Upgrading of OMIFCO Integrated Control System (ICS)

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Introduction: OMIFCO
**Introduction: OMIFCO**

- Oman India Fertiliser Company SAOC (OMIFCO) has been established, as the result of an initiative by the Governments of Oman & India, in order to operate a modern world scale two-train ammonia-urea fertiliser manufacturing plant.
- OMIFCO is a joint venture between Oman Oil Company (50%), IFFCO (25%) and KRIBHCO (25%).
- Capacity to produce 2x1,750 MT/Day of Anhydrous Ammonia from 2 Ammonia Plants and 2 x2,530 T/D of granular urea from 2 Urea Plants with captive power and steam generation, other plant utilities and off sites facilities.
- OMIFCO plant is located near Sur city in Sultanate of Oman.
Introduction: OMIFCO Process Diagram
Integrated Control System (ICS)

- Two separate systems:
  
  **DCS:** Process Control and Monitoring through Yokogawa Centum CS3000 Distributed Control System.
  
  **ESD:** Emergency Shut Down System for Process Safety through Yokogawa Prosafe-PLC.

- DCS and ESD communicating over plant wide control network through communication gateway (MULCOM).

- Operation and monitoring of both systems via common operator workstations.
ICS: Network Diagram

- Field Control Station (FCS)
- Prosafe-PLC Controller
- Prosafe-PLC Remote IO (RIO)
- Media Converter Panel
- Centum V-net Coaxial Network (Redundant)
- FO Cable Multi Mode (Redundant)
- V-net Bus End Terminator
- Redundant Communication Gateway (MULCOM)
ICS: Need to Upgrade

• **DCS:**
  - End of support for Windows2000 and Workstations Hardware.
  - DCS Centum CS3000 Software, Workstations Hardware and Software compatibility issues.

• **ESD:**
  - End of spares support for Prosafe-PLC hardware since 2009.
  - End of service support for Prosafe-PLC expected by 2018-2019.

• **Communication network issues:**
  - Control Network (V-net): Bus topology (Bus Network)
  - ESD-DCS Communication issues: MULCOM
Upgrade Strategy

• Upgrade Part-1 (DCS Upgrade):
  • DCS Software Upgrade from Centum CS3000 to Centum VP
  • Engineering Station, Operator Workstations hardware upgrade and software upgrade from Windows 2000 to Windows 2008 server/Windos7.

• Upgrade Part-2 (ESD Upgrade):
  • ESD system upgrade from Prosafe-PLC to Prosafe-RS.
  • DCS controller (FCS) upgrade from AFS30D to AFV30D.
  • Upgrade of plant control network from V-net bus network to VP star network.
Upgrade Part-1 (DCS Upgrade)

- Implemented in 2015-2016
- Online Implementation
- Installed GPS master clock for time synchronization.
- Prerequisite for ESD Upgrade
- Resolved compatibility issues related to DCS and workstation software and hardware.
Upgrade Part-2 (ESD Upgrade): Project Plan and Scope

• Phase-1: Ammonia22 and Urea21 stream
  • Upgrade of ESD system: 2300 I/O points
  • DCS Controller (FCS: 05 nos.) upgrade
  • Network Upgrade to Centum VP

• Phase-2: Utilities & Off sites, Ammonia25
  • Upgrade of ESD system and HRSG BMS: 3400 I/O points
  • DCS, LSS-ECS Controller (FCS: 10 nos.) upgrade
  • ECS-LSS IO Network and SOE Upgrade
  • Network Upgrade to Centum VP

• Phase-3: Ammonia12 and Urea11 stream
  • Upgrade of ESD System: 2300 I/O points
  • DCS Controller (FCS: 04 nos.) upgrade
  • Network Upgrade to Centum VP
• Phase-1: Commissioning of Ammonia22 and Urea21 ESD System within available shutdown period of 14 days in TA-2018.

• Phase-2 and 3: Commissioning of Utilities & Off sites, Ammonia12 and Urea11 ESD System within available shutdown period of 21 days in TA-2019.
ESD Upgrade: Project Philosophy

• Removal of following components:
  • Prosafe-PLC System Cabinets
  • Prosafe-PLC Field Termination Assemblies (FTAs)

• Retaining of Field Marshalling Cabinets
  • Minimum disruption to field cables routing
  • Reduce shutdown time.

• Installation of following Prosafe-RS components
  • Prosafe-RS System Cabinets
  • Prosafe-RS Field Termination Assemblies (FTA) Cabinets
  • Interconnection between new FTAs and field Marshalling Cabinets
  • Cabinet installation in spare locations wherever possible, to minimise shutdown scope of activities.
ESD Upgrade: Project Philosophy: IS Loop

Field JB

Field Marshalling Cabinet

Field Terminal Assembly FTA

System Cabinet Prosafe-PLC

Safety Barriers

Multi Pair Cable

Prefab Cable
ESD Upgrade: Project Philosophy: IS Loop

Field JB

Field Marshalling Cabinet

Field Terminal Assembly FTA

System Cabinet Prosafe-PLC

Safety Barriers

Multi Pair Cable

Prefab Cable

Prefab Cable

Field Terminal Assembly FTA

System Cabinet Prosafe-RS

Termination Board

Safety Barriers Boards
ESD Upgrade: Project Philosophy: IS Loop

Field JB

Field Marshalling Cabinet

Field Terminal Assembly FTA

System Cabinet Prosafe-PLC

Prefab Cable

Multi Pair Cable

Safety Barriers

Prefab Cable

Prefab Cable

Field Terminal Assembly FTA

System Cabinet Prosafe-RS

Prefab Cable

Prefab Cable

Termination Board

Safety Barriers Boards
ESD Upgrade: Project Philosophy: IS Loop

- Field JB
- Field Marshalling Cabinet
- Field Terminal Assembly FTA
- System Cabinet Prosafe-PLC

Prefab Cable

Prefab Cable

Prefab Cable

Prefab Cable

Prefab Cable
ESD Upgrade: Project Philosophy: IS Loop

Field JB

Field Marshalling Cabinet

Termination Board

Field Terminal Assembly FTA

Prefab Cable

System Cabinet Prosafe-RS

Prefab Cable

Termination Board

Safety Barriers Boards
ESD Upgrade: Project Philosophy: IS Loop

Field JB

Field Marshalling Cabinet

Prefab Cable

Termination Board

Field Terminal Assembly FTA

System Cabinet Prosafe-RS

Safety Barriers Boards

Prefab Cable
ESD Upgrade: Project Philosophy: Non-IS Loop

Field JB/ Elect SS

Field Marshalling Cabinet

Field Terminal Assembly FTA

System Cabinet Prosafe-PLC

Terminal Block

Multi Pair Cable

Prefab Cable
ESD Upgrade: Project Philosophy: Non-IS Loop

Field JB/ Elect SS

Field Marshalling Cabinet

Field Terminal Assembly FTA

System Cabinet Prosafe-PLC

Multi Pair Cable

Prefab Cable

Termination Board

Terminal Block
ESD Upgrade: Project Philosophy: Non-IS Loop

- Field JB/ Elect SS
  - Terminal Block
  - Multi Pair Cable

- Field Marshalling Cabinet
  - Multi Pair Cable

- Field Terminal Assembly FTA
  - Prefab Cable

- System Cabinet Prosafe-PLC

- Field Terminal Assembly FTA
  - Multi Pair Cable
  - Termination Board

- System Cabinet Prosafe-RS
  - Prefab Cable
ESD Upgrade: Project Philosophy: Non-IS Loop

Field JB/ Elect SS → Field Marshalling Cabinet → Field Terminal Assembly FTA → System Cabinet Prosafe-PLC

- Prefab Cable
- Multi Pair Cable
- Terminal Block

Field Terminal Assembly FTA → System Cabinet Prosafe-RS

- Prefab Cable
- Multi Pair Cable
- Termination Board
ESD Upgrade: Project Philosophy: Non-IS Loop

- Field JB/ Elect SS
- Field Marshalling Cabinet
  - Terminal Block
- Multi Pair Cable
- Termination Board
- Prefab Cable
- Field Terminal Assembly FTA
- System Cabinet Prosafe-RS
ESD Upgrade: Project Philosophy: Non-IS Loop

Field JB/ Elect SS

Field Marshalling Cabinet

Terminal Block

Field Terminal Assembly FTA

Multi Pair Cable
Termination Board

Prefab Cable

System Cabinet Prosafe-RS
• Activities broadly planned as follows:

• Engineering Activities
• Construction (Pre-shutdown) Activities
• Site Preparatory Activities
• Commissioning (Shutdown) Activities
Yokogawa’s implementation of realisation phase of safety lifecycle
Collection of design inputs:
• Site Survey
  • Existing rack room layout, cable tray/routing
  • IO database,
  • Application Backup
• Installation verification:
  • Field Marshalling Cabinets termination details
  • Verification of logic diagrams and narratives with application backup
Basic Design Engineering:

- **System Integrity:**
  - Certified for use up to SIL3
  - High reliability and availability system

- **System Redundancy:**
  - Redundancy at all levels: Power Supply, Controller, IO modules, Network components
  - No single point of failure

- **Documentation review:**
  - Hardware Functional Design Specifications
  - System Architecture and Network Drawing
  - Cabinet layouts, cable tray layouts
Engineering Activities

Detailed Design Engineering:

Hardware Design:

• System Cabinet Design:
  • Process unit wise controller segregation in each plant
  • Controller loading < 40% for specified scan time
  • IO segregation: IS, Non-IS

• Marshalling Cabinet Design:
  • Segregation of IS, Non-IS cabinets
  • Bought out items selection and design
Engineering Activities

Detailed Design Engineering:

Software Design:
• Instrument Logic diagrams and narratives verification with existing application
• Software Architecture and building blocks selection/design

Document review
• System Cabinets, Marshalling Cabinets GA drawings
• Software Functional Design Specification review and approval
• Bill Of Material (BOM)
• Safety Validation Plan
Engineering Activities

Implementation:

Cabinet Integration:
• System and Marshalling Cabinets Integration.

Software Implementation:
• Migration of existing logic to Prosafe-RS
• Migration tool used for software migration
Engineering Activities

Internal Testing:
- 100% hardware and software testing
- Punch points resolution and test records

Factory Acceptance Test
- 100% hardware and software testing
- Presence of OMIFCO
- Punch points resolution
- Document review
- FAT reports
- AS shipped documentation
Preparatory Activities

- Single Mode Fiber Optic Network
  - Required for Centum VP and Prosafe-RS
  - Multicore SMFO cables required for each location connectivity to CCR.
- Field overhead and underground cable laying.
- Phase-1,3: CCR- SR2, CCR-SR3 FO cables laying
- Phase-2: CCR-SR1, CCR-SR6, CCR-SR6, SR1-LCR4 FO cables laying
Preparatory Activities

• Line Monitoring component replacement:
  • End-of-Line (EOL) resistor online replacement.
  • Replacement for all IS-DI loops.
  • Line Fault Transparency (LFT) achieved, enhancing the diagnostics of the IS-DI loops.
Construction Activities

- Installation of System and Marshalling Cabinets in spare control room locations.
- Power earthing cables laying and termination.
- System Multipair Cables termination at new FTA cabinet side and termination ready at field cabinet side.
- System Prefab Cables laying and termination at System cabinet side and new FTA cabinet side.
- Network cables laying and accessories installation.
- SMFO network setup and testing.
- New Cabinets power up and testing.
Commissioning Activities

• Removal of old system/marshalling cabinets.
• Installation of new system cabinets in old locations.
• Termination of system cables on field interface panels.
• Configuration and testing of all network components.
• Replacement of FCS controller nodes and configuration and download in database.
• ECS-LSS Remote IO Network and SOE Upgrade.
• Total system power ON.
• Hardware Loop checking.
• Functional testing and system commissioning.
• Demolition of old ESD cabinets.
ICS: Network Diagram : Post ICS Upgrade
<table>
<thead>
<tr>
<th>Project Activities</th>
<th>Project Timelines (Phase-1: )</th>
<th>(Phase-2: )</th>
<th>(Phase-3: )</th>
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<tbody>
<tr>
<td>Kickoff, Basic Engineering</td>
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<td>Detailed Engineering</td>
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<tr>
<td>Cabinet Integration</td>
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<tr>
<td>Testing, Inspection</td>
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<td>Site Construction</td>
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<tr>
<td>Site Preparatory Activities</td>
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<tr>
<td>Commissioning</td>
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Timeline:

- Mar-17
- Apr-17
- May-17
- Jun-17
- Jul-17
- Aug-17
- Sep-17
- Oct-17
- Nov-17
- Dec-17
- Jan-18
- Feb-18
- Mar-18
- Apr-18
- May-18
- Jun-18
- Jul-18
- Aug-18
- Sep-18
- Oct-18
- Nov-18
- Dec-18
- Jan-19
- Feb-19
- Mar-19
## Project Highlights

<table>
<thead>
<tr>
<th>S No</th>
<th>Activity</th>
<th>Phase-1</th>
<th>Phase-2</th>
<th>Phase-3</th>
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<tr>
<td>1</td>
<td>SMFO cable laying</td>
<td>4km</td>
<td>12km</td>
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<td>16 km</td>
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<td>2</td>
<td>EOL online replacement</td>
<td>350</td>
<td>300</td>
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<td>3</td>
<td>Cabinets Installation</td>
<td>20</td>
<td>38</td>
<td>17</td>
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<td>4</td>
<td>Power Earthing Cables laying and termination</td>
<td>60</td>
<td>114</td>
<td>51</td>
<td>225 lengths</td>
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<td>5</td>
<td>Multipair Cables laying and termination</td>
<td>300</td>
<td>400</td>
<td>300</td>
<td>1000 lengths</td>
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<tr>
<td>6</td>
<td>Prefab Cables laying and termination</td>
<td>350</td>
<td>500</td>
<td>350</td>
<td>1200 lengths</td>
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<td>7</td>
<td>Network Cables laying and termination</td>
<td>100</td>
<td>150</td>
<td>100</td>
<td>350 lengths</td>
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<td>8</td>
<td>Fiber Optic Patch cord laying</td>
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<td>120 lengths</td>
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<td>9</td>
<td>Signal Wiring terminations in cabinets and field junction boxes, verification and testing</td>
<td>9000</td>
<td>12000</td>
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<td>30000</td>
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<td>10</td>
<td>ILDs and narratives verification, Site Functional testing</td>
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<td>240</td>
<td>130</td>
<td>500 interlocks</td>
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<td>11</td>
<td>Old Cabinets demolition</td>
<td>15</td>
<td>25</td>
<td>15</td>
<td>55 nos.</td>
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</table>
Project Challenges and Findings

- Preparation of sequence and phase wise plan and scope for the upgrade
- Execution of the complete upgrade project with minimum team at OMIFCO.
- Single Mode Fiber Optic Cable laying during running plant.
- System design and engineering of HRSG- A,B BMS
- Co-ordination with all internal and external stakeholders of the project including third party construction contractor.
• ILDs, narratives verification proved very helpful for system inspection and commissioning
• Execution of Phase-1 of the project before Phase-2 and 3: Lessons learnt in Phase-1 were implemented in Phase-2&3.
• FAT: 100% hardware and logic checking and verification. Resulted in minimum loop troubleshooting during commissioning.
• Preparatory and Pre-shutdown activities minimised shutdown scope of activities.
• Functional testing of all safety interlocks before plant start up ensured commissioning of the system ahead of the schedule.
Conclusion

• Detailed planning of all activities in order to reduce duration of shutdown activities.

• Active engagement with all stakeholders during the whole course of the project.

• Adequate and timely allocation of resources and logistics.
Thank You