# ONGOING ACHIEVEMENTS IN ORP AUTHORIZATION BASIS CONSERVATISM REDUCTION

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## ABSTRACT

The U.S. Department of Energy (DOE) Office of River Protection (ORP) is reassessing overconservatism in the Hanford Site River Protection Project (RPP) tank farms Authorization Basis. Reassessment of overconservatism in the Final Safety Analysis Report (FSAR) accident analyses and associated controls is currently underway in the following areas:

a. Major potentially public affecting accident scenarios of historic concern;

b. Additional accident analysis bases and scenarios having broad potential impacts on operations;

c. Identification and elimination of unnecessary overly conservative safety-class and safety-significant structures, systems and components (SSC); and

d. Removal of unnecessary and costly Authorization Basis based constraints on operations.

During fiscal year (FY) 2000, ORP negotiated performance incentives with CH2M HILL Hanford Group, Inc. (CHG) to expedite FSAR implementation activities, as well as, increase operating efficiency by creating an Authorization Basis based on historical data, industrial failure modes, and plausible accident scenarios/progression. The re-analysis of the Authorization Basis is based on characterization data and flammable gas release information resulting from retrieval of Tanks 241-SY-101 and 241-C-106. The FSAR waste transfer leak, tank bump, and other flammable gas accidents were re-analyzed using plausible scenarios and assumptions. Revised radiological and toxicological source terms based on waste characterization data were developed for use in safety analysis accompanied more realistic transport and dose models.

- Conversion of several safety-class SSCs in the Tank Farms to safety-significant SSCs.
- Operational cost reduction to date (conservatively estimated) of $3,000,00/year for the subjects as listed in Table III.
- Deferred or eliminated near term projected costs estimated at $1,000,000 in Capital and $600,000 in Operating Costs due to avoidance of expenditures. (See Table III)
- Operating efficiency improved through the use of flexible Technical Safety Requirement [TSR] controls that directly focus on the protective function (e.g., double valve isolation, flexible use of vehicular barriers).

## BACKGROUND

Recent progress in defining an integrated safety basis and revising the Final Safety Analysis Report (FSAR, 2000) and Technical Safety Requirements (TSR, 2000) for operation of the River Protection Project (RPP) waste tank associated programs, provided ORP an opportunity to reevaluate the historically necessary conservative operating basis for the Hanford Site Tank Farms and associated facilities. Completing an almost 10-year long process to obtain detailed characterization of the waste stored in double- and single-shell tanks at Hanford, and gaining an understanding of the waste chemistry and physics associated with priority one safety issues and resolving these issues support establishment of the protective safety basis for the waste storage facilities. The recent work verified (based on a cumulative 8000 tank years of operation experience) that none of the high consequence significant accident scenarios identified as "anticipated" in the safety analysis performed to date have occurred.

The FSAR was approved in March 1999, and a phased implementation of the FSAR Authorization Basis was initiated subsequently. The Phase I implementation was completed in October 1999, with transition of the Authorization Basis from the Basis of Interim Operation (BIO, 1990) to the FSAR. The Phase II FSAR implementation, including explicit focus on accident analysis conservatism reduction was completed by September 2000, and the ongoing Phase III implementation will be completed during the first annual update of the Authorization Basis in FY 2001. The Phase II and Phase III FSAR implementation comply with DOE FSAR Safety Evaluation Report (SER) [Bevelacqua et al] directives for enhancing safety management of the Tank Farms and improving operational efficiencies without sacrificing safety.

At Waste Management 2000, ORP presented a paper on ORP Authorization Basis conservatism reduction entitled, A Win-Win Safety and Operating Strategy for Reducing Cost of Disposal for the Office of River Protection at Hanford [1]. The paper identified significant cost consequences of the overly conservative analysis methods used in the FSAR and presented the ORP approach toward re-analysis that would put the postulated accidents into a more realistic perspective without sacrificing tank farm operations safety. The results of Authorization Basis conservatism re-analyses are presented below.

## RE-ANALYSIS RESULTS

In general, during FY 2000, ORP directed CHG to re-evaluate the accidents with the highest apparent risk [See Table I], as identified by oversight groups and in the FSAR SER. The Authorization Basis re-analysis strategy included replacing existing cascading bounding accident analysis assumptions in the FSAR with conservative but more realistic best engineering estimates. CHG used actual tank farm data, DOE complex-wide experience, historical and industrial failure modes, plausible accident progression sequences, and waste storage system responses as the basis for re-analysis. In addition to items identified by ORP, CHG identified additional opportunities for reducing conservatism and eliminating Authorization Basis-based operational efficiencies that could reduce the needs and costs for controls without loss to operating safety. Several of these items are listed in Table II.

The FY 2000 and ongoing re-analysis efforts were focused in the areas identified in Tables I and II, and the re-analysis is discussed in detail below. Initial estimates of cost reduction and/or cost avoidance are identified in Table III.

An independent review team of ORP, DOE-RL personnel, and nationally known subject matter experts from the National Laboratories and independent consultants formally reviewed the results of the re-analyses. As part of the re-analysis process, most of the accident scenarios identified in BIO that potentially pose the greatest risk to the off-site public and on-site workers were re-analyzed. This was accomplished in a realistic but defensibly conservative manner to ensure that a more physically accurate representation of accident initiators, accident sequences and ultimately better defined system pressures, and released "waste" flow characteristics for the higher energy waste dispersing accidents were obtained. Results of the refined consequences of such re-analysis also led CHG to reassess existing controls including requirements for safety affecting SSCs. Finally, ORP and CHG are in the process of implementing a more flexible approach to controls based on actual individual tank-associated risk data that are part of the TSRs. See Tables I and II.

**Highlights of the Accident(s) Re-analysis**

Waste Transfer Leaks – One of the accidents in the FSAR associated with the greatest potential consequences to both the public and the co-located and facility workers were the spray leak and/or pool leak accidents. Both accidents [i.e., now integrated as Waste Transfer Leaks] were re-analyzed by CHG using a stochastic approach to derive reasonably conservative rather than worst-case results. This is one of the few instances in the DOE-Complex where stochastic methods were used to analyze non-reactor accidents. The new analysis evaluated a full range of transfer structure sizes (e.g., pits and clean-out boxes [COBs]) as part of the modeling effort. For example, leak flow rate is calculated as a function of line pressure, which is reduced to gravity flow when the transfer pump is shut off. Gravity drainback head and volumes are modeled in a realistic manner rather than as the worst-case only. Analytical consequences at the 95th percentile were used to redefine controls to prevent or mitigate waste leaks. As a result of the re-analysis, credible data exists to make the determination that such accidents do not pose a risk to the public; therefore, the CHG control strategy can be focused on worker protection. Use of a stochastic technique constitutes a major step forward in accident analysis methodology for the RPP, allowing evaluation of a more representative spectrum of accident boundaries and progression scenarios. The overall results of the waste transfer leak re-analysis, clearly demonstrated that projected accident consequences, even without controls, are significantly reduced from those reported in the current FSAR analysis, as stated below.

> *Other accidents [e.g., tank bump and gas flammability related issues] were re-analyzed deterministically using actual data obtained from ongoing tank instrumentation based flammable gas measurements and waste characterization results. Models were redefined to be more realistic and physically accurate, as were the modeling assumptions.*

Gas Flammability Accident Re-analyses – The flammable gas associated risks that were re-analyzed focused on double contained receiver tanks, accidents in waste transfer systems and associated structures, flammable gas requirements for salt well pumping controls, and flammable gas lightning associated controls. In most of the re-analyses, radiological consequences for a representative set of accident cases were recalculated, using the new source terms described below, while toxicological consequences were for the present, reassessed qualitatively.

Source Terms and Evaluation Guidelines – ORP also directed a re-analysis of Source Terms and associated unit liter doses based on characterization data obtained during the last 10 years rather than the artificially conservative Super Tank Model used in the FSAR. CHG updated existing radiological and toxicological source term documents to reflect plausible best-known tank inventory as of November 30, 1999. Using these plausible values, CHG recalculated source term unit liter dose and reassessed consequent source term tank groupings. The results of the re-analysis of radiological source term resulted in significant reduction in source terms used to define materials at risk, compared to values in the FSAR. The revised toxicological source term document is under review.

A detailed reevaluation of Tank Farm systems associated evaluation guidelines was completed, and guidelines were developed to meet DOE Standard 3009-94 (Change Notice 1), Appendix A requirements. The Appendix A guidelines are less constrained than those currently used in the FSAR. The existing FSAR guidelines were also several orders of magnitude more constraining than those used by Savannah River Site and Idaho National Engineering and Environmental Laboratory for the associated high-level waste facilities.

Revised consequences for the accidents listed above, and currently being incorporated in the FSAR as Authorization Basis amendments, are well below off-site risk evaluation guidelines without controls and the revised evaluation guidelines, but still conservatively exceed on-site evaluation guidelines without controls.

## SUMMARY OF ACCOMPLISHMENTS

Based on the significantly reduced consequences, safety controls were simplified and revised. A number of controls will be converted from TSRs to defense in depth or revised to allow more operational flexibility. With the recommended controls implemented, accident consequences are either mitigated or prevented, and are well within on-site evaluation guidelines. The Key FY 2000 Accomplishments are provided in Figure 1.

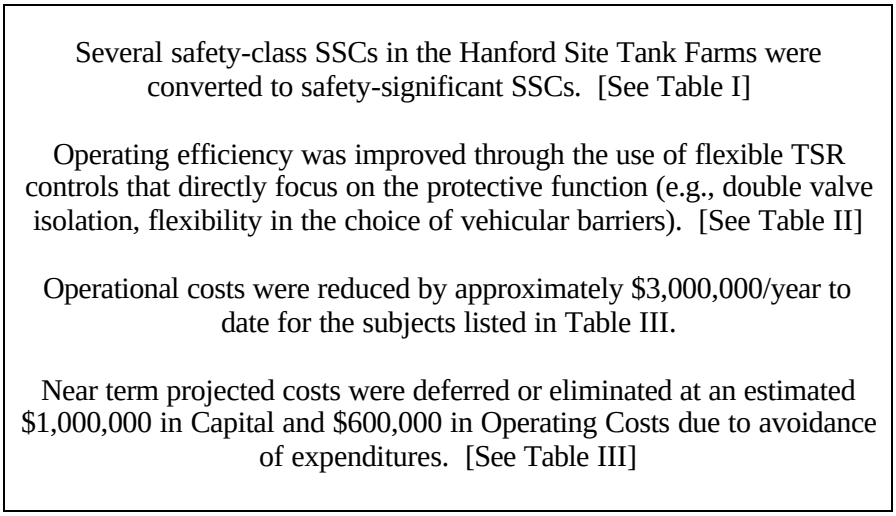


Fig. 1: Key FY 2000 Achievements

The re-analysis of unnecessary and overly protective Authorization Basis constraints has already led to the identification of millions of dollars of annual savings in operational costs and has deferred an additional multi-million dollars in anticipated capital costs associated with now unnecessary tank farm upgrades. [See Table III.]

In parallel to the Authorization Basis re-analysis efforts, two major Priority I safety issues that occupied much of the Hanford Site's focus for the last ten years [organic complexant-nitrate salt deflagration accidents and organic solvent ignition issues] were closed.

The re-analysis has resulted in a slimmer, more focused FSAR and TSR-based Authorization Basis that lends itself more readily to evaluating unreviewed safety question issues as the arise.

## FUTURE AUTHORIZATION BASIS RE-ANALYSIS DIRECTIONS

Ongoing re-evaluation of the risk from flammable gas-initiated accidents due to be completed in FY 2001, is being put into perspective by defining controls focused on identified [more realistic] risks.

The ongoing effort by ORP and CHG will provide added information on Authorization Basis analysis efforts associated with waste feed delivery in support of tank waste retrieval. Planned amendments to the FSAR [FY 2001] will utilize the lessons learned from this year's effort to provide realistic data based on a more accurately modeled scenario to support disposal-associated activities.

Finally, activities necessary to incorporate the detailed Quality Assurance and facility safety requirements from the new safety management rule, 10 CFR 830 and its implementing guidelines, into the RPP Authorization Basis will be initiated later this year.

## REFERENCES

Waste Management '00, "Conservatism Reduction, A Win-Win Safety and Operating Strategy for Reducing Cost of Disposal for the Office of River Protection at Hanford," Tucson, AZ., February 27-March 2, 2000.

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J.J. BEVELACQUA, B.J. HARP, R.W. KUPP, R.C. NELSON, M.W. JACKSON, and A.C. JAMES; "Safety Evaluation Report for the Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) [HNF-SD-WM-SAR-067, Revision H, September 1998] and Technical Safety Requirements [HNF-SD-WM-TSR-006, Revision F2, August 1997]," TWRS-RT-SER-003, Revision 0, U. S. Department of Energy, Richland Operations Office, Richland, Washington (1999)

"Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," DOE-STD-3009-94, U.S. Department of Energy, Washington, DC, 1994, as modified CN No. 1 in January 2000.

"Tank Waste Remediation System Technical Safety Requirements," HNF-SD-WM-TSR-006 Rev. 1, Lockheed Martin, Richland, Washington, as amended.

Table I. Major Authorization Basis Conservatism Reduction Focus Areas

| Principal Focus | Individual Tasks | Key Technical Issue and Conclusions |
|---|---|---|
| Gas Flammability Issues | Tank 241-SY-101 Remediation | Has the remediation by dilution remediated the potential for gas buoyant displacement release events and for uncontrolled crust growth?<br><br>*Yes, and the action eliminates the cost of operating the mixer pump and reduces dome space and other monitoring frequencies for "normal" Group 2 double-shell tanks.* |
| | Flammability in Double Contained Receiver Tanks (DCRT) | What degree of dome space ventilation was needed to prevent DCRT headspace from reaching lower flammability limit [LFL] for these waste transfer structures?<br><br>*Conservative analysis results exceed on-site guidelines. The existing bubbler based ventilation system is designated as safety-significant.* |
| | Re-analysis of Limiting Condition for Operation (LCO) for River Protection Project (RPP) Single-Shell Tanks (SSTs) and Double-Shell Tanks (DSTs) [Licensing strategy only submitted.] | Based on characterization and modeling data could one justify the existing operationally intensive requirements for headspace monitoring requirements?<br><br>*It is unlikely that any new safety significant SSCs will be required when CHG submits a revised Authorization Basis amendment package in FY 2001.* |
| | Re-analysis of Saltwell Pumping Controls | Were portable ventilation systems, pump interlocks, and dual headspace and pump pit gas monitors needed in light of recent characterization data?<br><br>*Flammable gas concentrations in most tanks to be saltwell pumped are not expected to reach 25 percent of the LFL. Therefore, the controls to have an exhauster in "standby" mode, to have continuous gas monitoring in the pump pit and the dome space, and the requirement for monitoring in pump pits were eliminated. Also, the requirement for dome space gas flammability related pump interlocks was deemed unnecessary.* |
| | Gas Flammability Accidents in Waste Transfer Systems and Associated Structures | Are the flammability controls and associated SSCs protective with respect to gas flammability accidents in waste transfer associated structures?<br><br>*No flammable gas hazardous conditions identified with potentially significant off-site or on-site consequences or with potentially significant worker consequences with an anticipated frequency for waste transfer piping were identified. For waste transfer-associated structures, several flammable gas hazardous conditions with potentially significant on-site consequence were identified but the existing waste transfer leak controls adequately addresses these risks.* |

Table I. Major Authorization Basis Conservatism Reduction Focus Areas [Continued]

| Principal Focus | Individual Tasks | Key Technical Issue and Conclusions |
|---|---|---|
| Evaluation Guidelines for SSC for Off-site Radiation Protection | Incorporate Appendix A of DOE-STD 3009-94, as modified in the Authorization Basis | Are the incorporation of new off site risk guidelines in accordance with guidance in DOE-STD 3009-94, as modified, providing a more realistic basis for defining safety-class SSCs?<br><br>*Raising the evaluation guideline in accordance with Appendix A could directly affect the classification of safety affecting SSCs and/or TSR level controls in future Authorization Basis analyses. None of the accidents re-analyzed in FY 2000 were affected by the changed guidelines.* |
| Source Term and Unit Liter Dose (ULD) Reevaluation | Radiological Source Term Re-analysis | In light of current knowledge of tank chemistry and radiological content and waste transport phenomena, are the "Super Tank Model" based source terms used for the various waste types, overly conservative?<br><br>*Reassessing the source terms in accordance with the new characterization data selection of controls would directly affect the classification of safety affecting SSCs. Those savings would be directly allocated to the accidents being re-analyzed.* |
| | Toxicological Source Term Re-analysis | In light of current knowledge of tank chemistry and toxicological data, are the source terms used for the various waste types, overly conservative. Are there computational methodologies that better reflect the accident conditions that bound the RPP Authorization Basis?<br><br>*This re-analysis analysis is still in progress. However, reducing the source terms in accordance with the revised analysis would directly affect the need for safety affecting SSCs and/or TSR level controls. Those savings would be directly allocated to the accidents being re-analyzed.* |

Table I. Major Authorization Basis Conservatism Reduction Focus Areas [Continued]

| Principal Focus | Individual Tasks | Key Technical Issue and Conclusions |
|---|---|---|
| Tank Bump Issues | A reassessment of Tank Bump (e.g., Steam Bump) Accidents | Would a re-analysis of these accidents using conservative but more realistic best engineering estimates and tank farm data result in determination of a lower risk for such accidents and ensure reduction of controls?<br><br>*No off-site evaluation guidelines are now exceeded. Existing ventilation associated SSCs for existing accidents support this potential accident. The two safety SSCs analyzed in the BIO/FSAR (Temperature Monitoring Systems and Tank Level Detection Systems) were downgraded to General Service and will be addressed as part of the implementation of Administrative Controls.* |
| Waste Transfer Issues | Re-analysis of a wide variety of waste transfer leak scenarios | For pool (surface and subsurface) and spray leaks (surface and in-facility) leaks that could be postulated during waste transfer activities, did the use of conservative but more realistic best engineering estimates and actual tank farm experience of the accident and associated source terms provide a more realistic assessment of risk from these bounding accidents?<br><br>*Radiological consequences are dominated by doses from gamma shine and skyshine from waste pools. The primary control strategy is leak detection with response actions to stop the transfer motive force (e.g., transfer pump) and evacuate on-site and facility workers to increase distance and reduce exposure time. More focused controls allow mitigation of aerosol generation from direct spray and splash/splatter that can result in significant on-site toxicological consequences and be a hazard to facility workers are also in place.* |

Table II. Additional Operationally Significant Conservatism Reduction Focus Areas

| Principal Focus | Individual Tasks | Key Technical Issue |
|---|---|---|
| Double Closed Valves for Physically Disconnecting Tank Waste Transfer Systems | Analyze to risks from the use of double valve containment systems for preventing waste transfer accidents | Does the use of two valves in series provide sufficient protection of operators, co-located workers and the public from misroutes during waste transfers?<br><br>*When used as "physical disconnected" TSR purposes, double valve containment systems are safety-significant. This use significantly enhances Tank Farm operating flexibility and reduces cost.* |
| High Heat Tank 241-C-106 Remediation | Verify that the Priority 1 High Heat Tank Safety Issues was Closed | Has the transfer of waste solids from single-shell tank 241-C-106 to double-shell tank 241-AY-102 remediated the high heat safety issue while not creating flammable gas of tank bump safety issues in the receiver tank?<br><br>*Accident scenarios associated with Tank 241-C-106 no longer exceeds evaluation guidelines. No safety SSCs are required for Tank 241-C-106. Flammable gas associated SSCs and controls continue to apply to Tank 241-AY-102. However, no unique controls apply to either Tank 241-C-106 or Tank 241-AY-102 after remediation.* |
| In-tank Fuel Fire/Deflagration Accident Re-analysis | Develop a Strategy for Reassessing the Subject Accidents | Will a realistic analysis of In-tank fuel fires and fuel deflagration accidents obviate the need for this accident scenario, and associated controls in the RPP Authorization Basis?<br><br>*Preliminary analysis suggests that the in-tank fuel fire and/or deflagration will not exceed evaluation guidelines for either on- or off-site exposures. No safety SSCs appear to be required for control of this accident. Only vehicular access controls are likely to apply to prevent this hazard.* |
| Safety Classification of SSTs and DSTs | Evaluate the Classification of SST and DST as Passive Design Barriers | Would the knowledge gained by RPP as a result of waste characterization, tank monitoring, and more realistic accident analysis allow the classification of the tanks as passive design features (structures, systems and/or components [SSCs])?<br><br>*Re-analysis determined that there is no added protection to be gained by classifying the single- and double-shell tanks as safety affecting relative to evaluation guidelines for either on- or off-site exposures. CHG concluded that there is no added protection to be gained by classifying the single- and double-shell tanks as safety affecting, relative to designating them as safety affecting SSCs. Therefore, no changes in accident-related controls for the hazards identified in the FSAR result from the re-analysis since the re-analysis demonstrates that no gross failure of tank structural integrity is possible under Tank Farm authorized operating conditions.* |

Table II. Additional Operationally Significant Conservatism Reduction Focus Areas [Continued]

| Principal Focus | Individual Tasks | Key Technical Issue |
|---|---|---|
| Use of Vehicle Barriers for Above Ground Waste Transfer Systems | Reassess the Highly Prescriptive Vehicular Barrier Controls in the FSAR/TSRs | Can a more flexible approach to defining alternate acceptable vehicular barriers to prevent above ground waste transfer accidents obviate the need for the present concrete barrier systems that limit operational flexibility?<br><br>*Re-analysis determined that added flexibility in choice of vehicular barrier could be made without adversely affecting safety.* |
| Ventilation System Controls | Alternatives to use of Continuous Air Monitors (CAMs) for Ventilation Interlocks to Protect Against Accidents that Pressurized Tanks | Can the use of differential pressure switches, in lieu of CAMs, provide protection against release of radioactivity from tank pressurization and/or flammable gas deflagration accidents?<br><br>*Preliminary analysis suggest that the changing the ventilation interlock system by using dP switches to protect High Efficiency Particulate Air (HEPA) filters will not change consequences of the previously analyzed accidents. CHG requested that the protective function of the CAM be reassigned to the dP switches and related logic controller. ORP mandated that CHG perform function tests on the dP switch system while maintaining the availability of the CAM system. At issue is whether the dP switched interlock provides equivalent levels of protection of the ventilation system safety function under tank pressurization or other HEPA failure promoting conditions.* |

Table III. Cost Avoidance and/or Reduction Resulting From Authorization Basis Re-analysis

| Principal Focus | Individual Tasks | Net Cost Reduction | Net Cost Avoidance |
|---|---|---|---|
| Gas Flammability Issues | Tank 241-SY-101 Remediation | None Yet Available [a] | None Yet Available [a] |
| | Flammability in Double Contained Receiver Tanks (DCRT) | No appreciable cost savings | No appreciable cost savings |
| | Re-analysis of Limiting Condition for Operation (LCO) for River Protection Project (RPP) SSTs and DSTs | $270,500 expense | $590,000 New Capitol<br>$186,500/yr. Operations Costs |
| | Re-analysis of Saltwell Pumping Controls | $484,000 expense [cumulative 5-7 years] | None Identified |
| | Gas Flammability Accidents in Waste Transfer Systems and Associated Structures | Included in Waste Transfer Re-analysis Costs | Included in Waste Transfer Re-analysis Costs |
| Evaluation Guidelines for SSC for Off-site Radiation Protection | Incorporate Appendix A of DOE-STD 3009-94, as modified in the Authorization Basis | None Yet Available | None Yet Available |
| Source Term and Unit Liter Dose (ULD) Reevaluation | Radiological Source Term Re-analysis | None directly Identified [b] | None directly Identified [b] |
| | Toxicological Source Term Re-analysis | None directly Identified [b] | None directly Identified [b] |
| Tank Bump Issues | A Reassessment of Tank Bump (e.g., Steam Bump) Accidents | $12,000/yr. expense | |
| Waste Transfer Leak Analysis | Re-analysis of a Wide Variety of Waste Transfer Leak Scenarios | $2,900,000/yr. Operations [Expense] | $386,000 Capital Expenses |
| Double Closed Valves for Physically Disconnecting Tank Waste Transfer Systems | Analyze to Risks from the use of Double Valve Containment Systems for Preventing Waste Transfer Accidents | Savings are incorporated in waste transfer leak savings | |
| High Heat Tank 241-C-106 Remediation | Verify that the Priority 1 High Heat Tank Safety Issues were Closed | None Yet Available [d] | None Yet Available |
| In-tank Fuel Fire/Deflagration Accident Re-analysis | Develop a Strategy for Reassessing the Subject Accidents | None Yet Available | None Yet Available |
| Safety Classification of SSTs and DSTs | Evaluate the Classification of SST and DST as Passive Design Barriers | None Identified [c] | $150,000 initial + 30-40 K/yr. |
| Ventilation System Controls | Alternatives to use of Continuous Air Monitors (CAMs) for Ventilation Interlocks to Protect Against Accidents that Pressurized Tanks | $728,845/yr. If test activities verify Authorization Basis assumptions | |

Notes:

[a] Eliminates the cost of operating the mixer pump and reduces dome space and other monitoring frequencies to that for Group 2 double-shell tank.

[b] Reducing the source would directly affect the need for Safety affecting SSCs and/or TSR level controls. Those savings would be directly allocated to the accidents being re-analyzed.

[c] No cost saving identified since tanks were treated as a passive design feature pending re-analysis.

[d] A significant reduction in monitoring, water addition, and other operational needs occurred.