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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Inquiries should be directed to:
**EmersonExchange@Emerson.com**

**Fawaz Alshaiban**

Process Control System Specialist / Saudi Aramco

**Neil Duhaylungsod**

Sales Manager / Emerson

**Mohamed Salman**

SIS Business Development Manager / Emerson

# Our Agenda Today

| | |
|---|---|
| **Fawaz Alshaiban/ Ali Alkhamis** | Company Introduction |
| **Mohamed Salman** | Legacy Emergency Shutdown System Challenges |
| **Mohamed Salman** | Fully-Rated Multi-Well Oil Safety Instrumented Function Design |
| **Neil Duhaylungsod & Mohamed Salman** | Strategy on Emergency Shutdown Systems at Wellheads |
| **Mohamed Salman** | Implementation at Site |
| **Mohamed Salman** | Summary |

# Saudi Aramco

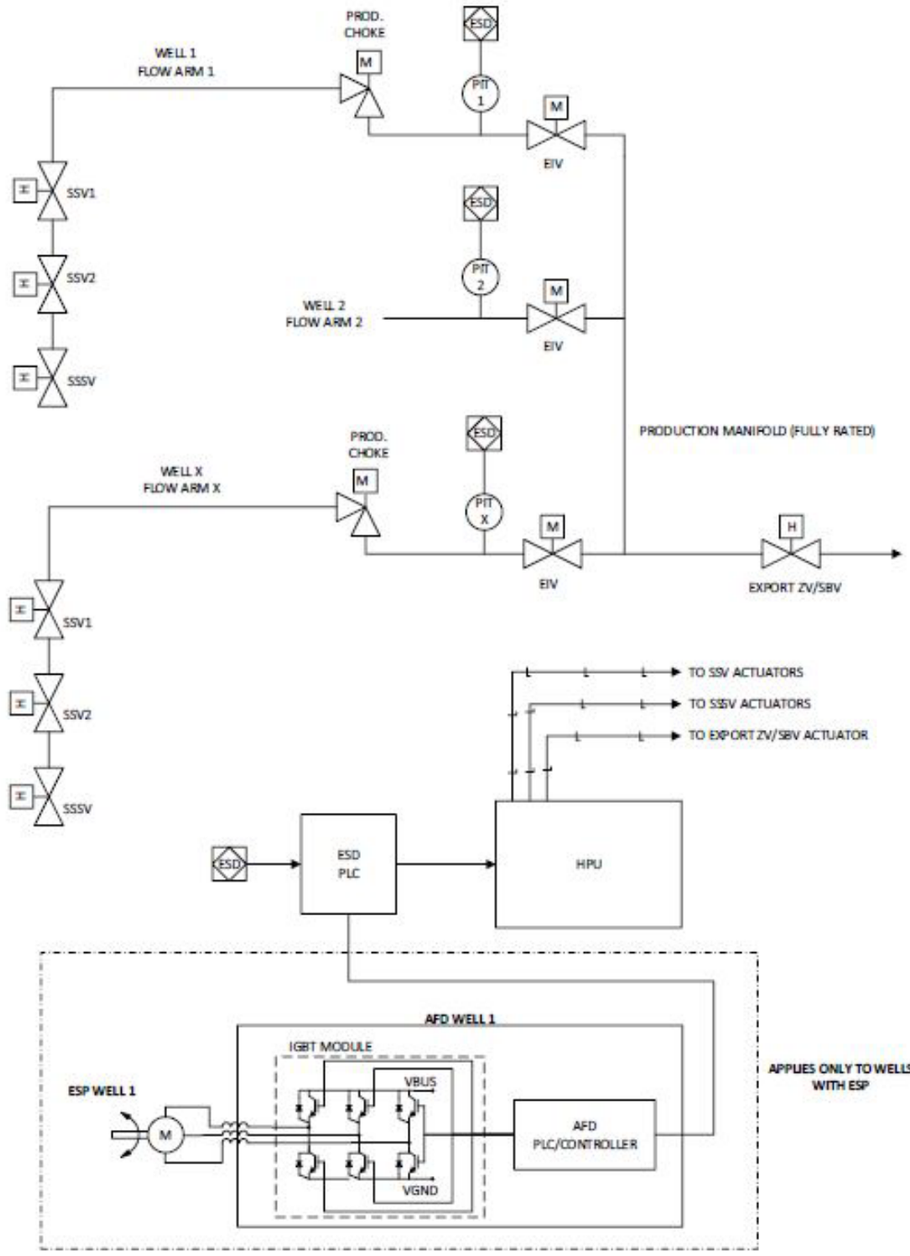

- Officially known as Saudi Arabian Oil Company
- Based in Dhahran, Saudi Arabia
- Primarily operates in the production, refining, distribution, and exploration of hydrocarbons
- In 2019, Aramco went public with the world's largest initial public offering (IPO), listing on the Tadawul stock exchange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



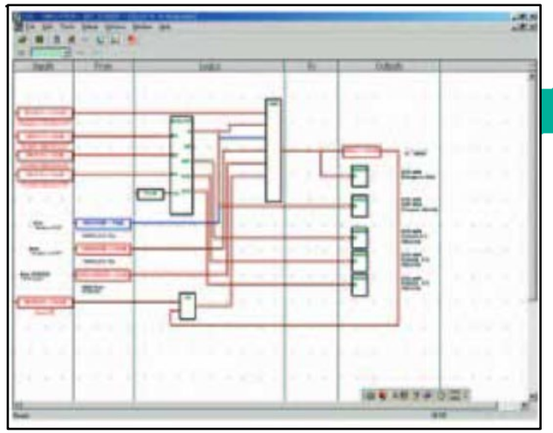
# Strategy on Emergency Shutdown Systems at Wellheads

- 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)

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



Reverse Engineering

- IO Lists
- C & E Diagram
- Traceability Matrix

**End User Approval**

- Software Configuration
- Internal Testing
- FAT

# Verifying the DeltaV SIS Logic: Three Key steps

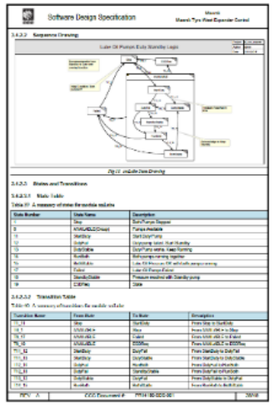
| Steps | Objective | Outcome |
|---|---|---|
| Step 1. | Analyse existing safety logic and existing documentation, and identify ***any and all differences*** between them | Discuss, resolve and agree C&E Specification requirements for replacement system |
| Step 2. | Develop software for replacement 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 *all feasible input combinations result in the same outputs as the old system* (except where any differences have been agreed) | Approval |

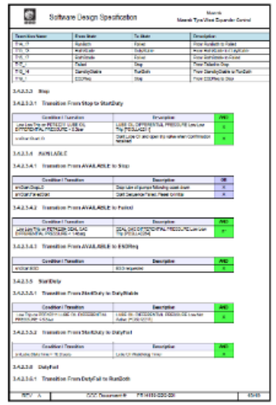
# Analyse existing safety logic and existing documentation

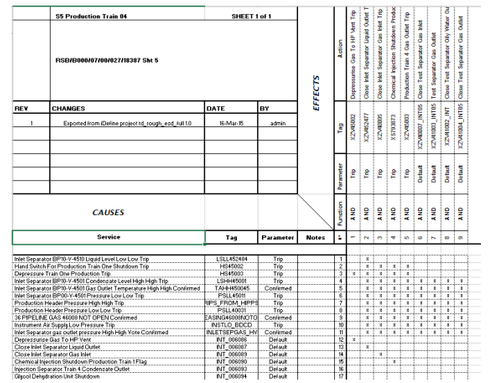
| Steps | Objective |
|---|---|
| Step 1.1 | Data Gathering From Yokogawa System. It is very crucial to have the Site Backup and related information in readable and searchable format. |
| Step 1.2 | IO Extraction -<br>• Prepare SIS IO List<br>• HW I/Os & SW I/Os Reconciliation |
| Step 1.3 | Functional Analysis on extracted data –<br>Identifying Bypass, Reset, Voting, Degradation functionality, Status Handling, Overrange-under range, Discrepancy alarms, deviations alarms etc. |
| Step 1.4 | Reverse Engineering -<br>• Prepare or Update C&E Document Against SW backup<br>• Preparation of Traceability Matrix Document<br>• Review / Verification of deliverables produced |

# Generating Data from the existing System

- Controller & IO Module
- List of Classes and Composites
- IO List and Assignment
- SOE
- Modbus List



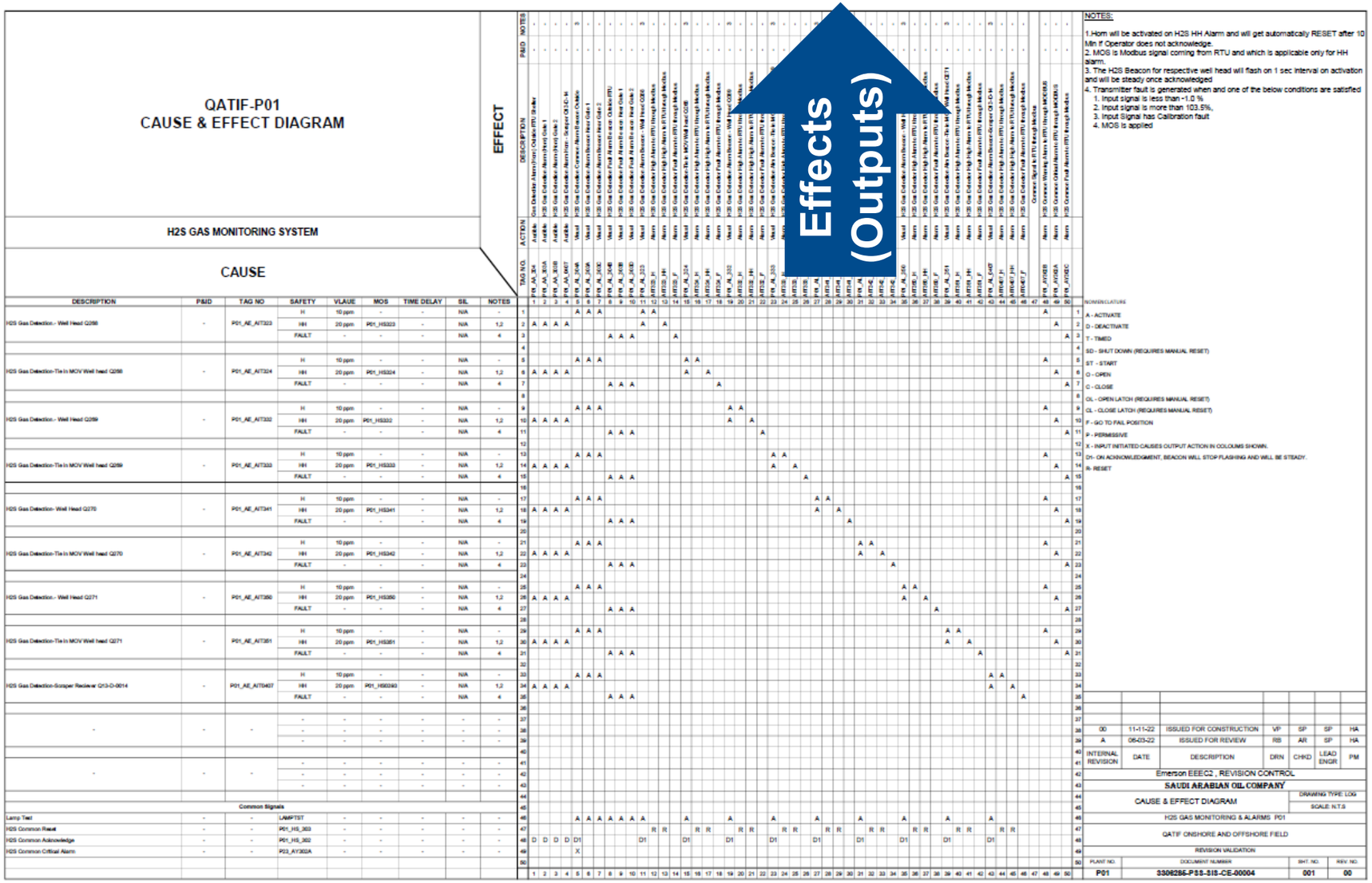




***Functional analysis to extract the information related to the bypass, reset, voting, degradation functionality, status handling, overrange -under range , discrepancy alarms, deviation alarms.***

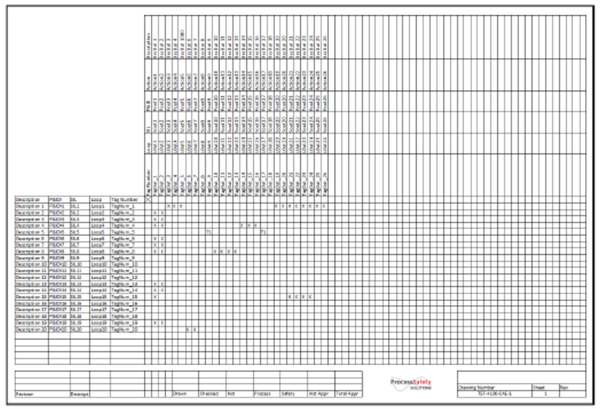
# Generate New Cause and Effect

Causes (Inputs)

Effects (Outputs)

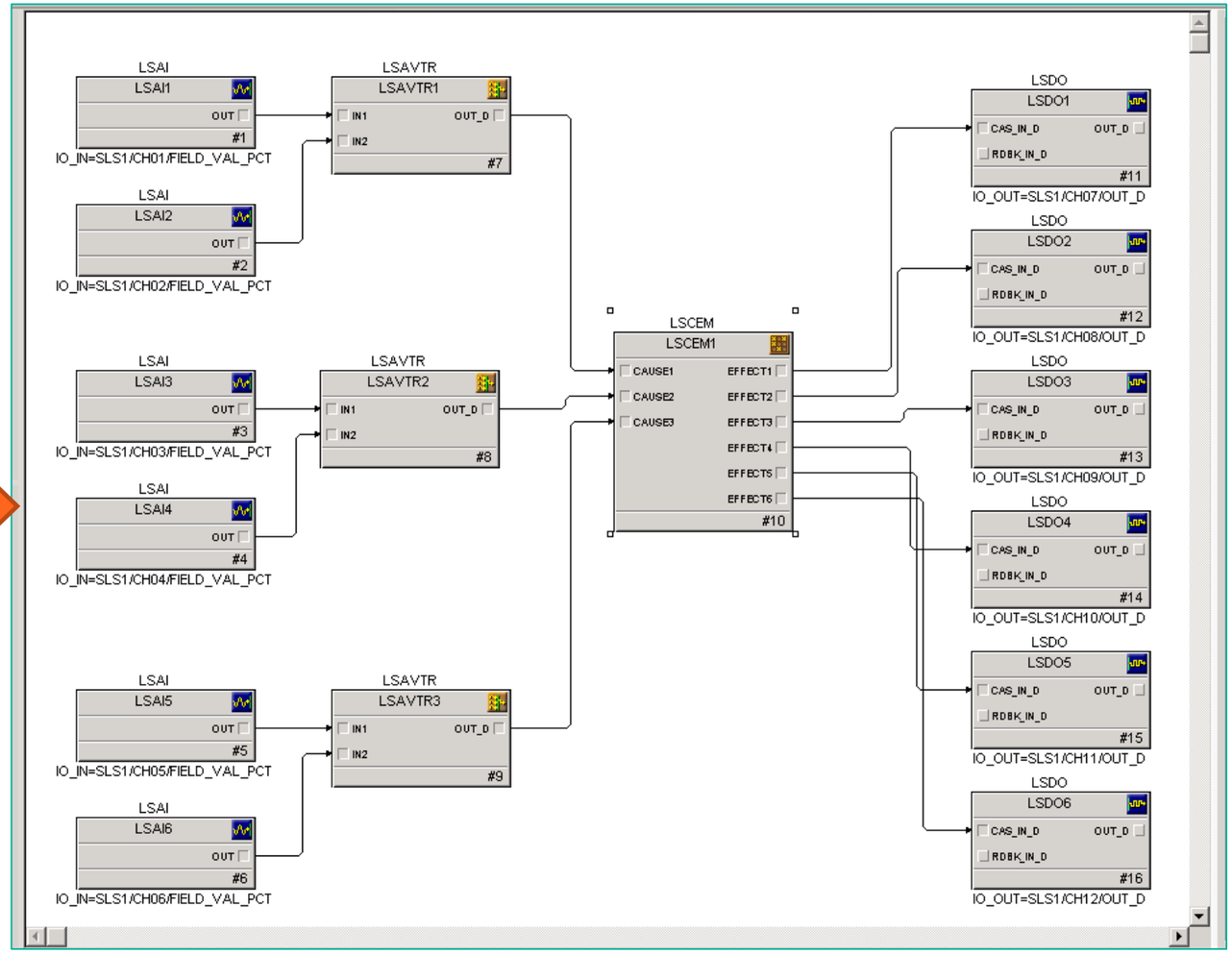


# Develop the Application Program using TUV Certified Function Blocks

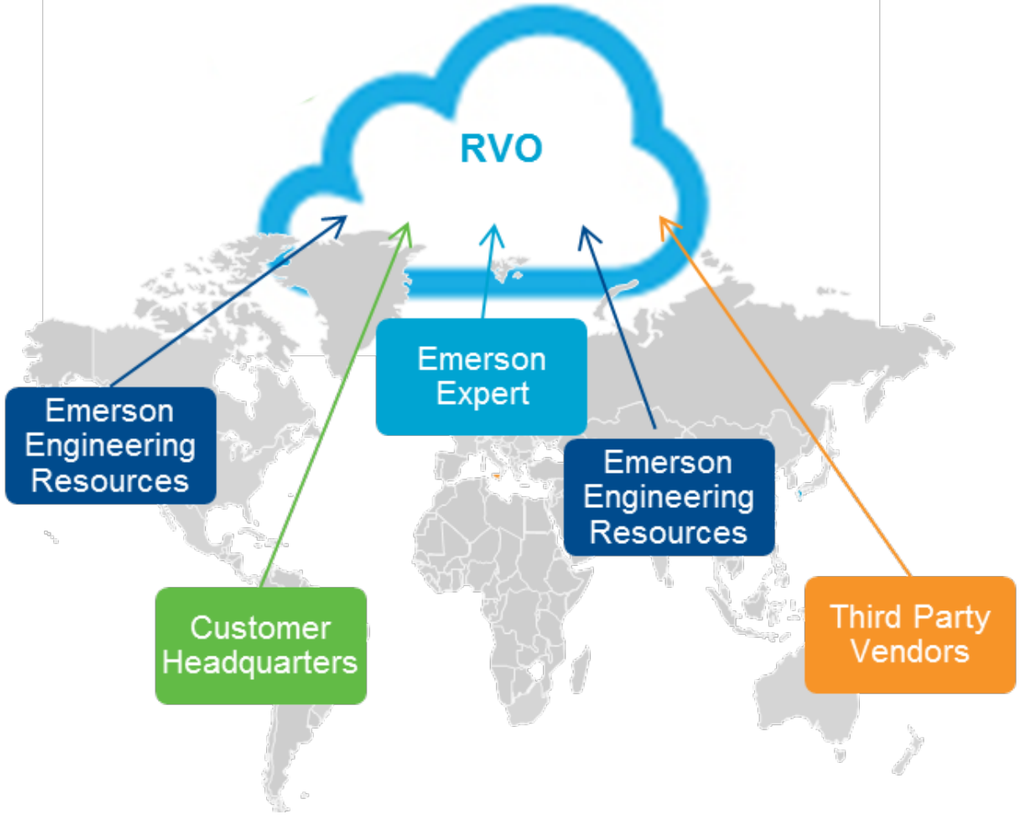


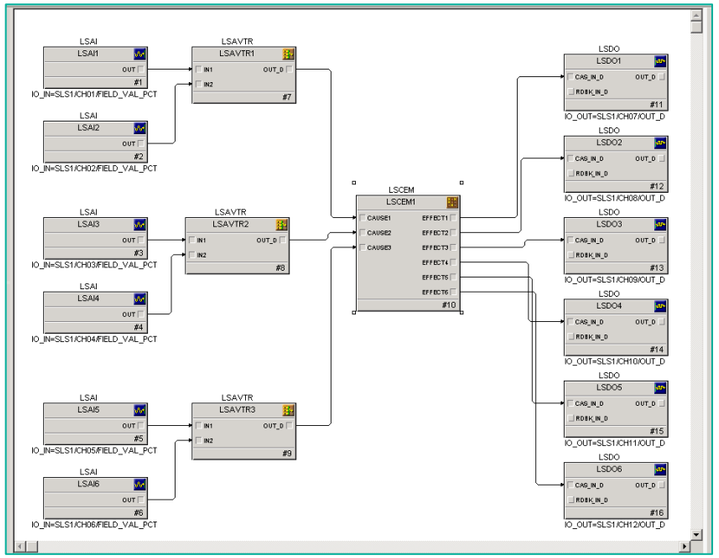
(C&E Revised and Approved by End User)

**Manual Coding**



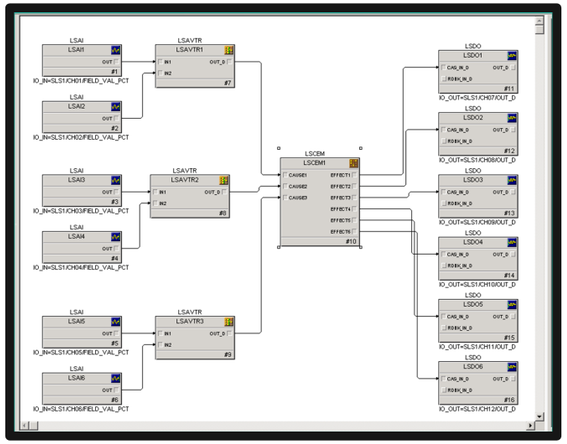
# Testing – Internal Software Testing utilizing Remote Virtual Office (RVO)



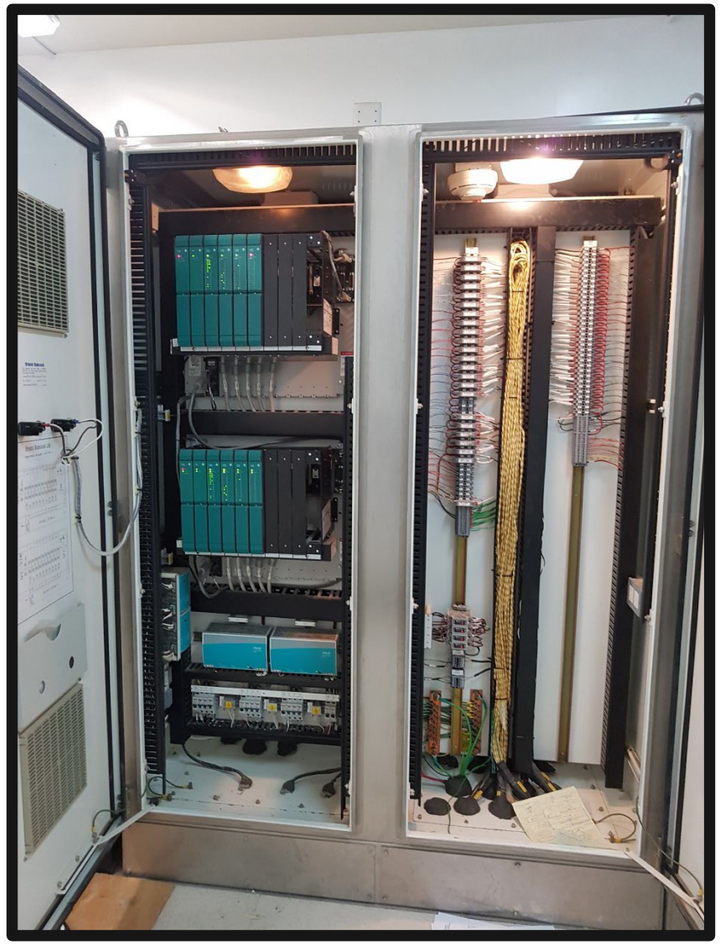

***Configuration and testing of SIS logic in a virtual environment, eliminating the need for physical project hardware and enabling faster project startup and reducing the project risk.***

# Testing the Hardware and the Software – FAT

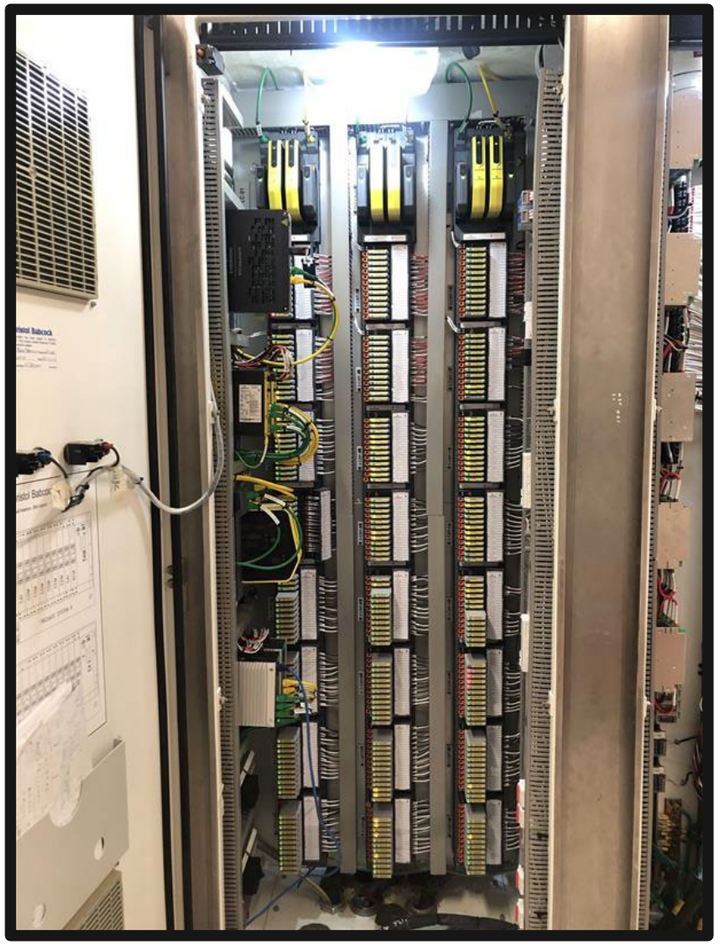
# The rubber meets the road

## 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 maping 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 |

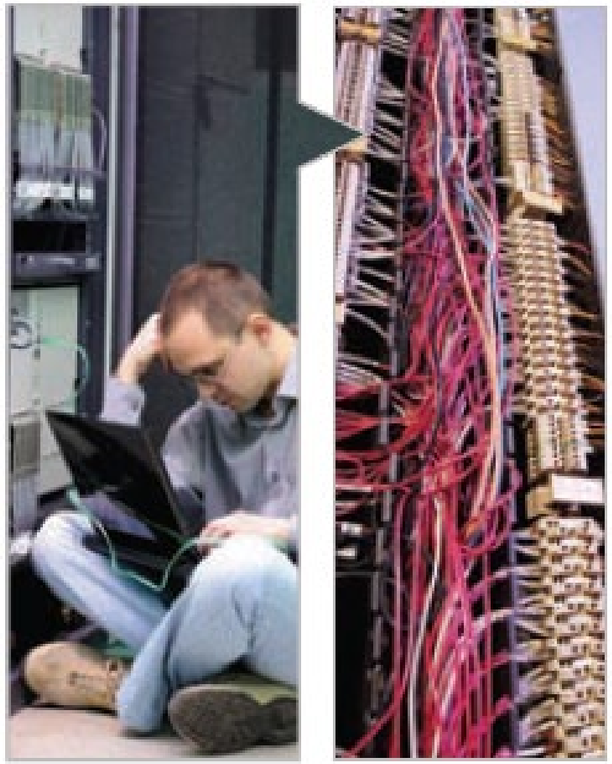
# About Electronic Marshalling Technology

## 3 Wires H2S and Hydrocarbon Detectors

General Monitors S5000

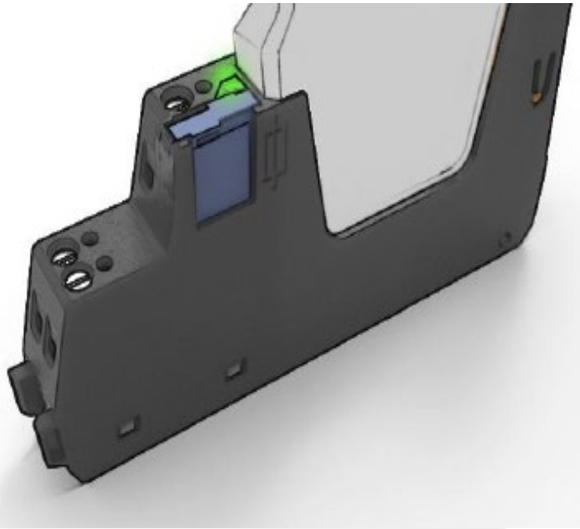
Detcon Model TP-524D

## Traditional Complex 3 wiring

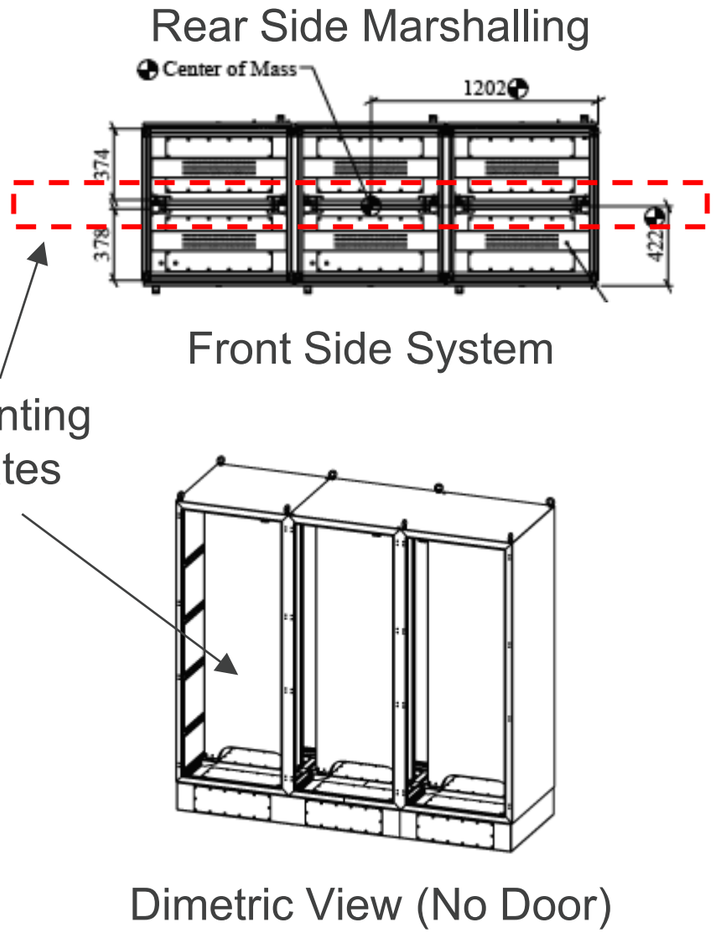


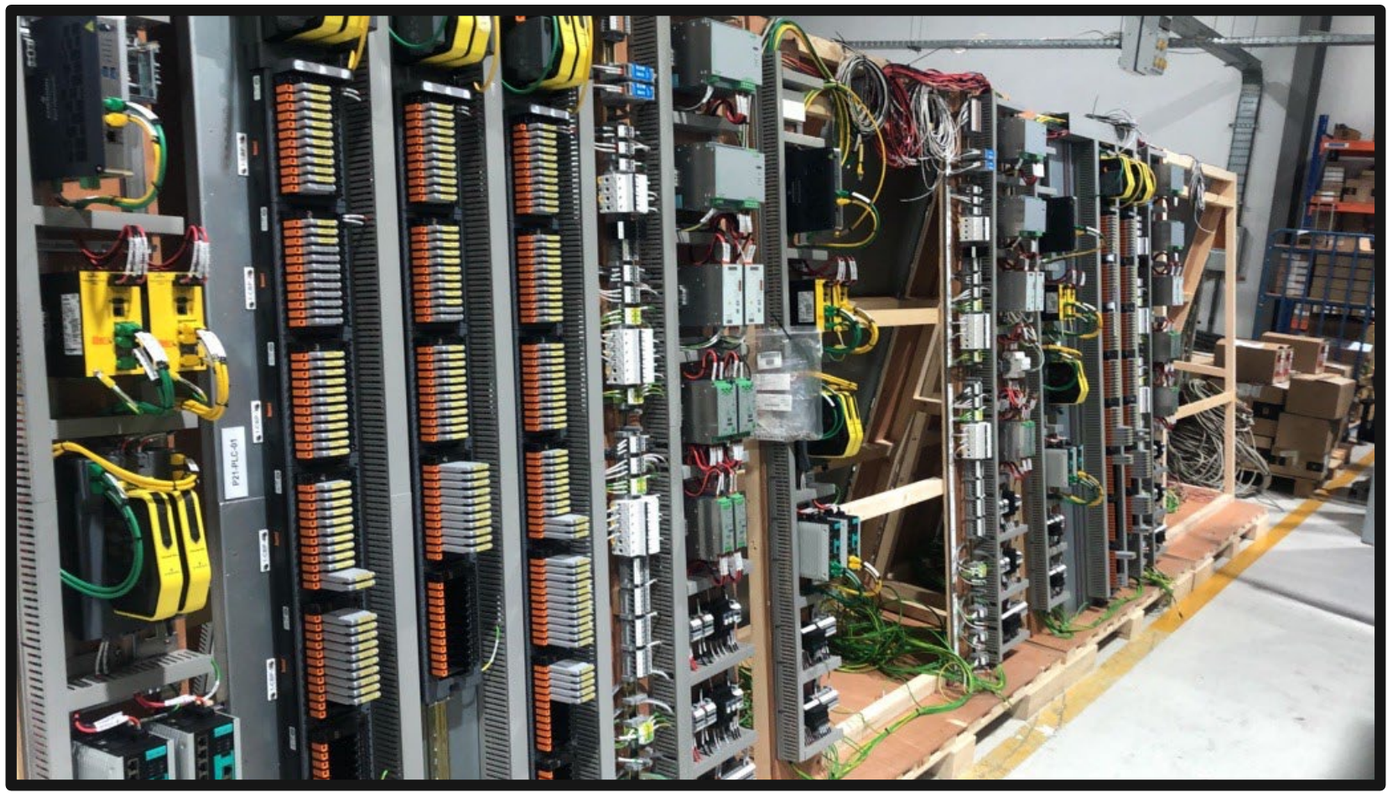
## Better way for wiring 3 wires type detectors

**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.

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# Find More Information

## Contacts

Ali A Alkhamis

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# Thank You