

Process Industry Practices
P&ID



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Guidance on Practice for Piping and Instrumentation Diagrams

GP 08-01

PIP PIC001
Piping and Instrumentation
Diagram Documentation Criteria

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 08-01. This Guidance on Practice (GP) is based totally on documents from Process Industry Practices as follows:

Process Industry Practices

PIP PIC001

Piping and Instrumentation Diagram Documentation Criteria

PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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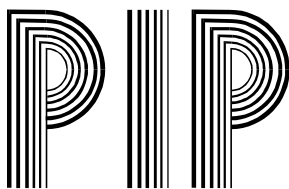
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Process Industry Practices P&ID

PIP PIC001 Piping and Instrumentation Diagram Documentation Criteria

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1. Introduction

1.1 Purpose

This Practice provides criteria for the development of Piping and Instrumentation Diagrams (P&IDs).

1.2 Scope

This Practice addresses the format and content shown on a P&ID. The Practice is independent of time in a facility life cycle and encompasses design, construction, operations and maintenance.

This Practice covers the generation of new P&IDs and does not apply to the revision of existing P&IDs. It also applies to P&IDs provided by packaged equipment vendors.

A P&ID is a detailed graphical representation of a process including the hardware and software (e.g., piping, equipment, instrumentation) necessary to design, construct and operate the facility. Common synonyms for P&IDs include EFDs (Engineering Flow Diagrams), UFDs (Utility Flow Diagrams) and MFDs (Mechanical Flow Diagrams). This Practice applies to all diagrams that fit the definition of a P&ID.

The criteria presented in this Practice can be applied to whichever CAD system is employed for developing the P&IDs and are not vendor, hardware or software specific.

The example P&IDs included in the Appendices are not intended to recommend specific design details or requirements. Example P&IDs are included to provide an illustration of how the elements of the recommended Practice are combined into a P&ID.

2. References

Applicable requirements in the latest edition (or the edition indicated) of the following industry standards and Process Industry Practices shall be considered an integral part of this Practice. Short titles will be used herein when appropriate.

2.1 Process Industry Practices (PIP)

- PIP INEG1000 - *Insulation Design and Type Codes*
- PIP PCCIP001 - *Instrument Piping and Tubing Systems Criteria*
- PIP PCCPS001 - *Instrument and Control Systems Criteria for Packaged Equipment*
- PIP PCEDO001 - *Guidelines for Control Systems Documentation*
- PIP PCSIP001 - *Instrument Piping and Tubing Systems Specifications*

- PIP PNE00001 - *Design of ASME B31.3 Metallic Piping Systems*
- PIP PNSM0001 - *Piping Line Class Designator System*

2.2 Industry Codes and Standards

- American National Standards Institute (ANSI)
 - ANSI/FCI 70-2-1991 - *Quality Control Standard for Control Valve Seat Leakage*
- American Society of Mechanical Engineers (ASME)
 - *ASME Boiler and Pressure Vessel Code*
Section VIII - *Pressure Vessels*
- ISA
 - ISA S5.1 - *Instrumentation Symbols and Identification* (R1992)
 - ISA S5.2 - *Binary Logic Diagrams for Process Operations* (R1981)
 - ISA S5.3 - *Graphic Symbols for Distributed Control / Shared Display Instrumentation, Logic and Computer Systems*
 - ISA S84.01 - *Application of Safety Instrumented Systems for the Process Industries*
 - ISA S91.01 - *Identification of Emergency Shutdown Systems and Controls That Are Critical to Maintaining Safety in Process Industries*
- Tubular Exchanger Manufacturers Association (TEMA)
 - TEMA Standards

2.3 Government Regulations

- Occupational Safety and Health Administration (OSHA)
 - OSHA 29 CFR 1910.119 - *Occupational Safety and Health Standards, Process Safety Management of Highly Hazardous Chemicals*

3. Definitions

For the purposes of this Practice, the following definitions apply:

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) (Reference ISA S5.1.)

Automated Valve: Any valve with a locally or remotely controlled actuator. Examples are throttling control valves and on/off block valves. Actuators are typically air-operated (diaphragm or piston), electric or hydraulic, some with spring return function. Manually-operated valves are sometimes also tagged as automated valves such as when a manual valve is fitted with position switches.

Auxiliary P&ID: P&ID used to show details in order to un-clutter other P&IDs (e.g., lube oil system, sample systems, instrument details)

Basic Process Control System (BPCS): The Basic Process Control System is the control equipment and system that is installed to regulate normal production functions. The BPCS may contain combinations of single loop pneumatic controllers, single loop electronic controllers, Programmable Logic Controllers (PLCs) and Distributed Control Systems (DCSs). The BPCS is required to operate the process. Examples of control functions included in the BPCS are cascade control, override control and pump start/stop. (also known as Basic Regulatory Controls). See definitions for HLCS and SIS.

Bubble: The circular symbol used to denote and identify the purpose of an instrument or function. It usually contains a tag number. Synonym for balloon. (Reference ISA S5.1.)

Design Pressure: The pressure used in the design of a vessel component together with the coincident design metal temperature for the purpose of determining the minimum permissible thickness or physical characteristics of the different zones of the vessel (Reference ASME Boiler Pressure Vessel Code Section VIII, Division 1, Appendix 3.)

Equipment Trim: Items attached to equipment as an integral component, identified as part of the equipment that is exposed to the process and whose function is local to the equipment it serves. Examples are vent and drain valves, instrument bridles, blind flanges, plugs or other miscellaneous items associated with a piece of equipment.

Fail Closed (FC): The characteristic of an automated valve that results in the valve closing as a result of specific malfunctions, including loss of signal or motive power (Reference ISA S5.1.)

Fail Indeterminate (FI): The characteristic of an automated valve that results in the valve moving to an unknown position as a result of specific malfunctions, including loss of signal or motive power. Some automated valves will not stay at the last position upon failure and will instead move with the process differential pressure. Additional equipment may be needed to meet the definition of FC, FO or FL. (Reference ISA S5.1.)

Fail Locked (FL) Last Position: The characteristic of an automated valve that results in the valve remaining in the last (locked) position as a result of specific malfunctions, including loss of signal or motive power. Automated valves may fail indeterminate without additional equipment. (Reference ISA S5.1.)

Fail Open (FO): The characteristic of an automated valve that results in the valve opening as a result of specific malfunctions, including loss of signal or motive power (Reference ISA S5.1.)

Hand Switch (HS): Any operator manipulated discrete control device, including hardwired panel switches and software points

Heat Exchanger Type: Type designation shall be shell and tube, plate and frame, spiral, etc. For shell and tube exchangers use the three letter designation describing stationary head, shell and rear end or head, in that order, per TEMA.

Higher Level Control System (HLCS): The Higher Level Control System provides sophistication above that of the BPCS. The HLCS is not necessary to operate the process. HLCS functions are typically based in process computers or higher level DCS hardware that interacts with the process by manipulating setpoints in the BPCS. Examples of control functions in the HLCS are statistical process control and model predictive control. See definitions for BPCS and SIS.

Interlock: A system that, in response to a predetermined condition, initiates a predefined action. Typically comprised of binary (on - off) signals and logic used for process control, sequencing or protective interruption of normal process control functions. Protective interlocks are typically further defined as being either safety related or commercial (asset or production protection) related.

Line Class: A section of the Piping Material Specifications which provides a listing of piping components for specific design conditions

Logic solver: The control equipment that performs the logic function. It can be either hardwired (e.g., relays) or Programmable Electronic Systems (e.g., DCS or PLC based, including dual or triple redundant microprocessors).

Packaged Equipment: One or more pieces of equipment furnished by a vendor with supportive devices and components to perform a specific operation as a unit

Piping and Instrumentation Diagram (P&ID): A detailed graphical representation of a process including the hardware and software (e.g., piping, equipment, instrumentation) necessary to design, construct and operate the facility. Common synonyms for P&IDs include EFDs (Engineering Flow Diagrams), UFDs (Utility Flow Diagrams) and MFDs (Mechanical Flow Diagrams).

Programmable Electronic System (PES): Logic performed by programmable or configurable devices (Reference ISA S84.01.)

Root valve: The first valve or valves between the process and an auxiliary device (e.g., an instrument) that contacts the process and is used to isolate the device from the process. This is typically a line class valve used for shut-off and isolation. It is also commonly referred to as the primary block valve.

Safety Critical Control: A control whose failure to operate properly will directly result in a catastrophic release of toxic, reactive, flammable or explosive chemical (Reference ISA S91.01.)

Safety Integrity Level (SIL): One of three possible discrete integrity levels (SIL 1, SIL 2, SIL 3) of Safety Instrumented Systems. SILs are defined in terms of Probability of Failure on Demand (PFD). (Reference ISA S84.01.)

Safety Instrumented Systems (SIS): Systems composed of sensors, logic solvers and final control elements for the purpose of taking the process to a safe state when predetermined conditions are violated. Other terms commonly used include Emergency Shutdown System (ESD, ESS), Safety Shutdown System (SSD) and Safety Interlock System. (Reference ISA S84.01.) See definitions for BPCS and HLCS.

Skirt: A cylindrical supporting structure, welded to the bottom of a vertical vessel and extended to the base support

Tagged: For the purposes of labeling instrumentation and control components, a hardware device or a software point that is identified with an ISA style tag number

4. Requirements

Practice requirements are divided into five sections (General, Format, Equipment, Piping and Instruments & Controls). Reference the appropriate section for the specific area of interest.

4.1 General

Practice requirements are intended to provide a balance between the desire to show all data on P&IDs with the need to make P&IDs legible and easy to read. Most details that are available from other types of documentation (e.g., instrument loop diagrams, vessel data sheets) are not recommended for inclusion on P&IDs.

This Practice utilizes the concepts of typical details with implied components whenever appropriate to simplify P&IDs. See the cover sheet in Appendix B Page 4 for examples. Additional examples may be added as required.

4.2 Format

4.2.1 Layout

- 4.2.1.1 Criteria contained herein apply to reading a P&ID from the bottom or right side of the drawing. The top of a horizontal line and the left side of a vertical line is the top of a pipe. The bottom of a horizontal line and the right side of a vertical line is the bottom of a pipe. Use a note to clarify as required.
- 4.2.1.2 Drawing size is 22" x 34" (560 mm x 864 mm).
- 4.2.1.3 Layout each P&ID to avoid clutter and allow future modifications. Show no more than three pieces of major equipment per P&ID. A set of pumps in the same service is one piece of equipment for the purpose of P&ID layout per Appendix C Page 1.
- 4.2.1.4 Show primary flow on each P&ID from left to right.

Show flow through equipment relative to actual arrangement (e.g., cooling water supply in bottom of exchanger tube bundle and cooling water return out top).

4.2.1.5 Show primary process lines heavier than secondary and utility lines as described in Section 4.2.3.

4.2.1.6 Show off-page connector arrows for primary, secondary and instrumentation lines entering the P&ID horizontally 0.25" (6.4 mm) from the left inside borderline and exiting 0.25" (6.4 mm) horizontally from the right inside borderline per Appendix C Page 1.

Utility connectors may be shown at any convenient location on the body of the P&ID.

4.2.1.7 Show utility collection/distribution P&IDs laid out relative to Plot Plan orientation per Appendix C Page 3.

In order to depict Plot Plan orientation, utility off-page connectors for a utility connection/distribution P&ID may be positioned vertically per Appendix C Page 3.

When match lines are required on Utility P&IDs, the lines are to match the connecting drawing match lines per Appendix C Page 3.

4.2.1.8 Show service description, connector number, P&ID number and origin/destination for off-page connectors per Appendix A-3 Page 7.

Show origin/destination as an equipment number, line number, or loop number.

Show service description as name of fluid (e.g., Cracked Gas) or line description (e.g., Reactor Feed, Tower Overhead), for piping off-page connector.

Show service description as a line function (e.g., Low Level Override) or equipment to be controlled (e.g., PV-10014A/B) for instrument off-page connector.

Show service description and origin/destination text starting at left side of off-page connector symbol.

4.2.1.9 Show equipment arrangement relative to its elevation to grade (e.g., pumps at bottom of P&ID) per Appendix C Page 1.

4.2.1.10 Show control valve actuator above a horizontal line or left of a vertical line.

4.2.1.11 When a control valve identification bubble is required, show center point of bubble 0.5" (12.7 mm) above and 0.5" (12.7 mm) away from the actuator in a horizontal line or 0.5" (12.7 mm) to the left and 0.5" (12.7 mm) away from the actuator in a vertical line.

4.2.1.12 Show the center point of an instrument bubble 0.5" (12.7 mm) directly above an in-line instrument in a horizontal line or 0.5"

(12.7 mm) directly left of an in-line instrument in a vertical line.
Examples are restriction orifices and stand-alone thermowells.

- 4.2.1.13 Show pump and compressor driver piping, instrumentation and auxiliaries on a separate auxiliary P&ID.
- 4.2.1.14 Use typical details when they eliminate clutter without detracting from clarity. Show these details on the P&ID, on an auxiliary P&ID, or on a cover sheet.
- 4.2.1.15 Show the center point of a PSV (Pressure Safety Valve) identification bubble 0.5" (12.7 mm) above and 0.5" (12.7 mm) away from the safety valve.

Show the PSV in a vertical and upright position.
- 4.2.1.16 Show the center point of a PSE (Pressure Safety Element) identification bubble 0.5" (12.7 mm) above a horizontal line or left of a vertical line and 0.5" (12.7 mm) away from the rupture disc or equipment.

4.2.2 Symbolology

- 4.2.2.1 Show format, equipment, piping and instrument symbols per Appendices A-1, A-2, A-3 and A-4.

Show equipment internals using a short dash/space line at a weight of 0.02" (0.5 mm).

Show a mating piping flange to an equipment nozzle at a distance of 0.06" (1.5 mm).

Show a connection to an equipment nozzle when the connection is welded per Appendix A-3 Page 6.
- 4.2.2.2 Show a note reference symbol per Appendix A-1 Page 2 at a weight of 0.03" (0.8 mm).

Show a note number in the symbol at a weight of 0.02" (0.5 mm).
- 4.2.2.3 Show normally closed manual valves using a darkened solid symbol.

When darkened in valves cannot be used because of symbol type (e.g., butterfly valve), use the abbreviation for Normally Closed (NC) directly below the valve in a horizontal line or to the right of the valve in a vertical line.

Show on-off valves in normal operating position.

Do not show control valves or relief valves normally closed.

4.2.3 Lines

- 4.2.3.1 Show primary process lines per Appendix A-3 Page 3 at a weight of 0.06" (1.5 mm).

- 4.2.3.2 Show secondary, utility, future or existing lines per Appendix A-3 Page 3 at a weight of 0.02" (0.5 mm).
- 4.2.3.3 Show instrument line symbols per Appendix A-4 Page 4 at a weight of 0.01" (0.3 mm).
- 4.2.3.4 Show packaged equipment limit lines per Appendix A-1 Page 2 at a weight of 0.03" (0.8 mm).
- 4.2.3.5 Show line class and insulation breaks per Appendix A-1 Page 2 at a weight of 0.02" (0.5 mm).
- 4.2.3.6 Minimize "dog legged" lines.
- 4.2.3.7 Maintain a minimum of 0.5" (12.7 mm) spacing between lines.
- 4.2.3.8 Show flow arrows at corners and intersecting lines, where there is a change in direction of majority of flow.
- 4.2.3.9 Break vertical primary process lines when crossing horizontal primary process lines.
Break secondary and utility lines for primary process lines.
Break vertical secondary and utility lines for horizontal secondary and utility lines.
Break instrument lines for all process and utility lines.
For utility collection/distribution P&IDs, break entering and exiting lines around pipe rack lines.
- 4.2.3.10 Maintain line break gaps at 0.13" (3.2 mm).
- 4.2.3.11 Avoid routing lines across equipment or text.

4.2.4 Text

- 4.2.4.1 Show general text and notes using a text height of 0.1" (2.5 mm) at a weight of 0.02" (0.5 mm).
General text and notes are aligned left and start in the upper left corner of the notes area per Appendix C Page 1.
- 4.2.4.2 Show equipment numbers using a text height of 0.16" (4 mm) at a weight of 0.03" (0.8 mm).
Show equipment numbers underlined.
Show equipment title and data using a text height of 0.1" (2.5 mm) at a weight of 0.02" (0.5 mm).
Show equipment text top/center justified.
- 4.2.4.3 Show line numbers per Appendix A-3 Page 1 using a text height of 0.1" (2.5 mm) at a weight of 0.02" (0.5 mm).
Place line number text 0.06" (1.5 mm) from line and lined up vertically 0.25" (6.4 mm) from off-page connector.

Show line numbers at entering off-page connectors top/left justified. Show line numbers at exiting off-page connectors top/right justified.

- 4.2.4.4 When a note contains more than one line, show line spacing between each line at 0.05" (1.3 mm).

Show spacing between notes at 0.25" (6.4 mm) beneath the last line of the preceding note maintaining top/left text justification.

- 4.2.4.5 Show equipment numbers, titles and data for exchangers, vessels, towers, agitators, jets, mixers, furnaces, tanks, filters and material handling equipment within 2" (51 mm) from the top inside borderline of the P&ID, directly above the equipment and on the same horizontal plane as other equipment identification.

Show equipment numbers, titles and data for pumps, blowers and compressors within 2" (51 mm) from the bottom inside borderline of the P&ID, directly below the equipment and on the same horizontal plane as other equipment identification.

Show equipment number, title and data once for identical equipment with the same number, title and service (e.g., P-601A/B).

- 4.2.4.6 Show text horizontal where possible.

Show vertical text placed to the left of supporting graphics where possible. Read vertical text only from the right.

- 4.2.4.7 Show line numbering with the orientation of the line.

- 4.2.4.8 Show abbreviations per Appendix A-1 Page 1.

- 4.2.4.9 Show control valve failure action abbreviation 0.06" (1.5 mm) directly below control valve.

- 4.2.4.10 Show control valve size between the actuator and valve body symbol if the valve is not line size or easily inferred from adjoining pipe, reducers or equipment.

- 4.2.4.11 Show control valve seat leakage criteria (i.e., Tight Shut-Off (TSO)) between the actuator and valve body symbol.

- 4.2.4.12 Show the device size and set pressure for PSVs, PSEs, and Pressure Control Valves (PCVs) close to the identification bubble.

4.3 Equipment

4.3.1 Equipment General Information

- 4.3.1.1 Show equipment with simple outline representation. Exercise discretion so that equipment symbols do not dominate the drawing, but draw the symbols large enough for clear understanding. Do not draw equipment to scale. Show equipment