Parallax

a division of Energy*Solutions*

Salt Waste Processing Facility

Integrating Safety Into Design

Bob Bentley
Nuclear Safety Manager

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Bob Bentley

- Bob is “Director of Nuclear Safety” for Parallax, a division of Energy Solutions
- For 5 years, Bob has served as the Nuclear Safety Mgr for the Salt Waste Processing Facility at SRS.
- He also serves as the Manager for Commercial Grade Dedication at SWPF
- He has over 28 years of experience in the Nuclear Industry with approximately 12 years in Nuclear Power and 16 years at DOE sites
- BS in EE from SUNY at Stony Brook

Introduction to SWPF

- SWPF Project will process over 90M gallons of waste from the HLW Underground Storage Tanks at SRS.
- SWPF was authorized to Construct in December 2008
- Integrating Safety into Design was a key element in obtaining approval for construction.

Introduction to SWPF

- Central Processing Area (PC-3)
- Alpha Finishing Facility (PC-2 equiv.)
- Cold Chemical Area (PC-1)
- Administration Building
- Several Support Buildings (Compressors, Standby DG, Chiller)
- 120,000 linear feet (23 miles) of piping
- Approximately 2000 Valves
- 56 Vessels

Conceptual Design

- Contract Awarded in early 2004 (Conceptual Design)
- An Alpha Finishing Facility was added to the scope
  - Enhanced Conceptual Design Complete in late 2004
- Initial Enhanced Conceptual Design PHA (8/16/04)

Preliminary Design (PC-2 Facility)

- HAZOP 1 (Full-Scope) (12/17/2004)
  - 4 week round table review
- Industrial Safety and Chemical Review (2/25/05)
- PDSA (Rev. B) 3/8/05

Final Design (PC-2)

- Period of uncertainty between May and Dec, 2005
  - Project performed Cost and Schedule impact reviews:
    - PC-3 primary and secondary confinement
    - Active Confinement Issues
- DOE Impl. Plan for DNFSB Recommendation 2004-2 Active Confinement Ventilation (Issued August 2005)
- SWPF Safety Design Strategy Document Issued (12/8/2005)

Final Design (PC-3 Facility)

- HAZOP 2 (Full-Scope) was conducted (4/21/06)
- Safety Design Strategy Rev. 1 (6/2/2006)
- Industrial Safety and Chemical Review (6/16/06)
- PDSA Rev. D (7/17/06)
- ALARA Design Review R0 (9/13/06)

Final Design (PC-3 Facility)

- Comparative Assessment of DOE-EM Interim Guidance on Safety Integration into Design (10/25/06)
  - Addressed 95% meteorology
  - Comparison of Confinement Ventilation System design against 2004-2 IP Criteria
- Safety Design Strategy Rev. 2 (12/8/2006) – incorp. Blue Sky Initiatives
  - Evaluated several options to reduce cost
- Safety Design Strategy Rev. 3 (5/15/2007)

Final Design (PC-3 Facility)

- ALARA Design Review R1 (9/24/07)
- Maintenance Reviews 9/07, 10/07, 12/07
  - Labyrinth reviews
- HAZOP 4 (Full-Scope) 65% design completion (Used 3-D Model) (11/13/07)
- HAZOP 3 (Partial Scope) (12/14/07) - Analytical Lab
- HAZOP 5 (Partial-Scope) – ALARA Review Labyrinths (Used 3-D Model) (3/17/08)

Final Design

- Safety Design Strategy, Rev. 4 (4/11/2008)
- ALARA Design Review –R2 (6/18/08)
- Fire Hazards Analysis (7/25/08)

Final Design

- PDSA Rev. 0 (9/30/08)
- Approval for Construction (12/12/09)
- ALARA Design Rpt –R3 (5/14/09)

Safety Design Strategy Documents (DOE STD 1189)

- DOE STD 1189 (2008) states: “Should a significant change in the safety strategy occur, such changes may be documented by a revision to the Safety Design Strategy”.
- SWPF accomplished this through the periodic issuance of safety design memos throughout conceptual, preliminary, and final design phases.
- In addition nuclear safety established a team of safety representatives as part of the HAZOP process.

HAZard & OPerability (HAZOP)

- A systematic method for hazards analysis was conducted through HAZOPs. For the "Full-Scope" HAZOP, attendance included Process Engineers, Design Engineering, Health Physicist, Industrial Hygienist, Maintenance, Operations, Nuclear Safety, and DOE.
- 2 weeks of preparation time, approximately 4 weeks of Evaluation, and approximately 4 to 6 weeks for Documentation and Reviews.

SS/PC-1 Ventilation Systems

- **Process Building Ventilation System**
  - The facility ventilation system is a once through, non-recirculating, cascading air design. Air is drawn from clean (Zone 3) areas through areas of higher potential for airborne contaminants (Zone 2), then into the final areas of highest potential for airborne contaminants (Zone 1) after which it is filtered, monitored and discharged.
- **Process Vessel Ventilation System**
- **Alpha Finishing Facility Building Ventilation**

SS/PC-3 Air Dilution System

- 4-day air capacity provided to each CPA vessel for flammable vapor control (solvent & H2)
- Passive Mechanical (no electrical power or instrumentation required)
- Consists of two PC-3 Air Receiver Tanks
  - 17 ft in height each
  - 3 ft wide
  - 3000 psig
  - 2.6” wall
  - Process Vessel Ventilation System

Lock and Tag Review of All P&ID's

- All P&ID's critically reviewed to see what valves would be required to perform adequate and safe lock and tag for all maintainable equipment.
- Review led to a reduction of approximately 250 valves from the design which had the effect of reducing potential maintenance and therefore uptake.

Sloped Floors, Sumps and Surface Coatings

- All areas were evaluated for potential system leakage and the spread of contamination to adjacent areas.
- All labyrinths have sloping floors directing potential leakage to a recessed sump which is placed away from labyrinth entryways.
- Each area was evaluated and surface coatings (polyurea, epoxy, primer and paint, sealed concrete, etc.) were assigned based on the potential need for decontamination.

Radiation Shielding

- SWPF integrated (steel) shield doors for labyrinth entryways
- Scatter shields for duct penetrations to reduce dose rates in adjacent hallways during operations.
- Shield collars were implemented for piping located in labyrinths that may contain residual radioactive liquids. Collars reduce dose rates during labyrinth entry for inspection and/or maintenance.

Material Handling

- The original design utilized monorails within the labyrinths, this limited the coverage for material handling to just the pumps within a labyrinth. An improvement was to install bridge cranes within each labyrinth which enable maintainable items such as heat exchanges, flow meters and valves to be within the lifting envelope. This reduced the need to temporary load bearing scaffolds and purpose-built lifting attachments.
- The contactors area is an exception. A monorail is used since all contactors are within 2 parallel rows. However an improvement was to add a second monorail to the beam to enable the spare contactor to be in position when the contactor to be repaired is lifted out. This reduces significantly the time spent in the contactor cell.

Development of a Hot Maintenance Area

- The initial design concept employed “clean area” workshops for mechanical, electrical and instrument crafts
- Operations recognized that the majority of equipment to be maintained (pumps, contactors, instrumentation etc.) would have some residual contamination unsuitable for “clean areas”
- Drum-off cell is now converted to a hot maintenance area
  - Added secondary containment to this area to facilitate dressing-out/contamination control
  - Added localized ventilation
  - Added material handling capability

Installation of Camera's In Each Labyrinth

- The labyrinths contain some flanged piping and components increasing the risk for leaks.
- Leak Detection is provided for all labyrinth sumps.
- Cameras would be beneficial in the labyrinths upon detection of a leak. Aid in pre-job briefing and supervision of tasks that will reduce time in the labyrinth and improve safety.

Alternative Methods of De-Inventorying Tanks

- O&M rely on the ability to flush and drain. Some redundant pumps take suction from a common 3-way valve. A valve failure could preclude de-inventorying the tank. In high gamma fields, 65 Ci/gal Cs137/Ba137, recovery from a failure of a common component or both pumps must be considered
- Each system was examined and alternative methods of de-inventorying tanks were explored. Alternatives included:
  - using sample pumps to de-inventory a tank,
  - adding or changing the configuration of valves directing the suction line direct to drain if pumps failed,
  - adding alternative routes to different tanks if the receiving tank has limited capacity (as in the case of TK-101)
  - Using 2 two-way valves, instead of one three-way valve on the pump suction header.

Vibration Monitoring for Rotating Equipment in High Radiation Areas

- To ensure rotating equipment does not fail, vibration monitoring is installed on most pumps and contactors
- This allows maintenance to predict system health and increase the reliability of rotating equipment
- Aids in work-planning

Flushing Reviews

- This review ensured that all maintainable equipment within the process systems can be adequately flushed and drained.
- Due to differing types of pumps, centrifugal, gear, lobe, air operated diaphragm etc. each with different flushing characteristics, flushing and draining of the suction and discharge sides was examined and recommendations made to ensure that the equipment could be flushed and drained.
- These recommendations often resulted in changing the way an actuated valve failed (either fail-open or fail-closed) to ensure a system could be drained and also changed direction of pipe sloping.