

Control Room Consolidation at Hanford Tank Farms for Improved Conduct of Operation – 15345

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ABSTRACT

Washington River Protection Solutions (WRPS) manages the underground waste storage tanks at the Hanford site in Washington State on behalf of the DOE Office of River Protection. There are 177 tanks distributed among 18 tank farms spread across an area of desert scrub covering about 20 square miles. A single evaporator facility supports the tanks to provide waste reduction activities. Farms and associated equipment, including exhausters, have been operated locally since installation. Upgrades over time introduced limited automation, but using inconsistent platforms, and providing isolated control locations around the farms. However, as the Tank Farms move from maintenance operations to production operations, with increased numbers of waste transfers and evaporator campaigns, and also prepare for integration with the adjacent Hanford Waste Treatment Plant, then operational improvements were planned and are being implemented. Infrastructure improvement projects included upgrades of control systems to a common platform, and installation of a fiber optic based local area network to the majority of farms, which together provided a distributed control system supporting tank farms. This new infrastructure provided the basis to propose consolidation of control and monitoring operations to a single location.

More than a single location, the new Central Control Room was to increase effectiveness of operations by providing full status of all activities being performed across the Tank Farms and the Evaporator. The recent addition of productivity e-tools also would provide capability for management, supervisors and operators to make informed decisions regarding facility operations, through custom online applications designed to provide real time information derived from operational data. For example, tracking turnover activities between shifts, and maintaining compliance with limited conditions for operations. The Central Control Room would also have a single supervisor able to effectively manage the status of all assets and processes. The expected benefits of this arrangement include increased operator utility, increased situational awareness, improved response time for upset conditions, improvement in operator environment, and reductions in operating costs.

The projected ROI for the Central Control Room when fully operational was projected to be about two years based on reduced costs from freeing up operations staff to perform other work plus the time and material savings realized by operations being performed with increased situational awareness.

So the Central Control Room would become a hub for monitoring and controlling facility operations while responding to real time information affecting productivity and performance, from a centralized location customized to a fresh working environment.

Over a 14-month period, WRPS developed the concept and engineering, procured over 500 items, modified and installed in renovated building, and completed transition and testing of this new Central Control Room, turning over the initial phase to Operations for 24/7 use in April 2014.

INTRODUCTION

This paper discusses how WRPS implemented a Central Control Room for monitoring and control of tank farm and evaporator operations, considering the technical challenges, a tight deadline, the economics to ongoing operations, and the cultural changes necessary within the workforce to gain acceptance for a new approach to performing Tank Farm operations.

DISCUSSION

Background

WRPS performs the role of Tank Operations Contractor (TOC) under contract to the DOE Office of River Protection. Within the existing facilities operated by TOC are multiple independent control rooms supporting a variety of functions, including ventilation in double shell tank farms, waste transfers between facilities and tank farms, monitoring of tank temperatures and levels, operation of an evaporator, and shift office oversight. Eight separate locations support these functions.

The WRPS Engineering entity known as Process & Control System Engineering (P&CSE), with responsibility for maintenance and development of automation solutions for TOC, developed plans and strategy documents for the orderly upgrade of legacy systems and equipment taken over by TOC following contract award in 2008. This included the concept of a Central Control Room (CCR). This was further developed to identify how a CCR can include prominent displays and access to operations productivity tools (eTools) to provide the platform for improved status control of TOC assets and processes. These plans and strategies were presented over time to operations senior management in order to obtain buy in for CCR implementation.

The main process control and monitoring functions performed in the Tank Farms are implemented on three systems:

1. Tank Farms Monitoring and Control System (TFMCS) is an ABB 800xA distributed control system installed across all double shell tank farms to control exhauster operations, monitor tank pressure, and support waste transfers. TFMCS communicates over the Tank Farms Local Area network (TFLAN), which is a Ethernet system installed in copper, fiber optic, and wireless modes across the site.
2. Tanks Monitoring and Control System (TMACS) is a legacy system built on a Gensym platform for monitoring single and double shell tank levels and temperatures. The functions of this 1990's system are planned to be migrated to the TFMCS.
3. The Evaporator Monitoring and Control System (MCS) and Ventilation Control System (VCS) provide all monitoring and controls necessary to operate the Evaporator facility, built on a Novatech D/3 platform.

Where each of these systems displays data direct from field inputs, newly developed productivity tools, or eTools, have been launched by P&CSE to convert data into useful information to support other Operations, Management and Engineering functions. This information is equally of value to CCR personnel as they manage tank farm operations. eTools launched include Operations Tracking Tool, Limited Condition for Operation Tracking Tool, Shift Turnover, Requirements Management Database, MyPortal, Alarm Tracking & Analysis Tool, Electronic Rounds, Enterprise Historian, plus others in development. All of these are derived from a real function with an objective of making operations more effective and reducing the reliance on paper based systems.

Benefits of a Central Control Room

Consolidating the current geographically dispersed monitoring and control locations into a CCR has multiple benefits including:

- Operator utility is increased releasing other operators to support field operations
- Increased situational awareness and status control
- Improved response times for upset conditions
- Improves the operator environment
- Reduction in operating cost.

Maintaining status control requires knowledge of the systems design, functionality and availability, which is vital to safety and quality at the facility.

Facility and operational data derived from process control systems is collected, packaged, and presented as status control information to be used by Operations, Management, and Engineering for informed decision making when they need it, wherever they are. This requires reliable process control and monitoring, accurate status control, and strategic technology deployment, including applications using existing process control systems and new productivity tools operating independently of process controls.

Approach

Based upon operations input, including input from human performance improvement teams established within the Operations organization, direction was given to construct a new room in an existing single story facility to use as the CCR. The room attributes were:

- Room dimensions 32ft wide by 41ft long by 8ft high.
- Solid, insulated walls on all sides with two sliding windows, a single personnel access door and a set of double doors with proxy card access specific to the CCR.
- Sufficient power and communications network capacity to support multiple consoles and large screen monitors. Ethernet ports and power outlets required around the walls and in the floor under the consoles. The ability to connect these Ethernet ports to either the Hanford site network or TFLAN would be necessary.
- Zone recessed lighting controlled by a dimmer switch.
- Separate ventilation and controls.
- Two analog phone points.

Utilization of the CCR was planned in multiple phases:

- Phase 1 – Centralized monitoring and control for all areas (other than the Evaporator), with back up if necessary retained at existing control locations – completed in FY 14.
- Phase 2 – Evaporator connection to the CCR, plus any additional infrastructure upgrades and task analysis – scheduled to start in FY 15.
- Phase 3 – Evolution of CCR to accommodate future objectives such as waste feed to WTP. Schedule depends on externally managed project.

The CCR consoles layout is designed to accommodate addition of annunciators, which have been identified as required to support new safety instrumented systems.

Training and Procedure Impact

Implementation planned for changes to operating procedures, the roles and responsibilities of staff, and for additional training of operators to support the utilization of the CCR. The CCR has been implemented in phases in part to allow these changes to take place in a phased manner.

The impacts on procedures and training, along with any determinations of staffing levels, designations of control areas and operating permit changes were determined by the relevant organizations, and fed into the overall implementation of the project.

Implementing this part of the plan involved having operators use the CCR instead of their usual locations. In an operations organization structured around area teams, this is more about changing the comfort zone for staff and challenging the status quo. It is also about reassuring staff that their job is not at stake, but helps them to become more effective in what they do and how the company maximizes value of their contribution to the work place. The CCR provides a cultural change to behavior at the Hanford tank farms, and like all change, is evolving towards to intended goal.

Phase 1 – Centralized Monitoring & Control

The following key requirements were met in this phase:

- Ability to monitor and control TFMCS Transfers & Ventilation using TFMCS, and to monitor TMACS from a single location
- Provide environment to promote improved communications and situational awareness
- Control remains in existing control locations.

To meet these requirements the Human Machine Interfaces (HMI) from the four existing control locations were duplicated in the CCR. This involved installing new console furniture and setting up HMIs for the Evaporator MCS and TMACS with the same number of monitors as at existing control locations, along with two TFMCS consoles. In addition, Hanford site network access will be provided at the consoles for access to operations productivity tools along with operations and engineering information maintained on WRPS intranet.

Figure 1 shows a sketch of the proposed console layout. The console range selected was modular, allowing for evolution of the control room as necessary at a later date.

Five large monitors were installed on the walls to allow for display of important information and statuses from either the process control systems or the eTools. It was also made possible to view TFMCS and Evaporator MCS screens on these monitors. Previous installations of large monitors on site for display of text based information indicate that for effective viewing from a distance the monitor should be larger than 55" or 60". For the 8ft height of the CCR with a single row of monitors on the control desks in front of the large monitor, 70" 1080P LED or LCD high definition TVs were selected.

Additionally, a supervisor's control console is included in the layout. This console has access to both Hanford site network and TFMCS, and provides a location from where operations in all plant areas can be overseen. While the supervisor console does not have access to the Evaporator MCS or TMACS, it is located where the activity at the relevant consoles can be monitored.

For maintenance and engineering support to the Evaporator and TFMCS systems, a single console with two PCs supporting two displays via a KVM switch is installed.



Figure 1 - Phase 1 Console Layout

Figure 2 shows a 3D rendering of the proposed control consoles developed by the console vendor. Figure 3 shows a photograph of the completed installation ready for use.



Figure 2 - 3D Console Rendering from Vendor



Figure 3 – Actual Control Room

Support Equipment

In addition to the console furniture and computer hardware, the following equipment was also installed in the CCR during Phase 1:

- Whiteboards - the layout in Figure 1 includes space for a number of whiteboards which are used to track information which is not readily available on the HLAN displays in a suitable format. The number and positioning of these whiteboards was determined with input from operations personnel during detail design taking into account information available on the five 70" displays via the productivity e-tools.
- Telephones – VOIP and analog telephones are provided in the CCR. Two analog phone connections are provided, while the capability to connect a VOIP phone was provided at seven of the consoles.
- Speakers – a single soundbar speaker mounted to the bottom of one of the monitors on the console was provided at six of the consoles. As the 70" displays are TVs rather than monitors, each of these already has sound capability.
- Radios – Power is provided at the consoles to support radio base and/or charging stations for any radios used by the CCR operators. The number and location of CCR operator radio base and/or charging stations was determined during detail design. There are no constraints on the use of radio equipment in the CCR, as evaluated during detail design.
- Documentation Access – The CCR has ample space away from the consoles for storage of documents required for operations. There is also limited space for essential document storage at the consoles between the displays, on console corners and on HLAN consoles, which provides electronic access to documentation.
- Alarm Printers – Some existing systems (TMACS and Evaporator MCS) utilize dot matrix alarm printers, and these are located on tables away from the consoles. However, there is an expectation that the use of dot matrix printers for alarms will be phased out in the future.
- CCTV – At present, CCTV monitoring is not provided as it is our understanding that CCTV is not currently actively monitored from any current control locations or the shift office. If required at a later date, it is possible to either add additional console displays, displays on the walls, additional dedicated consoles, or use existing console or 70" displays. CCTV server equipment can be mounted with the 70" display PCs or in the consoles as required.
- Public Address Systems – Existing PA requirements are met by and will continue to be met by the current systems in place. However, during Phase 1, the Evaporator PA system has not been duplicated in the CCR, and the possibility of doing this in Phase 2 is to be investigated.

TMACS Migration to TFMCS

A future evolution of the CCR driven by the migration of the TMACS control equipment to ABB 800xA equipment will cause the TMACS console to transition to a TFMCS console allowing for greater flexibility in the use of the TFMCS consoles, providing the ability to support more concurrent transfers if required.

Phase 2 – Evaporator Transition to Monitoring and Control

In Phase 2, a more detailed analysis of Evaporator operations and requirements (including PA system requirements) is required prior to transiting control and monitoring from the Evaporator control room to the CCR.

Additionally, the following activities, at a minimum will need to be performed to complete this phase, possibly leading to additional equipment and infrastructure requirements.

- Determination of building modifications required in 274AW to support use as a control location including NFPA requirements etc.
- Analysis of need for any backup control locations and their required functionality including investigation of possible temporary backup locations
- Analysis of requirements for and design of backup power

- Changes to permits and licenses
- Any additional human factors, ergonomic and task analysis deemed necessary
- Training and procedure updates to support use of the CCR for monitoring and control

Phase 3 – Evolution to Support Future Objectives

In Phase 3, it is expected that the CCR will be evolved to meet future objectives such as a focus on feed to WTP. It is expected that task analysis will be performed during this phase which may lead to changes in layout, number of displays and number and layout of display graphics. Due to the current modular console design, providing that the CCR space is deemed adequate, the consoles can be rearranged and additional consoles can be purchased to support future requirements and task analysis. Further, it is anticipated that consideration for wholesale transition to high performance graphics, meeting current trends in process display development, will be assessed for all systems to provide a consistent look and feel.

Potential Return on Investment (ROI)

The project cost for Phases 1 & 2 is approximately \$1.5M, considering engineering, materials, construction, and testing. Reutilizing 5+ operators, previously assigned to multiple locations across all shifts, would save at least \$750K per year, leading to the new CCR providing a ROI in about two years. Added intangibles, with potential for cost avoidance, include increased situational awareness and improved response times for upset conditions. This assumes that the control room is continuously manned by an operator with the relevant training.

CONCLUSION

Through the course of implementing infrastructure upgrades in order to maintain safe and compliant operations of the Hanford tank farms, and in readiness for increased production activities as tank wastes are moved and processed, WRPS has built a state of the art control room from which monitoring and control of all tank farm facilities can be managed. This moved away from the established practice of satellite control areas close to the point of control, and pulled all data to a centralized location where trained operators and supervisors could share observations and make decisions together. Further, the translation of data from process control systems into information to support status control and decision making has enabled consolidation of processes to support streamlined and coordinated operations.