GENERATION OAHU DIVISION
OPERATOR TRAINEE TRAINING PROGRAM

SECTION 15

READING PIPING AND INSTRUMENTATION DIAGRAMS (P&ID)

P & IDs are drawings of the process and/or flow of the mechanical systems within a given power plant unit. In addition to showing the layout of the various mechanical and piping systems throughout this unit, all of the sensing, indicating, and recording instrumentation associated with these systems is also shown. The boiler feedwater system, the fuel oil piping system, and the boiler draft system are examples of systems that would be covered by piping and instrumentation drawings.

Each set of P&I Ds for a given unit has a Legend and Index sheet, listing all of the diagrams for the unit, and a summary explanation of the various symbols, codes and related data which appear on the diagrams themselves. The information contained in this section is an expansion of this Legend data as well as information designed to assist operators in interpreting P&I diagrams and broadening their knowledge of plant nomenclature. All of the data shown on these diagrams will not be defined here however; at least 85% of the symbols and codes are addressed.

Generally, there are one or more P&I diagrams reflecting each major mechanical system. The simpler systems may be shown on one such sheet while the more extensive systems may be reflected on two or more sheets.

P&I diagrams are schematic. A schematic diagram does not reflect dimensions; i.e., size, proportion, elevation, location, distance, etc. For example, a line on a schematic representing a pipeline does not reflect the fact that this particular pipeline actually spans several levels of the unit. Similarly, two identical symbols of the same size on a schematic representing valves do not reflect the fact that one of these valves is considerably larger than the other.

Since schematics do not acknowledge dimensions, they can reflect a large complex system with a multitude of equipment, utilizing a minimum of paper, and thus are very useful to operating and maintenance personnel. As illustration, the entire Waiau 8 boiler feedwater system with all associated instrumentation is shown on two sheets (52502 - Condensate System, 52503 - Feedwater system). If an operator did not have access to these two diagrams and needed to walk through or trace this system, he would have to utilize a file of drawings which do reflect dimensions. This file consists of some 35

drawings with each drawing being 3' x 4'. The P&I diagrams for Waiau Units 3 & 4 are on 17 x 24 sheets. The diagrams for Waiau Units 5 & 6 and 7 & 8 are on 11 x 17 sheets.

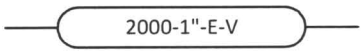
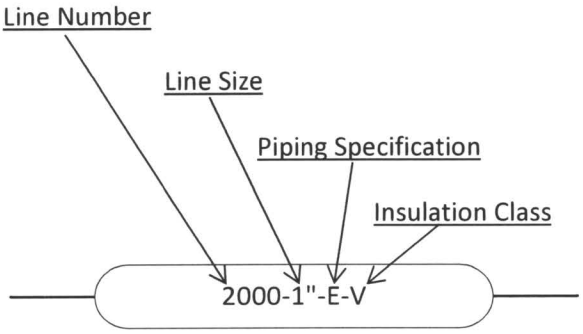
At the outset, a certain amount of basic formalized training will be furnished to the operators. However, operators will only become proficient in interpreting the diagrams for their units through practice over an extended period of time; i.e., tracing and/or walking through these systems, making a connection in their minds between the data reflected on the P&IDs and what that data physically represents in the plant.

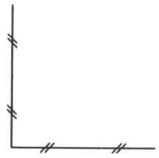
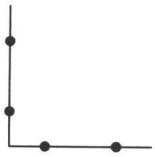
It should be noted that maintenance and other personnel also utilize these diagrams and operation do not necessarily have to interpret all of the data shown.

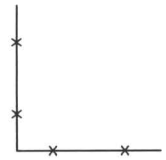
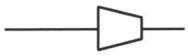
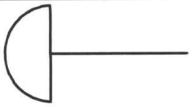
SYMBOLS

PIPELINES

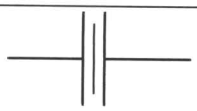
The information in this section basically pertains to the metal pipes themselves; no reference is made to any operational attachments or connection to these lines such as valves, gauges, etc.

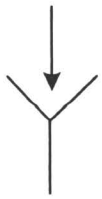
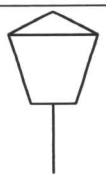
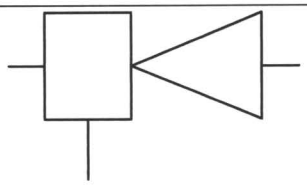
Item	P&I Code/Symbol	Explanation
1.		Line Data Code – All primary and secondary flow piping are labelled with this symbol/code. However other piping such as instrument process, control air, and capillary piping do not have this identification.  Line Number – assigned for identification and locating purposes. Line Size – size of the piping, this is a piping industry designation. Piping Specification Code – Identifies the service, schedule and material. Piping Insulation Class – Identifies service and material (usually expressed as a Roman Numeral)
2.		Primary Flow – Shown as darkened lines, and are thicker than all other lines representing piping. Primary flow lines carry

Item	P&I Code/Symbol	Explanation
		the main flow for a particular system (steam, water, air, etc.)
3.		Secondary Flow – Shown as the second thickest line. These lines serve such purposes as bypass, alternate route, and recirculation. A specific example would be a feedwater heater bypass line.
4.		Instrument Process – Shown as the third thickest line category. These are lines leading to instrumentation such as gauges which are indicating and/or recording data on various conditions of the system.
	Note: The degree of thickness between the secondary flow and instrument process piping as shown on the diagrams may be difficult to distinguish. Remember that secondary flow lines bear line data code and instrument process piping does not.	
5.		Control Air – Pipes which carry pressurized air used to operate various equipment and instrumentation such as valves, selectors, recorders, etc.
6.		Boiler Code – Piping that is constructed in accordance with the standards and requirements of the Boiler Code. P&I diagrams do not show all such piping. For example boiler tubing is not shown.

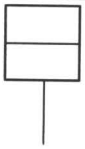
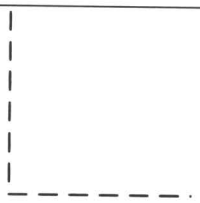
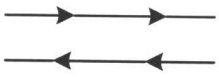
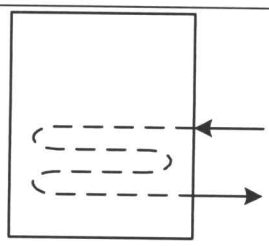
Item	P&I Code/Symbol	Explanation
7.		Capillary Tubing – Metal tubing carrying a mercury or gas power source to operate instrumentation such as temperature gauges.
8.		Union – A threaded device (similar to a standard coupling) joining two pieces of pip. These devices are placed at various points on certain lines and are designed so that maintenance personnel can readily open the lines for inspection or repair. Regular couplings are not reflected on P&IDs.
9.		Line Size Change – At these points pips of two different sizes are connected. For example a 1" line connected to a 2" line. The larger side of the symbol reflects connection to the larger line and the smaller side connection to the smaller line.
10.		Screwed Cap – Dead-end of pipeline.
11.		Welded Cap – Dead-end of pipeline

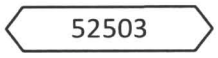
BASIC (NON-INSTRUMENT) PIPING AND DUCT ELEMENTS OTHER THAN VALVES

Item	P&I Code/Symbol	Explanation
12.		Orifice – A metal plate within a pipeline which had an opening smaller than the normal pipe size. This opening is designed to reduce line pressure and allow a measured amount of flow.
13.		Nozzle – Generally, a constructed restriction within a pipeline or duct which is connected to instrumentation in order to measure flow. The arrow denotes flow direction.
14.		Flexible Hose – A non metal section of a piping system. It is usually comprised of a material such as reinforce rubber. It is used for applications where the line or related equipment had to be moved (such as a burner gun connection) or where the line expansion is severe due to heat (such as aspirating air for boiler observation ports).
15.		Hose Connection – A metal connector utilized to connect a hose portion to a metal portion of a line, such as service air, service water and lube oil system lines.
16.		Drain – A portion of a line, duct, or equipment designed to drain the contents.
17.		Vent – A portion of a line or equipment designed to allow air/gas removal or intake.

18.		Funnel – Basically a part of a drain system which allows visual inspection of the flow, or is utilized for feeding chemicals into a container.
19.		Exhaust Head – An ending of a cent system designed to release the contents into the atmosphere.
20.	 Or 	Injector or Ejector Injector – A device connected to a pipeline designed to inject material into the system. Ejector – A device connected to a pipeline designed to eject material from a system.

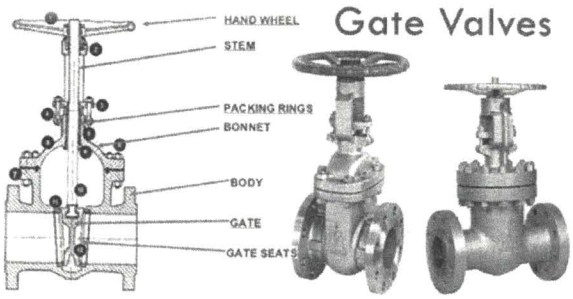
LOCAL VS. REMOTE MOUNTED APPARATUS AND INSTRUMENTATION

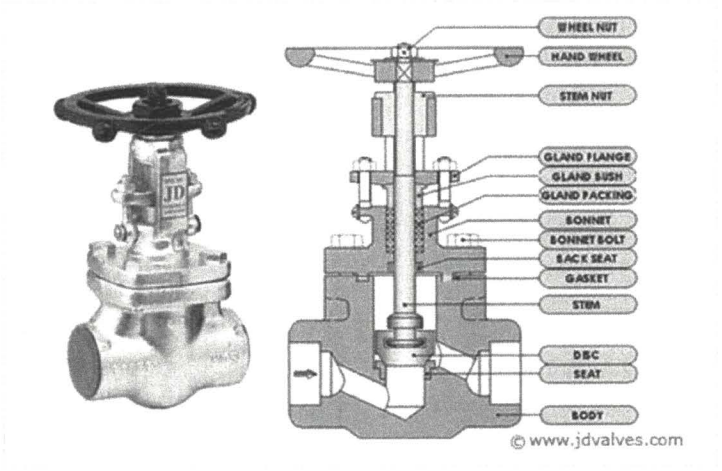
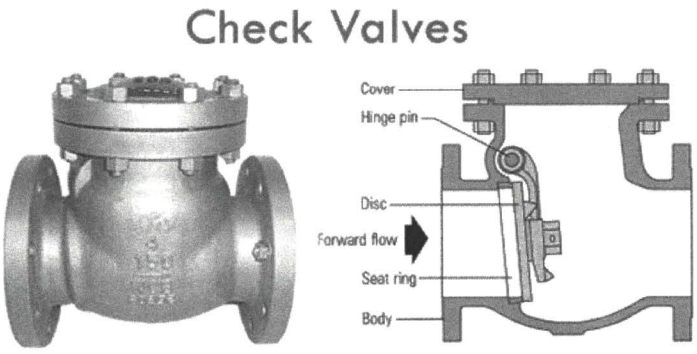
Item	P&I Code/Symbol	Explanation
21.		Local Mounted – The apparatus or instrumentation is actually located where the operation or sensing/indicating is taking place. An example would be feedwater heater temperature/pressure gauges.
21a.		Remote Mounted – The apparatus or instrumentation is located at a different location from where the operation or sending/indicating is taking place. Examples would be flow indicators and/or recorders in the control room.
22.		Instrument Electrical Leads – Wiring transmitting electrical signals to operate instrumentat9ion and equipment such as fuel oil trip valves and alarms. These leads are normally shown on the P&ID when they are remotely located; they are normally not shown when they are locally mounted.
Directional and Reference Symbols		
23.		Arrow Heads – Flow Direction – These arrow heads indicate the flow direction in all primary and most secondary lines and may be shown on certain ducts. They are normally not shown on other lines such as Instrument Process, Control Air, Boiler Code, and Capillary Tubing.
24.		Lines/Apparatus/Elements Located Within Vessels – P&IDs do not usually reflect all such data. Where they are reflected they are shown in dotted line form.
25.		Spray Bars – Spray bars are an example of an apparatus which would be within a vessel. They are metal pipelines designed to spray water into condensers.

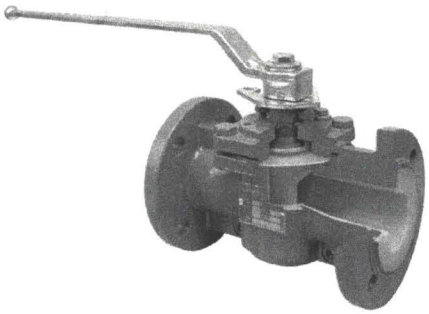
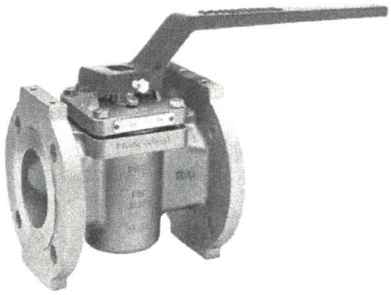
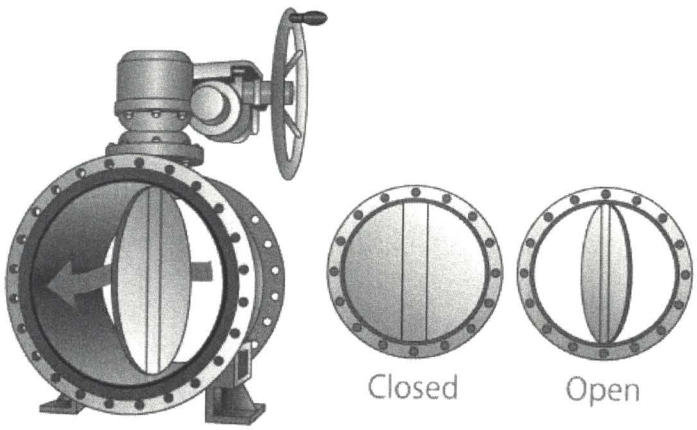
Item	P&I Code/Symbol	Explanation
26.		This symbol mean that the supplier of the main equipment also furnishes all associated equipment to the main equipment as well
27.	CH. SP.	This pertains to piping only and is the abbreviation for the phrase "Change of Specification." At these points where the code appears it is an indication that the piping has changed in some manner. For example a change from Specification Code A to B type of pipe.
28.		Reference Tie-In to Another P&I Diagram or Drawing - This symbol will bear the drawing number of another P&ID which will reflect the continuance of a particular line or system. In moving from one diagram to another where primary and secondary lines are involved, the line number will normally appear close to the matching point on both diagrams; this will assist the reader in picking up the correct tie-in point. Frequently (but not always) a phrase will appear on drawings which will also assist the reader in picking up the correct tie-in point. Example: Drawing 52502 - Condensate System Drawing 52503 - Feedwater System At the end of line No. 8195 on Drawing 52502 the following is noted: "To Boiler Feed Pumps". At the beginning of line No .8195 on Drawing 52503 the following is noted: "From Condensate System".

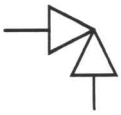
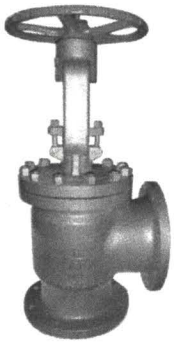
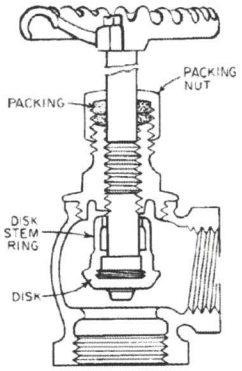
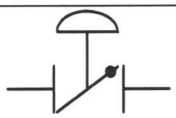
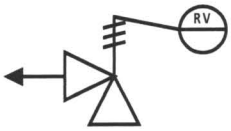
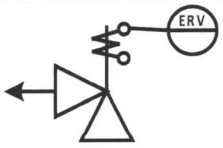
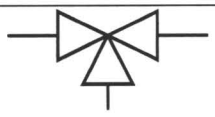
VALVES

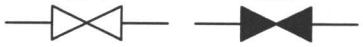
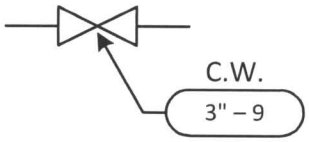
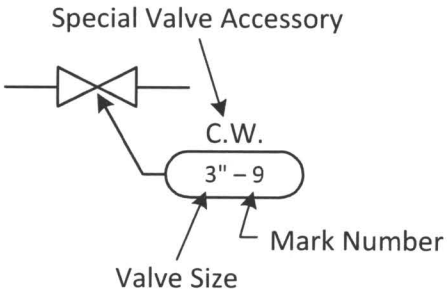
The descriptions for items 29 through 34 include cross section diagrams which are intended to reflect the basic internal composition of these valves. These diagrams reflect the valves as being manually operated. It should be noted that these diagrams cannot be used to assist in physically identifying such valves in the plant since differences between manufacturers as well as valves which are power operated may change the exterior appearance from those as shown in these diagrams.

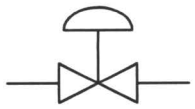
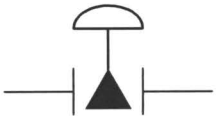
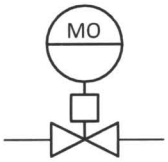
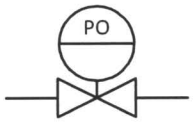
Item	P&I Code	Explanation
29.		Gate Valve – This valve is primarily for open and closed service. It is well adapted for isolation of equipment, where for long periods of time it will remain in the open or closed position and offers little or no obstruction to the flow. 

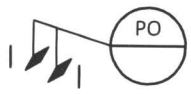
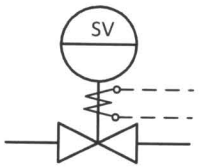
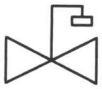
Item	P&I Code	Explanation
30.		Globe Valve – This valve provides an additional function over that of a gate valve – it can be used wide open, fully closed or in addition in an intermediate position for regulating flow. 
31.		Check Valve – This valve is entirely automatic in its operation, and is activated internally by the flow which it regulates. This valve permits the flow of fluids or gases in only one direction; if the flow stops or tries to reverse its direction the valve closes immediately and prevents a backflow. As soon as the line pressure is re-established, this valve opens and the flow is resumed. 

Item	P&I Code	Explanation
32.		Plug Valve – This valve is not restricted to one-way flow since it can be installed in either direction because it holds pressure in either direction. Flow can be reversed anytime without the danger of leakage or jamming.  
33.		Butterfly Valve – This valve is used in lines with large flow volume such as circulating water or condenser flow reversing systems. 

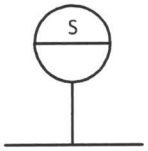
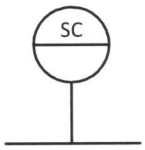
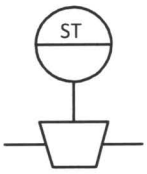
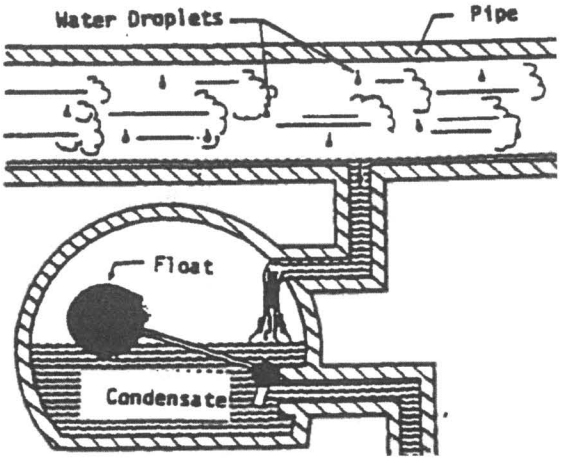
Item	P&I Code	Explanation
34.	 Or 	Angle Valve – This valve is basically a globe type valve, and is installed at a point where a line takes a right angle turn.  
35.		Bleeder Trip Valve – A check valve, operated by a pneumatic power source. It is used in such areas as turbine bleed steam lines.
36.		Relief Valve – This valve is normally closed. It is operated to open when the actual pressure in a line or vessel reaches a given point, and is designed to protect the line or vessel from an overpressure condition.
37.		Electromatic Relief Valve – Same function as a relief valve and is normally closed. Operated to open by an electrical impulse which is triggered when the pressure in a line or vessel reaches a predetermined set point.
38.		Three Way Valve – This valve allows a routing of the normal flow to 1 of 2 other directions. It is a combination of the globe and angle valve types.
39.		Gate, Globe, and Plug Valves Normally Open – When these valve types are normally open, they are shown in "lightened" form as illustrated in the symbol of a normally opened gate valve as shown here.

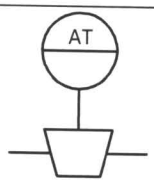
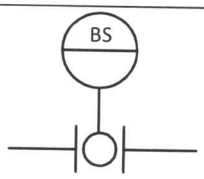
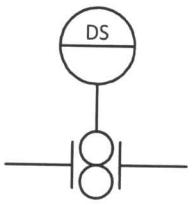
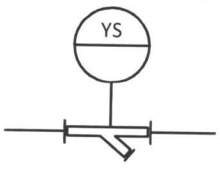
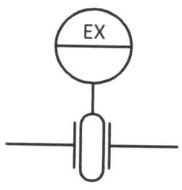
Item	P&I Code	Explanation
39a.		Gate, Globe, and Plug Valves Normally Closed – When these valve types are normally closed they are shown in "darkened" form as illustrated in the symbol of a normally closed gate valve as shown here.
	Note: Since the symbols for the gate and globe valves are very similar, it is difficult to readily distinguish which valve type is involved when this valve types are shown on the P&ID as "Normally Closed."	
40.		All Valves – Locked Open or Locked Closed – When a valve is locked open or locked closed the letters "L.O." or "L.C." will appear next to the symbol as illustrated here. The usual method of locking a valve is with a chain and padlock.
41.		Valve Data Code – All valves are labelled with this code as shown here.  Valve Size – Show in inches. Is a piping industry designation. Valve Mark – Refers to a valve index which is used by maintenance and engineering personnel. The index lists such data as type, service, and design data. Special Valve Accessory – These abbreviations identify additional apparatus which is installed for the operation of the valve. A list of codes appear on page ____

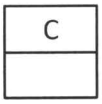
Item	P&I Code	Explanation
42.		Diaphragm – Various types of valves which employ a diaphragm operator and which are normally powered by air.
43.		Diaphragm operated control valve which will automatically open upon air failure in the line.
43a.		Diaphragm operated control valve which will automatically close upon air failure in the line.
44.		Equipment or Apparatus which is operated by an electric motor. As shown in this item, a gate valve.
45.		Equipment or Apparatus which is operated by a power source other than electric. For example by a pneumatic or hydraulic source. As shown in this item, a gate valve.

Item	P&I Code	Explanation
46.		Power Operated Damper - Dampers are utilized to control flow in air and gas duct systems. They are normally air powered.
47.		Solenoid Powered Equipment or Apparatus - A solenoid is a 2 position electric powered device, normally for the open and closed positions. As shown in this item, a solenoid operated gate valve.
48.		Float Operated Equipment or Apparatus – The level of fluid (water/oil) in a vessel raises or lowers a float which in turn operates the equipment. As shown in this item, a gate valve. (The explanation of #50 includes an illustration of float operated equipment.

OTHER APPARATUS

Item	P&I Code	Explanation
49.		Sample - A connection to a pipeline which al lows the withdrawal of content samples for inspection/analysis. An example would be a /211 pipe nipple with a 1/2" valve mounted at its end.
49a.		Sample/Cooler - Same as item 49 except that there is a cooling coil within the extension. This is utilized where the sample contents being withdrawn are at high temperatures.
50.		Steam Traps - As steam loses heat travelling through a line, droplets of water (condensate) collect on the inner surfaces of the pipe. If this water is allowed to build up in the line it will eventually fill the space needed by the steam and the flow will be blocked; also, water in the line could cause mal function of equipment to which the line is connected. These traps are designed to let condensate out of the line while retaining the steam. There are several types of steam traps in our system. The illustration below is a reflection of the operation of a float type steam trap. 

Item	P&I Code	Explanation
51.		Air Trap - Air traps serve the same purpose in airlines as steam traps (Item 50) serve in steam lines. Air traps remove liquid from air lines while retaining the air in the line.
	STRAINERS - ITEMS 52, 52a, 52b Strainers are designed to remove solid particles from pipelines which carry fluids. These particles may enter a pipeline in the fluid itself or may form within the line as the insides of the pipe walls corrode. By removing these solid particles excessive wear and equipment malfunction are minimized.	
52.		52. Single Basket Strainer - Contains 1 strainer. The line flow must be stopped when the strainer is removed for cleaning or replacement.
52a.		52a. Duplex Strainer - Contains 2 strainers. Normally the flow is through 1 strainer. However, by operating a valve, flow can be diverted through one strainer while the other strainer is being cleaned or replaced; thus line flow is uninterrupted.
52b.		52b. WYE Strainer - A single basket type strainer. This strainer can be cleaned without removal by using the line pressure, since there is a blow down valve connected to a point in the line adjacent to the strainer. As with the duplex strainer, the WYE strainer can be cleaned without interrupting line flow.
53.		53. Expansion Joint - A joint in a pipeline or duct that can expand to compensate for any one of or combination of three elements: Heat, weight, or pressure. Also in some instances these joints are utilized to compensate for piping misalignments. Such joints are usually comprised of a material such as reinforced rubber or a bellows type of construction employing stainless steel ribbing.
Item	**P&I Code**	**Explanation**

54.		54. Drain Trap - Similar function as steam traps and air traps (Items 50 & 51). Drain traps remove steam which may get into lines carrying fluids.
55.		Manual Switch - Has no provision for automatic operation. Is operated manually on a on-off basis. Is powered by air or electricity.
56.		Auto-Manual Control - A switch or other control device which can be set to be operated either automatically or manually. Has on-off and intermediate position capability.

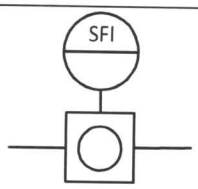
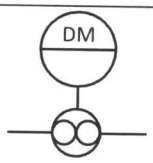
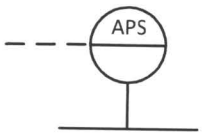
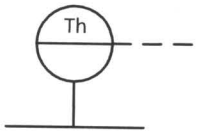
INSTRUMENTATION IN GENERAL

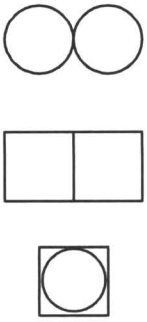
Power Plant instruments perform a wide variety of functions. However, all of these functions fall within a framework of 2 general categories, which are outlined below.

1. Sensing/Measuring - Instruments sense (or measure) a variable, such as pressure, temperature, flow, level, etc. Normally all instruments appearing on the P&IDs are shown at the point in the system where their sensing is taking place.
2. Indicating and/or Action - Instruments have an indicating and/or action function. "Indicating" is communicating the information, such as the pressure reading on a gauge. An instrument with an "Action" function is designed to automatically trigger some action in the system when it senses a given condition or conditions. An alarm is an example of the action function; Item 59, an automatic pump start, is another example.
3. Recording - This is a form of the indicating function, in that the information is permanently recorded in some manner. Item 62, a multipoint recorder is an example of this application.

Page 23 outlines the Instrument Identification Table. Proficient use of the table can be attained through practice.

INDIVIDUAL INSTRUMENT SYMBOLS SHOWN ON THE P&I LEGEND

Item	P&I Code	Explanation
57.		Sight Flow - An attachment which is part of a line carrying fluids which has a glass panel to al low visual inspection of the line flow. These devices are only utilized on low pressure lines.
58.		58. Flow Meter - An ·attachment which is part of a line carrying fluids. This attachment contains wheel s/flappers which in turn are connected to a meter which indicates the line flow rate.
59.		Automatic Pump Start - An instrument which senses abnormal pressure level s in a line carrying fluids and will automatically start a pump or pumps to restore the line pressure to normal level.
60.		Thermocouple - An instrument which electrically indicates the temperature in a line or duct. Thermocouples are installed with and without recording capability, depending on need.
61.		Multipoint Indicator - A set of gauges indicating various combinations of flow rate, pressure and temperature which are sensed at various points in lines and ducts. These indicating devices are normally located in the control room.
62.		Multipoint Recorder - Same as Multipoint Indicator (Item 61.); however the data is recorded.

Item	P&I Code	Explanation
63.		Two instrument devices located in the same casing, with both devices utilizing a common sensing point. In some instances this symbol is expanded to reflect 3 or more such devices instead of 2. Shared displays or shared control

INSTRUMENT IDENTIFICATION TABLE

"D"	Differential Instrument
"H"	High Variable Instrument
"L"	Low Variable Instrument
"HD"	High Variable Differential Instrument
"LD"	Low Variable Differential Instrument

PRIMARY TABLE

FUNCTION OF DEVICE (Third Letter)		CONTROLLER		TRANSMITTER		METER			MISCELLANEOUS			
		"C"		"T"								
TYPE OF DEVICE / MEASURED VARIABLE (First Letter) / (Second Letter)		Indicator or Blind	Recorder	Idicator or Blind	Recorder	Direct Indicator	Pneumatic Indicator	Recorder	Switch	Primary Sensing Element	Test Point or Well	Visual Observation Device
		---	"R"	---	"R"	---	"I"	"R"	"S"	"E"	"X"	---
Pressure	P	PC	PRC	PT	PRT	P	PI	PR	PS	---	PX	P
Temperature	T	TC	TRC	TT	TRT	T	TI	TR	TS	TE	TX	T
Flow	F	FC	FRC	FT	FRT	---	FI	FR	FS	FE	FX	SFI
Level	L	LC	LRC	LT	LRT	L	LI	LR	LS	LE	---	L
Conductivity	C	---	---	---	CRT	---	---	---	---	CE	---	---
Oxygen	O2	---	---	---	---	---	---	O_2R	---	---	---	---
H+ Conc.	pH	---	---	pHT	---	---	---	---	---	pHE	---	---
Position	Po	---	---	PoT	---	---	PoI	---	PoS	---	---	---
N_2H_4 Conc.	Hz	---	---	HzT	---	---	---	---	---	HzE	---	---
PO_4 Conc.	PO_4	---	---	---	---	---	PO_4I	---	PO_4S	---	---	---
Combustibles	Cb											
Hydrogen	H2											
Smoke Density	Sm											
Speed	Sp											

ALARM

"A"	When applicable this will be the last letter in the series.

BASIC DEFINITIONS

MEASURED VARIABLES – PRIMARY INSTRUMENT IDENTIFICATION TABLE

Measured Variable	Definition
Pressure	The force that is being exerted on an area. It is usually measured or indicated in terms of pounds per square inch.
Temperature	The magnitude of heat of a fluid, gas, steam, or metal. It is either measured or indicated in terms of degrees Fahrenheit or degrees Centigrade.
Flow	Flow Rate - The amount of fluid or gas that passes a point during a given time interval. It can be measured or indicated as volume per unit time such as "gallons per minute", or as weight per unit time such as "pounds per hour".
Level	The height of a fluid in a vessel.
Conductivity	The amount of dissolved impurities in water or steam.
Oxygen	The amount of dissolved oxygen in a vessel, line, or duct.
H+ Conc.	Hydrogen Ion Concentration - The amount of hydrogen ions in water at various points in the system.
Position	The degree of opened position of a given piece of equipment such as a circulating water valve or a fan damper.
N_2H_4 Cone.	Hydrazine Concentration - The amount of hydrazine in boiler feedwater.
PO_4 Conc.	Phosphate Concentration - The amount of phosphate in boiler water.
Combustibles	The amount of incomplete burning of fuel oil.
Hydrogen	The amount of hydrogen gas density in a generator.
Smoke Density	The amount of smoke density in a stack.
Speed	The number of revolutions per minute (RPM) of a given device or mechanism, such as a turbine.

INSTRUMENT IDENTIFICATION PREFIX TABLE

Code	Explanation
D	Differential Instrument - Measures a variable at 2 different points and indicates the difference.
H	High Variable Instrument - Measures and indicates a variable of a high magnitude for a given system, such as high pressure or temperature
L	Low Variable Instrument - Measures and indicates a variable of a low magnitude for a given system, such as low pressure or temperature.
HD	High Variable Differential Instrument - Measures a variable of a high magnitude for a given system at 2 different points and indicates the difference.
LD	Low Variable Differential Instrument - Measures a variable of a low magnitude for a given system at 2 different points and indicates the difference.

SPECIAL VALVE ACCESSORIES

Code	Explanation
CW	Chain Wheel - The valve hand wheel is operated with a chain. This method of manual valve operation is employed where valves are located at high elevations above the surface upon which the operator can stand.
ES	Extension Stem - The stem of a given valve is longer than the normal length utilized for that valve. Extended stems are utilized in situations where valves are located at points where operators would not have ready access to them if the stems were of normal length.
FS	Floor Stand - Valves located below floor level normally will have an extension stem passing through the floor surface. A metal casing is normally placed around the portion of the stem which is above floor level.
GO	Gear Operator - A gear attachment to the valve stem which furnishes the operator more leverage. Gear operation is normally utilized on the larger valves. The figure in the explanation of item 33 shows a gear operation attachment on the butterfly valve.
WS	Water Seal - Water is provided (by tubing) to the valve gland area, which prevents air intake. An example would be preventing air intake into a valve which is a part of the condensate system which is under vacuum.
PS	Position Switch - A switch device mounted on a valve which indicates whether the valve is currently open or closed, and in some cases partially opened/closed.

PIPING SPECIFICATION DATA

Specification Code	Type of Metal – Lines*	Pressure Range – Lbs. Per Sq. Inch (0= Vacuum)	Temperature Range (Degrees Fahrenheit)
A	Alloy Steel	1875	1005
B	Carbon Steel	1600-3300	300-650
C	Alloy Steel	580	1005
D	Carbon Steel	600-625	490-710
E	Carbon Steel	200-565	100-480
EE	Alloy Steel	5-250	800-900
	Carbon Steel	0-175	100-775
G	Carbon Steel	1100	300
H	Carbon Steel	50-150	100-300
I	Carbon Steel	5-300	70-120
J	Cast Iron	25-120	83-96
K	Galvanized Steel, or Seamless Copper Tubing, or Stainless Steel Tubing	100	120
M	Galvanized Steel	75	100
N	Alloy Steel	125	80
P	Carbon Steel	20	85
PP	Cast Iron	20	85
T	Seamless Aluminum Alloy	75	100
V	Stainless Steel	300	100
W	Stainless Steel	2500	110

*Pertains only to the line itself – frequently valves and other connections on the line are of a different type of metal.

PIPING INSULATION DATA

Insulation Class	Temperature Range (Degrees F)	General Type or Nature of Insulation
I	751-1005	Calcium silicate in blocks or molded form. Aluminum jacket on all straight pipe. On valves, fittings or bends, either aluminum jacket throughout, or canvas jacket indoors and weatherproof coating outdoors.
II	551-750	Same as Class I, except thickness or extent of insulation is less than Class I
III	351-550	Same as Class I, except thickness or extent of insulation is less than Class II
IV	251-350	Same as Class I, except thickness or extent of insulation is less than Class III
V	120-250	Same as Class I, except thickness or extent of insulation is less than Class IV
VI	135+	Same as Class I, except thickness or extent of insulation is less than Class V. Class IV insulation is for personal protection only; heat less is not a factor as it is with Classes I thru V. Also some of this piping may not be insulated in areas where the chances of personal contact are remote.