

1.7 Drawings

1.7.1 Piping and Instrumentation and Process Flow Drawings

Table 1.7-1 contains a list of system piping and instrumentation diagrams (P&ID) and process flow diagrams (PFD) provided in Tier 2. Figure 1.7-1, sheets 1 and 2 define the symbols used on these drawings.

1.7.2 Instrument, Control and Electrical Drawings

Interlock block diagrams (IBD), instrument engineering diagrams (IED) and single-line diagrams (SLD) are listed in Table 1.7-2. Figure 1.7-2 defines the graphic symbols used in the IBDs.

1.7.3 ASME Standard Units to Preferred Metric Conversion Factors

The ASME standard units are applied with the numerical values converted to the preferred metric units system as listed in Table 1.7-3.

1.7.4 Preferred Metric Conversion to ASME Standard Units

Selected flow, pressure, temperature, and length preferred metric units are converted to ASME standard units as listed in Table 1.7-4.

1.7.5 Drawing Standards

Guidelines for identifying systems, facilities, equipment types, and numbers and for drawing P&IDs and PFDs are treated in Table 1.7-5.

1.7.6 P&ID Pipe Schedules

The minimum pipe schedule for ANSI nominal pipe sizes are identified below for any individual piping system shown on a Piping and Instrumentation Diagram (P&ID).

	ASME Section III	ASME B31.1
Carbon Steel and Alloy Pipe		
50mm (2 inch) and smaller	Schedule 80	Schedule 80
65mm (2-1/2 inch) and larger	Standard Weight	Standard Weight
Stainless Steel Pipe		
50mm (2 inch) and smaller	Schedule 40S	Schedule 40S
65mm (2-1/2 inch) through 150mm (6 inch)	Schedule 10S	Schedule 10S
200mm (8 inch) through 300mm (12 inch)	Schedule 40S	Schedule 40S
350mm (14 inch) and larger	10mm (0.375 inch)	10mm (0.375 inch)

Table 1.7-1 Piping and Instrumentation and Process Flow Diagrams

Tier 2 Fig. No.	Title	Type
4.6-8	CRD System	P&ID
4.6-9	CRD System	PFD
5.1-3	Nuclear Boiler System	P&ID
5.4-4	Reactor Recirculation System	P&ID
5.4-5	Reactor Recirculation System	PFD
5.4-8	Reactor Core Isolation Cooling System	P&ID
5.4-9	Reactor Core Isolation Cooling System	PFD
5.4-10	Residual Heat Removal System	P&ID
5.4-11	Residual Heat Removal System	PFD
5.4-12	Reactor Water Cleanup System	P&ID
5.4-13	Reactor Water Cleanup System	PFD
6.2-39	Atmospheric Control System	P&ID
6.2-40	Not Used	
6.3-1	High Pressure Core Flooder System	PFD
6.3-7	High Pressure Core Flooder System	P&ID
6.5-1	Standby Gas Treatment System	P&ID
6.7-1	High Pressure Nitrogen Gas Supply System	P&ID
9.1-1	Fuel Pool Cooling and Cleanup System	P&ID
9.1-2	Fuel Pool Cooling and Cleanup System	PFD
9.2-1	Reactor Building Cooling Water System	P&ID
9.2-2	HVAC Normal Cooling Water System	P&ID
9.2-3	HVAC Emergency Cooling Water System	P&ID
9.2-4	Makeup Water System (Condensate)	P&ID
9.2-5	Makeup Water System (Purified)	P&ID
9.2-7	Reactor Service Water System	P&ID
9.3-1	Standby Liquid Control System	P&ID
9.3-1A	Standby Liquid Control System	PFD
9.3-6	Instrument Air System	P&ID
9.3-7	Service Air System	P&ID
9.4-1	Control Building HVAC	PFD
9.4-8	Drywell Cooling System	P&ID
9.5-1	Suppression Pool Cleanup System	P&ID

Table 1.7-1 Piping and Instrumentation and Process Flow Diagrams (Continued)

Tier 2 Fig. No.	Title	Type
11.2-1	Radwaste System	PFD Simplified
11.3-1	Offgas System	PFD
11.3-2	Offgas System	P&ID

Table 1.7-2 Instrument Engineering, Interlock Block and Single-Line Diagrams

Tier 2 Fig. No.	Title	Type
5.2-8	Leak Detection and Isolation System	IED
5.4-14	Reactor Water Cleanup System	IBD
7.2-9	Reactor Protection System	IED
7.2-10	Reactor Protection System	IBD
7.3-1	High Pressure Core Flooder System	IBD
7.3-2	Nuclear Boiler System	IBD
7.3-3	Reactor Core Isolation Cooling System	IBD
7.3-4	Residual Heat Removal System	IBD
7.3-5	Leak Detection and Isolation System	IBD
7.3-6	Standby Gas Treatment System	IBD
7.3-7	Reactor Building Cooling Water/Reactor Service Water System	IBD
7.3-9	HVAC Emergency Cooling Water System	IBD
7.3-10	High Pressure Nitrogen Gas System	IBD
7.4-1	Standby Liquid Control System	IBD
7.4-2	Remote Shutdown System	IED
7.4-3	Remote Shutdown System	IBD
7.6-1	Neutron Monitoring System	IED
7.6-2	Neutron Monitoring System	IBD
7.6-5	Process Radiation Monitoring System	IED
7.6-7	Containment Atmosphere Monitoring System	IED
7.6-8	Containment Atmosphere Monitoring System	IBD
7.6-11	Suppression Pool Temperature Monitoring System	IED
7.6-12	Suppression Pool Temperature Monitoring System	IBD
7.7-2	Rod Control and Information System	IED
7.7-3	Rod Control and Information System	IBD
7.7-4	Control Rod Drive System	IBD
7.7-5	Recirculation Flow Control System	IED
7.7-7	Recirculation Flow Control System	IBD
7.7-8	Feedwater Control System	IED

**Table 1.7-2 Instrument Engineering, Interlock Block
and Single-Line Diagrams (Continued)**

Tier 2 Fig. No.	Title	Type
7.7-9	Feedwater Control System	IBD
7.7-12	Steam Bypass and Pressure Control System	IED
7.7-13	Steam Bypass and Pressure Control System	IBD
7.7-14	Fuel Pool Cooling and Cleanup System	IBD
8.2-1	Power Distribution System Routing Diagram	SLD
8.3-1	Electrical Power Distribution System	SLD
8.3-2	Instrument and Control Power Supply System	SLD
8.3-3	Plant Vital AC Power Supply System	SLD
8.3-4	Plant Vital DC Power Supply System	SLD

Table 1.7-3 Conversion to ASME Standard Units

	From	To Convert to	Divide by
(1)	Pressure/Stress		
	kilopascal	1 Pound/Square Inch	6.894757
	kilopascal	1 Atmosphere (STD)	101.325
	kilopascal	1 Foot of Water (39.2°F)	2.98898
	kilopascal	1 Inch of Water (60°F)	0.24884
	kilopascal	1 Inch of HG (32°F)	3.38638
(2)	Force/Weight		
	newton	1 Pound - force	4.448222
	kilogram	1 Ton (Short)	907.1847
	kilogram	1 Tons (Long)	1016.047
(3)	Heat/Energy		
	joule	1 Btu	1055.056
	joule	1 Calorie	4.1868
	kilowatt-hour	1 Btu	0.0002930711
	kilowatts	1 Horsepower (U.K)	0.7456999
	kilowatt-hour	1 Horsepower-Hour	0.7456999
	kilowatt	1 Btu/Min	0.0175843
	joule/gram	1 Btu/Pound	2.326
(4)	Length		
	millimeter	1 Inch	25.4
	centimeter	1 Inch	2.54
	meter	1 Inch	0.0254
	meter	1 Foot	0.3048
	centimeter	1 Foot	30.48
	meter	1 Mile	1609.344
	kilometer	1 Mile	1.609344
(5)	Volume		
	liter	1 Cubic Inch	0.01638706
	cubic centimeter	1 Cubic Inch	16.38706
	cubic meter	1 Cubic Foot	0.02831685

Table 1.7-3 Conversion to ASME Standard Units (Continued)

	From	To Convert to	Divide by
	cubic centimeter	1 Cubic Foot	28316.85
	liter	1 Cubic Foot	28.31685
	cubic meter	1 Cubic Yard	0.7645549
	liter	1 Gallon (US)	3.785412
	cubic centimeter	1 Gallon (US)	3785.412
	E-03 cubic centimeter	1 Gallon (US)	3.785412
(6)	Volume Per Unit Time		
	cubic centimeter/s	1 Cubic Foot/Min	471.9474
	cubic meter/h	1 Cubic Foot/Min	1.69901
	liter/s	1 Cubic Foot/Min	0.4719474
	cubic meter/s	1 Cubic Foot/Sec	0.02831685
	E-05 cubic meter/s	1 Gallon/Min (US)	6.30902
	cubic meter/h	1 Gallon/Min (US)	0.22712
(7)	Velocity		
	centimeter/s	1 Foot/Sec	30.48
	centimeter/s	1 Foot/Min	0.508
	meter/s	1 Foot/Min	0.00508
	meter/min	1 Foot/Min	0.3048
	centimeter/s	1 Inches/Sec	2.54
(8)	Area		
	square centimeter	1 Square Inch	6.4516
	E-04 square meter	1 Square Inch	6.4516
	square centimeter	1 Square Foot	929.0304
	E-02 square meter	1 Square Foot	9.290304
(9)	Torque		
	newton-meter	1 Foot Pound	1.355818
(10)	Mass Per Unit Time		
	kilogram/s	1 Pound/Sec	0.4535924

Table 1.7-3 Conversion to ASME Standard Units (Continued)

	From	To Convert to	Divide by
	kilogram/min	1 Pound/Min	0.4535924
	kilogram/h	1 Pound/Min	27.215544
(11)	Mass Per Unit Volume		
	kilogram/cubic meter	1 Pound/Cubic Inch	27679.90
	kilogram/cubic meter	1 Pound/Cubic Foot	16.01846
	kilogram/cubic centimeter	1 Pound/Cubic Inch	0.0276799
	liter/s	1 Gallon/Min	0.0630902
(12)	Dynamic Viscosity		
	Pa*s	1 Pound-Sec/Sq Ft	47.88026
(13)	Specific Heat/Heat Transfer		
	joule/kilogram kelvin	1 Btu/Pound-Deg F	4186.8
	watt/square meter kelvin	1 Btu/Hr-Sq Ft-Deg F	5.678263
	watt/square meter kelvin	1 Btu/Sec-Sq Ft-Deg F	2.044175E+4
	watt/square meter	1 Btu/Hr-Sq Ft	3.154591
(14)	Temperature		
	degrees celsius	Degrees Fahrenheit	$T_{\circ F} = T_{\circ C} \times 1.8 + 32$
	Degree C Increment	1 Degree F Increment	0.555556
(15)	Electricity		
	coulomb	1 ampere hour	3600
	seimens/meter	1 mho/centimeter	100
(16)	Light		
	candels/square meter	1 candela/square inch	1550.003
	lux	1 footcandle	10.76391
(17)	Radiation		
	megabequerel	1 curie	37,000
	gray	1 rad	0.01
	sievert	1 rem	0.01

Note:

Rounding of Calculated values per Appendix C of ANSI/IEEE Std 268.

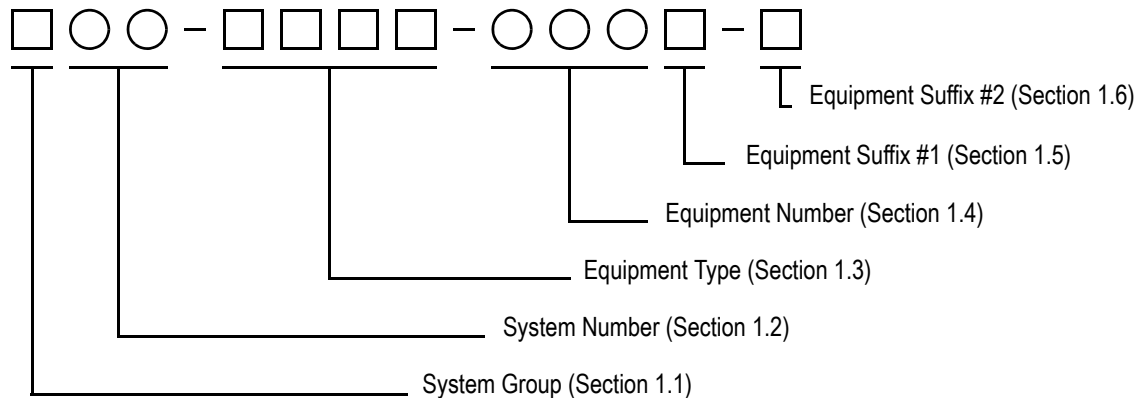
Table 1.7-4 Conversion Tables—Metric to ASME Standard Units

Flow-Volume Per Unit Time							
m³/h	gal/min	m³/h	gal/min	m³/h	gal/min	m³/h	gal/min
1	4.4	10	44	100	440	1000	4402
2	8.8	20	88	200	881	2000	8805
3	13.2	30	132	300	1321	3000	13207
4	17.6	40	176	400	1761	4000	17610
5	22.0	50	220	500	2201	5000	22012
6	26.4	60	264	600	2641	6000	26414
7	30.8	70	308	700	3082	7000	30817
8	35.2	80	352	800	3522	8000	35219
9	39.6	90	396	900	3962	9000	39621
Temperature							
°C	°F	°C	°F	°C	°F	°C	°F
0.1	32.18	1	33.8	10	50	100	212
0.2	32.36	2	35.6	20	68	200	392
0.3	32.54	3	37.4	30	86	300	572
0.4	32.72	4	39.2	40	104	400	752
0.5	32.90	5	41.0	50	122	500	932
0.6	33.08	6	42.8	60	140	600	1112
0.7	33.26	7	44.6	70	158	700	1292
0.8	33.44	8	46.4	80	176	800	1472
Pressure							
kPa	psi	kPa	psi	kPa	psi	kPa	psi
1	0.145	10	1.45	100	14.51	1000	145.1
2	0.290	20	2.90	200	29.01	2000	290.1
3	0.435	30	4.35	300	43.52	3000	435.2
4	0.580	40	5.80	400	58.02	4000	580.2
5	0.725	50	7.25	500	72.53	5000	725.3
6	0.870	60	8.70	600	87.03	6000	870.3
7	1.015	70	10.15	700	101.54	7000	1015.4
8	1.160	80	11.60	800	116.04	8000	1160.4
9	1.306	90	13.06	900	130.55	9000	1305.5

Table 1.7-4 Conversion Tables—Metric to ASME Standard Units (Continued)

Length							
cm	inch	cm	inch	m	ft	m	ft
0.01	0.004	0.1	0.039	1	3.28	10	32.81
0.02	0.008	0.2	0.079	2	6.56	20	65.62
0.03	0.012	0.3	0.118	3	9.84	30	98.43
0.04	0.016	0.4	0.157	4	13.12	40	131.2
0.05	0.020	0.5	0.197	5	16.40	50	164.0
0.06	0.024	0.6	0.236	6	19.69	60	196.9
0.07	0.028	0.7	0.276	7	22.97	70	229.7
0.08	0.032	0.8	0.315	8	26.25	80	262.5
0.09	0.035	0.9	0.354	9	29.53	90	295.3

Table 1.7-5 Drawing Standards

1.0 Equipment Identification**1.1 System Groups**

The plant systems and facilities are divided into several major groups. Each group is represented by a single alphabetical letter as follows:

- A Plant in general
- B Reactor steam-generating systems
- C Control systems
- D Radiation monitoring systems
- E Core cooling systems
- F Reactor handling equipment
- G Reactor auxiliary systems
- H Control panels
- J Fuels
- K Waste-processing systems
- N Plant main systems
- P Plant auxiliary systems
- R Onsite electrical systems
- S Power transmission and receiving systems
- T Reactor containment vessel and ancillary facilities
- U Various buildings and ancillary facilities
- W Water intake facilities and ancillary facilities
- Y Other facilities on the grounds

Note: The following letters are not used: I, L, M, O, Q, V, X, Z

Table 1.7-5 Drawing Standards (Continued)**1.2 System Numbers**

The system number for each system or facility consists of a two-digit number. Table 3.2-1 shows the system group and system numbers (MPL numbers) for each system and facility.

1.3 Equipment Type

The equipment type is represented by from one to four alphabetical letters as follows:

Mechanical Equipment**Identifying**

Letter	Description	
A	Tanks	Such as collection tanks, sample tanks, surge tanks, precoat tanks, backwashing tanks, sludge and resin tanks, other tanks, lining vats
B	Heat transfer equipment	Various types of heat exchangers, coolers, condensers, heaters
C	Rotating equipment	Such as various types of pumps and prime movers, fans and blowers, generators, exciters
D	Other equipment	Such as reactor pressure vessel, reactor internals, steam separators, dryers, control rod drive mechanisms, hydraulic control units, control rods, flow-limiting orifices, strainers, filters, demineralizers, agitators, extractors, ejectors, dispersers, and other types of equipment
E	Tools and servicing equipment	
F	Valves and their operators (where supplied)	
G	Pipes, hangers and supports	
H	Insulation	

Structural Equipment**Identifying**

Letter	Description
U	Foundation and supporting structure
V	Steel structures
W	Structural concrete and reinforcement bars
X	Equipment structures such as flues, chimneys, ducts, louvers, and cable trays

Table 1.7-5 Drawing Standards (Continued)

Electrical Equipment			
Identifying Letter	Description	Identifying Letter	Description
J	Electrical equipment-buses, transformers, power supply facilities	MV/I	Millivolt/current converters
K	Auxiliary relays	O/E	Optic/electric converters
L	Limiters	P/E	Pneumatic-electric converters (including air-pressure-to-current and air-pressure-to-voltage converters)
P	Panels and racks	R/I	Resistance/current converters
S	Operation switch	RMC	Remote controllers
T	Timing relays	RMS	Remote operating switches
Z	Complicated controllers such as ratio setters, function generators, division/multiplication calculators, time-lag calculators, addition/subtraction calculators. All microprocessor based algorithms.	R/P	Resistance/pneumatic converters
AM	Analog memory	RY	Relay modules
D/D	Converters	SQRT	Square-root calculators
E/O	Electric/optic converters	SRU	Resistance units
E/P	Electropneumatic converters (including current-to-air-pressure and voltage-to-air-pressure convertors)	S/S	Selector switch
E/S	Power supply for instrumentation	SSA	Selector-selector switch automatic
E/T	Relay terminal boards	TDS	Time delay switches
I/O	I/O module	TMC	Cycle timers
I/V	Current/voltage converters	TPR	Program timers
M/A	Manual and manual/automatic controllers	V/V	Voltage/voltage converters
MRY	Deviation monitor		

Table 1.7-5 Drawing Standards (Continued)**1.3.1 Instrumentation**

The identification for “equipment type” provides information about the measured variable as well as the instrument function (Figure 1.7-1, sheet 2).

1.4 Equipment Number

Mechanical, structural and electrical equipment is numbered from 001 to 999 within the system for each equipment type.

1.4.1 Flow Direction Numbering Method

Equipment numbers are assigned in the direction of flow starting from the reactor vessel (or the upstream flow boundary) and moving in sequence from upstream to downstream. In systems which have two flow paths, the main flow path takes priority. The “Flow-Direction” method takes priority over the “Alternate” method below.

1.4.2 Alternate Numbering Method

For items having the same “Equipment Type” with different specifications and arranged in parallel, the equipment numbers are assigned according to equipment layout following a priority according to the direction, either from north to south or from the sea to the mountains. The north-to-south direction takes priority over the sea-to-mountain direction. However, within a system, the degree of importance of the individual pieces of equipment takes priority over the aforesaid rule, and the numbers are assigned in order of priority from the more important pieces of equipment. In the case in which the items are in parallel and are arranged above and below each other (e.g., upper and lower floors), the priority in numbering from more important to less important supersedes numbering from upper to lower floor.

1.4.3 Rules for Adding and Eliminating Equipment

When equipment is added to a system as the design progresses, the sequential numbers in the system upstream and downstream of the added equipment are not changed, and the added equipment is given the number following the last of the sequential numbers of the equipment at that time. When equipment is eliminated, its equipment number shall not be used again, and the numbers of the equipment on the downstream side remain unchanged.

Table 1.7-5 Drawing Standards (Continued)**1.4.4 Valve Numbering**

Valves are divided into three categories—(1) Process Valves, (2) Drain Valves and Vent Valves, and (3) Instrument Valves having the following sets of numbers:

Process Valves	001 to 499
Drain and Vent Valves	500 to 699
Instrument Valves	700 to 999

1.4.5 Instrument Numbering

Equipment numbers for instruments are assigned in a series, for instruments only, from the upstream side of the system. They are assigned without relation to the symbols for the type of equipment; that is, without regard to the variables measured and measuring functions. The following sets of numbers are used for instruments according to their location and equipment classification:

001 to 299	Instruments installed in local panels.
301 to 399	Instruments installed locally, attached to equipment only.
601 to 999	Instruments installed in main control room, including instrument functions performed by data communication. The instrument number assigned to the latter is prefixed by the letter Z.

For a system having more than one fluid stream, instruments are numbered in sequence with those used for water first, then for steam and then for air. Within any of the above categories, for local instruments mounted on equipment, the priority is for level instruments first, then pressure and then temperature. Instruments measuring the same quantities, in this case, are numbered in sequence from those which have higher setting values, or from those which have higher upper limit values.

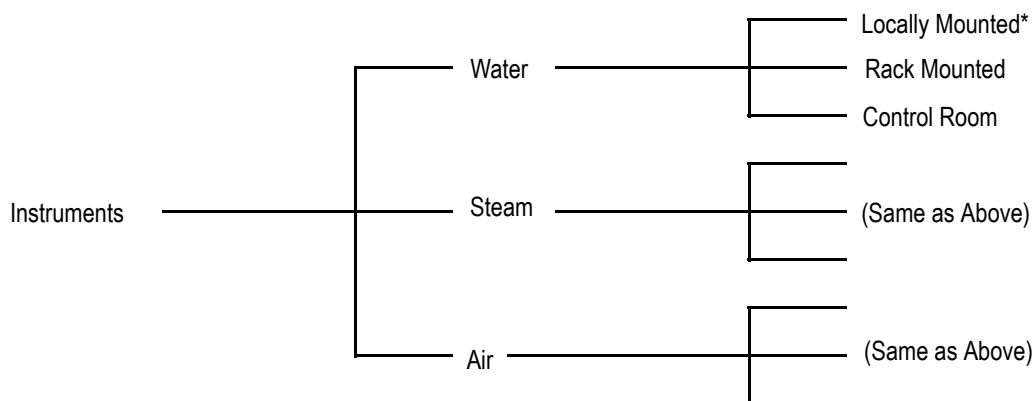
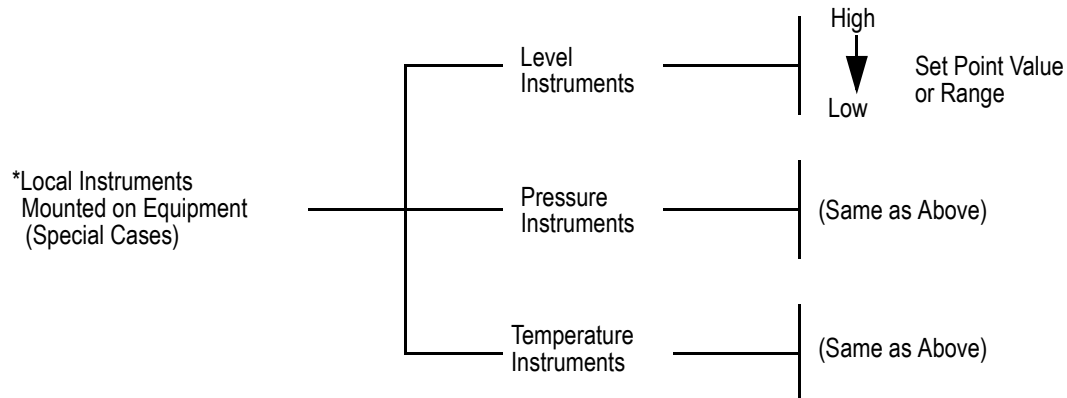


Table 1.7-5 Drawing Standards (Continued)



1.4.6 Numbering Within a Loop

Instruments or instrument functions performed by the data communication in the same loop have the same last two numbers. Instruments located in the main control room that receive signals from locally installed instruments in the same loop are numbered by adding 600 to the local or local panel-mounted instrument number in the loop.

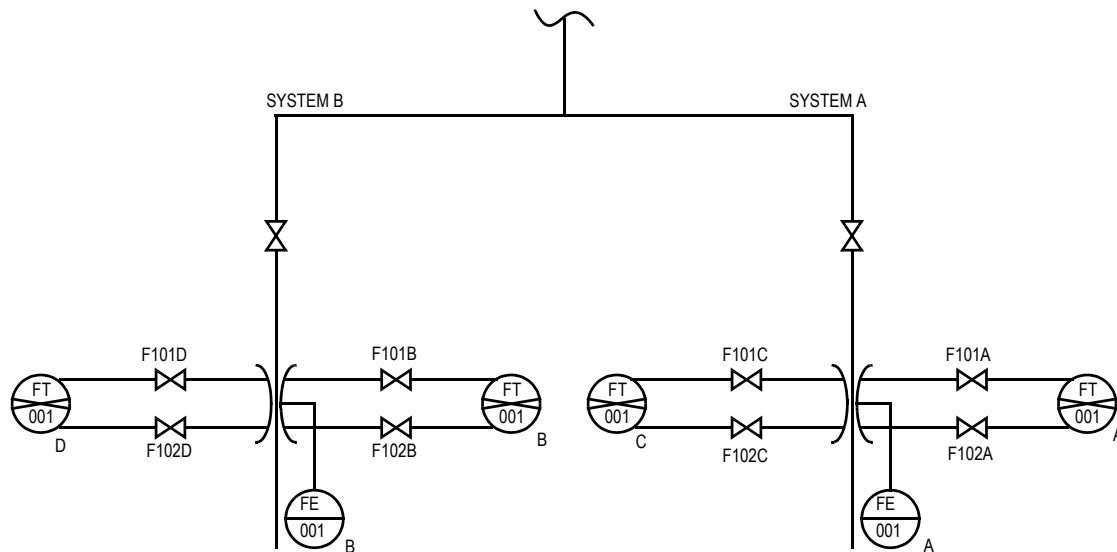
1.5 Equipment Suffix #1

Equipment suffix #1 shall consist of a single letter (A, B, C, etc.). This is assigned when equipment or instruments in a system have the same equipment numbers and are required to be differentiated because of safety/separation considerations or because there are redundant instrument or mechanical loops. The following set of guidelines is followed in assigning equipment suffix #1:

- Equipment suffix #1 is the same as the suffix assigned to the reactor vessel nozzle to which the associated system or subsystem containing that equipment or instrument is connected.
- For equipment or instruments arranged in parallel and their systems having the same flow direction, the equipment suffix #1 is assigned by the equipment arrangement. The numbering is done from north-to-south or from sea-to-mountain. The north-to-south direction takes priority over the sea-to-mountain direction.
- For equipment or instruments having the same flow direction but which are installed at upper and lower levels, the suffix #1 is assigned as "A", "B", "C", etc., from the lower level up.
- For the secondary system, the equipment suffix #1 is the same as that for the equipment in the primary system.
- If equipment or instruments belonging to an interfacing system are connected to equipment with suffix A and B in the primary system, their equipment suffix #1 may be omitted if they can be differentiated without it.

Table 1.7-5 Drawing Standards (Continued)

- (f) When components connected to a dual system are further divided, the equipment suffix #1 is assigned in a staggered fashion. That is, component elements of the secondary system which are connected to system A have suffix A, C, E, G, J, L,....., while those which are connected to system B have suffix as B, D, F, H, K, M.....



- (g) The Hydraulic Control Units (HCUs) in the Control Rod Drive (CRD) System shall be assigned a different type of equipment suffix #1. The core-coordinates of the two fuel bundles to which a particular HCU belongs shall be used as suffix. For example, C12D0010722/2718 represents an HCU for control rods belonging to fuel bundles at core coordinates 07,22 and 27,18.

1.6 Equipment Suffix #2

Equipment suffix #2 is only used for instruments if necessary. This number will differentiate instruments of the same type in an instrument loop. A single digit number is used in specifying the equipment suffix #2.

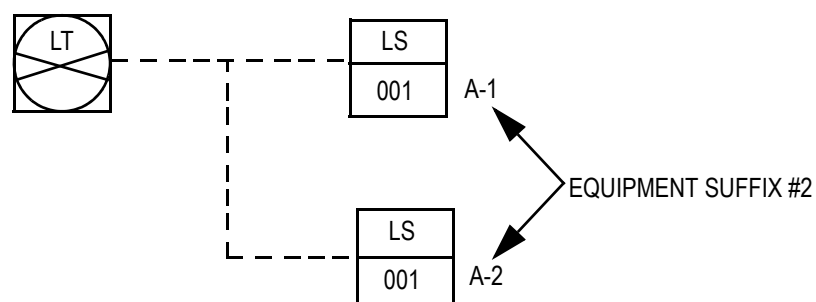
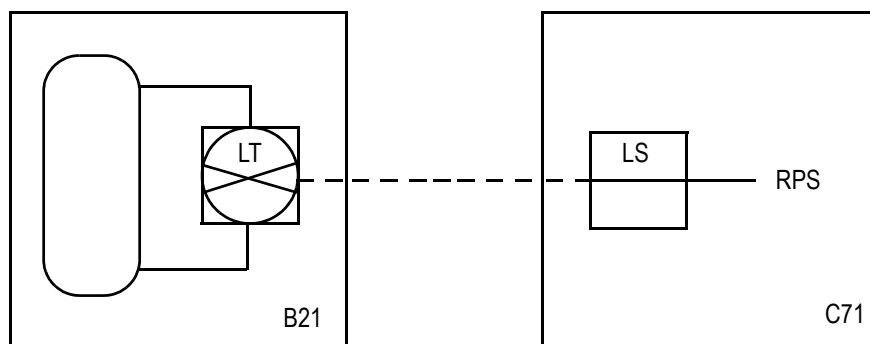


Table 1.7-5 Drawing Standards (Continued)**1.7 Numbering of Shared Equipment**

The following rules are followed in assigning numbers to equipment shared between systems or between loops within a system:

- (a) "System group and number" of shared instruments—Assign the system number of whichever system has the largest number of instruments using the shared component. If the number of instruments is the same, use the system number which has the system group and system number closest to A00.
- (b) "Equipment Number" of shared instruments—Except for instruments with a recording function, the same rule as outlined for unshared instruments is followed. All recorders, regardless of the "measured variable", are numbered in a single series from 001 to 999.
- (c) In instrumentation systems which monitor the process quantities of one system and perform interlock controls with another system, the primary instruments (elements and transmitters, or local switches) are assigned the system and equipment number of the system being monitored; and the other instruments are assigned the system and equipment number of the latter system. However, switch functions sending signals to multiple systems are excepted from the above rule and are considered as a part of the primary system.

**2.0 Piping and Instrument Diagram Standards****2.1 P&ID**

The P&ID provides a schematic illustration of a specific system. It may contain the following information:

- (a) Equipment, valves, piping and instrumentation required for system function.
- (b) Interface between components and other systems to show control and function of each valve.
- (c) Electrical and instrumental interlocks, protective features and logic connections.
- (d) Valves and associated components shown in plant normal operating mode (e.g., valve open—valve closed) or as defined on the drawing or specified in the notes. An exception to this is a three-way solenoid valve supplied with associated air or nitrogen-operated valve, which is shown in the de-energized mode.

Table 1.7-5 Drawing Standards (Continued)

- (e) The P&ID shows the location of the valves, pipe junctions, pumps, instruments, tanks and other equipment in actual sequence along the pipeline. Piping takeoff connections from equipment are shown at their proper locations relative to the equipment whenever practicable.
- (f) System design (maximum) conditions such as design pressure, design temperature, material and seismic class are given in the P&ID. The changing points for these items are defined.
- (g) The identification of building(s) (including yard) is defined.
- (h) Equipment, valves and instrumentation belonging to another system or used in common are shown by broken line with two dots between each line break, and the system group and number(s) clearly stated for other system or systems.
- (i) Instrument root valves in the instrument piping branching from the process piping are shown. Valves on the instrument side are not shown.
- (j) Drain, vent and test connections are shown on P&IDs. The discharge of drains and vents is assigned to the appropriate drain system whose system acronym is written at the end of the line.
- (k) System (group and number) and system acronyms are given in the upper right-hand corner of the first sheet of the P&ID.
- (l) Use of a black box on a P&ID is allowed when other sheets of the same drawing or a different drawing contains complete information about the contents of the black box. A note is added that specifies the drawing number of the contents of the black box.
- (m) Piping is divided into three categories—Process piping, drain and vent piping and instrument piping. The following sets of numbers are used for these categories:

Process Piping	001 to 499
Drain and Vent Piping	500 to 699
Instrument Piping	700 to 999

When numbers in a series run out, four-digit pipe numbers may be used. For example, for process piping, after 499, the numbers from 1001 to 1499 are used.
- (n) The pipe numbering is done using the flow direction method, same as the equipment numbering method described in Subsection 1.4.1.
- (p) Piping is basically identified by a single number (Example 1 below). If the P&ID is changed during the detailed design after the initial numbering and if an additional pipe number is required due to the change, a suffix number may be applied (Example 2):



Example 1	400A-MUWC-001
Example 2	400A-MUWC-001-1
	400A-MUWC-001-2
- (q) Nominal pipe diameter is identified by the symbol "A" preceeded by a millimeter dimension consistent with inches or the ANSI standard outside diameter as shown by the following examples:

Table 1.7-5 Drawing Standards (Continued)

Nominal Diameter Inches	ABWR P&ID Symbol mm	ANSI OD mm
2	50A	60.3
4	100A	114.3
8	200A	219.1
16	400A	406.4
24	600A	609.6

3.0 Process Flow Diagram Standards**3.1 PFD**

The process flow diagram shows the engineering requirements or conditions (e.g., modes of operation, flow, pressure and temperature) at specified locations throughout the system using the following guidelines:

- (a) Main flow lines of the system are shown. Drain lines, vent lines and instrument lines are not shown.
- (b) Identification numbers of the main valves are included. All symbols used are the same as the P&ID.
- (c) Operating conditions for each mode of operation are shown in a tabular form.
- (d) The position nodes for the key locations at which the operating conditions are given are shown by the symbol  (circle) or  (hexagon).

3.6 Operating Conditions

The operating conditions include the following items:

- (a) Flow (m^3/h)
- (b) Pressure (kPaG or kPaA)
- (c) Temperature ($^{\circ}\text{C}$)
- (d) Valve opening/closing conditions.
- (e) Maximum pressure drop (m) if necessary.

The following figure is located in Chapter 21 :

Figure 1.7-1 Piping and Instrumentation Diagram Symbols (Sheets 1–2)

No.	Function	Graphic Symbol	Explanation of Function																																				
1	Condition Symbol or Signal	<div><div><div>Y</div><div>X</div></div><div><div>Y</div><div>OR</div><div>X</div></div><div><div>Z</div><div>S</div></div></div>	<p>Symbol indicates signal condition or action (e.g. valve close signal). Action shifts to right when condition is met.</p> <p>Y – Is instrument number Z – Represents the name of condition signal S – Shows above or below setpoint for transfer of signal condition</p>																																				
2A	AND	<div><div><div>A</div><div>B</div></div><div></div><div>C</div></div>	<p>Output exists if and only if all specified inputs exist</p> <table><tr><td>A</td><td>B</td><td>C</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table> <p>2-Input AND Truth Table</p>	A	B	C	0	0	0	0	1	0	1	0	0	1	1	1																					
A	B	C																																					
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2B		<div><div><div>A</div><div>B</div><div>C</div></div><div></div><div>D</div></div>	<table><tr><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table> <p>3-Input AND Truth Table</p>	A	B	C	D	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0	0	1	1	1	1
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2C		<div><div><div>A</div><div>B</div><div>C</div><div>D</div></div><div></div><div>E</div></div>	<p>4-Input AND Truth Table (Not Shown)</p>																																				

Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 1 of 8)

No.	Function	Graphic Symbol	Explanation of Function																																				
2D	Coincident Variable Gate (CVG)	<div><div><div>A</div><div>B</div><div>C</div></div><div><div>2/3</div></div><div>D</div></div> <div>2/3 AND</div>	<div>Output exists if specified number of inputs exist (2 of 3, 2 of 4, or 3 of 4)</div> <table><tr><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table> <div>Truth Table 2/3 AND</div> <div>2/4 and 3/4 AND's Truth Tables (Not Shown)</div>	A	B	C	D	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1
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2E	<div><div><div>A</div><div>B</div><div>C</div><div>D</div></div><div><div>2/4</div></div><div>E</div></div> <div>2/4 AND</div>																																						
2F	<div><div><div>A</div><div>B</div><div>C</div><div>D</div></div><div><div>3/4</div></div><div>E</div></div> <div>3/4 AND</div>																																						
3A	OR	<div><div><div>A</div><div>B</div></div><div><div></div></div><div>C</div></div> <div>2-Input OR</div>	<div>Output exists only when at least one input exist</div> <table><tr><td>A</td><td>B</td><td>C</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table> <div>Truth Table 2-Input OR</div>	A	B	C	0	0	0	0	1	1	1	0	1	1	1	1																					
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3B	<div><div><div>A</div><div>B</div><div>C</div></div><div><div></div></div><div>D</div></div> <div>3-Input OR</div>	<table><tr><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table> <div>Truth Table 3-Input OR</div>	A	B	C	D	0	0	0	0	0	0	1	1	0	1	0	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	
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Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 2 of 8)


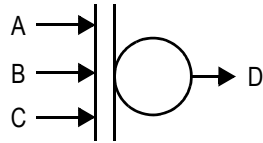
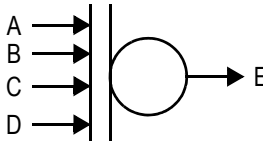
No.	Function	Graphic Symbol	Explanation of Function																																																																																					
3C	X OR (Exclusive "OR")	<div></div> <p>2-Input X OR</p>	<p>These logic symbols represent an Exclusive "OR" Gate whose output assumes 1 state if one and only one of the logic input assumes the 1 state</p> <table border="1"><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table> <p>Truth Table 2-Input Exclusive "OR"</p>	A	B	C	0	0	0	0	1	1	1	0	1	1	1	0																																																																						
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3D	<div></div> <p>3-Input X OR</p>	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr></table> <p>Truth Table 3-Input Exclusive "OR"</p>	A	B	C	D	0	0	0	0	0	0	1	1	0	1	0	1	1	0	0	1	1	0	1	0	0	1	1	0	1	1	0	0	1	1	1	0																																																		
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3E	Exclusive "OR"	<div></div> <p>4-Input X OR</p>	<table border="1"><tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr></table> <p>Truth Table 4-Input Exclusive "OR"</p>	A	B	C	D	E	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0	0	1	1	0	0	0	1	0	0	1	1	0	0	1	0	1	0	1	0	0	1	0	0	1	1	0	0	1	0	1	0	0	1	1	0	0	0	0	1	1	1	0	1	0	1	1	0	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0
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Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 3 of 8)


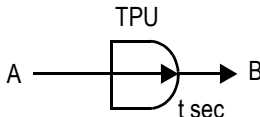
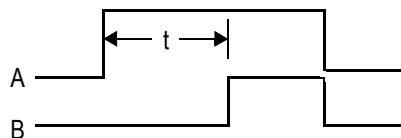
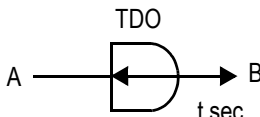
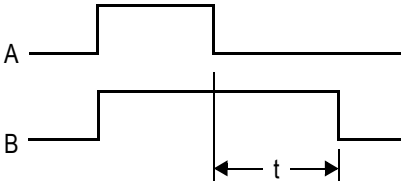
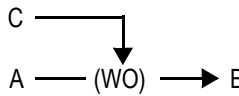
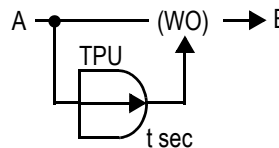
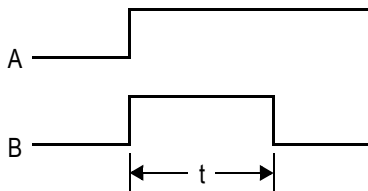
No.	Function	Graphic Symbol	Explanation of Function															
4	Not		<p>This symbol shows the “NOT” condition. Output B is opposite to input A</p> <table border="1" data-bbox="1031 478 1187 598"><thead><tr><th>A</th><th>B</th></tr></thead><tbody><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></tbody></table>	A	B	0	1	1	0									
A	B																	
0	1																	
1	0																	
5A	Timer Elements	 <p>Delayed Initiation</p>	<p>TPU– Signal B is energized within specified time limit (t) after signal A is energized. B terminates when A terminates.</p> 															
5B		 <p>Delayed Termination (Reset)</p>	<p>TDO– Initially B is energized when A is energized. signal B is de-energized within specified time limit (t) after signal A is de-energized</p> 															
6A	Wipe-Out (Signal Block)		<p>When signal C is not present, signal A is transmitted to B. When signal C is present, signal A is stopped and does not flow to B. (WO: Wipe-out)</p> <table border="1" data-bbox="990 1316 1224 1512"><thead><tr><th>A</th><th>C</th><th>B</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></tbody></table>	A	C	B	0	0	0	0	1	0	1	0	1	1	1	0
A	C	B																
0	0	0																
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1	0	1																
1	1	0																
6B	Delayed Wipe-Out (One-Shot)		<p>The output signal to B is stopped after time interval “t”.</p> 															

Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 4 of 8)

No.	Function	Graphic Symbol	Explanation of Function
7A	Self-Hold or Reset		When condition C does not exist, Condition A holds itself and there is output to B. The self holding is released when condition C is established and there is an output to B only when there is an A condition (A takes priority).
7B			When condition C does not exist, Condition A holds itself and there is output to B. The self holding is released when condition C is established and there is no output to B (C takes priority).
8	Operating Switch		<p>S – Place of installation X – Switch operation name Y – Switch type, e.g. CS—Control Switch Spring Return COS—Control Operating Switch Position Hold PBS—Pushbutton Switch PBL—Pushbutton Illuminated Type KS—Key Switch (Spring Return) KOS—Key Operating Switch (Position Hold) CRT—CRT Touch-Screen Z – Switch Position: On, Off, Pull Hold, ... etc.</p>
9	Control Component or Device		<p>Shows a component or device to be controlled X – Part # of controlled device Y – Controlled device name e.g. pump, valve, etc. Z – Controlled condition, e.g., Start, Stop, On, Off, Open, Close, ... etc.</p>
10	Electromagnetic Valve		<p>This symbol represents an electromagnetic valve E – Energize DE – De-energized</p>

Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 5 of 8)

No.	Function	Graphic Symbol	Explanation of Function
11	Electromagnetic Pilot Valve		This symbol represents an electromagnetic pilot valve E – Energized DE – De-energized
12	Memory (Flip-Flop)	 *Output D shall not be shown if not used.	S Represents “Set Memory” R Represents “Reset Memory” Logic output C exists when logic input A exists. C continues to exist regardless of subsequent state of A and until reset by input at B C remains terminated regardless of subsequent state of B, until A causes memory to reset. Logic output D, if used, exist when C does not exist, and D does not exist when C exists.
13	Static Transducer (Converter)		This device converts “E” (Electrical Signal) to “P” (Pneumatic Signal)
14	Electromagnetic Pilot Valve for Control		Shows a pilot electromagnetic valve for a control valve. When the pilot electromagnetic valve is energized by a signal from A, opening of the control valve is adjusted by a signal from B.
15	Transmission Signals or Lines		Indicates electrical signal and flow direction Indicates pneumatic line and flow direction Indicated oil hydraulic pressure line and flow direction Indicates mechanical linkage
16	Electrical Signal Connection		Signal is connected electrically Signal is not connected electrically
17	Signal Input		This symbol represents an input signal to a computer, display, test panel, etc. as designated by the letter X inside the triangle. The letter N indicates the assigned signal number.
18	Operational Condition		This graphical presentation is used in sequential control

Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 6 of 8)







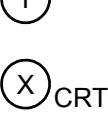




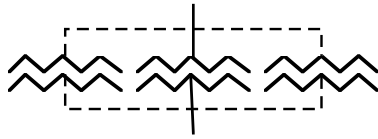
No.	Function	Graphic Symbol	Explanation of Function
19	Virtual Condition Signal		Used only for signals which do not actually exist but are convenient to show on IBD.
20	Panel Indicator Lights	     	<p>Red indication light: Shows actuation, input and valve opening</p> <p>Green indication light: Shows stop, interruption and valve closure</p> <p>White (milk-white) indication light: Shows condition indication, automatic mode operation... etc.</p> <p>Orange indication light: Shows caution and failure</p> <p>Colorless or transparent indicating light</p> <p>Light indicator to be shown on CRT. X represents the color of the light to be indicated.</p>
	Alarm		Indicates an annunciated alarm or warning. The letter N indicates the alarm number.
	Isolator		<p>This symbol represents that the input signal shall be divisionally isolated from the output signal</p> <p>X – Input division number</p> <p>Y – Isolation output division number</p>
22 to 32		Intentionally left blank for future additions	
33	Signal Transfer	 OR 	<p>These symbols indicate signal transfer to other location(s). The upper half of the symbol is used to enter the transfer code. The lower left portion of symbol is used to reference the sheet number to go to, and the lower right hand portion will indicate the location where the signal can be found. The transfer code shall utilize either an English letter or a number if signal transfer is within the same sheet or to other sheets of the IBD. For signal transfer from/or to other MPL systems, the transfer code shall be expressed with 2 English letters starting with "AA". Also indicate the system MPL reference where the signal goes to or originates next to the symbol.</p>

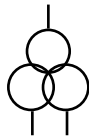
Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 7 of 8)

No.	Function	Graphic Symbol	Explanation of Function
34	MOV's Position Indication Designators (See Appendix "D" for Application Examples)	<p>LS: Limit SW TS: Torque SW</p>	<p> L — Limit Off L(T) — Limit Off With Torque Backup TL — Both Limit and Torque Off T — Torque Off TL(C) — With Chattering Prevention at TL T(C) — With Chattering Prevention at T </p> <p>The above letter designators are used to show the control methods of motor-driven valves. The control method should be indicated above the left side of the component block for valve "Opening" and below the left side for valve "Closure".</p>
35A	Comparator		These symbols represent a comparator that provide an output when the condition $A \geq B$ or $A \leq B$ is met.
35B			
36A	Load Driver		This symbol represents a standard load driver.
36B			This Symbol represents a load driver whose output power signal DIV 3 is isolated internally from the input logic signal division 1.

Figure 1.7-2 Graphical Symbols for Use in IBDs (Sheet 8 of 8)

Transformer

Three 1Ø



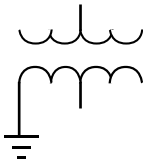
Three winding - 3Ø



Two winding - 3Ø or 1Ø



Two winding - 3Ø



Two winding - 3Ø center tap ground

Note: Symbol in transformer = winding connection type i.e.



Star

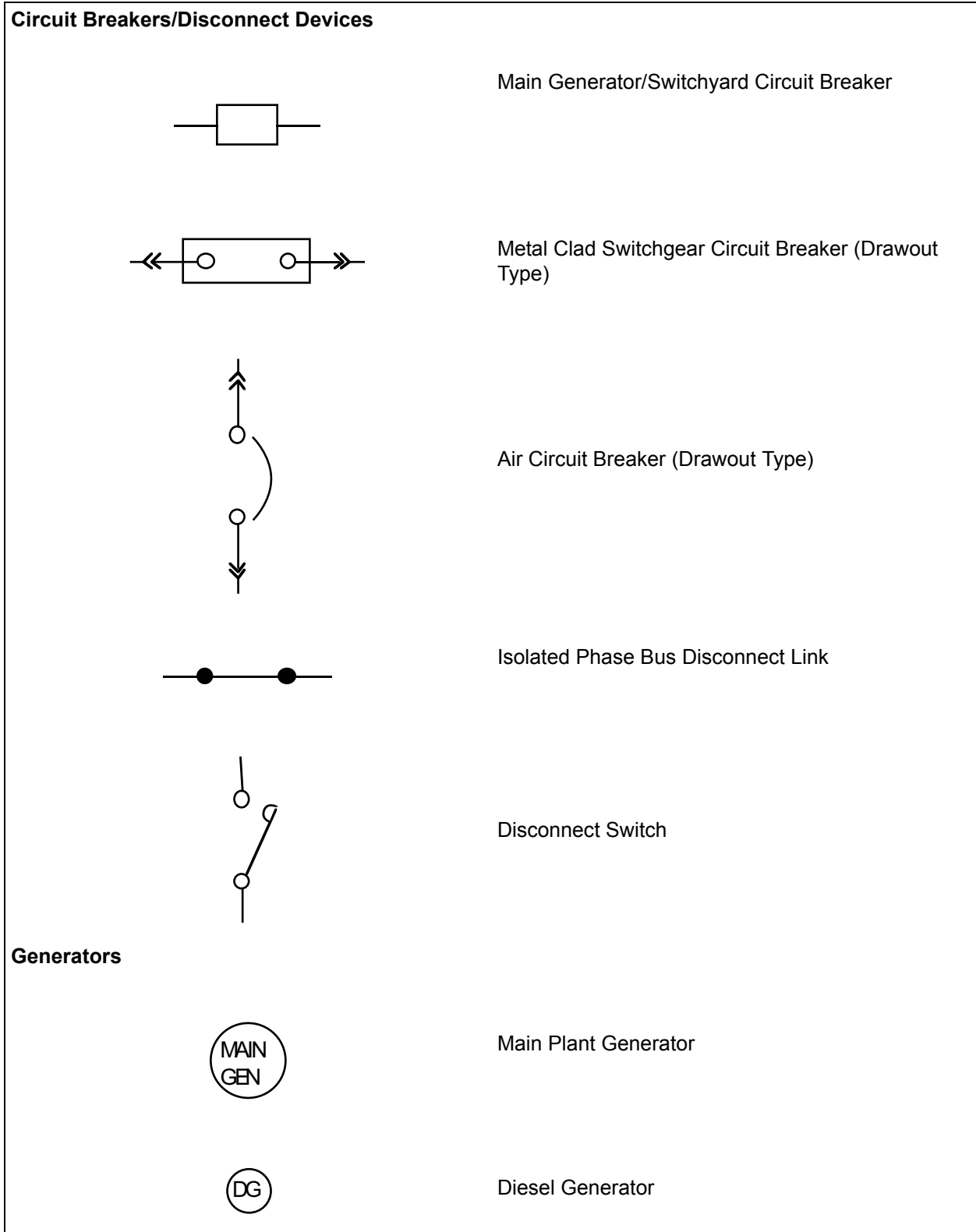


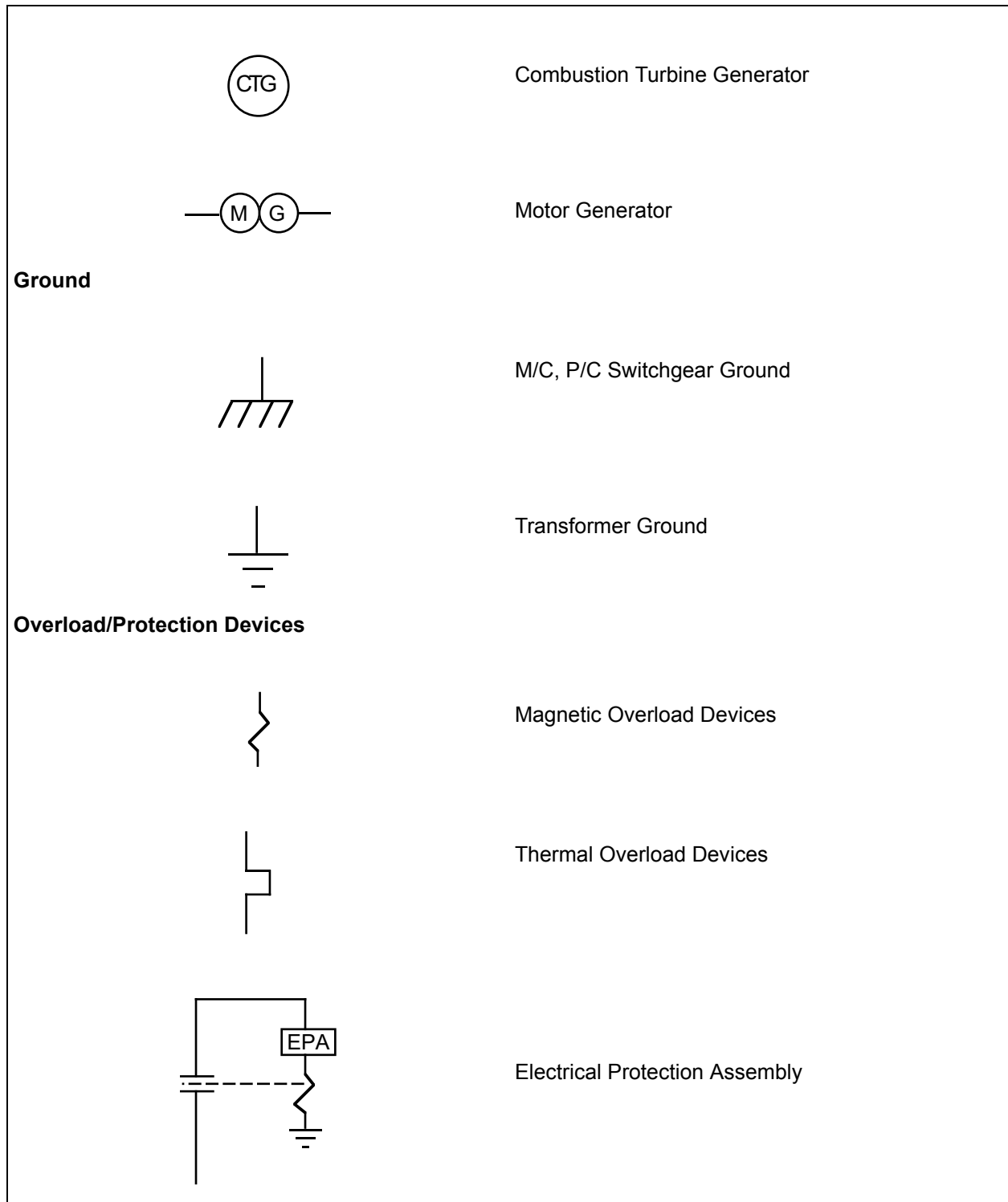
Delta

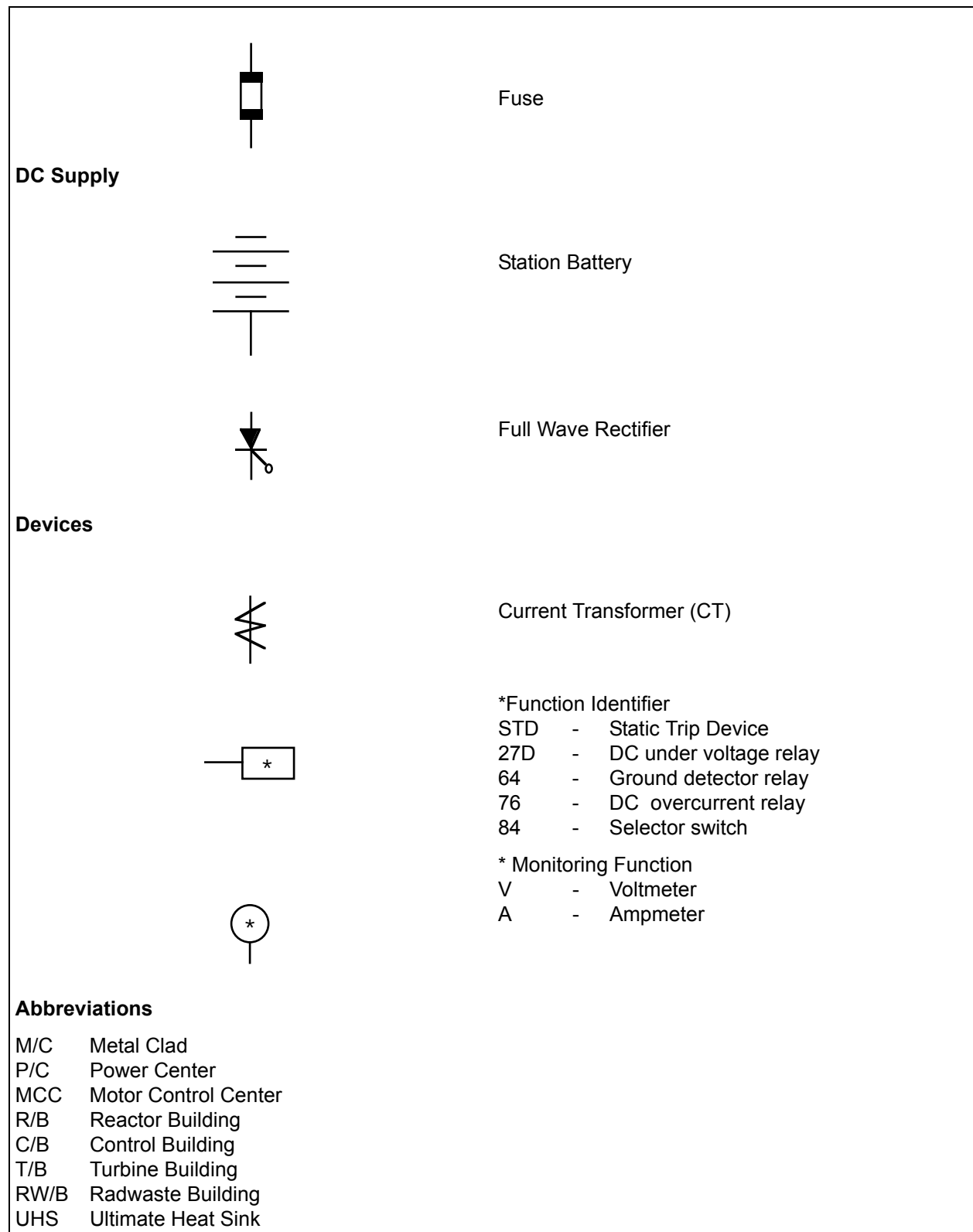


Special

Figure 1.7-3 Graphical Symbols for Use in Electrical SLDs (Sheet 1 of 4)

**Figure 1.7-3 Graphical Symbols for Use in Electrical SLDs (Sheet 2 of 4)**

**Figure 1.7-3 Graphical Symbols for Use in Electrical SLDs (Sheet 3 of 4)**

**Figure 1.7-3 Graphical Symbols for Use in Electrical SLDs (Sheet 4 of 4)**