Environmental Operation Area (EOA) Automation Project-Control Systems Improvements

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Abstract *— Since April thru July 2017, it was reported that the downtimes and cycle times at the Environmental Operation Area of a manufacturing plant had increased, since the instrument and control systems are highly degraded. In addition, it was observed the treatment operations had constant human intervention to execute the process, causing delays to the manufacturing plant. A Capital Road Map for the EOA Automation Project was developed after a detailed evaluation of the control system actual conditions. A three-phase capital investment road map was established to install a reliable control system, minimize manual interventions and mitigate downtime & regulatory compliances. Capital funds for first phase were approved. Control System option analysis was performed and DCS DeltaV control System was selected, making the EOA control system the most advance system in the Plant.*

Key Terms *— Control System, DCS, PLC, Commissioning.*

INTRODUCTION

The Environmental Operations Area (EOA) of Baxter Healthcare is presenting an issue with the current control systems. The obsolete EOA's control system have been causing regulatory issues, downtimes and unsafe work environment. A capital project is executing to mitigate the negative impact to the site and improve the actual conditions of the control system.

Baxter Healthcare of Puerto Rico in Guayama is a manufacturing facility of inhalation anesthesia. The main products are Forane® (Isoflurane), Suprane® (Desflurane), and Sevoflurane.

Operations started in Guayama, Puerto Rico in 1981. At that time, as a subsidiary of the British Oxygen Corporation (BOC), only Isoflurane and Enflurane were manufactured. In 1992, a major plant expansion was completed for the introduction of Desflurane and a new Isoflurane plant. To complete this expansion, 13 acres of land were acquired, increasing the site total area to 37 acres. In 1998, Baxter Healthcare Corporation acquired the facility. In 1999, the refurbishing of the Plant I facilities was initiated to support the manufacturing of the generic drug Sevoflurane. Today Baxter Guayama Site is composed of the following main areas: Plant I (Sevoflurane), Plant II (Isoflurane & Desflurane), Fill & Pack, Quality, Supply Chain, Engineering and Environmental Operations (EOA).

The EOA treatment plant is unique in its class in Puerto Rico as it uses no bacteria technology to break down the substrates as it is typically found in the industries but the water is subjected to a chemical and physical treatment for the removal of metals and organic dissolved in the water. Making better use of the treatment equipment and given the wide range of conditions of the influent the plant has three treatment trains to meet the three combinations of used water we receive; One of the trains is for used waters with high concentration of salts and low concentration of organic, another is with low concentration of salts and high concentration of organics and the third is high concentration of salts and high concentration of organics. The operation of this treatment plant mainly uses two types of technology; Filtering by filter presses and extraction of organic matter by distillation column. In cases where the precipitation of any metal cannot be achieved by the adjustment of PH, polymer-type precipitating agents are used. This whole process has a hydraulic capacity of processing approximately 37.000 gallons per day by uniting all the batches processed by the three trains.

The EOA treatment plant needs to be operating to manufacture the Bulk anesthesia. However, the actual conditions of the treatment plant have been impacting negatively the manufacturing operations.

The actual condition of the control system present the following negative aspects that are the root cause of the downtimes in the area:

- Obsoleted Control System
  - End of life (no support available)
  - Spare Part Availability
- Physical Condition Highly degraded (Figure 1)
- Not Historian available
- Complex Control Integration
- Lack accurate drawings/hard to troubleshooting
- Instrumentation wiring without tags
- Control System Operation in separate places
- System does not have protection for the current corrosive environment
- Limited trained (system knowledge) resources
- Prone to Power failure (Not UPS power)
- Level Indicator degraded (recurrent failures)
- Not Charge/Discharge/ Agitation Sequence (Manual Operations)

Figure 1
Pictures Showing Examples of the current Control System

PROJECT OVERVIEW

The project pursued improve the EOA Control System with capital investment from 2017 to 2020. An analysis study was performed to detail the project objectives, phases and the best control system for the area.

After a detailed evaluation, it was defined the following project objectives.

- Install new control system
- Establish new control Room
- Reduce manual interventions.
- Improve level indication.

CONTROL SYSTEM OPTIONS ANALYSIS

Currently the EOA control system is a Programable Logic Control (PLC), however the manufacturing plant have a distributed control system (DCS). Therefore, an evaluation it was performed between DCS DeltaV System and Control Logix & Compact Logix PLC systems. Refer to Tables 1 and 2 for Control Systems Evaluation.

Table 1
Control System Benefits and Disadvantage Comparison

DeltaV	Control Logix
Benefits: ▪ Robust Control System ▪ Easy Integration/ ▪ Historian ▪ Expansion Capability ▪ Configuration in one platform ▪ Existing Templates ▪ Resources with high technical Knowledge ▪ Spare part available on site ▪ Standardize control system around the plant	**Benefits:** ▪ Robust Control System ▪ Less Expensive ▪ Historian ▪ Expansion Capability (modular system)
Disadvantage: ▪ Expensive	**Disadvantage:** ▪ Hard Integration/Configuration ▪ Configuration in separates platforms ▪ Limited resources on site with technical knowledge ▪ Spare part unavailable on site

Table 2
Control System Cost Comparison

	Hardware	Current DST Conf.	New DST Conf.	Estimate Cost
DeltaV	$184,040	$73,400	$160,000	$417,440
Control Logix	$143,557	$91,312	$189,800	$424,669
Compact Logix	$127,500	$91,940	$189,800	$409,204

Based on the control system technical analysis performed it's recommended the Delta V System solution for the Environmental Operations process. DCS functionality is based towards control loops while PLC is based to execute fast logic sequences task. Therefore, DCS will help to reduce cost and gain better control. Initial investment for the DeltaV System will be approximately 15% more

than the Control Logix System, however the developer can concentrate on adding functionality that will provide more benefits, reducing the return on investment payback period and enhancing the system's contribution for years to come. The recommendation is in accordance with the system standardization initiatives.

CAPITAL PROJECT PHASES

As mentioned previously the capital investment started on 2017 and continues until 2020. The improvement project has been divided into three phases with an inversion of over 1.5 million in three years.

Proposed Design Phase #1

The first stage of the project included the following items:

- Convert Safety Office in new EOA Control Room
- Install the following:
    - New DeltaV Cabinet and hardware inside the Control Room to connect PR17 instruments (current and new).
    - ProPlus Station Server
    - Operator Station Server
    - DeltaV Historian Server
    - S series controllers
    - Charm IO for 200 DST
    - UPS
    - HVAC
    - Fire System
- New conduit and wiring for current instrumentation at PR-17
- Develop New Process Graphics (Based on P&ID)
- Configure Modules using available library templates
    - Develop Required Documents
    - Develop Required Drawings
    - Execute HFAT
    - Execute SAT
    - Commissioning
    - Demolition
    - Training to Operators
    - Move existing SCADA supervisor to the new Control Room (temporary)

The capital project approved for design phase #1 was **$528,000.**

Proposed Design Phase #2

The second stage of the project included the following items:

- New DeltaV Cabinet and hardware inside the PR35 and PR37 to connect instruments (current and new).
- Improve PR37 Control Cabinet Area
- Fiber Optic wiring between PR35/37 to the EOA Control Room
- Operator Station Server
- Remote Terminal Station
- S series controllers
- Charm IO for 400 DST
- Configure Modules using available library templates
- Develop New Process Graphics (Based on P&ID)
- Replace DP Cell for Vega Radars
- Supply and Install New Instrumentation
- Develop Required Documents
- Develop Required Documents
- Develop Required Drawings
- Execute HFAT
- Execute SAT
- Commissioning
- Demolition

The project budgetary estimates for design phase #2 is **$500,000**

Proposed Design Phase #3

The thirds and final phase of the control system improvement project included the following"

- Charm IO for 400 DST
- Configure Modules using available library templates (new instrumentation)
- Replace DP Cell for Vega Radars

- Update Process Graphics
- Supply and Install New Instrumentation
- Develop Sequence to Reduce Manual
- Interventions
- Fiber Optic Wiring to Connect to the complete new EOA DeltaV System to existing DeltaV Backup & Recovery System

The project budgetary estimates for proposed design phase 3 is **$500,000.**

EOA Automation Project-Control Systems Improvements-Phase 1

On August 2017, it was presented the project proposal to the senior staff and corporate and it was approved $528,000 to start the phase #1.

Once the capital was approved it was executed a bidding process for the two major investment areas, Control System Hardware and Software and Electrical & Instrumentation work. For the Control System Hardware and Software were participated a total of three companies and for Electrical & Instrumentation seven companies. Refer to Tables 3 and 4 for bidding results details.

Table 3
Control System Hardware/Configuration/ Documentation Bidding Results

Control System Hardware/Configuration/ Documentation	
Company	Proposal Amount
1	$227,743.80
2	$314,357.23
3	$377,203.00

Table 4
Electrical & Instrumentation Bidding Results

Electrical & Instrumentation	
Company	Proposal Amount
1	$176,529.00
2	$205,729.00
3	$226,800.00
4	$257,023.00
5	$265,292.82
6	$269,365.00
7	$346,295.00

Phase #1 Control System Deliverables

- Control System Design. Figure 2 shows a proposed concept design.
- Supply DeltaV Cabinet and Hardware.
- Supply Control Room Rack and Rack Mount DeltaV Server and DeltaV Control System
- Hardware/Software. (One rack-mount DeltaV Proplus Server, One rack-mount Operator Station, and two remote terminals via KVM's.)
- Program DeltaV Control Modules and HMI Graphics using Baxter all-ready validated Control Module templates and HMI graphic objects.
- Test Cases for qualifications (One for each Control Module)

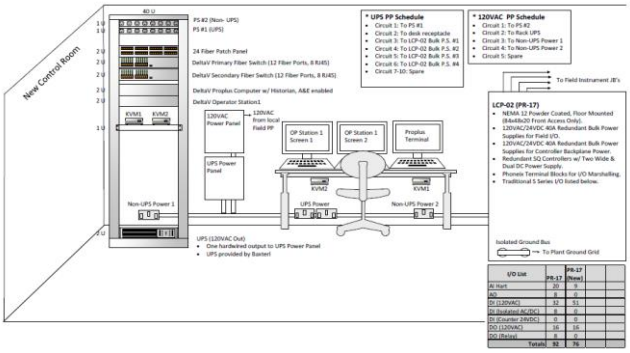

Figure 2
EOA Control Room System Design

Phase #1 Electrical and Instrumentation Deliverables

- LCP-02 Conduit and wiring Demolition.
- PVC-Coated Conduit Furnish from PR-17 LCP02 to PR17 instrumentation.
- Engineer Support and Drawings.
- New Loop Drawings & Update P&ID

Phase #1 EOA Control Room Improvements Deliverables

- Convert Safety Office in the EOA Control Room. Figures 3 and 4 show a proposed concept design for the new control room.
- Install acoustic celling and lamps.
- Install 18kbtu split unit for the operator area.
- Install 10KVA UPS

- Install a Fire Control System for the Server Area.
- Install new HVAC System for the Server area with redundancy.
- Install new electrical and communication distribution
- Install new furniture

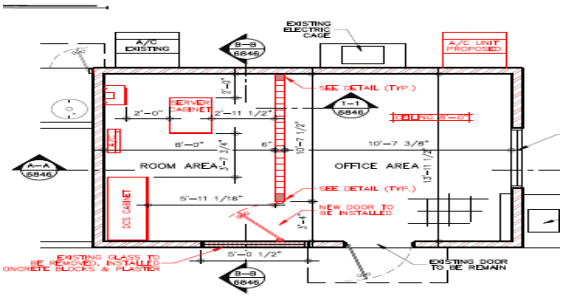

Figure 3
EOA Control Room Improvements Design

Figure 4
EOA Control Room Furniture

Phase #1 Factory Acceptance Test and Documents

As part of a regulated manufacturing environment the documentation plays a fundamental role. For the phase one it was developed the following documents: Control System Requirements, Functional and Design Specification, Equipment modules Configuration Design, Factory Acceptance Test Protocol for EOA Control System.

On December 4 to December 8 2017 it was executed the Factory Acceptance Test (FAT) in Atlanta GA were Hardware and software were accepted after the issues found were successfully fixed.

The project fully implantation will be executed during the summer shutdown, since the impact of the Hurricane Maria was delayed its implementation. During the implementation process a detailed commissioning protocol will be executed. All the EOA operators will be trained and procedures must be issued and effective.

CONCLUSION

In this case, the main objective of the project selected were install new reliable control system and establish a new EOA control room to mitigate the downtime, regulatory observations and unsafe environment conditions. After the phase #1 completion, it will be accomplished those objectives. Making the Environmental Operations Area control system must update control system installed at the site. In addition, the project reduces the operators' manual interventions and provide an historian that could be used for future investigations and process improvement projects. With the three phases implemented the manual intervention will be reduced in 70%, with accurate metering and automated sequences.

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