

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 1 OF 56
DATE : 2010.11.25		

BASIC DESIGN MANUAL SPD0037ERN P&I DIAGRAM REV. : 1 DATE : 2010.11.25
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	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 2 OF 56

목 차

	PAGE
1. SCOPE -----	7
2. VELLUMS, DRAFTING AND ARRANGEMENT -----	7
2.1 Vellums -----	7
2.2 Drafting -----	7
2.3 Arrangement -----	7
3. EQUIPMENT/PIPING/INSTRUMENT SYMBOLS -----	8
4. CRITERIA PREPARATION FOR CLIENT APPROVAL -----	8
5. MINIMUM INFORMATION TO BE SHOWN ON P & I DIAGRAM -----	8
5.1 General -----	8
5.2 Equipment Indication -----	9
5.2.1 Columns and Vessels -----	9
5.2.2 Heat Exchangers -----	9
5.2.3 Air Coolers -----	9
5.2.4 Fired Heaters -----	9
5.2.5 Rotary Machineries -----	10
5.3 Piping Indication -----	10
5.4 Instrument indication -----	10
5.5 General Notes to be Put into P & I Diagram -----	11
6. DESIGN CRITERIA FOR PREPARATION OF P & I DIAGRAM -----	12
6.1 Assembly Piping of Pumps -----	12
6.1.1 Valve Size Selection Basis for Pump -----	12
6.1.2 Selection of Strainer Type -----	12
6.1.3 Pump Vents -----	12
6.1.4 Warming-up Line -----	12
6.2 Steam-out Connection -----	12
6.2.1 Temporary Steam-out Connection -----	12
6.2.2 Permanent Steam-out Connection -----	13
6.3 Drain and Vent for Vessel -----	13
6.3.1 Sizing Basis -----	13
6.3.2 Assembly of Vent and Drain for Vessel -----	13
6.4 Bypass for Safety/Relief Valve -----	13
6.5 Block and Bypass Valves for Control Valve -----	14
6.5.1 Without Block and Bypass Valves -----	14
6.5.2 With Block and Bypass Valves -----	15
6.5.3 Sizes of Block and Bypass Valves -----	15
6.6 Nozzle size for Instrument -----	15
6.7 Line Numbering Basis -----	15
7. TYPICAL ARRANGEMENT -----	16

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 3 OF 56

TABLES AND FIGURES

Table 6-1. Block and bypass Size of Control Valve	17
Fig. 3-1. Equipment Symbols for vessels and Columns	18
Fig. 3-2. Equipment Symbols for Heat Exchangers	19
Fig. 3-3. Equipment Symbols for Air Fin Cooler	20
Fig. 3-4. Equipment Symbols for Pumps, Compressors and Blower	21
Fig. 3-5. Equipment Symbols for Others	23
Fig. 3-6. Piping Symbols for Lines	24
Fig. 3-7. Piping Symbols for Valves	25
Fig. 3-8. Piping Symbols for Others	26
Fig. 7-1. Typical Utility Connection	27
Fig. 7-2. Typical Sampling Station	29
Fig. 7-3. Typical Steam Trap Assembly	33

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 4 OF 56

목 차

	PAGE
1. SCOPE -----	31
2. STEPS FOR PREPARING P & I DIAGRAM -----	31
2.1 Necessity for Establishing Steps -----	31
2.2 Establishment of Preparatory Step -----	32
2.3 Definition of Each Step -----	32
3. BASIC ITEMS FOR PREPARATION OF P & I DIAGRAM AND OUTLINE OF POD -----	33
3.1 Basic Items for Preparation of P & I Diagram -----	33
3.2 Process Operation Diagram (POD) -----	34
4. METHOD OF CARRYING OUT EACH STEP -----	36
4.1 Step I Preparatory Step for Preparation of P & I Diagram -----	36
4.1.1 Basic Items for Preparation of P & I Diagram -----	36
4.1.2 Process Operation Diagram (POD) -----	36
4.2 Step II P & I Diagram for Engineering Start -----	37
4.2.1 Purpose -----	37
4.2.2 Main Items of Information to be Indicated -----	37
4.2.3 Interoffice Review Meeting -----	38
4.2.4 Review Meeting with Client -----	39
4.3 Step III P & I Diagram for Piping Layout -----	40
4.3.1 Purpose -----	40
4.3.2 Additional Information -----	40
4.4 Step IV P & I Diagram for Piping Drawings -----	41
4.4.1 Purpose -----	41
4.4.2 Additional Information -----	41
4.5 Step V P & I Diagram for Construction -----	41
4.5.1 Purpose -----	41
4.5.2 Precautions -----	41
4.6 Step VI P & I Diagram As-Built -----	42
4.6.1 Purpose -----	42
4.6.2 Method of Preparation -----	42
5. HANDLING OF LICENSED PROCESS -----	42
5.1 Type of Contract and SECL*s Scope of Work -----	42
5.1.1 Licensing Contract via SECL (SECL and the licensor jointly give a process performance guarantee to the client) -----	42
5.1.2 Direct Contract between Client and Licensor (SECL need not give any process performance guarantee) -----	42
5.2 Licensing Contract via SECL -----	43
5.2.1 Case where Licensor Prepares P & I Diagram -----	43
5.2.2 Case where Client Prepares P & I Diagram -----	44

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 5 OF 56
DATE : 2010.11.25		

5.3	Direct Contract between Client and Licensor	44
5.3.1	Case where SECL*s Verification is Required	44
5.3.2	Case where SECL need not give any Verification	45
6.	SCOPE OF WORK	45
7.	REVISION OF P & I DIAGRAM	45
7.1	Method of Revision	45
7.2	Revision of P & I Diagram	46
7.3	Notification of P & I Diagram Change	46
8.	RELATION TO CLIENT	47
8.1	Basic Items for Preparation of P & I Diagram	47
8.2	Approval of P & I Diagram	47
8.2.1	Step II P & I Diagram for Engineering Start	47
8.2.2	Step III P & I Diagram for Piping Layout	48
TABLES AND FIGURES		
	Table 2-1 Each Step for Preparing the P & I Diagram	49

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 6 OF 56
DATE : 2010.11.25		

목 차

	PAGE
1. SCOPE -----	53
2. FORMAT -----	53
3. PURPOSE -----	53
4. CONTENTS -----	53

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
DATE : 2010.11.25		REV. : 1
		PAGE 7 OF 56

1. Scope

This specification cover the format and technical basis for the Piping and Instrument Diagram for process and utility plant.

2. VELLUMS, DRAFTING AND ARRANGEMENT

2.1 Vellums

The P & I Diagram shall be drawn on standard Size A0 vellums.

2.2 Drafting

The drafting must be of sufficiently high quality to maintain legibility when the drawing is reduced to an A3 size sheet.

The following size and thickness shall be used:

Lettering

- Drawing Number 7 mm
- Drawing title and equipment 5 mm
- General and instrument lettering 3 mm

Line thickness

- Main process line 0.7 mm
- Equipment outline 0.5 mm
- Secondary line 0.3 mm
- Instrument signal 0.3 mm

2.3 Arrangement

- (1) The preferred arrangement is such that towers, vessels and fired heaters be shown in the upper half of the diagram, heat exchange equipment in the upper three quarters as practical, and compressors in the lower quarter. The spacing of equipment and flow lines shall permit ready identification and tracing of the lines.
- (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 crossings 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 enter and leave the drawing on the right-hand end and vice versa. Whenever possible, a line should be appeared at the same position on the continuation flow scheme.
- (5) Each process line entering or leaving the side of the drawing should indicate the (a) continuation drawing number, (b) the service, and (c) the origin or destination equipment item number.
- (6) Process lines to/from other units shall be terminated at the bottom of the drawing at a box indicating the service and source or destination unit name and number. The drawing number of the connecting flow diagrams shall be indicated in the box.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
DATE : 2010.11.25		REV. : 1
		PAGE 8 OF 56

- (7) All utility lines entering or leaving the diagram shall be terminated at any convenient location.
- (8) Instrument signals from sheet to sheet shall be terminated at the side of sheet with indication of the continuation instrument number, location, and drawing number.

3. EQUIPMENT/PIPING/INSTRUMENT SYMBOLS

- Equipment symbols shown in Figs. 3-1 to 3-5 shall be used.
- Basic piping symbols shown in Figs. 3-6 to 3-9 shall be used.
- As for the instrument letter and symbols, in general ISA Symbols.(ISA-S5.1) shall be used. Furthermore, Specification 13917-J-101 Para. 3.4 shall be referred.

4. CRITERIA PREPARATION FOR CLIENT APPROVAL

Prior to preparing the original P & I Diagram, the following matters should be confirmed with Client and approved in order to prevent the delay of schedule due to change of criteria.

- Size of drawing
- Symbols to be used for P & I Diagram
- Instrument symbols
- Contents of equipment description
- Standard drawing such as sampling, purging connection, etc.
- Connection of utility system
- Size of drain and vent
- Valve size for pump
- Safety/relief valve arrangement
- Piping arrangement for level instrument
- Block and bypass valve size for control valve
- General notes which is put into "General Notes and Symbols Diagram".
- Numbering system for equipment, instrument and line (This should be clarified by BEDD.)

5. MINIMUM INFORMATION TO BE SHOWN ON P & I Diagram

5.1 General

- The identification number and service presentation shall be shown for each piece of equipment. This information shall be shown above or adjacent to towers, drums, heaters, tanks and heat exchangers, etc.
- It is recommended to tabulate the brief data for each piece of major equipment, across the bottom of drawing. The brief data to be displayed are as follows:

Column and Vessel	- Diameter and length, design pressure and temperature
Heat exchangers	- Type of exchanger, dimension, thermal duty, surface area, design pressure and temperature
Pumps and Compressors	- Design capacity, discharge pressure, and driver HP

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 9 OF 56

Furnaces - Thermal duty

- Vendor supplied packages only as a dashed/dotted "box" with an outline of the main component (s) inside.

5.2 Equipment Indication

5.2.1 Columns and Vessels

- (1) The symbol used shall represent the outline, i.e. changes of shell diameter, water drop-out boots, etc. shall be shown, although not necessarily to scale.
- (2) Show all nozzles and manholes, instrument connections, drains and vents and safety/relief valve connections.
- (3) All flanged connections shall be so indicated, and all connections whose purpose is not readily evident shall indicate the purpose (examples: spare inlet, catalyst drawoff, etc.).
- (4) Show draw-off trays with tray number and diagrammatic representation of the downcomer position (e.g. side or center).
- (5) Show all other internals such as inlet distributors, grids, packings, baffles, demister pads, rotating discs, mixers, cyclones, tangential inlet, vortex breaker, etc.
- (6) All nozzles and connections shall be shown in their correct position relative to the items under (4) and (5).
- (7) Show elevations above base line to bottom tangential line of column or to bottom of horizontal drum.

5.2.2 Heat Exchangers

- (1) Show all nozzles, instrument connections, drains and vents, and safety/relief valves, if required.
- (2) Spectacle blinds for the isolation shall be indicated, if required.
- (3) Elevation required for process reason shall be clearly indicated, e.g. reboilers, condensers.
- (4) Show realistic representation of two-folded and/or three-folded heat exchangers.

5.2.3 Air Coolers

- (1) Show whether induced or forced draft.
- (2) Show any automatic control (fan pitch control or louver control) and any alarm (vibration alarm, etc.)
- (3) Show where louvers are fitted.
- (4) Show only one bundle and fan. When multiple bundles are required, indicate header's arrangement as separate detailed sketch.

5.2.4 Fired Heaters

- (1) Show the items listed under Para. 5.2.1 (2) and (3).
- (2) Show damper and ducting arrangement including damper actuators where fitted.
- (3) Show waste heat recovery system, if present.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 10 OF 56

- (4) Show decoking connections.
- (5) Show one complete set of burner around piping and burner number required for each type of burner.
- (6) Show tube coils schematically in correct relative positions and show all skinpoint thermocouples.

5.2.5 Rotary Machineries

- (1) Show the items listed under Para. 5.2.1 (2) and (3).
- (2) Show the type of pump, blower, compressor and its driver.
- (3) Show pump vent and drain, cooling water, seal oil and tube oil connections where applicable.
- (4) Show lube and seal oil systems on a separate sheet, if necessary.

5.3 Piping Indication

- (1) All piping shall be shown on P&I Diagrams, including process lines, utility/common facility branch lines (sealing and flushing, lines, cooling water lines, steam-out connections, nitrogen connections, safety/relief valve discharge lines, etc.), and start-up/shut-down lines.
(pump-outlines, vent lines, start-up lines, regeneration lines, sulphiding lines, spool pieces and equipment and control valve bypasses, etc.)
- (2) All line sizes and line classification shall be shown.
- (3) The direction of normal flow shall be shown for all lines.
- (4) The points at which line sizes or line specifications change shall be clearly indicated.
- (5) All blinds shall be indicated on the drawings, and the symbols used shall distinguish between tab blinds and spectacle blinds.
- (6) All vent and drain connections shall be identified whether screw capped or blind flanged, if required.
- (7) Steam traced lines and steam jacketed lines shall be so indicated.
- (8) All equipment flanges, all reducers and non-standard fittings, such as expansion bellows, flexible tubes, shall be shown.
- (9) 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 show flange and rating.
- (10) Control valve sizes shall be shown..
- (11) Insulation requirements shall be covered by a line numbering system.
- (12) Any locations where slopes, straight runs, minimum mixing runs, etc. are required for process reasons must be indicated.

5.4 Instrument indication

The following shall be indicated.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 11 OF 56

- (1) All instrumentation including test points.
- (2) Isolation valves connecting to instruments.(Primary connection valve)
- (3) Solenoid shutdown devices at control valves.
- (4) Handwheels when provided on control valves.
- (5) Limit switches on control valves when required.
- (6) Mechanical stopper and/or signal stopper on control valves when required.
- (7) The instrument air failure position of control valves.
- (8) Push buttons and switches associated with shutdown systems.
- (9) The instrument tag number for each instrument.
- (10) Control valve, safety/relief valve and rupture disc tag numbers shall be shown.
- (11) Simple interlock systems by connecting the actuating devices to the actuated devices with instrument signals. Complex shutdown systems may be shown as a "black box" with reference made to the logic diagram. All actuating and actuated devices shall connect to the "black box".
- (12) On-line analyzers with quick response recirculation loop, if required.
- (13) Measuring elements only when a specific type is required for process reasons.
- (14) Sizes and set pressure of safety/relief valves
- (15) Transmitters

5.5 General Notes to be Put into P & I Diagram

It is normal practice to put the General Notes on the front sheet of P & I Diagram.

- (1) All indication of length or distance on the P & I Diagram are shown on "Millimeter" unless otherwise noted.

(2) Piping Drains and Vent

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

(a) Drains for all size

- Alloy piping : 3/4 inch gate valve with blind flange
- Carbon steel piping : 3/4 inch gate valve with threaded plug

(b) Vents for 2 inch and larger

High point vent shall be provided for the Piping of 2 inch and larger except system for air, inert gas, and steam not exceeding design pressure or temperatures of 125 psig and 350°F. Size and type are based on the following.

- Alloy Piping : 3/4 inch gate valve with blind flange
- Carbon steel piping : 3/4 inch gate valve with threaded plug
- The vent provided for hydrostatic testing shall be 3/4 inch boss with threaded plug.

(3) Block valves on orifice tap

- (a) 1/2 inch single gate valve shall be provided for the all orifices of the piping class of 600# and less

- (b) 3/4 inch single gate valve shall be provided for the all orifices of the piping class

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 12 OF 56

of 900# and over .

6. DESIGN CRITERIA FOR PREPARATION OF P & I Diagram

6.1 Assembly Piping of Pumps

6.1.1 Valve Size Selection Basis for Pump

Generally, the size is likely different between pump suction line and pump suction nozzle, or pump discharge line and pump discharge nozzle.

In case of the 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	One size smaller than line	Same as suction line size
	Two or more sizes smaller than line	Select one size smaller than line
At pump discharge	Smaller than discharge line	Select one size smaller than line

6.1.2 Selection of Strainer Type
The suction strainer of pumps shall be selected in accordance with the following:

Line Size	Strainer Type
3" and larger	T
2" and smaller	Y

6.1.3 Pump Vents
It is recommendable to route the vent gas from pump casing to closed system such as flare for the following service.

- (1) Fluids contain toxic gas (esp. H₂S)
- (2) Fluids with a vapor pressure greater than atmosphere at operating temperature
- (3) Fluids with a flash point below 100°F

6.1.4 Warming-up Line

The provisions for warming-up of pump is required for the pump operated at 170°C and higher.

6.2 Steam-out Connection

6.2.1 Temporary Steam-out Connection

When the steam-out connection is temporarily provided for the purge-out of the system, the size will be 1 inch as same as the utility station.

The assembly of the temporary steam-out connection is shown in Fig. 7-1 (b).

6.2.2 Permanent Steam-out Connection

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 13 OF 56

When the steam-out connection is permanently provided for vessel, etc., their size should be based on the following.

Vessel Volume (m ³)	Size
– 150	1"
150 – 400	1-1/2"
400 –	2"

The recommendable assembly of piping for the steam-out connections are also shown in Fig. 7-1(b).

6.3 Drain and Vent for Vessel

6.3.1 Sizing Basis

Size of drain and vent for vessel shall be decided based on the following table.

Capacity (m ³)	Vent (inch)	Drain (inch)
– 150	1-1/2"	1-1/2"
150 – 400	2"	2"
400 – 700	3"	3"

The minimum size of drain is decided to prevent the plugging of scale, sludge, etc.

6.3.2 Assembly of Vent and Drain for Vessel

A valved and blinded atmospheric vent shall be provided at vessel high points and/or overhead piping.

6.4 Bypass for Safety/Relief Valve

The bypass will be provided for venting the hydrocarbon gas or toxic gas to flare system while plant shut-down or start-up. Therefore, the following are applied for providing the bypass.

(1) Gas service

- (a) If there is other purge line to flare on same stream line, bypass is not required for safety/relief valve.
- (b) 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 vessel.

(2) Liquid Service

Bypass valves are generally not provided for the liquid service.

6.5 Block and Bypass Valves for Control Valve

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 14 OF 56

6.5.1 Without Block and Bypass Valves

(Refer to API RP 550 Part I, Para. 6.9.5)

Block and bypass valve system may not be necessary where the process can be shut-down to repair the control valve without significant economic loss or where the process cannot be feasibly operated through the bypass. However, the consequences of shutting down a process unit to perform a simple task (such as replacing control valve packing) should always be considered.

Same instances where these valves are not always necessary are the following.

- (1) With control valves in steam lines to pump drives which are sparing motor drives.
- (2) In instances where it is desirable to reduce the sources of leakage of hazardous fluids, such as hydrogen, phenol, or hydrofluoric acid.
- (3) In clean service where the operating conditions are mild, and omission of valves will not jeopardize the safety or operability of the unit.
- (4) In interruptable operations.

In cases where the block and bypass valves are not used, the control valve should be equipped with a handwheel or other operating devices.

As for the practical experience, the following cases may be omitted the block and bypass valves.

- (1) High pressure service over 1500# piping class with hydrogen service has omitted the block and bypass valves from the standpoint of the following.
 - (a) To ensure minimum leakage of H
 - (b) From the standpoint of economic
 - (c) Manual operation could not permitted due to severe operation condition and safety of plant.
- (2) Reflux control valve or pump around control valve for the fractionator may omit the block and bypass valve. The manual control by handwheel may be possible by adjustment so that the excess reflux operation are proceeding until the shut-down of plant.
- (3) Temporary service such as start-up or shut-down, and where the other operation mode are possible while the repairing of control valve, such as blending system of oil.
- (4) Compressor minimum flow bypass valve may omit the block and bypass valves. The compressor may operate for excess recycle gas operation by adjusting the handwheel.
- (5) Systems operating in parallel, where the shutdown of one or more streams is tolerable.
- (6) Where shutdown of side stream processing facilities may be tolerated or where temporary elimination of a process may be tolerated.
- (7) Designs where process time constants make operation under manual control impractical for period required to replace or repair control valves, such as reboiler sources, etc.
- (8) Where three-way valves are used.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 15 OF 56

6.5.2 With Block and Bypass Valves

Control valves in lethal service of the plant shall be furnished with block and bypass valves. The following service should be provided with block and bypass valves.

- (1) Control valves less than 2 inch size require the block and bypass valves due to small diameter of trim, and may have a possibility of plugging of sludge or foreign matters.
- (2) Services containing abrasive solids or corrosive fluids result in damage of trim of control valve, and require the repair.
- (3) Product rundown and feed supplying service require block and bypass.
- (4) Fuel supply system.
- (5) Cooling medium supply service.
- (6) Steam reducing station.

6.5.3 Sizes of Block and Bypass Valves

When control valves requires the block and bypass valves, the size of valves should be based on the Table 6-1.

6.6 Nozzle size for Instrument

When the connections for pressure gauge, pressure indicator, temperature gauge, level gauge, and level controller are mounted on the vessel or on the piping, the size are based on the following.

Connection	Nozzle Size
PG	3/4"
PI or PIC	3/4"×1/2" Swage nipple and 1/2" valve
TG or TW	1" NPT screwed or 1-1/2" flanged
TI or TIC	1" NPT screwed or 1-1/2" flanged
LG	3/4" nipple
Diff. Press. Type LC, LI	3/4"×1/2" Swage nipple and 1/2" valve
Displacement type LC, LI	2"

6.7 Line Numbering Basis

- (1) Line numbers are to be assigned to all lines with the following origins and destinations.
 - From individual equipment item to individual equipment item.
 - From line to individual equipment item and vice versa (exceptions: multiple connections to the same unique item of equipment require only one line number).
 - From line to line (exceptions - control valve bypasses, block valve warm-up and equalizing bypasses, and safety/relief valve bypasses).
 - From unique equipment to the same unique equipment item (except level standpipe)
 - From line or equipment to atmosphere, funnel, or closed drainage system (exception -

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 16 OF 56

continuous process vent stacks and process drains to be numbered).

- (2) A separate line number need be assigned at a pipe class change.
- (3) 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.
- (4) All process lines routed from unit to unit shall be assigned an 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.

7. TYPICAL ARRANGEMENT

The following figures show typical valving and instrumentation arrangement.

Fig. No.	Service
7-1.	Typical Utility Connection
7-2.	Typical Sampling station
7-3.	Typical Steam Trap Assembly

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 17 OF 56

Table 6-1. Block and Bypass Size of Control Valve Pipe Nominal Size

Pipe Normal Size

		3/4"	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	Valve
	3/4"	3/4"	1"	1 1/2"	2"	2"	2"						Block
	3/4"	3/4"	1"	1"	1"	1"	1"						Bypass
	1"		1"	1 1/2"	2"	2"	2"						Block
	1"		1"	1 1/2"	1 1/2"	1 1/2"	1 1/2"						Bypass
Control	1 1/2"			1 1/2"	2"	2"	2"						
Valve	2"				2"	3"	3"	3"					
Body	2 1/2"					3"	3"	3"					
Size	3"					3"	4"	4"	4"				Block
	4"						4"	6"	6"	6"			and
	5"							6"	6"	6"	6"		Bypass
	6"							6"	8"	8"	8"		
	8"								8"	10"	10"		
	10"									10"	12"	12"	

Note

Block Valve : Gate Valve

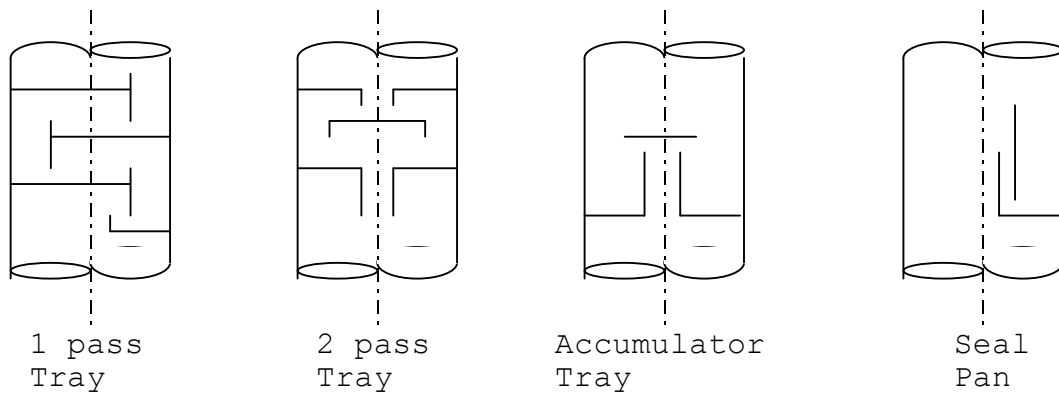
Bypass Valve : Up to 6" - glove valve

Over 8" - gate valve

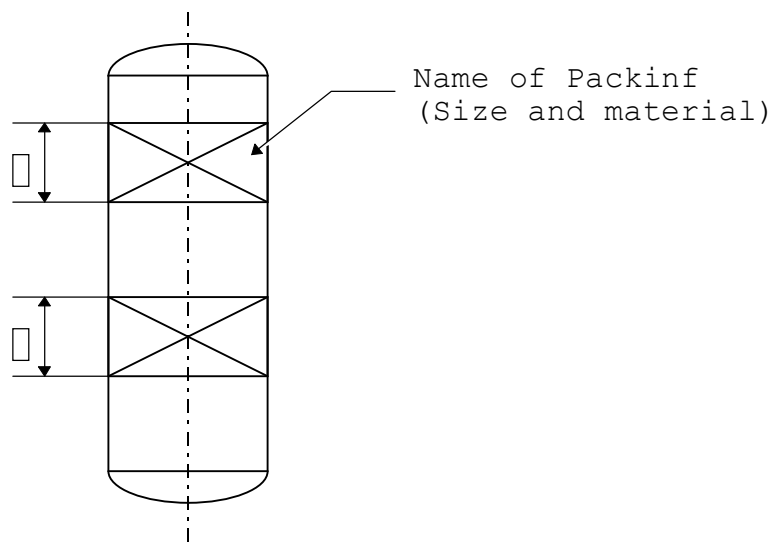
	BASIC DESIGN MANUAL	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		P&I DIAGRAM

Fig. 3-1. Equipment Symbols for Vessels and Columns

1. Tray(Trays shown only where significant and numbered from top to bottom)



2. Packing



Remarks : Vessels, columns shall be shown in simple outlines

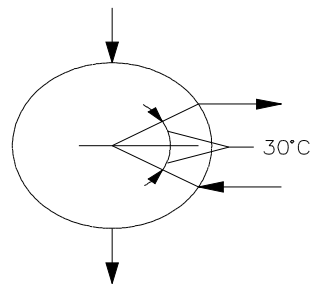
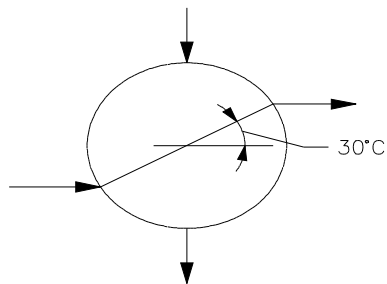
	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 19 OF 56

Fig. 3-2 Equipment Symbols for Heat exchanger

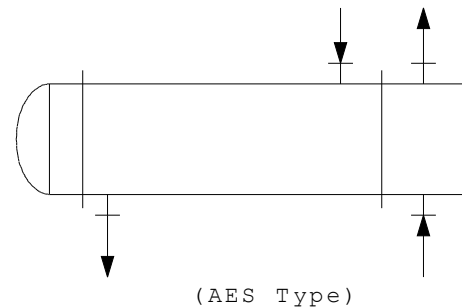
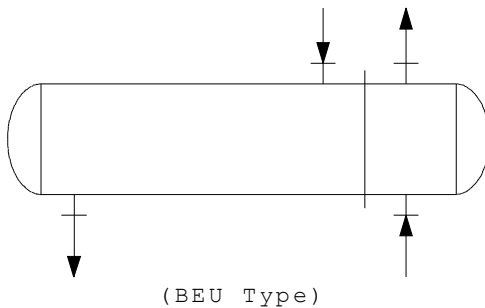
1. Shell and Tube Heat Exchanger

Type shall be selected from the following symbols.

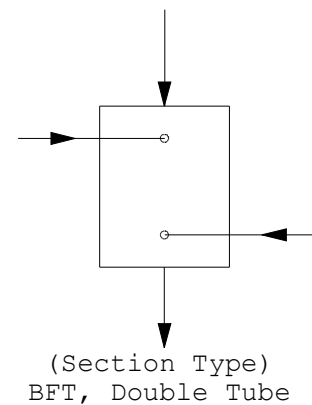
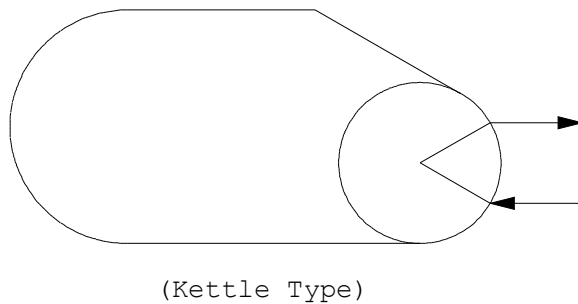
Simple Indication



Side View Indication

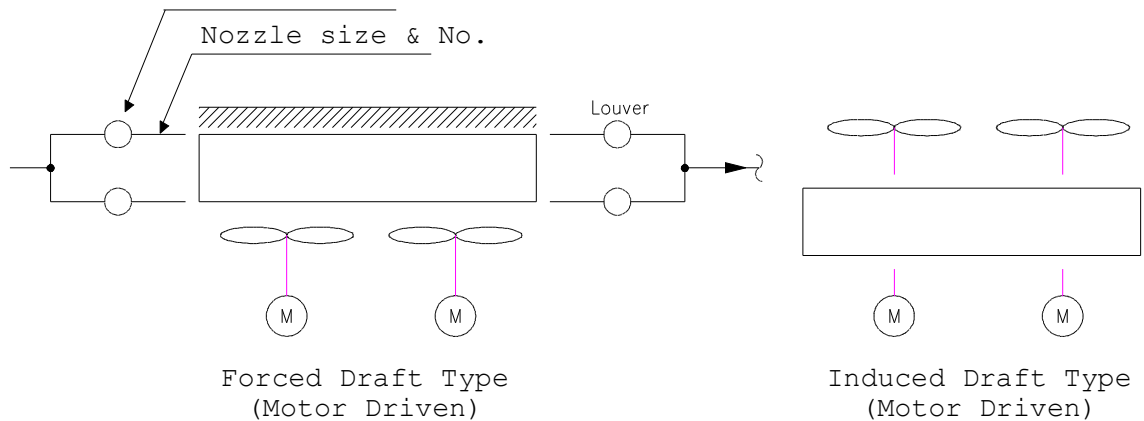


2. Kettle Type Reboiler/sectional Type Exchanger

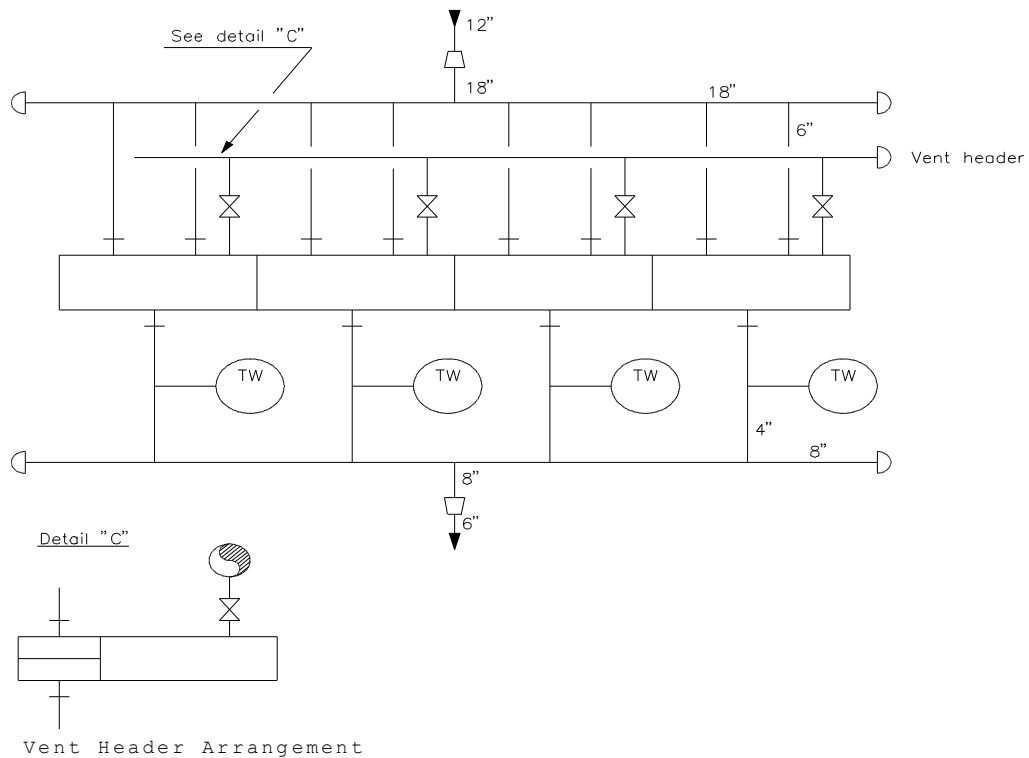


	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 20 OF 56

Fig. 3-3 Equipment Symbols for Air Fin Cooler



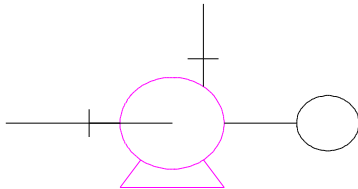
When multiple bundles are required, indicate header arrangement as follows in a separate detailed sketch.



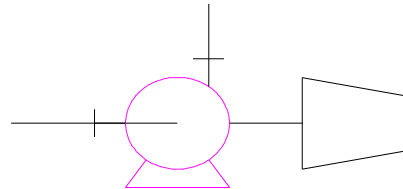
Example of Header Arrangement

	BASIC DESIGN MANUAL	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		P&I DIAGRAM

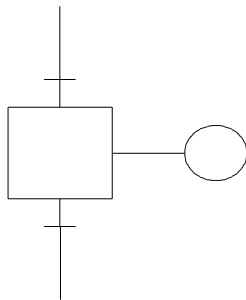
Fig. 3-4 Equipment Symbols for Pumps, Compressors and Blower



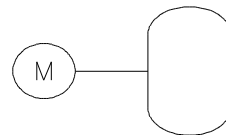
Centrifugal Pump
(Motor Driven)



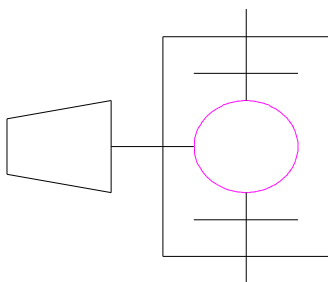
Centrifugal Pump
(Turbine Driven)



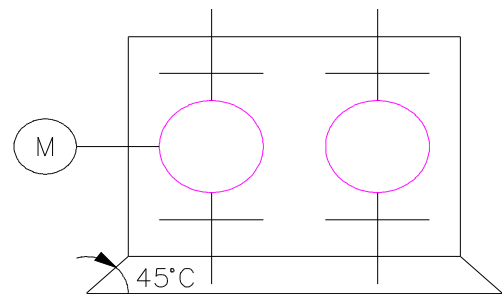
Rotary Pump



Rotary Pump



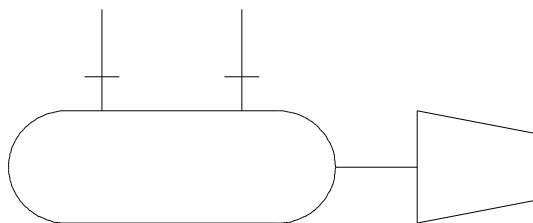
Reciprocating Compressor
(Turbine Driven)



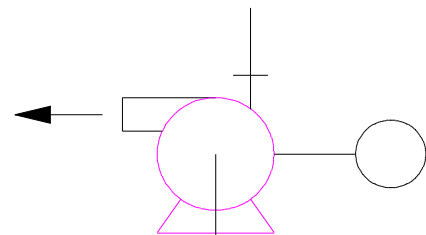
Multiple Reciprocating
Compressor
(Motor Driven)

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 22 OF 56

Fig. 3-4 Equipment Symbols for Pumps, Compressors and Blower (concluded)



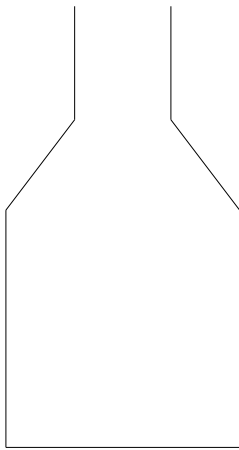
Centrifugal Type Compressor
(Turbine Driven)



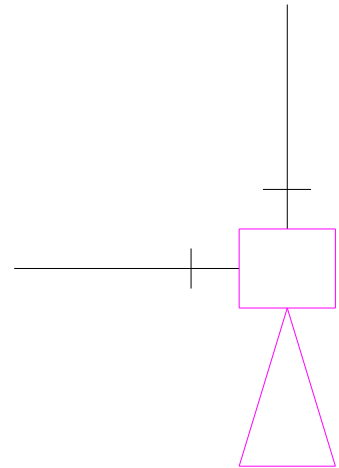
Blower
(Motor Driven)

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 23 OF 56

Fig. 3-5 Equipment Symbols for Others



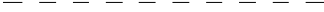
Fired Heater



Ejector or Eductor

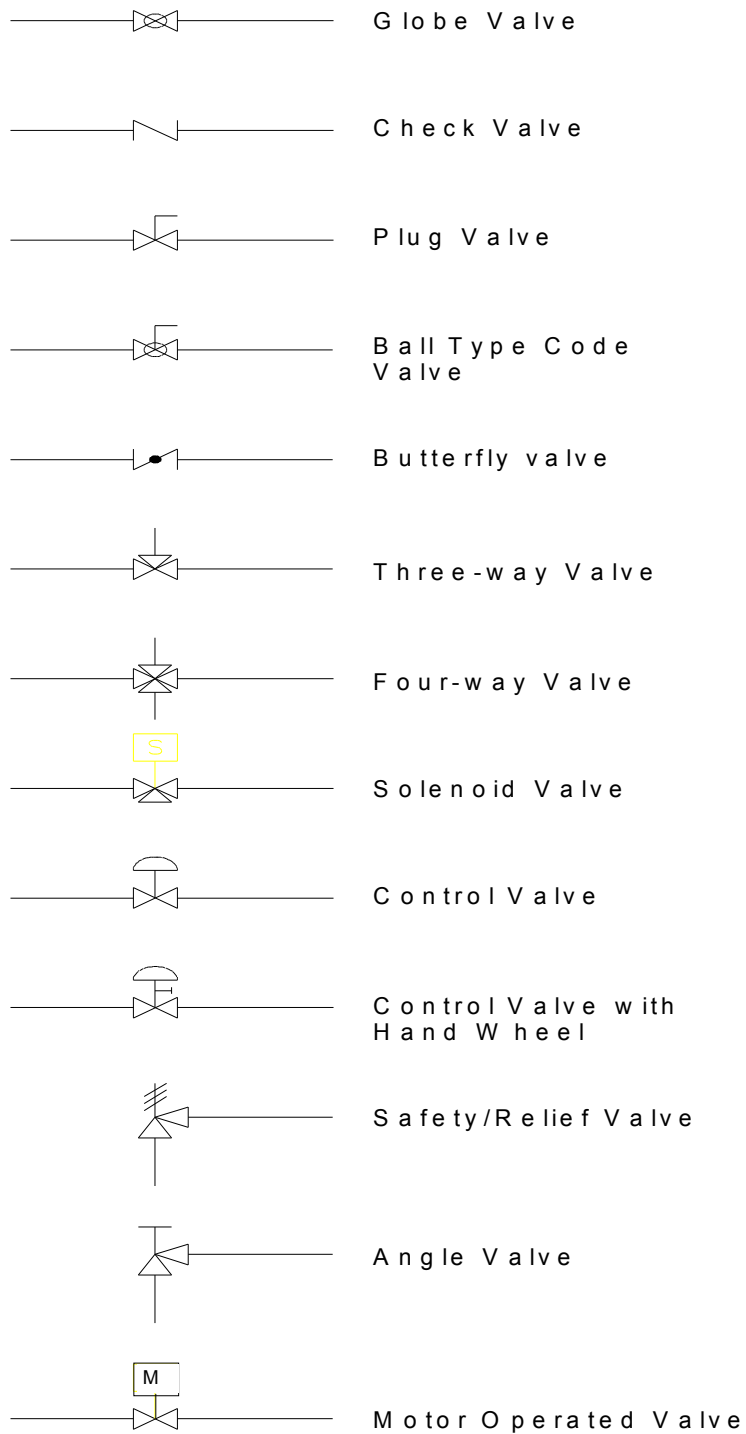
	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 24 OF 56

Fig. 3-6 Piping Symbols for Lines

Symbols	Service
	Main Process Line
	Secondary Process Line and Service Line
	Underground Line
	Steam Traced Line
	Steam Jacket Line
	Flexible Hose
	Spectacle Blind
	Reducer
	Piping Cap
	Removal Spool
	Coupling Connection

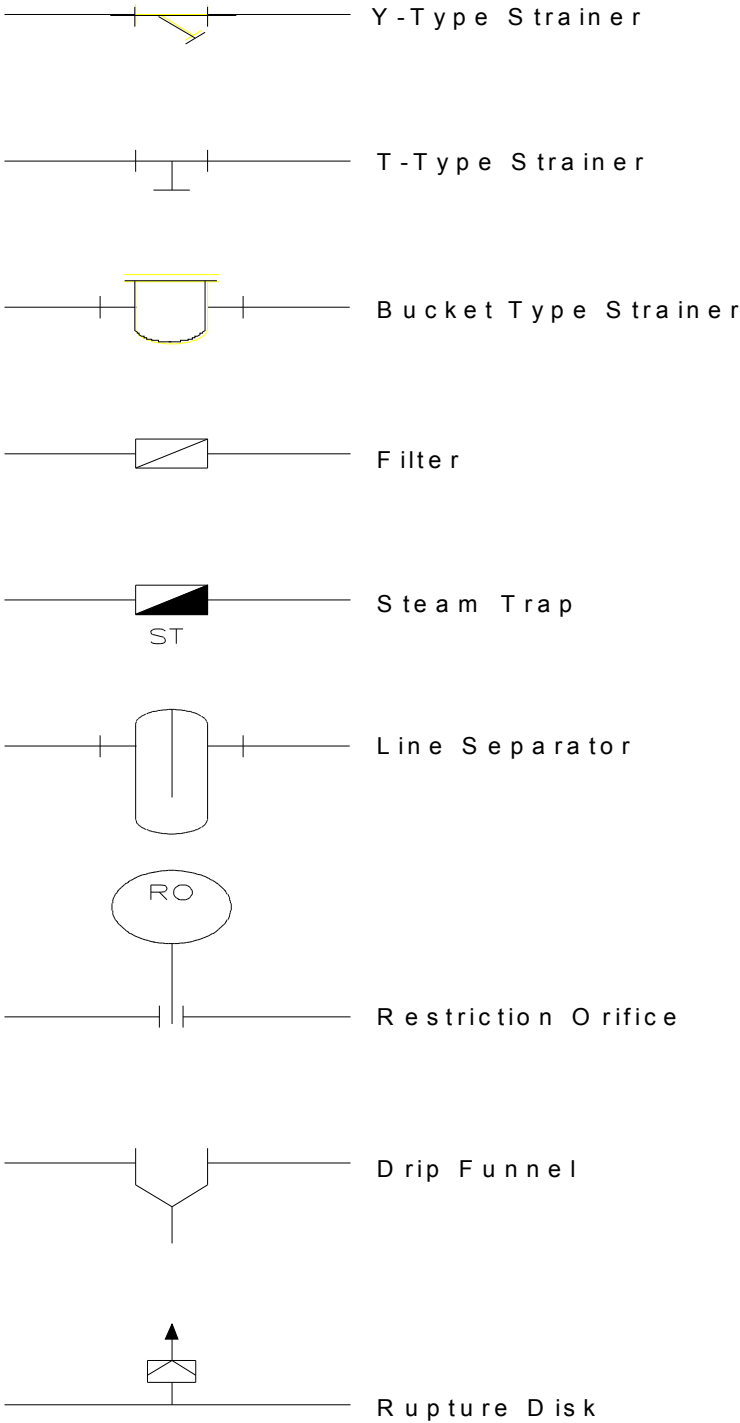
	BASIC DESIGN MANUAL	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		P&I DIAGRAM

Fig. 3-7 Piping Symbols for Valves



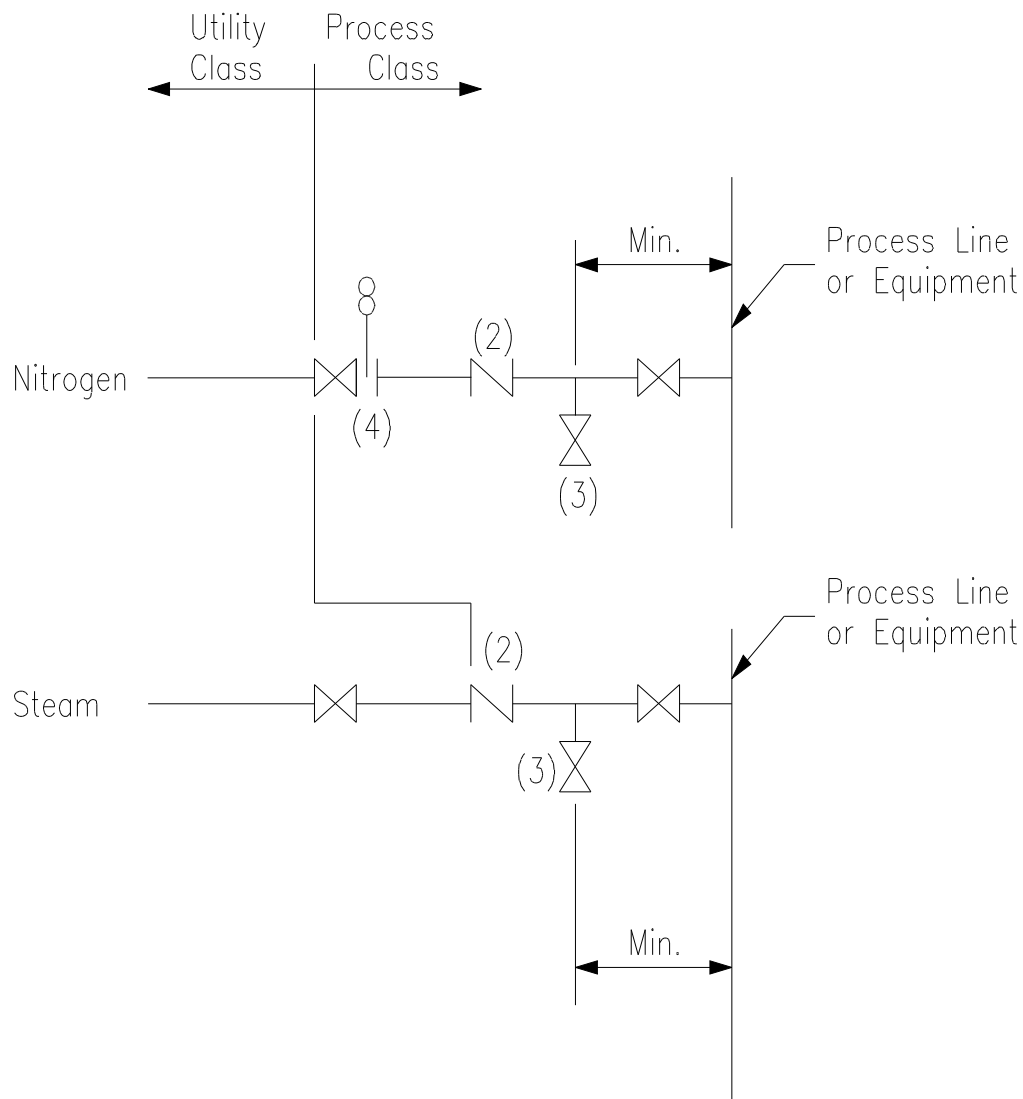
	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 26 OF 56

Fig. 3-8 Piping Symbols for Others



	BASIC DESIGN MANUAL	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		P&I DIAGRAM

Fig. 7-1(a) Typical Utility Connection
(To processline for steam and nitrogen only)



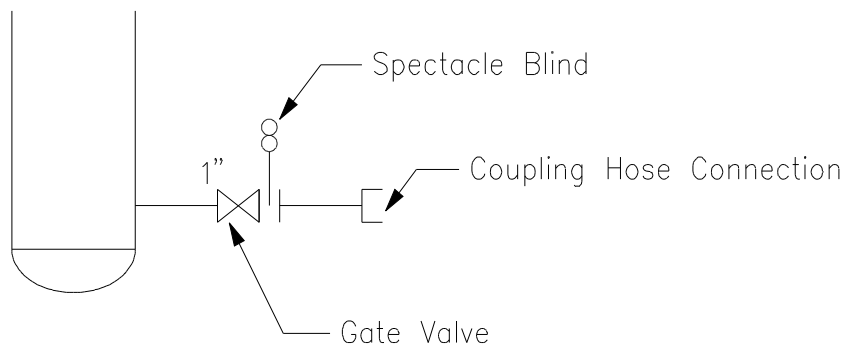
Notes on Utility Tie-in

- (1) The isolation valve may be omitted if the process line is open to the atmosphere.
- (2) A check valve is to be provided.
- (3) Provide a drain upstream of the check valve to check the leakage.
- (4) Provide the spectacle blind and block valve for N₂ service (not required for steam).

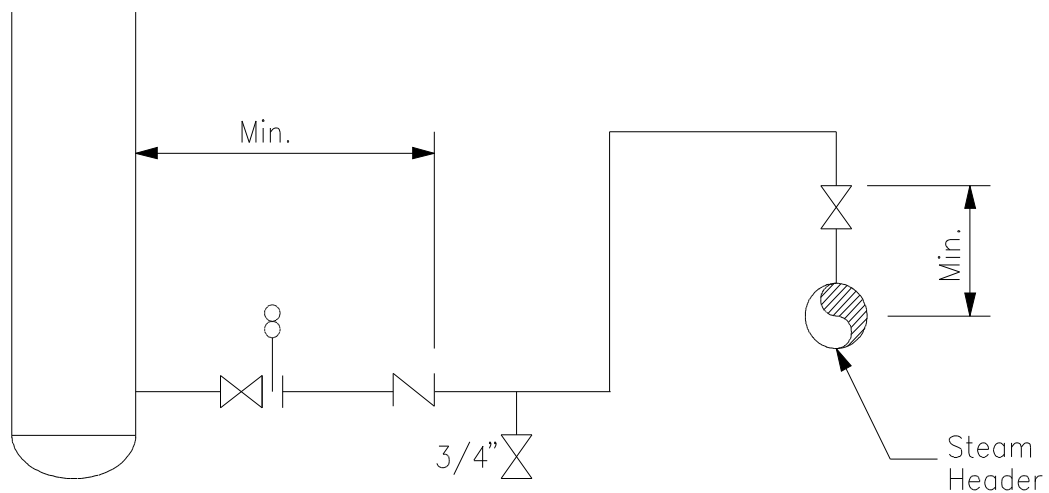
	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 28 OF 56

Fig. 7-1(b) Typical Utility Connection
(To vessel for temporally/permanent steam only)

Temporally steam out Connection



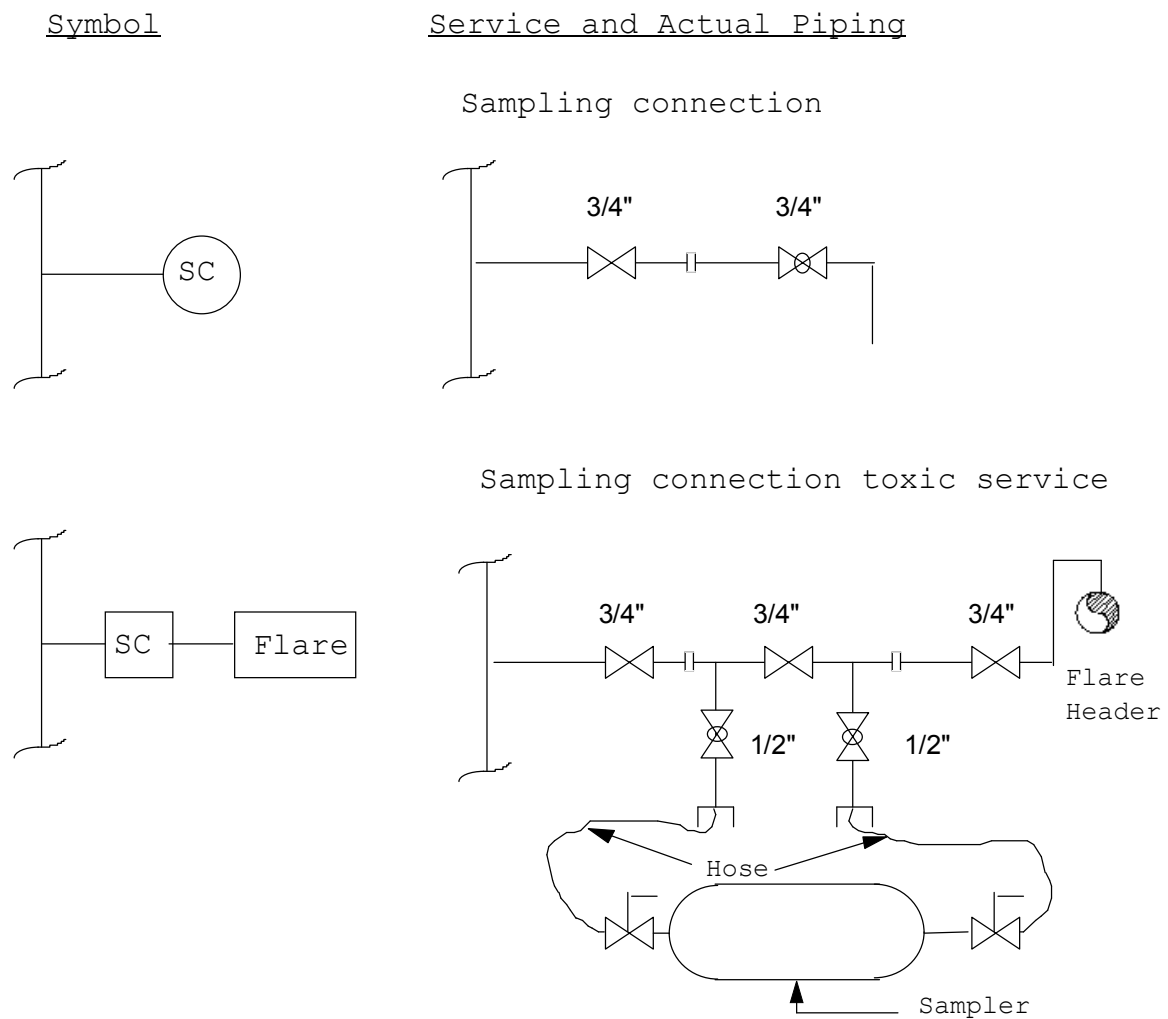
Permanent Steam out Connection



	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 29 OF 56

Fig. 7-2 Typical Sample Connections

It is normal practice to prepare the symbols for the sample connections. The recommended symbols and actual piping arrangement are as follows.



	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 31 OF 56

1. SCOPE

This manual is intended to clarify the contents and services of the P & I diagram for each of those P & I diagram preparation steps for the process plant (including utility and offsite) which have been established in accordance with the execution flow of engineering works, and indicate in detail the sphere of responsibility of each speciality department, relations to the client, and all other matters concerning the execution procedure of the P & I diagram.

There are two ways of preparing the P & I diagram;

- (1) SECL carries out by itself the preparation of the P & I diagram from that of the draft to that of the as-built P & I diagram.
- (2) SECL reviews and revises the draft of the P & I diagram prepared by the licenser, and prepares the as-built drawings finally.

This manual covers the above-mentioned two ways.

In some cases it is difficult to apply this manual completely owing to the effect of the contract type peculiar to the project, that of the engineering schedule, etc. since engineering work is performed by exchanging information through preparation of the P & I diagram.

In such cases, it is allowable to separately establish, prior to commencing engineering work, the engineering work method concerning the preparation of the P & I diagram on the basis of this manual and taking the peculiarity of the project into consideration, provided that the undermentioned philosophy is adopted without fail so as to satisfy the purpose of this manual, i.e. reduction of manhours and improvement of quality.

- (1) For the purpose of minimizing the revisions, personnel concerned in preparatory work shall be designated prior to the commencement of P & I diagram preparation work to have them clarify the required basic items. This step is called as "Preparatory Step".
- (2) For the purpose of avoiding unnecessary works, the steps for preparing the P & I diagram shall be established taking into account the required progress of engineering work carried out by each department.

It is envisaged that the P & I diagram involves many factors having cost effects.

This manual does not cover any of the form, mode of indication, details of the items to be indicated, and other items concerning the preparation of the P & I diagram. For these items, refer to Section 14-2 to 14-5 of the Basic Design Manual (herein after called the BDM).

The process engineering department referred to in this manual covers collectively Nos. 1, 2 and 3 Process Engineering Departments and the Nuclear & Process Engineering Department.

This manual is a translation from JGS 214-131-1-03.

2. STEPS FOR PREPARING P & I DIAGRAM

2.1 Necessity for Establishing Steps

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

Accordingly, it is desirable to minimize the revisions of the P & I diagram. However, it is impossible to obtain all required design information at the commencement of the preparation of

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 32 OF 56

the P & I diagram. As engineering work proceeds, design information becomes more detailed and is increased in volume.

Accordingly, in order to minimize the revisions of information called for by the downstream-side work, and obtain the shortest engineering schedule, it is necessary to establish the steps for preparing the P & I diagram taking the entire execution flow of engineering work into consideration upon correctly grasping the types of information required by the downstream-side works, stages where the above-mentioned items of information are required and stages where the above-mentioned items of information are supplied by the upstream-side work, and clarify the purpose of each step and items of information to be incorporated into the P & I diagram at each step.

2.2 Establishment of Preparatory Step

Concerning the P & I diagram, there are many cases where the client has, on the basis of its long period of experience, established a variety of its own standards concerning the mode of indication, operation method and control method, etc.

Accordingly, to eliminate revisions caused by the above-mentioned standards during execution of engineering work, it is necessary to make adjustments with the client, and unify the design philosophy, prior to preparing the P & I diagram.

For this purpose, personnel concerned in preparatory work shall be designated prior to commencing the P & I diagram preparation work, who shall prepare the undermentioned data and obtain client's approval thereon. Where there is no applicable client's standard, while SECL-S standards shall be used, it is necessary also to obtain client's approval.

(1) Basic items for preparation of P & I diagram

(2) Process operation diagram (hereinafter called the POD)

For the respective outlines of the above-mentioned basic items and process operation diagram, refer to Chapter 3, and for the respective details thereof, to the BDM, Sections 14-2 to 14-4.

2.3 Definition of Each Step

The process of preparing the P & I diagram including the preparatory step is divided by engineering procedure analysis into the undermentioned six steps from the commencement to the completion of the P & I diagram preparation work.

The purpose of each step, main items of information to be incorporated into the P & I diagram at each step, etc. are given in detail in Table 2-1.

Step I	Preparatory step for the preparation of the P & I diagram
Step II	P & diagram for engineering start
Step III	P & diagram for piping layout
Step IV	p & diagram for piping drawings
Step V	P & diagram for construction
Step VI	P & diagram as built

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 33 OF 56

3. BASIC ITEMS FOR PREPARATION OF P & I DIAGRAM AND OUTLINE OF POD

The basic design philosophy concerning those basic items for the preparation of the P & I diagram which shall be established at the preparatory step (Step I) and the POD, and the required items of information are given below.

3.1 Basic Items for Preparation of P & I Diagram

The basic items for the preparation of the P & I diagram cover the mode of indication, indication standards, numbering system, valve arrangement and those other basic items on which agreements shall be made by the client and SECL prior to the preparation of the P & I diagram.

Prior to commencing the preparation of the P & I diagram, the client's and/or SECL's standards relating to the above-mentioned basic items shall be summarized as the document and subjected to adjustment by the client and SECL, and the basic design philosophy concerning the preparation of the P & I diagram shall be unified upon obtaining the client's on the above-mentioned basic items.

Where there is no client's applicable standard, SECL's standards given in the BDM Section 14-3 shall be applied.

Examples of the basic items are as follows:

- (1) Vellum and drafting
 - (a) Size and vellum of drawing
 - (b) Title
 - (c) Drafting
 - (d) Arrangement
 - (e) Equipment description
 - (f) Interconnection
- (2) Numbering system
 - (a) Drawing No.
 - (b) Equipment No.
 - (c) Instrument tag No.
 - (d) Line No.
- (3) Symbol
 - (a) Equipment
 - (b) Piping parts
 - (c) Instrument symbol
 - (d) Process stream symbol
 - (e) Utility symbol
- (4) Around equipment
 - (a) Valve arrangement for drain, vent and purge
 - (b) Valve arrangement around steam-out
 - (c) Sizes of the nozzles for installing the instrument
 - (d) Valve arrangement around the heater

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
DATE : 2010.11.25		REV. : 1
		PAGE 34 OF 56

- (e) Valve arrangement around the pump
- (f) Valve arrangement around the steam turbine
- (5) Piping
 - (a) Valve arrangement at the battery limit
 - (b) Valve arrangement for drain, vent and purge
 - (c) Valve arrangement for steam-out
 - (d) Valve arrangement around the steam trap
 - (e) Valve arrangement around the sample point
 - (f) Blow-down
 - (g) Valve type selection standards
 - (h) Strainer type selection standards
 - (i) Classification standards
 - (j) Standards on the minimum piping size
- (6) Instrument
 - (a) Valve arrangement around the control valve
 - (b) Valve arrangement around the safety/relief valve
 - (c) Valve arrangement-around other instruments
 - (d) Instrument type selection standards
 - (e) Mode of indication concerning computer control
- (7) Miscellaneous
 - (a) Winterizing
 - (b) Reuse of steam condensate
 - (c) Disposal of drain water/waste water

Upon the client approving of the basic items for the preparation of the P & I diagram, the "General Notes, Diagrams and Symbols" intended to serve as an explanation of the P & I diagram, shall be prepared on the basis of the above-mentioned basic items, to form a part of the P & I diagram. The "General Notes, Diagrams and Symbols" shall have the following contents:

- (1) General notes
- (2) Symbol indication standards
 - Equipment
 - Piping
 - Instrumentation
- (3) Standard arrangement

For the details, refer to the BDM Section 14-3.

3.2 Process Operation Diagram (POD)

For the purpose of obtaining, together with the client, unified design philosophy and appropriate design relations among the units, the POD shall be obtained by indicating, on the process flow diagram (hereinafter called the PFD), the illustrated process considerations

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 35 OF 56

concerning operation (startup, normal, shutdown), safety, and features, etc. of the unit.

Where it does not suffice to give mere illustrations, additional brief written explanations in phrases shall be given.

The items covered by the POD and the range of indications shall be decided by personnel concerned in the P & I diagram in accordance with the design features of equipment, conditions of the contract with the client, etc. However, the POD shall be prepared as far as possible for those items which may cause revisions of the P & I diagram upon preparation thereof.

Examples of items covered by the POD are as follows:

- (1) Precommissioning and startup operations
 - (a) Flushing
 - (b) Purging
 - (c) Soda washing
 - (d) Chemical cleaning
 - (e) Steaming-out
 - (f) Evacuation
 - (g) Drying
 - (h) Water operation
 - (i) Cold circulation
 - (j) Hot circulation
 - (k) Catalyst pretreating: sulfiding, reduction, etc.
 - (l) Feed cut-in
 - (m) Off-spec. product handling
- (2) Normal operation
 - (a) Recorder and indicator points
 - (b) Stream analyzer point
 - (c) Sampling point and type
 - (d) Control valve block and bypass
 - (e) Driver type
 - (f) Chemical injection point
 - (g) Batch operation
 - (h) Local start
 - (i) Instrument for guarantee
- (3) Shutdown operation
 - (a) Depressuring
 - (b) Feed cut-out
 - (c) Cooling
 - (d) Purging
 - (e) Steaming-out
 - (f) Decoking

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
DATE : 2010.11.25		REV. : 1
		PAGE 36 OF 56

(g) Catalyst regeneration

The shutdown operation has a lot of procedures similar, or common in some cases, to the startup operation. In such cases, the procedure for either the startup or shutdown operation shall be indicated, together with an explanation to that effect.

(4) Safety operation

- (a) Location of safety/relief valves
- (b) Failure action of control valves
- (c) Prealarm system
- (d) Emergency shutdown system
- (e) Auto start system

4. METHOD OF CARRYING OUT EACH STEP

All steps given herein are applicable to the case where SECL carries out by itself, the preparation of the P & I diagram from that of the draft to that of the as-built P & I diagram. In the case where the licenser prepares the P & I diagram, a part of the above-mentioned steps is applied.

4.1 Step 1 Preparatory Step for Preparation of P & I Diagram

The process engineering department shall prepare both the draft of the basic items for the preparation of the P & I diagram and that of the POD in cooperation with the departments concerned, subject the above-mentioned drafts to client's review, and make adjustments. Serving as standards for the preparation of the P & I diagram, the above-mentioned basic items and the POD are of importance, and have many factors the decision of which is governed by the design philosophy of the client.

Accordingly, in preparing the above-mentioned basic items and the POD, a review meeting shall, depending on necessity, be held with the client so as to obtain a uniform design philosophy between the client and SECL

4.1.1 Basic Items for Preparation of P & I Diagram

The draft of the basic items for the preparation of the P & I diagram shall be prepared at the earliest stage possible upon commencement of the project and with consideration given to a sufficiently long scheduled period of client's review, and client's approval on the above-mentioned draft shall be obtained prior to commencing the preparation of the "P & I diagram for engineering start".

4.1.2 Process Operation Diagram (POD)

The preparation of the POD shall be commenced at a stage where the PFD has been nearly completed, and client's approval on the above-mentioned POD shall be obtained prior to official issuance of the "P & I diagram for engineering start".

The allowable period for revising the POD shall be up to official issuance of the "P & I diagram for engineering start", and revisions involving the POD if required upon completion of the above-mentioned official issuance shall be made by directly revising the

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 37 OF 56

P & I diagram. A part of the POD shall be incorporated into the operation manual for utilization purposes.

4.2 Step II P & I Diagram for Engineering Start

The draft of the P & I diagram shall be prepared by the process engineering department in cooperation with each speciality department and on the basis of various process information and that POD and those basic items for the preparation of the P & I diagram which have been prepared at Step I.

The items of information required by each speciality department for the purpose of preparation of the above-mentioned draft shall be collected by the process engineering department at its own responsibility upon holding discussions if necessary with the relevant departments.

An interoffice review meeting shall, presided over by the process engineering department, be held at as early a stage as possible upon preparation of the above-mentioned draft. At the interoffice review meeting, explanation on the overall process design philosophy shall be made to enable personnel concerned to satisfactorily understand the above-mentioned design philosophy, and discussions shall be held on the problems and proposed improvements set forth by personnel concerned.

In this case, minutes of meeting of the above-mentioned discussions shall be prepared. Then, the "P & I diagram for engineering start" covering the above-mentioned results shall be officially issued. At this stage, however, the above-mentioned P & I diagram shall be subjected to client's review as far as possible.

In this case, the above-mentioned P & I diagram shall be sent to the client for the purpose of client's review, and revised on the basis of the results of client's review, and the "P & I diagram for engineering start" covering the above-mentioned revisions shall be officially issued. How to proceed P & I diagram review meeting is given here.

Furthermore, purpose of issuing the "P & I diagram for engineering start", and main items of information to be indicated in the above-mentioned P & I diagram, are discussed below:

4.2.1 Purpose

- (1) In relation to the client:

Client's approval on the overall process design philosophy shall be obtained as far as possible (the POD shall be effectively used).

- (2) Project department:

For commencing safety assessment.

- (3) Mechanical (piping) engineering department:

For the detailed review of the plot plan.

- (4) Instrumentation & control department:

For commencing the basic works.

4.2.2 Main Items of Information to be Indicated

- (1) Information concerning equipment

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 38 OF 56

: Number of equipment

: Type of equipment (column, vessel, heat exchanger, compressor, etc.)

: Equipment No. and name

(2) Information concerning piping

: Size of main piping

: Necessity or otherwise of steam trace, jacket piping

: Valve type

: Drain, vent

: Purge, steam-out

: Chemical injection

: Water injection

: Line No.

(3) Information concerning 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.

(4) Information concerning the vendor:

The connection line (especially utility) assumed by SECL shall be indicated. However, it is unnecessary to indicate the piping size or any other detailed information.

4.2.3 Interoffice Review Meeting

The interoffice review, presided over by the process engineering department, shall be conducted from the overall and speciality standpoints for conducting engineering work, and for the purpose of enabling personnel concerned of each department to deepen their understanding of the relevant processes.

(1) Preparatory work

The undermentioned items of preparatory work shall be carried out prior to holding the interoffice review meeting:

(a) The draft of the "P & I diagram for engineering start" and the POD shall be distributed to the personnel concerned of each department, and a sufficiently long period of review shall be provided.

(b) Personnel concerned of each department, shall prepare and previously submit to the process engineering department a review list summarizing the problems, items calling for improvement, etc.

(2) Attendants at interoffice review meeting

The respective personnel concerned of the project department, process engineering department, mechanical (piping) engineering department and instrumentation & control department as a minimum shall attend the interoffice review meeting, and personnel

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 39 OF 56

concerned of the furnace & combustion system department, mechanical (equipment) engineering department, rotary machinery department, plant operation department, etc. shall attend the above-mentioned meeting depending on necessity.

(3) Review points for personnel concerned of each department

The personnel concerned of each department shall review the P & I diagram mainly in respect of the undermentioned items and from the overall and speciality standpoints.

(a) Project department:

Cost, schedule, applicable laws and regulations, effect on the environmental pollution prevention measures.

(b) Mechanical (piping) engineering department:

Assumption of the plot plan and piping layout, and review of problems involved.

(c) Instrumentation & control department:

Display method, measurement and control method, types of instruments.

(d) Furnace & combustion system department :

Furnace and all items around the flare stack.

(e) Plant operation

All items concerning operation

(4) Review method

First of all, the process engineering department shall explain the process features on the basis of the PFD and POD so as to enable all personnel concerned to deepen their understanding of the entire process.

Then, detailed review shall be conducted.

(a) Process features

- . Explanation of the flow
- . Items in process calling for specific care

(b) Review

Discussions shall be held in regard to the review list prepared by the personnel concerned of each department, and the draft of the "P & I diagram for engineering start" shall be revised on the basis of the results of the above-mentioned discussions.

4.2.4 Review Meeting with Client

In the case of obtaining client's approval at the step "P & I diagram for engineering start", a review meeting shall be held between the client and SECL prior to official issuance of the above-mentioned P & I diagram. Depending on necessity, however, client's approval shall be obtained at the step "P & I diagram for piping layout".

(1) Preparatory work

The draft of the "P & I diagram for engineering start" shall be sent to the client. A review list showing the results of client's review shall be previously obtained, and JGC's views on the above-mentioned results shall be established.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 40 OF 56

A sufficiently long period for client's review shall be provided.

(2) Attendants at review meeting with client

At least the respective personnel concerned of the process engineering department, project department and instrumentation & control department shall attend the review meeting held between the client and SECL

(3) Method of review

Discussions shall be held on the basis of the client's review list, and the required matters thus established on the basis of the results of the above-mentioned discussions shall be indicated in the P & I diagram to form the draft of the "P & I diagram for engineering start". Specifically important matters shall be confirmed upon preparing minutes of meeting. In the case of requesting the client to review the draft of the "P & I diagram for engineering start", the line Nos. and instrument tag Nos. shall be indicated not in advance but upon completion of the review meeting held between the client and SECL.

4.3 Step III P & I Diagram for Piping Layout

The purpose of issuing the "P & I diagram for piping layout" and main items of information to be added to the P & I diagram prepared at the preceding step are given below. At this step, client's approval shall be obtained without fail since all items of information required for the P & I diagram are involved.

4.3.1 Purpose

(1) In relation to the client:

Client's approval of the basis for, and detailed design of, piping layout.

(2) Project department:

No specific purpose

(3) Mechanical (piping) engineering department:

For commencing piping layout and material take-off

(4) Instrumentation & control department:

Confirmation of detailed matters

4.3.2 Additional Information

(1) Information concerning equipment

: Elevation of equipment

: Size of equipment

: Internal of equipment

(2) Information concerning piping

: Line class

: Miscellaneous piping size (except around the safety/relief valve and control valve)

: Thermal insulation, cold insulation

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 41 OF 56

- : Precautions concerning piping layout
- (3) Information concerning instrumentation
 - : Additions and revisions on the basis of detailed design
- (4) Information concerning the vendors
 - : The details of some information concerning the vendors shall be indicated.

4.4 Step IV P & I Diagram for Piping Drawings

The purpose of issuing the "P & I diagram for piping layout" and main items of information to be added to the P & I diagram prepared at the preceding step are as follows:

4.4.1 Purpose

- (1) In relation to the client:
 - No specific purpose
- (2) Project department:
 - No specific purpose
- (3) Mechanical (piping) engineering department:
 - For checking piping layout
 - For commencing the preparation of the piping drawings
- (4) Instrumentation & control department:
 - No specific purpose

4.4.2 Additional Information

- (1) Information concerning equipment
 - : Not specifically required
- (2) Information concerning piping
 - : Piping around the safety/relief valve and control valve, valve size
 - : Additional review of the pipe size and branch by the checking of piping layout
- (3) Information concerning instrumentation
 - : Sizes of the safety/relief valve and control valve
 - : Details concerning the level gauge
- (4) Information concerning the vendors
 - The details of almost all information concerning the vendors shall be indicated

4.5 Step V P & I Diagram for Construction

4.5.1 Purpose

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

4.5.2 Precautions

- (1) The P & I diagram shall be frozen prior to issuance of the final edition of the piping material table.
- (2) Absolutely required revisions only shall be made after freezing the P & I diagram,

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 42 OF 56

and shall be put into effect by conducting design revisions using the relevant field sketches, and executing the relevant items of modification work. This is applicable to revisions called for at the design department. The frozen P & I diagram shall not be revised.

4.6 Step VI P & I Diagram As-Built

4.6.1 Purpose

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

4.6.2 Method of Preparation

The P & I diagram as-built shall be prepared in accordance with the results of line checking and the final edition of the field sketches. The precautions are as follows:

- (1) The specified piping and instrument take-off and branch points shall be observed as strictly as possible.
- (2) 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.

5. HANDLING OF LICENSED PROCESS

Where a licensed process or basic design prepared by a licensor or contractor (hereinafter called the licensor) is involved, SECL's scope of work concerning the P & I diagram is dependent on the type of contract with the client or the licensor. Accordingly, it is necessary to clarify the type of contract and SECL's scope of work concerning the P & I diagram prior to reviewing the method of preparing the P & I diagram.

5.1 Type of Contract and SECL's Scope of Work

The types of contracts and SECL's scope of work for the preparation of the P & I diagram concerning the licensed process are classified as follows:

5.1.1 Licensing Contract via SECL (SECL and the licensor jointly give a process performance guarantee to the client)

SECL's scope of work is of the following two types:

- (1) The licensor shall prepare the P & I diagram, and SECL shall review the P & I diagram thus prepared.
- (2) SECL shall prepare the P & I diagram on the basis of a typical P & I diagram or relevant information supplied by the licensor.

5.1.2 Direct Contract between Client and Licensor (SECL need not give any process performance guarantee)

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 43 OF 56

While the P & I diagram is given by the client, it is in some cases required that SECL give verification.

- (1) Case where SECL*S verification is required.
- (2) Case where SECL need not give any verification.

5.2 Licensing Contract via SECL

A process performance guarantee shall be given by SECL to the client, or by the licensor to SECL

5.2.1 Case where Licensor Prepares P & I Diagram

The P & I diagram supplied by the licensor is equivalent to the "P & I diagram for piping layout" given in this manual, and contains all design philosophies concerning process. In connection with the licensor's preparation of the P & I diagram, SECL shall carry out the following items of work:

- (1) Prior to the licensor's commencing the preparation of the P & I diagram, SECL shall establish the basic items for the preparation of the P & I diagram, and in principle, send the above-mentioned items to the licensor. SECL shall request the licensor to prepare the P & I diagram in accordance with the above-mentioned items.
- (2) Presided over by the process engineering department, each speciality department shall review the P & I diagram prepared by the licensor. The main review items are as follows:
 - (a) Process engineering department
 - . In accordance with the items to be covered by the POD, the POD shall be prepared on the basis of the operation guide or P & I diagram prepared by the licensor. Then review shall be made in regard to operability, safety, conformity in design of the unit, etc. The above-mentioned POD is for interoffice use, and need not be submitted to the client.
 - . Checking of the above-mentioned P & I diagram against the basic items for preparing the P & I diagram.
 - . Checking of the above-mentioned P & I diagram against the relevant design data.
 - . General review and checking of miscellaneous matters.
 - (b) The review items for each speciality department is as per Para. 4.2.3.
- (3) The results of the above-mentioned checking and review shall be indicated in a review list, sent to the licensor, and used as review data at a review meeting to be held between the licensor and SECL.
- (4) Depending on necessity, a review meeting shall be held, which shall be attended by the licensor or client. Then, SECL shall request the licensor to revise the P & I diagram in accordance with the results of the above-mentioned meeting, and officially issue the revised P & I diagram. The P & I diagram thus prepared is equivalent to the "P & I diagram for piping layout" given in this manual.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 44 OF 56

- (5) Then, the undermentioned items of reviews on revision of the P & I diagram shall be conducted by SECL in accordance with the progress of detailed design:
 - (a) Review in accordance with the results of detailed hydraulic review.
 - (b) Review in accordance with the results of detailed design.
 - (c) Review on the basis of information concerning vendors.
- (6) Those revisions, if called for during SECL's execution of the above-mentioned reviews, which are expected to have an effect on process performance shall be made upon obtaining licensor's approval without fail.

5.2.2 Case where SECL Prepares P & I Diagram

As per Chapter 4 since the P & I diagram is prepared exclusively by SECL. However, the undermentioned items shall be carried out prior to, and upon, preparing the P & I diagram.

- (1) Obtain, from the licensor, required sufficient information for the preparation of the P & I diagram.
- (2) Subject the prepared P & I diagram to licensor's review.

5.3 Direct Contract between Client and Licensor

It is usually required that SECL give mechanical guarantee only, and not any process performance guarantee.

5.3.1 Case where SECL's Verification is Required

Usually, the required verification is limited to mechanical and hydraulic matters.

However, for the purpose of reducing manhours and avoiding troubles, it is necessary to hold sufficient discussions with the client, and decide in detail the items and contents of verification and the sphere of responsibility concerning verification.

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

- (1) The basic items for preparation of the P & I diagram shall be prepared. In this case, however, the above-mentioned items shall be limited to the minimum items required.
- (2) In accordance with the items to be covered by the POD, the POD shall be prepared on the basis of the operation guide or P & I diagram prepared by the licensor. The above-mentioned POD is for interoffice use, and need not be submitted to the client.
- (3) In accordance with the above-mentioned basic items for preparation of the P & I diagram and POD, the matters contained in the above-mentioned P & I diagram shall all be checked satisfactorily similar to the case of preparing the P & I diagram.
- (4) Hydraulic checking and checking of the above-mentioned contained therein against the detailed design data shall be conducted.
- (5) The problems found during execution of the above-mentioned items of work shall be indicated in a verification list, and reviewed at a review meeting held between the client and SECL.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 45 OF 56

(6) The results of the above-mentioned review are equivalent to the "P & I diagram for piping layout".

(7) Upon completion of the above-mentioned items of work, Paras. 4.3, 4.4 and 4.5 shall be applied.

5.3.2 Case where SECL need not give any Verification

The required minimum review of the undermentioned items shall be conducted.

(1) Results of the detailed hydraulic review (this review shall be limited to the required review items because of the plot plan and piping layout).

(2) Results of the detailed design.

(3) Information concerning the vendors.

6. SCOPE OF WORK

The responsibility for the preparation, revision and handling of the P & I diagram and relevant coordination shall in principle, be transferred from the process engineering department to the project department upon issuance of the "P & I Diagram for Piping Layout"

(1) Up to issuance of the "P & I Diagram for Piping Layout":

Process engineering department

(2) Upon issuance thereof: Project department

Of the items of information covered by the P & I diagram, however, those which are related to process performance shall be covered under the responsibility of the process engineering department throughout the entire period of the P & I diagram preparation work.

7. REVISION OF P & I DIAGRAM

7.1 Method of Revision

The following four items are the main conceivable reasons for revising the P & I diagram:

(1) Correction of errors

(2) Client's instructions

(3) Accumulation of pertinent information in the course of execution of the relevant engineering work.

(4) Additional information concerning vendors.

The P & I diagram shall be revised by the undermentioned methods regardless of the reasons for revisions.

(1) Revisions called for before issuance of the "P & I diagram for piping layout" shall in principle be made by directly revising the P & I diagram.

(2) Revisions called for upon issuance of the "P & I diagram for piping layout" shall in principle be made not by directly revising the P & I diagram but by issuing the NPIC (Notification of P & I diagram Change).

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 46 OF 56

7.2 Revision of P & I Diagram

While the revised editions of the P & I diagram shall be issued per step, the P & I diagram shall be revised depending on necessity at each step in addition to the above-mentioned revised edition. Accordingly, it does not follow that the step No. and revision No. coincided with each other. At the time of revising the P & I diagram, the NPIC issued up to that time and information concerning vendors obtained up thereto shall be incorporated into the P & I diagram.

7.3 Notification of P & I Diagram Change

The NPIC shall be issued in the following manner:

- (1) Form 1516 "Notification of P & I Diagram Change (Japanese)" or Form 1513 "Notification of P & I Diagram Change (English)" shall be used.
- (2) The NPIC shall be prepared by the department where the revision involved was called for.

The revisions required by the client shall be handled by the departments concerned.

- (3) The P & I diagram shall be issued by the following route:
 - (a) P & I diagram involving process performance:
Department concerned in the preparation of the P & I diagram -- process engineering department -- project department -- issuance.
 - (b) P & I diagram not involving any process performance:
Department concerned in the preparation of the P & I diagram -- project department -- issuance.
- (4) For the purpose of effective execution of the revision work which calls for a large amount of manhour, i.e. preparation of the NPIC, the details of the revisions shall be indicated in a list or existing drawings and documents as far as possible in the undermentioned manner, and the above-mentioned list, etc. shall be attached to the NPIC.
 - (a) Preparation of a list:
Where the size of the control valve, safety/relief valve or other item of the same category the required revisions of which amount to a large number, is involved, a list of the above-mentioned revisions shall be prepared and attached to the NPIC.
 - (b) Utilization of existing drawings and documents:
The revisions shall be indicated in the P & I diagram-before-revision, and the required portions shall be cut out and attached thereto. For revisions around the liquid level gauge, the LC-LG arrangement shall be utilized.
 - (c) Where information concerning the vendor has been revised, resulting in the tie in between the vendor and SECL and engineering work being effected, the NPIC shall be issued. Other types of required revisions shall be made at each time the P & I diagram is revised.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 47 OF 56

8. RELATION TO CLIENT

In order to effectively carry out, in steps, the various items of work concerning the preparation of the P & I diagram, it is necessary to obtain client's approval at proper times. Accordingly, it is necessary to explain to the client, the data to be obtained at the preparatory step for the preparation of the P & I diagram, and the features of each P & I diagram preparation step.

8.1 Basic Items for Preparation of P & I Diagram

Client's approval of the basic items for preparation of the P & I diagram shall be obtained prior to commencement of the P & I diagram preparation work. For this purpose, a letter of request for approval, an example of which is given below, shall be submitted to the client for the purpose of explaining the basic items for preparation of the P & I diagram.

"Intending to commence the preparation of the P & I diagram, SECL would like to request you to review and approve of the attached basic items for preparation of the P & I diagram, which are indispensable for the preparation of the P & I diagram under a unified design philosophy."

8.2 Approval of P & I Diagram

The step for obtaining client's approval of the P & I diagram shall be either one of the undermentioned two steps, and shall be decided in accordance with the features of the project.

8.2.1 Step II P & I Diagram for Engineering Start

The obtaining of client's approval at this step is mainly applicable to the case where SECL shall prepare the P & I diagram, and is the most desirable. In this connection however, it is to be noted that the "P & I diagram for engineering start" contains a part only of the information to be indicated in the P & I diagram. This calls for sufficient explanation to the client.

The preparation of the P & I diagram can effectively be completed by submitting to the client for the first time, the P & I diagram for review not indicating any line No. or instrument tag No., and submitting to the client the P & I diagram for official approval indicating the results of review conducted at the review meeting with the client and the instrument tag and line Nos. At the review meeting, process descriptions shall be given by using the POD so as to obtain client's sufficient understanding. An example of descriptions of the P & I diagram to be made to the client is as follows:

SECL would like to request you to review this P & I diagram, the descriptions of which are given below."

Purpose

Entire design philosophy concerning process

Information included in this P & I diagram

(1) Items concerning operation:

All instruments and piping

(2) Equipment:

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 48 OF 56

Number

Type

Equipment No. and name of equipment

(3) Piping:

All piping and all valves

Necessity or otherwise of steam trace and jacket piping

(4) Instrumentation:

Types of instruments, and locations of the primary elements.

Locations and discharge destinations of the safety/relief valves.

Location, type and valve functioning (failure action) of the control valve.

Measurement and control method.

Information not included in this P & I diagram

The undermentioned items are excluded from, or give preliminary information only in this P & I diagram. Information concerning the undermentioned items shall be gradually added to the P & I diagram in accordance with the progress of the design work.

(1) Equipment:

Elevation

Size

Internal

(2) Piping:

Line No.

Line class

Thermal insulation, cold insulation

Sizes of piping other than main main piping

Instruction for layout

(3) Instrumentation:

Instrument tag No.

Sizes of safety/relief valves

Sizes of control valves

Details concerning level gauges

(4) Information concerning the vendors:

8.2.2 Step III P & I Diagram for Piping Layout

Where the P & I diagram prepared by the licenser has been reviewed or verified, client's approval of the above-mentioned diagram shall be obtained at Step III. Even where the P & I diagram prepared by SECL is involved, client's approval of such diagram shall be obtained at Step III if so required under the circumstances.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 49 OF 56

Table 2-1 EACH STEP FOR PREPARING THE P & I DIAGRAM (1/4)

Step No. (Name)		Step I (Preparatory step)	Step II (for engineering start)	Step III (for piping layout)	Step IV (for piping drawing)	Step V (for construction)	Step VI (as built)
Design Phase		Basic design phase		Detailed design phase		Construction phase	
In relation to the client	1.Client*s approval on the basic items for the preparation of the P & I diagram shall be obtained.	1.Client*s approval on the design philosophy concerning the entire process shall be obtained as far as possible (POD shall be effectively used.)	1.Client*s appoval on the basics concerning piping layout and the detailed design shall be obtained.	Generally nil	For construction work	For filing and submission to the client	
Project Department	1.Efforts Shall be made to unify the designphilosophy concerning the preparation of the P & I diagram.	1.For commencing safety assesment	Generally nil	Generally nil			
Mechanical (piping) Engineering Department		1.For the detailed review of the plot plan	1.For commencing piping layout 2.For commencing material take-off	1.For checking piping layout 2.For commencing the preparation of the piping drawings			
Instrumentation & Control Department		1.For commencing the basic items of work	1.Confirmation of the detailed matters	Generally nil			
A.Information concernig equipment		A-1.Number of items of equipment A-2.Type of equipment (column, vessel, heat exchanger, etc.) A-3.Equipment No. and name	A-1~A-3. As per Step II A-4.Elevation of equipment A-5.Size of equipment A-6.Internal of equipment	A-1~A-6. As per Step III	As per Step IV		

Purpose

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 50 OF 56

Table 2-1 EACH STEP FOR PREPARING THE P & I DIAGRAM (2/4)

Step No. (Name)	Step I (Preparatory step)	Step II (for engineering start)	Step III (for piping layout)	Step IV (for piping drawing)	Step V (for construction)	Step VI (as built)
Design Phase	Basic design phase		Detailed design phase		Construction phase	
B.Information concerning piping		B-1 Size of main piping B-2 Necessity or otherwise of steam-trace, jacket piping B-3 Type of the valveB-4 Drain, ventB-5 Purge, steam-out B-6 Chemical injectionB-7 Water injectionB-8 Line No.	B-1~B-8 As per Step IIB-9 Line class B-10 Miscellaneous piping size (except around the safety/relief valve and control valve) B-11 Thermal insulation, cold insulationB-12 Insulation for piping layout	B-1~B-12 As per Step III B-13 Piping around the safety / relief valve and control valve, and valve size B-14 Additional review of the piping size and branch by the checking of piping layout	As per Step IV	
C.Information concerning instrumentation		C-1 Type of the instrument, and location of the primary elementC-2 Location and discharge destination of the safety/relief valve C-3 Location, type and valve functioning(failure action) of the control valveC-4 Measurement control method C-5 Instrument No.	C-1~C-5 As per Step II C-6 Additions and revisions on the basis of detailed design	C-1~C-6 As per Step III C-7 Sizes of the safety/relief valve and control valve C-8 Detailed concerning the valve gauge		

Main items of information to be indicated

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 51 OF 56

Table 2-1 EACH STEP FOR PREPARING THE P & I DIAGRAM (3/4)

Step No. (Name)	Step I (Preparatory step)	Step II (for engineering start)	Step III (for piping layout)	Step IV (for piping drawing)	Step V (for construction)	Step VI (as built)
Design Phase	Basic design phase		Detailed design phase		Construction phase	
D. Information concerning the vendor		D-1 The connection lines (especially utility) assumed by JGC shall be indicated(however, it is unnecessary to indicate the piping size or any other detailed information).	D-2 The details of some information concerning the vendor shall be indicated.	D-3 The details of almost all information concerning the vendors shall be indicated	D-4 The details of all information concerning the vendors shall be indicated.	
Handing of the NPIC and field sketches	Main items of information to be indicated			Revisions shall be made on the basis of the NPIC	Revisions shall be made on the basis of the NPIC	Revisions shall be made on the basis of the drawings for field sketches issued after frozen.
Notes	(1) (2) (3)	(4) (5)	(6) (7)		(8)	
	(1) Client's approval on the basic items for preparing the P&I diagram shall be obtained prior to commencing the preparation of the P&I diagram. (2) The prepared POD shall be subjected to client's review and adjustment prior to officially issuing the P&I diagram for engineering start.		(5) In relation to the client: (a) Client's approval shall be obtained at this step as far as possible. (b) In this case, no line No. nor any instrument tag No. nor any instrument tag No. shall be indicated, and the P&I diagram "for review" shall be issued to the client, and a review meeting shall be held between the client and SECL		(7) The NPIC shall be issued at Step III and subsequent steps, in principle. (8) The revisions of the final P&I diagram for construction shall be conducted by using the field sketch drawings.	

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
DATE : 2010.11.25		PAGE 52 OF 56

Table 2-1 EACH STEP FOR PREPARING THE P & I DIAGRAM (4/4)

Step No. (Name)	Step I (Preparatory step)	Step II (for engineering start)	Step III (for piping layout)	Step IV (for piping drawing)	Step V (for construction)	Step VI (as built)
Design Phase	Basic design phase		Detailed design phase		Construction phase	
Notes	(3) Being of importance for the preparation of the P & I diagram, basic items for the preparation of the P & I diagram and the POD shall be prepared upon conducting sufficient review together with the client. (4) In relation to SECL's departments concerned: (a) Upon being prepared, the draft of the P & I diagram for engineering start shall be distributed to each department concerning to enable personnel concerned to understand the entire design philosophy concerning process, and comments of personnel concerned if any shall be obtained. If necessary, a review meeting shall be held. (b) The mechanical(Piping) Engineering Department and the Instrumentation & Control Department shall conduct the numbering of piping and instruments on the basis of the above-mentioned draft.		(c) Line Nos. and instrument Nos. shall be indicated on the P & I diagram "for engineering start" upon reviewing the comments given by the client, and client's approval on the above-mentioned P&I diagram shall be obtained (6) This step is for the commencement of piping layout, and detailed information required for this purpose shall be gradually supplied by issuing the NPIC			

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 53 OF 56

1. SCOPE

This manual covers the purpose and preparation of Process Operation Diagrams (hereinafter referred as POD).

2. FORMAT

POD shall be described on the Process Flow Diagram after completion. The relevant equipment, piping and instruments shall be stated in larger and thicker letters and lines than those of other portions so that they can be clearly understood. If necessary, brief explanations by sentences shall be added for better understanding.

For batch operation, an explanation by sequence logic diagram will also be helpful.

3. PURPOSE

The purpose of POD is to clarify operational requirements before start of the preparation of the P & I diagram to completely reflect them on the P & I diagrams. Since the contents of a P & I diagram are generally huge it is not easy to prepare the whole of it under a consistent philosophy without committing any oversight. As the client also reviews the P & I diagram under similar conditions, it is difficult for him to completely understand the process.

For this reason, when the engineering has proceeded to some extent, inadequacies will be found and/or changes will be made in the lines of thought.

These will often have large impacts on the schedule and/or engineering manpower supply plan.

If POD is prepared and used, the above problems can be settled and the P & I diagrams can be prepared so as to be philosophically complete at the initial stage. Hence, POD must be submitted to the owner for approval prior to proceeding with the P & I diagram as a rule. Detailed procedure was given in im "Execution Procedure on P & I Diagram."

The role of POD will terminate when POD is approved by the owner.

After the owner's approval, POD need not be followed up as a rule.

This is intended to avoid a waste of manpower and confusion in the engineering which will be caused if documents of the same contents are used.

However, as a part of POD will be incorporated into the operation manual, the part must be followed up until the preparation of the operation manual.

4. CONTENTS

POD shall be prepared for such items as those discussed below.

If the operations are complicated, POD shall be provided for each major step.

The operating conditions (pressures, temperatures, flow rates, etc.) known at the stage shall be indicated in POD. This will assist in sizing and rating piping, making entries in instrument data sheets and other matters.

(1) Precommissioning and start-up operation

(a) Flushing

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
DATE : 2010.11.25		REV. : 1
		PAGE 54 OF 56

- (b) Purging
- (c) Soda washing
- (d) Chemical cleaning
- (e) Steaming-out
- (f) Evacuation
- (g) Drying
- (b) Water operation
- (i) Cold circulation
- (j) Hot circulation
- (k) Catalyst pretreating (sulfiding, reduction, etc.)
- (l) Feed cut-in
- (m) Off spec. product handling

(2) Normal operation

- (a) Recorder and indicator point
- (b) Stream analyzer
- (c) Sampling point and type
- (d) Control valve block and bypass
- (e) Driver type
- (f) Chemical injection point
- (g) Batch operation
- (h) Local start
- (i) Instrument for guarantee

In the case of batch operations, it is desirable that POD should be prepared together with sequence logic diagrams.

(3) Shut-down operation

- (a) Depressuring
- (b) Feed cut-out
- (c) Cooling
- (d) Purging
- (e) Steaming-out
- (f) Decoking
- (g) Catalyst regeneration

Many of the steps of the shut-down procedure are the same as those of the start-up procedure. Such steps should be shown in either and the matter should be noted in the other.

(4) Safety operation

- (a) Location of safety/relief valves
- (b) Failure action of control valves
- (c) Prealarm system
- (d) Emergency shut-down sequence

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 55 OF 56
DATE : 2010.11.25		

(e) Auto start system

In cases where a process safeguarding flow scheme (PSFS) is prepared, some of the above items can be substituted with PSFS.

For PSFS, see Sect. 13-4.

	BASIC DESIGN MANUAL P&I DIAGRAM	SPD0037ERN
		REV. : 1
		PAGE 56 OF 56

개정번호	개 정 일 자	개정 페이지	개 정 사 유
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