



EMERSON EXCHANGE 2025

ACCELERATING INNOVATION



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Upgrade Legacy PLC at Qatif Wells to DeltaV SIS Electronic Marshalling

Session Number: 3-1176

May 2025

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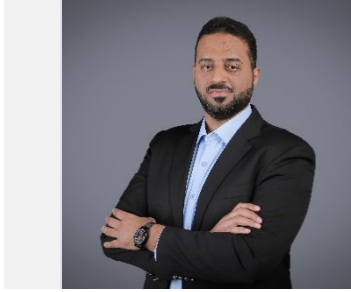
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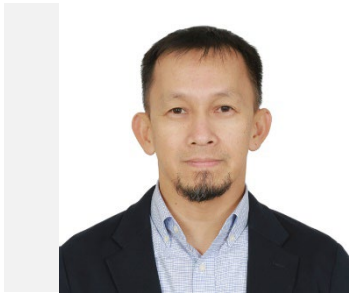
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Our Agenda Today

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Company Introduction

Legacy Emergency Shutdown System Challenges

Fully-Rated Multi-Well Oil Safety Instrumented Function Design

Strategy on Emergency Shutdown Systems at Wellheads

Implementation at Site

Summary

Saudi Aramco

- Officially known as Saudi Arabian Oil Company
- Based in Dhahran, Saudi Arabia
- Primarily operates in the production, refining, distribution, and exploration of hydrocarbons
- In 2019, Aramco went public with the world's largest initial public offering (IPO), listing on the Tadawul stock exchange in Riyadh
- The Saudi government maintains a majority stake in the company

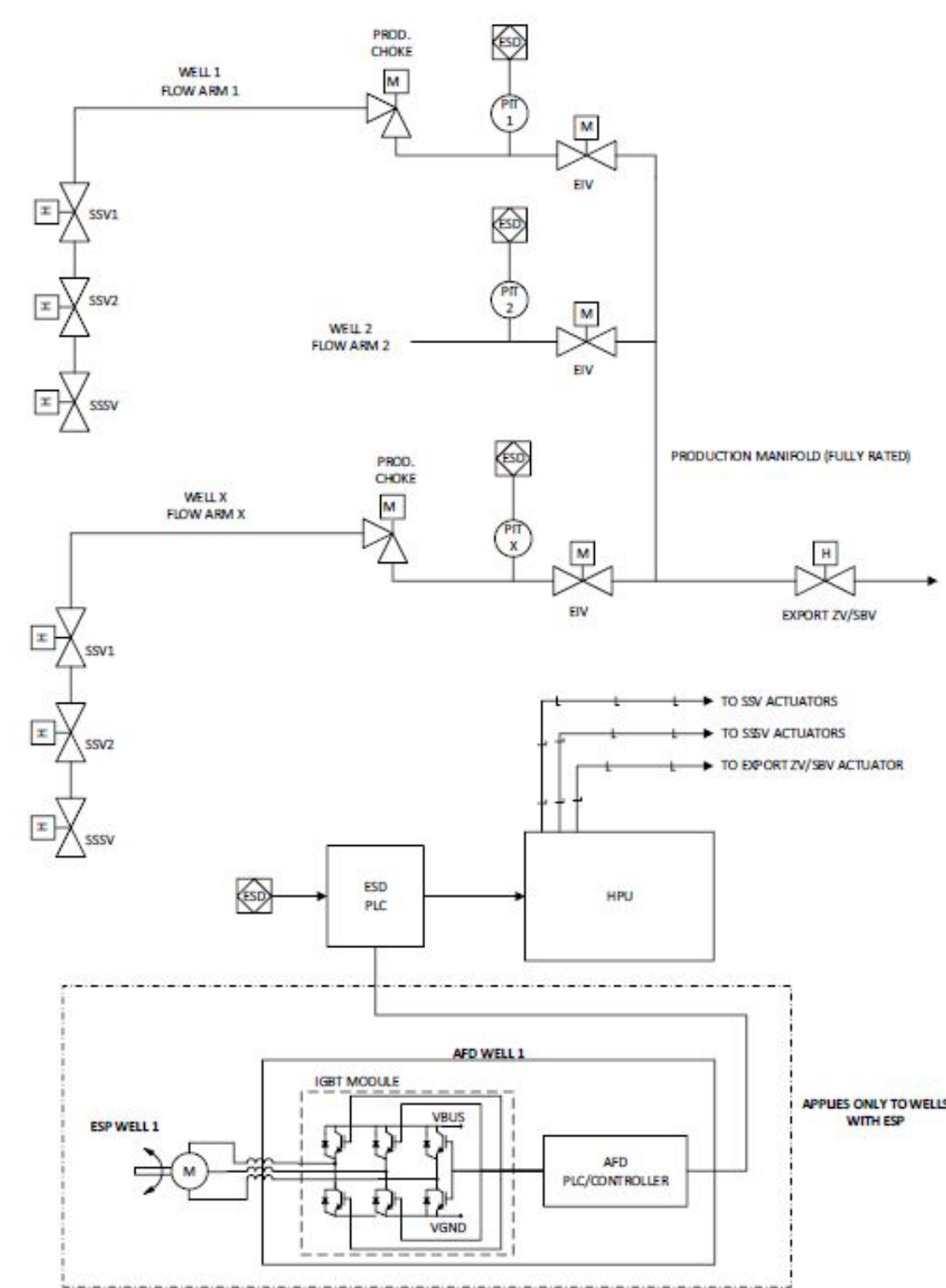


Legacy Emergency Shutdown System Challenges

- Frequent shutdown due the aging of the system – increased spurious trip rates.
- Increased safety and financial risks due to unplanned shutdowns.
- Uncertain safety integrity of ESD system running in wear out phase.
- Slow Restoration due to limited diagnostics tools – longer troubleshooting activities.

Fully-rated Multi-Well Oil Safety instrumented Function Design

- Sensing Elements
- Logic Solver
- Final Elements



Strategy on Emergency Shutdown Systems at Wellheads

- Software Reverse Engineering
 - DeltaV SIS Logic Verification
 - Existing logic and documentation analysis
 - Develop software based on Functional Safety Management
 - Thorough test of the new software
- Hardware Migration
- Project Schedule and Responsibility Matrix
 - This is at the time of worldwide electronic components shortage



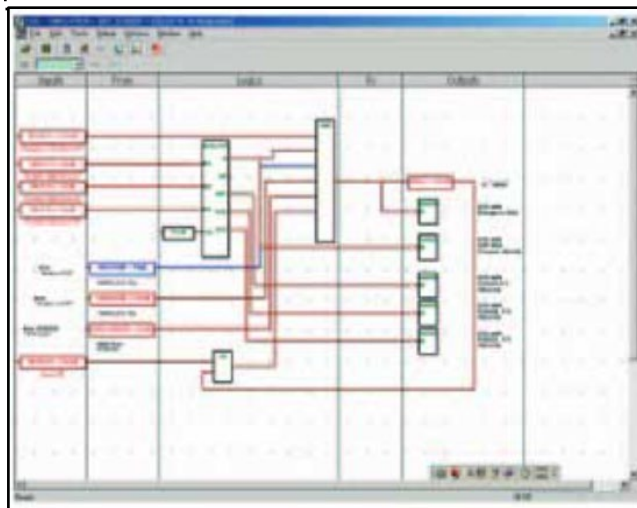
Workflow : Software Reverse Engineering

IO Database
(CSV, XLS)



Reverse Engineering

Operational Software
logic- Function Block
Diagram (PDF) and
Graphic snaps



- IO Lists
- C & E Diagram
- Traceability Matrix



End User
Approval



- Software Configuration
- Internal Testing
- FAT

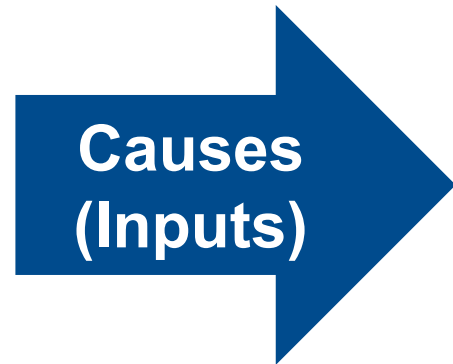
Verifying the DeltaV SIS Logic: Three Key steps

Steps	Objective	Outcome
Step 1.	Analyse existing safety logic and existing documentation, and identify <i>any and all differences</i> between them	Discuss, resolve and agree C&E Specification requirements for replacement system
Step 2.	Develop software for replacement SIS system following Functional Safety Management procedures	New software application to replace existing SIS logic
Step 3.	Thoroughly test the new software to confirm that <i>all feasible input combinations result in the same outputs as the old system</i> (except where any differences have been agreed)	Approval

Analyse existing safety logic and existing documentation

Steps	Objective
Step 1.1	Data Gathering From Yokogawa System. It is very crucial to have the Site Backup and related information in readable and searchable format.
Step 1.2	IO Extraction - <ul style="list-style-type: none"> • Prepare SIS IO List • HW I/Os & SW I/Os Reconciliation
Step 1.3	Functional Analysis on extracted data – Identifying Bypass, Reset, Voting, Degradation functionality, Status Handling, Overrange-under range, Discrepancy alarms, deviations alarms etc.
Step 1.4	Reverse Engineering - <ul style="list-style-type: none"> • Prepare or Update C&E Document Against SW backup • Preparation of Traceability Matrix Document • Review / Verification of deliverables produced

Generate New Cause and Effect



QATIF-P01 CAUSE & EFFECT DIAGRAM										EFFECT	P&ID NOTES	
H2S GAS MONITORING SYSTEM												
CAUSE										ACTION	DESCRIPTION	
DESCRIPTION	P&ID	TAG NO	SAFETY	VLAVE	MOS	TIME DELAY	SEL	NOTES	TAG NO.			
H2S Gas Detection - Well Head Q298	-	P01_AE_ATT323	H	10 ppm	-	-	N/A	-	1	1	Gas Detector Alarm (Front) Outside RTU Beaker	1
			HH	20 ppm	P01_H5323	-	N/A	1.2	2	2	2	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection-Tie In MOV Well head Q298	-	P01_AE_ATT324	H	10 ppm	-	-	N/A	-	3	3	Gas Detector Alarm (Front) Outside RTU Beaker	3
			HH	20 ppm	P01_H5324	-	N/A	1.2	4	4	4	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection - Well Head Q299	-	P01_AE_ATT332	H	10 ppm	-	-	N/A	-	5	5	Gas Detector Alarm (Front) Outside RTU Beaker	5
			HH	20 ppm	P01_H5332	-	N/A	1.2	6	6	6	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection-Tie In MOV Well head Q299	-	P01_AE_ATT333	H	10 ppm	-	-	N/A	-	7	7	Gas Detector Alarm (Front) Outside RTU Beaker	7
			HH	20 ppm	P01_H5333	-	N/A	1.2	8	8	8	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection-Well Head Q270	-	P01_AE_ATT341	H	10 ppm	-	-	N/A	-	9	9	Gas Detector Alarm (Front) Outside RTU Beaker	9
			HH	20 ppm	P01_H5341	-	N/A	1.2	10	10	10	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection-Tie In MOV Well head Q270	-	P01_AE_ATT342	H	10 ppm	-	-	N/A	-	11	11	Gas Detector Alarm (Front) Outside RTU Beaker	11
			HH	20 ppm	P01_H5342	-	N/A	1.2	12	12	12	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection - Well Head Q271	-	P01_AE_ATT350	H	10 ppm	-	-	N/A	-	13	13	Gas Detector Alarm (Front) Outside RTU Beaker	13
			HH	20 ppm	P01_H5350	-	N/A	1.2	14	14	14	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection-Tie In MOV Well head Q271	-	P01_AE_ATT351	H	10 ppm	-	-	N/A	-	15	15	Gas Detector Alarm (Front) Outside RTU Beaker	15
			HH	20 ppm	P01_H5351	-	N/A	1.2	16	16	16	Gas Detector Alarm (Front) Outside RTU Beaker
H2S Gas Detection-Scoper Rackw/ Q13-D-0014	-	P01_AE_ATT407	H	10 ppm	-	-	N/A	-	17	17	Gas Detector Alarm (Front) Outside RTU Beaker	17
			HH	20 ppm	P01_H5340	-	N/A	1.2	18	18	18	Gas Detector Alarm (Front) Outside RTU Beaker
Common Signals	-	-	-	-	-	-	-	-	19	19	Gas Detector Alarm (Front) Outside RTU Beaker	19
			-	-	-	-	-	-	-	20	20	Gas Detector Alarm (Front) Outside RTU Beaker
Lamp Test	-	-	LAMP10T	-	-	-	-	-	21	21	Gas Detector Alarm (Front) Outside RTU Beaker	21
H2S Common Reset	-	-	P01_H5_303	-	-	-	-	-	22	22	Gas Detector Alarm (Front) Outside RTU Beaker	22
H2S Common Acknowledge	-	-	P01_H5_302	-	-	-	-	-	23	23	Gas Detector Alarm (Front) Outside RTU Beaker	23
H2S Common Critical Alarm	-	-	P02_AY302A	-	-	-	-	-	24	24	Gas Detector Alarm (Front) Outside RTU Beaker	24



NOTES:

1. Horn will be activated on H2S HH Alarm and will get automatically RESET after 10 Min if Operator does not acknowledge.
2. MOS is Modbus signal coming from RTU and which is applicable only for HH alarm.
3. The H2S Beacon for respective well head will flash on 1 sec interval on activation and will be steady once acknowledged.
4. Transmitter fault is generated when and one of the below conditions are satisfied
 1. Input signal is less than -1.0 %
 2. Input signal is more than 103.5%
 3. Input signal has Calibration fault
 4. MOS is applied

ABBREVIATIONS:

- A - ACTIVATE
- D - DEACTIVATE
- T - TIMED
- SD - SHUT DOWN (REQUIRES MANUAL RESET)
- ST - START
- O - OPEN
- C - CLOSE
- OL - OPEN LATCH (REQUIRES MANUAL RESET)
- CL - CLOSE LATCH (REQUIRES MANUAL RESET)
- F - GO TO FAIL POSITION
- P - PERMISSIVE
- X - INPUT INITIATED CAUSES OUTPUT ACTION IN COLUMNS SHOWN
- DI - ON ACKNOWLEDGMENT, BEACON WILL STOP FLASHING AND WILL BE STEADY.
- R - RESET

REV	DATE	DESCRIPTION	DRN	CHKD	LEAD ENGR	PM
00	11-11-22	ISSUED FOR CONSTRUCTION	VP	SP	SP	HA
01	06-03-22	ISSUED FOR REVIEW	RS	AR	SP	HA

Emerson EEEEC2 - REVISION CONTROL
SAUDI ARABIAN OIL COMPANY

CAUSE & EFFECT DIAGRAM
DRAWING TYPE LOG
SCALE: N.T.S

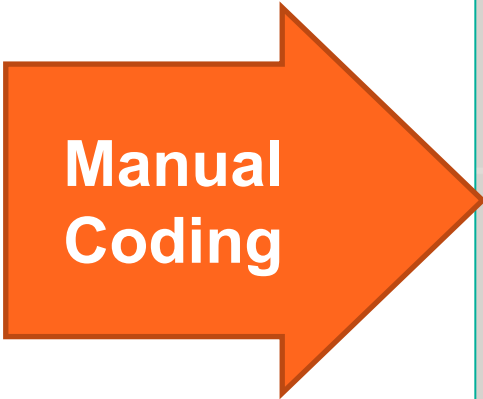
H2S GAS MONITORING & ALARMS P01
QATIF ONSHORE AND OFFSHORE FIELD

REVISION VALIDATION

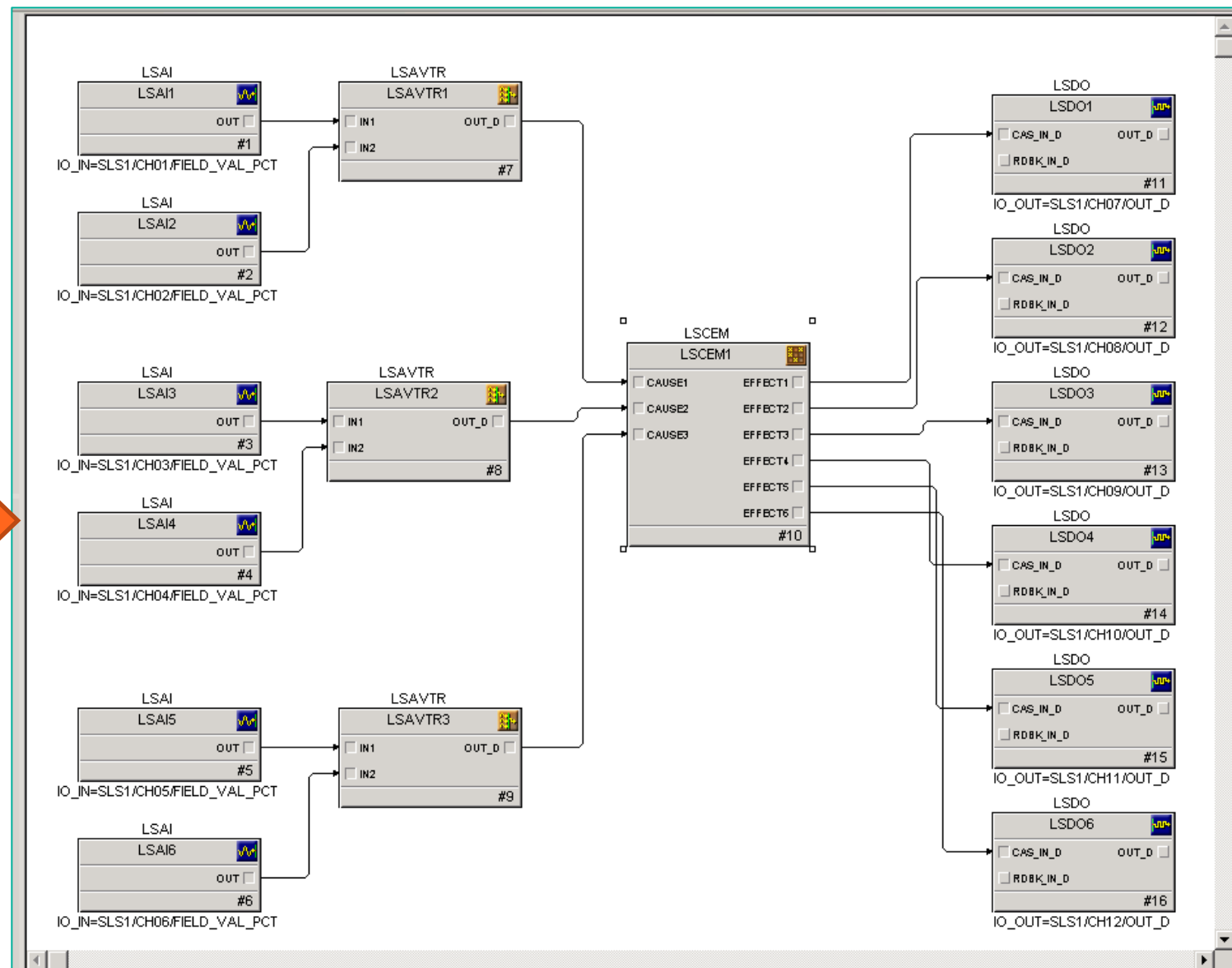
PLANT NO.	DOCUMENT NUMBER	SHT. NO.	REV. NO.
P01	3308286-P01-315-CE-00004	001	00

Develop the Application Program using TUV Certified Function Blocks

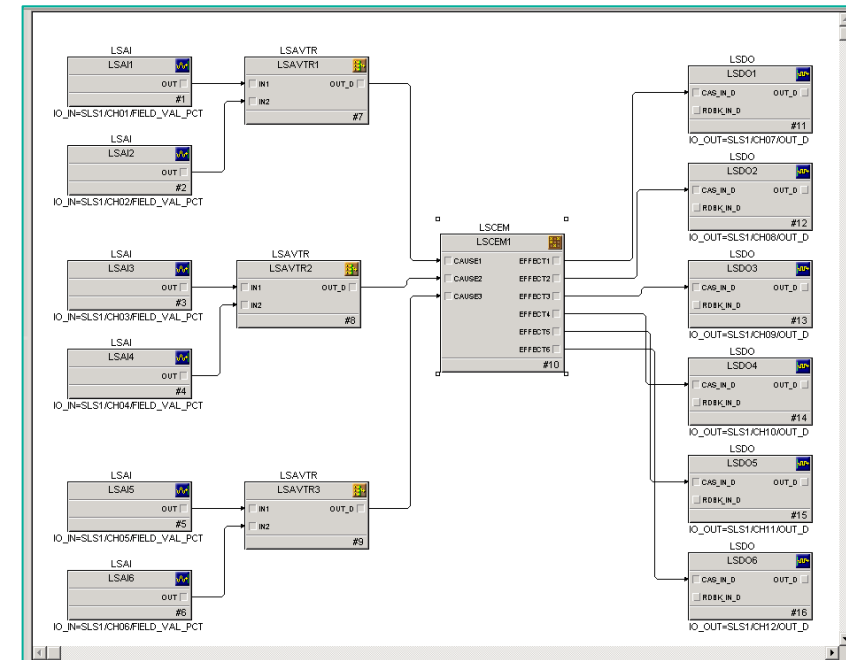
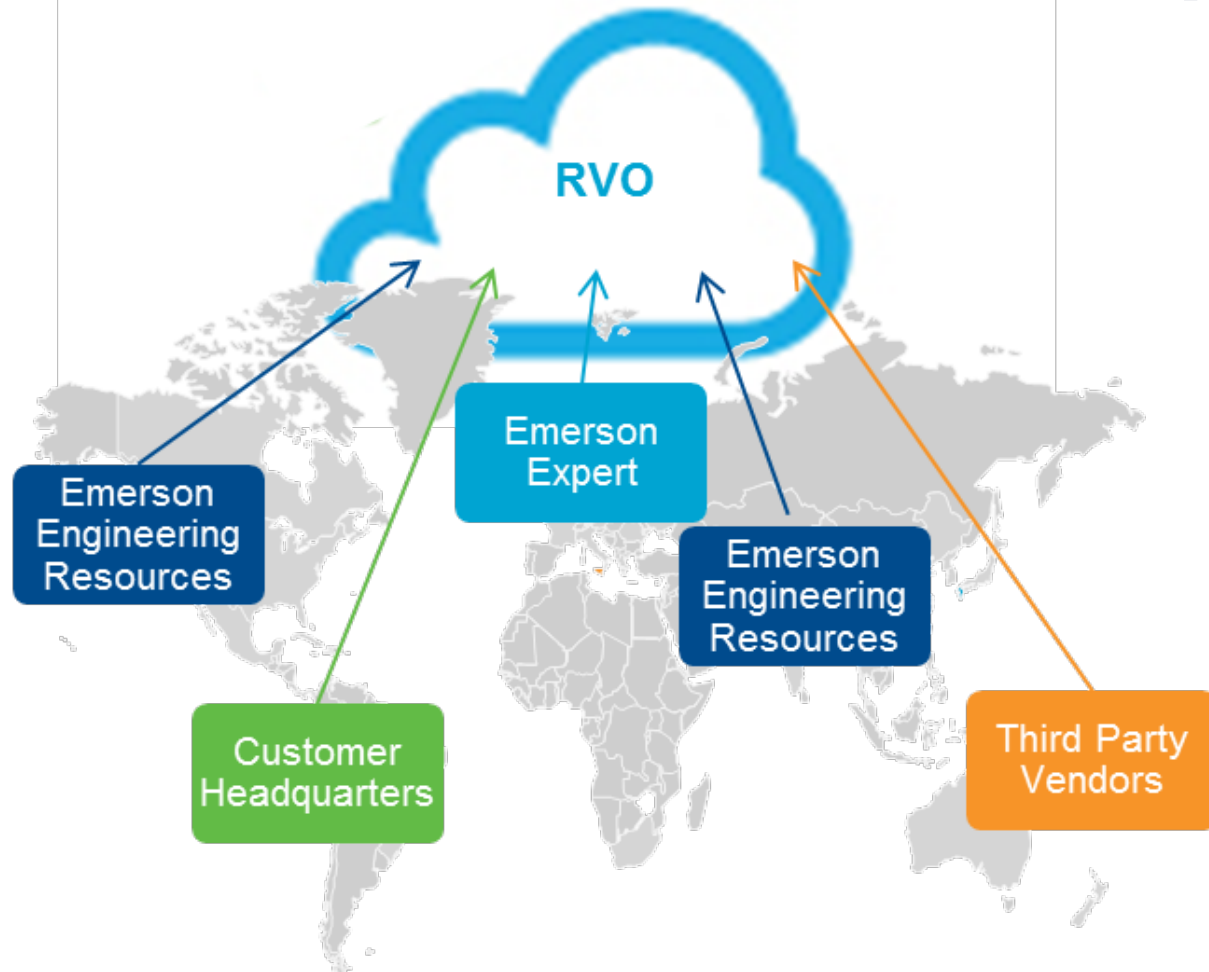
Block	IO_IN	IO_OUT	IO_IN_D	IO_OUT_D	IO_IN_PCT	IO_OUT_PCT	IO_IN_D_PCT	IO_OUT_D_PCT
LSAI1	SLS1/CH01/FIELD_VAL_PCT							
LSAI2	SLS1/CH02/FIELD_VAL_PCT							
LSAI3	SLS1/CH03/FIELD_VAL_PCT							
LSAI4	SLS1/CH04/FIELD_VAL_PCT							
LSAI5	SLS1/CH05/FIELD_VAL_PCT							
LSAI6	SLS1/CH06/FIELD_VAL_PCT							
LSAVTR1								
LSAVTR2								
LSAVTR3								
LSCEM1								
LSDO1								
LSDO2								
LSDO3								
LSDO4								
LSDO5								
LSDO6								



(C&E Revised and Approved by End User)

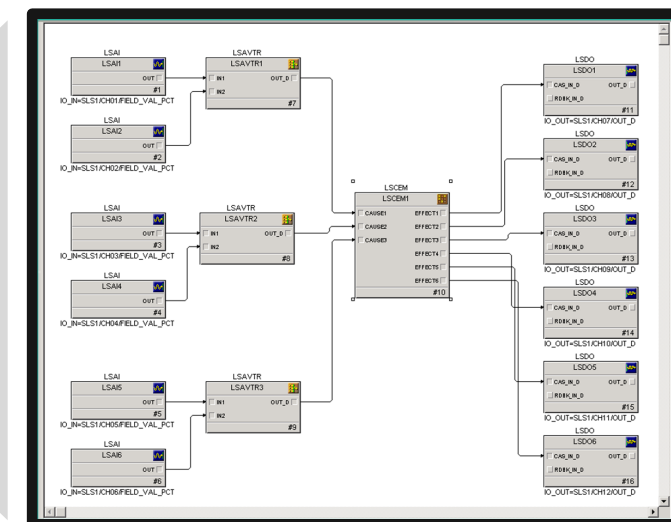


Testing – Internal Software Testing utilizing Remote Virtual Office (RVO)



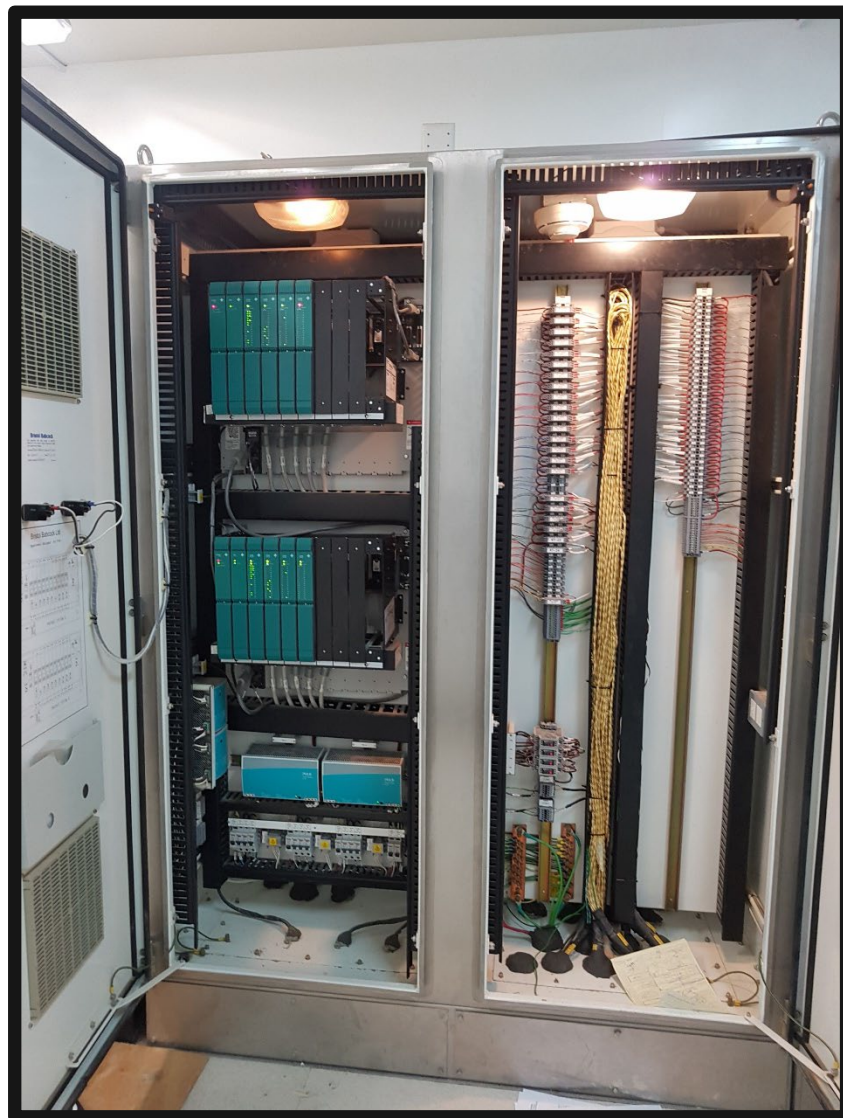
Configuration and testing of SIS logic in a virtual environment, eliminating the need for physical project hardware and enabling faster project startup and reducing the project risk.

Testing the Hardware and the Software – FAT



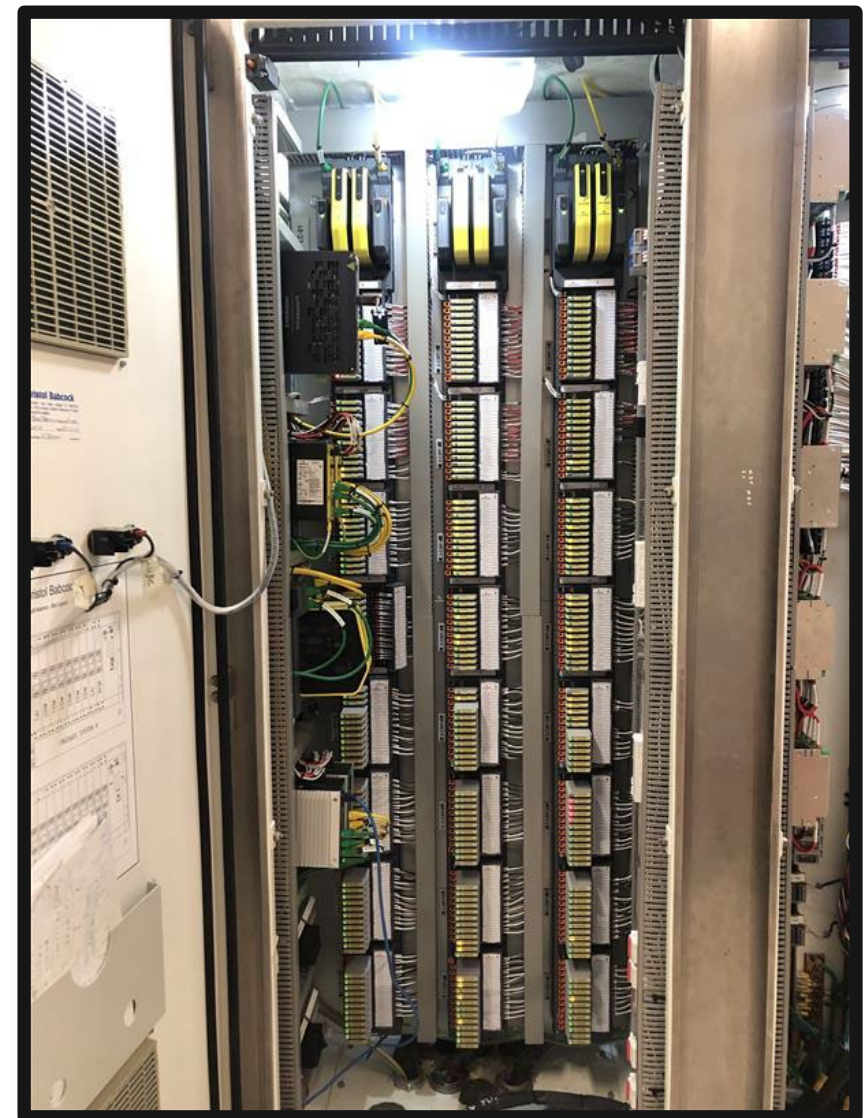
The rubber meets the road

ProSafe-PLC Cabinet



Transformation

DeltaV SIS with Electronic Marshalling



Implementation at Site

Project Schedule and Responsibilities Matrix

Sr. No.	Activity Description	Duration	Emerson LSTK	Saudi Aramco
1	Initial IO Database submission for the proposal issuance	1 Day	P	R
2	Logic backup printout or PDF	1 Day	P	R
3	Provision of Existing Mounting Plates drawing	1 Day	P	R
4	PO Issuance & Acknowledgement	1 Day	R	R
5	Kick Off Meeting	1 Day	R	R
6	Site survey to verify the I/Os and existing wiring	1 Day	R	H
7	Issuing update I/O database for aramco approval	1 Day	R	A
8	Issue for construction (IFC) input documents including I/O list, P&ID, Intelock list, Cause and Effect, control narratives and functional requirement specifications.	1 Day	P	R
9	Reverse Engineering	4 Weeks	R	H
10	Update Cause and Effect (C&E) and the logic diagram documents	1 Day	R	A
11	NMR 601 issuance for approval PDR	4 Weeks	R	P
12	NMR 601 approval	2 Weeks	C	R
13	Pocurement	18 Weeks	R	P
14	NMR 602 Issuance for approval CDR	4 Weeks	R	P
15	NMR 602 approval	2 Weeks	C	R
16	Software Implementation & Testing	6 Weeks	R	P
17	Mounting Plates build at the staging facility in Dammam	8 Weeks	R	P
18	Hardware and software FAT	1 Week	R	W/A
19	IFAT (Simulated to ensure the correct modbus mapping with the existign RTUs)	1 day	R	W/A
20	Shipment to the sites	1 Day	R	H
21	Unpack the Mounting Plate and place it near its final place of Installation	1 Day	R	H
22	Disconnect power	1 Day	R	H
23	Remove cables - Power, signal and earthing, communication	2 Day	R	W
24	Remove the old Mounting Plate with components	1 Day	R	W
25	Install the new Mounting plate and connect the signals, power, erathing cables and communication	2 Day	R	W
26	System Wiring Termination to existing Marshalling TB's/Relay's	1 Week	R	W
27	Power Up checks & SAT	1 Day	R	W
28	Downlaod database	1 Day	R	W
29	Establish communication with the RTU	1 Day	R	W
30	Perform communcation check with the SCADA	1 Day	R	W
31	Perfrom HOT loop check	1 Week	R	W/A
32	Perform functional checks	1 Week	R	W/A
33	SAT Sign off & System Handover	1 Day	R	W/A

A - Approve,
C- Coordinate,
H - Assist/Support
P - Review,
R - Responsible,
S- Supervise,
W - Witness

Hardware Migration – Basis of the solution

- Principle 1: Utilize existing cabinets without adding new cabinet.
- Principle 2: Retain the existing components as practical as possible.
- Principle 3: Avoid disturbing the field wiring.

	Description	Status
1	Frame of the existing systems and marshalling cabinet	Retained/Intact
2	Marshalling section	Retained/Intact
3	Existing Relays	Retained/Intact
4	Signal wires (multicore) from field to marshalling	Retained/Intact
5	Field Terminal blocks in the marshalling cabinet	Retained/Intact
6	ProSafe-PLC Obsolete Components	Replace with New ESD components

About Electronic Marshalling Technology

3 Wires H2S and Hydrocarbon Detectors



General Monitors S5000



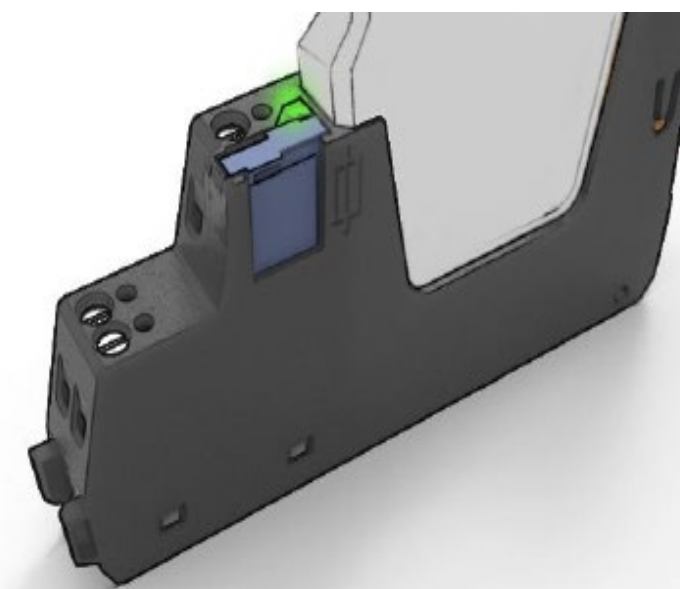
Detcon Model TP-524D

Traditional Complex 3 wiring

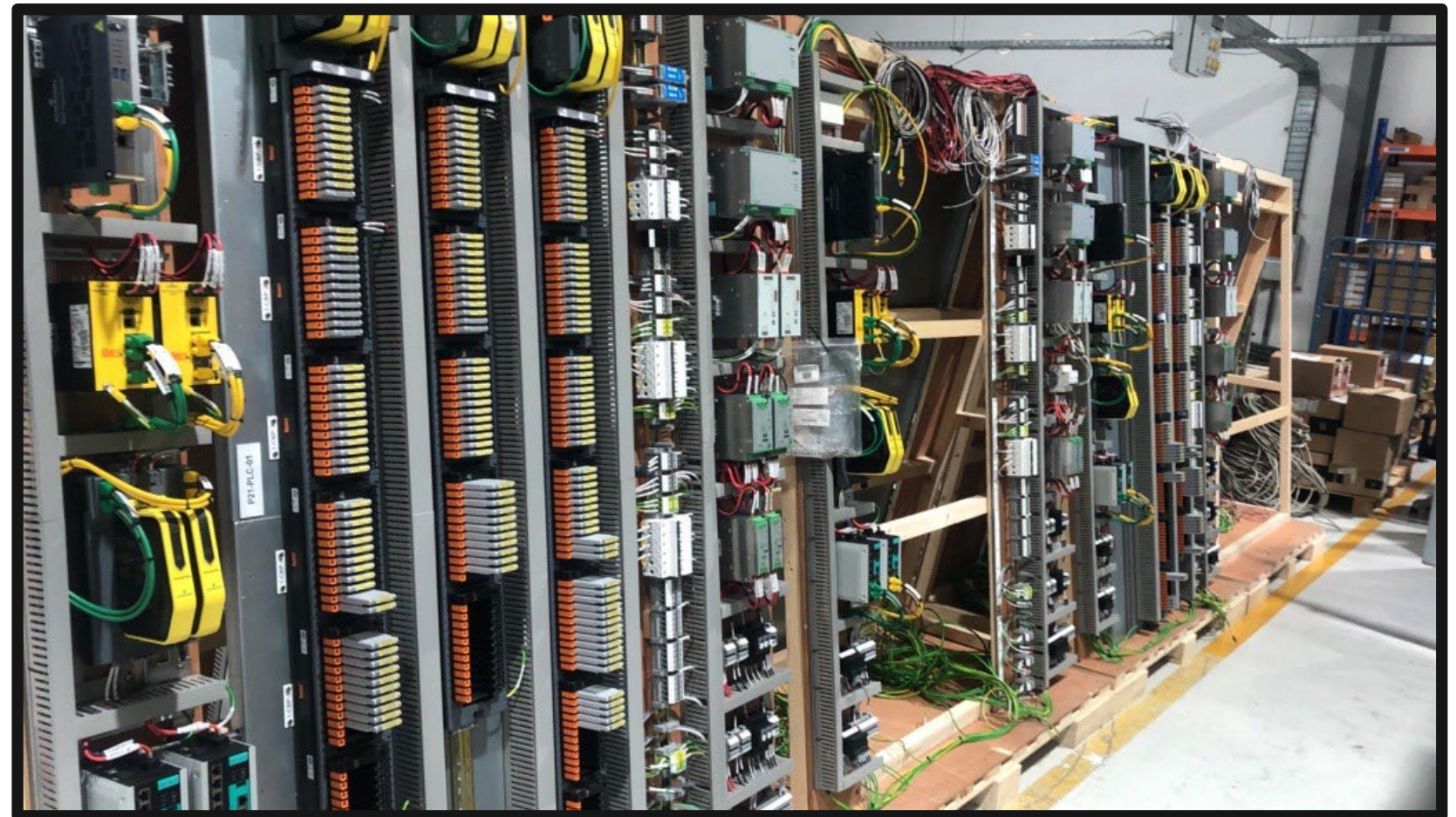
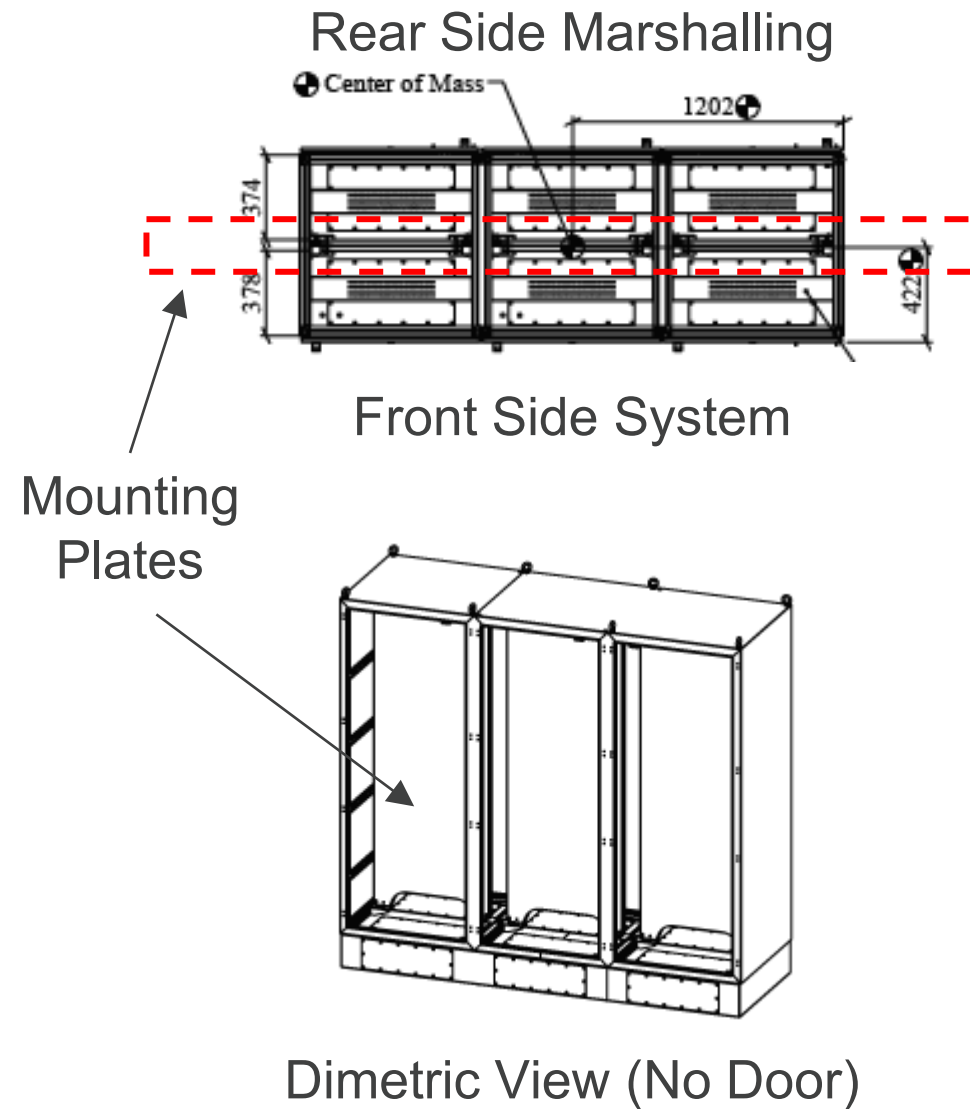


Better way for wiring 3 wires type detectors

Injected Power 3-Wire AI Terminal Block



Mounting Plate arrangement



Summary

- Enhanced Safety (SIS running in its useful lifetime, eliminating the risk of SIS running in wear out phase)
- Increased maintenance reliability with built in diagnostics tools.
- Integrated support for the RTU and the ESD PLC (with the main plant based on DeltaV)
- Support the extension of the wellheads production to another 20-25 years.

Exhibit # 3-1176

Find More Information

Contacts

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Thank You