the intended uses. Stated below are typical examples of items for inclusion at the user's discretion.

1) Process equipment, lines, and their identification numbers, source, designation, or flow direction.

2) Reference to supplementary records and drawings, such as installation details, P&IDs, location drawings, wiring diagrams or drawings, and instrument specifications.

3) Specific location of each device, such as elevation, area, panel subdivision, rack or cabinet number and location, I/O location, etc.

4) Cross reference between loops that share a common discrete component, such as multipen recorders, dual indicators, etc.

5) References to equipment descriptions, manufacturers, model numbers, hardware types, specifications or data sheets, purchase order numbers, etc.

6) Signal ranges and calibration information, including setpoint values for switches, and alarm and shutdown devices.

7) Software reference numbers, such as I/O addresses, control block types and names, network interfaces, point names, etc.

8) Engraving or legend information that helps identify the instrument or accessory.

9) Accessories, tagged or otherwise identified, such as regulators, filters, purge meters, manifold valves, root valves, etc.

10) References to manufacturer's documentation such as schematics, connection details, operating instructions, etc.

11) Color code identification for conductors or tubes that use numbers for differentiation.

6 Format

6.1 Consistency for ease of use. The following format conventions should be consistently employed for improved communications and ease of use.

6.2 Size of drawing. The minimum size for the original drawing should be 11 inches X 17 inches. Attention to the proper size of text and symbols will keep them legible on reduced copies. (For convenience in printing and binding, this standard uses reduced size example figures.)

6.3 Drawing content. An instrument loop diagram should typically contain only one loop. Avoid showing a loop on multiple pages or sheets where practical. Use judgment to accommodate the individual situations where loops that share common components can be adequately and completely communicated on a single diagram. Prevent overcrowding and provide space for future additions and loop data.

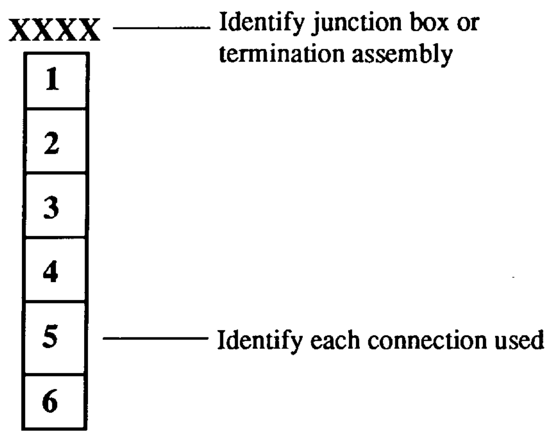
6.4 General layout. Maintain a consistent layout (horizontal or vertical) throughout a project. A suggested layout is to divide the drawing into sections for relative locations of devices.

7 Symbols

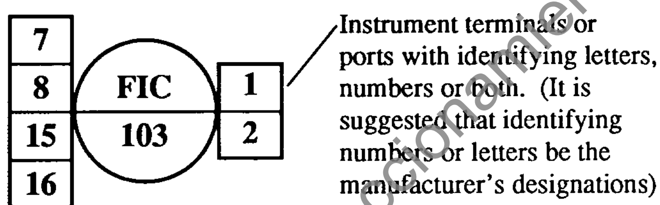
7.1 Instrument connection and action information. The symbols in ISA-5.1 apply for instrument loop diagrams. However, expansion of those symbols to include connection points, energy source (electrical, air, hydraulic), and instrument action is necessary to provide the information required on instrument loop diagrams.

> **NOTE:** The terminals or ports shown are not to be pictorial.

7.2 General terminal or bulkhead symbol

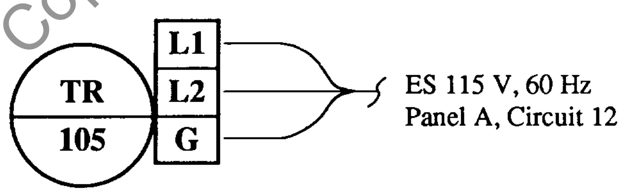


7.3 Instrument terminals or ports

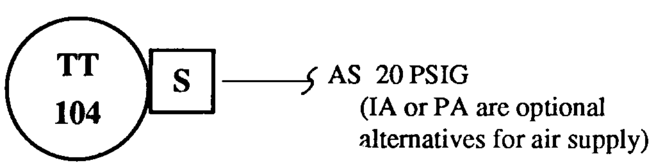


7.4 Instrument system energy supply

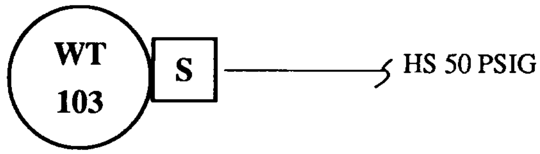
7.4.1 Electrical power supply. Identify electrical power supply followed by the appropriate supply level identification and circuit number or disconnect identification.



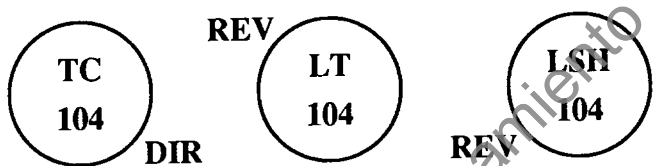
7.4.2 Air supply. Identify air supply followed by air supply pressure.



7.4.3 Hydraulic fluid supply. Identify hydraulic fluid followed by the fluid supply pressure.



7.5 Identification of instrument action. Show the direction of the instrument signal by placing appropriate letters close to the instrument bubble. Identify an instrument in which the value of the output signal increases or changes to its maximum value, as input (measured variable) increases by the letters "DIR." Identify an instrument in which the value of the output signal decreases or changes to its minimum value, as the value, of the input (measured variable) increases by the letters "REV." However, since most transmitters are direct-acting, the designation DIR is optional for them.



8 Examples

8.1 Typical symbols for various control hardware. The example figures illustrate this standard's symbols and identifications that are typical for the various instrument hardware types. This usage does not imply, however, that the applications or designations of the symbols or identifications are restricted in any way. No inference is to be drawn from the choice of any of the information depicted as being a recommendation for the illustrated control method.

8.2 Examples of minimum required items. Sample instrument loop diagrams illustrate the use of the symbols for various relatively simple feedback flow control loops. Figures 1, 2, and 3 show the minimum required items on those loop diagrams.

8.3 Examples of minimum plus optional items. Figures 4 through 6 show the minimum required items, plus examples of optional items presented in various alternate formats.

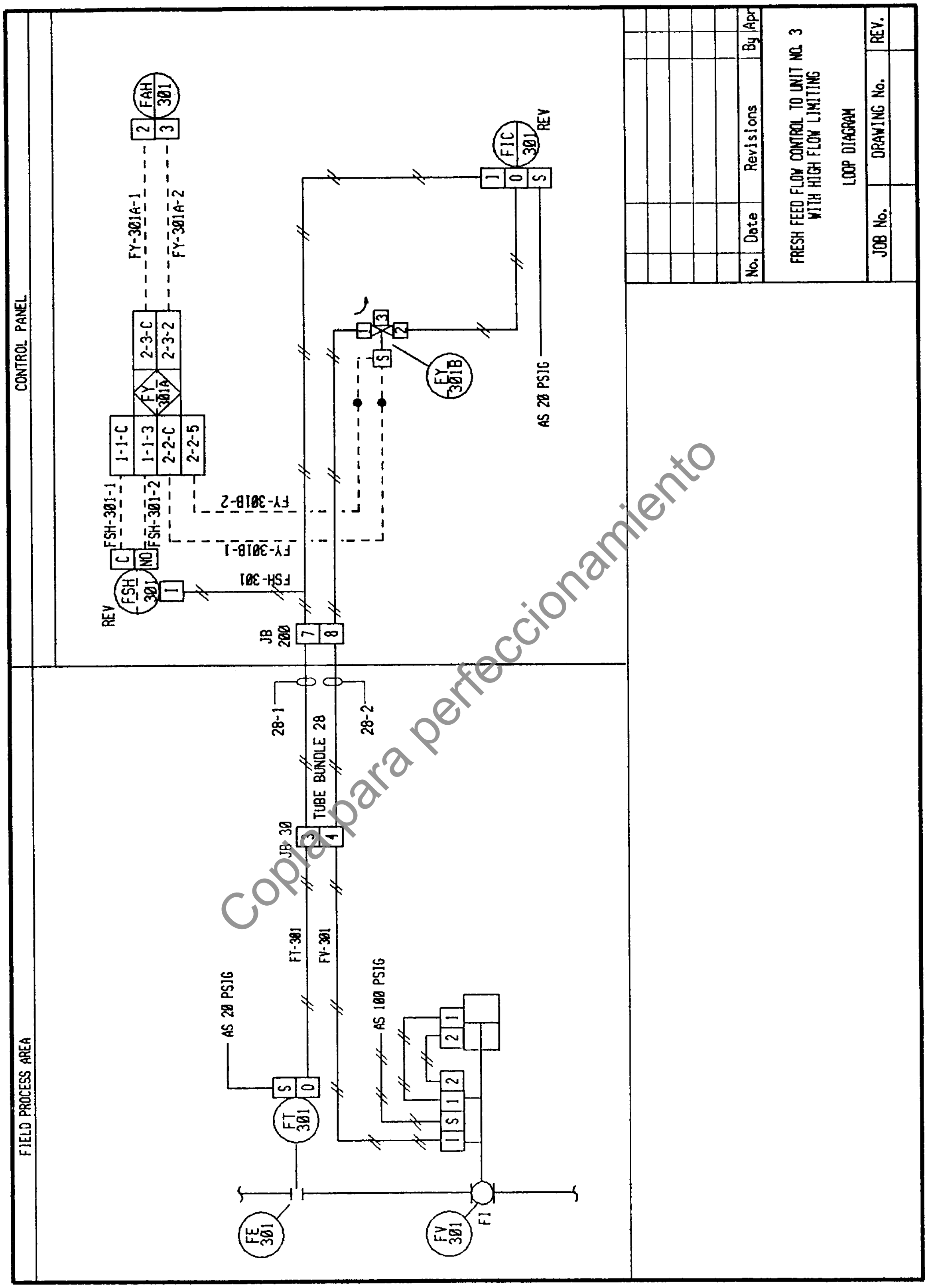


Figure 1 — Loop diagram, pneumatic control, minimum required items.

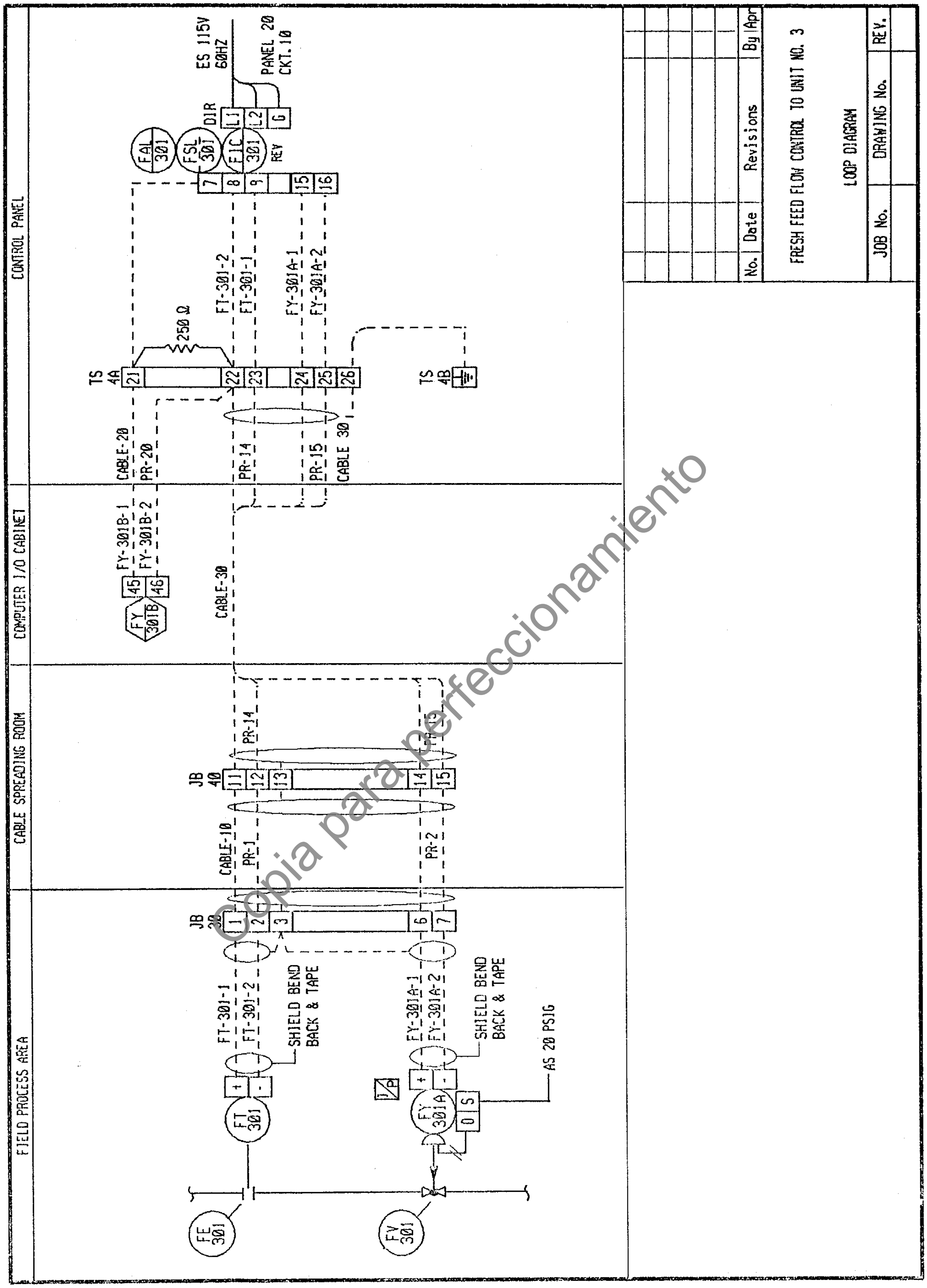


Figure 2 — Loop diagram, electronic control, minimum required items.

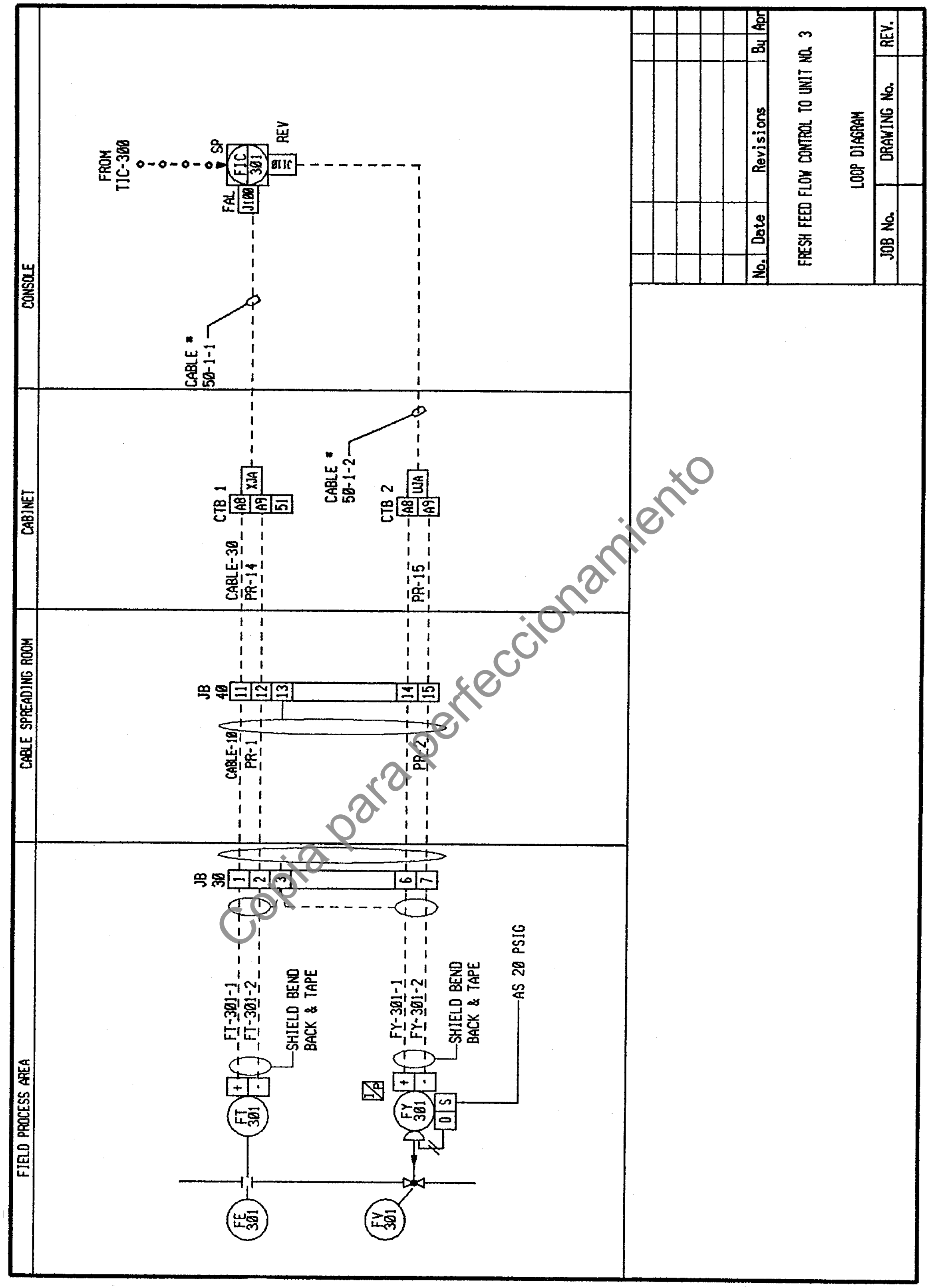


Figure 3 — Loop diagram, shared display and control, minimum required items.

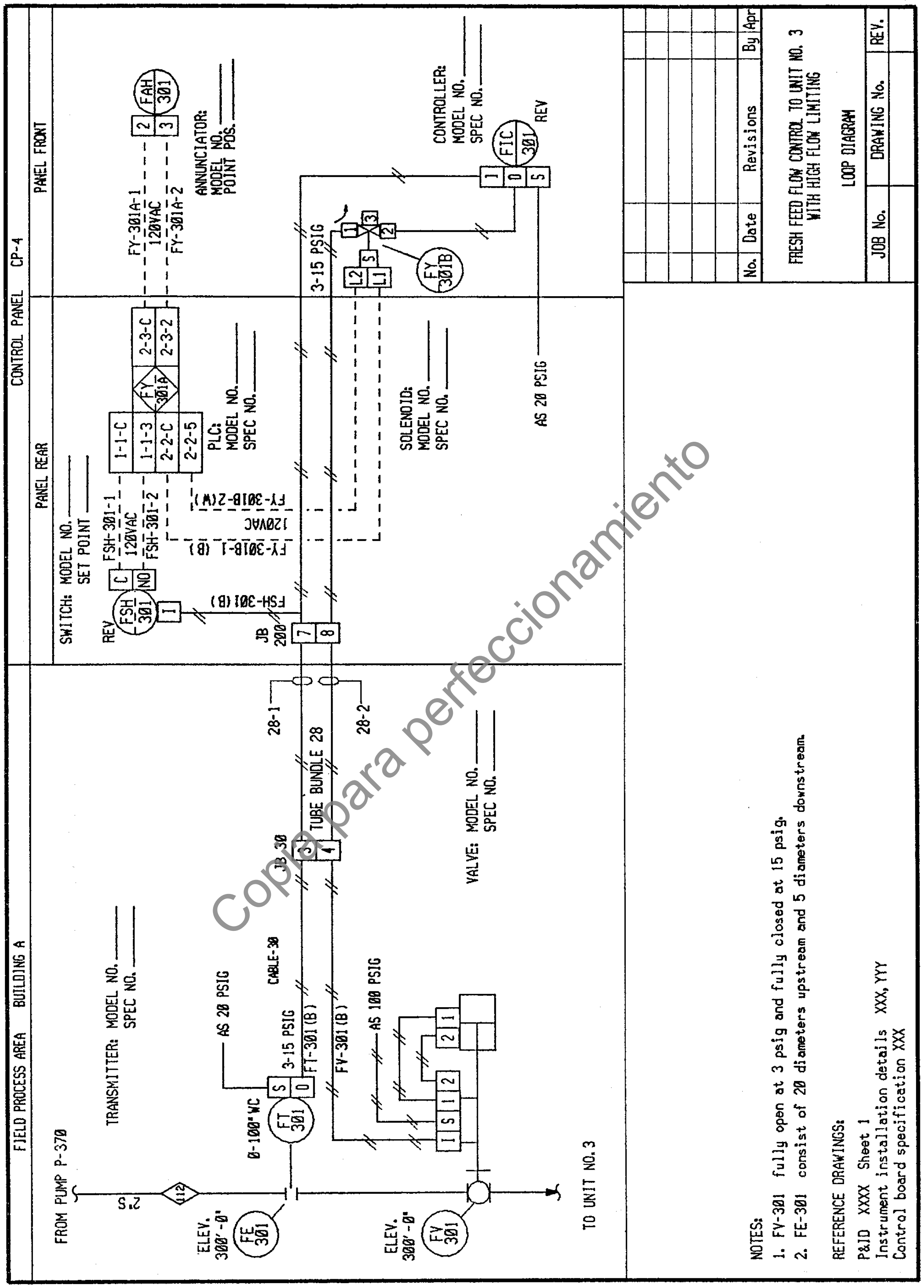


Figure 4 — Loop diagram, pneumatic control, minimum required items plus optional items.

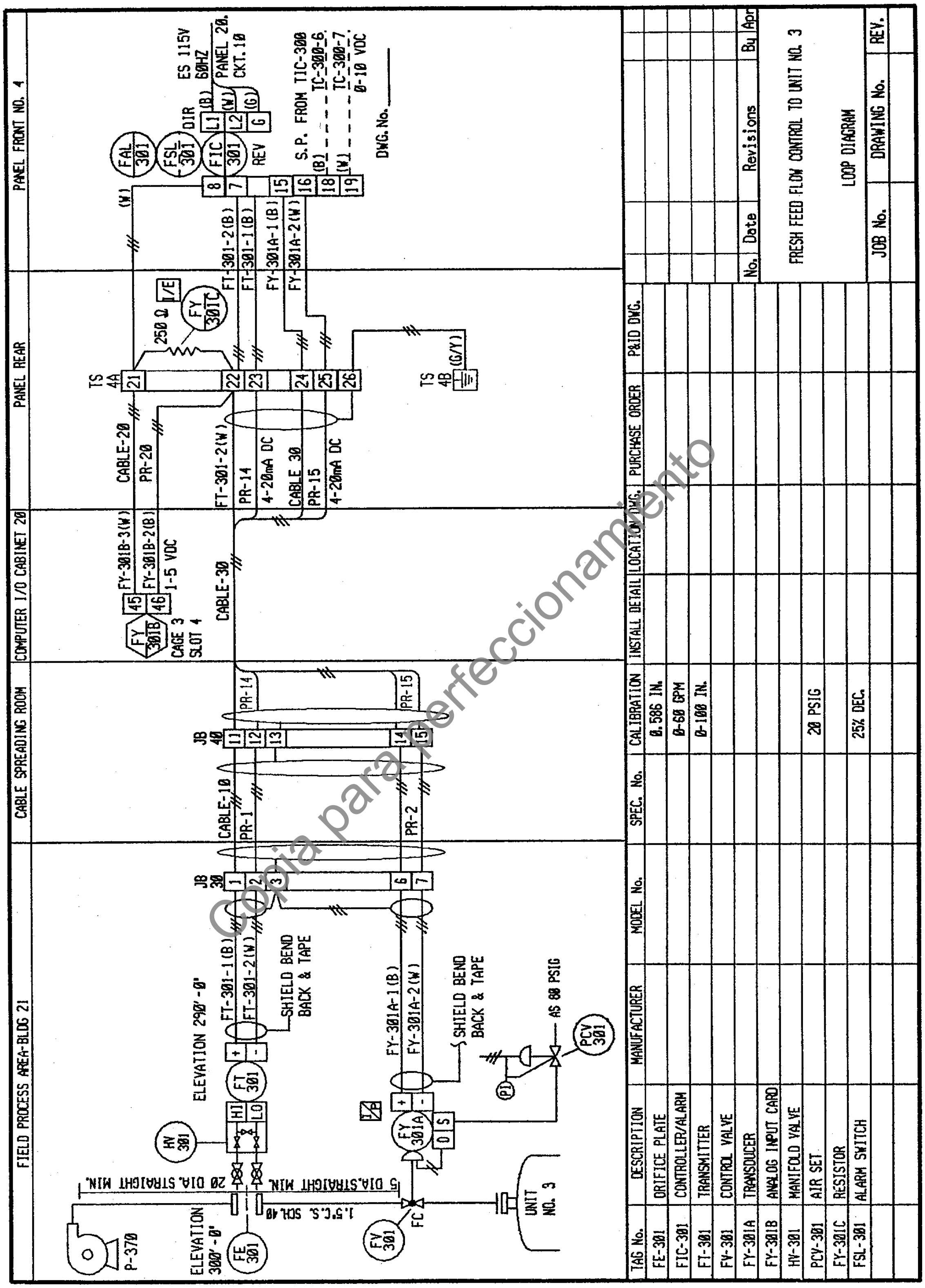


Figure 5 — Loop diagram, electronic control, minimum required items plus optional items.

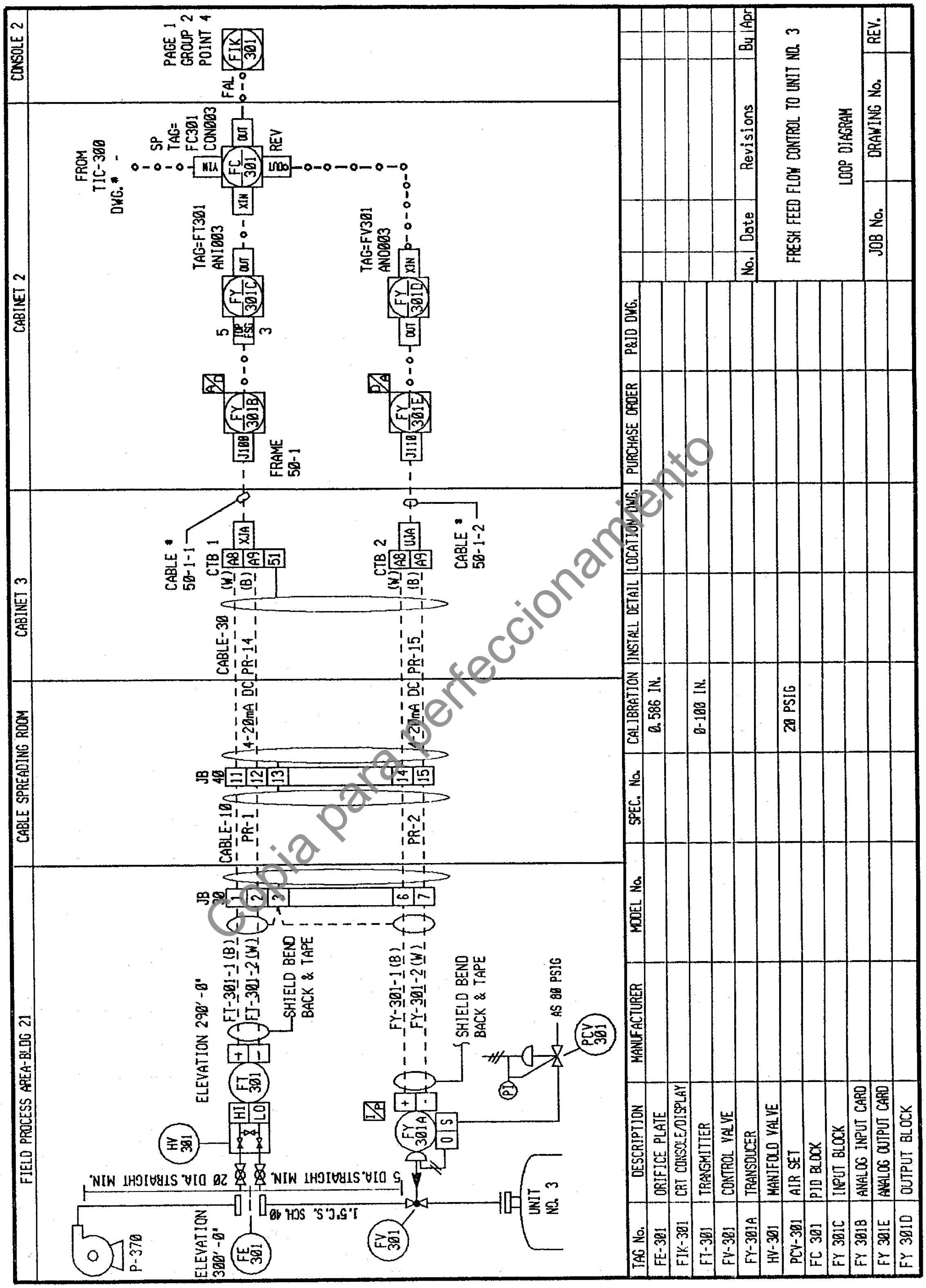


Figure 6 — Loop diagram, shared display and control, minimum required items plus optional items.

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STANDARD

ISA–5.5–1985

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Graphic Symbols for Process Displays

Approved 3 February 1986

ISA–The Instrumentation, Systems, and Automation Society

ISA-5.5-1985, Graphic Symbols for Process Displays

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P.O. Box 12277
Research Triangle Park, North Carolina 27709

Preface

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The information contained in this preface, in the footnotes, and in the appendices is included for information only and is not part of the standard.

The original draft of this document resulted from the committee work of the International Purdue Workshop on Industrial Computer Systems, the Man/ Machine Communication Committee TC-6.

The use of graphic symbols representing entities and characteristics of processes has evolved rapidly during the course of the last decade. Technology has allowed the presentation of a physical process to be represented and controlled by the use of computers and advanced electronic systems. These systems use video-display technologies such as CRTs, plasma screens, and other media to present to the user a graphic representation of his process. It is through these devices and the symbology used to represent the process in question that the user monitors and controls the particular operation.

Process displays convey information to the user in the form of both text and graphic symbols. Text information is based on the use of numeric data and the alphabet to construct the words necessary to convey the meaning of the information. This text information is structured around the use of written language and is highly ordered and understood by users. On the other hand, the use of graphic symbols for process and information presentation is highly dependent upon the manufacturer and the user of the product. These graphic symbols are generally customized to the particular application at hand.

Standard graphic symbols provide a more logical and uniformly understandable mechanism for modern control processes. For example, a control system may be constructed of several control systems and a central control system. In cases such as this, the operator often finds that he must become familiar with the graphic symbology of several different systems, although they may represent common elements.

It is the intent of this document that both the manufacturers and users of process displays use these graphic symbols in their systems whenever applicable. It is recognized that technology is rapidly changing in the types of devices available for process display use. The graphic symbols suggested in this standard should provide a foundation for all display systems that are used to display and control processes. The graphic symbols that are represented in this standard are divided into 13 major groups. Attributes associated with the various types of symbols such as color usage, blink, orientation, etc., are addressed in the document.

The symbols defined in ISA-S5.5 are intended to supplement those of ISA-S5.1 and ISA-S5.3 to provide a cohesive integration of graphic symbology and common industry usage of flow diagrams. ISA-S5.1 and ISA-S5.3 are drafting standards which govern the depiction of process and instrumentation symbols for drawings and other printed documents. The ISA-S5.5 symbols were developed for use on video devices that represent both character display and pixel addressable displays. Use of the symbols also applies to both color and monochromatic video displays as well as other media. Therefore, the symbols that are represented in this standard may differ from those in the other standards because of the nature of the physical devices used to display the symbols. The principal users of these symbols are operators and other personnel who use information concerning process operations.

The main intent of the graphic symbols is to provide to the user an easily understandable representation of his process on a display device. Computers, distributed control systems, stand-alone microprocessor-based systems, etc., can appear to be similar or to perform similar functions; however, they are diverse in philosophy and graphic presentation. Therefore, it is essential that a common set of symbols be used to convey process information to the users of such devices.

The symbols presented in this standard are by no means all that were suggested or that may be required; however, by adopting these as a standard, the majority of present processes may be adequately represented. When it becomes necessary to develop special symbols for equipment not included in the standard, simplicity of form is considered of paramount importance.

The ISA Standards Committee on Graphic Symbols for Process Displays SP5.5 operates within the ISA Standards and Practices Department, Norman Conger, Vice President. The persons listed below served as members of ISA Committee SP5.5, which prepared this standard:

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A. S. Fortunak	Inland Steel Company
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F. W. Magalski	Industrial Data Terminals
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J. A. Shaw	Taylor Instrument Company
J. Ventresca	AccuRay Corporation
D. Winward	Aydin Controls

The persons listed below served as members of ISA Committee SP5, which approved this standard:

NAME	COMPANY
D. E. Rapley, Chairman	Rapley Engineering Services
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This standard was approved for publication by the ISA Standards and Practices Board in December 1985.

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T. J. Harrison*	IBM Corporation
R. G. Marvin*	Roy G. Marvin Company
W. B. Miller*	Moore Products Company
G. Platt*	Consultant
J. R. Williams*	Stearns Catalytic Corporation

*Director Emeritus

Contents

1 Purpose

The purpose of this standard is to establish a system of graphic symbols for process displays that are used by plant operators, engineers, etc., for process monitoring and control. The system is intended to facilitate rapid comprehension by the users of the information that is conveyed through displays, and to establish uniformity of practice throughout the process industries.

Resulting benefits are intended to be as follows:

a) A decrease in operator errors

b) A shortening of operator training

c) Better communication of the intent of the control system designer to the system users

An objective of the standard is to insure maximum compatibility of symbols on process visual display units (VDUs) with related symbols used in other disciplines.

The symbols in this standard are intended to depict processes and process equipment. The symbols are suitable for use on Visual Display Units (VDUs), such as Cathode Ray Tubes (CRTs).

2 Scope

The standard is suitable for use in the chemical, petroleum, power generation, air conditioning, metal refining, and numerous other industries.

Though the standard may make use of standard symbols now used for piping and instrument diagrams, logic diagrams, loop diagrams, and other documents, the symbols of the standard are generally expected to be used in ways complementing existing types of engineering documents.

The symbolism is intended to be independent of type or brand of hardware or computer software.

2.1 Application to work activities

This standard is suitable for use whenever any reference to process equipment on VDUs is required. Such references may be required for the following uses as well as others:

a) Process displays on CRTs

b) Process displays on other visual media such as plasma displays, liquid crystal displays, etc.

2.2 Relationship to other ISA Standards

This standard complements, whenever possible, ISA Standards S5.1 "Instrumentation Symbols and Identification," S5.3 "Flow Diagram Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems," RP60.05 "Graphic Displays for Control Centers," and ANSI/ISA S51.1 "Process Instrumentation Terminology."

2.3 Relationship to other symbol standards

This document complements the ANSI Standard for process flow sheets, ANSI Y32.11M — "Graphic Symbols for Process Flow Diagrams in the Petroleum and Chemical Industries" and ANSI/NEMA Standard ICS 1-1978 "General Standards for Industrial Control and Systems" whenever possible and practical.

2.4 Definitions

Aspect ratio: The ratio of a symbol's height to its width.

Background: The field that information is displayed upon for contrast.

Blinking: A periodic change of hue, saturation, or intensity of a video display unit pixel, character, or graphic symbol.

Character: A term used to refer to a predefined group of pixels.

Chromaticity: The color quality of light, which is characterized by its dominant wavelength and purity.

Color coding: The use of different background and foreground colors to symbolically represent processes and process equipment attributes, such as status, quality, magnitude, identification, configuration, etc.

Foreground: The information element on a background field.

Graphic symbol: An easily recognized pictorial representation.

Highlighting: A term encompassing various attention-getting techniques, such as blinking, intensifying, underscoring, and color coding.

Intensity: The lumination level (i.e., brightness) of the pixels of a VDU.

Pixel: The smallest controllable display element on a VDU. Also referred to as picture element (PEL).

Process visual display: A dynamic display intended for operators and others engaged in process monitoring and control.

Reverse Video: The interchange of foreground and background attributes, such as intensity, color, etc.

Task/Surround lumination ratio: The luminance ratio between the keyboard and screen (TASK) and workplace (SURROUND) within the operator's field of view.

Visual Display Unit (VDU): A generic term used for display units based on technologies such as Cathode Ray Tubes (CRTs), Plasma Discharge Panels (PDPs), Electroluminescent Devices (ELs), Liquid Crystal Displays (LCDs), etc.

3 Symbols

3.1 Symbol usage

3.1.1 General

1) The graphic symbols in this standard are intended for use on VDUs.

2) Because size variations of symbols representing the various pieces of equipment are anticipated, no scale is indicated on the graphic symbol sketches. The integrity of the defined symbols should be preserved by maintaining the aspect ratio depicted.

3) Color coding to improve the perception of information and ease of interpretation of the displayed image is anticipated.

4) Graphic symbols should be arranged to depict spatial relationships, energy, material and data flows in a consistent manner (e.g., left to right, top to bottom, etc.). Equipment outlines and piping lines may be differentiated by color, intensity, or width.

5) Symbols may be rotated in any orientation on a VDU in order to represent the process in the most effective manner.

6) Arrows may be used on process lines to indicate direction of flow.

7) Symbols should be shown only when they are important to understanding the operation or are an integral part of the process depicted. Symbol qualities, such as luminance, size, color, fill, and contrast should be considered collectively and judiciously in order to avoid any psychophysiological masking of adjacent display targets, such as measurement values, alarm messages, labels, etc.

8) Numeric values and text may be included to enhance comprehension. The values may be either static or dynamic.

9) Graphic displays may contain both static and dynamic symbols and data. The symbol set, while intended for color displays, is also usable on monochromatic displays.

10) Special characteristics of displays should be used to enhance the understanding of process symbols. These characteristics may be used to indicate the status of process devices:

- Reverse video
- Blinking
- Intensity variation
- Color coding

These characteristics can be used for both static and dynamic symbol applications.

11) The use of outline and solid (filled) forms to indicate status is as follows:

- An outline symbol form indicates an off, stopped, or nonactive state.
- A solid (filled) symbol form indicates an on, running, or active state.

Status designation by use of solid or outline forms are particularly applicable to the

Rotating Equipment and Valves and Actuators groups of symbols. Prudence in judgment should be used when adhering to this practice as some symbols should not change from their outline form. In depicting valve position, use solid to show open (material flowing or active) and outline to show closed (material stopped or nonactive). Another usage is solid/outline to represent a pump running/stopped as the generally accepted practice. Some industries, such as the power industry, use solid/outline to show closed (active or unit energized)/open (nonactive or unit deenergized). In these special cases, the explicit uses of these conventions are to be made clear to the operator and noted in operation manuals.

12) A symbol may be partially filled or shaded to represent the characteristic of the contents of a vessel, e.g., level, temperature, etc.

13) Properties of physical or chemical states, as measured by primary elements or instruments, can be represented on a VDU by symbolic characters. It is not normal to display these characters on a process display, but they are available if required. Appendix B contains the recommended designated characters and an example of their usage. This list has been derived from character designations based on the ISA Standard S5.1, "Instrumentation Symbols and Identification." It has been modified for use on VDU displays. An excerpt of the S5.1 document explaining the identification-letter usage is also included in Appendix B.

3.1.2 Color

Color is an effective coding technique used either singularly or redundantly with symbol, shape, and alphanumeric coding. Although this standard pertains exclusively to the definition and configuration of display symbols, certain color application guidelines have, nevertheless, been included for the convenience of the display designer. They are as follows:

1) Information-bearing color schemes should be simple, consistent, and unambiguous.

2) The most common color technology is the CRT using the raster display scheme and an additive color generation technique based on the three primaries: red, blue, and green. The number of selectable colors can range from six plus black and white to the thousands. The number of colors in one display should be limited to the minimum necessary to satisfy the process interface objectives of the display. Color is an effective coding technique for dynamic identification and classification of display elements. Used judiciously, it can improve operator performance, e.g., reduce search time, improve element identification, etc. Conversely, irrelevant color can act as visual noise and negate the positive effects of color coding. Typically, four colors can accommodate the dynamic coding requirements of process displays.

3) Large background areas should be black. In situations where the black background results in a high task/surround lumination ratio, a brighter background may be used, preferably blue or brown.

4) Compatible color combinations, i.e., those with high chromaticity contrast, should be used. Some good combinations include: black-on-yellow, red-on-white, blue-on-white, and green-on-white. Combinations to avoid include: yellow-on-white, yellow-on-green, red-on-magenta, and cyan-on-green. In each case, the weight or size of the foreground element must also be considered. Certain combinations like blue-on-black can be acceptable only when the blue element is sufficiently large. These generalizations neglect the effects of lumination levels and ambient lighting. Each pair should be evaluated on a per-case basis.

5) Use color as a redundant indicator along with text, symbol, shape, size, reverse video, blinking, and intensity coding to preserve communications of critical process state and quality information with individuals having limited color perception.

6) To insure fast operator response, use highly saturated colors such as red or yellow.

7) Colors should not be used to indicate quantitative value.

8) The display designer should establish a project-related set of generic color meanings before developing a list of specific color-to-display-element associations. This generic set should be based on applicable plant, industry, and agency (OSHA, NRC, ANSI, etc.) conventions. Each project may have its unique set of generic definitions; e.g., Project A uses red to indicate closed or inactive states, while Project B uses green. In some special cases, such as the power industry, red may indicate closed and active or unit energized. This is suitable as long as the color meanings are defined as such for the particular project. Listed below is an example of a unique project-related color plan:

Color plan example

Color	**Generic meaning**	**Element association**
Black	Background	
Red	Emergency	A) Stop B) Highest Priority Alarm C) Closed D) Off
Yellow	Caution	A) Abnormal Condition B) Second Priority Alarm
Green	Safe	A) Normal Operation B) Start C) Open D) On
Cyan (Light Blue)	Static & Significant	A) Process Equipment in Service B) Major Labels
Blue	Nonessential	A) Standby Process Equipment B) Labels, Tags, etc.
Magenta (Purple)	Radiation	A) Radiation Alarms B) Questionable Values
White	Dynamic Data	A) Measurements & State Information B) System Messages C) Trend D) Active Sequential Step

3.2 Grouping of symbols

The graphic symbols for process displays have been divided into related groups. There are 13 groups and their contents are as follows:

Group	Symbol	Section
Connectors		3.3.1
Containers and Vessels		3.3.2
Process	Distillation Tower	3.3.2
	Jacketed Vessel	3.3.2
	Reactor	3.3.2
	Vessel	3.3.2
Storage	Atmospheric Tank	3.3.2
	Bin	3.3.2
	Floating Roof Tank	3.3.2
	Gas Holder	3.3.2
	Pressure Storage Vessel	3.3.2
	Weigh Hopper	3.3.2
Electrical	Circuit Breaker	3.3.3
	Manual Contactor	3.3.3
	Delta Connection	3.3.3
	Fuse	3.3.3
	Motor	3.3.3
	State Indicator	3.3.3
	Transformer	3.3.3
	Wye Connection	3.3.3
Filters	Liquid Filter	3.3.4
	Vacuum Filter	3.3.4
Heat Transfer Devices	Exchanger	3.3.5
	Forced Air Exchanger	3.3.5
	Furnace	3.3.5
	Rotary Kiln	3.3.5
HVAC (Heating Ventilating and Air Conditioning)	Cooling Tower	3.3.6
	Evaporator	3.3.6
	Finned Exchanger	3.3.6
Material Handling	Conveyor	3.3.7
	Mill	3.3.7
	Roll Stand	3.3.7
	Rotary Feeder	3.3.7
	Screw Conveyor	3.3.7

Group	Symbol	Section
Mixing	Agitator	3.3.8
	Inline Mixer	3.3.8
Reciprocating Equipment	Reciprocating Compressor or Pump	3.3.9
Rotating Equipment	Blower	3.3.10
	Compressor	3.3.10
	Pump	3.3.10
	Turbine	3.3.10
Scrubbers and Precipators	Electrostatic Precipitator	3.3.11
	Scrubber	3.3.11
Separators	Cyclone Separator	3.3.12
	Rotary Separator	3.3.12
	Spray Dryer	3.3.12
Valves and Actuators		3.3.13
Actuators	Actuator	3.3.13
	Throttling Actuator	3.3.13
	Manual Actuator	3.3.13
Valves	Valve	3.3.13
	3-Way Valve	3.3.13
	Butterfly Valve	3.3.13
	Check Valve	3.3.13
	Relief Valve	3.3.13

The symbols are presented in Section 3.3, Structure of Symbols. The symbols are categorized into their respective groups and are presented in alphabetical order. Each symbol is described with the following information:

Group	An associated classification of similar symbols
Subgroup	Represents further division within a group
Symbol Name	The name of the process symbol
Symbol Mnemonic	A four-character name given to the symbol to be used as its reference name in a computer system
Description	A brief description of what the symbol represents
Symbol Drawing	The actual drawing of the symbol itself. Although no specific aspect ratio is given, the shape that is drawn should be depicted as closely as possible. Process connections and flow directions have been included with some symbols for functional clarity. These may be arranged as necessary. Heads shown on containers and vessels are those most frequently encountered for that specific type. However, dished, elliptical, hemispherical, conical, or flat heads may be substituted where appropriate to match the actual configuration of the device.

3.3 Structure of symbols

3.3.1 Group: Connectors

Subgroup: N/A

Symbol Name: N/A

Symbol Mnemonic: N/A

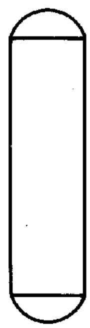
Description: For the purpose of this document, the various possible connectors have been excluded. In the majority of cases, pipe connections are not required to be detailed. A recommended practice to avoid any confusion on the video display is to use line breaks to indicate that the lines do not join. The most important lines should be kept solid with the secondary lines being broken. If all lines are of equal importance, a usual convention is to break the vertical line.

3.3 Structure of symbols

3.3.2 Group: Containers and vessels

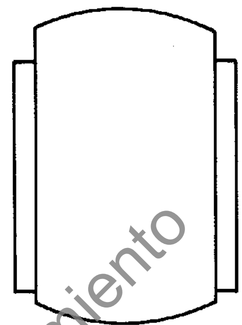
Subgroup: Process
Symbol Name: Distillation Tower
Symbol Mnemonic: DTWR

Description: A packed or trayed distillation tower used for separation. Packing or trays may be shown to indicate type of distillation tower.



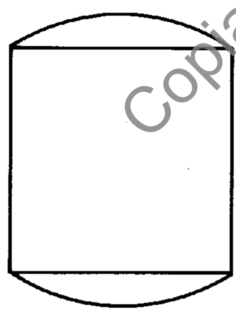
Subgroup: Process
Symbol Name Jacketed Vessel
Symbol Mnemonic: JVSL

Description: A vessel with a heating or cooling jacket. Jacket may be on straight shell, on bottom head, on top head, or any combination, as required to match the actual process vessel.



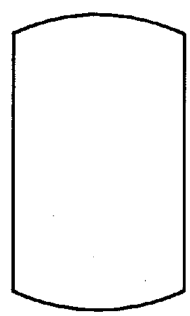
Subgroup: Process
Symbol Name: Reactor
Symbol Mnemonic: RCTR

Description: A chemical reactor. Internal details may be shown to indicate type of reactor.



Subgroup: Process
Symbol Name: Vessel
Symbol Mnemonic: VSSL

Description: A vessel or separator. Internal details may be shown to indicate type of vessel. Can also be used as a pressurized vessel in either a vertical or horizontal arrangement.

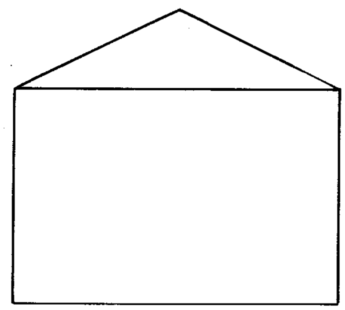


3.3 Structure of symbols

3.3.2 Group: Containers and vessels (cont'd)

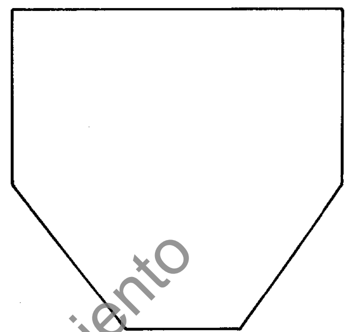
Subgroup: Storage
Symbol Name: Atmospheric Tank
Symbol Mnemonic: ATNK

Description: A tank for material stored under atmospheric pressure.



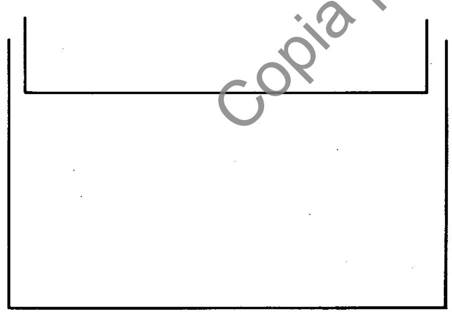
Subgroup: Storage
Symbol Name Bin
Symbol Mnemonic: BINN

Description: A container used to store solid or granular material that is discharged from the bottom.



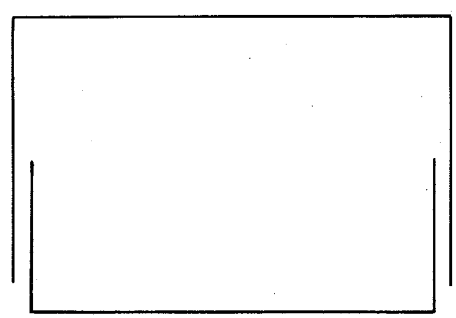
Subgroup: Storage
Symbol Name: Floating Roof Tank
Symbol Mnemonic: FTNK

Description: A tank for liquids with roof of vessel moving up and down with a change in stored volume.



Subgroup: Storage
Symbol Name: Gas Holder
Symbol Mnemonic: GHDR

Description: A tank for gases with roof of vessel moving up and down with a change in stored volume.

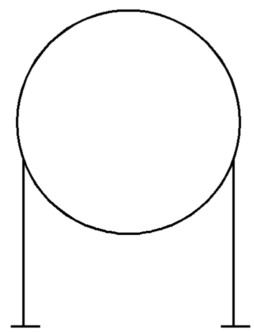


3.3 Structure of symbols

3.3.2 Group: Containers and vessels (cont'd)

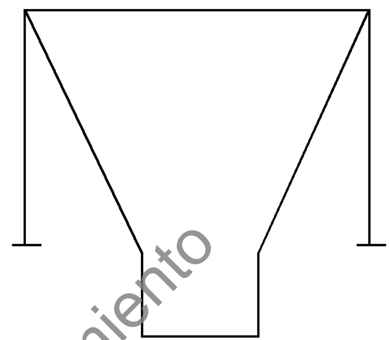
Subgroup: Storage
Symbol Name: Pressure Storage Vessel
Symbol Mnemonic: PVSL

Description: A pressurized spherical vessel for storage of gases and liquids.



Subgroup: Storage
Symbol Name Weigh Hopper
Symbol Mnemonic: WHPR

Description: A vessel used for weighing material.



3.3 Structure of symbols

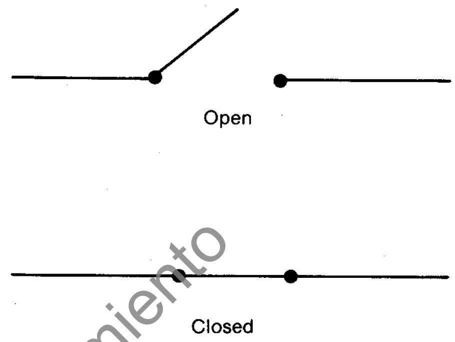
3.3.3 Group: Electrical

Subgroup: N/A
Symbol Name: Circuit Breaker
Symbol Mnemonic: CBRK

Description: Representation of a circuit breaker for electrical systems. See STATE INDICATOR symbol for alternative use.

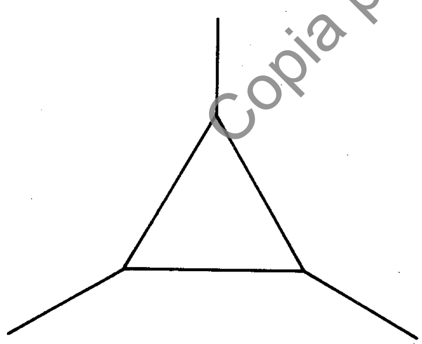
Subgroup: N/A
Symbol Name Manual Contactor
Symbol Mnemonic: MCTR

Description: A power distribution switch used for device isolation.



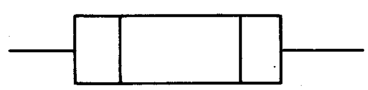
Subgroup: N/A
Symbol Name: Delta Connection
Symbol Mnemonic: DLTA

Description: Representation of a 3-phase delta connection.



Subgroup: N/A
Symbol Name: Fuse
Symbol Mnemonic: FUSE

Description: Representation of a fuse as an over-current protection device.

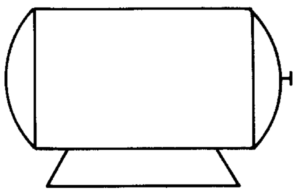


3.3 Structure of symbols

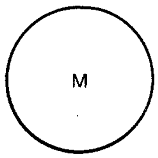
3.3 Group: Electrical (cont'd)

Subgroup: N/A
Symbol Name: Motor
Symbol Mnemonic: MOTR

Description: An ac or dc motor.



OR

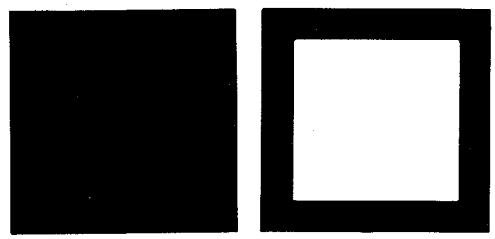


This is the preferred symbol for process diagrams (base optional).

This is the preferred symbol for electrical diagrams.

Subgroup: N/A
Symbol Name State Indicator
Symbol Mnemonic: STAT

Description: Used to represent binary states. For example: Circuit Closed/Circuit Open, etc.

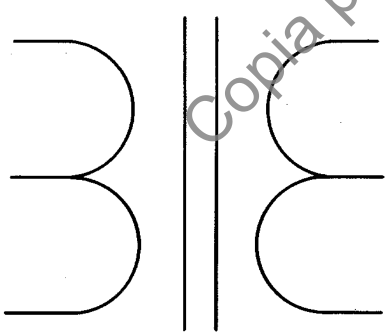


Circuit Closed

Circuit Open

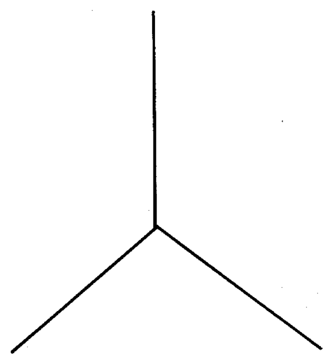
Subgroup: N/A
Symbol Name: Transformer
Symbol Mnemonic: XFMR

Description: A universal transformer.



Subgroup: N/A
Symbol Name: WYE Connection
Symbol Mnemonic: WYEC

Description: Representation of a 3-phase wye (star) connection.

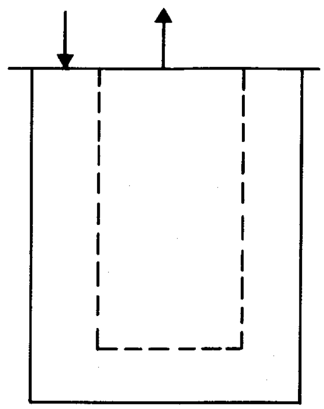


3.3 Structure of symbols

3.3.4 Group: Filters

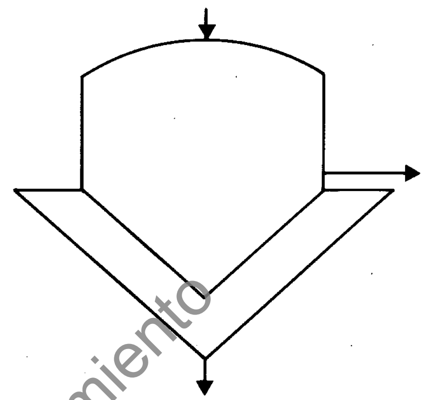
Subgroup: N/A
Symbol Name: Liquid Filter
Symbol Mnemonic: LFLT

Description: A liquid filter.



Subgroup: N/A
Symbol Name Vacuum Filter
Symbol Mnemonic: VFLT

Description: A vacuum-assisted filtration device.

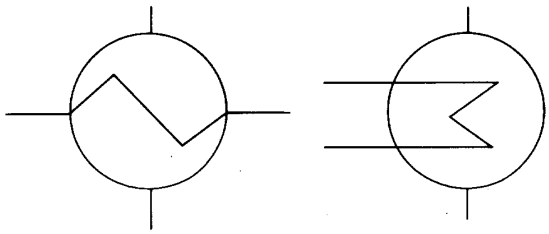


3.3 Structure of symbols

3.3.5 Group: Heat transfer devices

Subgroup: N/A
Symbol Name: Exchanger
Symbol Mnemonic: XCHG

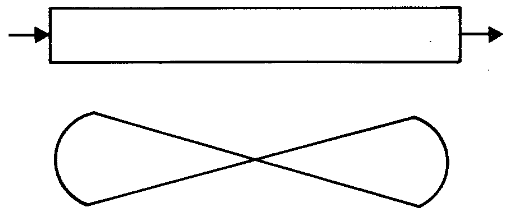
Description: Heat transferral equipment. An alternative symbol is depicted.



Alternative

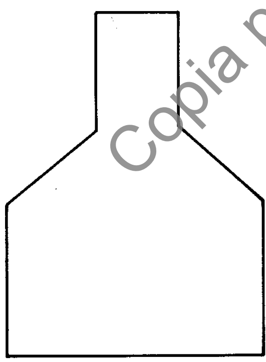
Subgroup: N/A
Symbol Name Forced Air Exchanger
Symbol Mnemonic: FAXR

Description: A forced-air heat exchanger.



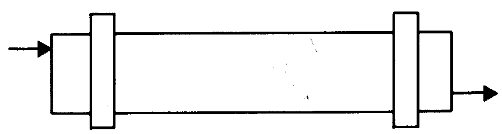
Subgroup: N/A
Symbol Name: Furnace
Symbol Mnemonic: FURN

Description: Process heater or furnace. Internal details may be shown as needed.



Subgroup: N/A
Symbol Name: Rotary Kiln
Symbol Mnemonic: KILN

Description: Typical gas, oil, coal or coke-fired kiln.

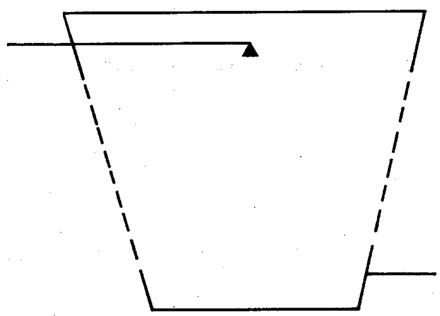


3.3 Structure of symbols

3.3.6 Group: HVAC (heating ventilation & air conditioning)

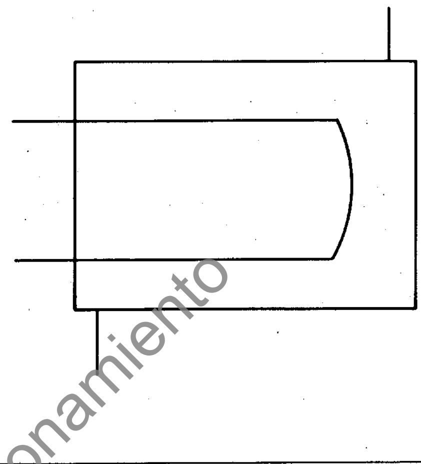
Subgroup: N/A
Symbol Name: Cooling Tower
Symbol Mnemonic: CTWR

Description: A device for use in HVAC or other processes indicating the atmospheric cooling of water by forced evaporation.



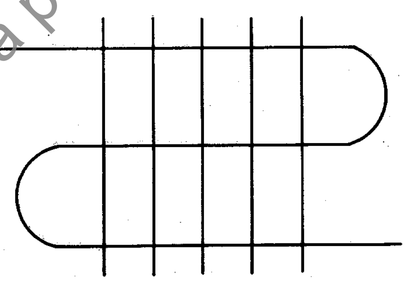
Subgroup: N/A
Symbol Name Evaporator
Symbol Mnemonic: EVPR

Description: An HVAC device used to represent the exchange of heat between a liquid or gas and a refrigerant.



Subgroup: N/A
Symbol Name: Finned Exchanger
Symbol Mnemonic: FNXR

Description: A high surface transfer device used to exchange heat between a liquid or gas and air.

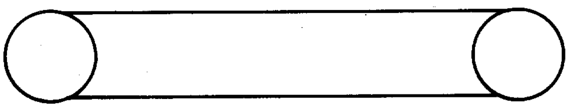


3.3 Structure of symbols

3.3.7 Group: Material handling

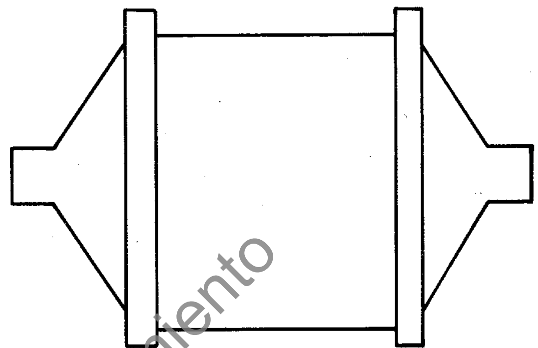
Subgroup: N/A
Symbol Name: Conveyor
Symbol Mnemonic: CNVR

Description: Belt conveyors, chain conveyors, and roller conveyors used in association with other symbols to represent more complex equipment such as a paper machine.



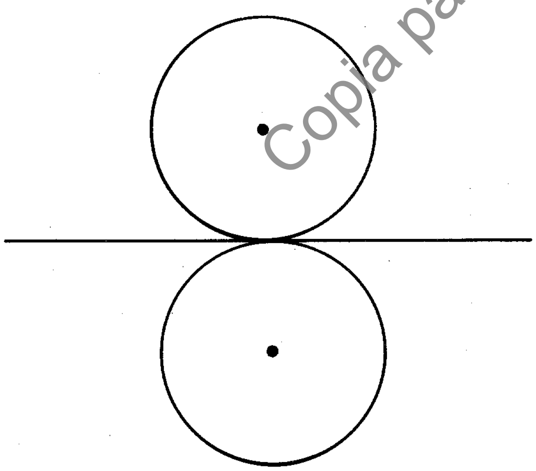
Subgroup: N/A
Symbol Name Mill
Symbol Mnemonic: MILL

Description: Rotating rod, ball, autogenous, or semiautogenous mill used for size reduction of solids.



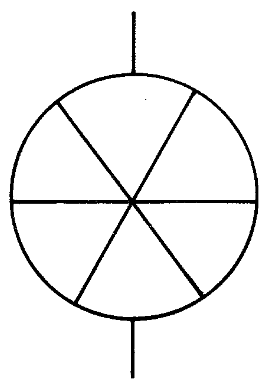
Subgroup: N/A
Symbol Name: Roll Stand
Symbol Mnemonic: RSTD

Description: Roll stand used in metal, paper, rubber, plastic, and glass industries.



Subgroup: N/A
Symbol Name: Rotary Feeder
Symbol Mnemonic: RFDR

Description: A rotary feeder used to convey material in dry powder form from one location to another.

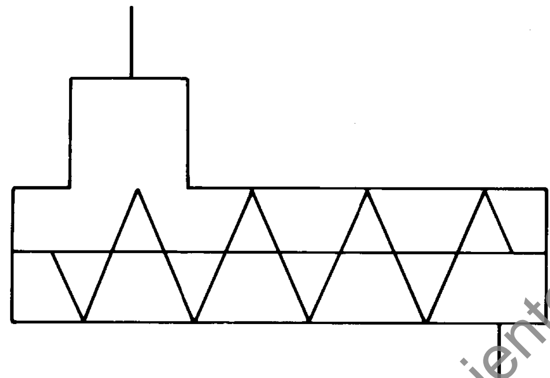


3.3 Structure of symbols

3.3.7 Group: Material handling (cont'd)

Subgroup: N/A
Symbol Name: Screw Conveyor
Symbol Mnemonic: SCNV

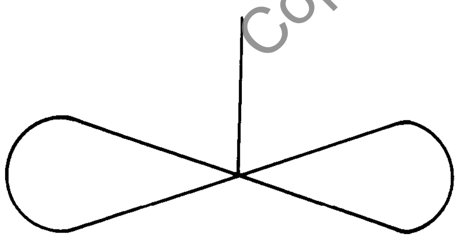
Description: A typical screw conveyor or screw pump.



3.3.8 Mixing

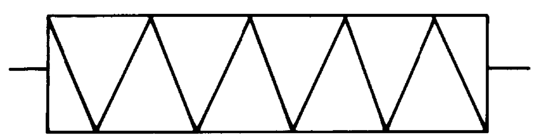
Subgroup: N/A
Symbol Name Agitator
Symbol Mnemonic: AGIT

Description: A blade, propeller, or paddle-type agitator.



Subgroup: N/A
Symbol Name Inline Mixer
Symbol Mnemonic: IMIX

Description: A mixing device used to continuously blend materials.



3.3 Structure of symbols

3.3.9 Group: Reciprocating equipment

Subgroup: N/A
Symbol Name: Reciprocating Compressor
Symbol Mnemonic: RECP

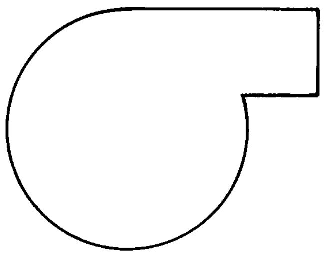
Description: A reciprocating compressor or pump represents that class of equipment used to transport slurries or liquids by reciprocating action. Examples are pistons, diaphragms, plungers, etc.

3.3 Structure of symbols

3.3.10 Group: Rotating equipment

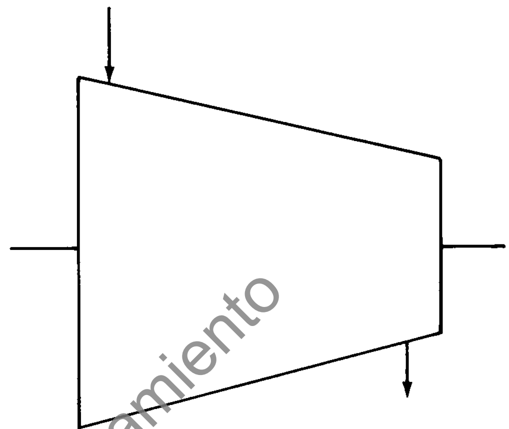
Subgroup: N/A
Symbol Name: Blower
Symbol Mnemonic: BLWR

Description: A device used to convey a gas under slight pressure.



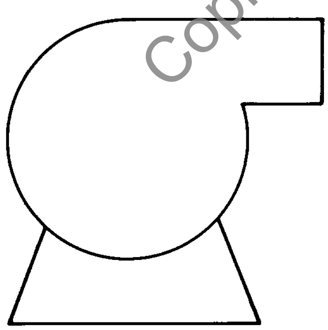
Subgroup: N/A
Symbol Name Compressor
Symbol Mnemonic: CMPR

Description: A device used to convey a gas under high pressure.



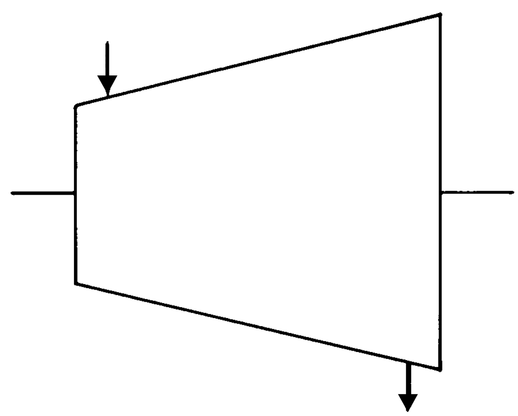
Subgroup: N/A
Symbol Name: Pump
Symbol Mnemonic: PUMP

Description: Represents that class of equipment used to transport slurries or liquids by internal rotary action. Examples are centrifugal, gear, lobe, etc.



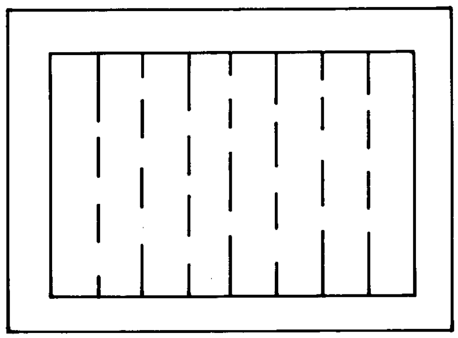
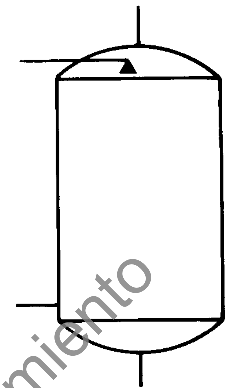
Subgroup: N/A
Symbol Name: Turbine
Symbol Mnemonic: TURB

Description: A device using the force of expanding gas to propel rotating equipment.



3.3 Structure of symbols

3.3.11 Group: Scrubber and precipitators

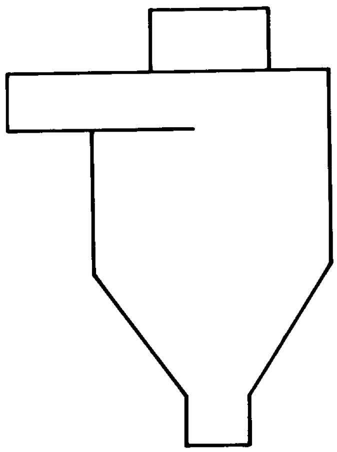
Subgroup: N/A **Symbol Name:** Electrostatic Precipitator **Symbol Mnemonic:** EPCP **Description:** A device used to separate solid particles from a gas (e.g., in a smoke stack) by means of an electrostatically charged grid. 	**Subgroup:** N/A **Symbol Name** Scrubber **Symbol Mnemonic:** SCBR **Description:** A device that uses a liquid spray to scrub gas. 

3.3 Structure of symbols

3.3.12 Group: Separators

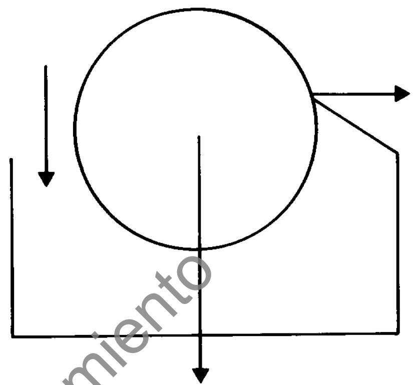
Subgroup: N/A
Symbol Name: Cyclone Separator
Symbol Mnemonic: CSEP

Description: A device used for solid, liquid, or vapor separation.



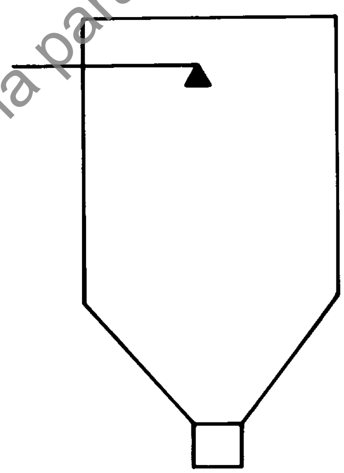
Subgroup: N/A
Symbol Name Rotary Separator
Symbol Mnemonic: RSEP

Description: A rotary device for separating solids from liquids.



Subgroup: N/A
Symbol Name: Spray Dryer
Symbol Mnemonic: SDRY

Description: A device used for evaporation of liquids from mixtures of solids and liquids.



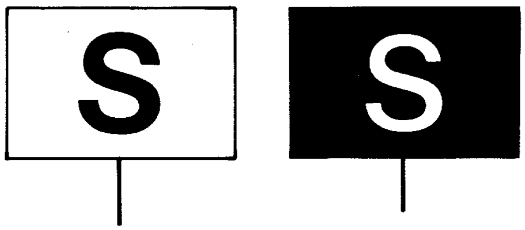
3.3 Structure of symbols

3.3.13 Group: Valves and actuators

Subgroup: Actuators
Symbol Name: Actuator
Symbol Mnemonic: ACTR

Description: Represents the final control element that determines the state of a two-state device.

Desired Device State is CLOSED — Desired Device State is OPEN



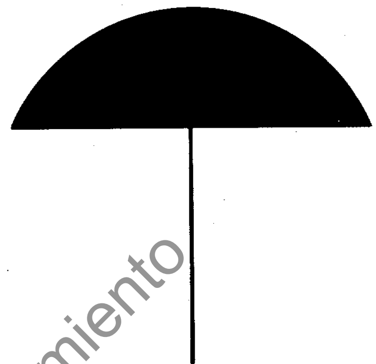
The use of a letter in the symbol to designate the type of actuator is optional. Other choices include:

Character Designation

M = Electrical Motor
S = Solenoid
H = Hydraulic
A = Air Motor

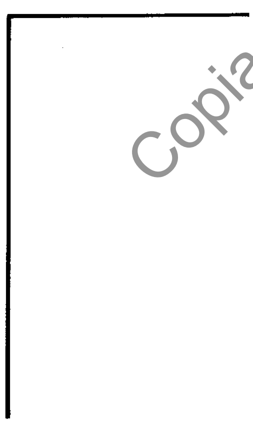
Subgroup: Actuators
Symbol Name Throttling Actuator
Symbol Mnemonic: TACT

Description: Represents a diaphragm actuator that can affect multiple positions of the controlled device.



Subgroup: Actuators
Symbol Name: Manual Actuator
Symbol Mnemonic: MATR

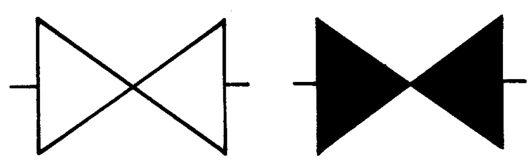
Description: Represents a manually-operated valve actuator.



Subgroup: Valves
Symbol Name: Valve
Symbol Mnemonic: VLVE

Description: Represents GLOBE, GATE, BALL, and NEEDLE valves used to regulate fluid flow through piping systems. Can be used with various combinations of actuators to convey multiple manipulation schemes.

Actual State is CLOSED — Actual State is OPEN



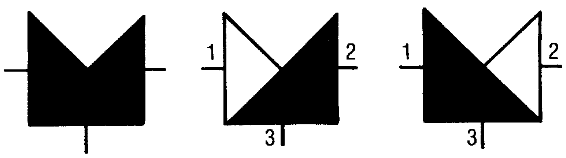
3.3 Structure of symbols

3.3.13 Group: Valves and actuators (cont'd)

Subgroup: Valves
Symbol Name: 3-Way Valve
Symbol Mnemonic: VLV3

Description: Represents a valve used in piping systems to select flow paths or regulate between flow paths. Can be used with various combinations of actuators to convey multiple manipulation schemes.

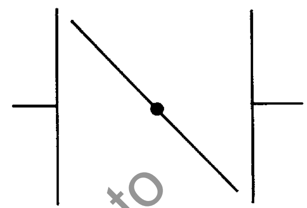
THROTTLING | SELECTING (Pathway open only between Ports 2 & 3) | SELECTING (Pathway open only between Ports 1 & 3)



Note: Port numbers are not part of symbol.

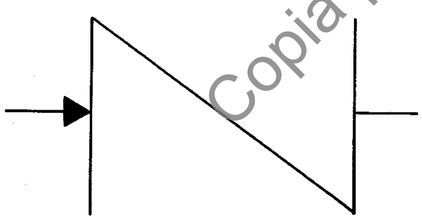
Subgroup: Valves
Symbol Name Butterfly Valve
Symbol Mnemonic: BVLV

Description: Represents a butterfly valve, damper, or vane used to throttle (modulate) fluid flow through a pipe, duct, or stack.



Subgroup: Valves
Symbol Name: Check Valve
Symbol Mnemonic: CVLV

Description: Represents a device that mechanically limits fluid flow to only one direction in a piping system — typically a check valve or backdraft damper.

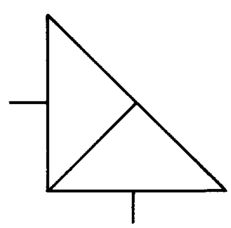


Arrow shows direction of allowable flow and is part of the symbol.

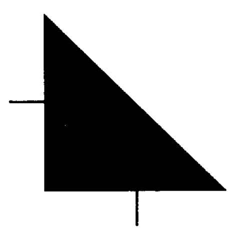
Subgroup: Valves
Symbol Name: Relief Valve
Symbol Mnemonic: RVLV

Description: Represents a one-way mechanically actuated pressure relief valve. While these valves are normally closed, two symbols are shown to accommodate those situations where feedback signals are provided to indicate actual status.

Normally closed valve that is actually CLOSED



Normally closed valve that is actually OPEN



Appendix A — Examples of use

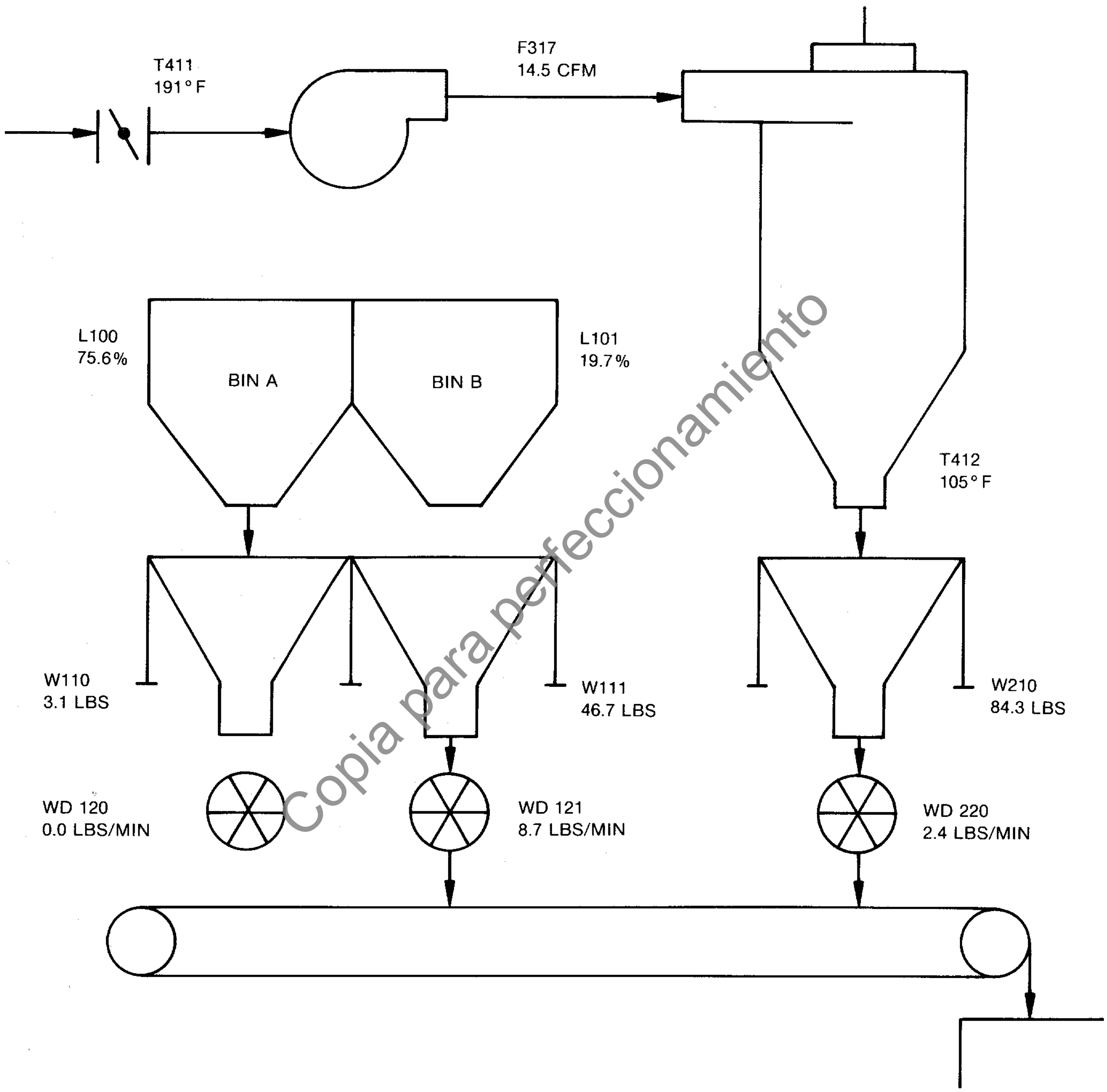


Figure A-1 — Gas cleaning and particle collection

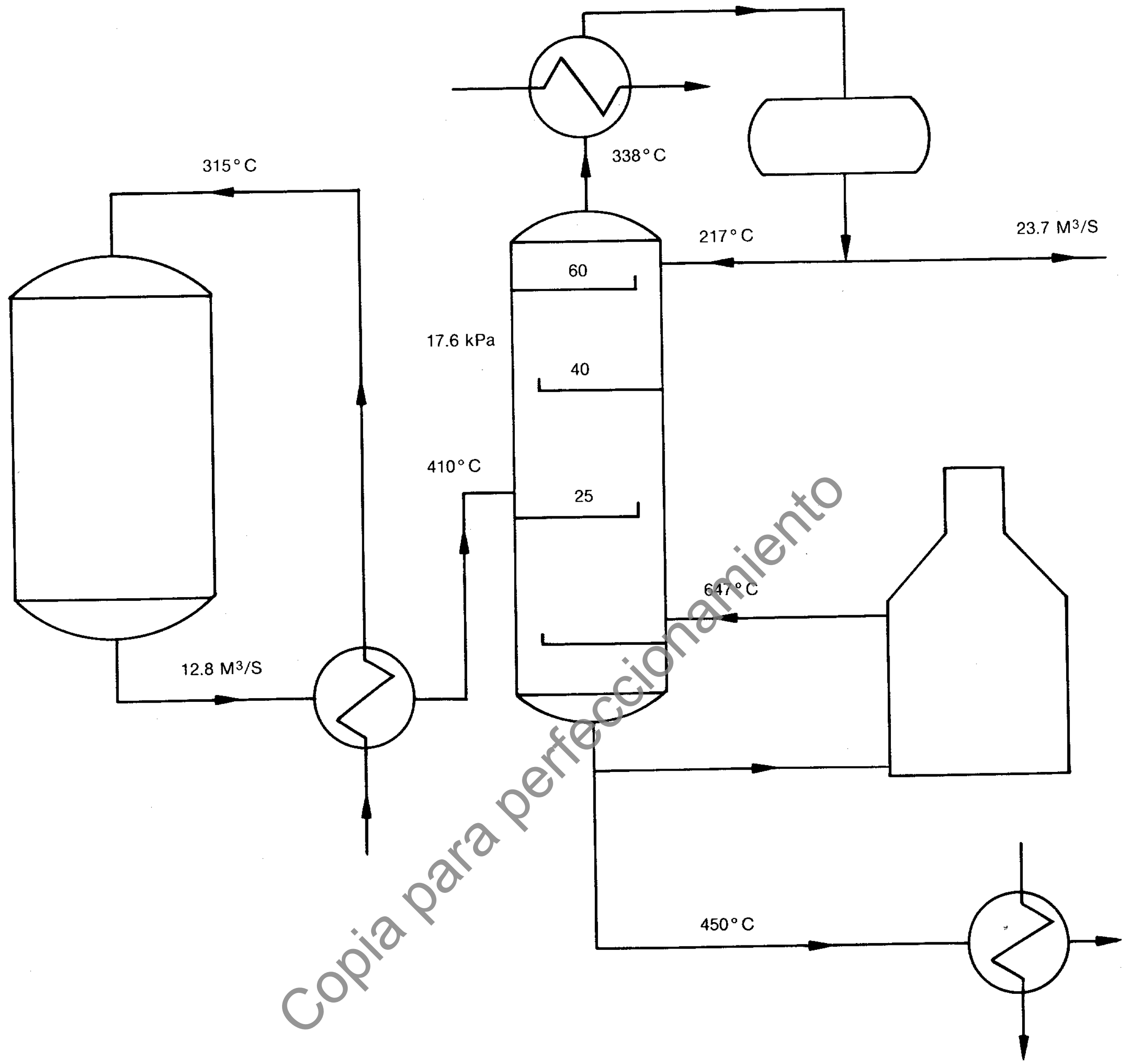


Figure A-2 — Chemical process

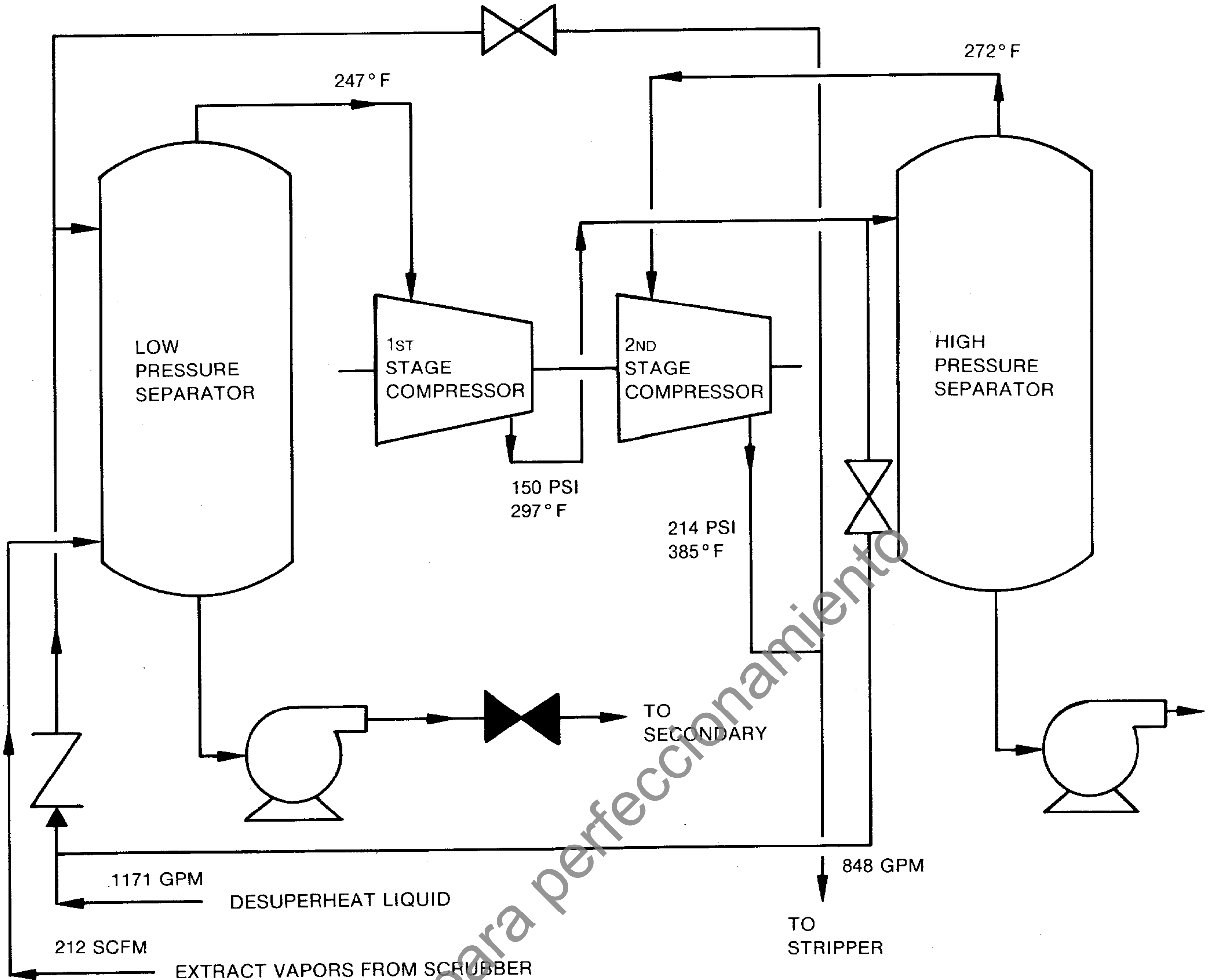


Figure A-3 — Heat pump system

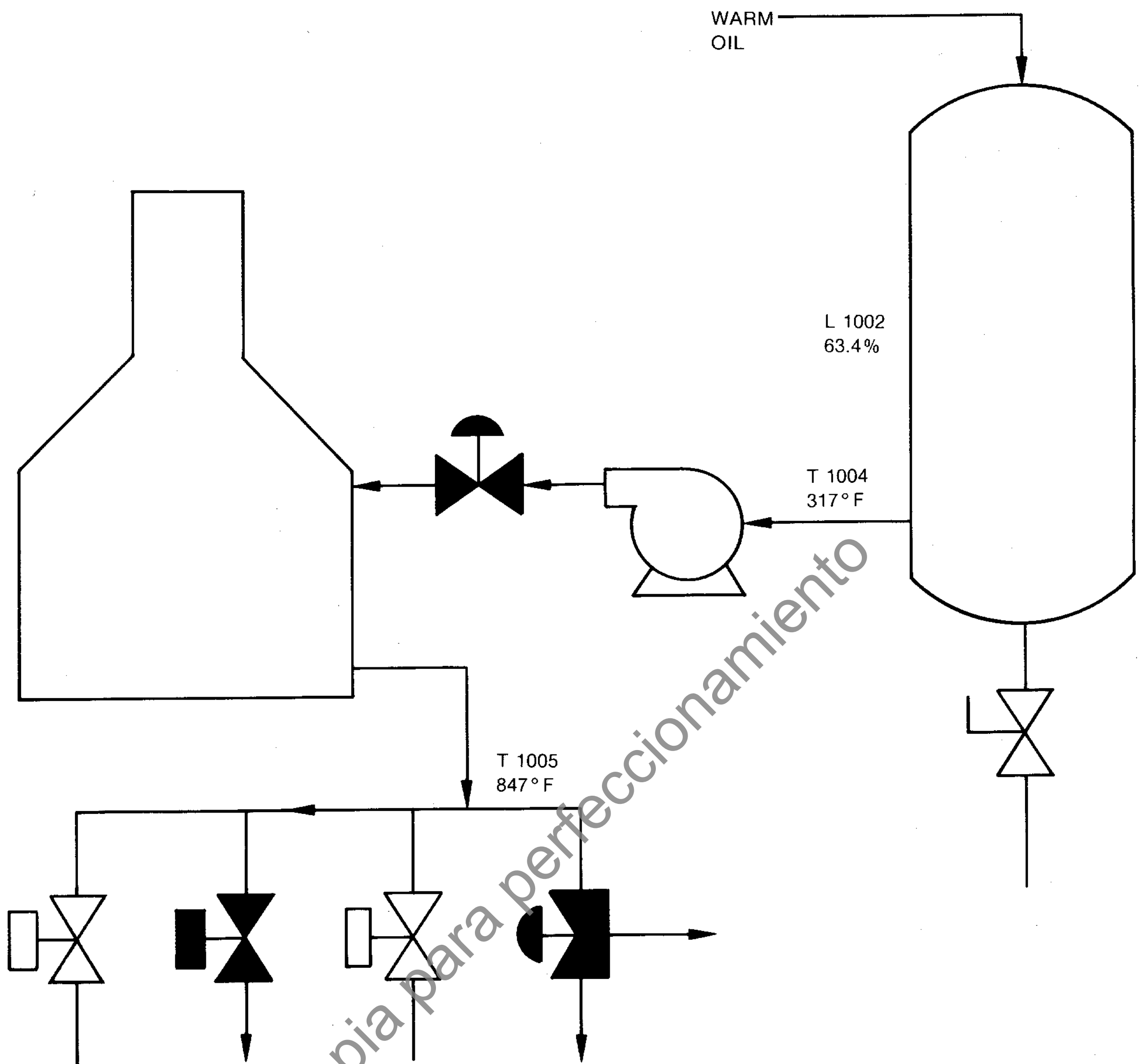


Figure A-4 — Hot oil system

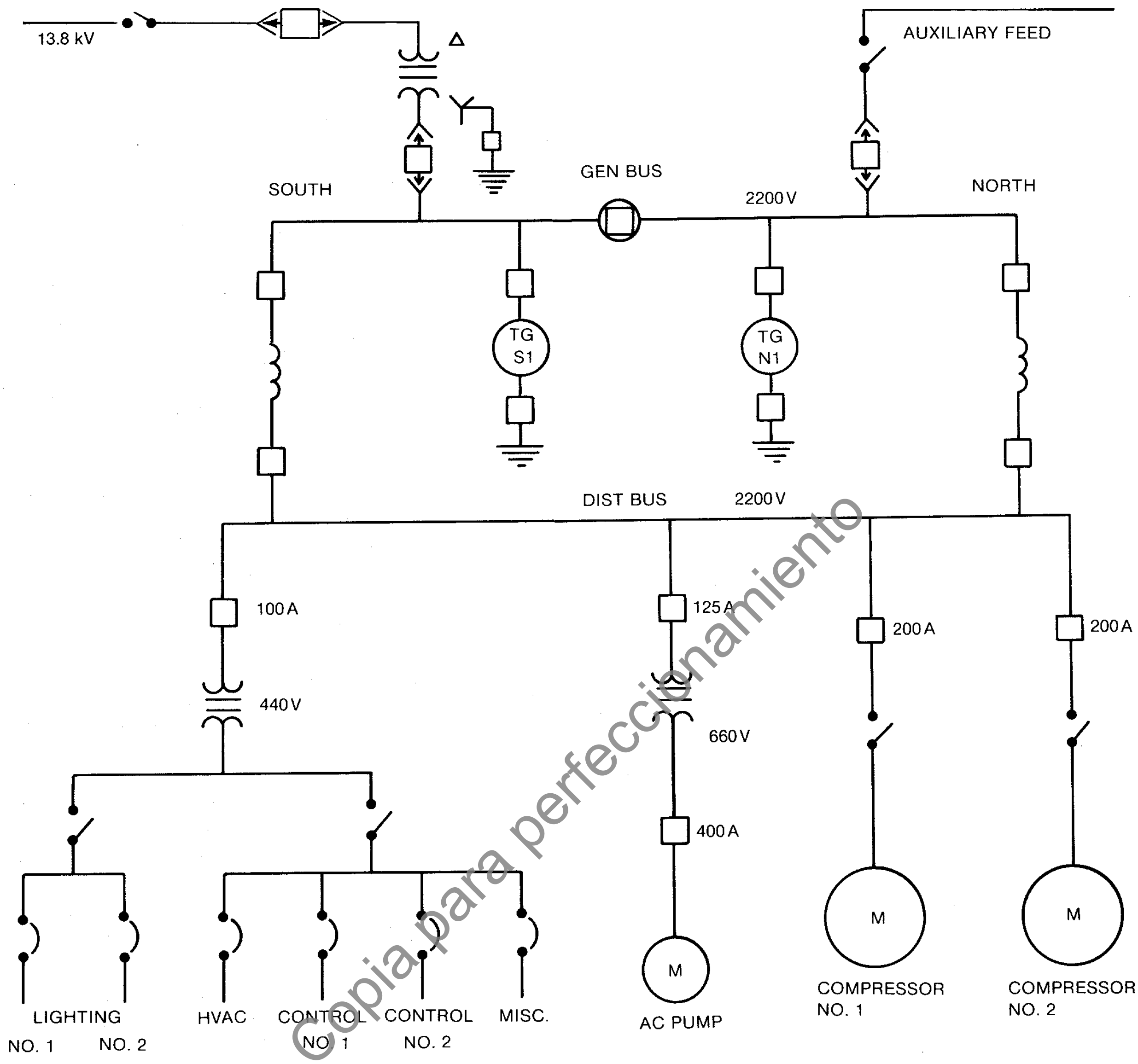


Figure A-5 — Electrical power system

Appendix B — Primary measurement recommended usage

Primary elements or instruments can be depicted on a VDU by a character(s). The characters that are recommended for use are:

First character	Type of measurement	Notes
A	Analysis	4
B	Burner, Combustion	
C	User's Choice	1
D	User's Choice	1
E	Voltage (EMF)	
F	Flow Rate	
G	User's Choice	1
H	Hand (Manual)	
I	Current (Electric)	
J	Power	
K	Time	
L	Level	
M	User's Choice	1
N	User's Choice	1
O	User's Choice	1
P	Pressure/Vacuum	
Q	Quantity	
R	Radiation	
S	Speed, Frequency	
T	Temperature	
U	Multivariable	5
V	Vibration, Mechanical Analysis	6
W	Weight, Force	
X	Unclassified	2
Y	Event, State or Presence	7
Z	Position, Dimension	
First modifier*	**Type of measurement**	**Notes**
D	Differential	
F	Ratio	
K	Time Rate of Change	8
Q	Integrate or Totalize	

*(See Note 3)

The above character designations are based on ISA Standard S5.1, "Instrumentation Symbols and Identification."

NOTE 1: A "USER'S CHOICE" letter is intended to cover unlisted meanings for primary measurements that will be used repetitively in a particular project. If used, the letter will have one meaning as a first letter and a different meaning for the second letter. The meanings need be defined only once in the beginning of the project. For example, the letter 'M' may be defined as "MOISTURE" in one project, but as "MASS" in another.

NOTE 2: The unclassified letter 'X' is intended to cover unlisted meanings that will be used only once or to a limited extent. If used, the letter may have any number of meanings as a first letter and any number of meanings as a succeeding letter.

Except for its use with distinctive measurements, it is expected that the meaning will be defined outside the symbol. For example, 'X' may be a stress measurement at one point and a volume measurement at another point.

The units of the quantity measured will assist in determining the actual usage of the letter 'X'.

NOTE 3: Any first letter, if used in combination with modifying letters 'D' (differential), 'F' (ratio), 'K' (time rate of change), or 'Q' (integrate or totalize), or any combination of them, shall be construed to represent a new and separate measured variable, and the combination shall be treated as a first-letter entity. Thus, instrument measurements 'T' and 'TD' measure two different variables, namely, temperature and differential temperature. These modifying letters shall be used when applicable.

NOTE 4: First letter 'A' for analysis covers all analyses not described by a "USER'S CHOICE" letter. It is expected that the type of analysis will be defined outside the symbol. The units of the quantity measured will assist in determining the actual type of analysis occurring. Additional information can be added as text to the Visual Display Unit.

NOTE 5: Use of the first letter 'U' for "Multivariable" in lieu of a combination of first letters is optional. It is recommended that nonspecific designators such as 'U' be used sparingly.

NOTE 6: First letter 'V,' "Vibration or Mechanical Analysis," is intended to perform the duties in machinery monitoring that the letter 'A' performs in more general analyses. Except for vibration, it is expected that the variable of interest will be defined outside the actual symbol. This definition can occur as a result of units of the quantity measured or as additional text shown on the visual display unit.

NOTE 7: First letter 'Y' is intended for use when control or monitoring responses are event-driven as opposed to time or time-schedule driven. It can also signify presence or state.

NOTE 8: Second letter 'K,' in combination with a first letter such as 'L,' 'T,' or 'W,' signifies a time rate of change of the primary measurement. As an example, 'WK' may represent "Rate of Weight Loss or Gain."

The following are Identification Letters and their usage from ISA Standard S5.1, "Instrumentation Symbols and Identification," Revision 4.

Table B-1: Identification letters

First letter (4)			Succeeding letters (3)		
Measured or initiating variable		**Modifier**	**Readout or passive function**	**Output function**	**Modifier**
A	Analysis (5, 19)		Alarm		
B	Burner, Combustion		User's Choice (1)	User's Choice (1)	User's Choice (1)
C	User's Choice (1)			Control (13)	
D	User's Choice (1)	Differential (4)			
E	Voltage		Sensor (Primary Element)		
F	Flow Rate	Ratio (Fraction) (4)			
G	User's Choice (1)		Glass, Viewing Device (9)		
H	Hand				High (7, 15, 16)
I	Current (Electrical)		Indicate (10)		
J	Power	Scan (7)			
K	Time, Time Schedule	Time Rate of Change (4, 21)		Control Station (22)	
L	Level		Light (11)		Low (7, 15, 16)
M	User's Choice (1)	Momentary (4)			Middle, Intermediate (7, 15)
N	User's Choice (1)		User's Choice (1)	User's Choice (1)	User's Choice (1)
O	User's Choice (1)		Orifice, Restriction		
P	Pressure, Vacuum		Point (Test) Connection		
Q	Quantity	Integrate, Totalize (4)			
R	Radiation		Record (17)		
S	Speed, Frequency	Safety (8)		Switch (13)	
T	Temperature			Transmit (18)	
U	Multivariable (6)		Multifunction (12)	Multifunction (12)	Multifunction (12)
V	Vibration, Mechanical Analysis			Valve, Damper, Louver (13)	
W	Weight, Force		Well		
X	Unclassified (2)	X Axis	Unclassified (2)	Unclassified (2)	Unclassified (2)
Y	Event, State or Presence (20)	Y Axis		Relay, Compute, Convert (13, 14, 18)	
Z	Position Dimension	Z Axis		Driver, Actuator, Unclassified Final Control Element	

Notes for Table B-1:

NOTE 1: A "USER'S CHOICE" letter is intended to cover unlisted meanings that will be used repetitively in a particular project. If used, the letter may have one meaning as a first letter and another meaning as a succeeding letter. The meanings need to be defined only once in a legend, or otherwise, for that project. For example, the letter 'N' may be defined as "MODULUS OF ELASTICITY" as a first letter and "OSCILLOSCOPE" as a succeeding letter.

NOTE 2: The unclassified letter 'X' is intended to cover unlisted meanings that will be used only once or to a limited extent. If used, the letter may have any number of meanings as a first letter and any number of meanings as a succeeding letter. Except for its use with distinctive symbols, it is expected that the meanings will be defined outside a tagging bubble on a flow diagram. For example, XR-2 may be a stress recorder and XX-4 may be a stress oscilloscope.

NOTE 3: The grammatical form of the succeeding letter meanings may be modified as required. For example, "indicate" may be applied as "indicator" or "indicating," "transmit" as "transmitter" or "transmitting," etc.

NOTE 4: Any first letter, if used in combination with modifying letters 'D' (differential), 'F' (ratio), 'M' (momentary), 'K'(time rate of change), 'Q' (integrate or totalize), or any combination of these is intended to represent a new and separate measured variable, and the combination is treated as a first-letter entity. Thus, instruments 'TDI' and 'TI' indicate two different variables, namely, differential temperature and temperature. Modifying letters are used when applicable.

NOTE 5: First letter 'A,' "Analysis," covers all analyses not described by a "USER'S CHOICE" letter. It is expected that the type of analysis will be defined outside a tagging bubble.

NOTE 6: Use of first letter 'U' for "Multivariable" in lieu of a combination of first letters is optional. It is recommended that nonspecific designators such as 'U' be used sparingly.

NOTE 7: The use of modifying terms "high," "low," "middle" or "intermediate," and "scan" is optional.

NOTE 8: The term "safety" applies to emergency protective primary elements and emergency protective final control elements only. Thus, a self-actuated valve that prevents operation of a fluid system at a higher than desired pressure by bleeding fluid from the system is a backpressure-type PCV, even if the valve is not intended to be used normally. However, this valve is designated as a PSV if it is intended to protect against emergency conditions, i.e., conditions that are hazardous to personnel and/or equipment and that are not expected to arise normally.

The designation 'PSV' applies to all valves intended to protect against emergency pressure conditions regardless of whether the valve construction and mode of operation place them in the category of the safety valve, relief valve, or safety relief valve. A rupture disc is designated 'PSE.'

NOTE 9: The passive function 'G' applies to instruments or devices that provide an uncalibrated view such as sight glasses and television monitors.

NOTE 10: "Indicate" normally applies to the readout, analog or digital, of an actual measurement. In the case of a manual loader, it may be used for the dial or setting indication, i.e., for the value of the initiating variable.

NOTE 11: A pilot light that is part of an instrument loop should be designated by a first letter followed by the succeeding letter 'L.' For example, a pilot light that indicates an expired time period should be tagged 'KQL.' If it is desired to tag a pilot light that is not part of an instrument loop, the light is designated in the same way. For example, a running light for an electric motor may be tagged 'EL,' assuming voltage to be the appropriate measured variable, or 'YL,' assuming the operating status is being monitored. The unclassified variable 'X' should be used only for applications that are limited in extent. 'XL' should not be used for motor running lights as these are commonly numerous. It is permissible to use the "USER'S CHOICE" letters 'M,' 'N,' or 'O' for a motor running light when the meaning is previously defined. If 'M' is used, it must be clear that the letter does not stand for the word "Motor," but for a monitored state.

NOTE 12: Use of a succeeding letter 'U' for "Multifunction" instead of a combination of other functional letters is optional. This nonspecific variable designator should be used sparingly.

NOTE 13: A device that connects, disconnects, or transfers one or more circuits may be either a switch, a relay, an ON-OFF controller, or a control valve, depending on the application.

If the device manipulates a fluid process stream and is not a hand-actuated ON-OFF block valve, it is designated as a control valve. It is incorrect to use the succeeding letters 'CV' for anything other than a self-actuated control valve. For all applications, other than fluid process streams, the device is designated as follows:

A *switch*, if it is actuated by hand.

A switch or an ON-OFF controller, if it is automatic and is the first such device in a loop. The term "Switch" is generally used if the device is used for alarm, pilot light, selection, interlock, or safety. The term "Controller" is generally used if the device is used for normal operating control.

A relay, if it is automatic and is not the first such device in a loop, i.e., it is actuated by a switch or an ON-OFF controller.

NOTE 14: It is expected that the functions associated with the use of succeeding letter 'Y' will be defined outside a bubble on a diagram when further definition is considered necessary. This definition need not be made when the function is self-evident, as for a solenoid valve in a fluid signal line.

NOTE 15: The modifying terms "high," "low," and "middle" or "intermediate" correspond to values of the measured variable, not of the signal, unless otherwise noted. For example, a high-level alarm derived from a reverse-acting level transmitter signal shall be an 'LAH,' even though the alarm is actuated when the signal falls to a low value. The terms may be used in combinations as appropriate (see Section 6.9A ISA-S5.1).

NOTE 16: The terms "high" and "low," when applied to positions of valves and other open-close devices, are defined as follows: "high" denotes that the valve is in or approaching the fully open position, and "low" denotes it is in or approaching the fully closed position.

NOTE 17: The word "record" applies to any form of permanent storage of information that permits retrieval by any means.

NOTE 18: For use of the term "transmitter" versus "converter," see the definitions in Section 3, ISA-S5.1.

NOTE 19: First letter 'V,' "Vibration or Mechanical Analysis," is intended to perform the duties in machinery monitoring that the letter 'A' performs in more general analyses. Except for vibration, it is expected that the variable of interest will be defined outside the tagging bubble.

NOTE 20: First letter 'Y' is intended for use when control or monitoring responses are event-driven as opposed to time- or time-schedule-driven. 'Y,' in this position, can also signify presence or state.

NOTE 21: Modifying letter 'K,' in combination with a first letter, such as 'L,' 'T,' or 'W,' signifies a time rate of change of the measured or initiating variable. 'WKIC,' for instance, may represent a rate-of-weight-loss controller.

NOTE 22: Succeeding letter 'K' is a user's option for designating a *control station*, while the succeeding letter 'C' is used for describing automatic or manual *controllers*. See Definitions, ISA S5.1.

Table B-2 — Typical letter combinations

		Controllers				Readout devices		Switches and alarm devices*			Transmitters									
First letters	**Initiating or measured variable**	**Recording**	**Indicating**	**Blind**	**Self-actuated control valves**	**Recording**	**Indicating**	**High†**	**Low†**	**Comb**	**Recording**	**Indicating**	**Blind**	**Solenoids relays computing devices**	**Primary elements**	**Test point**	**Well or probe**	**Viewing device glass**	**Safety device**	**Element**
A	Analysis	ARC	AIC	AC		AR	AI	ASH	ASL	ASHL	ART	AIT	AT	AY	AE	AP	AW			AV
B	Burn./Comb.	BRC	BIC	BC		BR	BI	BSH	BSL	BSHL	BRT	BIT	BT	BY	BE		BW	BG		BZ
C	User's Choice																			
D	User's Choice																			
E	Voltage	ERC	EIC	EC		ER	EI	ESH	ESL	ESHL	ERT	EIT	ET	EY	EE					EZ
F	Flow Rate	FRC	FIC	FC	FCV, FICV	FR	FI	FSH	FSL	FSHL	FRT	FIT	FT	FY	FE	FP		FG		FV
FQ	Flow Quantity	FQRC	FQIC			FQR	FQI	FQSH	FQSL			FQIT	FQT	FQY	FQE					FQV
FF	Flow Ratio	FFRC	FFIC	FFC		FFR	FFO	FFSH	FFSL						FE					FV
G	User's Choice																			
H	Hand		HIC	HC																HV
I	Current	IRC	IIC			IR	II	ISH	ISL	ISHL	IRT	IIT	IT	IY	IE					IZ
J	Power	JRC	JIC			JR	JI	JSH	JSL	JSHL	JRT	JIT	JT	JY	JE					JV
K	Time	KRC	KIC	KC	KCV	KR	KI	KSH	KSL	KSHL	KRT	KIT	KT	KY	KE					KV
L	Level	LRC	LIC	LC	LCV	LR	LI	LSH	LSL	LSHL	LRT	LIT	LT	LY	LE		LW	LG		LV
M	User's Choice																			
N	User's Choice																			
O	User's Choice																			
P	Press./Vacuum	PRC	PIC	PC	PCV	PR	PI	PSH	PSL	PSHL	PRT	PIT	PT	PY	PE	PP			PSV, PSE	PV
PD	Press./Diff.	PDRC	PDIC	PDC	PDCV	PDR	PDI	PDSH	PDSL		PDRT	PDIT	PDT	PDY	PDE	PDP				PDV
Q	Quantity	QRC	QIC			QR	QI	QSH	QSL	QSHL	QRT	QIT	QT	QY	QE					QZ
R	Radiation	RRC	RIC	RC		RR	RI	RSH	RSL	RSHL	RRT	RIT	RT	RY	RE		RW			RZ
S	Speed/ Frequency	SRC	SIC	SC	SCV	SR	SI	SSH	SSL	SSHL	SRT	SIT	ST	SY	SE					SV
T	Temperature	TRC	TIC	TC	TCV	TR	TI	TSH	TSL	TSHL	TRT	TIT	TT	TY	TE	TP	TW		TSE	TV
TD	Temperature/Diff.	TDRC	TDIC	TDC	TDCV	TDR	TDI	TDSH	TDSL		TDRT	TDIT	TDT	TDY	TE	TP	TW			TDV
U	Multivariable					UR	UI							UY						UV
V	Vibration Machinery Analysis					VR	VI	VSH	VSL	VSHL	VRT	VIT	VT	VY	VE					VZ
W	Weight/Force	WRC	WIC	WC	WCV	WR	WI	WSH	WSL	WSHL	WRT	WIT	WT	WY	WE					WZ
WD	Weight/Force/ Diff.	WDRC	WDIC	WDC	WDCV	WDR	WDI	WDSH	WDSL		WDRT	WDIT	WDT	WDY	WDE					WDZ
X	Unclassified																			
Y	Event, State Presence			YC		YR	YI	YSH	YSL				YT	YY	YE					YZ
Z	Pos./Dimen.	ZRC	ZIC	ZC	ZCV	ZR	ZI	ZSH	ZSL	ZSHL	ZRT	ZIT	ZT	ZY	ZE					ZV
ZD	Gaug/Devia.	ZDRC	ZDIC	ZDC	ZDCV	ZDR	ZDI	ZDSH	ZDSL		ZDRT	ZDIT	ZDT	ZDY	ZDE					ZDV

NOTE: This table is not all inclusive.
*A, alarm, the annunciating device, may be used in the same fashion as S, switch, the actuating device.
† The letters H and L may be omitted in the undefined case.

Other possible combinations:

FO	(Restriction Orifice)	PFR	(Ratio)
FRK, HIK	(Control Stations)	KQI	(Running Time Indicator)
FX	(Accesories)	QQI	Indicating Counter)
TJR	(Scanning Recorder)	WKIC	(Rate-of-Weight Loss Controller)
LLH	(Pilot Light)	HMS	(Hand Momentary Switch)

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ISA
Attn: Standards Department
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, NC 27709

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