

KLM Technology Group Project Engineering Standard	 www.klmtechgroup.com	Page : 1 of 143
		Rev: 01
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KLM Technology Group #03-12 Block Aronia, Jalan Sri Perkasa 2 Taman Tampoi Utama 81200 Johor Bahru Malaysia	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	

TABLE OF CONTENT

SCOPE	2
REFERENCES	2
DEFINITIONS AND TERMINOLOGY	3
SYMBOLS AND ABBREVIATIONS	3
UNITS	3
GENERAL	4
MINIMUM INFORMATION TO BE SHOWN ON P&I DIAGRAMS	10
DESIGN CRITERIA FOR PREPARATION OF P&I DIAGRAMS	25
CRITERIA FOR UTILITY FLOW DIAGRAMS	35
ABBREVIATIONS / GRAPHICAL SYMBOLS / IDENTIFICATIONS	37
PREPARATION OF P&I DIAGRAMS	38
APPENDIX A	51
APPENDIX B	118
APPENDIX C	120
APPENDIX D	121
APPENDIX E	122
APPENDIX F	123
APPENDIX G	124
APPENDIX H	126
APPENDIX I	128
APPENDIX J	129

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 2 of 143
		Rev: 01
		Feb 2011

SCOPE

This Engineering Standard Specification covers the format and technical basis for the Piping and Instrumentation Diagrams (P&IDs) and Utility Distribution Flow Diagrams (UDFDs) for process, offsite and utility plants. Namely, the purpose of this manual is to indicate in general terms, the extents of detailing, valving philosophy and instrumentation requirements of similar process designs.

This Standard is also intended to establish uniform symbols for equipment, piping and instrumentation on P&IDs and UDFDs throughout the Oil, Gas and Petrochemical (OGP) projects.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

- B31 Series "For Pressure Piping"
- B16.1 "Cast Iron Pipe Flange and Flanged Fittings, Class 25, 1st.Ed.,1989"
-

2. ISA (THE INTERNATIONAL SOCIETY OF AUTOMATION)

- S5.1 "Instrumentation Symbols and Identification 1st. Ed., 1984"
- S5.2 "Binary Logic Diagrams for Process Operations 2nd. Ed., 1981 (Reaffirmed 1992)"
- S5.3 "Graphic Symbols for Distributed Control / Shared Display Instrumentation, Logic and Computer Systems "Ed.,1983"
- S5.4 "Instrument Loop Diagrams Ed., 1991"
- S5.5 "Graphic Symbols for Process Displays 1st. Ed., 1985"

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 3 of 143
		Rev: 01
		Feb 2011

- S18.1 "Annunciator Sequences and Specifications 1st. Ed., 1979 (Reaffirmed 1992)"
- S50.1 "Compatibility of Analogue Signals for Electronic Industrial Process Instruments 1st. Ed., 1975 (Reaffirmed 1995)"
- S51.1 "Process Instrumentation Terminology 1st. Ed., 1979 (Reaffirmed 1993)"

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3. ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

- 3098 "Drawings-Lettering, Part 1: Currently Used Characters 1st. Ed. 1974"
- 3511 "Process Measurement Control Functions and Instrumentation-Symbolic Representation
- 6708 "Pipe Work components-Definition and Selection of DN(Nominal size) "

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4. API (AMERICAN PETROLEUM INSTITUTE)

- Standard 602 "Compact steel gate valves flanged, threaded, welding and extended body ends 7th Ed., 1998"

DEFINITIONS AND TERMINOLOGY

Licenser - A company duly organized and existing under the laws of the said company's country and as referred to in the preamble to the contract.

Project- the equipment, machinery and materials to be procured by the contractor and the works and/or all activities to be performed and rendered by the contractor in accordance with the terms and conditions of the contract documents.

Unit- one or all process, offsite and/or utility Units and facilities as applicable to form a complete operable oil, gas and/or petrochemical plant.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 4 of 143
		Rev: 01
		Feb 2011

SYMBOLS AND ABBREVIATIONS

For symbols and abbreviations refer to Appendix A of this Standard.

UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

GENERAL

Definition

The Piping and Instrument Diagram (P&ID), based on the Process Flow Diagram (PFD), represents the technical realization of a process by means of graphical symbols for equipment and piping as well as graphical symbols for process measurement and control functions. The Utility Distribution Flow Diagram (UDFD) is a special type of a P&ID which represents the utility systems within a process plant showing all lines and other means required for the transport, distribution and collection of utilities. The process equipment in the UDFD can be represented as a box with inscription (e.g., identification number) and with utility connections.

Representation

The representation and designation of all the equipment, instrumentation and piping should comply with the requirements of this Standard. Auxiliary systems may be represented by rectangular boxes with reference to the separate diagrams.

Dimensions of the graphical symbols for equipment and machinery (except pumps, drivers, valves and fittings) should reflect the actual dimensions relative to one another as to scale and elevation. The graphical symbols for process measurement and control functions for equipment, machinery and piping, as well as piping and valves themselves, shall be shown in the logical position with respect to their functions.

All equipment shall be represented such that the consistency in their dimensions is considered if not in contrast to the good representation of the equipment.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 5 of 143
		Rev: 01
		Feb 2011

Drafting

1. General rules

Drafting shall be in accordance with the requirements outlined in this Standard. The drafting must be of sufficiently high quality to maintain legibility when the drawing is reduced to an A3 size sheet.

2. Drawings sheet sizes

Diagrams should be shown on A0 size (841 mm × 1189 mm). A1 size (591 mm × 841 mm) may be used for simple P&IDs and UDFDs as per Company's approval.

3. Drawing title block

a. The following requirements shall be shown on the title block of each drawing (see Appendix B):

- Revision table;
- Main Company's name (e.g., National Oil Company);
- Name of Company Relevant Organization, (if any), (e.g., Refineries Engineering and Construction);
- Name of refinery or plant (in English words);
- COMPANY'S emblem;
- Contractor's name;
- Drawing title;
- Company's project No.;
- Contractor's job No. (optional);
- Contractor's drawing No. (optional);
- Company's drawing No.

b. Title block sizes and drawing dimensions shall be as follows:

Drawing Dimensions (mm × mm)	Title Block Size (Including Revision Table) Width (mm) × Length (mm)
A0 = 841 × 1189	180 × 190
A1 = 594 × 841	130 × 175
A2 = 420 × 594	100 × 155
A3 = 297 × 420	75 × 120

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 6 of 143
		Rev: 01
		Feb 2011

4. Line widths

To obtain a clear representation, different line widths shall be used. Main flow lines or main piping shall be highlighted.

The following line widths shall be applied:

- 0.8 mm for main process lines;
- 0.5 mm for other process lines; utility lines, and underground lines;
- 0.5 mm for graphical symbols for equipment and machinery, except valves and fittings and piping accessories;
- 0.5 mm for rectangular boxes for illustrating Unit operations, process equipment, etc.;
- 0.5 mm for subsidiary flow lines or subsidiary product lines and for energy carrier lines and auxiliary system lines;
- 0.4 mm for class changes designation;
- 0.3 mm for graphical symbols for valves and fittings and piping accessories and for symbols for process measurement and control functions, control and data transmission lines;
- 0.3 mm for all electrical, computer and instrument signals;
- 0.3 mm for reference lines;

Line widths of less than 0.3 mm shall not be used.

5. Line spacing

The space between parallel lines shall not be less than twice the width of the heaviest of these lines with a minimum value of 1 mm. A spacing of 10 mm and more is desirable between flow lines.

6. Direction of flow

In general, the main direction of flow proceeds from left to right and from top to bottom. Inlet and outlet arrows are used for indicating the inlet and outlet of flows into or out of the diagram. Arrows are incorporated in the line for indicating the direction of the flows within the flow diagram. If necessary for proper understanding, arrows may be used at the inlets to equipment and machinery (except for pumps) and upstream of pipe branches. If a diagram consists of several sheets, the incoming and outgoing flow lines or piping on a sheet may be drawn in such a manner that the lines continue at the same level when the individual sheets are horizontally aligned.

7. Connections

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 7 of 143
		Rev: 01
		Feb 2011

Connections between flow lines or pipelines shall be drawn as shown in Fig. 1 and 2 below:

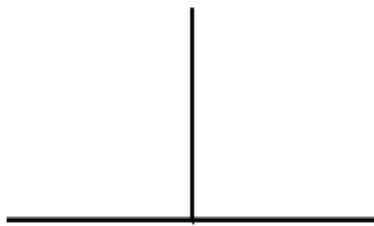


Fig.1

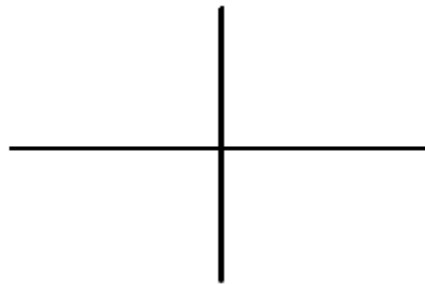


Fig.2

Figs. 3 and 4 show two flow lines or pipelines, which are not connected:

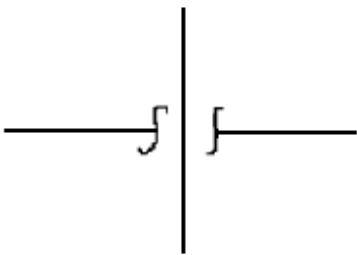


Fig.3

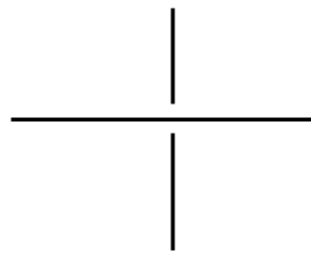


Fig.4

8. Inscriptions

a. Type of lettering

Lettering in accordance with ISO 3098 Part 1, Type B vertical, to be used.

b. Height of lettering

The height of letters should be:

- 7 mm for drawing number;
- 5 mm for drawing title and identification numbers of major equipment;
- 3 mm for other inscriptions.

c. Arrangement of inscription

i) Equipment

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 8 of 143
		Rev: 01
		Feb 2011

Identification numbers for equipment should be located close to the relevant graphical symbol, and should not be written into it. Further details (e.g., designation, design capacity, design pressure, etc.) may also be placed under the identification numbers.

ii) Flow lines or piping

Designation of flow lines or piping shall be written parallel to and above horizontal lines and at the left of and parallel to vertical lines. If the beginning and end of flow lines or piping are not immediately recognizable, identical ones should be indicated by corresponding letters.

iii) Valves and fittings

Designation of valves and fittings shall be written next to the graphical symbol and parallel to the direction of flow.

iv) Process measurement and control functions

The representation should be in accordance with the requirements stipulated in ISA-S5.1 and ISO 3511, Parts 1 and 4, latest revisions unless otherwise specified in this Standard.

Equipment Location Index

Piping and Instrument Diagrams shall be divided into equivalent intervals (each in 50 mm) either in length or width. The intervals shall be designated with numbers from 1 to 23 in length and alphabets from "A" to "P" in width. Equipment location on each diagram shall be addressed by the relevant coordinates where required. In upper right-hand area of the flow diagram under title of "Item Index" all main equipment shall be listed by equipment number, alphabetically and numerically and equipment location coordinates. In a separate sheet apart from P&IDs, an "Item Index" shall be prepared to summarize all equipment of the Unit/Plant with reference P&IDs and equipment location.

Arrangement

1. The preferred arrangement is such that towers, vessels and fired heaters are shown in the upper half of the diagram, heat exchange equipment in the upper three quarters as practical, and machinery equipment in the lower quarter. The spacing of equipment and flow lines shall permit identification and tracing of the lines easily.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 9 of 143
		Rev: 01
		Feb 2011

2. The area above the title block on each sheet shall be completely left open for notes.
3. The general flow scheme shall be from left to right. Unnecessary line crossing should be avoided.
4. Process lines entering and leaving the diagram from/to other drawings in the Unit shall be terminated at the left-hand or right-hand side of the drawing. Lines from/to higher number drawings shall enter and leave the drawing on the right-hand end and vice versa.
5. Each process line entering or leaving the side of the drawing should indicate the following requirements in an identification box (see Appendix B):
 - a. The line service
 - b. The origin or destination equipment item number
 - c. Continuation drawing number with the relevant coordinates.
6. Process lines to/from other Units should be terminated at the bottom of the drawing at a box indicating the following requirements (see also Appendix B):
 - a. The line service
 - b. Source or destination Unit name and number
 - c. The drawing number of the connecting flow diagrams with the relevant coordinates.
7. All utility lines entering or leaving the diagram shall be terminated at any convenient location at a box indicating the relevant utility service abbreviation (e.g., CWS, CWR, IA, etc.). See Appendix A of this Standard for utility services abbreviations. "Utilities Identification Table" Showing utility services with the reference drawings should be provided at top or left hand side of each drawing title block (see Appendix C).
8. Instrument, control system and software linkage signals from sheet to sheet shall be terminated preferably at the side of sheet or in an appropriate location at a box indicating the continuation instrument number, location, and drawing number (see Appendix B).
9. Equipment descriptions of towers, vessels, tanks, furnaces, exchangers, mixers and other equipment except machinery shall be located along the top of the flow diagram. Machinery descriptions shall be along the bottom.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 10 of 143
		Rev: 01
		Feb 2011

MINIMUM INFORMATION TO BE SHOWN ON P&I DIAGRAMS

General

Each P&ID shall present all information as required herein below during implementation of a project in detailed design phase. Extent of information shown on each P&ID in the basic design stage shall be agreed by Company in advance.

Vendor supplied packages with an outline of the main components shall be shown in a dashed/dotted box. Letter "PU" referring to package shall be indicated adjacent to each equipment and instrument of the package.

Equipment, instruments or piping which are traced or jacketed, shall be shown.

The identification number and service presentation shall be shown for each piece of equipment. This information shall be indicated in or adjacent to towers, drums, heaters, tanks and heat exchangers, etc.

Equipment Indication

1. Vessels, towers, drums

a. The following requirements shall be shown:

- Changes of shell diameter (if any);
- Top and bottom trays, and those trays which are necessary to locate feed, reflux and product lines;
- All draw-off trays with tray number and diagrammatic representation of the downcomer position (e.g., side or center);
- All nozzles, manholes, instrument connections, drains, vents, pump-out and steam-out connections, blank-off ventilations, vortex breakers, safety/relief valve connections, sample connections and hand holes;
- Skirt or legs, top and bottom tangent lines;
- Elevations above base line to bottom tangent line of column or to bottom of horizontal drum;
- The position of high high liquid level (HHLL), high liquid level (HLL), normal liquid level (NLL), low liquid level (LLL) and low low liquid level (LLLL);

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 11 of 143
		Rev: 01
		Feb 2011

Notes:

- i) For draw-offs only "NLL" shall be shown. The other liquid positions will be shown as required.
 - ii) Indication of "HHLL" and "LLLL" shall be made when they are actuating start/stop of an equipment or machinery through a switch.
 - iii) "HLL", "NLL" and "LLL" shall be shown for all cases except as specified under Note i) above.
- All flanged connections; [all connections whose purpose is not readily evident shall indicate the purpose (e.g., spare inlet, catalyst draw-off, etc.)
 - Catalyst beds, packings, demisters, chimney trays, distributors, grids, baffles, rotating discs, mixers, cyclones, tangential inlet and all other internals;
 - Water drop-out boots;
 - Maintenance blinds for the vessel nozzles.
- b. Important notes:
- All nozzles and connections indicated on the equipment data sheet shall be shown in their correct positions.
 - All indications shall be such that the consistency in the dimensions is considered, although not necessarily to scale.
 - Numbering of the trays shall be from bottom to top.
 - Height of the vessel bottom tangent line shall be indicated.
 - Self standing : Skirt height
 - Elevated vessel: Minimum required height shall be shown as "min."
 - A valved drain for all columns and vessels shall be indicated. Generally, this valve is to be located on the bottom line outside the skirt and between the vessel and the first pipe line shut-off location (valve or blinding flange). The drain valve shall be located on the bottom of the vessel when:
 - i) No bottom line is present, or
 - ii) The bottom line is not flushed with the lowest point of the vessel.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 12 of 143
		Rev: 01
		Feb 2011

- The valved vent with blind flange for all columns and vessels provided on the top of the vessel should be indicated.
 - Safety Relief valves generally located on the top outlet line downstream of the vessel blinding location or directly connected to the vessel should be indicated
 - Utility connections on all vessel/columns shall be shown.
 - One local PI shall be indicated on top of vessel/column.
 - One local TI shall be indicated on the top outlet line of vessel/column.
 - Nozzles identifications on vessels, reactors and towers shall be according to Appendix D of this Standard.
- c. The following requirements shall be described under equipment description:
- Vessel item number (this number will also appear adjacent to the vessel);
 - Service;
 - Size [inside diameter(s) and tangent to tangent length];
 - Design pressure (internal/external) and design temperature;
 - Indication of insulation;
 - Line number of vessel trim (this applies to LG & LC connections, vents, sample connections, etc.);
 - Indication of cladding and lining (if any).

2. Tanks

- a. The following requirements shall be shown:
- All nozzles, man ways, instrument connections, drains, vents, vortex breakers, and safety/relief valve connections;
 - All internals such as steam coils, air sparkers, tank heaters, vortex breakers, water-draw off sump and etc.
- b. Equipment description
- equipment item number (this number also appears adjacent to the tank);
 - Equipment Description

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 13 of 143
		Rev: 01
		Feb 2011

- equipment item number (this number also appears adjacent to the tank);
 - inside diameter and height;
 - nominal capacity, in (m³);
 - Indication of insulation.
3. Fired heaters, boilers, incinerators
- a. The following requirements shall be shown:
- All nozzles, instrument connections, drains, vents and damper(s);
 - Ducting arrangement including damper actuators where required;
 - Detail of draft gages piping and arrangement;
 - Waste heat recovery system (if present), such as economizer, air preheater, forced draft fan, induced draft fan, etc.;
 - Decoking connections;
 - Detail of one complete set of burners for each cell and total burner number required for each type of burner;
 - Tube coils schematically in correct relative positions and all skin point thermocouples;
 - Logic diagram of shut down system (heat off sequence);
 - Number of passes and control arrangement;
 - Snuffing steam nozzles and piping arrangement;
 - Blow-down and steam-out connections;
 - Testing facilities;
 - Convection section (where applicable).
- b. Equipment description
- item number (this number will also appear adjacent to the equipment);
 - service;
 - duty (kJ/s);
 - design pressure and temperature of coils;
4. Heat exchangers, coolers, reboilers
- a. The following requirements shall be shown:

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 14 of 143
		Rev: 01
		Feb 2011

- All nozzles, instrument connections, drains and vents, chemical cleaning connections and safety/relief valves as indicated on the equipment data sheet;
- Spectacle blinds for the isolation;
- Elevations required for process reason (e.g., reboilers, condensers, etc.);
- The connections which allow pressure and temperature survey of heat exchanger facilities;
- The position of high liquid level (HLL), normal liquid level (NLL) and low liquid level (LLL) for kettle type reboilers;
- Direction of flow in each side of exchanger.

b. Important notes

Due considerations should be made for proper indication in the following requirements:

- Generally, direction of flow shall be downflow for cooled media and upflow for heated media.
- Isolation valves shall be provided on inlet and outlet lines where maintenance can be performed on the exchanger with the Unit operating. Provision of by-passing is required for this case.
- Shell and channel piping shall be provided with a valved vent connection and a drain connection unless venting and draining can be done via other equipment.
- At exchangers with circulating heat transfer media, the outlet valve shall be of a throttling type for control of heat duty.
- An inlet and outlet, temperature indicator shall be provided on each exchanger (on either shell or tube side) so that to facilitate checking of heat balance around exchanger.

Type of temperature indicator shall be as follows:

- A board mounted temperature indicator (TI) shall be provided at the inlet and outlet of all shell and tube process/process exchanger.
- For water coolers, the water side outlet shall be provided with a local TI only. The shell side in and out shall be provided with board mounted TIs.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 15 of 143
		Rev: 01
		Feb 2011

- Thermowells (TWs) shall be provided between each shell side and tube side of the same services when the exchangers are in series.
 - Local indicator type shall be provided for the requirement of local temperature control, such as manual bypass control.
- c. Equipment description
- Equipment item number (this number also appears adjacent to the equipment);
 - Service;
 - Duty (kJ/s);
 - shell side design pressure and temperature;
 - tube side design pressure and temperature;
 - Indication of insulation.
- d. Sequence of numbering for stacked exchangers/coolers shall be from top to bottom.
5. Air fin coolers
- a. The following requirements shall be shown:
- All nozzles and instrument connections;
 - Blinds for the isolation;
 - Any automatic control (fan pitch control or louver control) and any alarm (vibration alarm, etc.);
 - Configuration of inlet and outlet headers and the branches. Only one bundle and fan shall be shown; total number of fans and bundles shall be indicated. When multiple bundles are required, header's arrangement as separate detailed sketch shall be indicated;
 - Steam coil and condensate recovery system (if required);
 - Isolation valves (if required); isolation valves shall be provided in corrosive and fouling services where individual bundles can be repaired and maintained with the Unit operating;
 - Valved vent and valved drain connection for each header, vent header should be connected to closed system for volatile services;
 - A board mounted TI at inlet and outlet, (the TI will monitor the process side of each air fin service). If multiple bundles to be used for fouled services, provide TW's on the outlet of each bundle.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 16 of 143
		Rev: 01
		Feb 2011

b. Equipment description

- Equipment item number (this number will also appear adjacent to the equipment);
- Service;
- Duty (kJ/s);
- Tube side design pressure (internal and external) and design temperature.

6. Rotary machineries

a. The following requirements shall be shown:

i) Pumps

- All nozzles including instrument connections;
- Pump suction valve and strainer, and discharge valve and check valve. Provision of wafer type check valve should be avoided unless otherwise specified;
- Pump drains and vents piping and destination.
- The type of pump;
- Pump auxiliary system connections such as, cooling water, seal oil and lube oil, steam, etc.;
- Detail of lube and seal oil /sealing systems, cooling water piping arrangement, and minimum flow bypass line requirement for pumps;
- Winterization and/or heat conservation (steam or electrical) where required;
- Warm-up and flushing oil lines detail; a DN20 ($\frac{3}{4}$ inch) bypass/drain from the check valve to the pump discharge line shall be provided as warm-up line for the cases specified in item 8.1.4 of this Standard;
- Pressure gage located on the discharge of each pump; the gage shall be installed between the pump discharge nozzle and the check valve;
- Pressure relief safety valves (if any);
- Automatic start-up of standby unit (if required);

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 17 of 143
		Rev: 01
		Feb 2011

- Balanced or equalized line for vacuum service.
- ii) Compressors and blowers
- Type of compressor or blower;
 - Start-up facilities (i.e., inert gas purge system);
 - Safety/relief valves;
 - Suction and discharge valves;
 - Suction strainer (filter) and discharge check valve;
 - Suction and discharge pulsation dampener where required;
 - Valved vents and casing drains;
 - Winterization (steam or electrical tracing on suction piping) where required;
 - Lube and seal oil / sealing system and cooling water systems detail arrangement;
 - Interstage coolers where required;
 - Surge protection (where required);
 - Inlet and outlet nozzles;
 - All instrument connections.
- iii) Steam and gas turbine drivers
- All nozzles and connections;
 - Detail of all auxiliary systems for steam turbine drivers such as steam supply, condensate return, surface condenser and etc.;
 - Detail of lube oil, cooling water, etc.;
 - All instrumentations such as PI, TI, etc.;
 - Safety/relief valves; relief valves shall be located between the discharge nozzle and the outlet isolation valve; weep hole at exhaust of the relief valve which opens to atmosphere shall be provided to draw-off the condensate drain.
 - Warming bypass around inlet isolation valve for steam turbines; the valve on warm-up line shall be DN25 (1 inch) globe type;
 - Steam traps and condensate recovery system for the steam turbine casing drain and upstream of isolation valve at inlet of the turbine;

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 18 of 143
		Rev: 01
		Feb 2011

- Vent line to atmosphere at turbine exhaust; the vent is required for the start-up/test operation of the turbine.
- Detail of all firing and control systems for gas turbine drivers.

b. Equipment description

i) Pumps

- Pump item number (this number also appears below the pump);
- Service;
- Capacity, (m³/h, dm³/h for injection pumps);
- Differential pressure, (kPa
- Relative density (specific gravity) of pumped fluid at pumping temperature;
- Indication of insulation and tracing;
- Miscellaneous auxiliary piping (CW, flushing oil, seal oil, etc.).

ii) Compressors and blowers

- Equipment item number and stage (this number also appears below the compressor);
- Service;
- Capacity, (Nm³/h);
- Suction pressure, and temperature, [kPa (g)], (°C);
- Discharge pressure, and temperature, [kPa (g)], (°C);
- Miscellaneous auxiliary piping (CW, lube oil, seal oil / sealing system, etc.);
- Gas horse power, (kW).

c. Other requirements

- When a pump or compressor is spared, the data is listed once commonly for both pumps and compressors at the bottom of the flow diagram. The spare is identified by the word "Spare" below the pump or compressor. The operating equipment and the spare have the same number but with suffixes "A" and "B".
- Stage numbers are shown only for multistage compressors. All compressor data for the first stage shall be indicated. For subsequent stages only N m³/h may be omitted.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 19 of 143
		Rev: 01
		Feb 2011

7. Miscellaneous equipment

Depending on the type of equipment (silencer, flame arrestor, filter, etc.) the following information shall be presented:

- a. All nozzles, instrument connections, vents, drains, etc.;
- b. Equipment description at top of the flow diagram and including:
 - Equipment item number;
 - Service;
 - Tracing/insulation requirements;
 - Design pressure and temperature;
 - Capacity

Instrumentation

The following requirements shall be shown:

1. All instrumentation including test points;
2. Isolation valves connecting to instruments (primary connection valve);
3. Control valve sizes and air failure action (FC, FO, FL);
4. Block and bypass valve sizes at control valve stations;
5. Level gages connection type and range, and level controllers connection type, range and center of float (where NLL is not shown). Type, material and tracing requirement of level gages shall be shown
6. Sequence of opening and closing for the split range control valves;
7. Solenoid shut-down devices at control valves/shut-off valves;
8. Tight shut-off valves requirements (where required);
9. Hand wheels when provided on control valves;
10. Limit switches on control valves when required;
11. Mechanical stopper and/or signal stopper on control valves when required;
12. Push buttons and switches associated with shut-down systems;
13. The instrument tag number for each instrument;
14. Analyzer loop details and special notes as required;

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 20 of 143
		Rev: 01
		Feb 2011

15. Winterization of instruments;
16. Compressor local board mounted instrumentation;
17. Software linkage and alarm and shut-down logic system. Complex shut-down systems shall be shown as a "black box" with reference made to the logic diagram shown on a separate sheet. All actuating and actuated devices shall be connected to the "black box";
18. All elements of advance control and optimization systems;
19. Indication of "Readable From" for all local indicators and/or gages which shall be readable from a designated valve.

Piping

1. General
 - a. All piping shall be shown on P&I Diagrams, including:
 - Process lines;
 - Utility/common facility branch lines (e.g., sealing and flushing lines, cooling water lines, steam-out lines and connection, nitrogen lines, etc.);
 - Flare lines, including safety/relief valves discharge lines;
 - Start-up and shut-down lines;
 - Pump-out lines;
 - Drain and vent lines and connections;
 - Purge and steam-out facilities;
 - Catalyst regeneration lines;
 - Catalyst sulphiding lines;
 - Catalyst reduction lines;
 - Equipment and control valve bypasses;
 - Detail of spool pieces, equipment internals, etc., when required;
 - Steam tracing and steam jacketing.
 - b. All line numbers, sizes and line classification shall be shown.
 - c. The direction of normal flow shall be shown for all lines.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 21 of 143
		Rev: 01
		Feb 2011

- d. The points or spec. breaks at which line sizes or line specifications change shall be clearly indicated.
 - e. All blinds shall be indicated on the drawings, and the symbols used shall distinguish between tab blinds and spectacle blinds.
 - f. All vent and drain connections shall be identified whether screw capped or blind flanged, if required.
 - g. Steam traced lines and steam jacketed lines shall be so indicated.
 - h. All equipment flanges, all reducers and non-standard fittings, such as expansion bellows, flexible tubes, shall be shown.
 - i. All valves shall be shown by a symbol representing the type of valve. Any special orientation or location required for process reason and/or operability shall be shown. It is not necessary to show flanges at flanged valves except for those cases where the flanges deviate from the piping specification for the line in question, in which case flange and rating shall be shown. Any isolating valve shall be shown locked, normally open or closed.
 - j. Control valve sizes shall be shown.
 - k. All valves shown on the flow diagram shall have their size indicated by the valve, if different from line size.
 - l. Insulation and tracing requirements shall be covered in the line numbering system and shown above the line. Tracing requirement shall be noted on P&IDs by a dashed line parallel to the line to be traced.
 - m. Valve boxes/valve pits shall be shown by two embraced squares or rectangular with indication of "Valve Box" or "Valve Pit".
 - n. Safety relief valves type, inlet and outlet size and rating and set pressure should be shown.
 - o. For pressure ratings designations-nominal size and pipe component-nominal size see Appendices F & G of this Standard respectively.
2. Special requirements
- a. High point vents and low point drains are shown only when they are connected to a closed system, or are required for process reasons.
 - b. Utility lines originate and terminate adjacent to the equipment involved shall be shown. Only the length of line necessary for valving, instrumentation and line numbering is shown. Utility line origin and terminus is indicated by reference symbol or abbreviation only. Main utility

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 22 of 143
		Rev: 01
		Feb 2011

- headers are not shown on the P&IDs; they are shown on the utility system flow diagrams.
- c. Pertinent information regarding a line such as "do not pocket" or "slope", etc., shall be noted adjacent to the line.
 - d. Typical air cooler manifold piping arrangement should be shown.
 - e. Connections on process lines which require being blanked or deblanked for flow direction under special circumstances to be shown on P&ID.
 - f. Reduction and enlargement in line size are indicated by line size designation, and reducer and expander symbols.
 - g. Calculated wall thicknesses and/or schedules not already prespecified in the individual line classes shall be shown on the flow diagrams.
 - h. Corrosion allowances other than the nominal allowances indicated in the individual line classes shall be shown on the diagrams.
 - i. All operating drains shall be noted and sized on the flow diagrams and shall be routed to a drain funnel. Destination of the drains shall be according to the relevant specifications. All drains carrying light hydrocarbons (Reid vapor pressure 34.5 kPa absolute or greater) shall be segregated from the oily sewer system, and shall be connected to the flare system.
 - j. Sample and test connections shall be shown on the diagrams where required. Samples which require cooling and connections to the flare shall be shown with the cooling and flare lines connections.
 - k. Emergency showers, eye wash fountains and utility stations shall be shown on the Utility Distribution Flow Diagrams.
 - l. Any locations where slopes, straight runs, minimum mixing runs, etc., are required for process reasons must be indicated.
 - m. The necessary instrumentation and piping for start-up, control and shut-down, etc., shall be shown for any equipment on P&ID wherever applicable.
 - n. Break points between underground and aboveground piping with insulating flanges (if required) shall be shown.
 - o. Minimum distance requirement for in line blending to be indicated.
 - p. Weep hole requirement to be shown.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 23 of 143
		Rev: 01
		Feb 2011

3. Piping specialty items

- a. Piping components not identified by instrument or mechanical equipment numbers, etc., and not covered by the piping material specification, shall be identified by assigning a Specialty Item Number or an Item Code Number for identification symbol and shall be shown on the diagrams.
- b. Symbol "M" standing for "Monel Trim" should be mentioned on the valves on the P&IDs in services where there is a possibility of condensed water and H₂S being present except for the line classes which provide monel trim valves and other features. Where it is intended that the whole line should have monel trim valves it should also be indicated on the line list.
- c. ASME and non ASME Code change should be indicated for connection where ever applicable.

4. Steam traps & winterizing system

The following requirements shall be followed:

- a. Steam traps pertaining to the winterizing systems (steam tracing) are not shown on the P&IDs except for the following cases:
 - At dead ends/pockets on steam lines;
 - At upstream of the Unit battery limit main block valves on steam lines;
 - At all points which there is possibility of condensation;
 - At upstream of the first block valve of steam line going to the steam turbine drivers, steam coils or steam reboilers.
- b. Steam trap and the relevant steam and condensate lines to be shown for all steam reboilers, heaters, coils, etc.
- c. Steam/electrical tracing requirement shall be noted on P&IDs by a dashed line parallel to the line to be traced.

General Notes

General notes to be put on the front sheet of P&I Diagrams of each "Unit" under title of "General Notes". Reference should be made to the front sheet drawing No. showing "General Notes", on each P&I Diagram.

1. The following general notes shall be specified as minimum requirement:
 - a. All dimensions are in millimeters except as noted.
 - b. Elevations shown are above the highest point of paving.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 24 of 143
		Rev: 01
		Feb 2011

- c. All valves are line size unless otherwise shown.
 - d. This flow diagram is diagrammatic only. Design of pipe lines must be investigated for venting of gas and vapor pockets in piping and equipment, low points in piping, pumps and equipment for freezing and draining and accessibility of all valves, flanges and instruments including thermocouples etc.
 - e. All electronic instrumentation shall be installed away from steam lines and high temperature heat sources.
 - f. For level transmitter center of float is NLL. The range shall cover the difference between LLL & HLL.
 - g. Sample taping for gas samples shall be from the top of the main line. For liquid samples tapping shall be done from the side.
 - h. Except for process reasons, low point drains and high point vents are not shown.
 - i. All items marked (P) can be supplied as part of package Units.
 - j. Temperature instruments shown with "M" are provided with monel well.
2. The following general notes may be specified as required:
- a. Piping drains and vents

Low point drains and high point vents of piping shall be provided in accordance with the following:

 - i) Drains for all sizes
 - Alloy piping: DN 20 (¾ inch) gate valve with blind flange.
 - Carbon steel piping: DN 20 (¾ inch) gate valve with threaded plug.
 - ii) Vents for Dn 50 (2 inch) and larger

High point vent shall be provided for the piping of DN 50 (2 inch) and larger. Size and type are based on the following:

 - Alloy piping: DN 20 (¾ inch) gate valve with blind flange;
 - Carbon steel piping: DN 20 (¾ inch) gate valve with threaded plug;
 - The vent provided for hydrostatic testing shall be DN 20 (¾ inch) boss with threaded plug.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 25 of 143
		Rev: 01
		Feb 2011

- b. Block valves on orifice tap
 - DN 15 (½ inch) single gate valve shall be provided for the all orifices of the piping class of PN 100 (600 #) and less.
 - DN 20 (¾ inch) single gate valve shall be provided for the all orifices of the piping class of PN 150 (900#) and over.
- c. Drain valve of level gages and instruments:
 - Drain valves [DN 20 (¾ inch) gate valve] shall be provided.
 - The provisions should be made for routing the drain of liquids with RVP of greater than 34.5 kPa (abs) to flare.

DESIGN CRITERIA FOR PREPARATION OF P&I DIAGRAMS

The following design criteria shall be applied for preparation of P&I Diagrams unless otherwise specified in the relevant piping and/or equipment specifications of the Company. In case of any conflict, the specific piping and/or equipment specifications will be governed.

Assembly piping of pumps

1. Valve size selection basis for pumps

Generally, the size is likely different between pump suction line and pump suction nozzle, or pump discharge line and pump discharge nozzle. In case that, pump nozzle is one or more sizes smaller than the line size, the size of block valve shall be in accordance with the following:

	Nozzle	Block Valve
At Pump Suction	<ul style="list-style-type: none"> - One size smaller than line - Two or more sizes smaller than line 	<ul style="list-style-type: none"> - Same as suction line size - Select one size smaller than line
At Pump Discharge	Smaller than discharge line	Select one size smaller than line

2. Pump strainer

The suction strainer of pumps shall be selected in accordance with the following criteria:

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 26 of 143
		Rev: 01
		Feb 2011

Line Size	Strainer Type
DN 80 (3 inch) and larger	T
DN 50 (2 inch) and smal	Y

Strainers DN150 (6 inch) and larger shall have DN 25 (one inch) drain valve.

3. Pump vents and drains

Pump casing drains and vents shall be routed to closed system such as flare for the following services:

- a. Fluids containing toxic material;
- b. Fluids with a Reid vapor pressure greater than 34.5 kPa (abs) at pump operating temperature.

In addition to the above, the vent of casing for the vacuum service should be routed back to the suction vessel to make out the pressure balance prior to the pump operation. Drain of hydrocarbon pumps shall also have disposal to oily water sewer in all cases in addition to the above requirements unless otherwise specified.

4. Warming-Up line

The provisions for warming-up of pump is required for the pump operated at 170°C and higher or when the process fluid solidifies at ambient conditions or the fluids are corrosive or toxic.

5. Auxiliary piping of pump

Details of auxiliary piping such as, cooling water, plant water, steam and condensate, mechanical seal flush fluid, etc., which are required as per pump data sheet shall be shown on a separate drawing. Reference to the auxiliary piping drawing shall be noted under the pump description.

Steam-Out, Drain and Vent for Vessels

1. The vent valve shall be directly mounted on the vent nozzle with blind flange.
2. A blanked off ventilation nozzle shall also be provided on the top of the all horizontal vessels near the end opposite the manway.
3. Vent connections must be located on top of the vertical and horizontal vessels.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 27 of 143
		Rev: 01
		Feb 2011

4. The drain valve will be provided as follows:

- For low pressure services, up to design pressure of 3800 kPa, provide single block valve with blind plate.
- For high pressure services over design pressure of 3800 kPa, or where the nature of liquid requires it, provide double block valves with blind plate.

Bypass for Safety/Relief Valve

The bypass shall be provided for venting the hydrocarbon gas or toxic gas to flare system while plant shut-down or start-up. Provision of bypass shall be as per following criteria:

1. Vessels

Bypass shall be provided unless otherwise specified in the relevant Company's specifications.

2. Piping/equipment

a. Gas service

- If there is other purge line to flare on same stream line, bypass is not required for safety/relief valve.
- In case of no purge line to flare for toxic or flammable hydrocarbon, bypass valve shall be provided. The size of bypass valve and line shall be same as the vent size of piping/equipment.

b. Liquid service

Bypass valves are generally not provided for liquid service unless otherwise specified.

Block and Bypass Valves for Control Valve

Reference to be made to Appendix H of this Standard.

Line Numbering

1. Line numbers shall be assigned to all lines with the following origins and destinations:

- a. From individual equipment item to individual equipment item;

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 28 of 143
		Rev: 01
		Feb 2011

- b. From line to individual equipment item and vice versa. Another number is required for the line located at the downstream of equipment;
 - c. From line to line (exceptions: control valve bypass, block valve warm-up and equalizing bypasses, and safety/relief valve bypass);
 - d. From unique equipment to the same unique equipment item (except level standpipes);
 - e. From line or equipment to atmosphere, funnel, or closed drainage system (exception: continuous process vent stacks and process drains).
2. Pipe line numbers shall be prefixed, from source to Unit battery limit with the Unit number of the Unit of origin.
 3. A new line number is required when the pipe design condition can vary (e.g., downstream of the control valve assembly) or when a new piping class is to be specified.
 4. Line number shall be held up to the point where the line ends to the header or Unit battery limit block valve. All branches to and from header shall have an individual line number.
 5. All utility headers (systems) including all steam, water and sewer lines shall be numbered with their respective Units. All branches serving a specific Unit will be numbered with that Unit.
 6. Line numbers shall be selected so that consecutive line numbers are grouped first by common service. Spare line numbers may be left between the groupings.
 7. All process lines routed from Unit to Unit shall be assigned on interconnecting line number. Within the process Unit(s), Unit line numbers are to be assigned. The interconnecting Unit P&I Diagram is to show every interconnecting process line and indicate the line numbers inside the process Units at the Units battery limits.

Philosophy of Instrumentation Installation

Reference to be made to Appendix I of this Standard.

Utility Connections

Utility connections to process line and equipment for steam and nitrogen shall be as follows:

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 29 of 143
		Rev: 01
		Feb 2011

1. Connections to process line and/or equipment (see Figs. 5 and 6):

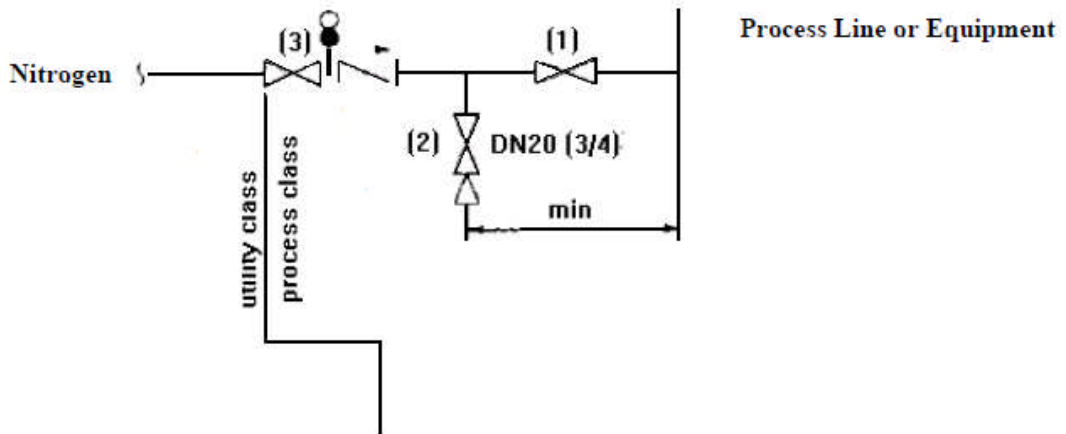


Fig. 5

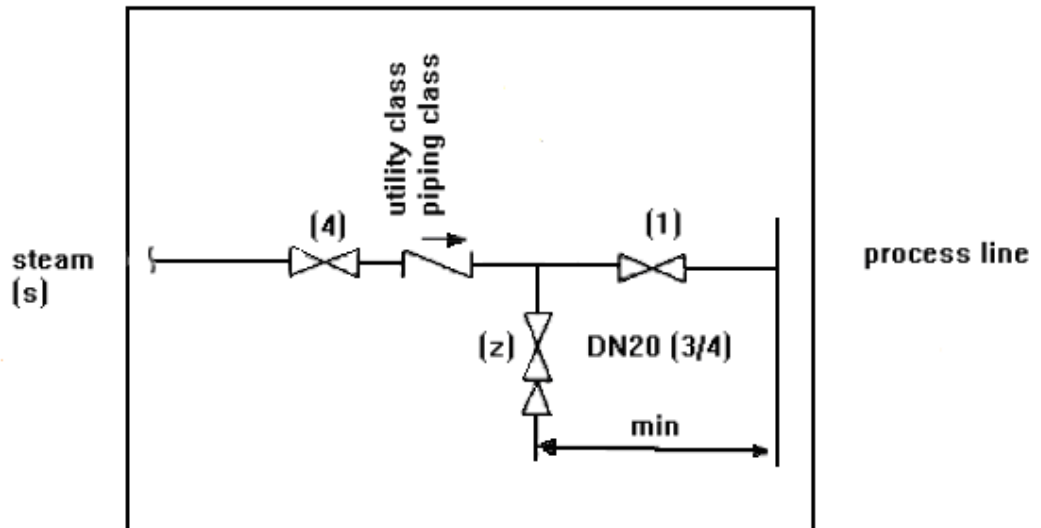


Fig. 6

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 30 of 143
		Rev: 01
		Feb 2011

Notes on utility tie-in:

- a. The isolation valve may be omitted if the process line is open to atmosphere.
 - b. Provide a drain at downstream of check valve to check the leakage.
 - c. Provide spectacle blind and block valve for N2 service.
 - d. Main block valve for steam service shall be at the branch point from steam header.
 - e. This configuration shall be used for low pressure steam (all sizes). For medium and high pressure steam double block valves with bleeder between the valves is required.
2. Connections to vessel for steam-out
- a. Permanent steam-out connection (see Fig. 7):

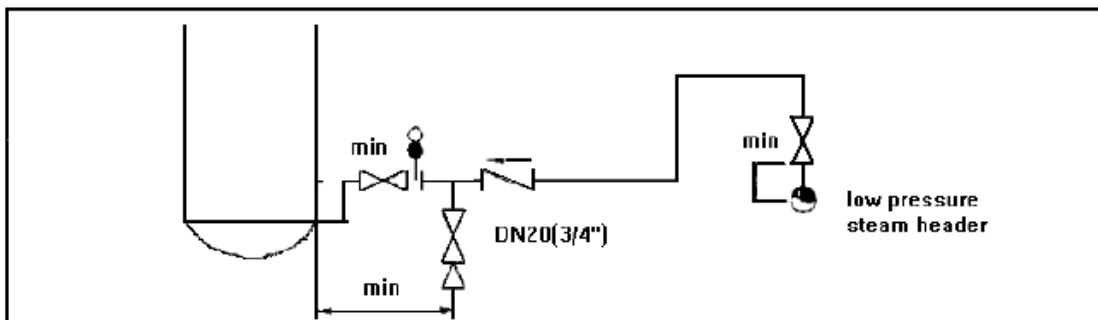
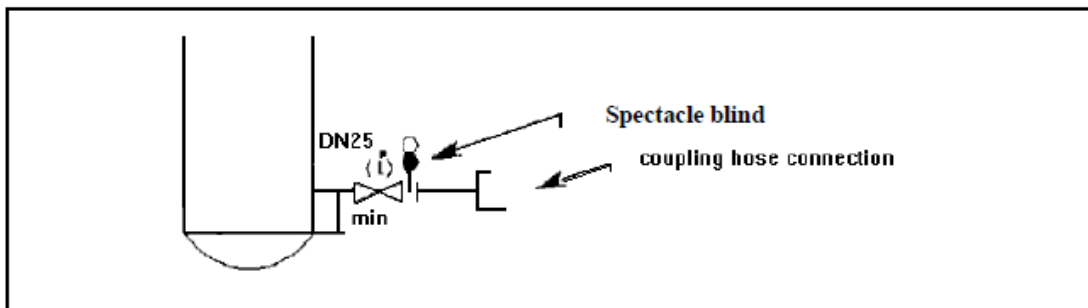


Fig. 7

- b. Temporary steam-out connection (see Fig. 8):



KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 31 of 143
		Rev: 01
		Feb 2011

Unit Battery Limit Installation

1. Process lines (see Figs. 9 and 10):

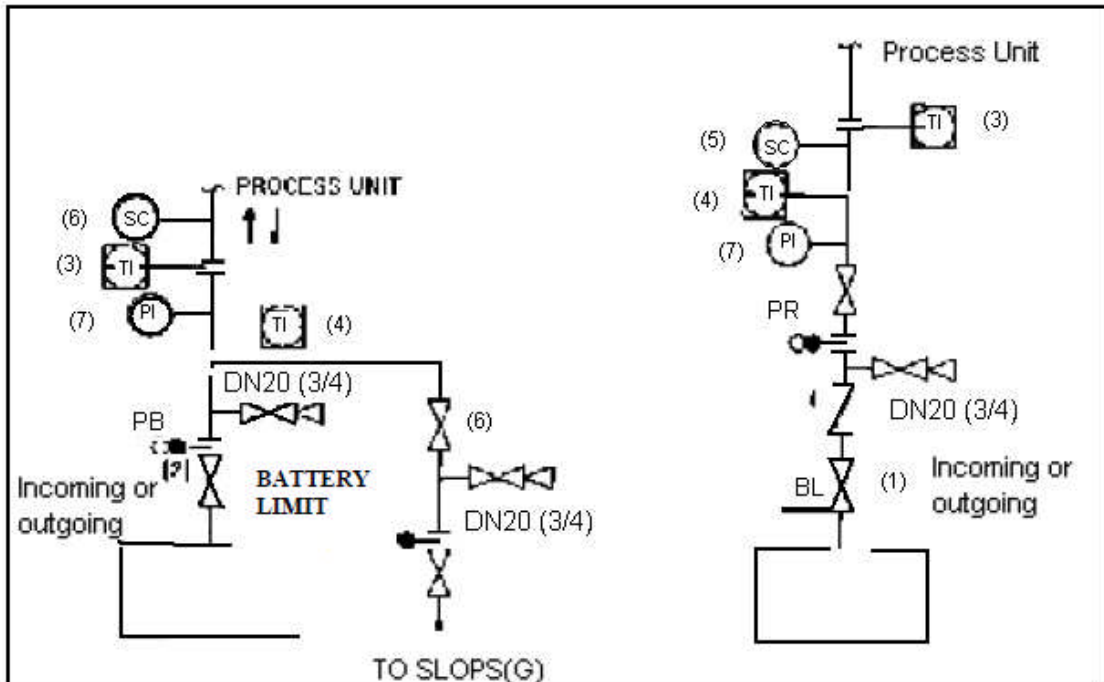


Fig. 9

Fig 10.

Notes on unit battery limit installation requirements:

- a. Provide for hydrogen, nitrogen, toxic gases and all high pressure fluids ($P > 3800$ kPa), double block valves, spectacle blind and drain as shown in Fig. 10.
- b. Provide for each process line (not included in item 1 above) an isolation valve, spectacle blind and drain as shown in Fig. 9.
- c. Provide a flow indicator and recorder shown on board for each process stream entering and leaving each Unit. Do not duplicate measuring elements in the same stream within one block area.
- d. Provide a board mounted TI on each process stream entering and leaving the Unit where a flow integrator is provided. Do not duplicate with TI's required for other purposes. Generally, the TI to be located at downstream of the flow element.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 32 of 143
		Rev: 01
		Feb 2011

- e. Provide a sample station for all products leaving and/or entering the Unit.
- f. Product streams leaving Units shall be piped at the Unit limits to the relevant slops header (light or heavy slops) as well as for the start-up (off-spec.) operation.
- g. Provide a local PI on each process stream entering and/or leaving the Unit. Do not duplicate with PI's required on the same streams. PI may be board mounted as required.
- h. Special attention should be made to the possibility of avoiding duplication of some or all of the above mentioned hardwares on the adjacent Units.

2. Utility lines (see figs. 11, 12 and 13):

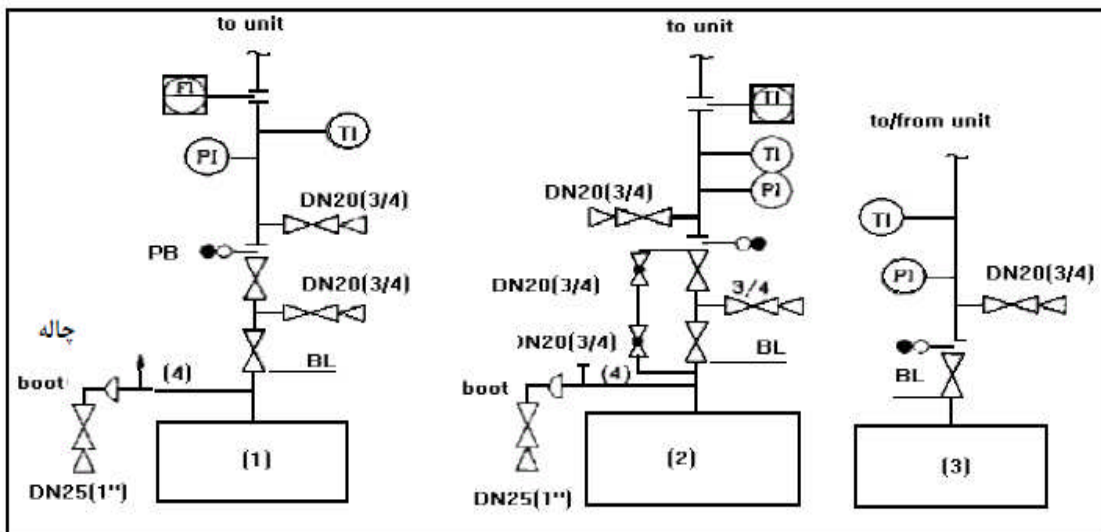


Fig. 11

Fig. 12

Fig. 13

Notes on unit battery limit installation requirements:

- a. Provide valves, drains and instrumentation as shown in Fig. 11 for the following cases:
 - low pressure steam (all sizes);
 - Medium pressure and high pressure steam [sizes smaller than DN200 (8 inch)];
 - Boiler feed water.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 33 of 143
		Rev: 01
		Feb 2011

- b. Provide valves, drains and instrumentation as shown in Fig. 12 for medium and high pressure steams for DN200 (8 inch) and larger sizes.
- c. Fig. 13 shall be applied for condensate lines.
- d. A line size boot at upstream of the first isolation valve shall be provided and shall discharge condensate to the condensate recovery system through steam trap. The boot and steam trap requirement is not needed for boiler feed water streams.

Sample Connections

For sample connection symbols, reference to be made to Appendix G and Appendix A of this Standard.

Steam Trap Assembly

For individual steam trap symbols reference to be made to Appendix A of this Standard.

- 1. Steam trap assembly with internal strainer for different services:

- a. Winterizing (see Fig. 14):

The following symbol can be used to demonstrate the steam trap assembly configuration as shown below in Fig. 14 on P&IDs and UFDs in order to avoid duplication.

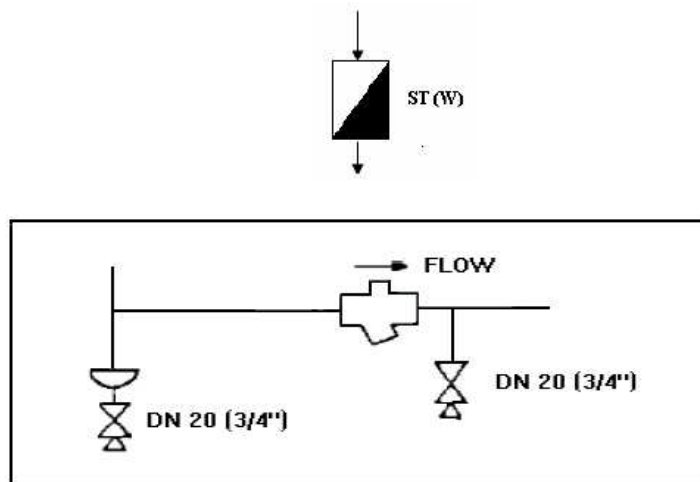


Fig. 14

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 34 of 143
		Rev: 01
		Feb 2011

b. Heat conservation

The following symbol can be used in place of the steam trap assembly shown below in Fig.15 on P&IDs and UFDs.

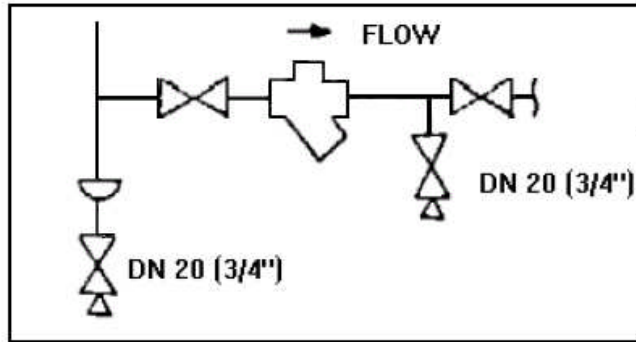
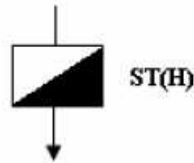


Fig. 15

2. Stream trap assembly with external strainer (see fig. 16)

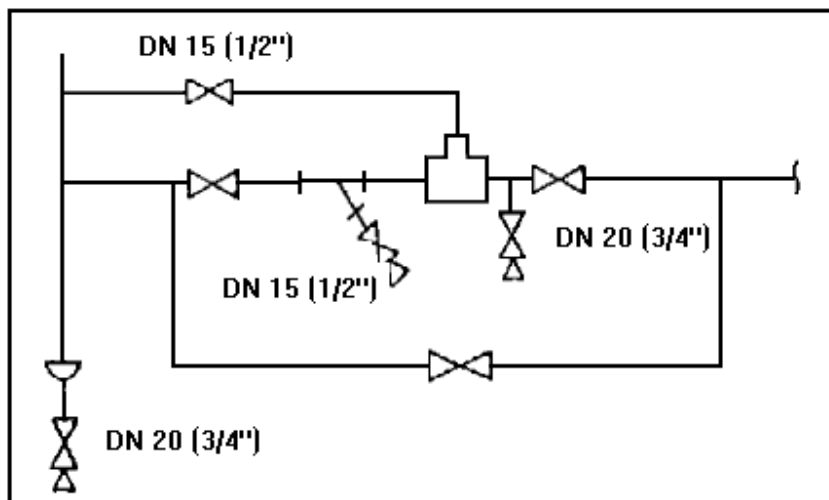


Fig. 16

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 35 of 143
		Rev: 01
		Feb 2011

CRITERIA FOR UTILITY FLOW DIAGRAMS

1. The Utility Flow Diagram(s) (UFDs) shall be prepared as separate drawing titled as "Utilities Distribution Flow Diagram". The distribution of utilities for plant operation shall be shown on the drawing. The utilities for plant operation are generally classified as follows where applicable:

- several grades of steam;
- several grades of condensate;
- boiler feed water;
- cooling water and sea water ;
- raw (fresh) water;
- plant and potable water;
- fuel oil and fuel gas;
- instrument and plant air;
- nitrogen;
- inert gas;
- seal oil/flushing oil;
- closed circuit hot oil system;
- flare and blow-down;
- Chemical system such as caustic and ammonia.

The above utilities are classified into several groups and shown on diagram(s) in accordance with the next articles. A dedicated drawing shall be prepared for "Flare and Blow-down".

2. Utility Flow Diagrams shall be presented in accordance with the requirements stipulated in this Standard for P&IDs where applicable.
3. Utility Flow Diagrams shall show main distribution/collection headers and finger headers with their isolating facilities and instrumentation. The branch line and subheader arrangement shall be shown as practical as possible.
4. Indication criteria of connection between P&IDs and UFDs is according to the following general philosophy:
 - a. The indication of isolation valve shall not be duplicated on P&ID and UFD.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 36 of 143
		Rev: 01
		Feb 2011

- b. Valve and instrument which will be used for the normal operation shall be indicated on P&ID, such as:
 - Block valves for water cooler inlet and outlet;
 - Block valves for snuffing steam of fired heater;
 - Globe valve for steam injection control;
 - Control valves for fuel control.
 - c. Valves which will be used only for start-up and shut-down shall be indicated on the UFD such as:
 - Header isolation valve for steam purge connection;
 - Isolation valve for fuel gas or fuel oil.
5. Utility/common facility branch line header valves at the process Unit battery limit shall be shown. The Utility Flow Diagram shall also indicate any valve in utility/common facility individual branch lines required for process and maintenance operations even if these valves may be physically located in the pipe rack or the sequence of branches may allow in the future for a single valve to serve several branch lines.
6. Isolation facilities shall be indicated for:
 - finger areas;
 - process Unit block areas;
 - at position of change from pipe rack to pipe rack.
7. The finger area is defined as being the area that serves a particular process area which may consist of one or more process Units. In addition to the equipment that is located alongside the finger pipe rack, the finger area also includes the equipment located alongside the main pipe rack.
8. Utility Flow Diagram shall be arranged to cover the whole refinery/plant area and these are divided into separate sheets each with corresponding match lines. Depending on the complexity and extent of the particular utility/common facility, sheets may be combined, extended or omitted as required.
9. All equipment that is supplying a particular utility common facility either from the system (e.g., steam boilers) or from a process Unit (e.g., waste heat boilers) shall be shown in a "box" in geographical location. This "box" shall give relevant equipment number(s), Unit number and sheet number of the drawing in which the equipment is detailed.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 37 of 143
		Rev: 01
		Feb 2011

ABBREVIATIONS / GRAPHICAL SYMBOLS / IDENTIFICATIONS

1. Graphical symbols presented in Appendix A shall be used throughout the Oil, Gas and Petrochemical projects in order to establish uniform symbols for equipment, piping and instrumentation on P&IDs and UFDs. This includes also Vendor drawings with the same purpose.

2. The graphical symbols shown for equipment may be turned or mirrored, if their meaning does not depend on the orientation. The representation of some graphical symbols (i.e., columns, vessels, etc.) can be adjusted to the actual scale with respect to the process plant.

The instrumentation symbol size may vary accordingly as required and as per type of document. However, consistency should be followed in all similar documents.

3. For complete equipment codes, instrument identification and instrumentation legends, reference should be made.

4. For all instrumentation symbols, logic diagrams, loop diagrams and graphical symbols not shown in this Standard, reference should be made to the latest revision of the following ISA standards:

S5.1 Instrumentation Symbols and Identification

S5.2 Binary Logic Diagrams for Process Operations

S5.3 Graphical Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems

S5.4 Instrument Loop Diagrams

S5.5 Graphic Symbols for Process Displays

S18.1 Annunciator Sequences and Specs

S50.1 Compatibility of Analogue Signals for Electronic Industrial Process Instruments

S51.1 Process Instrumentation Terminology

5. Reference should be made for the following requirements:

- Numbering of all Equipment, Piping and instrumentation.
- Unit Identification Number.
- Equipment Category Symbol (Equipment Codes).
- Instrumentation Identification Letters.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 38 of 143
		Rev: 01
		Feb 2011

- Instrumentation Typical Letter Combinations.
 - Painting, Insulation and Heat Tracing Designation.
 - Electrical Equipment Category Code.
 - System Distinction and Equipment Category Code for Communication Equipment.
 - Drawing Serial Number.
 - Fluid Abbreviation Symbols.
 - Building Drawing Categories.
 - Definition of Nominal Size.
6. Package Units are referred to a combination of completely prefabricated equipment with their accessories on a skidframe or delivered as prefabricated components for further field erection. Such Units are generally tagged with the letter "P". The extent of a package is shown in a box with lines. The tag numbers of the individual equipment and instrumentation inside a package shall be given within the package Units.
7. Appropriate graphical symbol should be provided by the Contractor for any special feature not shown in Appendix A, upon the Company's approval.

PREPARATION OF P&I DIAGRAMS

General

As the P&I Diagram contain a large amount of plant design information, its revision will have a great effect on the subsequent engineering works.

Accordingly for the purpose of minimizing the revisions and avoiding unnecessary works, the steps for preparing the P&I Diagrams shall be established. The following steps should be realized in preparing the P&I Diagrams. Upon the information which can be prepared as engineering work proceeds, steps 2, 3 and 4 may be combined or extended to more steps as required.

- **Step 1** Preparatory Step for Preparation of the P&I Diagrams
- **Step 2** P&I Diagrams for Engineering Start
- **Step 3** P&I Diagrams for Piping Layout
- **Step 4** P&I Diagrams for Piping Drawings

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 39 of 143
		Rev: 01
		Feb 2011

- **Step 5** P&I Diagrams for Construction
- **Step 6** P&I Diagrams As-built

In the case where the P&I Diagrams are prepared by the Licensor, only a part of the above-mentioned steps is applied and the main Contractor shall be responsible to complete the P&IDs preparation steps. The extent of Licensor's and Contractor's scope of work will be according to the relevant contracts.

Establishment of P&IDs Preparation Steps

1. Step 1, preparatory step for preparation of P&I diagrams

Through step 1, the basic design philosophy concerning those basic items for the preparation of P&IDs such as mode of indication, applicable standards, numbering system, valve arrangement and those other basic items on which agreements shall be made by the Company prior to the preparation of the P&ID should be clarified. The basic items which should be taken into consideration in step 1 are listed herein below but should not be limited to the following items:

- a. Vellum and drafting
 - Size and vellum of drawing;
 - Title;
 - Drafting;
 - Arrangement;
 - Equipment description;
 - Interconnection.
- b. Numbering system
 - Drawing No.;
 - Equipment No.;
 - Instrument tag No.;
 - Line No.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 40 of 143
		Rev: 01
		Feb 2011

c. Symbol

- Equipment;
- Piping components;
- Instrument symbol;
- Process stream symbol;
- Utility symbol.

d. Valve arrangement around equipment

- Valve arrangement for drain, vent and purge;
- Valve arrangement for steam-out;
- Sizes of the nozzles for installing the instruments;
- Valve arrangement around the heater and exchanger;
- Valve arrangement around the pump and compressor;
- Valve arrangement around the steam turbine.

e. Piping

- Piping classification standards;
- Valve arrangement at the battery limit;
- Valve arrangement for drain, vent, purge and steam-out on piping;
- Valve arrangement around the steam trap;
- Valve arrangement around the sample point/sample connections;
- Blow-down;
- Valve type selection criteria/standards;
- Strainer type selection standards;
- Pipe line sizing criteria.

f. Instrumentation

- Valve arrangement around the control valve;
- Valve arrangement around the safety/relief valve;
- Valve arrangement around other instruments;
- Instrument type selection standards;
- Mode of indication concerning computer control;

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 41 of 143
		Rev: 01
		Feb 2011

- Software linkage and DCS presentation.

g. Miscellaneous

- Winterizing and heat conservation;
- Recovery of steam condensate;
- Disposal of drains and waste water effluent.

For the purpose of obtaining a unified design philosophy and appropriate design relations among the Units, the illustrated process considerations concerning operation (start-up, normal, shut-down), Safety and other features of the Unit shall be achieved by indicating on the Process Flow Diagram (PFD). Where it does not suffice to give more illustrations, additional brief written explanations shall be provided. The items which should be covered to complete the design and operation philosophy and shown on P&ID (as required) shall include but not be limited to the following requirements (where applicable):

i) Precommissioning and start-up operations

- Flushing;
- Purging;
- Soda washing(where required);
- Chemical cleaning;
- Steaming-out;
- Evacuation;
- Drying;
- Water operation;
- Cold circulation;
- Hot circulation;
- Catalyst pretreating such as sulfiding, reduction, etc.;
- Feed cut-in;
- Off-spec. product handling.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 42 of 143
		Rev: 01
		Feb 2011

- ii) Normal operation
 - Recorder and indicator points;
 - Stream analyzer point;
 - Sampling point and type;
 - Control valve block and bypass;
 - Driver type;
 - Chemical injection point and types of chemical;
 - Batch operation;
 - Local start;
 - Instrumentation and control system needed for optimization and/or process control.
- iii) Shut-Down operation
 - Depressuring;
 - Feed cut-out;
 - Cooling;
 - Purging;
 - Steaming-out and flushing;
 - Decoking;
 - Catalyst regeneration.
- iv) Safety operation
 - Location of safety/relief valves;
 - Failure action of control valves;
 - Prealarm system;
 - Emergency shut-down system;
 - Auto start of equipment/system.
 - Results of hazard analysis and operability (HAZOP) study (if any). Note: Contractor shall perform the HAZOP study (if required by the owner) using PFD, P&ID and plot plan together with equipment data sheets and related safety equipment checklist. Contractor shall provide information about the

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 43 of 143
		Rev: 01
		Feb 2011

reported accidents in similar process units in the world during HAZOP meetings.

The Contractor should prepare both the draft of the basic items for preparation of the P&ID and all necessary operation and safety features as mentioned above to Company's review and approval before issuance of official revision of P&ID for engineering start.

2. Step 2, P&ID for engineering start

The following information as minimum requirement shall be reviewed and completed at this stage:

a. Equipment

- Number of equipment;
- Type of equipment;
- Equipment No. and name.

b. Piping

- Size of main piping;
- Winterizing/heat conservation requirement;
- Valve type;
- Provision of drain and vent;
- Provision of purge, steam-out, chemical injection and water injection connections and valving;
- line No.;
- Utility services connected to each equipment, piping and packaged Unites.

c. Instrumentation

- Type of instrument and location of the primary element;
- Location and discharge destination of the safety/relief valve;
- Location, type and valve functioning (failure action) of the control valve;
- Measurement and control method;
- Instrument tag No.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 44 of 143
		Rev: 01
		Feb 2011

The draft of the P&ID for engineering start shall be sent to the Company's review. After the joint meeting between the Company and Contractor, the P&ID for engineering start can be officially issued based on the established Company's comments as per the agreed items mentioned in the relevant minutes of meeting.

3. Step 3, P&ID for piping layout

The purpose of issuing the P&ID for piping layout is the Company's approval on the basis of detailed design for piping layout.

The minimum information which should be added on the P&ID at this stage shall be as follows:

a. Equipment

- Elevation of equipment;
- Size of equipment;
- Internal of equipment.

b. Piping

- Line class;
- Miscellaneous piping size (except around the safety/relief valve and control valve);
- Thermal and cold insulation;
- Precautions concerning piping layout;
- Correct orientation of piping around equipment.

c. Instrumentation

- Size of main control valves;
- Additions and revisions on the basis of detailed design.

d. Vendor's packaged units

The details of some available information concerning the Vendors shall be indicated.

4. Step 4, P&ID for piping drawings

The following information shall be added on the P&IDs at this stage:

a. Piping

- Piping around the safety/relief valve and control valve;

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 45 of 143
		Rev: 01
		Feb 2011

- Size of all valves;
- Additional review of the pipe size and branch by the checking of the piping layout;
- Hydraulic of system (checking and implementation of the necessary notes).

b. Instrumentation

- Sizes of the safety/relief valves;
- Sizes of the control valves;
- Details concerning level transmitters and level gages
- Logic diagram for heaters, incinerators, compressors, and all other main equipment (where applicable).
- Consequences of details of cause and effect tables.

c. Vendor's information

The necessary information concerning the Vendors equipment shall be indicated.

5. Step 5, P&ID for construction

At a stage where detailed design has been nearly completed, upon approval of the Company, the P&ID shall be frozen for the purpose of smooth execution of the construction work.

The P&ID shall be issued for construction after completion of the following activities:

- Piping material table;
- Piping class and all relevant job specifications;
- All job specifications and standard drawings in relation to the preparation of P&ID;
- Logic diagram of the main equipment;
- Hydraulic of system;
- Size of all piping, valves and instrumentation components;
- Vendor's information.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 46 of 143
		Rev: 01
		Feb 2011

Absolutely, required revisions after freezing of the P&ID shall be made only by conducting of design activities using the relevant field sketches and executing the required modifications approved by the Company. This is applicable to revisions called for at the design department. The frozen P&ID shall not be revised.

6. Step 6, P&ID as-built

The P&ID as-built shall be prepared upon completion of the project for filing and submission to the Company. Since the P&ID is intended for use in conducting operation control, maintenance or revamping, therefore, the prepared drawings shall be entirely in conformity with the completed facilities.

The P&ID as-built shall be prepared in accordance with the results of line checking and the final edition of the field sketches.

The specified piping and instrument take-off and branch points shall be observed as strictly as possible and shall be implemented on the P&ID. Although bearing no relationship to piping layout, none of the flange, cap, drain pot, spectacle blind and other miscellaneous piping designed for installation at the ends of the drain and vent required for operational purposes shall be omitted.

Handling of Licensed Process

Where a licensed process or basic design should be prepared by a Licenser, the Contractor's scope of work concerning the completion of the P&ID will be dependent on the type of contract with the Licenser and Contractor.

1. Licensing contract via the contractor

In this case, the Contractor and the Licenser jointly and severally shall give a process performance guarantee to the Company.

a. Case 1, licenser prepares P&ID

The P&ID supplied by the Licenser shall be equivalent to the " P&ID for piping layout" given in this Standard, and shall contain all design philosophies concerning process. The Contractor shall carry out mainly the following activities:

- Prior to the Licenser's commencing the preparation of P&ID, the Contractor shall establish the basic items for the preparation of the P&ID and shall submit to the Company for approval. The Licenser should prepare the P&ID based on the above mentioned items;

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 47 of 143
		Rev: 01
		Feb 2011

- Based on the P&ID and operational guides prepared by the Licensor, review shall be made with regard to operability, safety, conformity to design of the Unit, etc.;
- Checking of the above-mentioned P&ID against the basic items for preparing the P&ID and relevant design data;
- General review and checking of the drawings against the project requirements;
- Establishing the result of above-mentioned checking and reviews in a joint meeting with the Licensor. The Licensor should implement all necessary Contractor's engineering comments and issue the revised P&ID;
- The following items of review shall be made by the Contractor on the revised P&ID by the Licensor:
 - Review in accordance with the results of detailed design hydraulic review;
 - Review in accordance with the results of detailed design;
 - Review on the basis of information concerning vendors.

The Licensor's approval should be obtained on any revision which should be made during the execution of the abovementioned reviews by the Contractor.

b. Case 2, the contractor prepares P&ID

P&ID shall be prepared by the Contractor in accordance with Section 11 of this Standard and the following requirements:

- Required sufficient information for the preparation of the P&ID shall be obtained from the Licensor;
- The prepared P&ID shall be subject to the Licensor's review and approval.

2. Direct contract between company and licensor

In this case, the Licensor shall give a process performance guarantee to the Company. The Contractor will be responsible for hydraulic of system and mechanical guarantee.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 48 of 143
		Rev: 01
		Feb 2011

a. Case 1, the contractor's verification is required

Usually, the verification is limited to mechanical and hydraulic matters. However, extent of the Contractor's verification should be established in detail by the Company.

For the purpose of conducting verification, the Contractor shall carry out mainly the following basic items:

- The basic items for preparation of the P&ID as mentioned above shall be prepared and finalized with the Company;
- The required activities shall be performed to complete all design philosophies in relation to the process, operation, safety and other features based on the operational guides and/or P&ID prepared by the Licensor;
- P&ID Diagram prepared by the Licensor shall be checked against the above-mentioned finalized basic items and design philosophies;
- Checking of P&ID should be performed against the hydraulic of system and detailed design data;
- The results of the above-mentioned activities shall be finalized with the Company and shown on the P&ID as required;
- Upon the completion of the above-mentioned items, the required steps for preparation of the P&ID as outlined in Section 11.2 of this Standard shall be followed to complete detailed design activities.

b. Case 2, verification is not required by contractor

In this case, the following activities shall be conducted by the Contractor:

- Review for the detailed hydraulic of system;
- Review for implementation of results of the detailed design;
- Review for information concerning vendors;
- Completion of the P&ID preparation steps as stipulated in this Standard.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 49 of 143
		Rev: 01
		Feb 2011

Revisions of P&ID

1. General

Generally P&ID can be revised in the following conditions if complied with the requirements as outlined in Section 11 of this Standard:

- For correction of typographical and/or engineering errors;
- As per the Company's instructions;
- Implementation of pertinent information in the course of execution of the relevant engineering work on P&ID;
- Addition of information concerning vendors.

Upon agreement with the Company, revisions made after the issuance of the "P&ID for piping layout" may not be needed by directly revising the P&ID but by issuing the NPIC "Notification of P&ID Change".

2. Revisions

The P&ID shall be revised depending on necessity at each step in addition to the required edition(s) which shall be issued per each step. Accordingly it does not follow that the step No. and revision No. coincide with each other. At the time of revising the P&ID the NPIC issued up to that time and information concerning vendors obtained up thereto shall be incorporated on the P&ID.

3. NPIC

Issuance of Notification of P&ID Change (NPIC) and manner of presentation shall be agreed in advance with the Company. NPIC shall be issued in a NPIC form finalized with the Company. In general issuance of NPIC should consider:

- Minimization of P&ID revisions;
- Not accumulation of a large amount of additions/changes which should be incorporated on the new revisions of P&ID.

KLM Technology Group Project Engineering Standard	PIPING AND INSTRUMENTATION DIAGRAMS (P&ID) (PROJECT STANDARDS AND SPECIFICATIONS)	Page 50 of 143
		Rev: 01
		Feb 2011

Approval of P&ID

1. Company's approval of the basic items for preparation of P&ID shall be obtained prior to commencement of the P&ID preparation work.
2. The Company's approval at step 2 " P&ID for engineering start" shall be obtained regardless of the cases that P&ID is prepared by the Contractor or Licenser or both.
3. Where the P&ID prepared by Licenser has been reviewed or verified in step 3 "P&ID for piping layout" by the Contractor, Company's approval is needed before any official revision.
4. In general, Company's approval is required for any change, deletion and/or addition on the P&ID.