QuEST

BORN TO ENGINEER





Detail Engineering- Instrumentation & Controls

K. Rajender

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1. Input & Output List

- I/O List is a document containing list of instrumentation which serve as an input or output of control system. Therefore, only the tag number that physically has a cable which connects to the control system appears on I/O List.
- When there are more than one control system in a plant (let say PCS and SIS), the I/O list shall clearly indicates which instruments is assigned to which control system or may separate them to different section in the document.
- In I/O list, the following information should be stated but not limited to:

i. Tag number
ii. Loop Number
iii. Service description
iv. P&ID Number
v. Type of Instrument
vi. Location
vii. I/O Type
viii. Control System
ix. Range or set point

The information column in which I/O list contains may be as simple as above, however some project require I/O list to be detailed by having alarm list, controller action, logic “0”/“1”descriptor. Later on, I/O list would include I/O number assignment (rack, slot, channel number) which information to be provided by control system vendor.

The purpose of I/O List

I/O list is used to determine the size of control system required by project, by counting how many I/O exists within a plant by each control system

Input & Output List-Template

System I/O List																				
Customer:	Petrobras																			
GO:	E08014																			
BO:	E828002																			
Revision:	3																			
Doc:	DOC000000094032																			
Rev_#	Tag_Number	System_Name	Description	Signal_Nam	Sensor_Name	From	To	Powered By	Range	Units	PLC_Tag	Rack	Slot	Channel	Low_Low	Low	High	High_High	Trip	Permissive	Comments
CCC Vanguard																					
	LIT-22120123	Lube Oil	Oil Reservoir Level	AI	4-20mA	Field	CCC	CCC	0-100 / 0-2100	% / mm H2O	AI_01			1		56				Pump perm @ 31%	Interlock heater
	TIT-22120122	Lube Oil	Oil Reservoir Temperature	AI	4-20mA	Field	CCC	CCC	0-100	C	AI_02			2		18.3	71.1			Pump perm @ 10C	15- Heater On; 25- Heater Off
	PIT-22120113A	Lube Oil	Aux Oil Pump Discharge Pressure	AI	4-20mA	Field	CCC	CCC	0-21	kg/cm2	AI_03			3							3.5 = Aux Pump Running
	PIT-22120113B	Lube Oil	Main Oil Pump Discharge Pressure	AI	4-20mA	Field	CCC	CCC	0-21	kg/cm2	AI_04			4							3.5 = Main Pump Running
	TIT-22120115	Lube Oil	Pump(s) Discharge Temperature	AI	4-20mA	Field	CCC	CCC	0-100	C	AI_05			5		40	66				
	TIT-22120120	Lube Oil	Cooling Water Discharge Temperature	AI	4-20mA	Field	CCC	CCC	0-100	C	AI_06			6		22	50				
	PDIT-22120107	Lube Oil	Oil Filter Differential Pressure	AI	4-20mA	Field	CCC	CCC	0-2	kg/cm2	AI_07			7			1.4				
	TIT-22120104	Lube Oil	Oil Supply Temperature	AI	4-20mA	Field	CCC	CCC	0-100	C	AI_08			8		43.4	54.4			Comp perm @ 21.1C	
	PIT-22120109	Lube Oil	Oil Supply Pressure	AI	4-20mA	Field	CCC	CCC	0-15	kg/cm2	AI_09			9		7.73					< 7.73 - Start Aux Pump
	LIT-22120127	Lube Oil	Rundown Tank Level	AI	4-20mA	Field	CCC	CCC	-32.60-173/0-2100	% / mm H2O	AI_10			10		85	115			Comp perm @ 85%	
											AI_11			11							
	FIT-22120152	Seal Gas	Seperation Gas Flow IE	AI	4-20mA	Field	CCC	CCC	0-6350	mm H2O	AI_12			12							
	FIT-22120151	Seal Gas	Seperation Gas Flow DE	AI	4-20mA	Field	CCC	CCC	0-6350	mm H2O	AI_13			13							
	PIT-22120158	Seal Gas	Gas Reference Pressure	AI	4-20mA	Field	CCC	CCC	0-50	kg/cm2	AI_14			14			1.86				
	FIT-22120165	Seal Gas	Flush Gas Supply Flow	AI	4-20mA	Field	CCC	CCC	0- 311	kg/hr	AI_15			15		186.2					N2 or fuel gas, different values, how do
	FIT-22120155	Seal Gas	Primary Gas Supply Flow D.E.	AI	4-20mA	Field	CCC	CCC	0- 11.27	kg/hr	AI_16			16		7.35	10.87				
	FIT-22120153	Seal Gas	Primary Gas Supply Flow N.D.E.	AI	4-20mA	Field	CCC	CCC	0- 11.27	kg/hr	AI_17			17		7.35	10.87				
	PIT-22120156	Seal Gas	Primary Gas Supply Pressure D.E.	AI	4-20mA	Field	CCC	CCC	0-10.54	kg/cm2	AI_18			18		2.3					
	PIT-22120154	Seal Gas	Primary Gas Supply Pressure I.E.	AI	4-20mA	Field	CCC	CCC	0-10.54	kg/cm2	AI_19			19		2.3					
	PDIT-22120166A	Seal Gas	Flush Supply DP	AI	4-20mA	Field	CCC	CCC	0-1	kg/cm2	AI_20			20	0.07	0.21					Maintain at 0.35 kg/cm2.
				AI	4-20mA	Field					AI_21			21							
	PDIT-22120144	Seal Gas	Diff. Press. Across Gas Ref. and Comp. Inlet	AI	4-20mA	Field	CCC	CCC	0-2	kg/cm2	AI_22			22			0.7				
	PDIT-22120163	Seal Gas	Flush Gas Supply Filter DP	AI	4-20mA	Field	CCC	CCC	0-1	kg/cm2	AI_23			23			0.51				
					4-20mA	Field					AI_24			24							
					4-20mA	Field					AI_25			25							
	PDIT-22120148	Seal Gas	Primary Seal Gas Supply Filter DP	AI	4-20mA	Field	CCC	CCC	0-1	kg/cm2	AI_26			26			0.51				
					4-20mA	Field					AI_27			27							
	PDIT-22120145A	Seal Gas	Diff. Press. Across Primary and Flush Gas Supply	AI	4-20mA	Field	CCC	CCC	0-2.5354	kg/cm2	AI_28			28	0.7	1.41					Maintain at 2.1 kg/cm2.
				AI	4-20mA	Field					AI_29			29							
	FIT-22120150A	Seal Gas	Primary/Separation Seal Gas Supply Press	AI	4-20mA	Field	CCC	CCC	0-7	kg/cm2	AI_30			30		3.52					
	FIT-22120162	Seal Gas	Primary Seal Gas Vent Flow DE	AI	4-20mA	Field	CCC	CCC	0-1270	mm H2O	AI_31			31							
	FIT-22120160	Seal Gas	Primary Seal Gas Vent Flow IE	AI	4-20mA	Field	CCC	CCC	0-1270	mm H2O	AI_32			32							
											AI_33			33							
	PIT-22120159	Seal Gas	Separation Seal Gas Pressure DE	AI	4-20mA	Field	CCC	CCC	0-1	kg/cm2	AI_34			34		0.35				Pump perm @ 0.35	
	PIT-22120157	Seal Gas	Separation Seal Gas Pressure IE	AI	4-20mA	Field	CCC	CCC	0-1	kg/cm2	AI_35			35		0.35				Pump perm @ 0.35	
											AI_36			36							
											AI_37			37							
	PIT-22120147	Seal Gas	Nitrogen Backup Gas Pressure	AI	4-20mA	Field	CCC	CCC	0-16	kg/cm2	AI_38			38		10					
											AI_39			39							
	TT-22120150	RCP	RCP Temperature High Alarm	AI	4-20mA	RCP	CCC	CCC	-100-200	C	AI_40			40			50				Control
											AI_41			41							
	FZT-22124156	Antisurge	1st Stage Anti-Surge Valve Position	AI	4-20mA	Field	CCC	CCC	0-100	%	AI_42			42							
	FZT-22124252	Antisurge	2nd Stage Anti-Surge Valve Position	AI	4-20mA	LCP	CCC	CCC	0-100	%	AI_43			43							

2. Instrument Index:

- Instrument index is a document containing list of instrument devices within a plant. Instrument index shall include tag number of all physical instruments (e.g. field instrument, physical alarm and indicator) and pseudo instrument which commonly named “soft tag” (e.g DCS indication, alarm, and controller).

- Instrument index shall be created at the beginning of project and considered as a live document which should be kept updated even though the plant has been operated. Instrument index shall be revised if there is any plant or system modification which impact to additional, removal, or resetting of instrument.

- In instrument index document, the following information should be stated but not limited to:

i. Tag number
ii. Loop Number
iii. Type of Instrument
iv. Location
v. Service description
vi. P&ID Number
vii. Line number or equipment number
viii. I/O Type
ix. Control System
x. Range or set point along with engineering unit used

- Applicable reference Document (Instrument Data Sheet Number, Hook-up Drawing Number, Instrument Layout Number, Loop Drawing Number)

Package Number
Manufacturer
Model Number

Instrument Index:

- The following references are required in preparing instrument index to make it complete of information:

- Reference drawing: P&ID, HMB

P&ID (Piping and Instrumentation Diagram)

- From P&ID all instrument tag number are gathered along with its associated information such as service description, instrument type, line/equipment number, set point. A good quality P&ID may have distinct symbol that distinguish control system to which each instrument connected.

HMB (Heat and Material Balance)

- We can determine measurement range of instrument based on process data on each stream from HMB (Heat and Material Balance).

- Reference document: Cause & Effect

Instrument index should include fire and gas related tag numbers. Fire and gas devices usually do not appear in P&ID, they are stated in cause and effect instead.

The purpose of instrument index

From its self explanatory name, instrument index will be referred as an index for many purposes as follow:
As a basis to prepare the I/O list by extracting only the tag number which has I/O point
Searching, Listing, Filtering a tag number

Instrument Index-Template

CLIENT :
LOCATION :
PROJECT : UPGRADATION PROJECT (EPCC-1)
JOB NO. : 020313
UNIT NO. : DHDT

INSTRUMENT INDEX

INST. TAG NO.	INSTRUMENT TYPE / SERVICE	SYSTEM	RANGE / UNIT	LOC	P&ID NO. (31307-CO-)	EQUIP. No. LINE No. or	MR.&SPEC.NO. (02207-3-02-)	CONTROL SYSTEM INSTALLATION DRAWINGS: INST. SIGNAL LAYOUT (DALM-302-0-IO-) / INST. PNEU. SIG. & S.TUBING LAYOUT (DALM-302-0-IO-)	INST. LOCATION PLAN DWG. (DALM-302-0-IO-)	INST. LOOP DIAGRAM (DALM-302-0-IO-)	INST. LOGIC DIAGRAM (DALM-302-0-IO-)	INST. WIR. & S.TUB. CONN. DWG. (DALM-302-0-IO-)	INST. PROCESS PIP. & S.TUBING TRAC. DWG. (DALM-302-0-IC-IO-)	INST. WIR. & S.TUB. CONN. LIST (DALM-302-0-IO-)	REMARK
301-PSV-1503	SAFETY RELIEF VALVE *301-V09-G01*		-		301-131 5		427								
301-TT-0348C	TEMP. SMART TRANSMITTER *COLD AIR DUCT*		-		301-130 3C		4400-417								
301-TT-0348A	TEMP. SMART TRANSMITTER *COLD AIR DUCT*		-		301-130 3C		4400-417								
301-TT-0348B	TEMP. SMART TRANSMITTER *COLD AIR DUCT*		-		301-130 3C		4400-417								
301-AE-0301	ANALYZER ELEMENT *301-F-01*	-	-	L	301-130 3B	-	-	- 277	237					-	DD-00680-301-62-0 01
301-AI-0301	INDICATOR *REACTOR FEED HEATOR*	-	-	(D)	301-130 3B	-	4400-401	- -	-					-	
301-AT-0301	ANALYZER XMTR *REACTOR FEED HEATOR*	DCS	0 - 50 ppm V	L	301-130 3B	301-F-01	-	- -	-				A01	D02	
301-AE-0302	ANALYZER ELEMENT *301-F-01*	-	-	L	301-130 3B	-	-	- 277	237					-	DD-00680-301-62-0 01
301-AI-0302	INDICATOR *REACTOR FEED HEATOR*	-	-	(D)	301-130 3B	-	4400-401	- -	-					-	
301-AT-0302	ANALYZER XMTR *REACTOR FEED HEATOR*	DCS	0 - 100 ppm V	L	301-130 3B	301-F-01	-	- -	-				A01	D02	
301-AE-0303	ANALYZER ELEMENT *301-F-01*	-	-	L	301-130 3B	-	-	- 277	-					-	DD-00680-301-62-0 01
301-AIC-0303	INDICATOR *REACTOR FEED HEATOR*	-	-	(D)	301-130 3B	-	4400-401	- -	-					-	
301-AT-0303	ANALYZER XMTR *REACTOR FEED HEATOR*	DCS	0 - 15 %vol	L	301-130 3B	301-F-01	-	- -	237				A03	D02	
301-AY-0303B	ANALYZER *301-F-01*	-	-	D	301-130 3B	-	4400-401	- -	-					-	DD-00680-301-62-0 01

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3. Instrument Data sheet

- Instrument Data Sheet is a document containing specification and information of an instrument device. It specifies general information of instrument such as tag number identification, service description, location (line number/equipment number), P&ID number or drawing number reference, process data (if applicable), calibrated range (if applicable), material, performance details (such as accuracy, linearity – if applicable), hazardous certification (for electrical device), accessories required, etc. The details of information in data sheet may differ among each types of instrument such as transmitter, switch, gauge, control valve.
  Reference document: Piping and Instrumentation Diagram (P&ID), Heat and Material Balance (HMB), line list, instrument specification, piping specification, calculation, vendor catalog.

- Preparing a data sheet requires some document/drawing references. The following steps describe the work flow:

- **P&ID** provides general information such as instrument tag number, service description, line number/equipment number, P&ID number.

- **Process data**. Some of the following process data should be available for selection of instrument; fluid type, fluid state (gas/liquid), design pressure, operating pressure, design temperature, operating temperature, flow rate, density, viscosity, specific gravity, ratio specific heat (gas), molecular weight (gas). However, the information of process data which is required to be specified in the data sheet varies depends on the instrument type. For example, a pressure gauge data sheet does not require ratio of specific heat. By knowing those process data, Instrument engineer may select material of instrument, calibrated range, body rating, etc. Process data can be obtained from process discipline document named “Heat and Material Balance”. Other way, instrument engineer may look to the line list, also issued by process discipline, to get general process data. However, compared to HMB, only limited process data is provided in line list document.

- **Project specification**. Company has specification which details minimum requirement for instrumentation. In addition, it also provides standard that shall be applied to instrument in order to have uniform specification for certain instrument throughout the plant. This is intended to minimize the spare part and tools, also to give ease of maintenance.

- **Calculation**. Some instrument need to be calculated to have a proper size. This calculation is required prior data sheet preparation. Control valve, pressure safety valve, orifice plate, thermowell are some of instruments which need to be calculated.

Instrument Data sheet

- **Vendor catalog**. It is recommended to refer vendor catalog during data sheet preparation to ensure that the device is available on the market. Skipping this activity could result difficulties in finding the instrument on the market during procurement phase. If the instrument is not available on the market, it could change the design, not only the instrument design but also could revert back up to process design. Not only re-work, it also could result to project delay.

- **Code and Standard**. Last but not least, cross check to the related code and standard is needed although this issue mostly has been covered in project specification.

The purpose of instrument data sheet

When the data sheet completed, it is attached to requisition which to be sent to several vendors. Vendors will offer their quotation with various model and manufacturer among the offers. It is an instrument engineer responsibility to evaluate all quotation and determine which offer is technically acceptable.

Having been considered its technical and commercial aspects, the instrument is purchased. Following the purchase order, vendor will submit supporting document and drawing. Based on vendor data, instrument data sheet may be updated to accommodate details to make the data sheet “as-built”.

Finally, data sheet along with its supporting vendor data are stored in library or document control and will be referred during construction, operation and maintenance.

Instrument Data sheet-Template

Instrument Data Sheet 1

			DOC NO :						Rev		Rev		Rev	0			
			PAGE OF						Sign	DATE	Sign	DATE	Sign	DATE			
			CLIENT:				Made by:						Supervisor	11.10.200			
			UNIT:	300			Chkd by:										
PROJECT :			MSQ				Appr by:										
INSTRUMENT DATA SHEET FOR ON-OFF VALVE (BALL TYPE)																	
SUPPLIER :																	
UNITS: Pressure - kg/cm2g Temperature - DegC Level/Length - mm																	
GENERAL	1	Tag No.		300-UV-1802			ACTUATOR	Type of Actuator	Spring Diap		Piston Cyl		Spring Pist				
	2	Item Number	Quantity	21	ONE			Design	Single Act.	X	Double Act.						
	3	Nom Line Size	SCH	2"	S160			Action on Air Fail	Open		Close	X	Stayput				
	4	Line Spec.		CBD-0303-1101-A35A				Pneumatic Connection	1/2" NPT		1/4" NPT	X					
	5	Service		REACTOR DEPRESSURIZING				Colour	Mfg. Std.		Red	X	Green				
	6	IBR Certificate		-				Handwheel	Top		Side						
OPERATING CONDITIONS	7	Fluid	Fluid State	HC/H2 + TRACE				Unused Port	Breather								
	8	% Slurry Cont.	% Flashing	---				Actuator size									
			Units	MIN	NOR	MAX		Spring Range									
	9	Flow Rate	kg/hr	---	---	---	POSITIONER	Type of Positioner	Pneumatic		Not Reqd	X	E/P				
	10	Inlet Pres (P)	kg/cm2g	---	NOTE-1	---		Input Signal	0.2-1		4-20 mA						
	11	Outlet Pres	kg/cm2g	---	NOTE-1	---		Action	Universal		Direct		Reverse				
	12	Pres Drop	kg/cm2		MIN/MUM			Electrical Conn									
	13	dP Shut Off	kg/cm2g					Supply Conn (Air)									
	14	Design Temp	Deg C		200			Tubing Material									
	15	Design Pres	kg/cm2g		3.5			Output Air Sig Conn	1/2" NPT		1/4" NPT						
	16	Temp	Deg C		214			Gauges	Supply		Signal		Output				
	17	Density	kg/m3		---			Prot. Class (Elec)									
	18	Mol Wt			---			Ingress Prot.									
	19	Viscosity	cP					WP Enclosure	Diecast Al		Epoxy Paint						
	20	Vapour Pres	kg/cm2(a)					Air Supply Pres									
	21	Critical Pres	kg/cm2(a)				ACCESSORIES	Air Set Unit	Required	X	Not Reqd						
	22	Gas Compressibility Factor			---			Range	0-4 Bar		0-7 Bar	X					
	23	Cp/Cv Ratio						Filter Size	5 Microns	X	25 Microns						
	24	Degree of Superheat						Quick Exh. Valve	Required		Not Reqd	X					
	25	Insulation Type/Thick mm						Booster Relay	Required		Not Reqd	X					
VALVE SIZING				MIN	NOR	MAX		Supply Voltage	110 VDC +/- 10%								
	26	Calculated Cv						SOV prot. Class	EX-PROOF AND WP TO IP-65								
	27	Degrees Opening						Solenoid Valve	Required	X	Not Reqd						
	28	Selected Cv						Limit Switch	Required	X	Not Reqd						
	29	Maximum Opening		40 °		90 ° X		Type of Limit SW	Micro SW		Proximity	X					
	30	Predicted Sound Level dBA						Contact / Rating	2 NO/		24VDC, 5A						
	31	Crit Vel. M/Sec	Mach No.					Elec. Conn. Size	1/2" NPT	X	3/4" NPT						
BODY	32	Valve Type		BALL				Prot. Class Lim SW	INTRINSICALLY SAFE								
	33	Body Size	Bore Type	2"	FULL BORE			Ingress Prot.	IP-65	X							
	34	Rating	Finish/Facing	300#	RF, 125AARH			Material	Diecast Al	X	Epoxy Paint						
	35	End Connections		2" FLANGED, 300# RF 125AARH			MISC	Paint Body & Bonnet	Epoxy Paint	X	Acid resist						
	36	Body Materials		ASTM A 216 Gr WCB				Colour	Silver	X							
	37	Special Requirements		SOUR + NACE SERVICE				Pipe Run	Horizontal	X	Vertical						
	38	Certification							Model No				Manufacture				
	39	Ball Material		ASTM A 351 CF3M			MODEL NO	Valve	1220 HBL				ORBIT				
	40	Shaft Material	Pin Material					Actuator	V 125 SR				VIROO				
	41	Bushing/Bearing Material						Positioner									
	42	Line Material						Solenoid Valve	AFXB 307 C8U				ASCO				
	43	Characteristics		ON-OFF				Limit Switch	NCBS-M-GM-40-N0				P & F				
BONNET	44	Seat Material		PTFE				Other Requirements									
	45	Gland Packing		PTFE	X	Grafoil											
	46	Lubricator Valve		YES		NO X		Studs / Nuts Material	A 193 GR B7M / A 194 GR 2HM								
	47	Leakage Class															
	48	Bonnet Type		STANDARD													
	49																

4. Hookup Drawing

Hook-up drawing is a detailed drawing showing typical installation of instrument in a correct manner so that instrument operates properly (gives accurate indication and prevent any issued which could potentially affect the measurement such as liquid trap in gas impulse line).

Hook-up drawing indicates tubing slopes, position of instrument in reference to process tapping point, scope break between instrument vs piping.

Hook-up drawing also gives information the requirement of bulk material for each installation. It also details its specification (size, type and material) and the quantity.

There are two types of hook-up drawing:

1. Process Hook-Up

This hook-up drawing contains typical installations for instrument which connects to the process

1. Pneumatic Hook-Up

This hook-up drawing contains typical installations for instrument which requires instrument air such as control valve, actuated valve

Reference drawing: P&ID, Installation Detail Specification, Piping Specification

P&ID tells the designer which instrument requires a hook-up drawing. A good designer can also read whether the instrument tapped in gas service or liquid service.

Battery limit between instrument and piping shall be made clear, this is stated in P&ID symbol and typical sheet or piping documents.

Installation detail specification will also specify items that should be utilized and factor that should be considered in one installation

The purpose of Instrument Hook Up Drawing

As stated earlier, information of the requirement of bulk material is stated for installation on each sheet hence the bulk material required for the whole drawings could be summarized and tabulated in a document named Material Take Off.

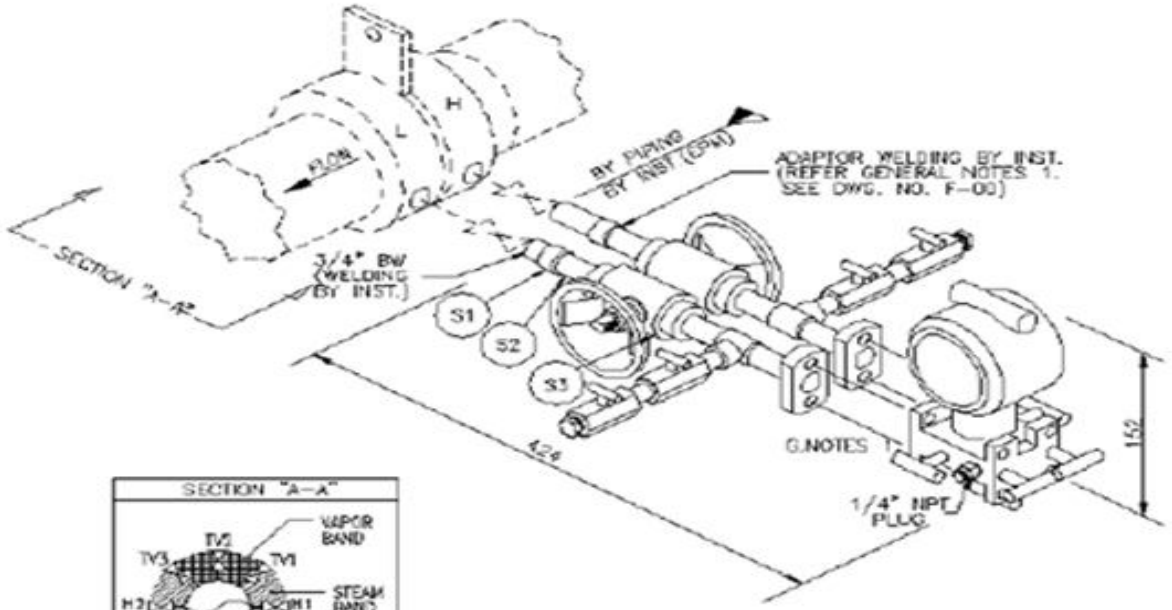
During project construction phase, this drawing is also referred as a guidance of how to install the instrument properly.

Hookup Drawing-Template

Hook-up

Loop Name : 000012	Hook Up
Field Tag : 301-FT-0104	FLOW F03

D/P SMART XMTR (FLOW)



5. Instrument Loop Diagram

- Loop diagram represents detailed drawing showing a connection from one point to control system. It could be connection between:

- Field instrument to control system (or vice versa)

- Signal from Control Panel to control system (or vice versa)

- from MCC to control system (or vice versa)

- Signal form one control system to another system

- Loop diagram shows instrument (in a symbol) and its terminal numbers which are to be connected, instrument cable number, junction box number, terminal number assigned for the specified instrument, multi-pair cable and pair number , marshaling cabinet number, terminal number in marshaling cabinet, control system details (rack, slot, I/O channel). It also clearly indicates location of each equipment by means of border line as a limit.

- Loop Diagram usually shows a single control loop which means it could only contains just one input (sensor to control system), just one output (control system to final element) or combination of both

- Reference drawing

To have the loop diagram completed and provide complete information, the following are list of data required along with its source/reference:

Instrument Loop Diagram

- Instrument Terminal number. Most instrument could be assumed to use (+) and (-). Terminals. Instrument which needs special arrangement such as smoke detector or instrument which in series loop, requires manufacturer connection detail to make the cable is properly connected.

- Junction box terminal number, this information could be obtained from JB wiring connection

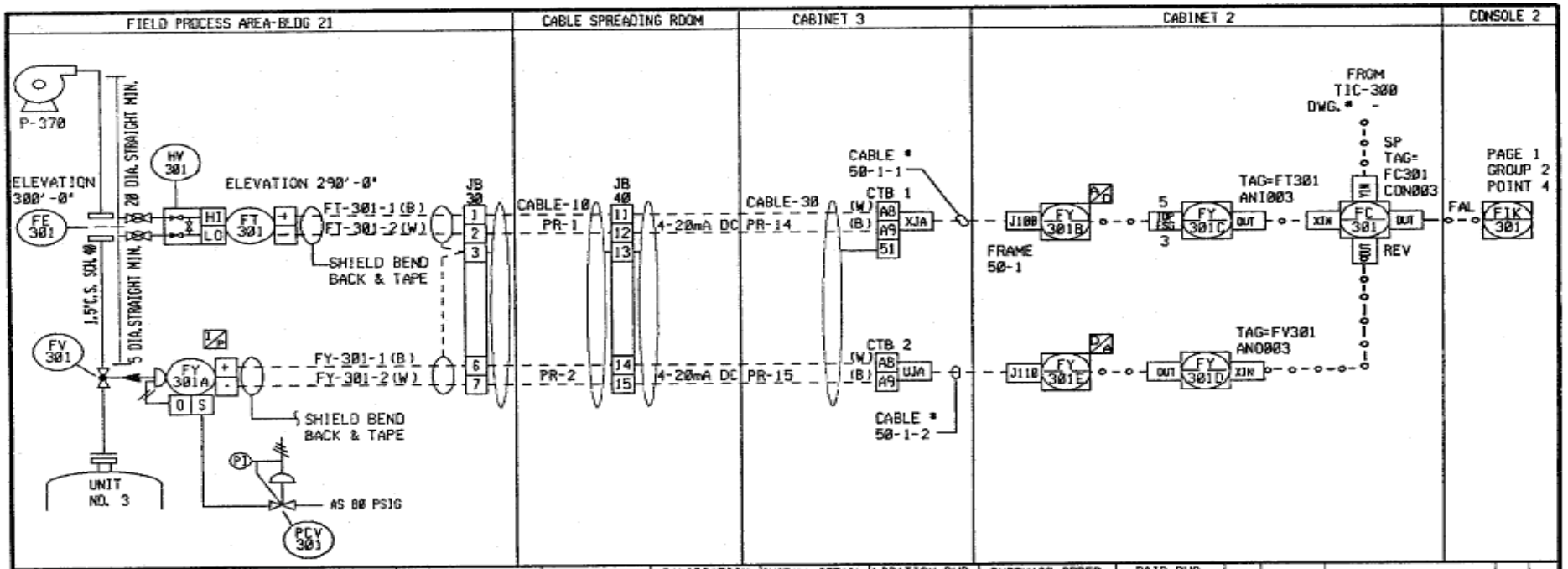
- Marshaling terminal number, this information could be obtained from marshaling wiring connection.

- I/O point detail information. Obtain this information from I/O assignment which is produced by system integrator or control system vendor.

- **The purpose of instrument loop diagram**

It is used in checking of a correct installation and connection when tested during pre-commissioning, commissioning and also for trouble shooting during operation.

Instrument Loop Diagram-Template



TAG No.	DESCRIPTION	MANUFACTURER	MODEL No.	SPEC. No.	CALIBRATION	INSTALL DETAIL	LOCATION DWG.	PURCHASE ORDER	P&ID DWG.
FE-301	ORIFICE PLATE				0.586 IN.				
FIK-301	CRT CONSOLE/DISPLAY								
FT-301	TRANSMITTER				0-100 IN.				
FV-301	CONTROL VALVE								
FY-301A	TRANSDUCER								
HV-301	MANIFOLD VALVE								
PCV-301	AIR SET				20 PSIG				
FC 301	PID BLOCK								
FY 301C	INPUT BLOCK								
FY 301B	ANALOG INPUT CARD								
FY 301E	ANALOG OUTPUT CARD								
FY 301D	OUTPUT BLOCK								

No.	Date	Revisions	By	Apr

FRESH FEED FLOW CONTROL TO UNIT NO. 3

LOOP DIAGRAM

JOB No.	DRAWING No.	REV.

6. Instrument Layout Diagram

- Instrument Layout is also known as instrument location plan. This drawing shows the exact position of each instruments with reference to plant layout. The drawing shall detail:

- The point indication of instrument position and its mounting stand where instrument to be mounted and process tap location.

- Often the tap location and the instrument is separated quite distant. In some project, it is not mandatory to show the process tap location.

- Elevation information of instrument (and its mounting stand) and process tap.
Junction box location including its elevation.

- Instrument Air Manifold location including its elevation.

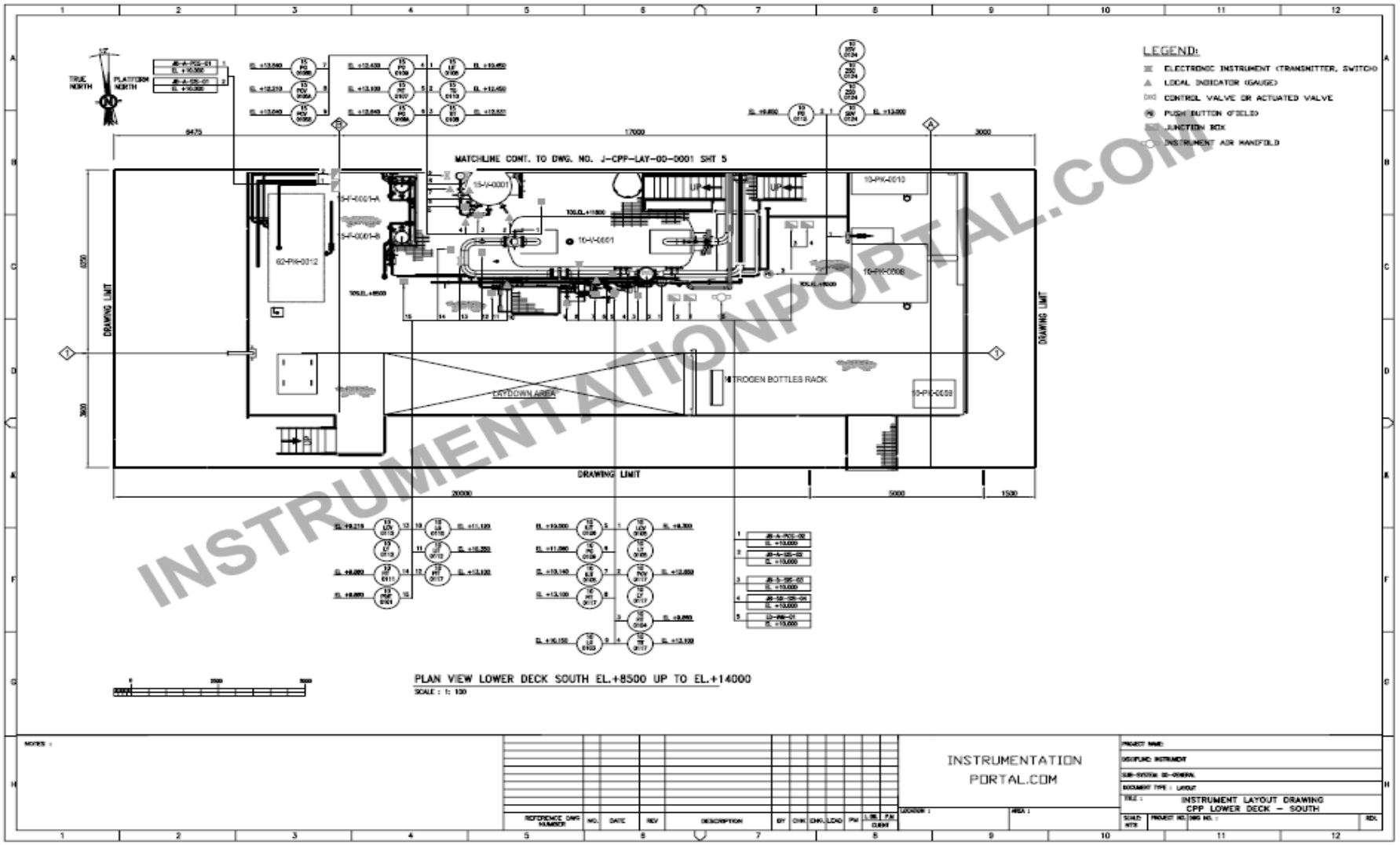
- Reference drawing: Piping plan, Isometric, P&ID

- To prepare instrument layout, designer should obtain piping plan which will used as a background. Refer to Piping isometric and P&ID to verify the location of tapping point location. Instrument shall be mounted on instrument stand at location as close as possible to the tapping point or at location where required by operator for ease maintenance/reading.

- **The purpose of Instrument Layout Drawing**
Instrument layout derives other layout related to instrument discipline such as instrument cable layout and instrument tubing layout. In instrument cable layout, cable connecting instrument and junction box as well as cable connecting junction box and control room will be routed with reference to instrument layout drawing.

- Likewise, the instrument which requires air supply such as control valves, actuated valves will have its tubing drawn in instrument tubing layout with reference to instrument layout drawing.

Instrument Layout Diagram-Template



7. Cause & Effect Diagram

- Some project categorizes Cause and effect is part of process document and some other projects consider Cause and effect is part of instrument deliverables. Literally, “cause” means something that makes something else happen and “effect” is what happens as a result of the cause.

- The interaction between cause and effect could simple to complex. For a simple example in process control: cause could be a tank high liquid level alarm and effect could be open the tank outlet valve. The complex example could be like this: If minimum two flame detectors detect fire in area 1 and coincide with one flame detector detect fire in area 2, then it should close valve A, close valve B, open valve C, de-energize the power outlet, etc.

- Cause and effect is presented as a form of matrix. The causes are listed in left section while the effects are listed on top section, both are described in form of tag number with their descriptions (other additional information such as P&ID may supplement). The marked intersection between both means that they are related as cause-effect. Marks could be in form of letter “X” which mean effect will be activated, “T” which mean effect will be activated with time delay, “P” which mean cause will give permissive to an effect.

- Reference document: SAFE Chart, philosophy

- SAFE Chart presents the required safety devices for each process equipment. SAFE Chart shall ensure all safety requirements have been fulfilled and what executive actions the safety devices take.

- Philosophy provide the narration and engineer shall translate it to cause and effect interaction so that the plant operates as the intended philosophy.

- **The purpose of Cause and Effect document**

Cause and effect document will be translated to program language by control system engineer and implemented in control system as logic. These logic will always monitor plant during operation and works if pre-determined condition attained.

Cause & Effect Diagram-Template

CONTROL SYSTEM
CAUSE AND EFFECT DIAGRAM

Legend
IS Inactive Side
AS Active Side
DE Drive/Driven End
NDE Non Drive/Driven End
IE Inlet End
DE Discharge End
LSS Low Speed Shaft
HSS High Speed Shaft
BN Bently Nevada

Notes:
1) 2oo2 Voting logic
2) 2oo3 Voting logic
3) Internal to the PLC: No tag name assigned 4) P&ID - I-DE-5295.00-2212-944-EWW-003
5) I/O List I-LI-5295.00-2212-600-EWW-006)
6) Internal to the PLC: No tag name assigned

SO#: E828002

Tag Name	Description	Doc	Sheet	Note	EFFECT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
						DESCRIPTION / CONTROL ACTION	ALARM	TRIP	PERM. FOR AUTO START OF MAIN LUBE OIL PUMP	PERM. FOR MAN. START OF MAIN LUBE OIL PUMP	PERM. FOR AUTO START OF AUXILIARY LUBE OIL PUM	PERM. FOR MAN. START OF AUXILIARY LUBE OIL PUM	PERM. FOR LUBE OIL HEATERS	PERMISSIVE FOR COMPRESSOR START	START LUBE OIL HEATER	START AUXILIARY LUBE OIL PUMP	START MAIN LUBE OIL PUMP	MAIN LUBE OIL PUMP RUNNING	AUXILIARY LUBE OIL PUMP RUNNING	PRIMARY SEAL GAS SUPPLY DIFFERENTIAL PRESSUR	FLUSH GAS SUPPLY DIFFERENTIAL PRESSURE	Motor Driver Stop	Motor Driver Trip	ESD (Both Sections)	CLOSE ANTISURGE VALVE STAGE 1	CLOSE ANTISURGE VALVE STAGE 2	
						Tag Name			note 6	note 6	note 6	note 6	note 6	note 6	XL-2212056	XL-2212058	XY-2212071	YL-2212063	YL-2212062	PDY-2212045	PDY-2212066	XL-2212063	XL-2212060	KS-2212079	SV-2124456	SV-2124452	
CAUSE							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	DRY GAS SEAL SYSTEM																										
PDAH-22120163	Flush Gas Supply Filter Differential Pressure High Alarm	Note 4	6		26		X																				
FAL-22120165	Flush Gas Supply Flow Low Alarm	Note 4	6		27		X																				
PDIT-22120166A	Flush Gas Supply Differential Pressure - Control	Note 4	6		28																						
PDAL-22120166B	Flush Gas Supply Differential Pressure - Alarm Low	Note 4	6		29		X														X						
PDALL-22120166B	Flush Gas Supply Differential Pressure - Alarm Low Low	Note 4	6		30		X																				
PDALL-22120166B	Flush Gas Supply Differential Pressure - Low Low Trip	Note 4	6		31																						
PDAH-22120148	Primary Seal Gas Supply Filter Differential Pressure High Alarm	Note 4	6		32		X																X	X	X	X	
PDIT-22120145A	Primary Seal Gas Supply Differential Pressure - Control	Note 4	6		33		X													X							
PDAL-22120145B	Primary Seal Gas Supply Differential Pressure - Alarm Low	Note 4	6		34		X																				
PDALL-22120145B	Primary Seal Gas Supply Differential Pressure - Alarm Low Low	Note 4	6		35		X																				
PDALL-22120145B	Primary Seal Gas Supply Differential Pressure - Low Low Trip	Note 4	6		36		X																X	X	X	X	
PAL-22120154	Primary Seal Gas Supply Pressure IE Low Alarm	Note 4	6		37		X																				
FAH-22120153	Primary Seal Gas Supply Flow IE High Alarm	Note 4	6		38		X																				
FAL-22120153	Primary Seal Gas Supply Flow IE Low Alarm	Note 4	6		39		X																				
PAL-22120156	Primary Seal Gas Supply Pressure DE Low Alarm	Note 4	6		40		X																				
FAH-22120155	Primary Seal Gas Supply Flow DE High Alarm	Note 4	6		41		X																				
FAL-22120155	Primary Seal Gas Supply Flow DE Low Alarm	Note 4	6		42		X																				
PDAH-22120144	Balance Drum Differential Pressure High Alarm	Note 4	6		43		X																				
PAL-22120157	Separation Seal Gas Supply Pressure IE Low Alarm	Note 4	6		44		X																				
PAL-22120159	Separation Seal Gas Supply Pressure DE Low Alarm	Note 4	6		45		X																				
PAL-22120147	Nitrogen Back-up Gas Pressure Low Alarm	Note 4	6		46		X																				
PAH-22120161A	Primary Seal Gas Vent Pressure DE High Alarm	Note 4	7		47		X																				
PAHH-22120161A	Primary Seal Gas Vent Pressure DE High High Alarm	Note 4	7		48		X																				
PAH-22120161B	Primary Seal Gas Vent Pressure DE High Alarm	Note 4	7		49		X																				
PAHH-22120161B	Primary Seal Gas Vent Pressure DE High High Alarm	Note 4	7		50		X																				
PAH-22120161C	Primary Seal Gas Vent Pressure DE High Alarm	Note 4	7		51		X																				
PAHH-22120161C	Primary Seal Gas Vent Pressure DE High High Alarm	Note 4	7		52		X																				
PAHH-22120161	Primary Seal Gas Vent Pressure DE 2oo3 Trip	Note 4	7		53			X															X	X	X	X	
PAH-22120163A	Primary Seal Gas Vent Pressure IE High Alarm	Note 4	7		54																						
PAHH-22120163A	Primary Seal Gas Vent Pressure IE High High Alarm	Note 4	7		55		X																				
PAH-22120163B	Primary Seal Gas Vent Pressure IE High Alarm	Note 4	7		56		X																				
PAHH-22120163B	Primary Seal Gas Vent Pressure IE High High Alarm	Note 4	7		57		X																				
PAH-22120163C	Primary Seal Gas Vent Pressure IE High Alarm	Note 4	7		58		X																				
PAHH-22120163C	Primary Seal Gas Vent Pressure IE High High Alarm	Note 4	7		59		X																				
PAHH-22120163	Primary Seal Gas Vent Pressure IE 2oo3 Trip	Note 4	7		60			X															X	X	X	X	
FAH-22120160	Primary Seal Gas Vent Flow IE High Alarm	Note 4	7		61		X																				
FAH-22120162	Primary Seal Gas Vent Flow DE High Alarm	Note 4	7		62		X																				
PIT-22120157	Separation Seal Gas Supply Pressure IE	Note 4	7		63				X	X	X	X															
PIT-22120159	Separation Seal Gas Supply Pressure DE	Note 4	7		64				X	X	X	X															

8. Cable Schedule

➢ **Cable Schedule** is a document containing list of instrument cable This document shows cable as well as gland required by each instrument or connection.

The information of the cable schedule shall consists:

i. Cable Number
ii. Cable Type / Specification
iii. Cable Size
iv. Cable Length
v. Source and destination termination description
vi. Cable gland type and size for each incoming cable

➢ Reference document: Instrument Index / I/O List

➢ Reference drawing: Instrument Cable Layout, Interconnection block diagram

➢ Filter tag numbers that has a wire from instrument index.

➢ I/O list will cover most of the tag number, because it only show instrument tag number which has I/O and therefore require wires.

➢ Please note that instrument which is not loop powered requires additional cable for power.

➢ Instrument cable layout and interconnection block diagram will make the preparation of cable schedule more convenience in specifying cable source and destination.

Cable Schedule-Template

- **The purpose of Cable Schedule**

- Cable schedule is a reference in preparing Material Take-Off of cable for procurement. However, cable length shown on this document are approximate only. Therefore, there should be contingency for material procurement to allow spare for cable cutting, unexpected barrier in the field, riser, etc.

- Cable schedule will be referred also during construction phase, however it is not recommended to cut the cable based on the length information stated on the cable schedule. For actual cutting during installation, the common practice is to pull the cable from its drum and cut in the field.

Zoom Out

CABLE SCHEDULE

Project Name : Dummy project
Project Number : XABCD0123

Document Number: J-CPP-LST-co-0003
Revision: 0

NO	CABLE NO	CABLE					FROM					TO				
		CABLE PROJECT SPEC	NUMBER OF PAIR / CORE/ TRIAD / QUAD	SIZE (mm2)	LENGTH (m)	INSULATION RATING	EQUIPMENT NO	DESCRIPTION	LOCATION	GLAND SIZE	GLAND SPEC (J-CPP-SPC-co-0020)	EQUIPMENT NO	DESCRIPTION	LOCATION	GLAND SIZE	GLAND SPEC (J-CPP-SPC-xx-xxxx)
1	SOV-0100	CssDFL	2/C	1.5	50	1000 V	XSV-0101	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
2	SOV-0101	CssDFL	2/C	1.5	50	1000 V	XSV-0102	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
3	SOV-0102	CssDFL	2/C	1.5	20	1000 V	XSV-0103	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
4	SOV-0103	CssDFL	2/C	1.5	20	1000 V	XSV-0104	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
5	SOV-0200	CssDFL	2/C	1.5	50	1000 V	XSV-0201	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
6	SOV-0201	CssDFL	2/C	1.5	50	1000 V	XSV-0202	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
7	SOV-0202	CssDFL	2/C	1.5	20	1000 V	XSV-0203	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
8	SOV-0203	CssDFL	2/C	1.5	20	1000 V	XSV-0204	SOLENOID VALVE	LD	1/2"NPT	HZ-BR-001	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
9																
10	JD-G-PL-0001	CssDFL	19/C	1.5	200	1000 V	JS-D-SIS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M32	HZ-BR-001	MR-SIS-001	SIS MARSHALLING CABINET	CR	M32	NO-BR-001
11																
12																
13	ZSO/C-0100	PssDFL	2/PR	0.75	50	300 V	ZSO/C-0100	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
14	ZSO/C-0101	PssDFL	2/PR	0.75	50	300 V	ZSO/C-0101	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
15	ZSO/C-0102	PssDFL	2/PR	0.75	20	300 V	ZSO/C-0102	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
16	ZSO/C-0103	PssDFL	2/PR	0.75	20	300 V	ZSO/C-0103	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
17	ZSO/C-0200	PssDFL	2/PR	0.75	50	300 V	ZSO/C-0200	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
18	ZSO/C-0201	PssDFL	2/PR	0.75	50	300 V	ZSO/C-0201	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
19	ZSO/C-0202	PssDFL	2/PR	0.75	20	300 V	ZSO/C-0202	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
20	ZSO/C-0203	PssDFL	2/PR	0.75	20	300 V	ZSO/C-0203	LIMIT SWITCHES	LD	1/2"NPT	HZ-BR-001	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
21																
22	JD-P-PL-0001	P24DFL	24/PR	0.75	200	300 V	JS-D-PCS-001	DIGITAL INSTRUMENT JUNCTION BOX	LD	M40	HZ-BR-001	MR-PCS-002	PCS MARSHALLING CABINET	CR	M40	NO-BR-001
23																
24																
25	FIT-0100	PssAFL	1/PR	0.75	50	300 V	FIT-0100	FLOW INDICATING TRANSMITTER - DP TYPE	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
26	FT-0102	PssAFL	1/PR	0.75	50	300 V	FT-0102	FLOW TRANSMITTER - TURBINE TYPE	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
27	LIT-0100	PssAFL	1/PR	0.75	50	300 V	LIT-0100	LEVEL INDICATING TRANSMITTER - MAGNETOSTRICTIVE	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
28	LY-0100	PssAFL	1/PR	0.75	50	300 V	LY-0100	LEVEL POSITIONER	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
29	PIT-0100	PssAFL	1/PR	0.75	50	300 V	PIT-0100	PRESSURE INDICATING TRANSMITTER	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
30	PY-0100	PssAFL	1/PR	0.75	50	300 V	PY-0100	PRESSURE POSITIONER	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
31	TIT-0100	PssAFL	1/PR	0.75	50	300 V	TIT-0100	TEMPERATURE INDICATING TRANSMITTER	LD	1/2"NPT	HZ-BR-001	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
32																
33	JA-P-PL-0001	P12AFL	12/PR	0.75	200	300 V	JS-A-PCS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M32	HZ-BR-001	MR-PCS-001	PCS MARSHALLING CABINET	CR	M32	NO-BR-001
34																
35																
36	LIT-0101	PssAFL	1/PR	0.75	50	300 V	LIT-0101	LEVEL INDICATING TRANSMITTER - MAGNETOSTRICTIVE	LD	1/2"NPT	HZ-BR-001	JS-A-SIS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
37	LIT-0102	PssAFL	1/PR	0.75	50	300 V	LIT-0102	LEVEL INDICATING TRANSMITTER - MAGNETOSTRICTIVE	LD	1/2"NPT	HZ-BR-001	JS-A-SIS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
38	PIT-0101	PssAFL	1/PR	0.75	50	300 V	PIT-0101	PRESSURE INDICATING TRANSMITTER	LD	1/2"NPT	HZ-BR-001	JS-A-SIS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
39	LT-1202	PssAFL	1/PR	0.75	50	300 V	LT-1202	LEVEL INDICATING TRANSMITTER - MAGNETOSTRICTIVE	LD	1/2"NPT	HZ-BR-001	JS-A-SIS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M20	HZ-BR-001
40																
41	JA-P-PL-0002	P08AFL	8/PR	0.75	200	300 V	JS-A-SIS-001	ANALOG INSTRUMENT JUNCTION BOX	LD	M25	HZ-BR-001	MR-SIS-001	SIS MARSHALLING CABINET	CR	M25	NO-BR-001
42																

9. Project Interconnection Diagram

➢ Interconnection block diagram is a drawing showing interconnection between each device including instrument, junction box, marshaling cabinet, panel, etc. This drawing can provide a glance view of overall connection of system. Some interconnection block diagrams provide detail information start from every field instruments up to control system. In larger project, this interconnection block diagram shows only from junction box / package system to main control system while the connection from junction box to each instrument is shown in junction box wiring diagram. Interconnection block diagram should also indicate cable number of each cable connecting two devices.

➢ Reference drawing: Instrument and control architecture diagram, instrument cable layout

To prepare an interconnection block diagram, reference should be made to instrument architecture diagram and Instrument cable layout.

➢ Instrument and control architecture diagram shows overall instrument and control system within a plant. Hence by having a look to architecture diagram, the preparation of interconnection block diagram is easier.

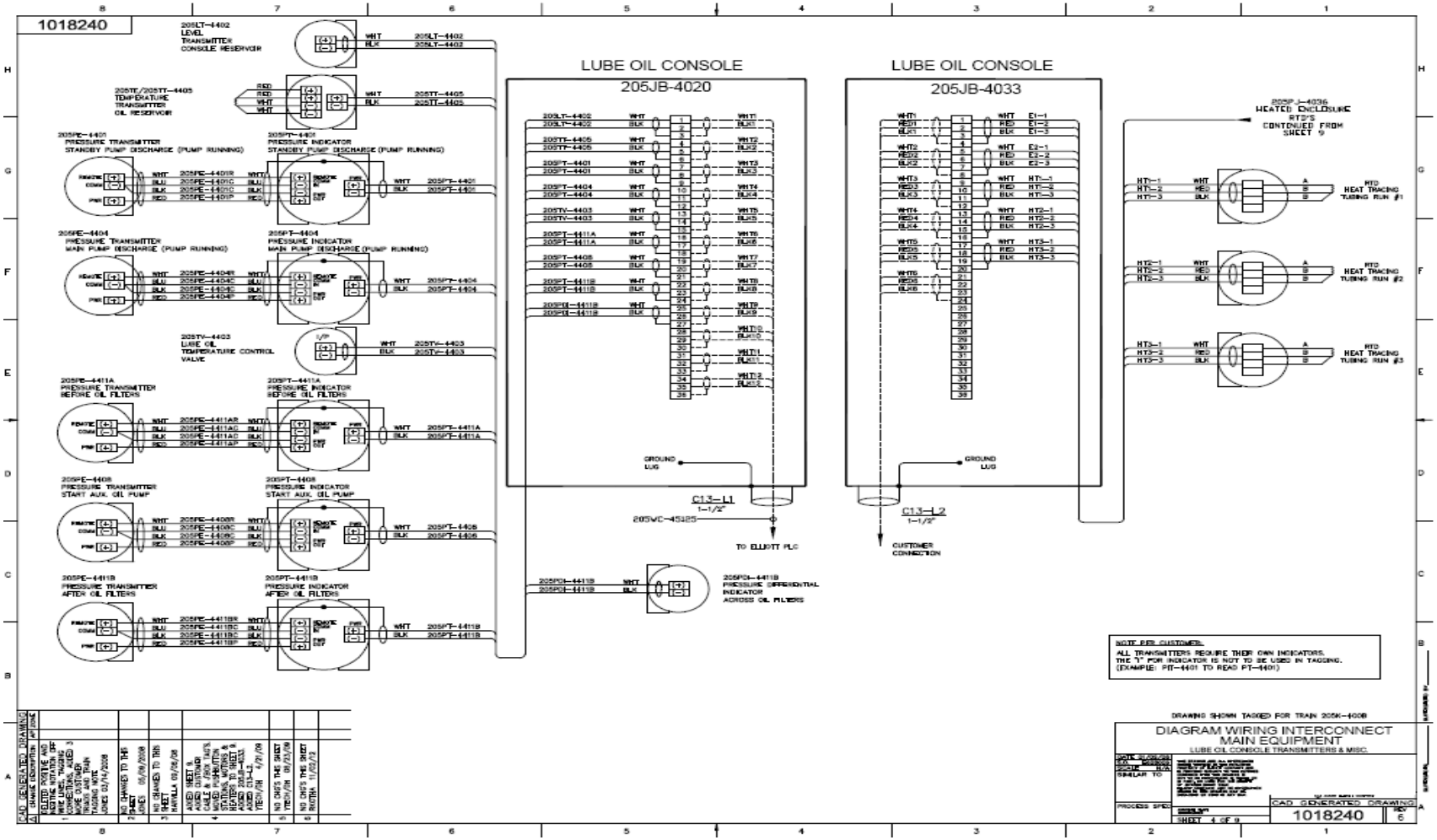
Instrument cable layout shows every instruments connection to its junction box.

The purpose of interconnection block diagram drawing

As a reference for preparing junction box wiring diagram/ connection list and marshaling cabinet wiring diagram which both subsequently are required for preparing instrument loop diagram.

Together with instrument cable layout, this drawing is also used as a reference for preparing instrument cable schedule

Project Interconnection Diagram-Template



QuEST

BORN TO ENGINEER