

PRESENTATION TO ASSP NIGERIA CHAPTER

ON

PROCESS FLOW SCHEME(PFS) & PROCESS ENGINEERING FLOW SCHEME (PEFS)

BY

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DISCLAIMER

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OUTLINE

- OBJECTIVE
- DEFINITIONS
- SYMBOLS
- INPUTS INTO PFS, PEFS
- KEY FEATURES
- PFS & PEFS TYPICALS
- OTHER KEY DRAWINGS
- APPLICATION OF PFS,PEFS
- CONCLUSION
- REFERENCES
- Q & A

OBJECTIVE

This knowledge sharing to help us understand how Process Flow Scheme (PFS), Process Engineering Flow Scheme (PEFS) are developed, it's application as part of the engineering solution both in Project execution phase and the operation phase of an Asset.

PFS- Process Flow Scheme (PFD- Process Flow Diagram)

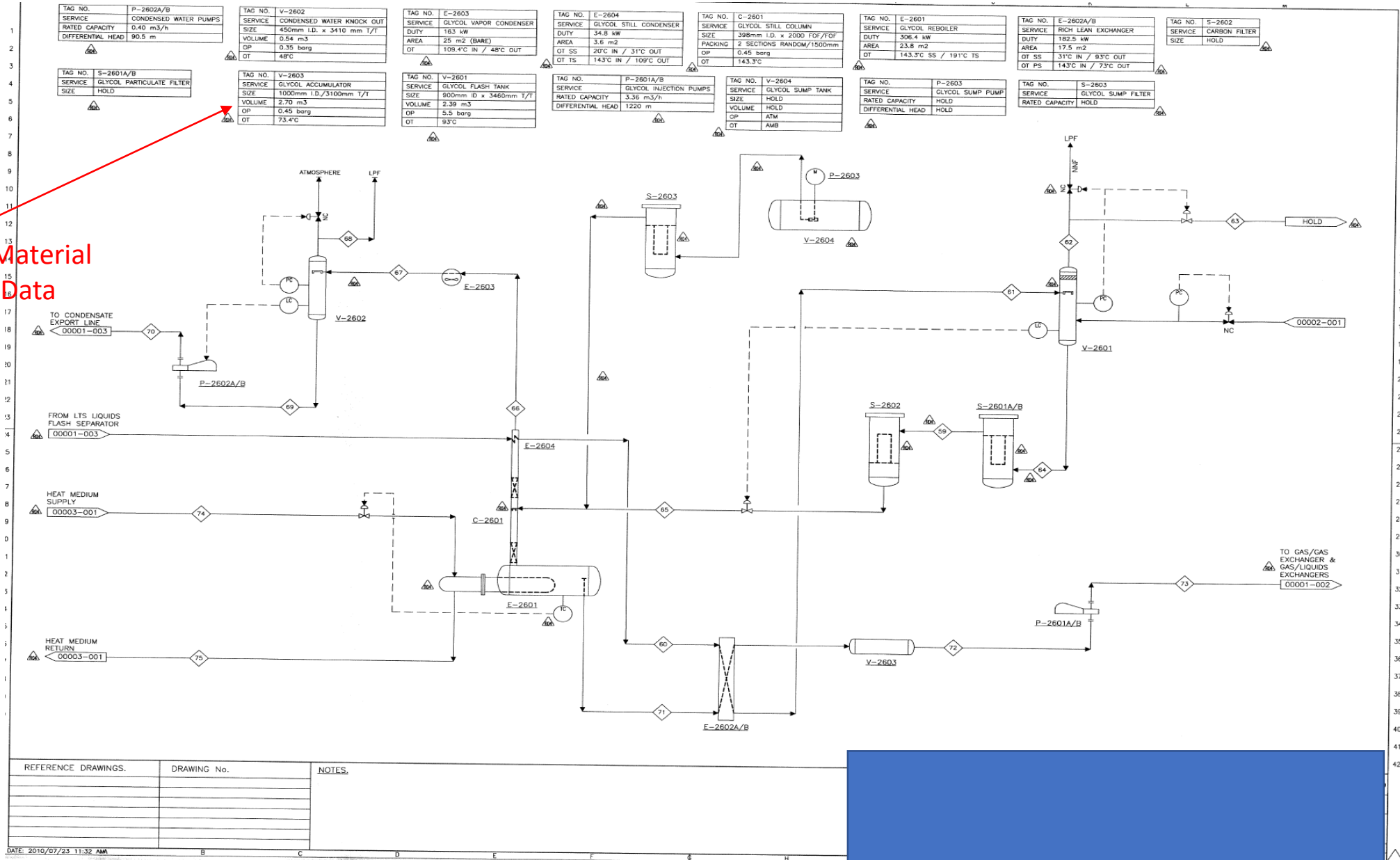
This provides clear and **high level description of a process** from upstream to downstream of a process.

This should show:

- Major Equipment
- Material balance sheets for major process streams
- Different modes of operation will have different PFS drawings
- Equipment spares shall not be shown
- Equipment and lines indicating process, utility and disposal flows shall be shown on PFS; only key automated or manual valves will be shown

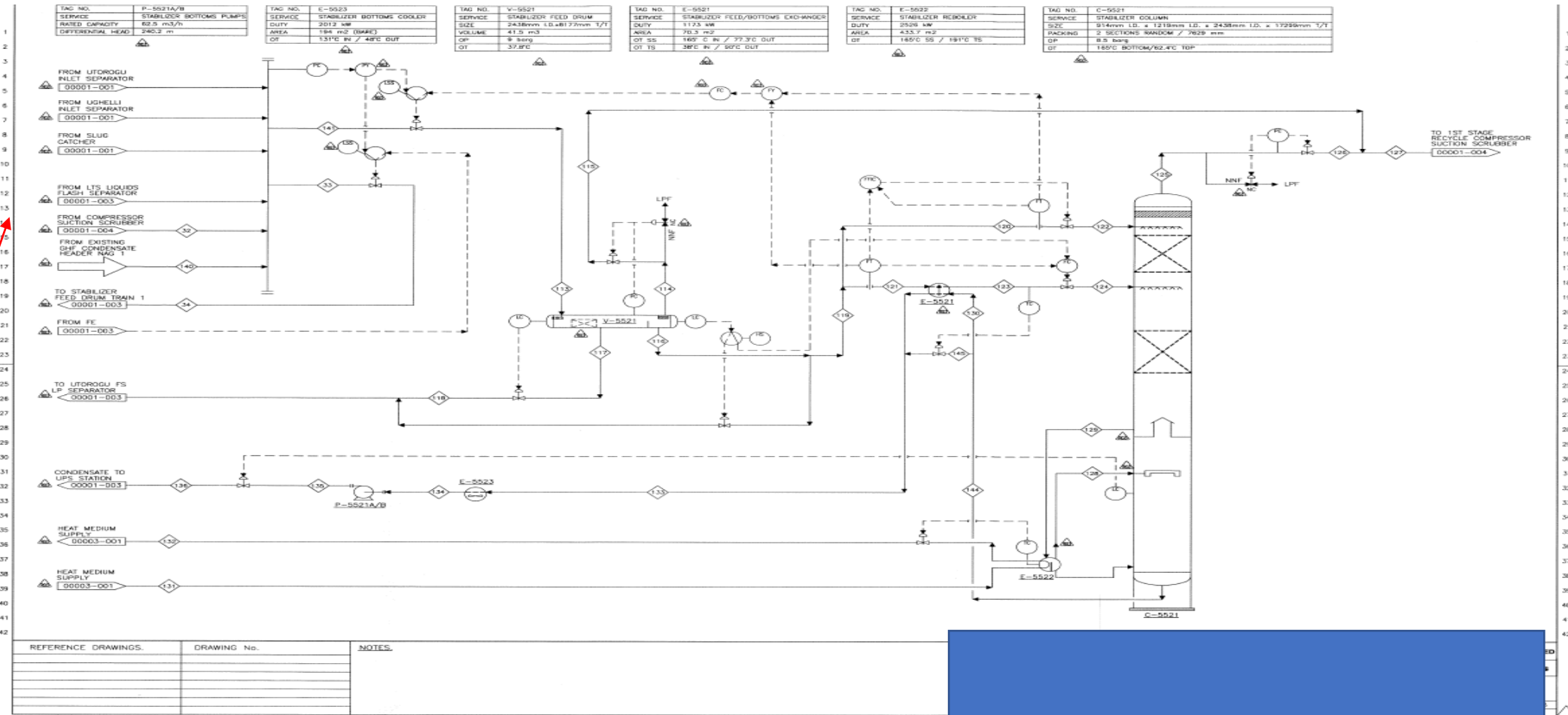
Process Flow Scheme/Diagram – Typical (1)

Heat & Material
Balance Data



Process Flow Scheme/Diagram – Typical (2)

Grid
Numbers



PEFS – Process Engineering Flow Scheme (or P&ID –Piping & Instrument Diagram)

PEFS is a schematic representation of a process, it gives clear representation of the process with engineering details as different from the PFS.

The PEFS include:

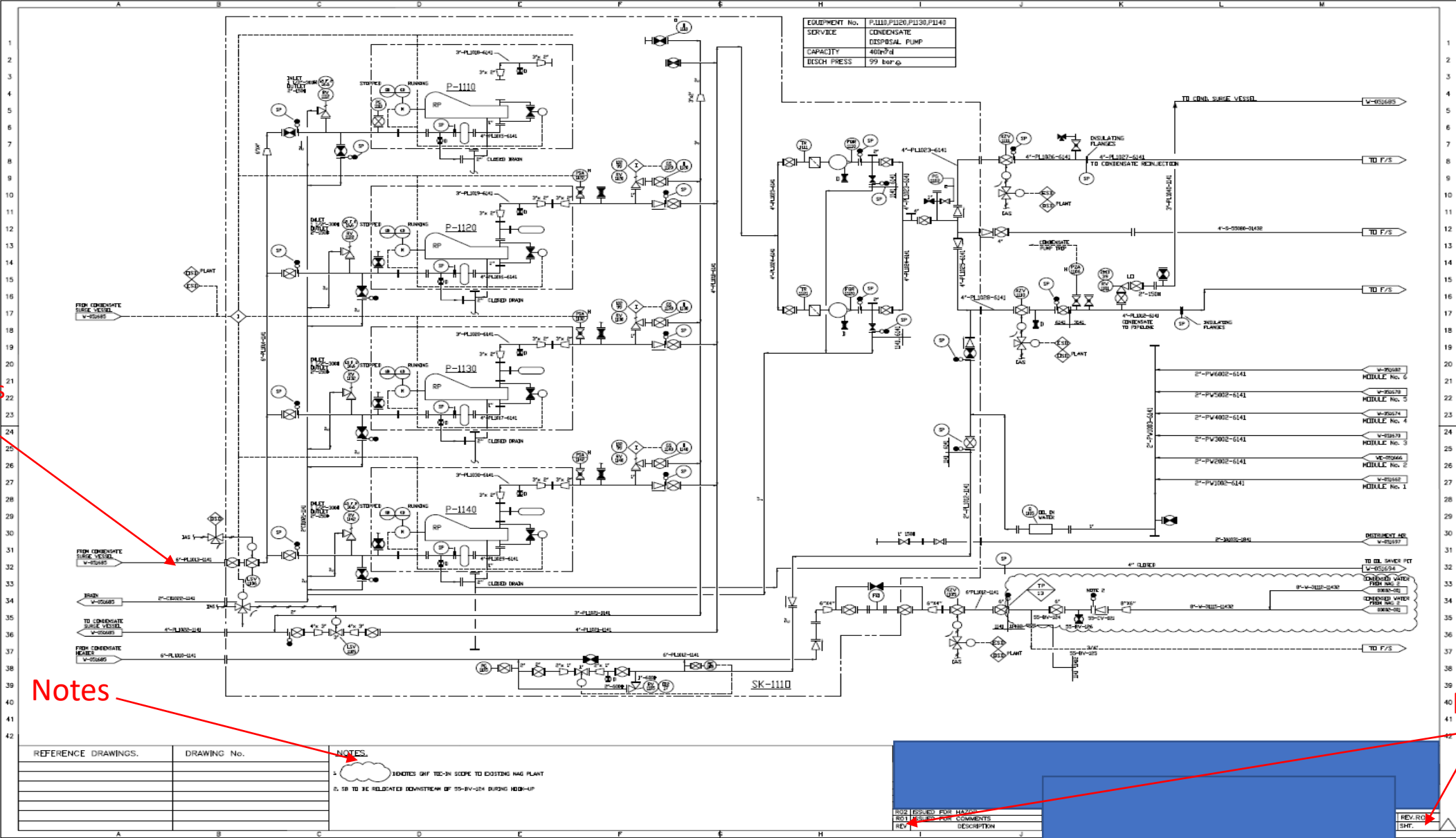
- All process and utilities equipment plus spares, Piping and ancillaries, instrumentations etc.
- Piping sizes, classes, ratings, tag numbers based on agreed tagging philosophy
- Major equipment details, dimensions, limits, range etc.
- Automated valves with their actions will be shown e.g. Fail-close (FC), Fail-open (FO)
- Manual valves status will be shown as per normal operation of facility; isolation valves with conditions e.g. Locked-close (LC) or Locked-open (LO) will be shown
- NOTES- these shall be added to explain specific process related requirements to aid construction and operations. Notes will be numbered at the bottom of PEFS
- LEGENDS – PEFS will have a Legend sheet which will include Symbols for equipment, piping and ancillaries; include line identification and numbering conventions etc.

Process Engineering Flow Scheme – Typical (1)

Line
Numbers

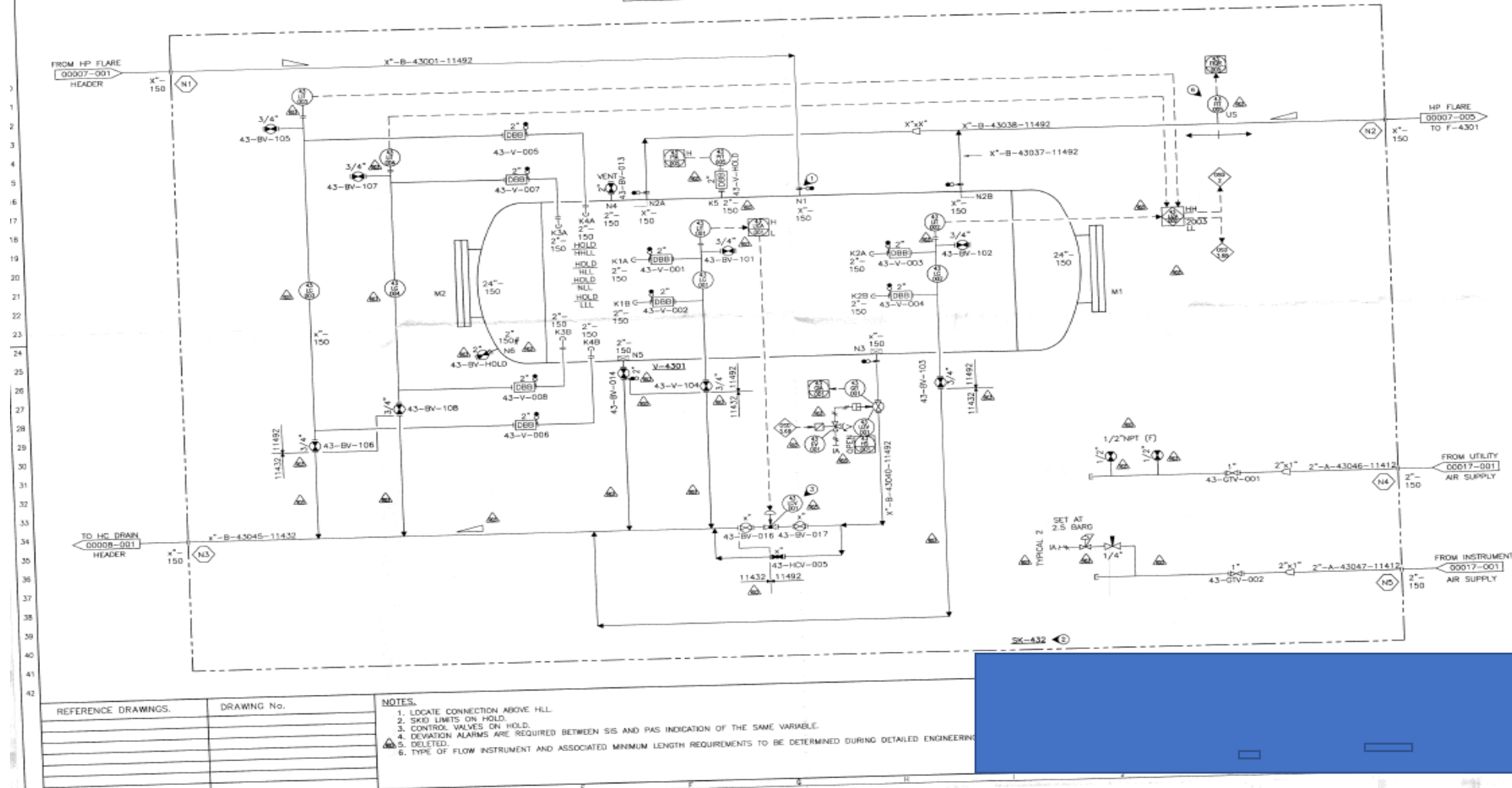
Notes

Revision



EQUIP. No.	S-2100
SERVICE	DIESEL STORAGE TANK
CAPACITY	2m³
DIMENSIONS	1000 mm x 2500 T.T.

TAG No.	V-4301
SERVICE	HP FLARE KNOCKOUT DRUM
SIZE	HOLD
DESIGN PRESSURE	HOLD barg
DESIGN TEMPERATURE	-45.5°C/150°C
OPERATING PRESSURE	ATM
OPERATING TEMPERATURE	AMB
MATERIALS	LTC5



INPUTS TO DEVELOP PFS & PEFS

SOME KEY INPUTS	DISCIPLINE (S)
Heat & Material Balance	Process
Process Control Scheme	PACO/Instrumentation
Process Control Narrative	Process + PACO
Process Safeguarding Memorandum	Process
Valving philosophy/Tagging	Mechanical
Instrument Tagging	PACO
Vendor Information	All Disciplines
Relief Valves sizing/settings	PACO/Mechanical
Operations Philosophy	Operations
Emergency Shutdown/Blowdown Philosophy + Shutdown Hierarchy	Process+ PACO

PEFS (P&ID) Symbols

- Symbols are based on ANSI/ISA (International Society of Automation) standards 5.1, ISO 14617 and ISO 10628, ISO 15519, ANSI Y32.11
- These symbols could comprise, Words, Letters and/or Numbers. These symbols represent all process plant components and equipment, e.g. Piping, Valves, Vessels, Pumps, Instrumentations etc.
- Symbols of components are NOT to scale and representation on PEFS does NOT actual geographical or physical location in the plant. The GA-General arrangement drawings, 3D models etc. are to be used for purpose of actual location.

HOW TO READ P&ID | PIPING AND INSTRUMENTATION DIAGRAM | PROCESS ENGINEERING | PIPI...



Pipe Line No. 3-NL-121007-A11A-IH30

Where:

3 = Line size (mandatory)

NL = Fluid service (mandatory)

121007 = 12 here signifies unit facility number

while 1007 denotes the serial number (mandatory)

A11A = pipe service class (mandatory)

A - Denotes flange rating like 150#, 300#..

11 - Denote the piping material

A - A suffix qualifying the piping material

IH = Hot Insulation (only when required)

30 = denote the insulation thickness

Other types of insulation include

IC = Cold Insulation,

IS = Safety Insulation,

IA = Acoustic (or Sound) Insulation, etc.

PP = personnel protection

Tracing include:

ET = Electric Tracing,

ST = Steam Tracing,

CWT = Chill Water Tracing,

TT = Thermon (Hot Oil) Tracing, etc.



4:51 / 25:04



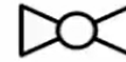
Final Control Elements - Valves



- Generic Two-way
- Straight globe
- Gate



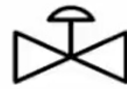
- Generic Two-way
- Straight globe
- Gate



Ball Valve



Screw-down



Generic 2-Way



Powered



Generic Two-Way
Angle



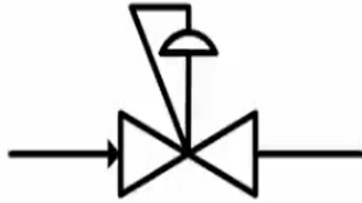
Generic 3-Way



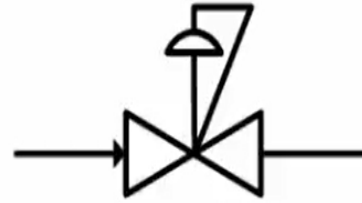
Generic 4-Way



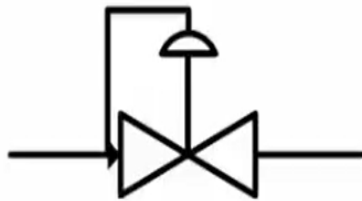
Final Control Elements - Valves



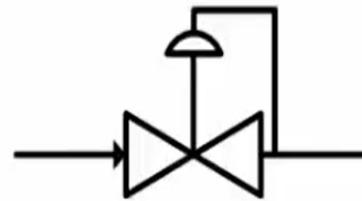
Backpressure
regulator, Internal
pressure tap



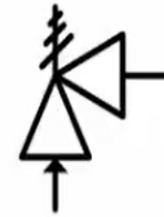
Pressure-reducing
regulator, Internal
pressure tap



Backpressure
regulator, External
pressure tap

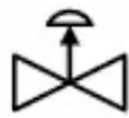


Pressure-reducing
regulator, External
pressure tap



Generic pressure
safety valve, Pressure
relief valve

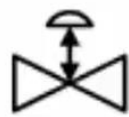




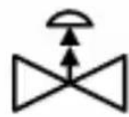
Fail to open position



Fail to closed position



Failed to last position



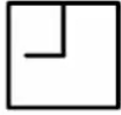
Fail t o last position, Drift open



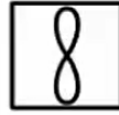
Fail t o last position, Drift closed



Primary Flow Measurement - Flowmeters



Standard Pitot Tube



Turbine, Propeller



Vortex Shedding



Magnetic 01



Magnetic 02











Positive Displacement











Variable Area



	Blind Disc
	Spectacle Blind (Open)
	Spectacle Blind (Close)
	Open Disc
	Orifice Plate
	Vent
	Syphon Drain

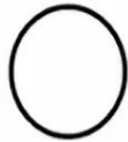
	Orifice Plate
	Slope Requirements Line
	Vent Silencer
	Flame Arrestor
	In-line Silencer
	Steam Trap
	Tundish
	Open Vent

	Pressure Control
	Pneumatic Binary Signal Line
	Electric Signal Line
	Electric Binary Signal Line
	Electric Binary Signal Line
	Spray Nozzle
	Curved Gas Vent
	Hose reel



Instrumentation Devices or Function Symbols

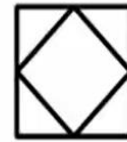
Field Mounted



Discrete
Instruments



Computer
Systems
And
Software



Alternate
Choice
Or
Safety
Instrumented
System

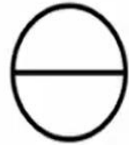


Primary
Choice
Or
Basic
Process
Control
System



Instrumentation Devices or Function Symbols

Normally Accessible to Operator



Discrete
Instruments



Computer
Systems
And
Software



Alternate
Choice
Or
Safety
Instrumented
System

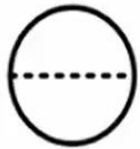


Primary
Choice
Or
Basic
Process
Control
System



Instrumentation Devices and Function Symbols

Normally inaccessible to the operator or behind-the-panel devices or functions



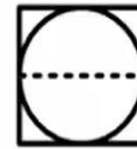
Discrete
Instruments



Computer
Systems
And
Software



Alternate
Choice
Or
Safety
Instrumented
System



Primary
Choice
Or
Basic
Process
Control
System



Instrumentation Devices and Function Symbols

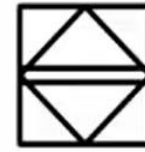
Auxiliary location normally accessible to the operator



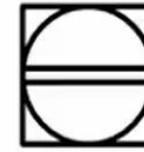
Discrete
Instruments



Computer
Systems
And
Software



Alternate
Choice
Or
Safety
Instrumented
System

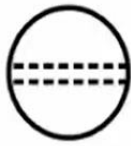


Primary
Choice
Or
Basic
Process
Control
System



Instrumentation Devices and Function Symbols

Normally inaccessible to the operator or behind-the-panel devices or functions



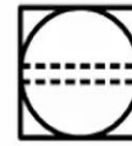
Discrete
Instruments



Computer
Systems
And
Software



Alternate
Choice
Or
Safety
Instrumented
System



Primary
Choice
Or
Basic
Process
Control
System

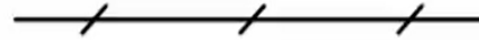


Instrument Line Symbols

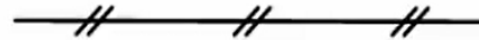
Instrument Supply
Or Connection to Process



Undefined Signal



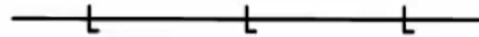
Pneumatic Signal



Electrical Signal



Hydraulic Signal



Instrument Line Symbols

Capillary Tube



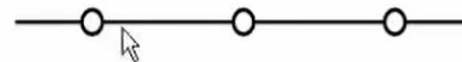
Electromagnetic or Sonic
Signal (Guided) ***



Electromagnetic or Sonic
Signal (Not Guided) ***



Internal System Link
(Software or Data Link)



*** Electromagnetic phenomena include heat, radio waves, nuclear radiation, and light.



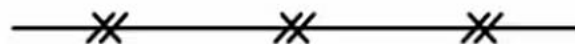
Instrument Line Symbols

Mechanical Link



Optional Binary (ON – OFF) Symbols

Pneumatic Binary Signal



Electric Binary Signal

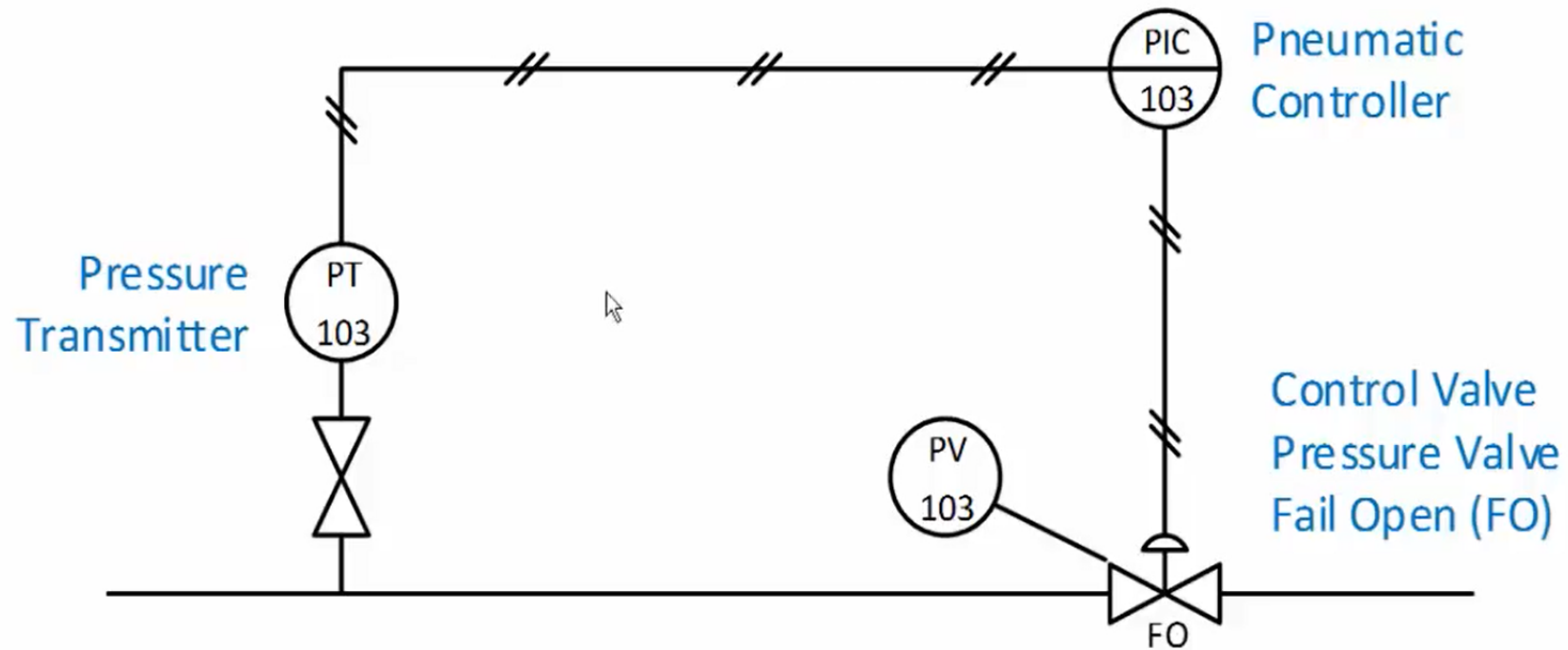




H - High, L - Low, O - Open, C - Closed

Letter	Column 1 (Measured value)	Column 2 (Modifier)	Column 3 (Readout/passive function)	Column 4 (Output/active function)	Column 5 (Function modifier)
A	Analysis		Alarm		
B	Burner, combustion		User choice	User choice	User choice
C	User's choice (usually conductivity)			Control	Close
D	User's choice (usually density)	Difference			Deviation
E	Voltage		Sensor		
F	Flow rate	Ratio			
G	User's choice (usually gaging/gauging)	Gas	Glass/gauge/viewing		
H	Hand				High
I	Current		Indicate		
J	Power	Scan			
K	Time, time schedule	Time rate of change		Control station	
L	Level		Light		Low
M	User's choice				Middle / intermediate
N	User's choice (usually torque)		User choice	User choice	User choice
O	User's choice		Orifice		Open
P	Pressure		Point/test connection		
Q	Quantity	Totalize/integrate	Totalize/integrate		
R	Radiation		Record		Run
S	Speed, frequency	Safety (Non SIS (S5.1))		Switch	Stop
T	Temperature			Transmit	
U	Multivariable		Multifunction	Multifunction	
V	Vibration, mechanical analysis			Valve or damper	
W	Weight, force		Well or probe		
X	User's choice (usually on-off valve as XV)	X-axis	Accessory devices, unclassified	Unclassified	Unclassified
Y	Event, state, presence	Y-axis		Auxiliary devices	
Z	Position, dimension	Z-axis or Safety Instrumented System		Actuator, driver or unclassified final control element	

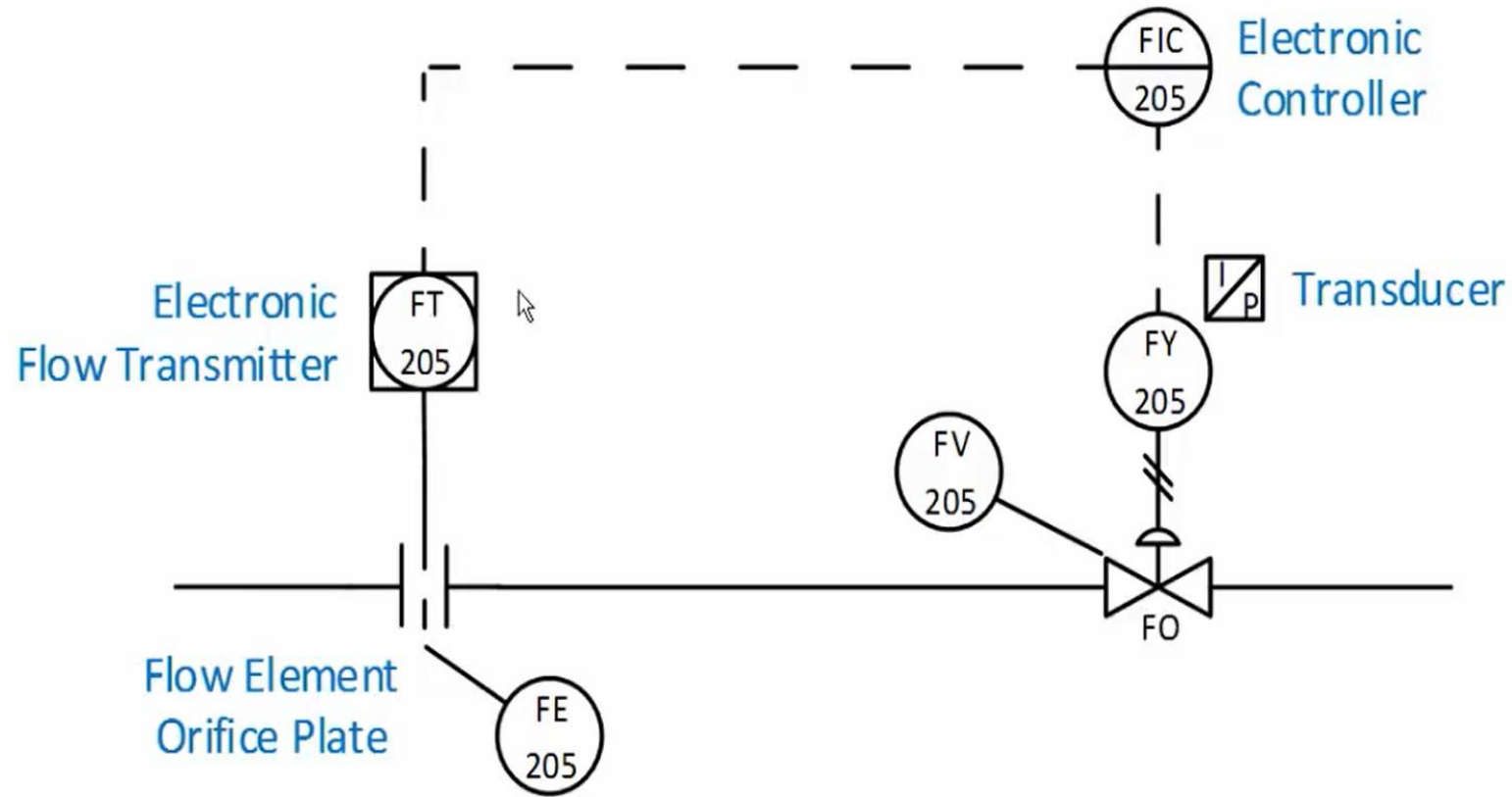
Pneumatic Control Loop



Control Loop 103 – Pressure Control Loop



Electronic Control Loop



Control Loop 205 – Electronic Flow Loop



FRONT-END ENGINEERING DESIGN	REVISIONS
Initial Design Drawings	R01
Inter-Discipline/Peer Reviews	R02
Inputs post-major reviews e.g. HAZOP, SIL studies, new Vendor information etc.	R03, R04
Approved for Design	A01
DETAILED ENGINEERING DESIGN	REVISIONS
Initial Design Drawings	D01
Inter-Discipline/Peer Reviews	D02
Inputs post-major reviews e.g. HAZOP, SIL studies, new Vendor information etc.	D03, D04 etc
Approved for Construction	C01
EXECUTION	REVISIONS
Construction/field changes	C02, etc
Post-construction	C0x- Stamped (AS-BUILT)
OPERATION	REVISIONS
Upgrades (Management of Change)	AS-BUILT (Marked-up with MOC approval)

APPLICATION OF PEFS/P&ID (1)

Project Capital Cost- pre Contract Award

Develop Contract specification – pre Contract Award

Develop Plot Plan

Development of Plan Layout

Identify Hazardous Area Classification (HAC)

Development of data sheets for equipment, valves and instrument

Development of piping layout

Development of bulk material take-off

Engineering and Operations staff training

APPLICATIONS OF PEFS/P&ID (2)

Process Safety Reviews

Hazard & Operability Study (HAZOP)

Safety Instrumented Function Assessment Study

Process Hazard Assessment

Layer of Protection Analysis Study (LOPA)

Risks Assessments

Process Safety Incidence Investigation

DCS HMI Graphics Development

Design Reviews

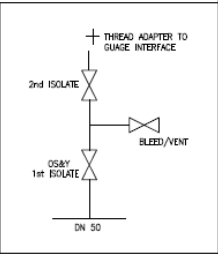
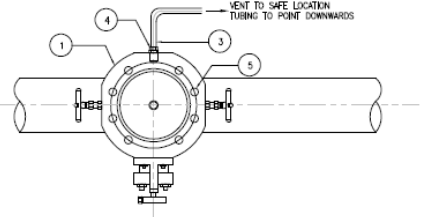
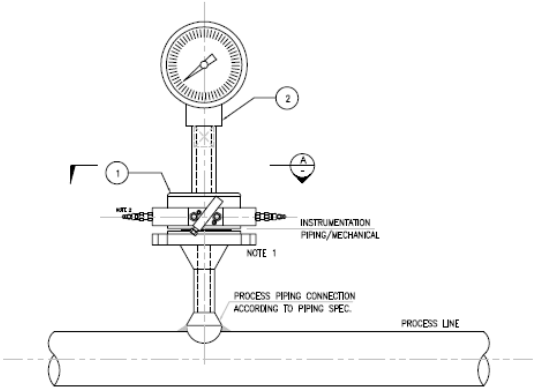
Commissioning and Start-ups

Asset Operations and Maintenance

COMPLEMENTARY DRAWINGS

Instrument Hook-up Drawing – Typical (1)

ITEM	QUANTITY	UNIT	DESCRIPTION/TYPE	SIZE	MATERIAL	MANUFT./MODEL	RMKS
1	1	PIECE	SUM LINE MONOFLANGE MANIFOLD (MF21)	2"	316 SS	MULTI-INSTR.	WITH 1/4" NPT-FEMALE VENT PORT
2	1	PIECE	PRESSURE GAUGE	#100mm	1.4571	WKA	WITH 1/2" NPT MALE CONNECTOR
3	1	M	TUBING SS 3/8" x 1.5mm	3/8" OD	316 SS	SWAGELOCK	TUBING WALL THICKNESS SHALL BE 1.5mm
4	1	PIECE	COUPLING NPT-3/8" x 1.5mm SS-TUBE	3/8" TUBING/4" NPT	316 SS	SWAGELOCK	
5	1	SET	BOLT SET INCL. GASKET		ACC PIPE CLASS	PIPING/MECH	GASKETS,BOLTS & NUTS ACC PIPING CLASS
		S/No.	TAG No.	LOCATION			
		1.	46-PG-013	20" EXPORT GAS LINE			



Instrument Hook-up Drawing – Typical (2)

BILL OF MATERIAL									REFERENCE DRAWING	
POS.	QTY.	UNIT	DESCRIPTION / TYPE	SIZE	MATERIAL	MANUFACTURER	MODEL	REMARKS	DESCRIPTION	DOCUMENT NO.
1	1	piece	CONTROL VALVE (PRESSURE)			EMERSON/FISHER			INSTRUMENT WIRING	625-40210701-001-04337-0001
2	1	piece	COUPLING 1/4" NPT x 3/8" OD/SS-602-1-4		316 SS	MULTI-INSTRUMENTS			GENERAL NOTES: 1. INCLUDING LOCAL PRESSURE INDICATION 2. INSTRUMENT EARTHING WITH 2.5mm SQ YEL/GN EARTH WIRE AND CONNECTED TO MAIN CABLE TRAY.	
3	1	m	SS TUBING 3/8" OD x 0.065" W THK/SS-TB-5-065-BWC		1.4571	MULTI-INSTRUMENTS				
4	1	SET	AIR FILTER/REGULATOR SET/57-075R	1/4"	316 SS	EMERSON/FISHER		NOTE 1		
5	1	piece	RF-POSITION TRANSDUCER/RELAY/0505010F		WRT'S	EMERSON/FISHER				
6	1	piece	CABLE GLAND	M16x30mm (4 SETS)	316 SS	STAHL				
7	1	piece	SURGE PROTECTOR 1P40	M30x1.5	316 SS			PARALLEL CONNECTED WITH SIGNAL WIRE		
8	AS REQ	M	RELIORUS CABLE	261mm						
ITEM		TAG No		LOCATION		SIZE				
1		KOL52-10-PCV-311		NAG corrosion inhibition System outlet		1"				

AIR SUPPLY CONNECTED TO NEAREST INSTRUMENT AIR HEADER

NOTE 1

AIR FILTER/REGULATOR SET

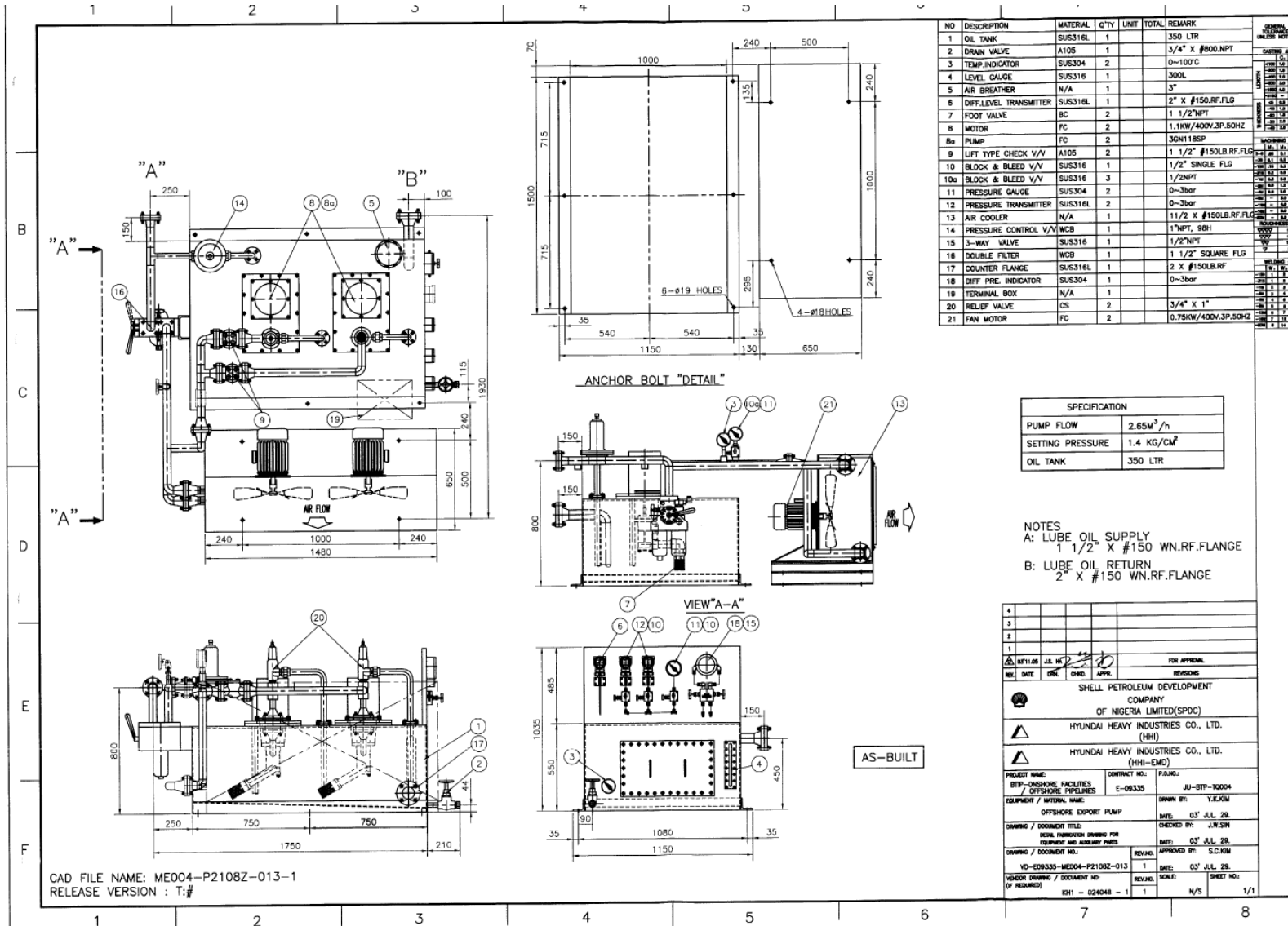
PAS RELIORUS CABLE

NOTE 2

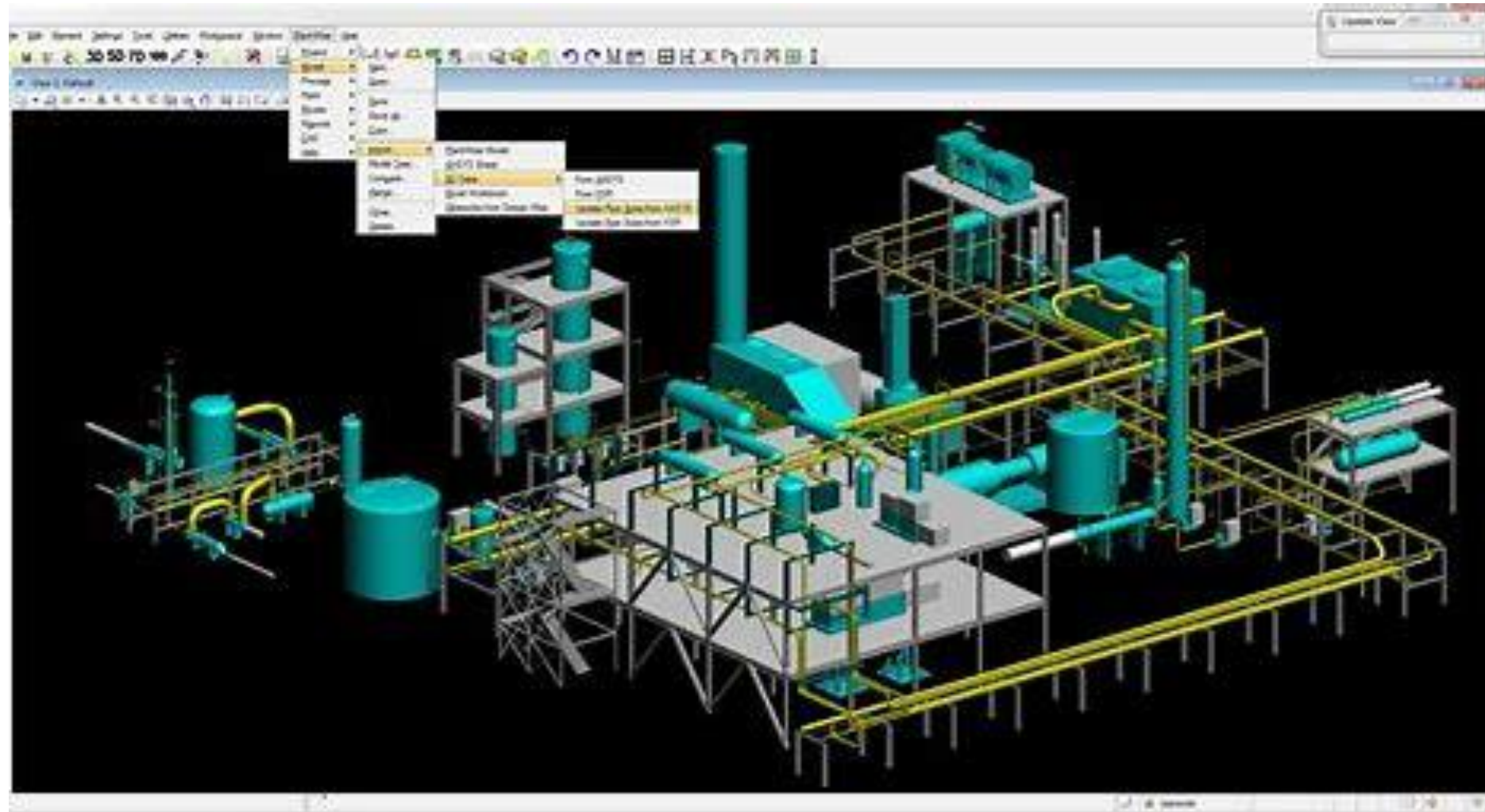
PARALLEL CONNECTED WITH SIGNAL WIRE

PRESSURE CONTROL VALVE

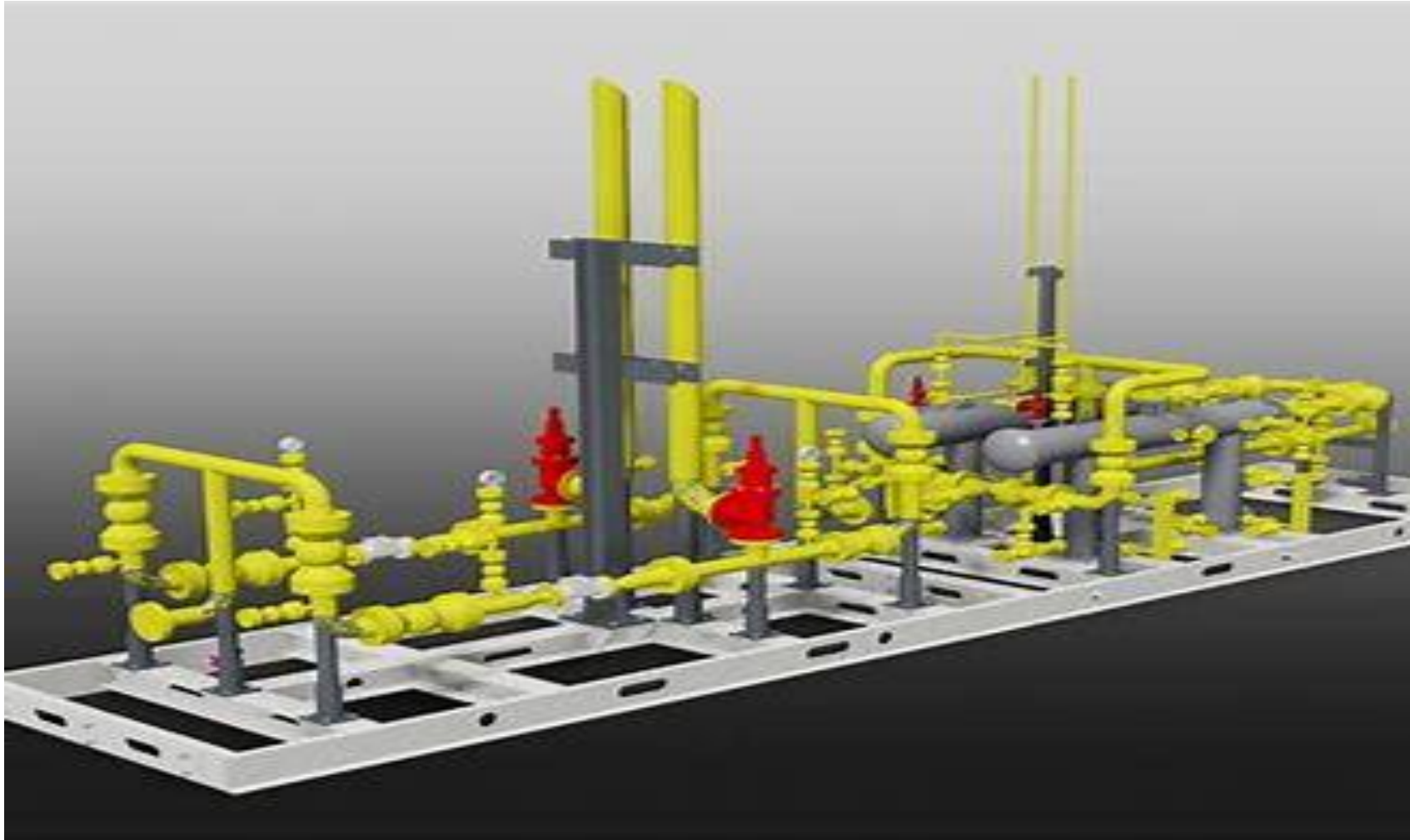
General Arrangement (GA) Drawing – Typical



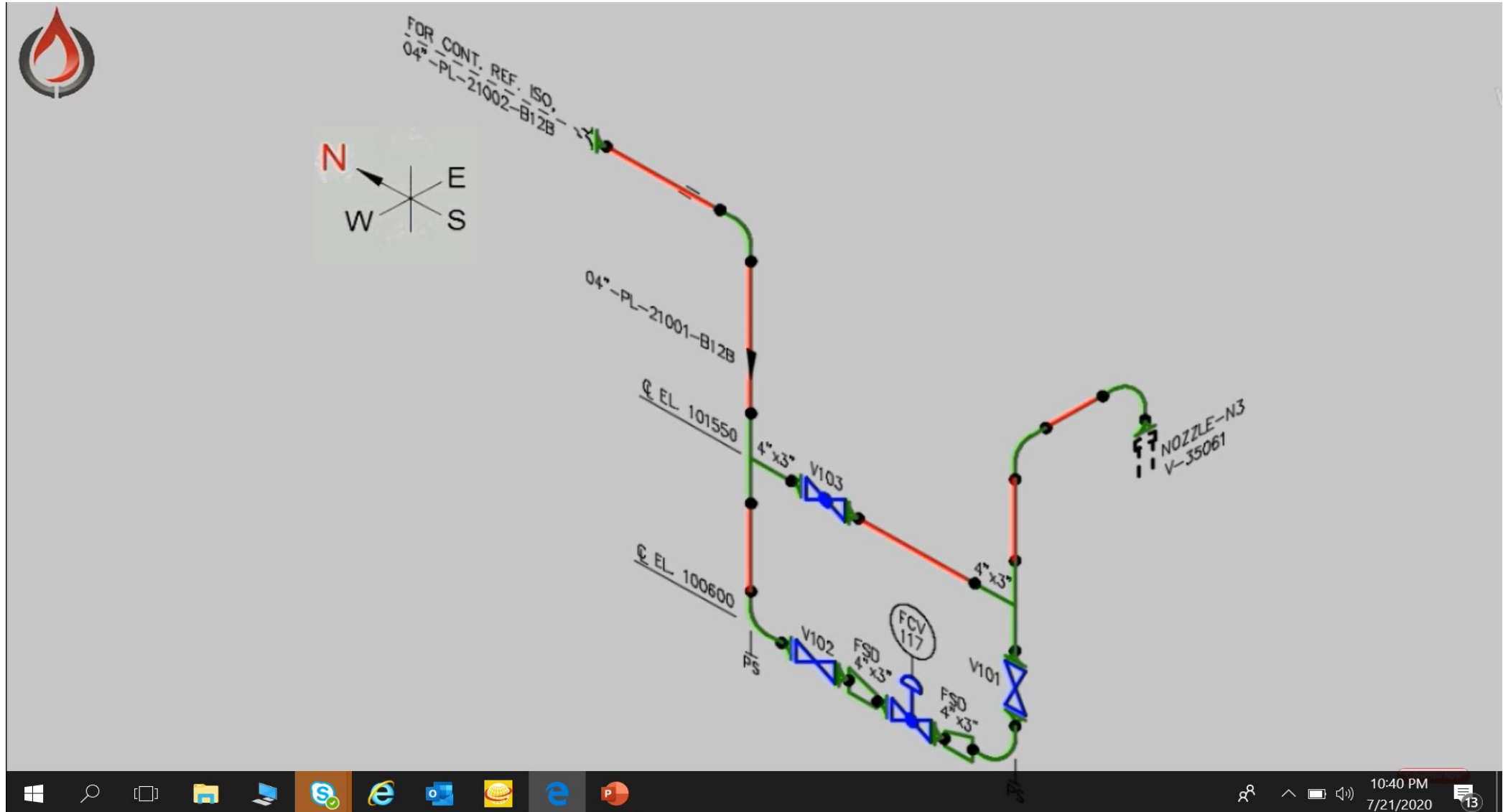
3D MODEL – Typical (1)



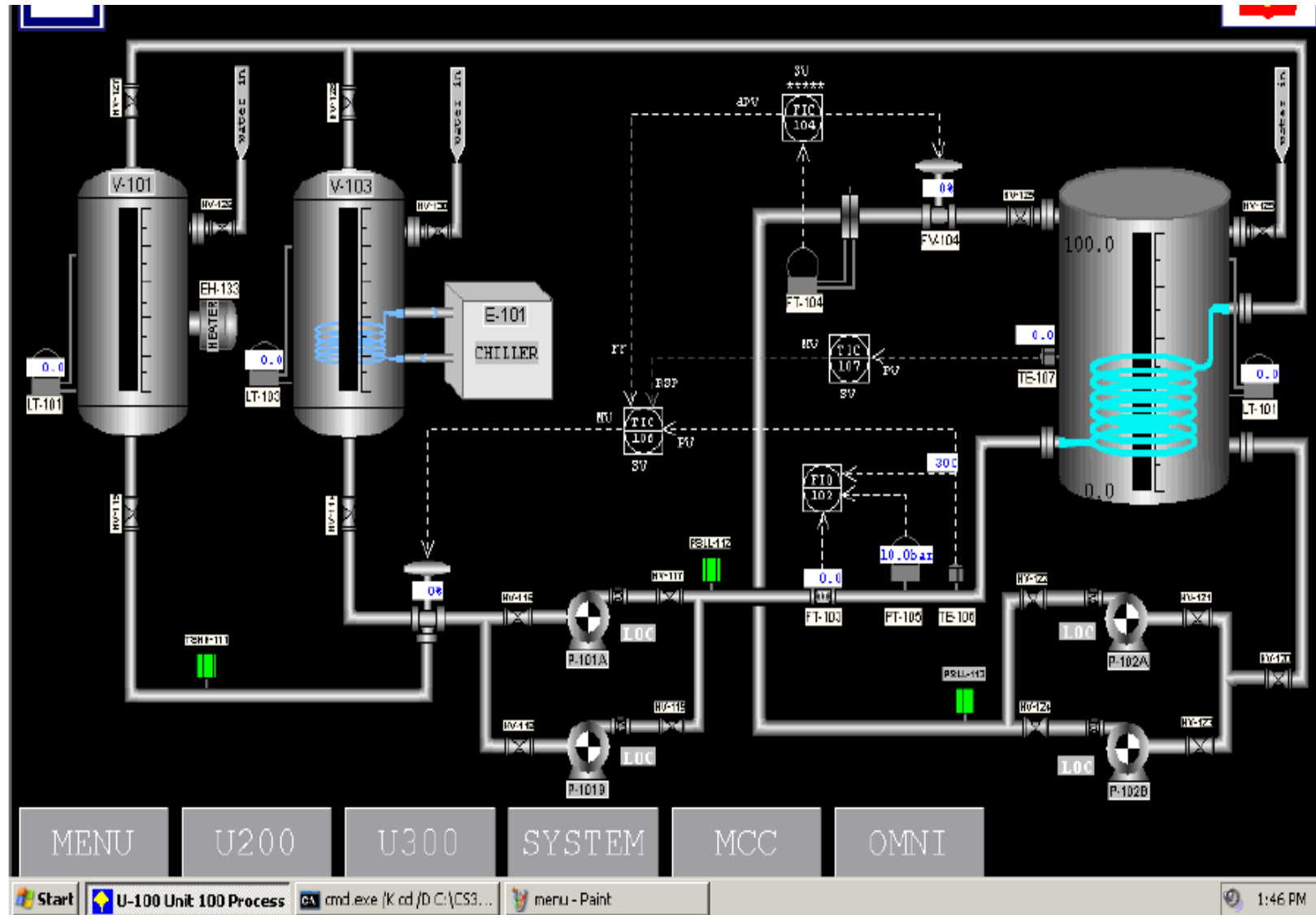
3D MODEL – Typical (2)



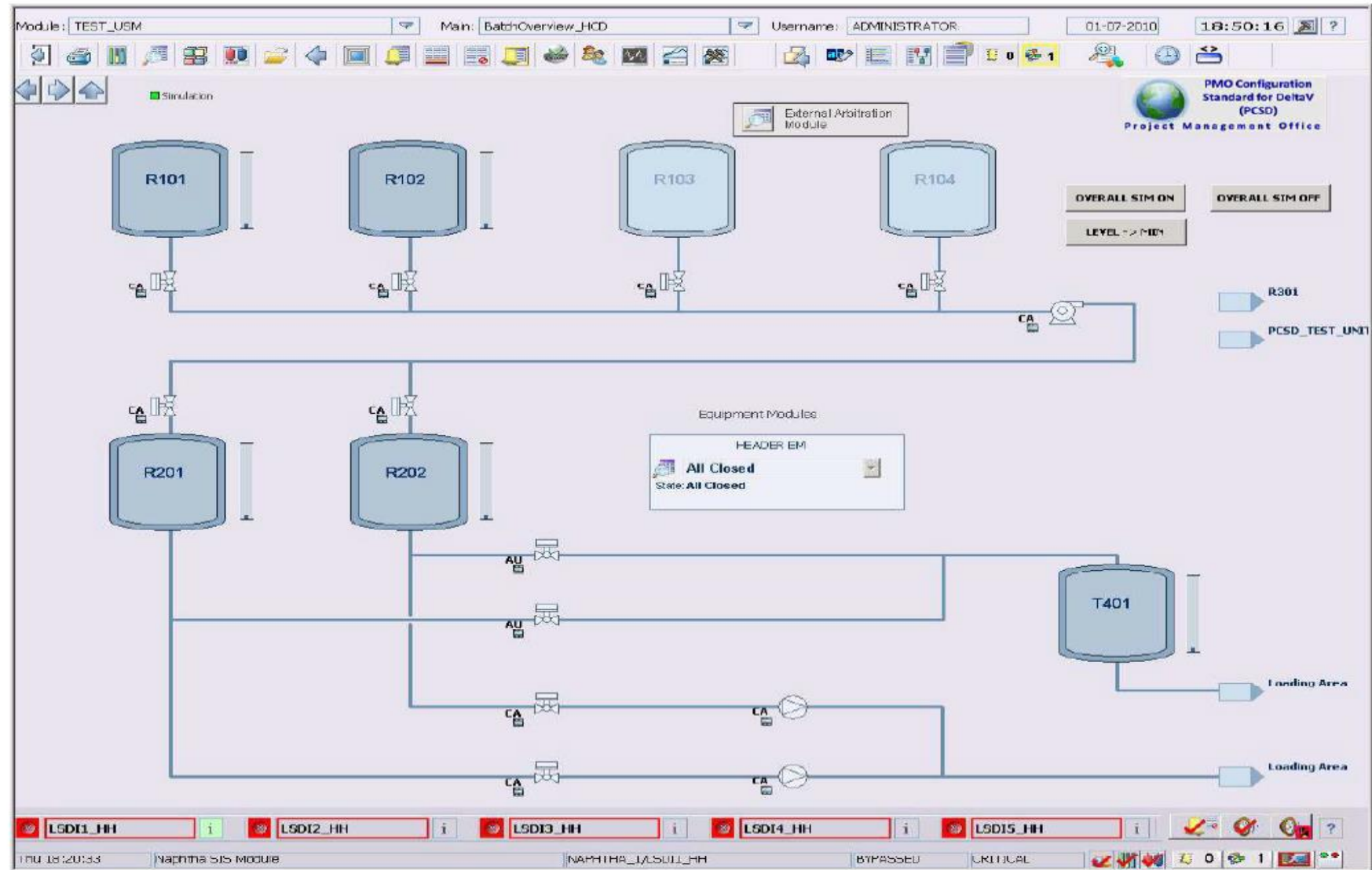
ISOMETRIC DRAWING - TYPICAL



TYPICAL DCS HMI GRAPHICS (1)



TYPICAL DCS HMI GRAPHICS (2)



CONCLUSION

PFS and PEFS are foundational drawings in engineering, presenting the entire process graphically and feeding into other drawings as well as providing inputs into even pre-Contract documentations etc.

REFERENCES

1. Piping Mantra
2. ANSI/ISA – 5.1 2009 Standard – internet class
3. Piping Official

THANK YOU!

QUESTION & ANSWER

Tag Numbers

1st Letter

P = Pressure

T = Temperature

F = Flow

L = Level

I = indicator,
C = controller,
S = switch,
E = element
T = transmit,
G = gauge
V = valve

Property being measured

FCV
045

2nd Letter -- is a modifier

D = differential, F = ratio

3rd Letter -- passive/readout function

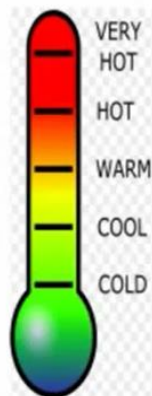
A = alarm, R = record, I = indicator, G = gauge

4th Letter -- active/output function

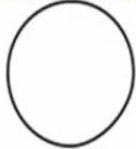
C = controller, T = transmit, S = switch, V = valve

5th Letter -- the function modifier

H = high, L = low, O = open, C = closed

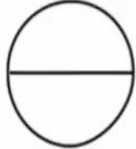


No Line



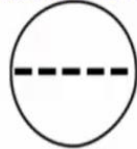
Device and/or its display are physically located in the field and if it has a display it is only readable locally.

Solid Line



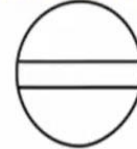
Display is located on a main control panel or video display and is normally accessible to the operator.

Dashed Line



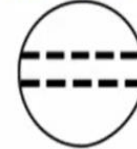
Display is NOT normally accessible to the operator

Double Solid Line



Display is located on a secondary or local control panel that is normally accessible to the operator.

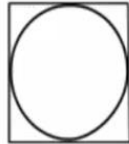
Double Dashed Line



Display is located on a secondary or local control panel is NOT normally accessible to the operator.



A shared device either displays information from multiple instruments, controls multiple instruments, or both. Inside the square will be either a circle or a diamond.



It is the primary choice or Basic Process Control System.



it is the alternate choice or Safety Instrumented System.



It shows computer systems.

