ENGINEERING STANDARD

FOR

PIPING & INSTRUMENTATION DIAGRAMS (P & IDs)

ORIGINAL EDITION

OCT. 1996

This standard specification is reviewed and updated by the relevant technical committee on Oct. 2002. The approved modifications are included in the present issue of IPS.

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APPENDICES:

0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Requirements for the Project Design and Engineering" is intended for convenience of use and pattern of follow-up and also a guidance.

These Standard Engineering Practice Manuals, also indicate the check points to be considered by the process engineers for assurance of fulfillment of prerequisitions at any stage in the implementation of process plant projects.

It should be noted that these Iranian Petroleum Standards (IPS), as Practice Manuals do not profess to cover all stages involved in every process project, but they reflect the stages that exist in general in process projects of oil, gas and petrochemical industries of Iran.

These preparation stages describe the following three main phases which can be distinguished in every project & include, but not be limited to:

Phase I: Basic Design Stages (containing seven Standards)

Phase II: Detailed Design, Engineering and Procurement Stages (containing two Standards)

Phase III: Start-Up Sequence and General Commissioning Procedures (containing two Standards)

The process engineering standards of this group include the following 11 Standards:

STANDARD CODE	STANDARD TITLE
I) Manuals of Phase I (Numbers 1 - 7)	
IPS-E-PR-150	"Basic Design Package"
IPS-E-PR-170	"Process Flow Diagram"
IPS-E-PR-190	"Layout and Spacing"
IPS-E-PR-200	"Basic Engineering Design Data"
IPS-E-PR-230	"Piping & Instrumentation Diagrams (P&IDs)"
IPS-E-PR-250	"Performance Guarantee"
IPS-E-PR-308	"Numbering System"
II) Manuals of Phase II (Numbers 8&9)	
IPS-E-PR-260	"Detailed Design, Engineering and Procurement"
IPS-E-PR-300	"Plant Technical and Equipment Manuals (Engineering Dossiers)"
III) Manuals of Phase III (Numbers10&11)	
IPS-E-PR-280	"Start-Up Sequence and General Commissioning Procedures"
IPS-E-PR-290	"Plant Operating Manuals"

This Engineering Standard Specification Covers:

"PIPING & INSTRUMENTATION Diagrams (P & IDs)"

1. 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.

Note:

This standard specification is reviewed and updated by the relevant technical committee on Oct. 2002. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 175 on Oct. 2002. These modifications are included in the present issue of IPS.

2. 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.

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME Code.

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI B 16.1	"Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800" 1st. Ed., 1989

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-200	"Basic Engineering Design Data"
IPS-E-PR-308	"Numbering System"
IPS-E-PR-725	"Process Design of Plant Waste Sewer Systems"
IPS-G-IN-160	"Control Valves"
IPS-D-AR-010	"Abbreviations & Symbols for HVAC&R Drawings"
IPS-D-AR-011	"General Notes for HVAC & R System"

ISA (INSTRUMENT SOCIETY OF AMERICA)

ISA-S5.1	"Instrumentation Symbols and Identification" 1st. Ed., 1984
ISA-S5.2	"Binary Logic Diagrams for Process Operations" 2nd. Ed., 1981 (Reaffirmed 1992)
ISA-S5.3	"Graphic symbols for distributed control / shared display instrumentation, logic and computer systems “Ed.,1983

ISA-S5.4	"Instrument Loop Diagrams" Ed., 1991
ISA-S5.5	"Graphic Symbols for Process Displays" 1st. Ed., 1985
ISA-S18.1	"Annunciator Sequences and Specifications" 1st. Ed., 1979 (Reaffirmed 1992)
ISA-S50.1	"Compatibility of analogue signals for electronic industrial process instruments" 1st. Ed., 1975 (Reaffirmed 1995)
ISA-S51.1	"Process Instrumentation Terminology" 1st. Ed., 1979

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 3098: Part 1	"Technical Drawings-Lettering, Part 1: Currently Used Characters" 1st. Ed. 1974
ISO 3511: Part 1 & Part 4	"Process measurement control functions and instrumentation-symbolic representation-Part 1: Basic requirements, 1st.Ed. 1977;Part 4: Basic symbols for process computer, Interface, and shared display/control functions" Ed. 1985 1st. Ed., 1984
ISO 6708	"Pipe component definition of nominal size" Ed., 1995.

API (AMERICAN PETROLEUM INSTITUTE)

API Standard 602	"Compact steel gate valves-flanged, threaded, welding and extended body ends "nine Ed., 1995

3. DEFINITIONS AND TERMINOLOGY

- Company or Employer/Owner:

Refers to one of the related and/or affiliated companies of the Iranian ministry of petroleum such as National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Petrochemical Company (NPC), etc.

- Contractor:

Refers to the persons, firm or company whose tender has been accepted by the Employer, and includes the Contractor's personnel representative, successors and permitted assigns.

- Licenser:

Refers to 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:

Refers to 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(s):

Refer to one or all process, offsite and/or utility Units and facilities as applicable to form a

complete operable oil, gas and/or petrochemical plant .

4. SYMBOLS AND ABBREVIATIONS

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

5. UNITS

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

6. GENERAL

6.1 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 together with graphical symbols for process measurement and control functions.

The Utility Flow Diagram (UFD) 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 UFD can be represented as a box with inscription (e.g., identification number) and with utility connections.

6.2 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.

6.3 Drafting

6.3.1 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.

6.3.2 Drawings sheet sizes

Diagrams shall be shown on A0 size (841 mm × 1189 mm) tracing paper. A1 size (591 mm × 841 mm) may be used for simple P&IDs and UFDs as per Company's approval (see Article 6.3.3.2 for drawing dimensions and title block sizes).

6.3.3 Drawing title block

6.3.3.1 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 Iranian Oil Company);
- name of Company Relevant Organization, (if any), (e.g., Refineries Engineering and Construction);
- name of refinery or plant (in English and Persian 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.

6.3.3.2 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

6.3.4 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.

6.3.5 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.

6.3.6 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.

6.3.7 Connections

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

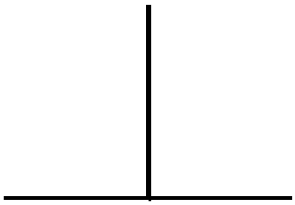


Fig. 1

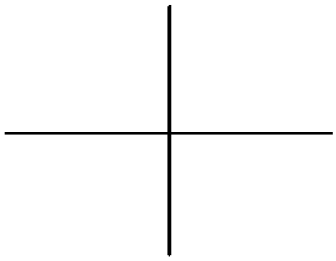


Fig. 2

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

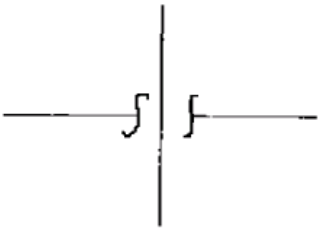


Fig. 3

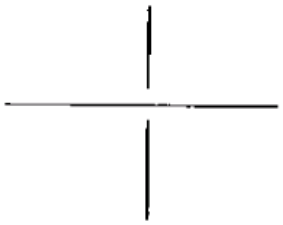


Fig. 4

6.3.8 Inscriptions

6.3.8.1 Type of lettering

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

6.3.8.2 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.

6.3.8.3 Arrangement of inscription

a) Equipment

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.

b) 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.

c) Valves and fittings

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

d) 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.

6.4 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.

6.5 Drawing Number

Numbering of drawings shall be according to IPS-E-PR-308, "Numbering System".

6.6 Arrangement

6.6.1 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 machinery equipment in the lower quarter. The spacing of equipment and flow lines shall permit identification and tracing of the lines easily.

6.6.2 The area above the title block on each sheet shall be completely left open for notes.

6.6.3 The general flow scheme shall be from left to right. Unnecessary line crossing should be avoided.

6.6.4 Process lines entering and leaving the diagram from/to other drawings in the Unit shall be terminated at the lefthand or righthand side of the drawing. Lines from/to higher number drawings shall enter and leave the drawing on the righthand end and vice versa.

6.6.5 Each process line entering or leaving the side of the drawing should indicate the following

requirements in an identification box (see Appendix C):

a) The service

b) The origin or destination equipment item number

c) Continuation drawing number with the relevant coordinates.

6.6.6 Process lines to/from other Units shall be terminated at the bottom of the drawing at a box indicating (see also

Appendix C):

a) The service

b) Source or destination Unit name and number

c) The drawing number of the connecting flow diagrams with the relevant coordinates.

6.6.7 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, ISA, etc.). See IPS-E-PR-308, "Numbering System" and Appendix A of this Standard for utility services abbreviations. A "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 D).

6.6.8 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 C).

6.6.9 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.

7. MINIMUM INFORMATION TO BE SHOWN ON P&I DIAGRAMS

7.1 General

7.1.1 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.

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

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

7.1.4 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.

7.2 Equipment Indication

7.2.1 Vessels, towers, drums

7.2.1.1 The following requirements shall be shown:

a) changes of shell diameter (if any);

b) top and bottom trays, and those trays which are necessary to locate feed, reflux and product lines;

c) all draw-off trays with tray number and diagrammatic representation of the downcommer position (e.g., side or center);

d) 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 handholes;

e) skirt or legs, top and bottom tangent lines;

f) elevations above base line to bottom tangent line of column or to bottom of horizontal drum;

g) 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);

Notes:

1) For draw-offs only "NLL" shall be shown. The other liquid positions will be shown as required.

2) Indication of "HHLL" and "LLLL" shall be made only when they are actuating start/stop of an equipment or machinery through a switch.

3) "HLL", "NLL" and "LLL" shall be shown for all cases except as specified under Note 1 above.

h) all flanged connections; [all connections whose purpose is not readily evident shall indicate the purpose (e.g., spare inlet, catalyst draw-off, etc.).];

i) catalyst beds, packings, demisters, chimney trays, distributors, grids, baffles, rotating discs, mixers, cyclones, tangential inlet and all other internals;

j) water drop-out boots;

k) maintenance blinds for the vessel nozzles.

7.2.1.2 Important notes:

a) All nozzles and connections indicated on the equipment data sheet shall be shown in their correct positions.

b) All indications shall be such that the consistency in the dimensions is considered, although not necessarily to scale.

c) Numbering of the trays shall be from bottom to top.

d) Height of the vessel bottom tangent line shall be indicated.

Self standing :	**Skirt height**
Elevated vessel:	**Minimum required height shall be shown as "min. ....".**

e) 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:

1) No bottom line is present.

or

2) The bottom line is not flushed with the lowest point of the vessel.

f) The valved vent with blind flange for all columns and vessels provided on the top of the vessel should be indicated.

g) Relief valves generally located on the top outlet line downstream of the vessel blinding location or directly connected to the vessel should be indicated.

h) Utility connections on all vessel/columns shall be shown.

i) One local PI shall be indicated on top of vessel/column.

j) One local TI shall be indicated on the top outlet line of vessel/column.

k) Nozzles identifications on vessels, reactors and towers shall be according to Appendix E of this Standard.

7.2.1.3 Equipment description

The following requirements shall be described under equipment description:

a) vessel item number (this number will also appear adjacent to the vessel);

b) service;

c) size [inside diameter(s) and tangent to tangent length];

d) design pressure (internal/external) and design temperature;

e) indication of insulation;

f) line number of vessel trim (this applies to LG & LC connections, vents, sample connections, etc.);

g) indication of cladding and lining (if any).

7.2.2 Tanks

7.2.2.1 The following requirements shall be shown:

a) all nozzles, manways, instrument connections, drains, vents, vortex breakers, and safety/relief valve connections;

b) all internals such as steam coils, air spargers, tank heaters and etc.

7.2.2.2 Equipment description

a) equipment item number (this number also appears adjacent to the tank);

b) service;

c) inside diameter and height;

d) nominal capacity, in (m^3);

e) design pressure and temperature;

f) indication of insulation.

7.2.3 Fired heaters, boilers, incinerators

7.2.3.1 The following requirements shall be shown:

a) all nozzles, instrument connections, drains, vents and damper(s);

b) ducting arrangement including damper actuators where required;

c) detail of draft gages piping and arrangement;

d) waste heat recovery system (if present), such as economizer, air preheater, forced draft fan, induced draft fan,etc.;

e) decoking connections;

f) detail of one complete set of burners for each cell and total burner number required for each type of burner;

g) tube coils schematically in correct relative positions and all skinpoint thermocouples;

h) logic diagram of shut down system (heat off sequence);

i) number of passes and control arrangement;

j) snuffing steam nozzles and piping arrangement;

k) blow-down and steam-out connections;

l) testing facilities;

m) convection section (where applicable).

7.2.3.2 Equipment description

a) item number (this number will also appear adjacent to the equipment);

b) service;

c) duty (kJ/s);

d) design pressure and temperature of coils;

7.2.4 Heat exchangers, coolers, reboilers

7.2.4.1 The following requirements shall be shown:

a) all nozzles, instrument connections, drains and vents, chemical cleaning connections and safety/relief valves as indicated on the equipment data sheet;

b) spectacle blinds for the isolation;

c) elevations required for process reason (e.g., reboilers, condensers, etc.);

d) the connections which allow pressure and temperature survey of heat exchanger facilities;

e) the position of high liquid level (HLL), normal liquid level (NLL) and low liquid level (LLL) for kettle type reboilers;

f) direction of flow in each side of exchanger.

7.2.4.2 Important notes

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

a) Generally, direction of flow shall be downflow for cooled media and upflow for heated media.

b) 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.

c) 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.

d) At exchangers with circulating heat transfer media, the outlet valve shall be of a throttling type for control of heat duty.

e) 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.

- 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.

7.2.4.3 Equipment description

a) equipment item number (this number also appears adjacent to the equipment);

b) service;

c) duty (kJ/s);

d) shell side design pressure and temperature;

e) tube side design pressure and temperature;

f) indication of insulation.

7.2.4.4 Sequence of numbering for stacked exchangers/coolers shall be from top to bottom.

7.2.5 Air fin coolers

7.2.5.1 The following requirements shall be shown:

a) all nozzles and instrument connections;

b) blinds for the isolation;

c) any automatic control (fan pitch control or louver control) and any alarm (vibration alarm, etc.);

d) 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;

e) steam coil and condensate recovery system (if required);

f) 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;

g) valved vent and valved drain connection for each header, vent header should be connected to closed system for volatile services;

h) 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.

7.2.5.2 Equipment description

a) equipment item number (this number will also appear adjacent to the equipment);

b) service;

c) duty (kJ/s);

d) tube side design pressure (internal and external) and design temperature.

7.2.6 Rotary machineries

7.2.6.1 The following requirements shall be shown:

7.2.6.1.1 Pumps

a) all nozzles including instrument connections;

b) pump suction valve and strainer, and discharge valve and check valve. Provision of wafer type check valve should be avoided unless otherwise specified;

c) pump drains and vents piping and destination.

d) the type of pump;

e) pump auxiliary system connections such as, cooling water, seal oil and lube oil, steam, etc.;

f) detail of lube and seal oil /sealing systems, cooling water piping arrangement, and minimum flow bypass line requirement for pumps;

g) winterization and/or heat conservation (steam or electrical) where required;

h) warm-up and flushing oil lines detail; a DN20 (¾ 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;

i) pressure gage located on the discharge of each pump; the gage shall be installed between the pump discharge nozzle and the check valve;

j) pressure relief safety valves (if any);

k) automatic start-up of standby unit (if required);

l) balanced or equalized line for vacuum service.

7.2.6.1.2 Compressors and blowers

a) type of compressor or blower;

b) start-up facilities (i.e., inert gas purge system);

c) safety/relief valves;

d) suction and discharge valves;

e) suction strainer (filter) and discharge check valve;

f) suction and discharge pulsation dampener where required;

g) valved vents and casing drains;

h) winterization (steam or electrical tracing on suction piping) where required;

i) lube and seal oil / sealing system and cooling water systems detail arrangement;

j) interstage coolers where required;

k) surge protection (where required);

l) inlet and outlet nozzles;

m)all instrument connections.

7.2.6.1.3 Steam and gas turbine drivers

a) all nozzles and connections;

b) detail of all auxiliary systems for steam turbine drivers such as steam supply, condensate return, surface condenser and etc.;

c) detail of lube oil, cooling water, etc.;

d) all instrumentations such as PI, TI, etc.;

e) 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.

f) warming bypass around inlet isolation valve for steam turbines; the valve on warm-up line shall be DN25 (1 inch) globe type;

g) steam traps and condensate recovery system for the steam turbine casing drain and upstream of isolation valve at inlet of the turbine;

h) vent line to atmosphere at turbine exhaust; the vent is required for the start-up/test operation of the turbine.

i) detail of all firing and control systems for gas turbine drivers.

7.2.6.2 Equipment description

7.2.6.2.1 Pumps

a) pump item number (this number also appears below the pump);

b) service;

c) capacity, (m^3/h, dm^3/h for injection pumps);

d) differential pressure, (kPa);

e) relative density (specific gravity) of pumped fluid at pumping temperature;

f) indication of insulation and tracing;

g) miscellaneous auxiliary piping (CW, flushing oil, seal oil, etc.).

7.2.6.2.2 Compressors and blowers

a) equipment item number and stage (this number also appears below the compressor);

b) service:

c) capacity, (Nm^3/h);

d) suction pressure, and temperature, [kPa (g)], (°C);

e) discharge pressure, and temperature, [kPa (g)], (°C);

f) miscellaneous auxiliary piping (CW, lube, oil, seal oil / sealing system, etc.);

g) gas horse power, (kW).

7.2.6.3 Other requirements

a) When a pump or compressor is spared, the data is listed once commonly for both pumps 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".

b) Stage numbers are shown only for multistage compressors. All compressor data for the first stage shall be indicated. For subsequent stages only N m^3/h may be omitted.

7.2.7 Miscellaneous equipment

Depending on the type of equipment (silensor, 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.

7.3 Instrumentation

The following requirements shall be shown:

7.3.1 all instrumentation including test points;

7.3.2 isolation valves connecting to instruments (primary connection valve);

7.3.3 control valve sizes and air failure action (FC, FO, FL);

7.3.4 block and bypass valve sizes at control valve stations;

7.3.5 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 (see IPS-E-PR-308);

7.3.6 sequence of opening and closing for the split range control valves;

7.3.7 solenoid shut-down devices at control valves/shut-off valves;

7.3.8 tight shut-off valves requirements (where required);

7.3.9 handwheels when provided on control valves;

7.3.10 limit switches on control valves when required;

7.3.11 mechanical stopper and/or signal stopper on control valves when required;

7.3.12 push buttons and switches associated with shut-down systems;

7.3.13 the instrument tag number for each instrument;

7.3.14 analyzer loop details and special notes as required;

7.3.15 winterization of instruments;

7.3.16 compressor local board mounted instrumentation;

7.3.17 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";

7.3.18 all elements of advance control and optimization systems;

7.3.19 indication of "Readable From" for all local indicators and/or gages which shall be readable from a designated valve.

7.4 Piping

7.4.1 General

7.4.1.1 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.

7.4.1.2 All line numbers, sizes and line classification shall be shown. For line numbering system see IPS-E-PR-308, "Numbering System".

7.4.1.3 The direction of normal flow shall be shown for all lines.

7.4.1.4 The points or spec. breaks at which line sizes or line specifications change shall be clearly indicated.

7.4.1.5 All blinds shall be indicated on the drawings, and the symbols used shall distinguish between tab blinds and spectacle blinds.

7.4.1.6 All vent and drain connections shall be identified whether screw caped or blind flanged, if required.

7.4.1.7 Steam traced lines and steam jacketed lines shall be so indicated.

7.4.1.8 All equipment flanges, all reducers and non-standard fittings, such as expansion bellows, flexible tubes, shall be shown.

7.4.1.9 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 flange and rating shall be shown. Any isolating valve shall be shown locked, normally open or closed.

7.4.1.10 Control valve sizes shall be shown.

7.4.1.11 All valves shown on the flow diagram shall have their size indicated by the valve, if different from line size.

7.4.1.12 Insulation and tracing requirements shall be covered in the line numbering system and shown above the line (see IPS-E-PR-308, "Numbering System"). Tracing requirement shall be noted on P&IDs by a dashed line parallel to the line to be traced.

7.4.1.13 Valve boxes/valve pits shall be shown by two embraced squares or rectangulars with indication of "Valve Box" or "Valve Pit".

7.4.1.14 Safety relief valves type, inlet and outlet size and rating and set pressure should be shown.

7.4.1.15 For pressure ratings designations-nominal size and pipe component-nominal size see Appendices F & G of this Standard respectively.

7.4.2 Special requirements

7.4.2.1 High point vents and low point drains are shown only when they are connected to a closed system, or are required for process reasons.

7.4.2.2 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 headers are not shown on the P&IDs; they are shown on the utility system flow diagrams

7.4.2.3 Pertinent information regarding a line such as "do not pocket" or "slope", etc., shall be noted adjacent to the line.

7.4.2.4 Typical air cooler manifold piping arrangement should be shown.

7.4.2.5 Connections on process lines which require to be blanked or deblanked for flow direction under special circumstances to be shown on P&ID.

7.4.2.6 Reduction and enlargement in line size are indicated by line size designation, and reducer and expander symbols.

7.4.2.7 Calculated wall thicknesses and/or schedules not already prespecified in the individual line classes shall be shown on the flow diagrams.

7.4.2.8 Corrosion allowances other than the nominal allowances indicated in the individual line classes shall be shown on the diagrams.

7.4.2.9 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 (see IPS-E-PR-725). 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.

7.4.2.10 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.

7.4.2.11 Emergency showers, eye wash fountains and utility stations shall be shown on the Utility Distribution Flow Diagrams.

7.4.2.12 Any locations where slopes, straight runs, minimum mixing runs, etc., are required for process reasons must be indicated.

7.4.2.13 The necessary instrumentation and piping for start-up, control and shut-down, etc., should be shown for any equipment on P&ID wherever applicable.

7.4.2.14 Break points between underground and aboveground piping with insulating flanges (if required) shall be shown.

7.4.2.15 Minimum distance requirement for in line blending to be indicated.

7.4.2.16 Weep hole requirement to be shown.

7.4.3 Piping specialty items

7.4.3.1 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.

7.4.3.2 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 H_2S 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.

7.4.3.3 ASME and non ASME Code change should be indicated for connection wherever applicable.

7.4.4 Steam traps & winterizing system

The following requirements shall be followed:

7.4.4.1 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.

7.4.4.2 Steam trap and the relevant steam and condensate lines to be shown for all steam reboilers, heaters, coils, etc.

7.4.4.3 Steam/electrical tracing requirement shall be noted on P&IDs by a dashed line parallel to the line to be traced.

7.5 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.

7.5.1 The following general notes shall be specified as minimum requirement:

7.5.1.1 All dimensions are in millimeters except as noted.

7.5.1.2 Elevations shown are above the highest point of paving.

7.5.1.3 All valves are line size unless otherwise shown.

7.5.1.4 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.

7.5.1.5 All electronic instrumentation shall be installed away from steam lines and high temperature heat sources.

7.5.1.6 For level transmitter center of float is NLL. The range shall cover the difference between LLL & HLL.

7.5.1.7 Sample tappings for gas samples shall be from the top of the main line. For liquid samples tapping shall be done from the side.

7.5.1.8 Except for process reasons, low point drains and high point vents are not shown.

7.5.1.9 All items marked (P) can be supplied as part of package Units.

7.5.1.10 Temperature instruments shown with "M" are provided with monel well.

7.5.2 The following general notes may be specified as required:

7.5.2.1 Piping drains and vents

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

a) 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.

b) 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.

7.5.2.2 Block valves on orifice tap

a) DN 15 (½ inch) single gate valve shall be provided for the all orifices of the piping class of PN 100 (600 #) and less.

b) DN 20 (¾ inch) single gate valve shall be provided for the all orifices of the piping class of PN 150 (900#) and over.

7.5.2.3 Drain valve of level gages and instruments:

a) Drain valves [DN 20 (¾ inch) gate valve] shall be provided.

b) The provisions should be made for routing the drain of liquids with RVP of greater than 34.5 kPa (abs) to flare.

8. 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.

8.1 Assembly Piping of Pumps

8.1.1 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	1- One size smaller than line	1- Same as suction line size
	2- Two or more sizes smaller than line	2- Select one size smaller than line
AT PUMP	Smaller than discharge line	Select one size smaller than line

DISCHARGE

8.1.2 Pump strainer

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

LINE SIZE	STRAINER TYPE
DN 80 (3 inch) and larger	T
DN 50 (2 inch) and smaller	Y

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

8.1.3 Pump vents and drains

Vent gas from 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 (see IPS-E-PR-725 for drain destinations).

8.1.4 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.

8.1.5 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.

8.2 Steam-Out, Drain and Vent for Vessels

8.2.1 Size and requirement of steam-out, vent and drain nozzles of vessels shall be according to the requirements stipulated in IPS-E-PR-200, "Basic Engineering Design Data". The vent valve shall be directly mounted on the vent nozzle with blind flange.

8.2.2 In addition to the vents required in article 8.2.1 above, a blanked off ventilation nozzle shall be provided on the top of the all horizontal vessels near the end opposite the manway. See IPS-E-PR-200 for size of the blanked off ventilation nozzle.

8.2.3 Vent connections must be located on top of the vertical and horizontal vessels.

8.2.4 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.

8.3 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:

8.3.1 Vessels

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

8.3.2 Piping/Equipment

8.3.2.1 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 piping/equipment.

8.3.2.2 Liquid service

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

8.4 Block and Bypass Valves for Control Valve

Reference to be made to Appendix I of this Standard.

8.5 Line Numbering

a) For line numbering system reference should be made to IPS-E-PR-308, "Numbering System".

b) Line numbers shall 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. Another number is required for the line located at the downstream of equipment;
- from line to line (exceptions: control valve bypass, block valve warm-up and equalizing bypasses, and safety/relief valve bypass);
- from unique equipment to the same unique equipment item (except level standpipes);
- from line or equipment to atmosphere, funnel, or closed drainage system (exception: continuous process vent stacks and process drains).

c) Pipe line numbers shall be prefixed, from source to Unit battery limit with the Unit number of the Unit of origin.

d) 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.

e) 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.

f) 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.

g) 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.

h) 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.

8.6 Philosophy of Instrumentation Installation

Reference to be made to Appendix J of this Standard.

8.7 Utility Connections

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

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

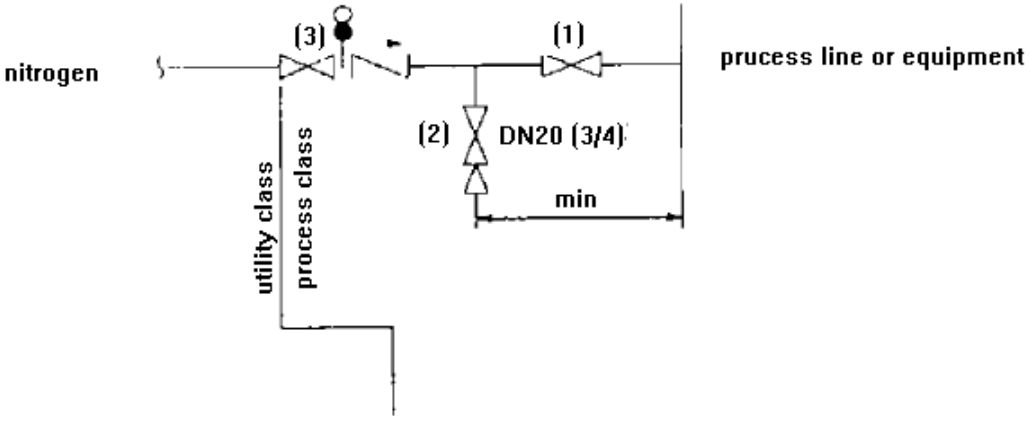
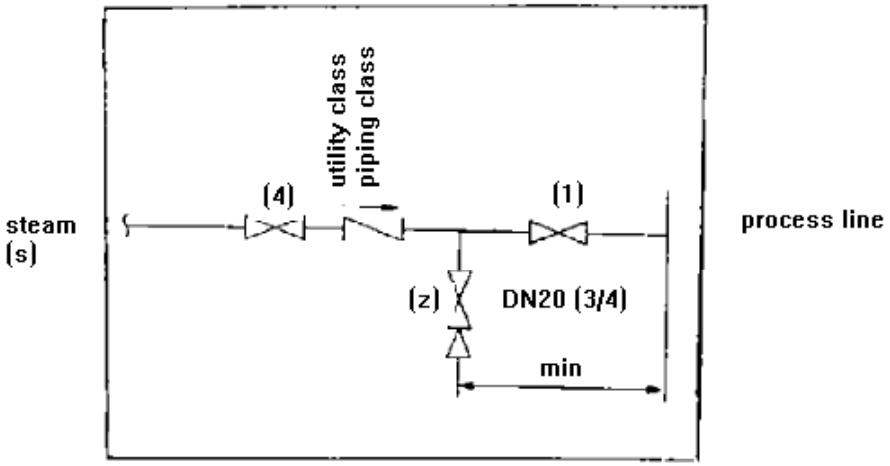


Fig. 5



Notes on utility tie-in:
1) The isolation valve may be omitted if the process line is open to atmosphere.
2) Provide a drain at downstream of check valve to check the leakage.
3) Provide spectacle blind and block valve for N_2 service.
4) Main block valve for steam service shall be at the branch point from steam header.
5) 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.

8.7.2 Connections to vessel for steam-out

8.7.2.1 Permanent steam-out connection (see Fig. 7):

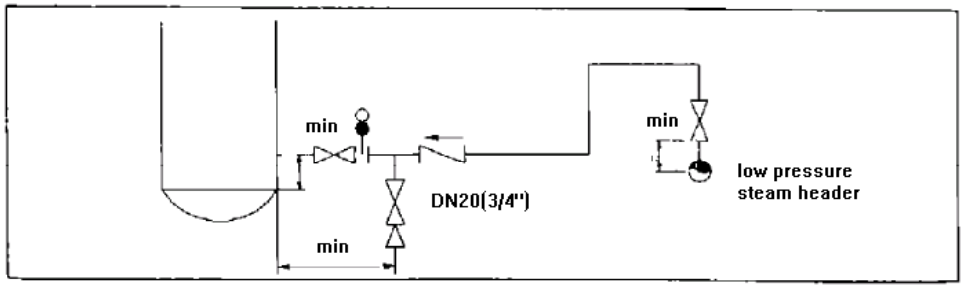


Fig. 7

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

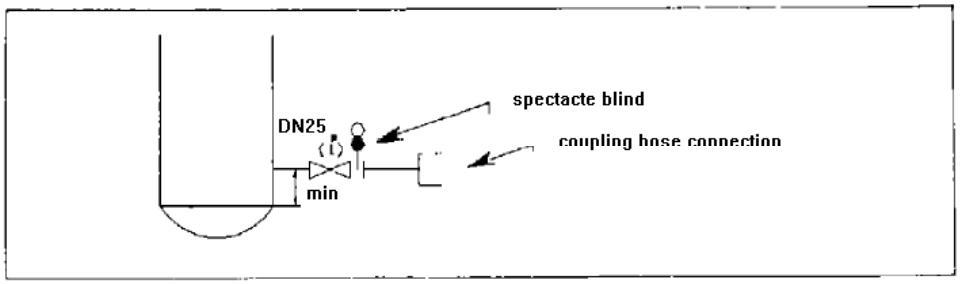


Fig. 8

8.8 Unit Battery Limit Installation

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

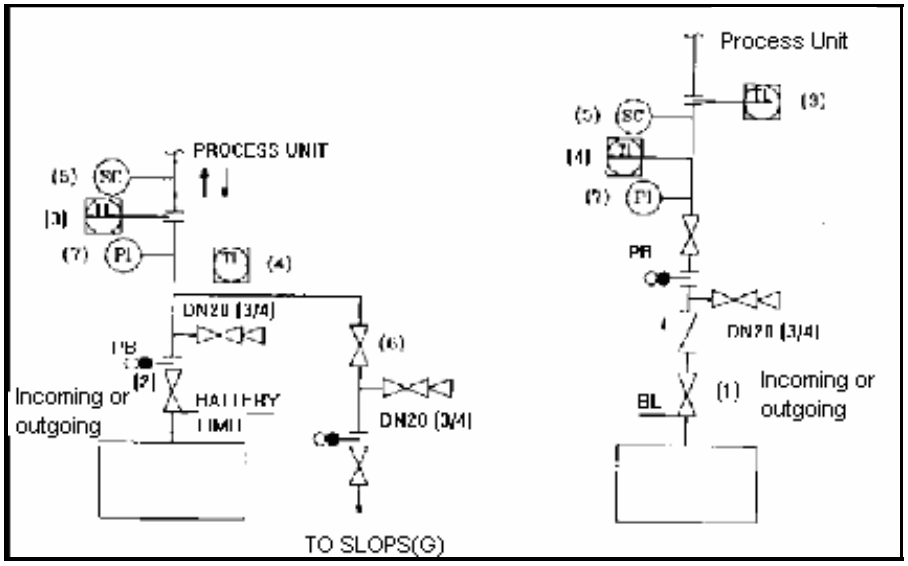


Fig. 9 **Fig. 10**

Notes on Unit battery limit installation requirements:

1) 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.

2) Provide for each process line (not included in item 1 above) an isolation valve, spectacle blind and drain as shown in Fig. 9.

3) 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.

4) 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.

5) Provide a sample station for all products leaving and/or entering the Unit.

6) 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.

7) 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.

8) Special attention should be made to the possibility of avoiding duplication of some or all of the above mentioned hardwares on the adjacent Units.

8.8.2 Utility lines (see Figs. 11, 12 and 13):

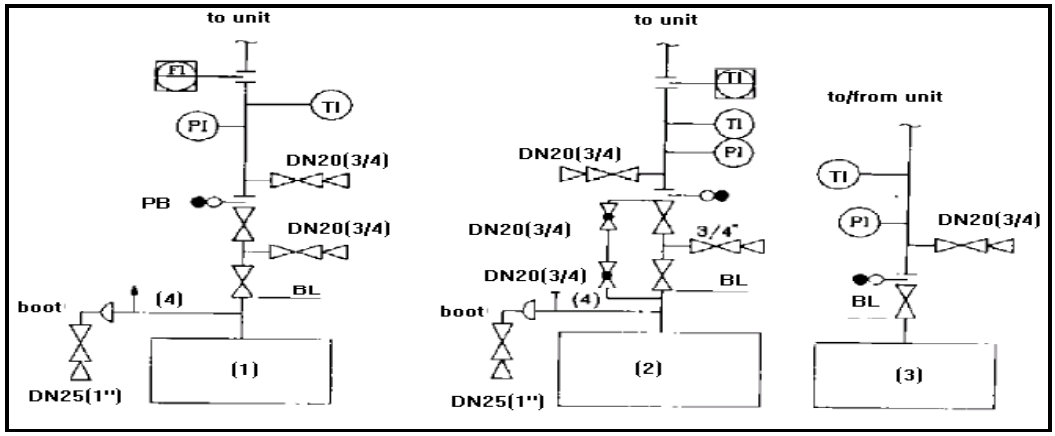


Fig. 11 **Fig. 12** **Fig. 13**

Notes on Unit battery limit installation requirements:

1) 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 (4 inch)];**
- **boiler feed water.**

2) Provide valves, drains and instrumentation as shown in Fig. 12 for medium and high pressure steams for DN200 (4 inch) and larger sizes.

3) Fig. 13 shall be applied for condensate lines.

4) 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.

8.9 Sample Connections

For sample connection symbols, reference to be made to Appendix H and Section A.2.2.1 of Appendix A of this Standard.

8.10 Steam Trap Assembly

For individual steam trap symbols reference to be made to Section A.2.2.1 of Appendix A of this Standard.

8.10.1 Steam trap assembly with internal strainer for different services:

a) Winterizing (see Fig. 14):

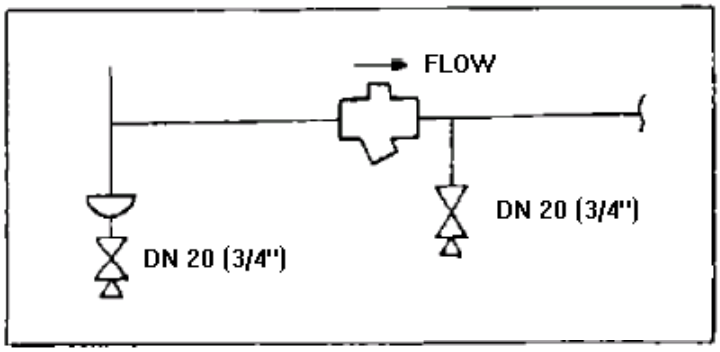


Fig. 14

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

b) Heat Conservation (see Fig. 15):

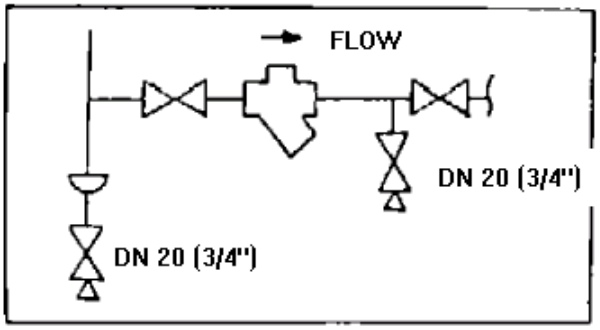


Fig. 15

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

8.10.2 Steam trap assembly with external strainer (see Fig. 16):

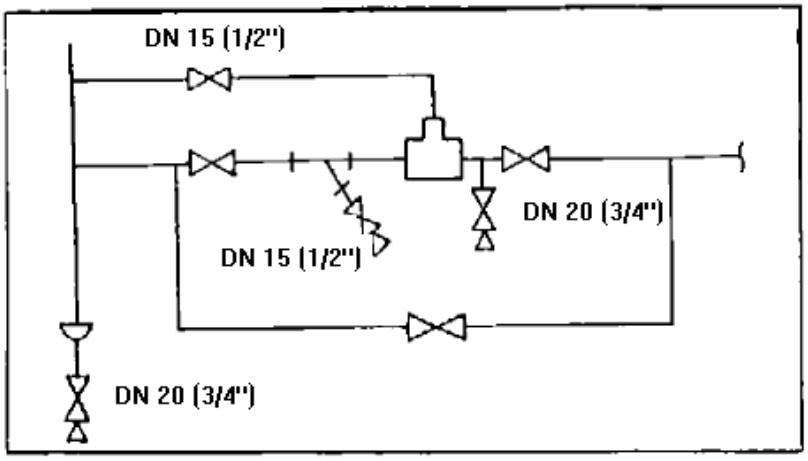


Fig. 16

9. CRITERIA FOR UTILITY FLOW DIAGRAMS

9.1 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".

9.2 Utility Flow Diagrams shall be presented in accordance with the requirements stipulated in this Standard for P&IDs where applicable.

9.3 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.

9.4 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.

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 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.

9.5 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.

9.6 Isolation facilities shall be indicated for:

- finger areas;
- process Unit block areas;
- at position of change from pipe rack to pipe rack.

9.7 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.

9.8 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.

9.9 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.

10. ABBREVIATIONS/GRAPHICAL SYMBOLS/IDENTIFICATIONS

10.1 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 include also Vendor drawings with the same purpose.

10.2 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.

10.3 For complete equipment codes, instrument identification and instrumentation legends, reference should be made to IPS-E-PR-308, "Numbering System".

10.4 For all instrumentation symbols, logic diagrams, loop diagrams and graphical symbols not shown in this Standard and/or in IPS-E-PR-308, 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"

10.5 Reference should be made to IPS-E-PR-308, "Numbering System" for the following requirements:

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

10.6 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 (see IPS-E-PR-308 for Numbering Procedure).

10.7 Appropriate graphical symbol should be provided by the Contractor for any special feature not shown in Appendix A, upon the Company's approval.

11. PREPARATION OF P&I DIAGRAMS

11.1 General

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 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
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.

11.2 Establishment of P&ID's Preparation Steps

11.2.1 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.

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;
- 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):

1) 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.

2) 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.

3) Shut-down operation

- depressuring;
- feed cut-out;
- cooling;
- purging;
- steaming-out and flushing;
- decoking;
- catalyst regeneration.

4) 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 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&I Diagrams and all necessary operation and safety features as mentioned above to Company's review and approval before issuance of official revision of P&I Diagram for engineering start.

11.2.2 Step 2, P&I diagram for engineering start

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

1) Equipment

- number of equipment;
- type of equipment;
- equipment No. and name.

2) 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.

3) 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.

The draft of the P&I Diagram for engineering start shall be sent to the Company's review. After the joint meeting between the Company and Contractor, the P&I Diagram 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.

11.2.3 Step 3, P&I Diagram for piping layout

The purpose of issuing the P&I Diagrams 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:

1) Equipment

- elevation of equipment;
- size of equipment;
- internal of equipment.

2) 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.

3) Instrumentation

- size of main control valves;
- additions and revisions on the basis of detailed design.

4) Vendor's packaged units

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

11.2.4 Step 4, P&I diagram for piping drawings

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

1) Piping

- piping around the safety/relief valve and control valve;
- 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).

2) 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.

3) Vendor's information

- The necessary information concerning the Vendors, equipment shall be indicated.

11.2.5 Step 5, P&I diagram for construction

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

11.2.5.2 The P&I Diagram 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&I Diagrams;
- logic diagram of the main equipment;
- hydraulic of system;
- size of all piping, valves and instrumentation components;
- vendor's information.

11.2.5.3 Absolutely, required revisions after freezing of the P&I Diagram 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&I Diagram shall not be revised.

11.2.6 Step 6, P&I diagram as-built

11.2.6.1 The P&I Diagram as-built shall be prepared upon completion of the project for filing and submission to the Company. Since the P&I Diagram is intended for use in conducting operation

control, maintenance or revamping, therefore, the prepared drawing shall be entirely in conformily with the completed facilities.

11.2.6.2 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.

11.2.6.3 The specified piping and instrument take-off and branch points shall be observed as strictly as possible and shall be implemented on the P&I Diagram. 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.

11.3 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&I Diagram will be dependent on the type of contract with the Licenser and Contractor.

11.3.1 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.

11.3.1.1 Case 1, licenser prepares P&I diagram

The P&I Diagram supplied by the Licenser shall be equivalent to the "P&I Diagram 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&I Diagram, the Contractor shall establish the basic items for the preparation of the P&I Diagram as per Article 11.2.1 above and shall submit to the Company for approval. The Licenser should prepare the P&I Diagram based on the above mentioned items;
- based on the P&I Diagram and operational guides prepared by the Licenser, review shall be made with regard to operability, safety, conformity to design of the Unit, etc.;
- checking of the above-mentioned P&I Diagram against the basic items for preparing the P&IDs 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 Licenser. The Licenser should implement all necessary Contractor's engineering comments and issue the revised P&I Diagram;
- the following items of review shall be made by the Contractor on the revised P&I Diagram by the Licenser:
    - 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 Licenser's approval should be obtained on any revision which should be made during the execution of the abovementioned reviews by the Contractor, if it is expected to have an effect on the process performance.

11.3.1.2 Case 2, the contractor prepares P&I diagram

P&I Diagram 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&I Diagram shall be obtained from the Licenser;
- the prepared P&I Diagram shall be subject to the Licenser's review and approval.

11.3.2 Direct contract between company and licenser

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

11.3.2.1 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&I Diagram as mentioned in Article 11.2.1 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&I Diagram prepared by the Licenser;
- P&I Diagram prepared by the Licenser shall be checked against the above-mentioned finalized basic items and design philosophies;
- checking of P&I Diagram 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&I Diagram as required;
- upon the completion of the above-mentioned items, the required steps for preparation of the P&I Diagram as outlined in Section 11.2 of this Standard shall be followed to complete detailed design activities.

11.3.2.2 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&I Diagram preparation steps as stipulated in Section 11.2 of this Standard.

11.4 Revisions of P&I Diagram

11.4.1 General

Generally P&I Diagram 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&I Diagram;
- addition of information concerning vendors.

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

11.4.2 Revisions

The P&I Diagram 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&I Diagram the NPIC issued up to that time and information concerning vendors obtained up thereto shall be incorporated on the P&I Diagram.

11.4.3 NPIC

Issuance of Notification of P&I Diagram 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&I Diagram revisions;

- not accumulation of a large amount of additions/changes which should be incorporated on the new revisions of P&I Diagram.

11.5 Approval of P&I Diagram

a) Company's approval of the basic items for preparation of P&I Diagram (see Article 11.2.1 above) shall be obtained prior to commencement of the P&I Diagram preparation work.

b) The Company's approval at step 2 "P&I Diagram for engineering start" shall be obtained regardless of the cases that P&I Diagram is prepared by the Contractor or Licenser or both.

c) Where the P&I Diagram prepared by Licenser has been reviewed or verified in step 3 "P&I Diagram for piping layout" by the Contractor, Company's approval is needed before any official revision.

d) In general, Company's approval is required for any change, deletion and/or addition on the P&I Diagram through all steps of "preparation of P&I Diagram" as outlined in Article 11.2 above except step 6, "P&I Diagram as-built" mentioned in Article 11.2.6. above.

APPENDICES

APPENDIX A

ABBREVIATIONS/GRAPHICAL SYMBOLS/IDENTIFICATIONS

CONTENTS: **PAGE No.**

APPENDIX A

ABBREVIATIONS/GRAPHICAL SYMBOLS/IDENTIFICATIONS

A.1 Abbreviations

A.1.1 General

See IPS-E-PR-308, "Numbering System" for:

- instrumentation identifications;
- equipment abbreviations (codes);
- fluid abbreviations;
- painting, insulation and heat tracing designations.

See IPS-D-AR-010, "Abbreviations & Symbols for HVAC&R Drawings" and IPS-D-AR-011, "General Notes for HVAC & R System" for:

- Abbreviations & Symbols for HVAC & Refrigeration Systems.

See Appendix D of this Standard for:

- Utilities Identifications Table (Typical).

See Appendix E of this Standard for:

- Nozzles Identifications on Vessels, Reactors and Towers.

A.1.2 Drain / Sewer Symbols

AMN	Amine Drains
AY	Amine Drain Funnel
CAU	Caustic Sewer
CDB	Concrete Drain Box
DH	Closed Drain Header
CSW	Chemical Sewer
CY	Chemical Drain Pit
DC	Drain Connection
DP	Drain Pit
DWW	Desalter Waste Water
NSW	Non Oily Water Sewer
OPD	Open Drain
OSW	Oily Water Sewer
SSW	Sanitary Water Sewer
SWA	Stripped Sour Water
TY	Toxic Drain Funnel
WSW	Storm Water Sewer
Y	Drain Funnel (General)

(to be continued)

APPENDIX A (continued)

A.1.3 Letters at Individual Valves Designations

A	Monel Trim (grease sealed seat and packing)
B	Monel Valve (grease sealed seat and packing)
BV	Ball Valve
CAO	Close-Automatic-Open
CC	Cable Control
CO	Chain Operated
CHV	Check Valve
CSC	Car Sealed Closed
CSO	Car Sealed Open
D	Drain
FB	Full Bore
FC	Fail Close (closes on minimum signal to valve actuator)
FD	Flex Disc Valve
FL	Fail Locked
FLC	Fail Locked Closed: Valve position does not change on loss of actuating medium supply (closes on minimum signal to valve actuator)
FLO	Fail Locked Open: Valve position does not change on loss of actuating medium supply (open on minimum signal to valve actuator)
FO	Fail Open (opens on minimum signal to valve actuator)
FP	Full Port
GM	Gear Operated and Motorized Valve
GO	Gear Operated Valve
IAV	Acoustical Insulated Valve
IHV	Hot Insulated Valve
LC	Locked Close
LO	Locked Open
M	Monel Trim Valve (general)
MOV	Motorized Valve
MT	Monel Trim (teflon insert with grease sealed packing)
NC	Normally Closed
NO	Normally Open
NV	Needle Valve
OV	Operating Valve
PIVA	Post Indicator Valve
PSE	Rupture Disk Assembly (Pressure Safety Equipment)
PSV	Pressure Safety Relief Valve
P	Plugged
SR	Split Range
SS	Soft Seat Valve
SSV	Stainless Steel Valve
ST	Stellite Trim
T	Trap
TSO	Tight Shut-off Valve
V	Vent
WV	Warning Valve
WP(J)	Jacketed Plug Valve
X	Type 316 Stainless Steel Trim Valve

(to be continued)

APPENDIX A (continued)

XCV	Steam Trap with Integral Strainer
XV	Shut-off Valve
xx	18-8 Stainless Steel Trim Valve

A.1.4 Piping Abbreviations

CM	Chrome Moly
CS	Carbon Steel
DN	Diameter Nominal
FF	Flat Face
FS	Forged Steel
HB	Hammer Blind
LJ	Lap Joint
MI	Mallable Iron
PB	Pressure Blind
PN	Pressure Nominal
PTP	Pipe Tap Plugged
RF	Raised Face
RS	Removable Spool
RSP	Ring Spacer
RTJ	Ring Type Joint
SF	Socket Weld Line Blind with Flexitallic Gaskets
SB	Spectacle Blind
SPB	Spade Blind
SO	Slip on
SS	Stainless Steel
ST(W)	Steam Trap (Winterizing)
ST(H)	Steam Trap (Heat Conservation)
SV	Socket Weld Line Blind with Viton Gaskets
SW	Socket Weld
VB	Vapor Blind
WN	Weld Neck

A.1.5 Miscellaneous Designations

AG	Above Ground
BL	Battery Limit
COF	Center of Float
DCS	Distributed Control System
F	Furnished
RO	Restriction Orifice
F&P	Furnished & Piped
HCB	Hydrocarbon
HCH	Hydrocarbon with Hydrogen
HHLL	High High Liquid Level
HIL	High Interface Liquid Level
HLL	High Liquid Level
LF	Liquid Foam
LG	Level Gage

(to be continued)

APPENDIX A (continued)

LIL	Low Interface Liquid Level
LLL	Low Liquid Level
LLLL	Low Low Liquid Level
LSHH	Level Switch High High
LSLL	Level Switch Low Low
MW	Manway
NIL	Normal Interface Liquid Level
NLL	Normal Liquid Level
P	Pressure
PB	Push Bottom
PFD	Process Flow Diagram
PG	Pressure Gage
PI	Pressure Indicator
P&ID	Piping & Instrumentation Diagram
PO	Pump Out
PT	Pressure Test Connection
RES	Residue
RG	Refrigerant Gas
RL	Refrigerant Liquid
RO	Restriction Orifice
RS	Remote Setpoint
RTD	Resistance Temperature Detector
RVP	Reid Vapor Pressure
SC	Sample Connection
SCL	Sample Cooler
SG	Sight Glass
SF	Solution Foam
SP	Set Point
SP.GR.	Relative Mass Density (Specific Gravity)
STO	Steam Out
TI	Temperature Indicator
T/T	Tangent to Tangent
TW	Thermo-Well
UFD	Utility Flow Diagram
UG	Under Ground
VB	Vortex Breaker

A.1.6 Utility Services Abbreviations

BFW	Boiler Feed Water
CLW	Chlorinated Water
COC	Cold Condensate
CW	Cooling Water
CWR	Cooling Water Return
CWS	Cooling Water Supply
DMW	Demineralized Water
DSW	Desalinarted Water
DWA	Drinking Water
FLG	Fuel Gas
FLR	Flare Discharge

(to be continued)

APPENDIX A (continued)

FOR	Fuel Oil Return
FOS	Fuel Oil Supply
FWA	Fire Water
HBW	High Pressure Boiler Feed Water
HPC	High Pressure Condensate
HPS	High Pressure Steam
ISA	Instrument Air
LLPS	Low Low Pressure Steam
LPC	Low Pressure Condensate
LPS	Low Pressure Steam
MBW	Medium Pressure Boiler Feed Water
MPC	Medium Pressure Condensate
MPS	Medium Pressure Steam
NG	Natural Gas
NIT	Nitrogen
PLA	Plant Air
PTW	Potable Water
PWA	Plant Water(service water)
QHW	Quench Water
RFO	Refinery Fuel Oil
RFW	Refrigerated water
RWA	Raw Water
SWA	Sour Water
TWA	Treated Water
WAT	Water

A.2 Graphical Symbols

A.2.1 Instrumentation

A.2.1.1 Instrument line symbols

ISA-S5.1 (latest revision) section 6.2 shall be used with the following amendments:

- **Electric Signal**
- **Electric Binary Signal**
- **Pneumatic Signal Line**
- **Heat Traced Line**
- **Steam Jacketed Line**

The following abbreviations shall be used to denote the types of power supply. These designations may also be applied to purge fluid supplies:

AS	Air Supply - ISA Instrument Air - PLA Plant Air
ES	Electric Supply
GS	Gas Supply

(to be continued)

APPENDIX A (continued)

HS Hydraulic Supply

NS Nitrogen Supply

SS Steam Supply

WS Water Supply

The supply level may be added to the instrument supply line, e.g., ISA-600 "a 600 kPa instrument air supply; ES-24 VDC " a 24-volt direct current power supply".

A.2.1.2 Interlock logic symbols

symbol	description
or — or	output exists if one or more input exists
and — and	output exists if and only if all the input exists
not — not	no output exists if one and only one input exists
td —	time delay output exists after preset time
xor — exclusive	output exists if one and only one input exists
▷ —	sequential logic control connection

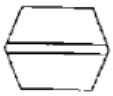
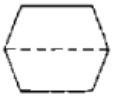
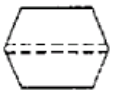
(to be continued)

APPENDIX A (continued)

A.2.1.3 Programmable logic controller (PLC) function symbols

symbol	description
	field mounted PLC integral to DCS not normally accessible to operator
	control mounted PLC integral to DCS not normally accessible to operator
	control board mounted axuiliary location normally accessible to operator
	behind of control board not normally accessible to operator
	behind of control board axuiliary location not normally accessible to operator

A.2.1.4 Computer (data storage) function symbols

symbol	description
	field mounted instrument not normally accessible to operator
	panel mounted instrument normally accessible to operator
	local panel mounted instrument normally accessible to operator
	instrument mounted behind control panel in control room
	instrument mounted behind local panel

(to be continued)

APPENDIX A (continued)

A.2.1.5 Distributed control/shared display symbols

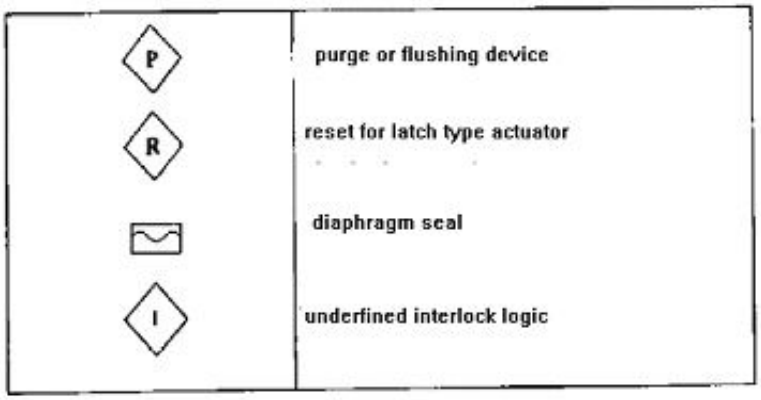
symbol	description
	field mounted instrument (not normally accessible to operator)
	indicator/controller/alarm (normally accessible to operator)
	auxiliary oparetors interface device

A.2.1.6 General instrument or function symbols

SYMBOL	DESCRIPTION
	field mounted instrument
	panel mounted instrument
	inrtrument mounted behind control panel incontrol room
	local panel mounted insrument
	instrument mounted behind local panel
	instrument sharing common housing with two function
	steam traced instrument
	electeric traced instrument
	light (color R=RED G=GREEN)
	valve position indicasting lamps

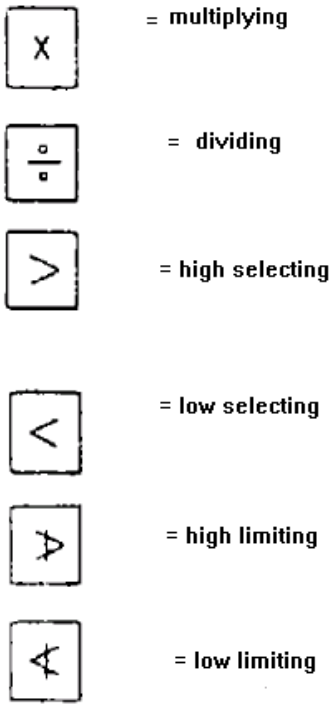
(to be continued)

APPENDIX A (continued)



Note:
1) For specific logic symbols, see ANSI/ISA standard S5.2.
A.2.1.7 Function identification (Note 1)

Refer to list below for identification (Note 2):



(to be continued)

APPENDIX A (continued)

= Time function

= nonliner or unspecified function

= summing

= averaging

= root extraction

= exponential

= derivative

= integral

= pneumatic to current

= current to pneu matic

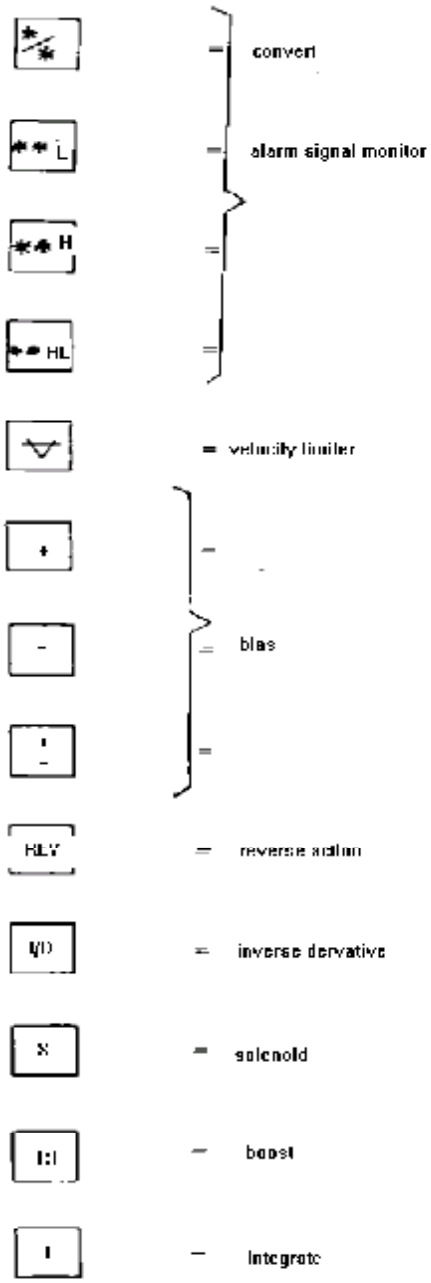
= proportial

= reverse proportional

= difference

(to be continued)

APPENDIX A (continued)



(to be continued)

APPENDIX A (continued)

 = gain 1:3 or 2:1 (tyoical)

 = on/off

 = analog/digital

 = (for input/ output see the following)

DESIGNATION	SIGNAL
E	VOLTAGE
I	CURRENT
H	HYDRAULIC
O	ELECTEOMAGNETIC
P	PNEUMATC
R	RESISTANCE
MV	MILIVPLTS
A	ANALPG
D	DIGITAL

Notes:

1) The function designations associated with controllers, computing devices, converters and relays may be used individually or in combination (also, see Table 1, Note 14 of ISA-S5.1). The use of a box avoids confusion by setting off the symbol from other markings on a diagram and permits the function to be used as a stand-alone block on conceptual designs.

2) See ISA-S5.1, Table 3 for math equation, graphic representation and definition.

A.2.1.8 Control valve body and damper symbols

Reference to be made to article 6.4 of ISA-S5.1 with the following additions:

A.2.1.9 Symbols for self-actuated regulators, valves, and other devices

See article 6.6 of ISA-S5.1.

(to be continued)

APPENDIX A (continued)

A.2.1.10 Symbols for actuator action in event of actuator power failure

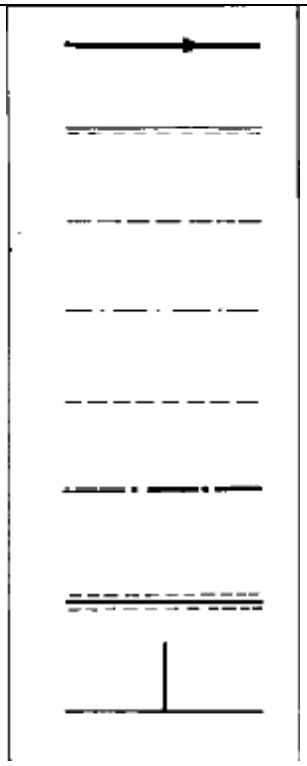
See article 6.7 of ISA-S5.1.

A.2.1.11 Primary element symbols

See article 6.8 of ISA S5.1

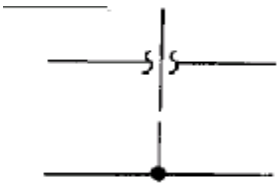
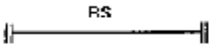
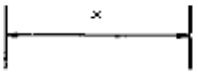
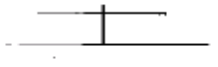
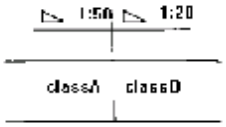
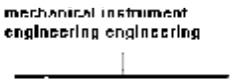
A.2.2 Piping and Miscellaneous

A.2.2.1 General

SYMBOL	DESCRIPTION
	Main process line (arrow of 30 ° indicates Direction of fluid flow)
	Heat traced pipe line
	Underground pipeline
	Existing line
	Future line
	Vendor package
	Jackated or double containment pipeline
	Line crossing (connected)

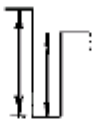
(to be continued)

APPENDIX A (continued)

	**Line crossing (unconnected)**
	Lines junction
	**Dripe funnel**
	**Platform**
	**Removable spoolpice**
	**Minimum distance**
	**Indication of point of change:**
	a)change in sloop
	**b) change in piping claass**
	c)change in responsibility

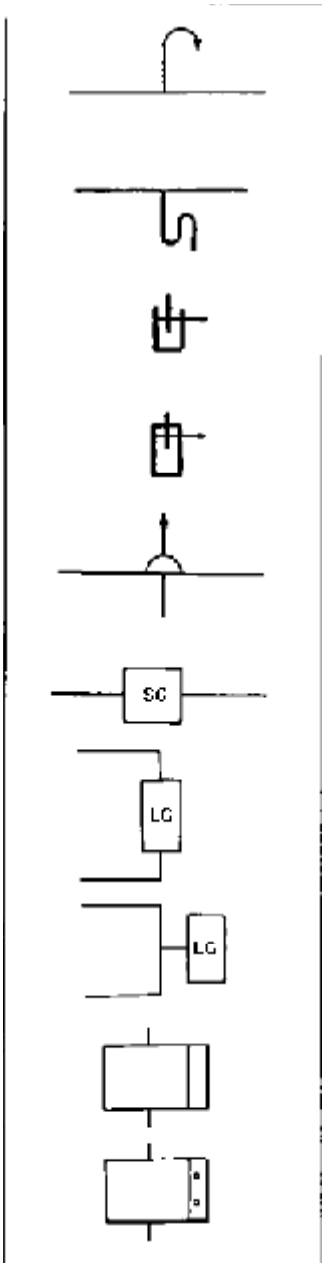
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Outlet to the atmosphere for steam / gas
	Flow / motion in diraction of arrow
	Arrow for inlet or outlet of essential substances
	Slope
	Level reference
	Limit , general
	Contractor/ vendor
	Battery limit
	Hood , general
	Distribution device for fluids , spray nozzle
	Siphon with dip length

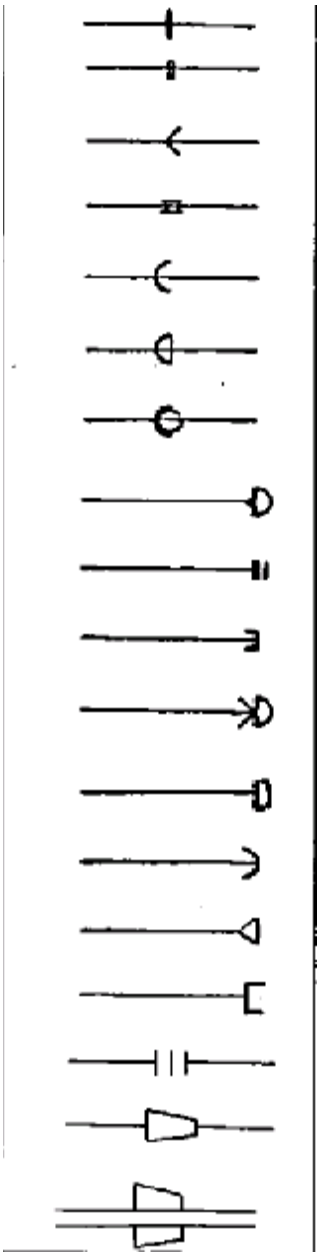
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Open vent
	Syphon drain(seal leg)
	Liquid seal, oen
	Liquid seal ,closed
	Butsting disc
	Sight glass
	Level gage
	Level gage on standpipe
	Level gage magnetic float type
	Level gage bull eye type

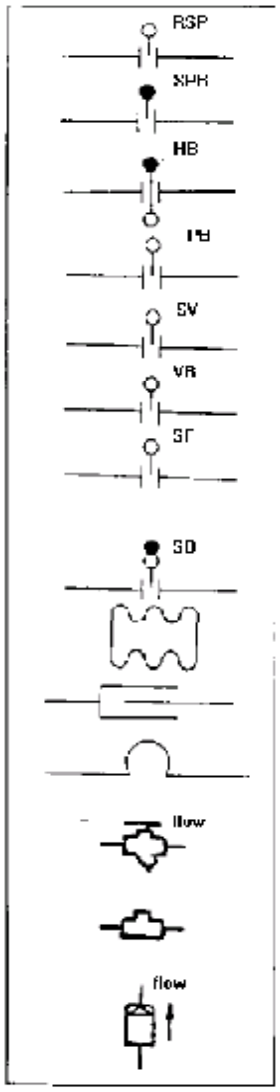
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Butt welded joint
	Flanged joint
	Screwed joint (arrow : 90 °)
	Socket welded joint
	Socket and spigot joint
	Compression joint
	Swivel joint
	End cap ,but welded
	End flanged and bolted
	End cap ,fillet welded (socket)
	End cap ,screwed (arrow:90 °)
	End closure, quick release
	End socket and spigot
	End screwed and plugged
	Quick coupling (hose connection)
	Union
	Concentric reducer
	Eccentric reducer (flush bottom)
	Eccentric reducer (flush top)

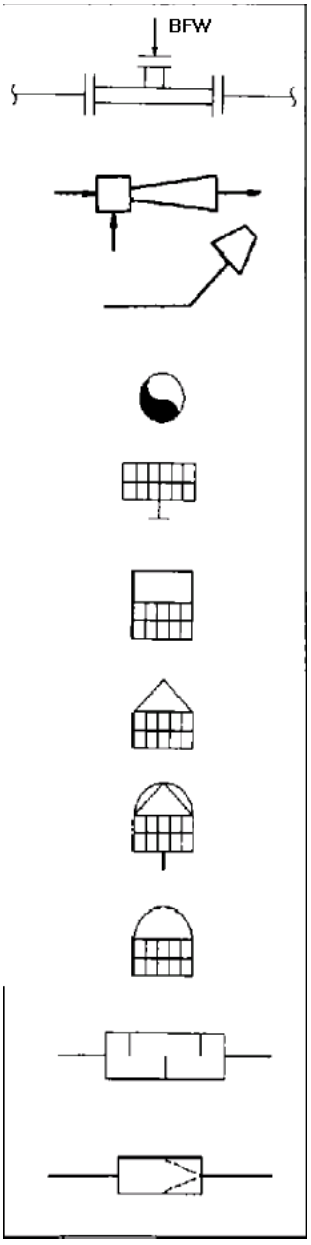
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	**Ring spacer** **Spade blind** **Hammer blind** **Pressure blind in welded line** **Standard socket weld line blind union W/viton gaskets** **6 mm thick blind to blank off equipment (vapor blind)** **standard socket weld line blind union W/flexitallic gaskets** **spectacle blind (normally open)** **expansion bellow** **sleeve extension** **expansion loop** **steam trap with built-in strainer (thermostatic or thermodynamic type)** **steam trap without built-in strainer (thermostatic or thermodynamic type)** **steam trap with integral check valve (bucket type)**

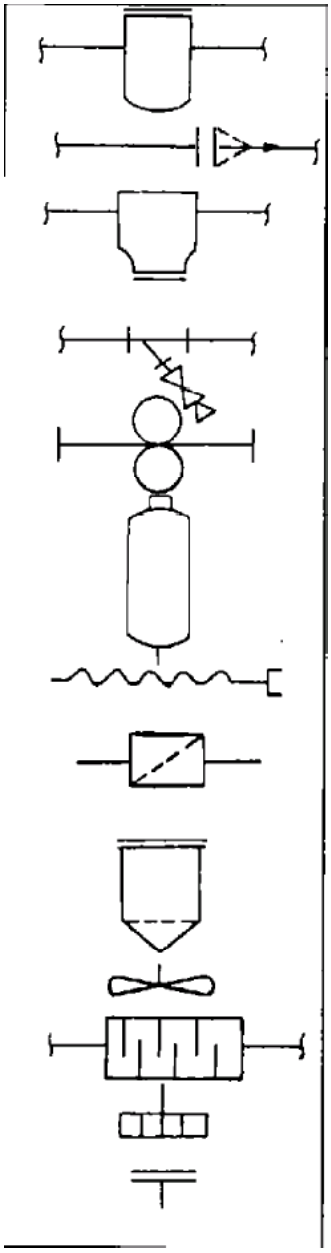
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	**Desuperheater**
	Ejector
	Jet mixer
	Ring header
	Flame arrestor (general)
	Explosion-proof flame arrestor (explosion comes From the side of the rectangular)
	Detonation –proof flame arrestor
	Fire –resistant detonation –proof flame arrestor with Outlet to the atmosphere
	Fire_ resistance flame arrestor
	Silencer
	Filter for compressor

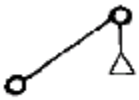
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Bucket (basket)type strainer Temporary strainer (cone type) T-type strainer Y- type strainer (with valved drain) Duplex strainer Pulsation dampener Flexible hose with quick coupling Filter (general) Cartridge type filter Propeller mixer In –line mixer (static) Turbine mixer Nozzle (blinded off)

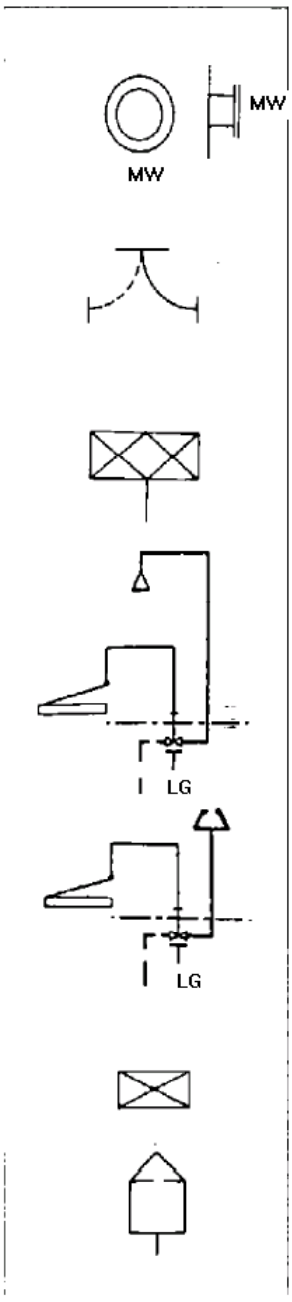
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Loading arm (basic symbol)
	Pull bo % fire alarm (alarm button)
	Hydrocarbon detector
	Halon protected area
	Portable extinguisher
	Wheeled extinguisher
	Foam sylinder (s)
	Foam chamber
	Insulation on equipment
	Spray

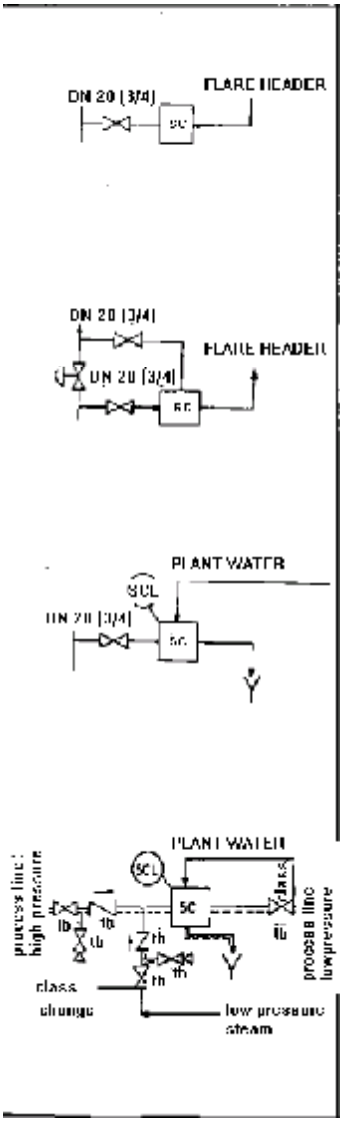
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	**Manway** **Swing elbo** **Breather** **Emergency (safety) shower equipped with no freezing drain valve** **Eyewasher equiped with no freezing drain valve** **Vortexx breaker** **Exhaust head**

(to be continued)

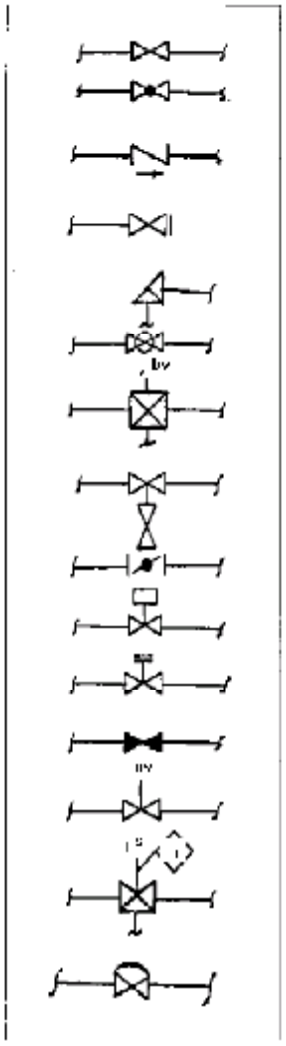
APPENDIX A (continued)

SYMBOL	DESCRIPTION
	**Sample connection (non toxic gas), see Appendix H for details (type 1)** **Sample connection (toxic gas or light liquid (PVC $\rangle$ 34.5 Kpa) ,see appendix H for details , (type 2)** **sample connection [hot oil & low pour point pour point $\langle$ A $^{\circ}C$),where A is determinded in the execution of basic design phase for each project].** **Sample connection [hot oil & high pour point (pour point $\rangle$ A $^{\circ}C$),where A is determinded in the execution of basic design phase for each project].**

(to be continued)

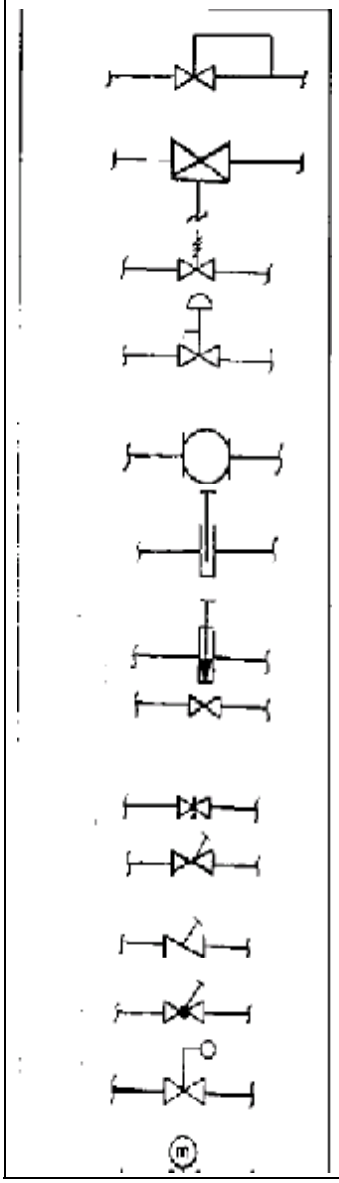
APPENDIX A (continued)

A.2.2.2 Symbols for manually operated and miscellaneous valves and monitors

SYMBOL	DESCRIPTION
	Gate valve (basic symbol) Globe valve Check valve (general) Gate valve behind off Angle valve Ball valve Fourway valve Gate valve with body bleed Butterfly valve Hydraulic control Metering cock Needle valve Plug valve S=solenoid valve R= Manual reset when indicated Diaphragm valve

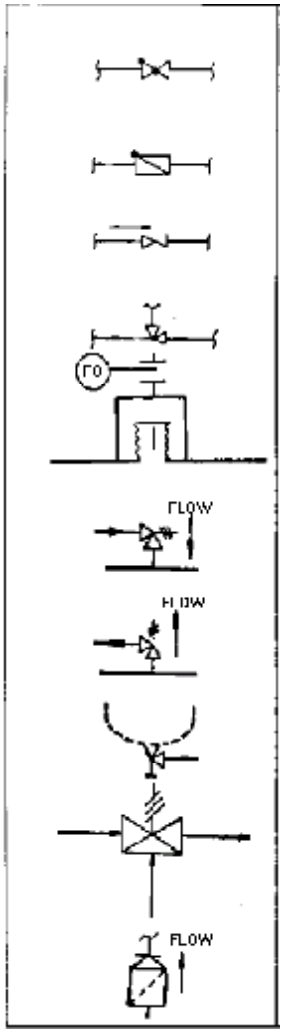
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Self contained regulator Treeway valve Spring loading valve Control valve with handweel Rotary valve Slide valve Knife valve Post indicator valve Piston valve Y- type below down valve Y-type stop check valve Y-type globe valve Float valve Motor operated valve

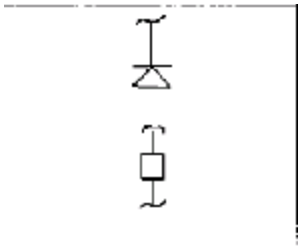
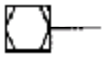
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Lift check valve
	Swing check valve
	Stop check
	Stop check , non -return valve
	Trip valve (low lube oil ppressure)
	Relief valve (angle ,vaccum)
	Relief valve (angle ,pressure)
	Flush bottom valve
	Pressure/ vacum valve
	Foot valve with strainer

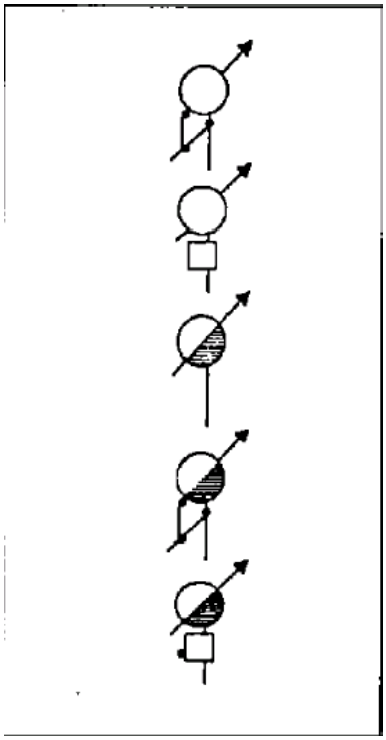
(to be continued)

APPENDIX A (continued)

SYMBOL	DESCRIPTION
	Foot valve
	Self draining valve
	Fire hydrant
	Fire hydrant with monitor
	Deluge valve
	Fire monitor
	Hydrant with water / foam monitor
	Yard hy drant
	Hose reel
	Hose house
	

(to be continued)

APPENDIX A (continued)

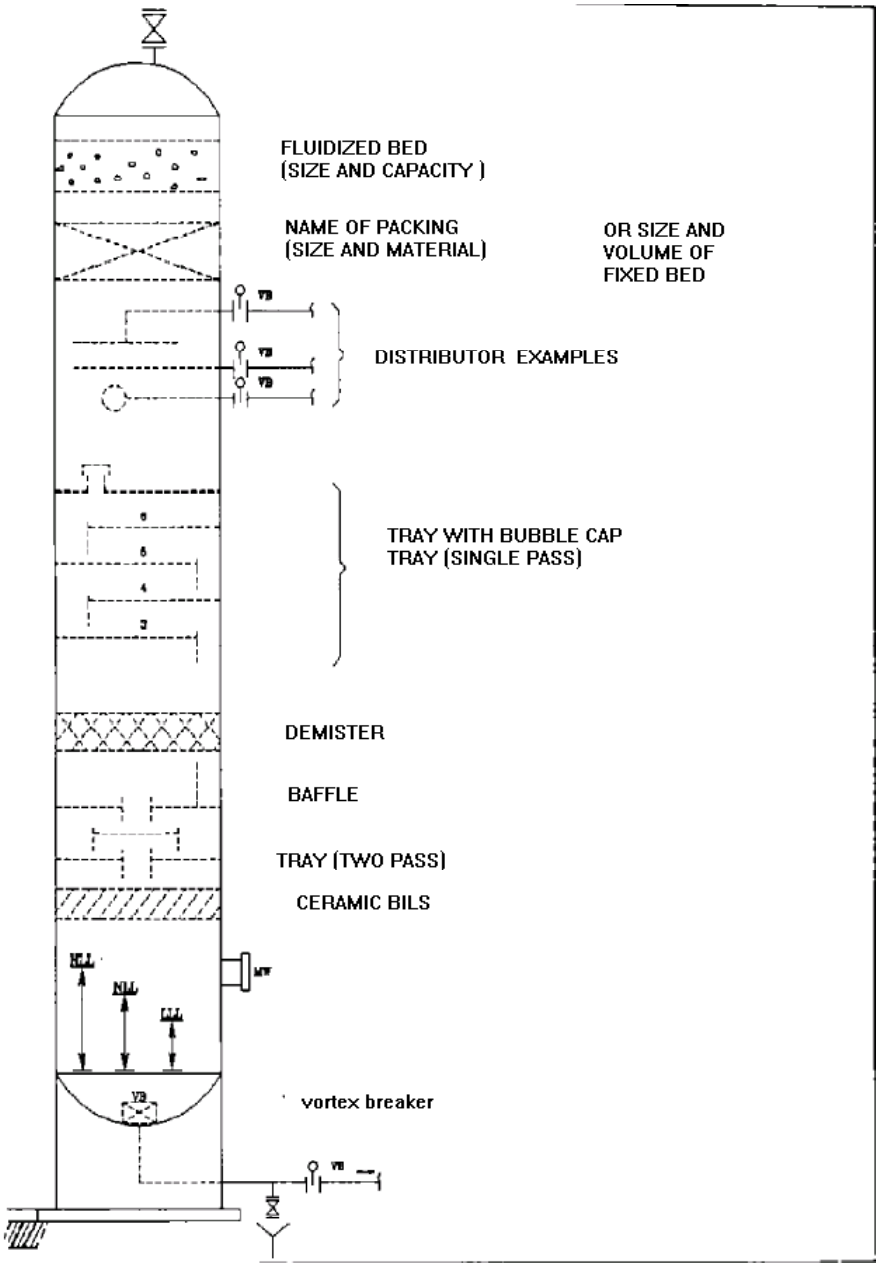
SYMBOL	DESCRIPTION
	Elevated fire monitor Remote fire monitor Foam monitor Elevated foam monitor Remote foam monitor

(to be continued)

APPENDIX A (continued)

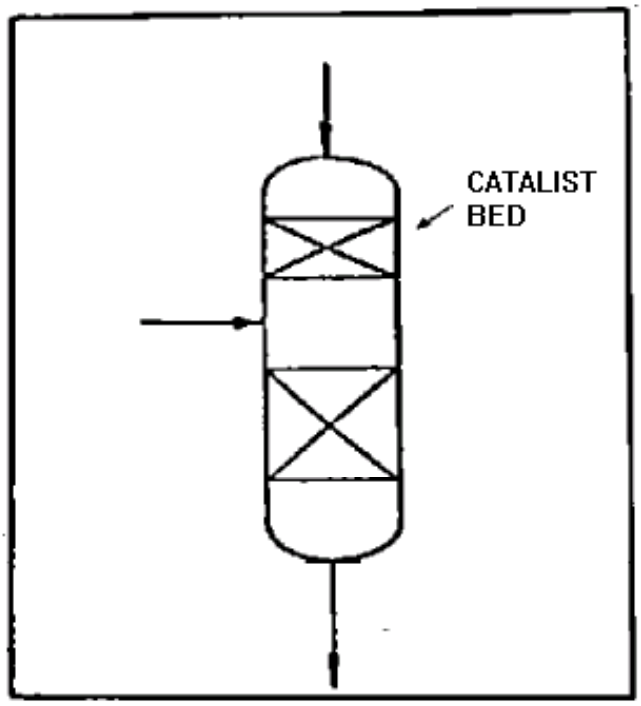
A.2.3 Equipment

A.2.3.1 Tower, column, vessel and reactor



(to be continued)

APPENDIX A (continued)

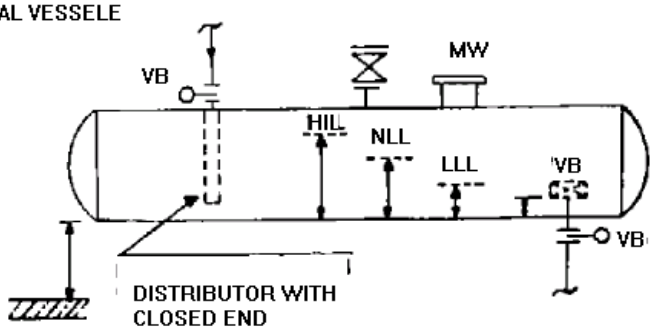


REACTOR

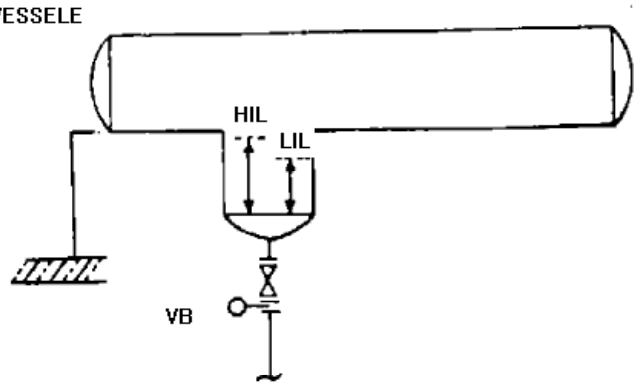
(to be continued)

APPENDIX.A (continued)

A.2.3.1.2 HORIZONTAL VESSELE



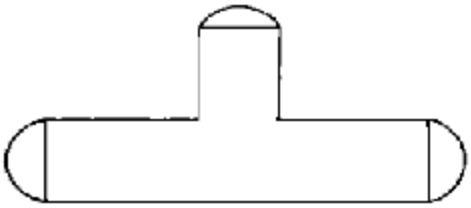
(A) HORIZONTAL VESSELE



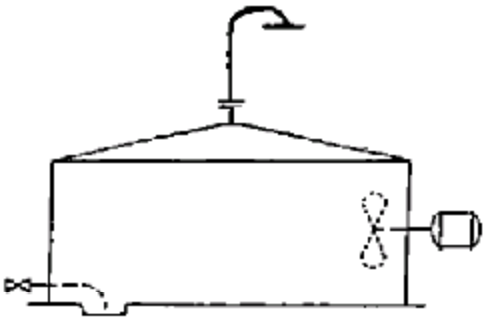
B) HORIZONTAL VESSELE WITH BOOT

(to be continued)

APPENDIX A (continued)



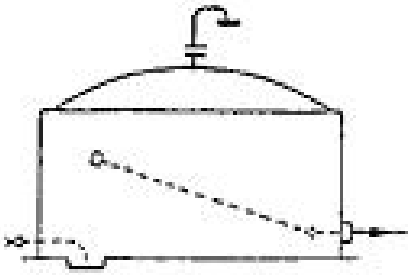
OPEN VENT WITH SCREEN



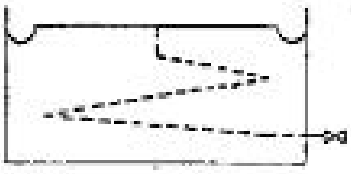
(to be continued)

APPENDIX A (continued)

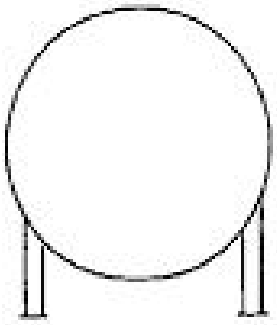
A.2.3.2 Strorage tanks



DOME ROOF
WITH SWING PIPE FLOAT TYPE



FLOATING ROOF



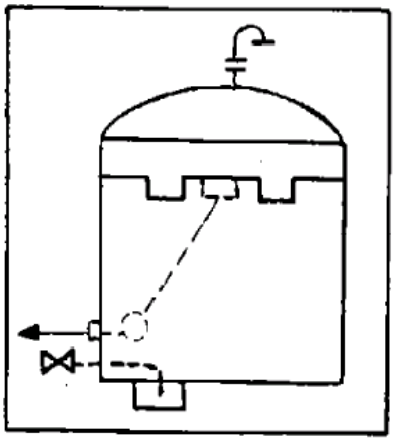
SPHERE

Note:

All tanks and spheres on each flow diagram are to be shown in Approximate relative size to each other.

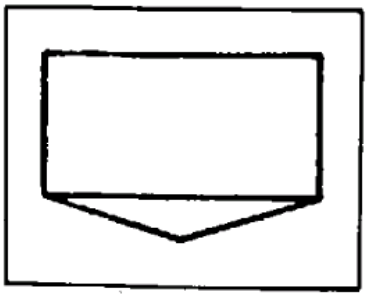
(to be continued)

APPENDIX A (continued)

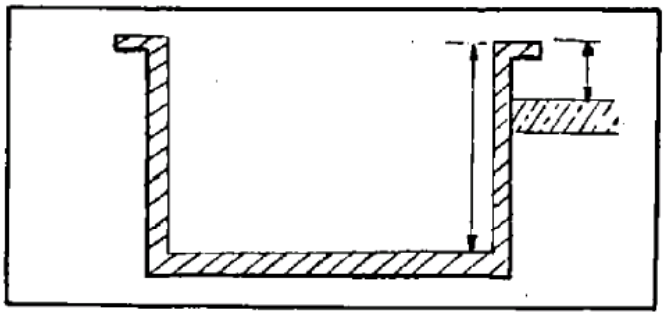


INTERNAL (COVERED) FLOATING ROOF TANK

WITH SWING SUCTION PIPE FLOAT TYPE



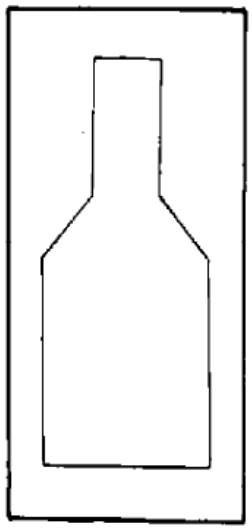
CONICAL BOTTOM TANK



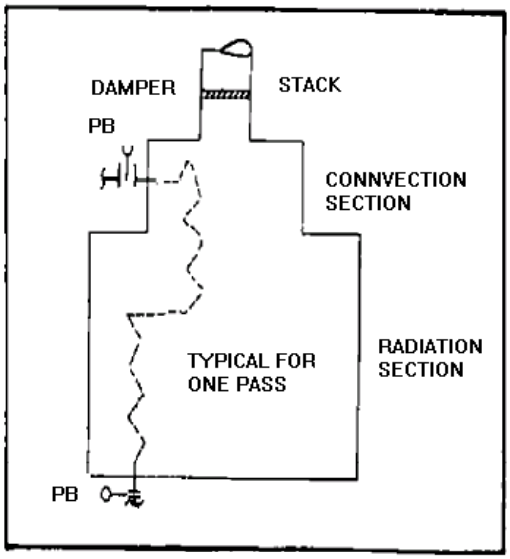
CONCRETE SUMP

(to be continued)

A.2.3.3 Heaters, exchangers, air coolers and water coolers



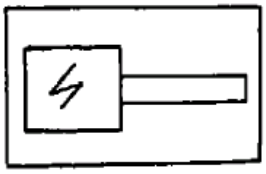
A) FURANCE (BASIC SYMBOL)



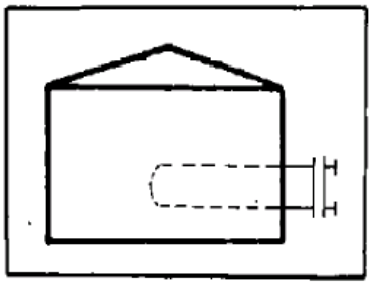
B) FIRED HEATER (BOX OR CYLINDERICAL TYPE) WITH COVECTION SECTION

(to be continued)

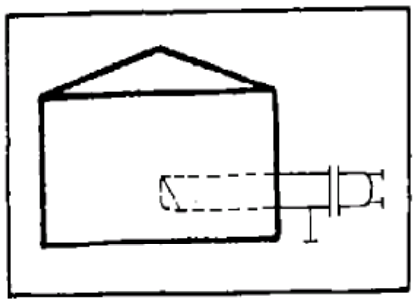
APPENDIX A (continued)

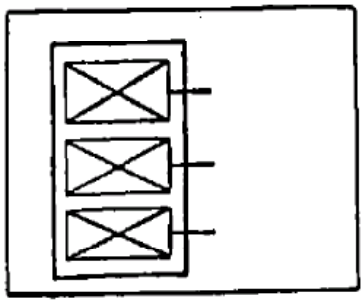


C) ELECTERICAL HEATER



D) TANK HEATER

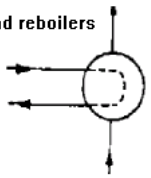




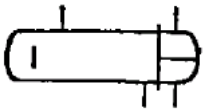
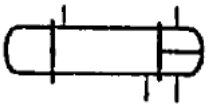
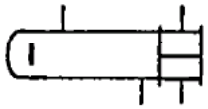
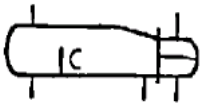
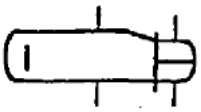
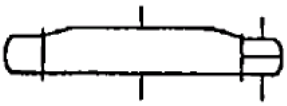
(to be continued)

APPENDIX A (continued)

A.2.3.3.2 exchangers water coolers and reboilers

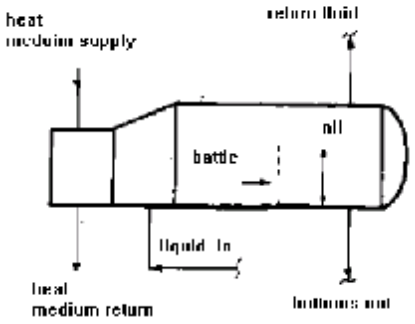


shell and tube heat exchanger(basic symbol)

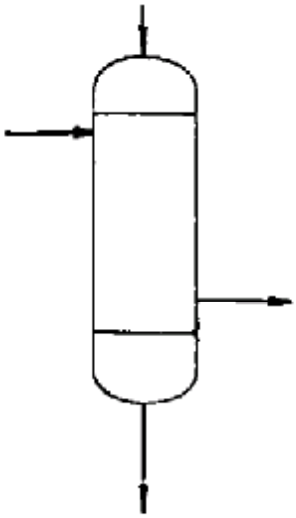
	heat exchanger/cooler/condenser with floating head
	heat exchanger/cooler/condenser u tube
	heat exchanger/cooler/condenser fixed tube sheet
	cooler/ condenser with floating head and cover plate
	horizontal reboiler fixed tube sheet
	kettle type rebioler u-tube
	kettle type vaporizer floating head
	kettle type vaporizer fixed tube sheet

(to be continued)

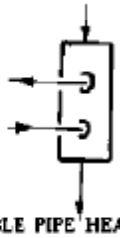
APPENDIX A (continued)



kettle type reboiler u tube type (general configuration)



vertical shell_tube heat exchanger (general)
the configuration shall be consistent with actual exchanger head type

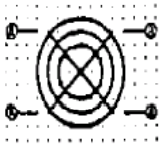


DOUBLE PIPE HEAT EXCHANGER

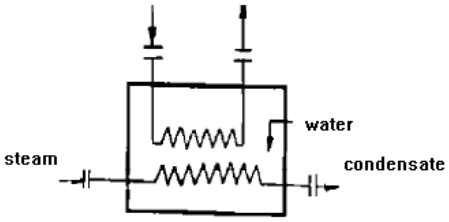
(to be continued)

APPENDIX A (continued)

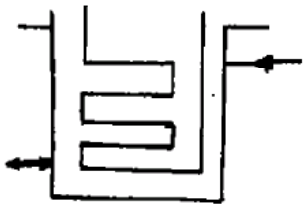
plate tyoe heat exchanger



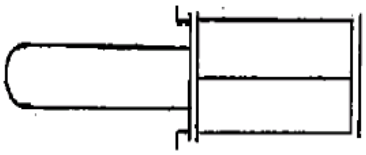
spiral type heat exchanger



vaporizer



box cooler

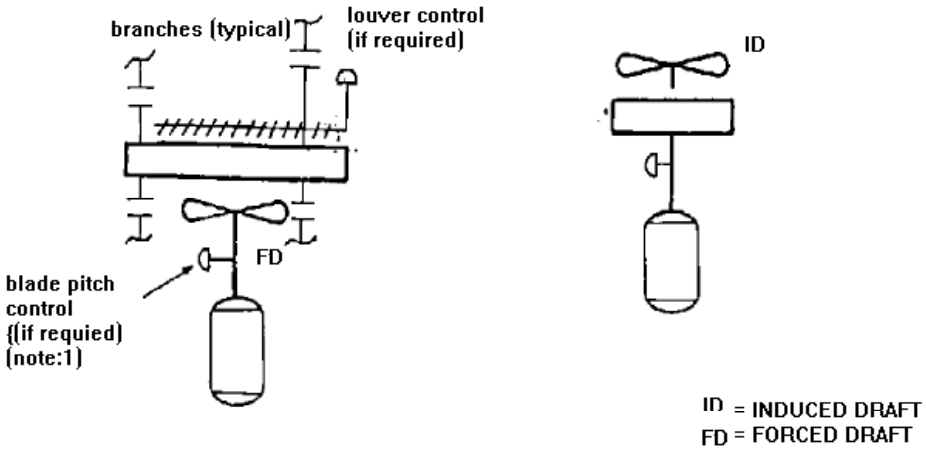


stab in heat exchanger

(to be continued)

APPENDIX A (continued)

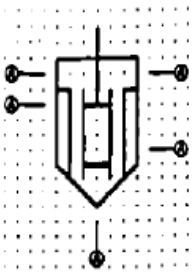
A.2.3.3.3 Air coolers



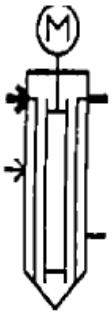
Note:

1) Indicate percentage of fans with automatic-variable pitch.

A.2.3.3.4 Film evaporator



film evaporator



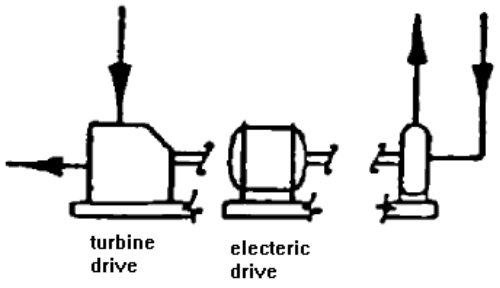
film evaporator with electric motor

(to be continued)

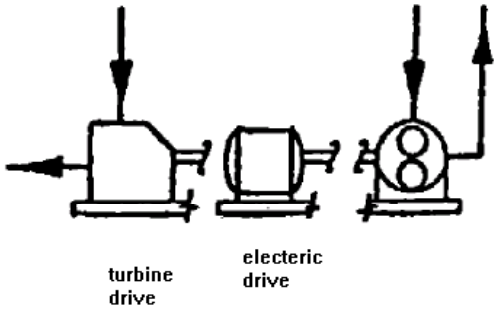
APPENDIX A (continued)

A.2.3.4 Machinery

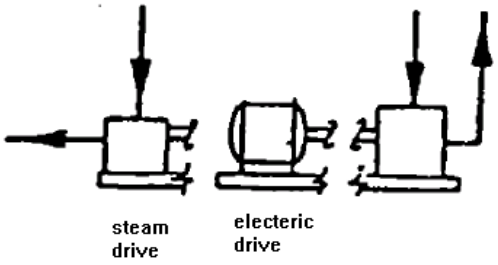
A.2.3.4.1 Pumps



centrifugal pump



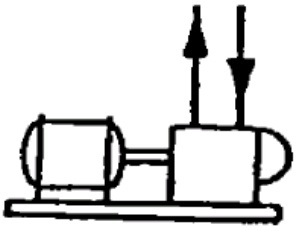
rotary pump (gear pump)



reciprocating pump

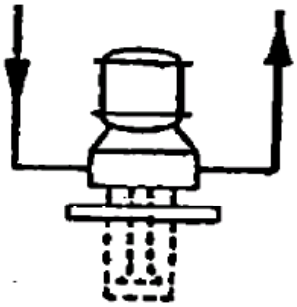
(to be continued)

APPENDIX A (continued)



multi stage or high pressure pump
(barrel type)

centrifugal in line pump

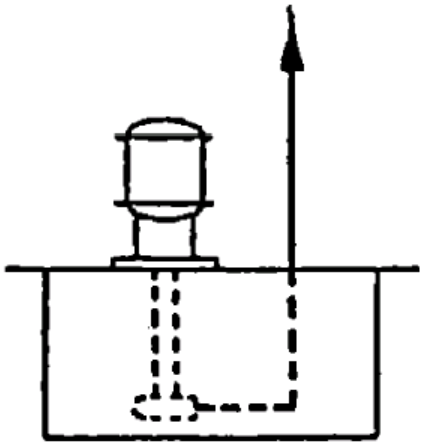


vertical can centrifugal pump

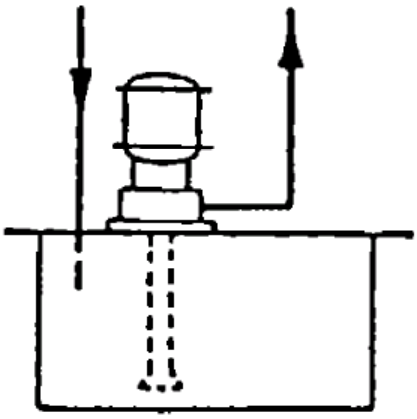
deep well pump

(to be continued)

APPENDIX A (continued)



SUMP PUMP (FOR CORROSIVE SERVICE)



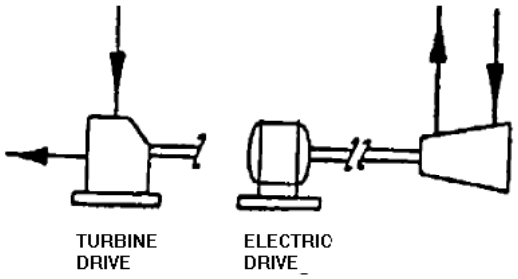
WET PIT SUMP PUMP

(FOR NON-CORROSIVE SERVICE)

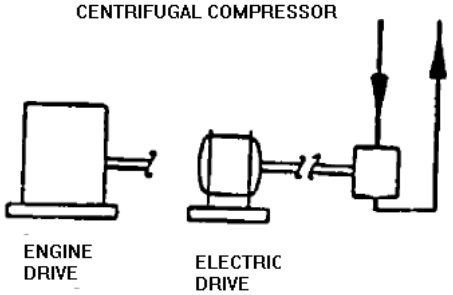
(to be continued)

APPENDIX A (continued)

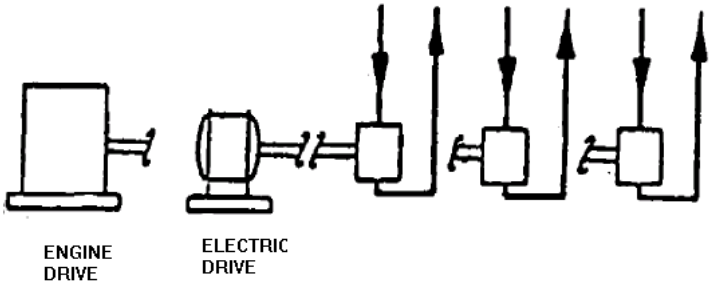
A.2.3.4.2 Compressors and fans



CENTRIFUGAL COMPRESSOR



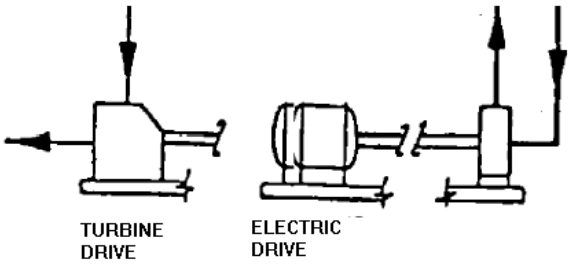
RECIPROCATING COMPRESSOR (SINGLE STAGE)



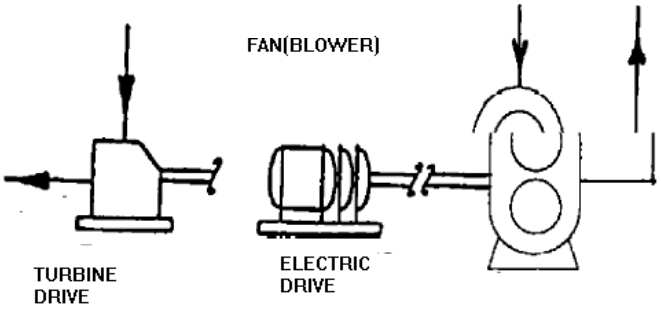
RECIPROCATING COMPRESSOR (MULTIPLE STAGE)

(to be continued)

APPENDIX A (continued)



FAN(BLOWER)



ROTARY COMPRESSOR

A.2.3.4.3 GENERAL SYMBOLS FOR DRIVERS

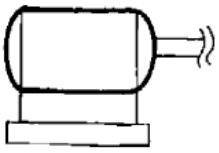
ELECTRIC MOTOR GENERAL

COMBUSTION ENGINE

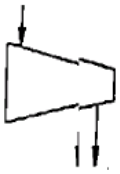
GEAR BOX

DISEL MOTOR

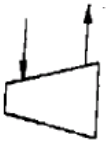
GAS TURBINE MOTOR



ELECTRIC DRIVE



TURBINE (BASIC SYMBOL)



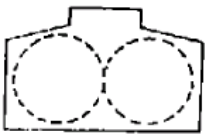
EXPANDER

(to be continued)

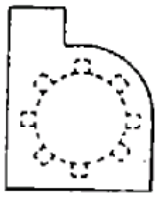
APPENDIX A (continued)

A.2.3.5 Miscellaneous mechanical equipment

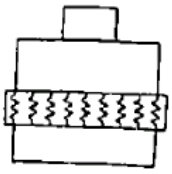
A.2.3.5.1 Crusher



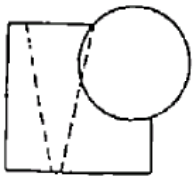
ROLL CRUSHER



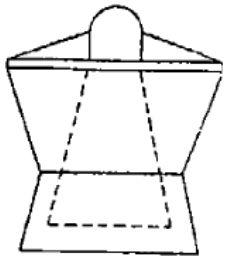
HAMMERMILL CRUSHER



CONE CRUSHER



JAW CRUCHER

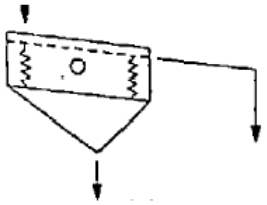


GYRATORY CRUSHER

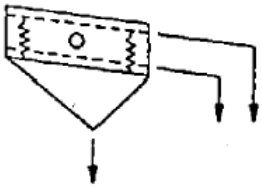
(to be continued)

APPENDIX A (continued)

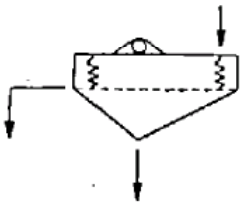
A.2.3.5.2 Screen



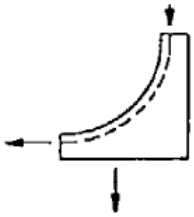
INCLINED SINGLE DECK VIBRATING SCREEN



INCLINED DOUBLE DECK VIBRATING SCREEN



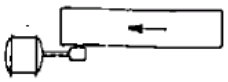
HORIZONTAL SINGLE DECK VIBRATING SCREEN



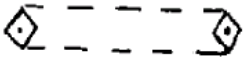
SLEVE BEND

(to be continued)

APPENDIX A (continued)

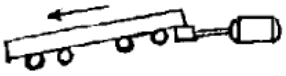


BELT CONVEYOR



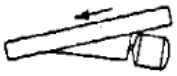
CHAIN CONVEYOR GENERAL

ROLLER GRAVITY CONVEYOR



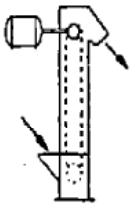
ROLLER MOTORIZED CONVEYOR

CUUTE OR TROUGH GRAVITY CONVEYOR

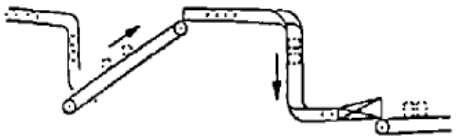


VIBRATOR OR SHAKER CONVEYOR

BELT ELEVATOR CONVEYOR



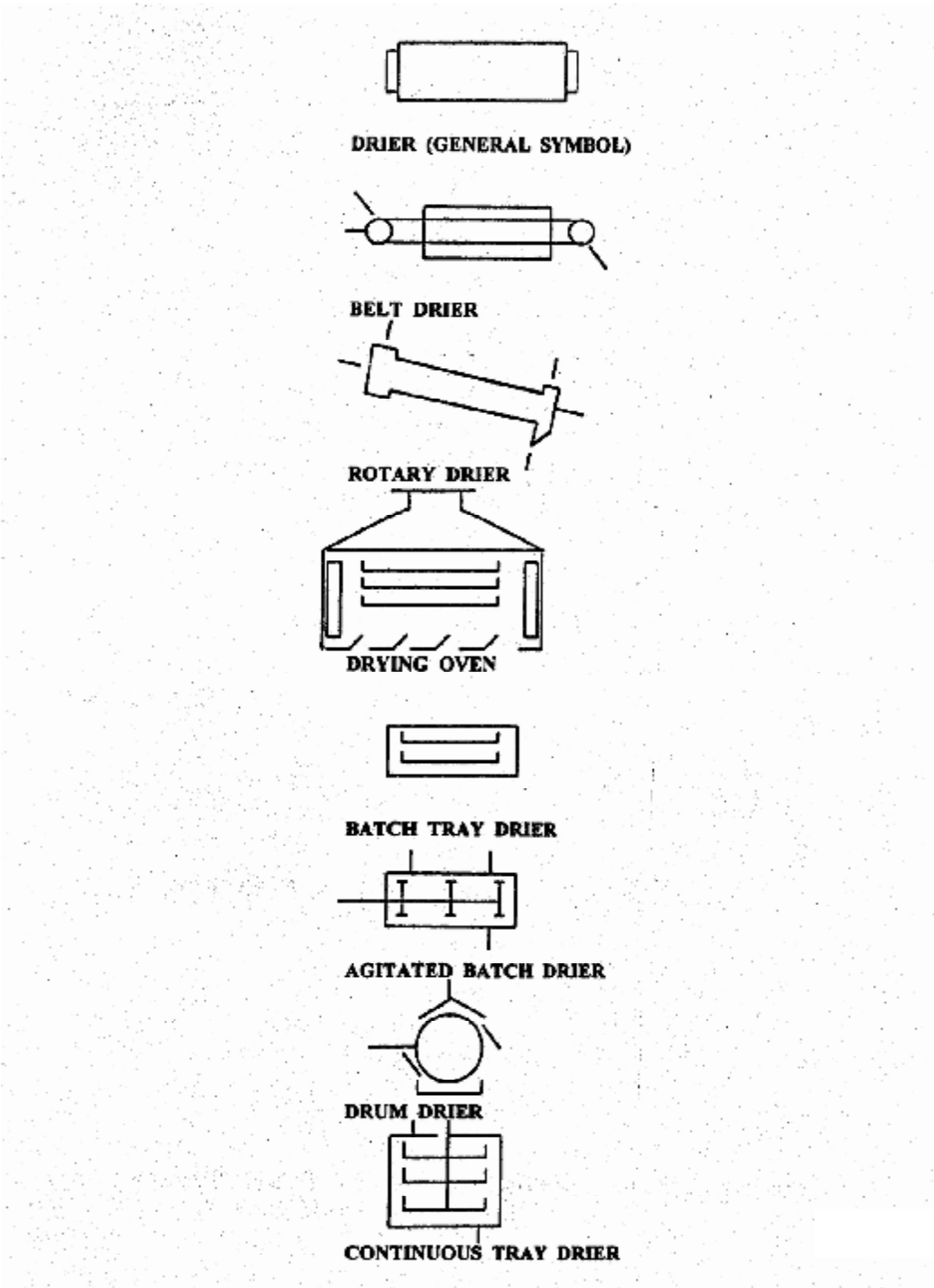
BUCKET ELEVATOR CONVEYOR



(to be continued)

APPENDIX A (continued)

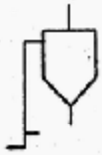
A.2.3.5.4 Drier



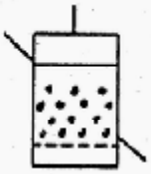
(to be continued)

APPENDIX A (continued)

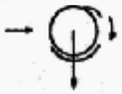
SPRAY DRIER



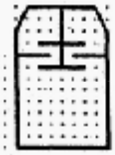
FLASH DRIER



FLUID BED DRIER

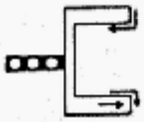


FILM DRIER, ROTARY FILTER OR FLAKER



DISK DRIER, MOVING SHELF DRIER, TURBODRIER

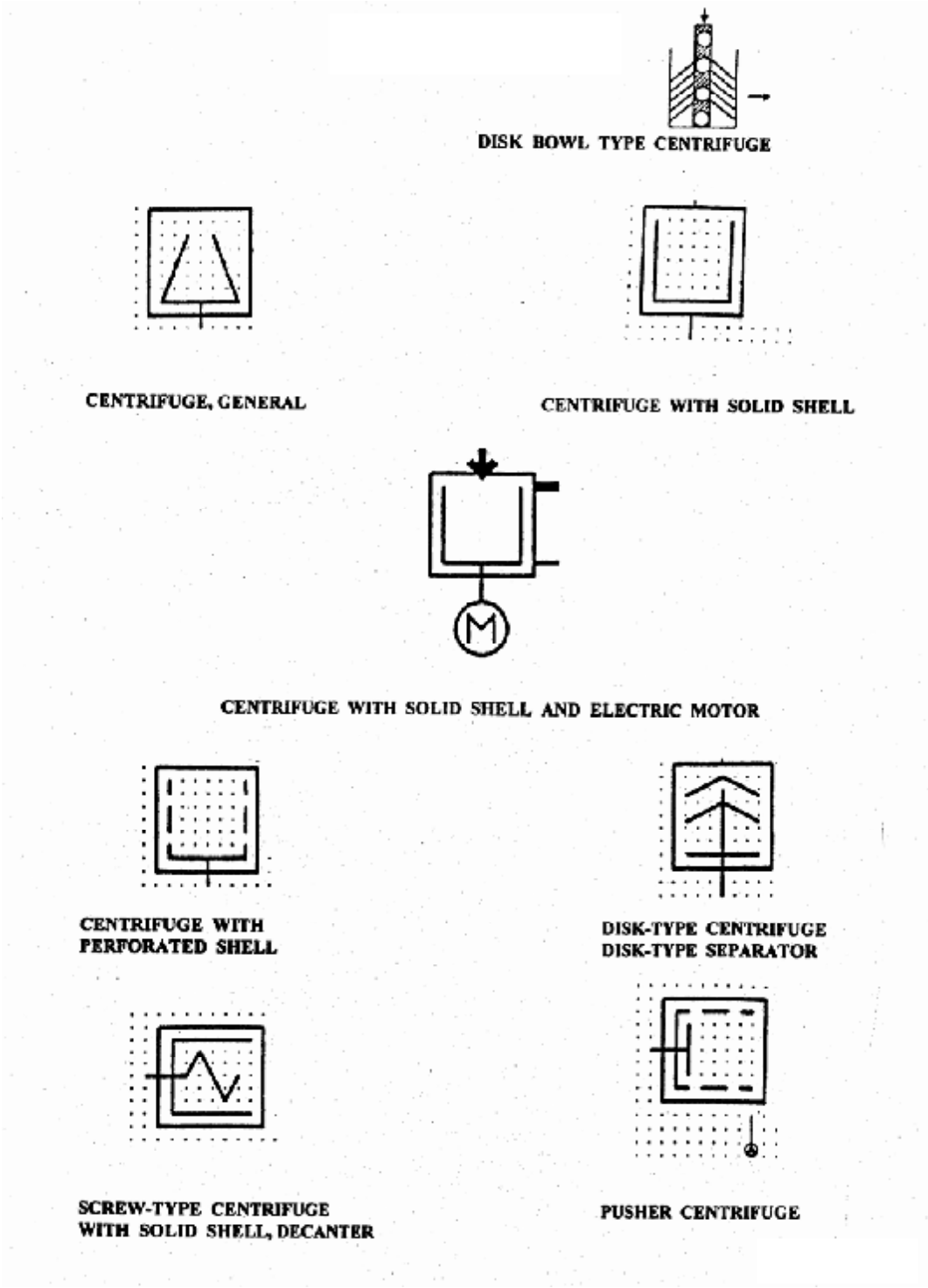
A.2.3.5.5 Centrifuge



HORIZONTAL PEELER TYPE CENTRIFUGE

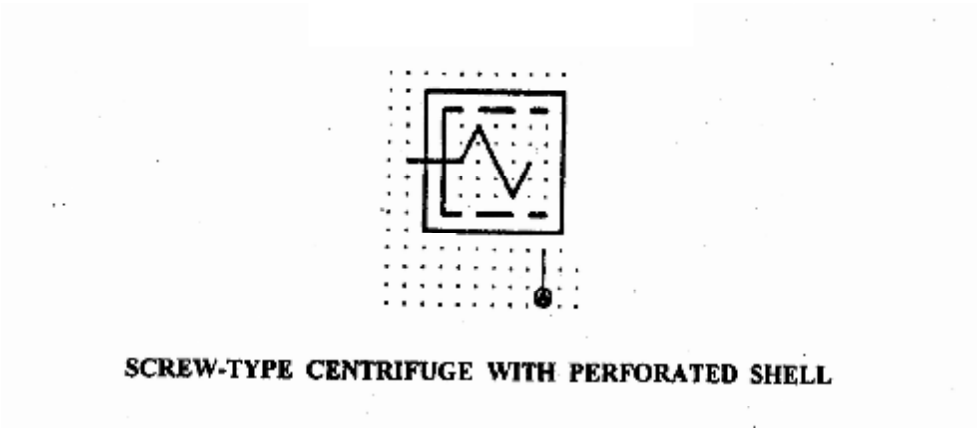
(to be continued)

APPENDIX A (continued)



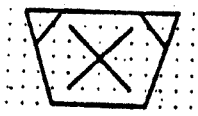
(to be continued)

APPENDIX A (continued)

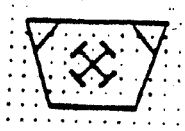


SCREW-TYPE CENTRIFUGE WITH PERFORATED SHELL

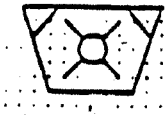
A.2.3.5.6 Mill



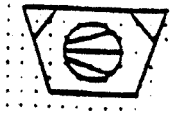
MILL, GENERAL



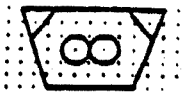
HAMMER MILL
IMPACT MILL



IMPACT MILL

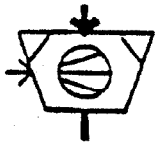


JET MILL



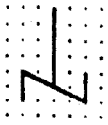
ROLLER MILL

VIBRATION MILL

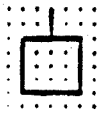


JET MILL WITH SOLID
AND GAS FLOW CONNECTION

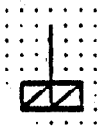
A.2.3.5.7 Agitator (mixer)



AGITATOR, GENERAL
STIRRER, GENERAL



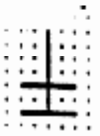
FLAT-BLADE PADDLE
AGITATOR



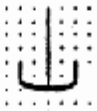
GATE PADDLE
AGITATOR

(to be continued)

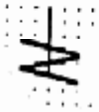
APPENDIX A (continued)



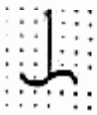
CROSS-BEAM AGITATOR



ANCHOR AGITATOR

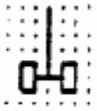


HELICAL AGITATOR

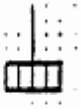


IMPELLER AGITATOR

PROPELLER AGITATOR



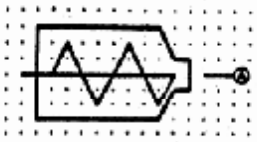
DISK AGITATOR



TURBINE AGITATOR

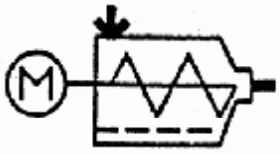
VESSEL WITH AGITATOR DRIVEN BY ELECTRIC MOTOR

A.2.3.5.8 Extruder

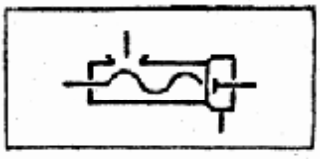


SCREW-TYPE EXTRUDER

EXTRUDER



SCREW-TYPE EXTRUDER DRIVEN BY ELECTRIC MOTOR

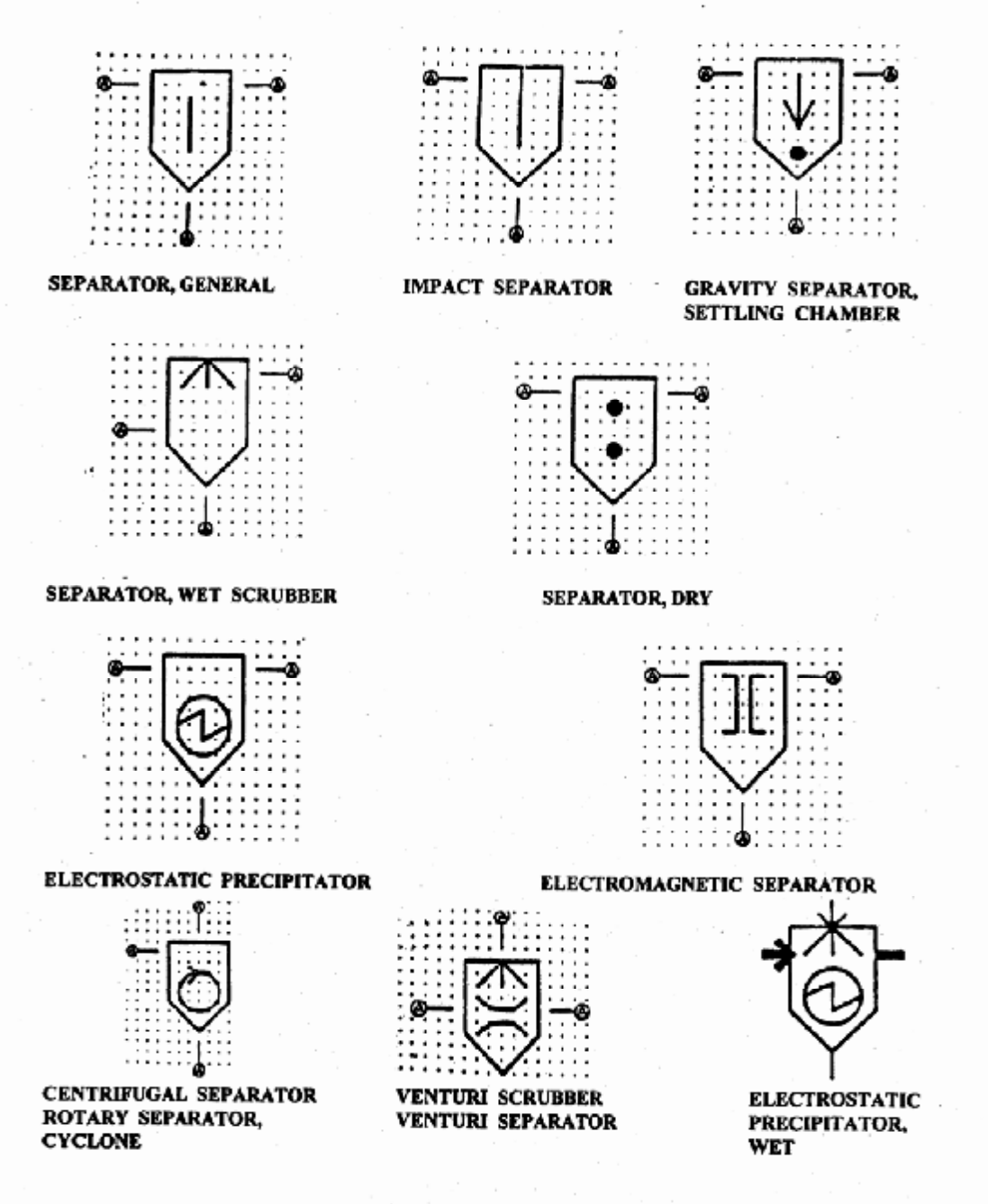


EXTRUDER WITH FACE CUTTING

(to be continued)

APPENDIX A (continued)

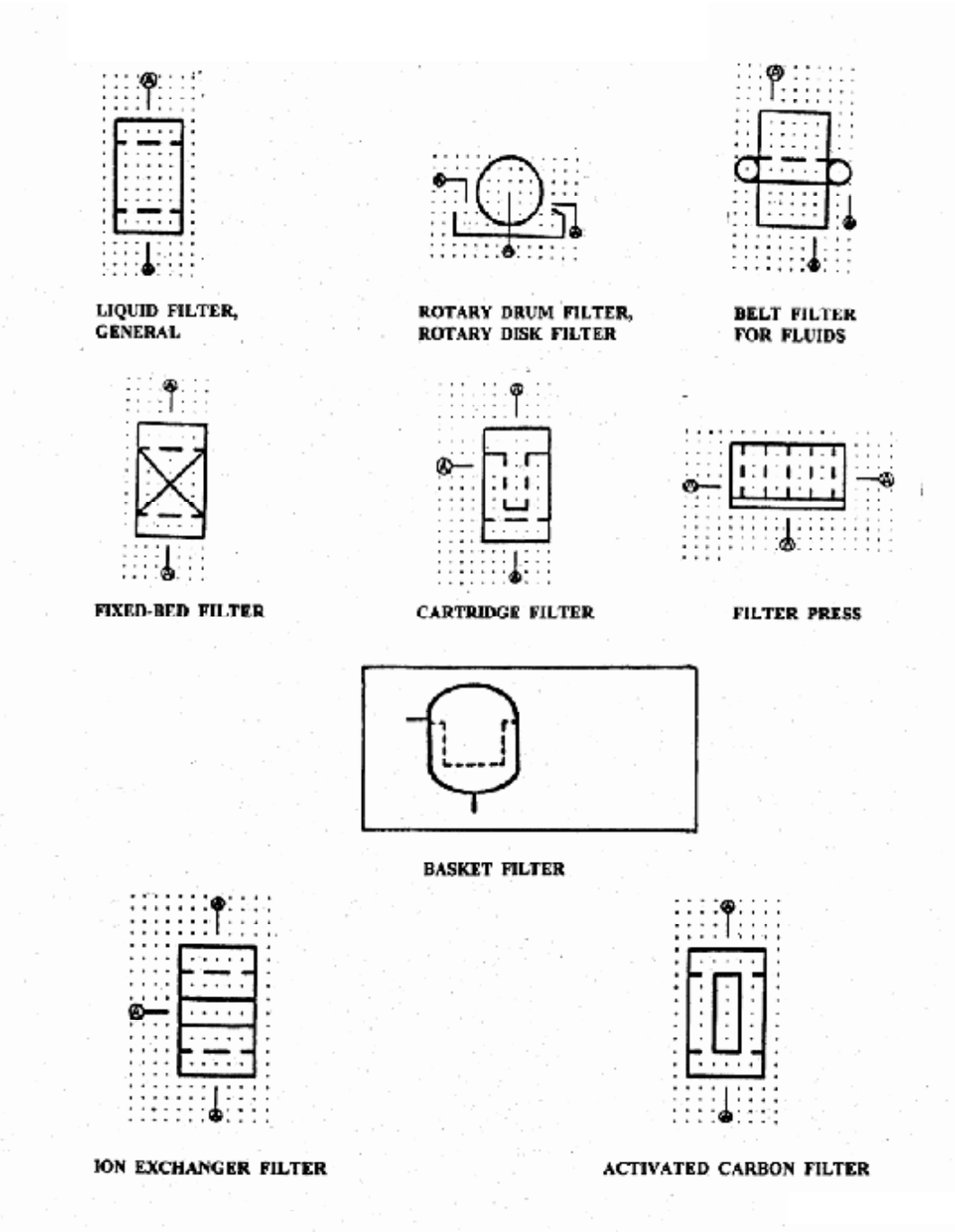
A.2.3.5.9 Separator



(to be continued)

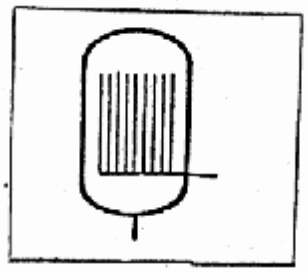
APPENDIX A (continued)

A.2.3.5.10 Filter

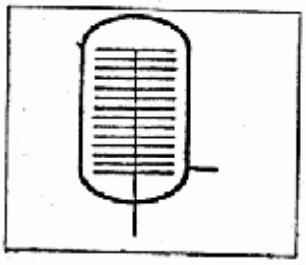


(to be continued)

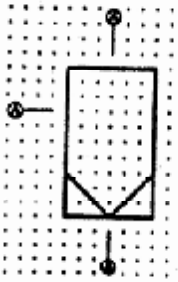
APPENDIX A (continued)



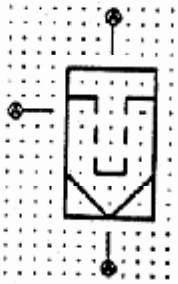
VERTICAL-PLATE PRESSURE FILTER



HORIZONTAL-PLATE PRESSURE FILTER



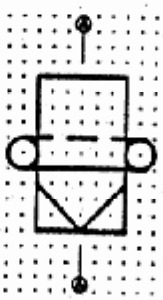
GAS FILTER, GENERAL
AIR FILTER, GENERAL



BAG FILTER, CARTRIDGE
FILTER FOR GASES

PACKED-BED
FILTER FOR
GASES

HIGH-EFFICIENCY
SUBMICRON PARTICULATE
AIR FILTER (HEPA)

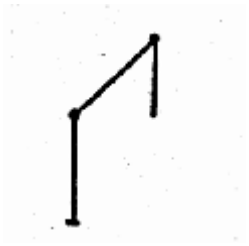
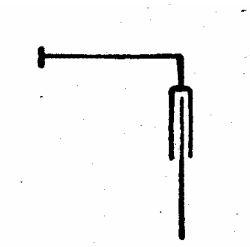
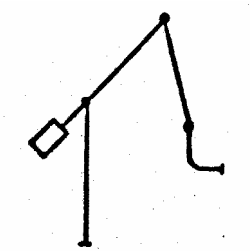
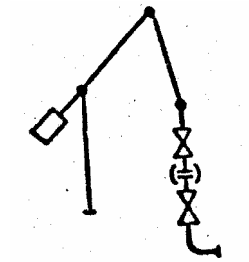


BELT FILTER
FOR GASES

(to be continued)

APPENDIX A (continued)

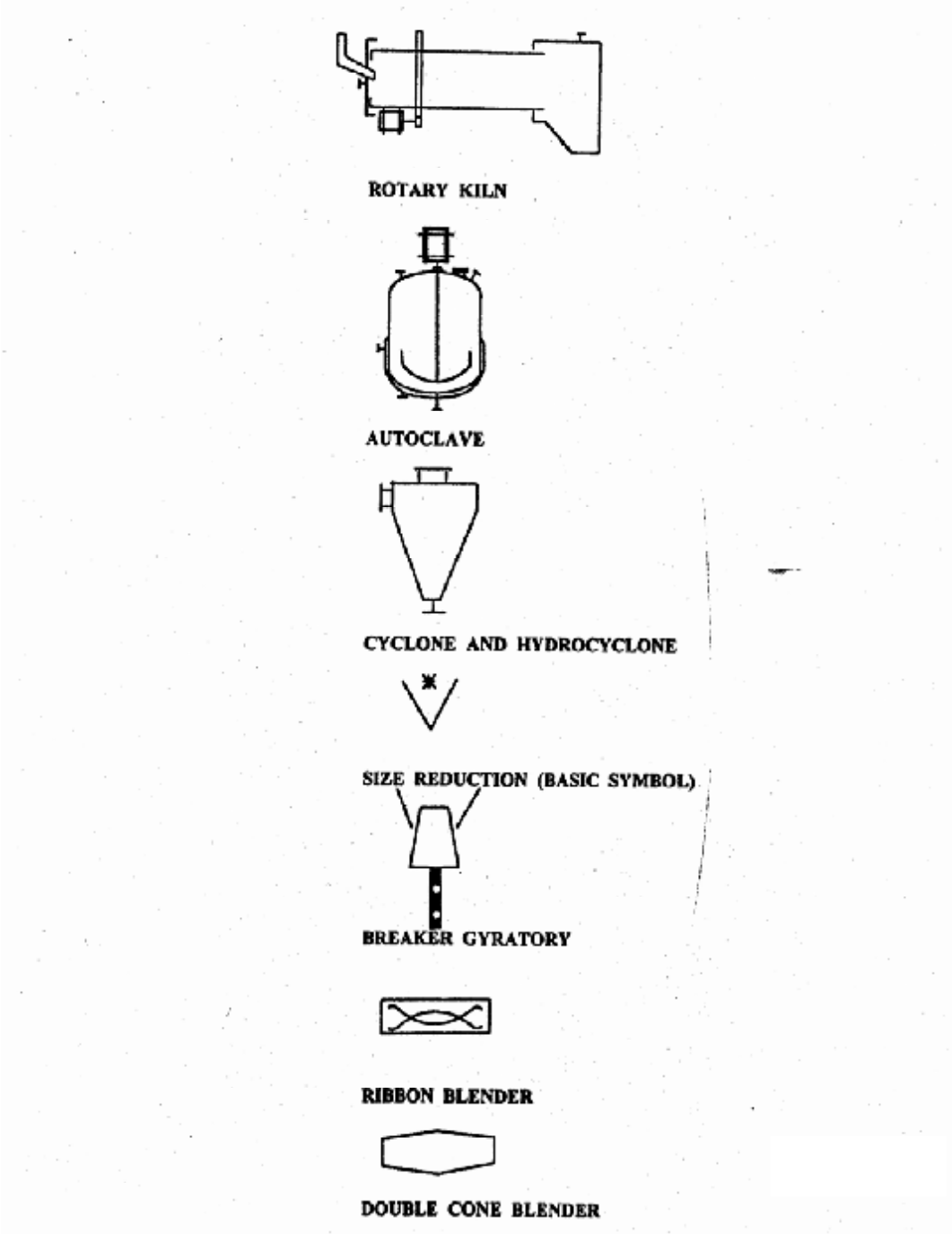
A.2.3.5.11 Bulk loading

	**Articulated loading arm (road/rail car loading)**
	**Telescopic loading lance (road/rail car loading)**
	**Marine loading arm**
	**Marine loading arm with emergency release system**

(to be continued)

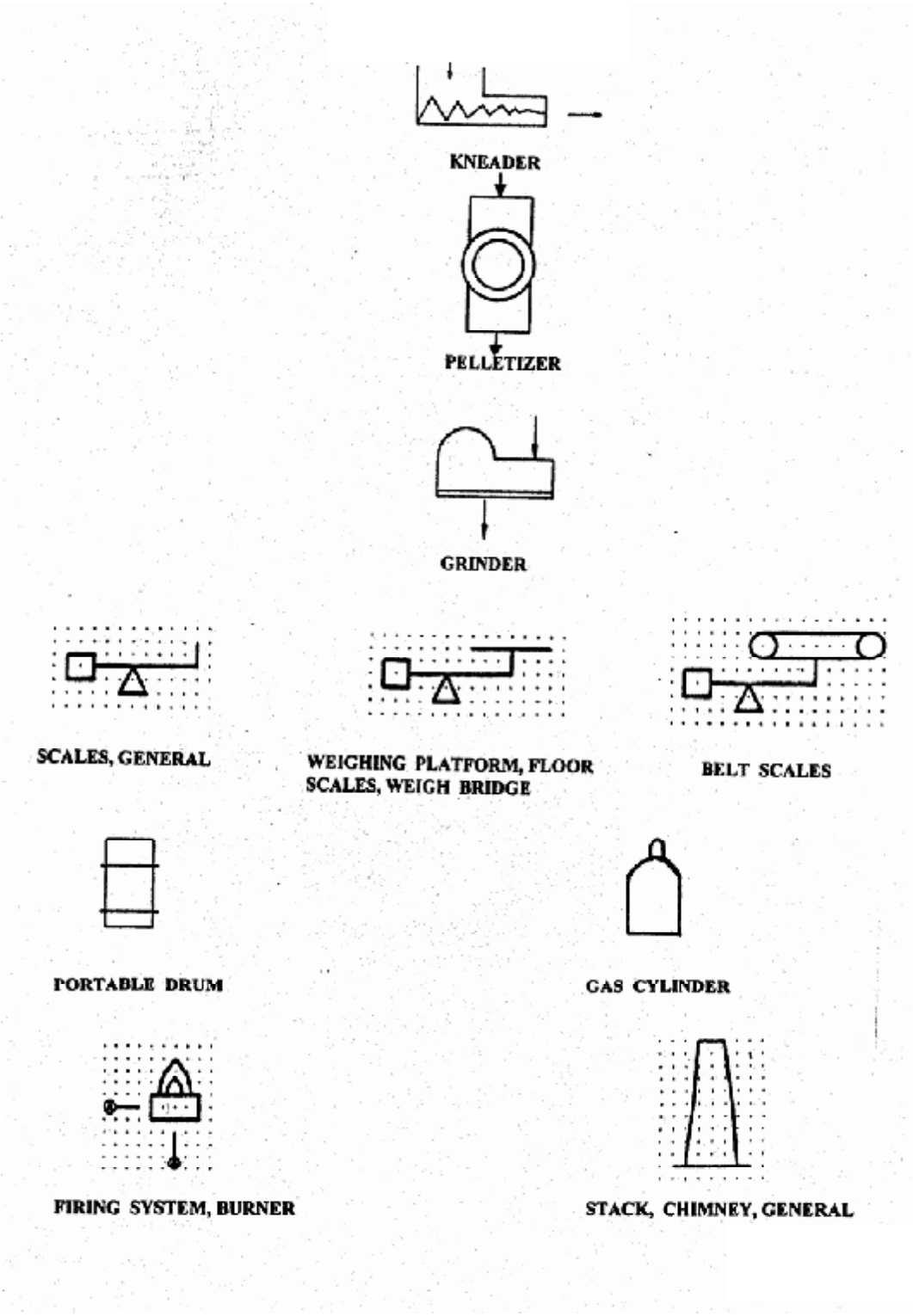
APPENDIX A (continued)

A.2.3.5.12 Other miscellaneous equipment



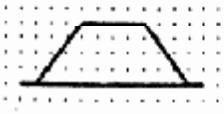
(to be continued)

APPENDIX A (continued)

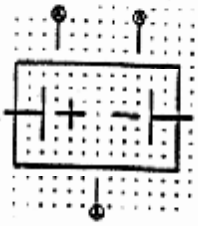


(to be continued)

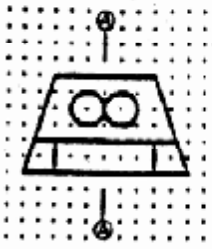
APPENDIX A (continued)



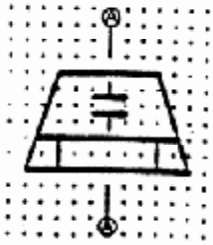
BULK STORAGE



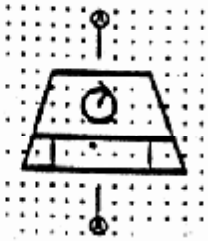
ELECTROLYSIS CELL, GENERAL



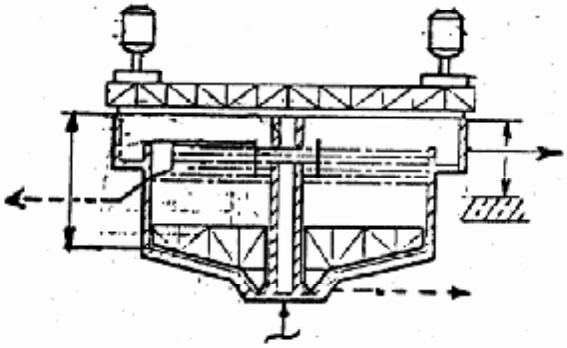
ROLLER PRESS



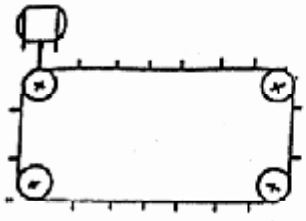
PISTON PRESS



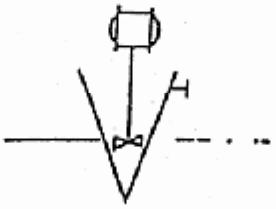
PELLETIZING DISK



CLARIFIER WITH TWO MOTOR DRIVER (TYPICAL)



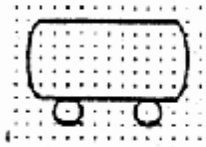
FLIGHT SCRAPERS



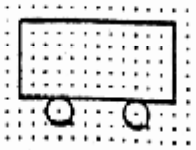
VORTEX OIL

(to be continued)

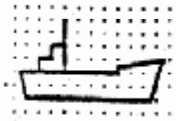
APPENDIX A (continued)



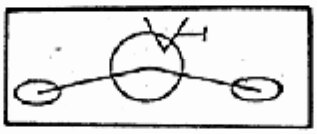
TANK CAR, TANK WAGON



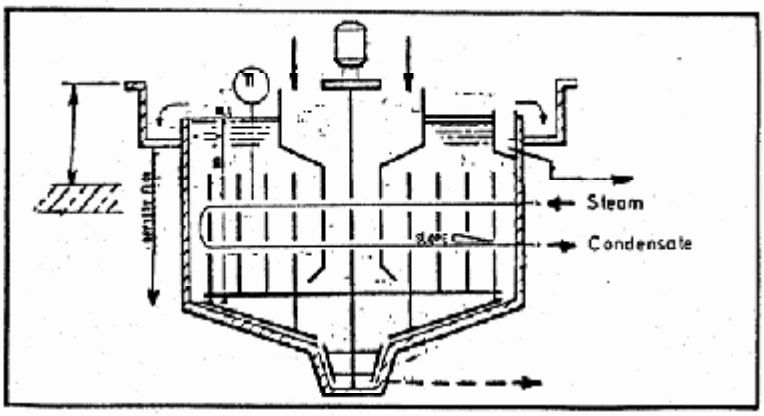
BOX TRUCK



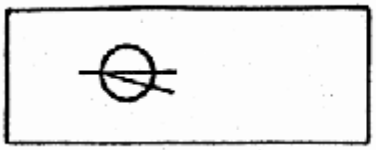
SHIP



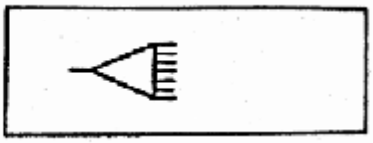
FLOATING OIL SKIMMER



THICKENER WITH STEAM COIL (IF REQUIRED)



DIVERTER VALVE

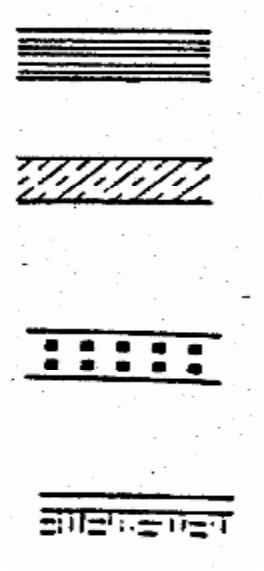


MULTIPLE DIVERTER

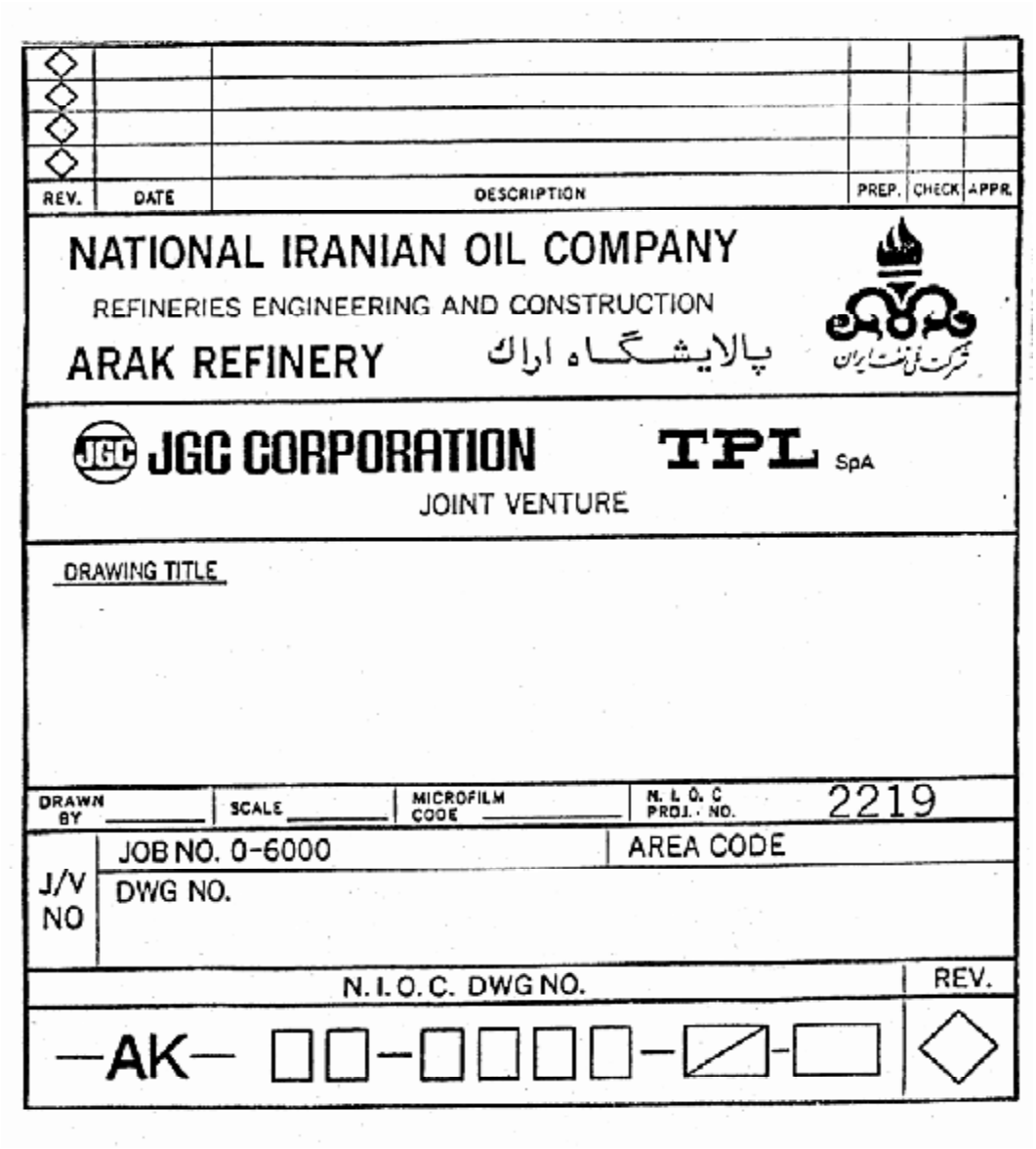
(to be continued)

APPENDIX A (continued)

A.2.4 Concrete/Birck/Soil

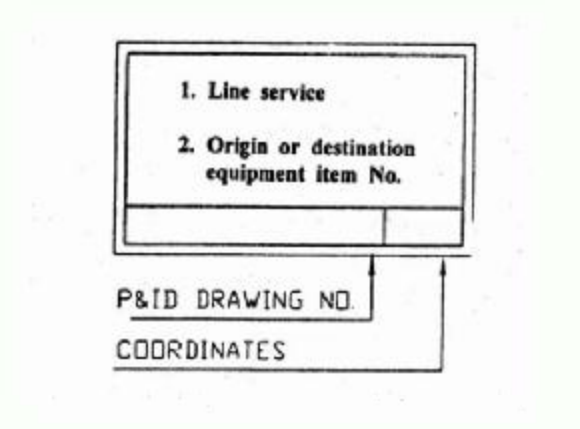
SYMBOL	DESCRIPTION
	Brickwork Concrete (reinforced) Refractory clay, Refractory bricks Soil

APPENDIX B
P&IDs/UFDs TITLE BLOCK (TYPICAL)

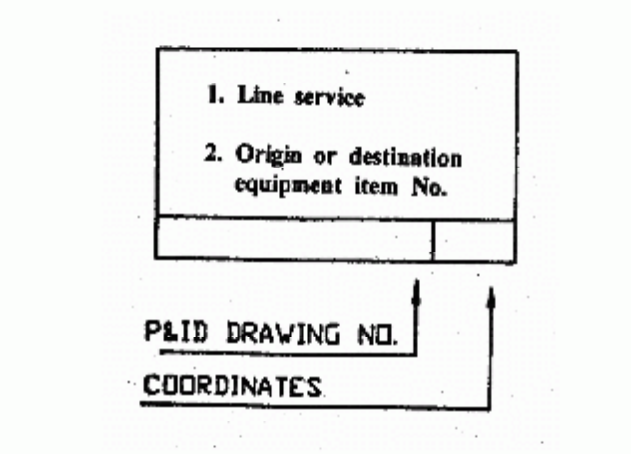


APPENDIX C
REFERENCE BLOCKS ON P&IDs

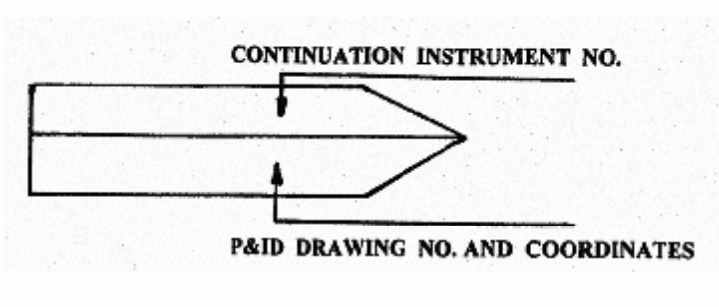
1. Reference blocks at the bottom of the drawing (only to be used for process and instrument lines routing over the subject Unit battery limit).



2. Reference blocks at the side of drawing (only to be used for process and instrument lines inside the same Unit).



3. Reference arrows for instrument, control system and software linkage signals at the inside of drawing (for the signals terminating or originating at the side or bottom of drawing see items 1 and 2 above).



APPENDIX D
UTILITIES IDENTIFICATION TABLE (TYPICAL)

UTILITIES IDENTIFICATION								
	DESCRIPTION	REF.DWG		DESCRIPTION	REF.DWG		DESCRIPTI ON	REF. DWG
FWA	FIRE WATER (FOAM SOLUTION)		HPS	HP STEAM		FLR	FLARE DISCHARGE	
DWA	DRINKING WATER		MPS	MP STEAM		ISA	INSTRUM ENT AI R	
DMW	DEMI WATER		LPS	LP STEAM		PLA	PLANT AIR	
PWA	PLANT WATER (SERVICE WATER)		LLPS	LOW LOW PRESSURE STEAM		NIT	NITROGEN	
RWA	RAW WATER		HPC	HP CONDENSATE		RFO	REFINERY FUEL OIL	
HBW	HP BOILER FEED WATER		MPC	MP CONDENSATE		FLG	FUEL BUS	
MBW	MP BOILER FEED WATER		LPC	LP CONDENSATE		NG	NATURAL GAS	
CWS	COOLING WATER SUPPLY		COC	COLD CONDENSATE				
CWR	COOLING WATER RETURN							
RFW	REFRIGERATED WATER							

APPENDIX E
NOZZLES IDENTIFICATIONS ON VESSELS, REACTORS AND TOWERS

The following symbols will be used for identification of the nozzles:

NOZZLE	IDENTIFICATION SYMBOL
A,A2	Inlets
B	Outlet
C	Condensate
D	Drain or Draw-off
E*	
F	Feed
G	Level gage or gage glass
H	Handhole
J	Pumpout
K*	
L	Level instrument (also LT, LI)
M	Manhole
N	Reboiler connection
P	Pressure connection (also PT, PI)
R	Reflux
S	Steam or sample connection
T	Temperature connection (also TI, TE, TW)
V	Vapor or vent
W	Relief valve connection (Oversize unless actual size known)

***Use E or K when non of the other symbols apply. Do not use I, O, Q, U, X, Y, or Z.**

APPENDIX F
PRESSURE RATINGS DESIGNATIONS-NOMINAL SIZE (IMPERIAL-METRIC)

IMPERIAL-METRIC

PRESSURE CLASSES	
150	20
300	50
400	68
600	100
900	150
1500	250
2500	420
4500	760

Equivalent pressure ratings designations.

IMPERIAL

PRESSURE CLASSES
25
125
250
800(1)
800(2)

Rating designations which have not exact equivalents

METRIC

PN DESIGNATION
2.5
6
10
16
25

Notes:

1) **As per ANSI B16.1 for cast iron valves.**
2) **As per API 602 for steel valves.**

APPENDIX G
PIPE COMPONENT-NOMINAL SIZE

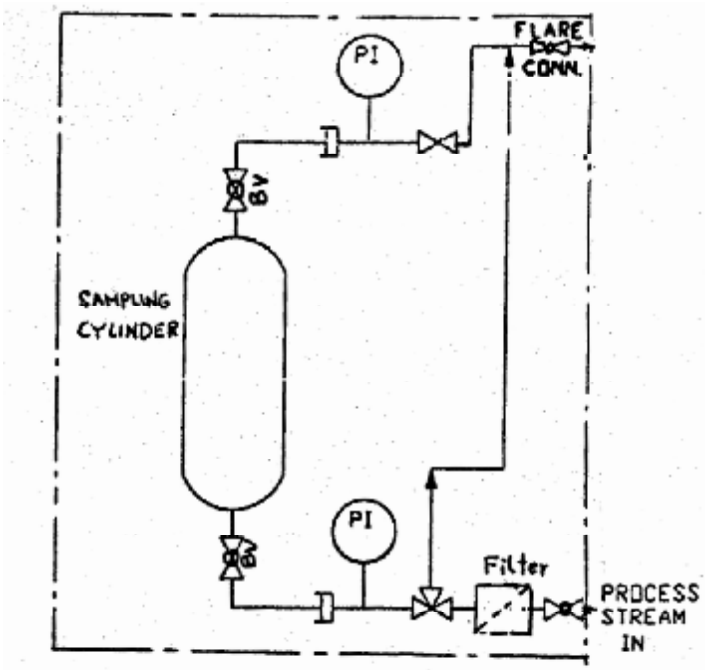
The purpose of this Appendix is to present an equivalent identity for the piping components nominal size in SI system and imperial unit system, in accordance with ISO 6708-1980 (E).

TABLE G.1- PIPE COMPONENT-NOMINAL SIZE (METRIC- IMPERIAL)

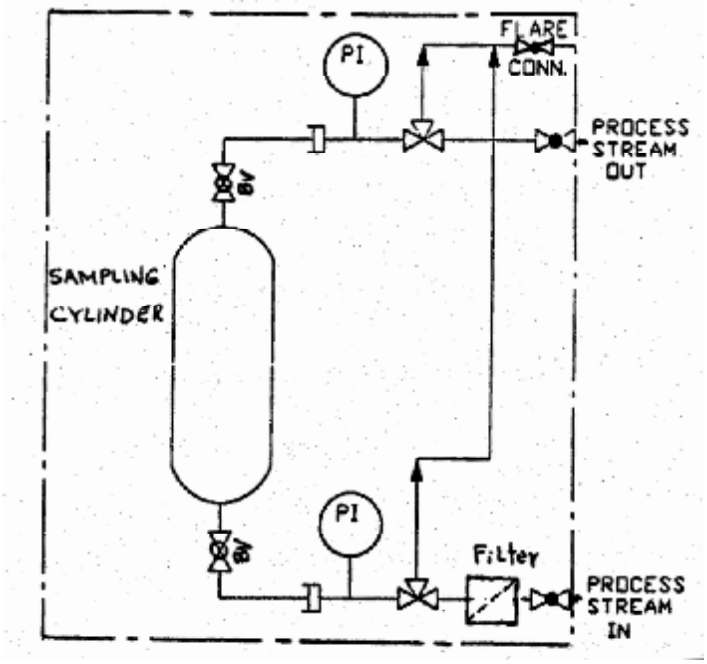
NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE	
DN(1)	NPS(2)	DN	NPS	DN	NPS	DN	NPS
6	¼	100	4	600	24	1100	44
15	½	125	5	650	26	1150	46
20	¾	150	6	700	28	1200	48
25	1	200	8	750	30	1300	52
32	$1^{1/4}$	250	10	800	32	1400	56
40	$1^{1/2}$	300	12	850	34	1500	60
50	2	350	14	900	36	1800	72
65	$2^{1/2}$	400	16	950	38		
80	3	450	18	1000	40		
90	$3^{1/2}$	500	20	1050	42		

1) **Diameter Nominal, mm.**
2) **Nominal pipe Size. Inch.**

APPENDIX H
TYPICAL SAMPLE CONNECTION DETAILS FOR GASES AND LIGHT LIQUIDS
(RVP ≥ 34.5 KPa)



TYPE 1; NON TOXIC GAS



APPENDIX I
BLOCK AND BYPASS VALVES FOR CONTROL VALVE

I.1 Without Block and Bypass valves

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

Block and bypass valves are not always necessary in the following cases:

a) In instances where it is desirable to reduce the sources of leakage of hazardous fluids, such as hydrogen, phenol, or hydrofluoric acid;

b) In clean service where the operating conditions are mild, and mission of valves will not jeopardize the safety or operability of the Unit;

c) In temporary services such as start-up or shut-down, and where the other operation modes are possible while the repairing of control valve, such as blending system of oil;

d) Pressure self regulating valves;

e) Shut-off valves

I.2 With Block and Bypass Valves

The following services should be provided with block and bypass valves:

a) Services where omission of valves will jeopardize the safety or operability of the Unit;

b) Services containing abrasive solids or corrosive fluids result in damage of trim of control valve, and require the repair;

c) In lethal services;

d) In product rundown and feed supplying services;

e) In fuel supply system;

f) In cooling medium supply service;

g) Control valves less than DN 50 (2 inch) size. The block and bypass valves are required due to small diameter of trim, and may have a possibility of plugging of sludge or foreign matters;

h) In services that are flashing or at high differential pressure.

I.3 Additional Requirements for Control Valves

Notwithstanding the requirements outlined in article I.1 and I.2 above the following notes should also be considered:

a) Provide an upstream isolation valve for all control valves unless the upstream system is to be shutdown on control valve failure.

b) Provide a downstream isolation valve whenever the downstream side of the control valve can not be isolated from other continuously operating pressure sources.

c) Provide a drain valve upstream of all control valves.

d) Provide a drain valve downstream of the control valve only when the process fluid is toxic or corrosive and for tight shut-off services.

I.4 Sizes of Block and Bypass Valves

For sizes of block and bypass valves, reference should be made to IPS-G-IN_160,”Control Valves”.

APPENDIX J
PHILOSOPHY OF INSTRUMENTATION INSTALLATION

J.1 Flow and quantity

Sufficient flow metering, temperature and pressure indications shall be installed in feed, rundown, and utility streams to provide information for the operation and the calculation of heat, pressure and material balances for each individual Unit.

J.2 Alarm and safeguarding system

If failure of any piece of plant equipment or its associated instrumentation may give rise to hazards for personnel, to consequence with considerable economic loss, or to undue environmental pollution, alarm and/or safeguarding instruments shall be installed. Where appropriate, safeguarding equipment shall be automatically bring the relevant plant or part of the plant to a safe condition when a desired measurement reaches an unacceptable value.

J.4 Separate Instrument connections

Depending on potential hazards, operational importance, instrument reliability, plugging of connections, etc, the need for separate connections from those for normal operation shall be decided upon in the design stage and indicated on P&IDs.

Separate connections are especially required for instrument of shut-down systems, such as:

- High or Low pressure point which actuate shut-down system.
- High or Low temperature connection which actuate shut-down system.
- High High or Low Low Level connection which actuate shut-down system.