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7. Abstract

This SD identifies cost effective Intrusion Prevention techniques & strategies that are regulatory compliant & compatible with interim storage and monitoring requirements for SST wastes.

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LIST OF TERMS

ALARA	as low as reasonably achievable
DST	double-shell tank
FIC	flow indicator control
gal	gallon
in.	inch
LOW	liquid observation well
RCRA	*Resource Conservation and Recovery Act*
RL	U.S. Department of Energy, Richland Operations Office
SST	single-shell tank

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ENGINEERING EVALUATION OF INTRUSION PREVENTION STRATEGIES FOR SINGLE-SHELL TANKS

1.0 OBJECTIVE

In this study, previously implemented actions (see Appendix A) to prevent liquid intrusion into out-of-service single-shell tanks (SSTs), i.e., interim isolation or partial interim isolation, are investigated and expanded to identify additional cost-effective intrusion prevention techniques that could be reasonably taken until SSTs are ready for waste retrieval. Possible precipitation, groundwater, and condensation pathways and internal tank connections that could provide possible pathways for liquids are examined. Techniques to block identified potential pathways are developed and costed to determine the potential benefit to costed trade-offs for implementing the techniques. (Note: Surveillance data show increased waste surface levels for several SSTs that indicate possible liquid intrusion despite interim isolation activities [WHC 1993c]).

1.1 BACKGROUND AND SCOPE

To reduce the risk of loss of SST liquids to the environment, SST liquids were jet pumped to double-shell tanks (DSTs) beginning in 1975 (tank 241-BY-107). As the first step toward final disposition, SST wastes were first interim stabilized in 1978. To be considered interim stabilized, a SST must have less than 50,000 gallons (gal) of drainable interstitial liquids and 5,000 gal of supernate. Interim stabilization is achieved by jet pumping interstitial liquids (0.5 gal per minute minimum rate), pumping the supernate, or declaring the SST administratively stabilized if the stabilization criteria are met.

As the second step toward final disposal of SST wastes, SSTs were to be interim isolated. All 149 SSTs were removed from active service in November 1980 (no longer authorized to receive waste). Interim isolation or intrusion prevention, as it is now designated, is designed to prevent, to the extent deemed practicable, the intrusion of liquids into SSTs. SSTs still requiring jet pumping or another method of waste stabilization are designated as partially interim isolated. Selected tank risers and piping systems are needed to allow final liquid waste transfer activities to be completed. Final intrusion prevention activities then can be accomplished. Ideally, the time to accomplish intrusion prevention is at the end of interim stabilization (termination of salt well jet pumping activities) while equipment is functional, and a knowledgeable staff is available.

The third step toward final disposal of SST wastes is the caretaking and monitoring of interim stabilized waste in intrusion prevented SSTs until it can be retrieved. The monitoring requirements for each SST must be determined and appropriate monitoring equipment designed and packaged to remotely monitor the condition of the waste. This step is not within the scope of this study.

The fourth step for disposal of SST wastes is its retrieval from SST storage. Again, this is not within the scope of the study. The final step is processing recovered SST waste through the disposal system used to process DST wastes. These last two steps are major federal actions involving installation of new retrieval, storage, and processing equipment and cross-site transfer systems that are compliant with federal and state codes and regulations. This considerable effort likely will be accomplished in the early twenty-first century.

The 200 West Area has a total of 83 SSTs of which 55 have had their wastes interim stabilized and the tank intrusion prevented; 1 has its wastes interim stabilized, but the tank is only partially interim isolated; and 28 have unstabilized wastes with partially interim isolated tanks (WHC 1994).

The 200 East Area has a total of 66 SSTs of which 46 have had their wastes interim stabilized and the tank intrusion prevented/interim isolated; 6 have their wastes interim stabilized, but the tanks are only partially interim isolated; and 15 have both unstabilized wastes and partially interim isolated tanks (WHC 1994). The seven SSTs selected for detailed study are located in the 241-BX and BY Tank Farms (BX-107, 109, 110, 111, and 112, and BY-102 and 109); they are being pumped in Fiscal Year 1994. They will be available shortly for intrusion prevention. The selected SSTs are classified partially interim isolated tanks which means they have not fully undergone intrusion prevention/interim isolation activities. Further, wastes in tanks 241-BX-111, 241-BY-102, and 241-BY-109 have not been interim stabilized, i.e., they have significant amounts of drainable, pumpable liquid present. Single-shell tank 241-BX-111 is currently being jet pumped to allow the waste to be interim stabilized. Single-shell tanks 241-BY-102 and -109 will be jet pumped beginning in May 1994. Plans call for the waste in these three SSTs to be interim stabilized by December 1994. Intrusion prevention activities will be accomplished by the end of Fiscal Year FY 2000 based on a mutually agreeable schedule between the Department of Energy Richland Operations Office (RL) and the Washington State Department of Ecology (Ecology et al. 1990).

In this study, investigations of how "best" to complete and finalize intrusion prevention activities will be considered generally for all SSTs partially based on the seven selected SSTs. Decisions to implement an activity will be based primarily on the cost (safety and dollars) to block a potential liquid intrusion pathway and the judged likelihood of its occurrence (see Appendix B). Compatibility with and cost impact on future retrieval operations are beyond the scope of the study.

1.2 PURPOSE AND NEED

The purpose of this study is to identify cost effective intrusion prevention techniques and strategies that are regulatory compliant and compatible with interim storage and monitoring requirements for SST wastes. Cost effective intrusion prevention techniques are needed to ensure that stabilized waste remains free of liquid intrusion during the interim storage period.

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2.0 SUMMARY

Previous intrusion prevention techniques (accomplished in the late 1970's and early 1980's) were reexamined for durability and effectiveness. Potential liquid pathways were also reexamined. Where appropriate, new techniques to block liquid intrusion pathways were identified and costed to determine what additional cost effective techniques should be implemented. Generic recommendations are made regarding the improvement of earlier intrusion prevention techniques and the blocking of additional intrusion pathways identified in the study.

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3.0 RECOMMENDATIONS AND CONCLUSIONS

The recommendations made are in addition to those previously accomplished or planned for interim isolation of SSTs after salt well pumping. A basic assumption of the study is that waste in some SSTs may be in interim storage for as long as 30 years. Intrusion prevention should reasonably ensure that failure of piping, gasketing material, seals and equipment will not inadvertently result in significant intrusion of liquids into stored wastes. The following recommendations are double containment in philosophy and generic to all SSTs. They are based on detailed specific information developed for the seven selected SSTs studied and are reported in the appendices of this report.

Recommended Intrusion Prevention Actions

1. Complete "interim isolation" activities previously planned for accomplishment after salt well pumping.

2. Seal all remaining nozzles and plug floor drains in all nonweather-covered boxes and pits after completion of salt well pumping.

3. Seal all "as is" nozzles and plug floor drains in boxes and pits when damaged or worn out weather covers are replaced.

4. Install maintainable and accessible leak detectors in pits and boxes that are not weather covered or when worn out/damaged weather covers are replaced.

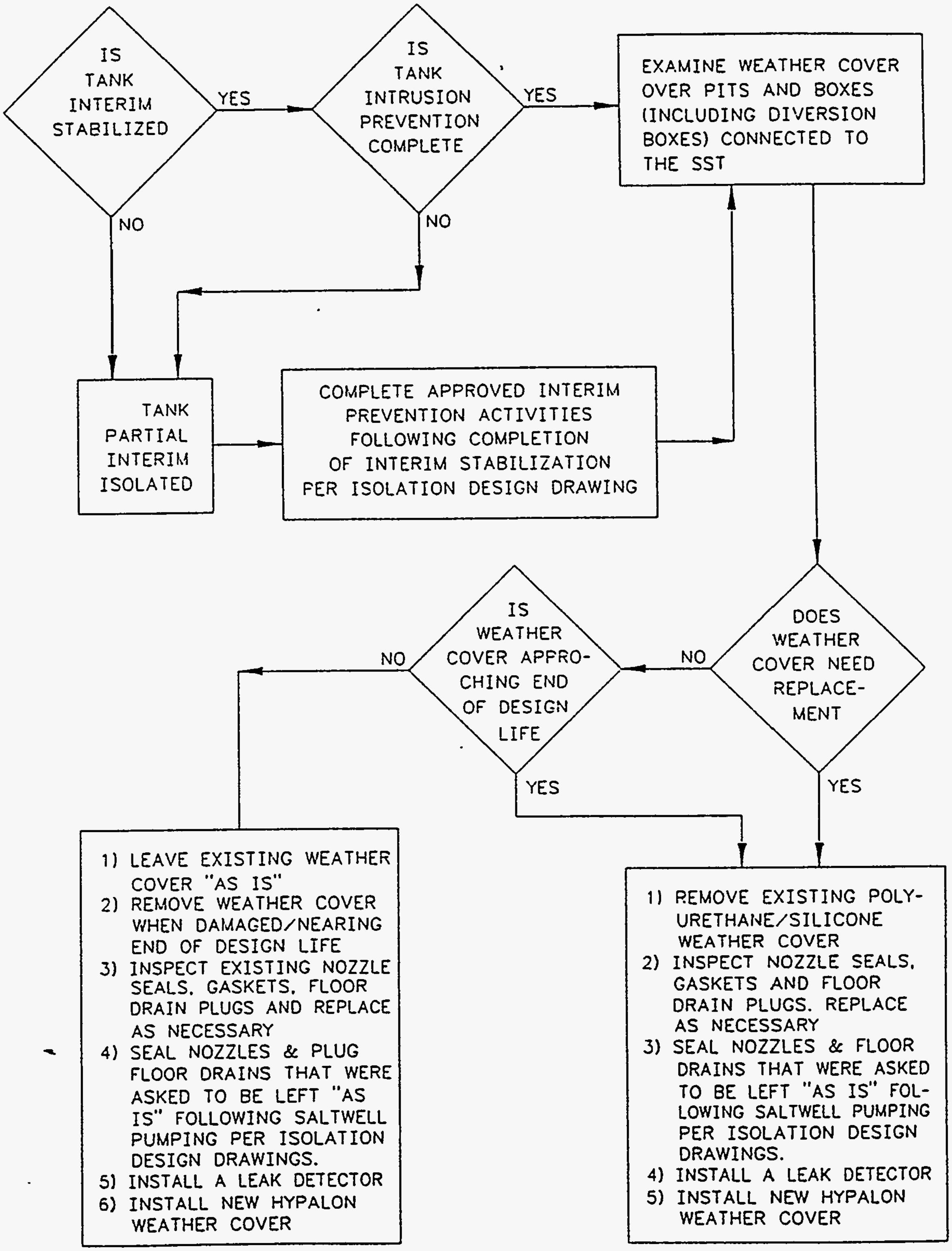
5. Install reusable and portable hypalon weather covers over pits and boxes whenever possible:

   a. At completion of salt well pumping, i.e., new cover installation over pumping pit.

   b. As replacement for damaged or worn out foam weather covers.

Figure 3-1 illustrates the process envisioned to fully accomplish Intrusion Prevention for all SSTs.

Figure 3-1. Intrusion Prevention Strategy for Single-Shell Tanks.



4.0 UNCERTAINTIES

A weighted scoring procedure was used to evaluate the practicality of implementing a given technology to limit the amount of liquid intrusion into SSTs. The scoring procedure is subjective and uses engineering judgment of study contributors to assign weighted scores to selected intrusion prevention technologies in four categories (i.e., worker safety, costs, maintainability, and degree of improved intrusion prevention attained). Should a different score (i.e., score factor) be assigned to a technology for a particular criterion, or should the importance of a criterion relative to other criteria change in the future, the desirability of implementing a given technology (relative to alternate intrusion prevention technologies) may also change. Additional criteria (not included in this evaluation procedure) may become significant and influence the selection of a particular intrusion prevention technology.

The success of implementing effective intrusion prevention activities for a given tank depends upon the accurate identification and assessment of all potential intrusion pathways into that tank. Isolation design drawings of the SSTs were used in this study to identify accesses through which liquids may enter the tanks. The effectiveness of the intrusion prevention strategy developed and recommended in this study cannot be determined with certainty because of the inaccuracy, lack of clarity, and incompleteness of many of the drawings. Process lines not included in the isolation design drawings can serve as pathways for liquid intrusion into the tanks. Whenever possible, field verification and interviews with tank farm personnel should be conducted to supplement the information found in isolation design drawings.

The extent of radiological contamination in the diversion boxes and pits is unknown. This could significantly impact the recommended plan to install nozzle seals and floor drain plugs in these pits/boxes. In cases where the radiation levels in the pits are low, the seals and plugs could be installed remotely without serious worker safety concerns. In instances where the radiation levels are high, dealing with increased worker safety concerns, including exposure to high radiation dosages, will significantly increase the cost of installing the nozzle seals and gaskets and floor drain plugs. Mirrors, green houses, and complex automated systems to install seals may be required to shield workers from radiation. Concerns over the spread of radiological contamination to the environment outside of the boxes/pits will delay intrusion prevention efforts and add to the costs of radionuclide confinement.

Past intrusion prevention activities have included the installation of weather covers over pits and boxes and the sealing of certain nozzles and floor drains within the pits/boxes. The recommended intrusion prevention plan for the future calls for the installation of removable hypalon weather covers in place of the existing silicone/polyurethane covers when they get damaged or worn out, the resealing (retightening) of all previously sealed nozzles and plugged drains, and the sealing of all nozzles and drains previously left "as-is." However, the recommended intrusion prevention activities cannot guarantee the complete isolation of the pits/boxes, and consequently cannot guarantee the isolation of the tank from liquids that manage to enter the pits/boxes. No effort was made in the past, and no new

technologies been proposed in this study to seal the sidewalls and the floors of the pits/boxes or to identify unknown accesses to the pits/boxes. High installation costs, and the anticipated need of pit facilities such as risers for future waste retrieval efforts have precluded the use of nearly irreversible technologies such as grouting to effectively isolate the pits/boxes.
A liquid detector installed in the pit may not be able to detect small amounts of liquid on the floor of the pit since its detection element would be located 1/2-inch above the floor's surface. This liquid may eventually find its way to the tank through a small access such as the gap between the riser flange and the concrete floor of the pit.

In this study, existing nozzle seals and floor drain plugs in weather-covered boxes and pits are recommended to be inspected and replaced, as required, when the weather covers themselves are replaced. Nozzles and floor drains that were left "as-is" following salt well pumping are also recommended to be sealed only when the existing weather cover over the pit/box is replaced. Given the restricted access to nozzles and drains because of weather covers, the effectiveness of nozzle seals and floor drain plugs cannot be determined, nor can liquid intrusion through nozzles and drains left "as-is" be determined. This issue is critical considering the length of time for which the tanks are expected to be interim stored (up to 30 years).

The ability of nozzle seals and floor drain plugs to protect SSTs against liquid intrusion during interim storage is uncertain. The inaccessibility to these seals, gaskets, and plugs because of weather covers enhances the desirability of double containment.

5.0 DESCRIPTION OF SST INTERIM ISOLATION AND INTRUSION PREVENTION STRATEGIES

Previously implemented SST interim isolated activities and newly identified intrusion prevention strategies are described in sections 5.3.1 and 5.3.2. respectively. Cost/benefit comparisons have been made for intrusion prevention technologies to identify candidate technologies for possible inclusion in future liquid intrusion prevention activities for SSTs. Basic monitoring requirements are also determined for different waste types in SSTs for the interim stabilized waste storage mode (Section 5.3.3). Instrument access needs, utility requirements and current methods for placing instrument packages into hardened SST waste are also identified and discussed (see Section 5.3.3). Finally, durability and maintenance issues associated with current weather covers are discussed in context with the need to access and maintain in-place monitoring equipment.

5.1 CRITERIA

To evaluate the relative merits of each intrusion prevention technique, criteria were selected, questions were asked, and responses were ranked.

Criteria related to worker safety, cost, maintainability, and degree of intrusion prevention. The questions asked were as follows:

1. Can the technique be implemented safely, i.e., workers are not unreasonable exposed to radiation (ALARA)?
2. Is the cost reasonable with respect to the benefit derived?
3. Can the technology be implemented without interrupting tank farm operations and schedules?

Responses were ranked from 1 to 5 in order of importance relative to the other criteria. A weight factor of 1 indicated lowest importance, and 5 indicated highest importance (see Table 5-1).

Table 5-1. Selection Criteria Weight Factor Definitions.

Importance	Weight Factor
Low	1
Low/Medium	2
Medium	3
Medium/High	4
High	5

For each intrusion prevention technology, score factors were given to each selection criterion. Score factors reflect the estimated impact on the selection criteria. A score factor of 5 had the highest impact, and a score factor of 0 the lowest (see Table 5-2).

Table 5-2. Selection Criteria Score Factor Definitions.

Impact	Score
None	0
Light	1
Light/Moderate	2
Moderate	3
Moderate/Heavy	4
Heavy	5

An intrusion prevention technique's impact score multiplied by the relative importance weight determines its total weighted score. The higher the total weighted impact score, the less favorable the intrusion prevention technique.

- **Worker Safety**

  Worker safety involves estimating the potential for industrial accidents, accidental exposure to waste materials, and routine radiation doses associated with a given tank intrusion prevention technique; and gauging the severity of these events with respect to worker health. Safety concerns were given the highest weight factor, i.e., 5.

- **Cost**

  Costs for implementing candidate intrusion prevention technologies were estimated. Implementation costs include procurement, installation, operation, and maintenance. Costs were given a weight factor of 3.

- **SST Farm Maintainability**

  Maintenance requirements and durability of the intrusion prevention technique were evaluated. Maintenance ratings were based on monitoring instrument accessibility, reliability, and durability to ensure liquid pathways remained blocked, and the ability to restore the protective intrusion prevention technique after gaining maintenance access. Maintainability was given a weight factor of 3.

- **Degree of Improved intrusion prevention**

  The degree of improved intrusion prevention resulting the proposed action was evaluated. Factors involved in this evaluation include both the likelihood and amount of liquid intrusion from the pathway identified and the effectiveness of the technology being proposed to block that liquid pathway. Degree of improved prevention was given a weight factor of 4.

5.2 ASSUMPTIONS

Key assumptions made in the study are as follows:

1. Interim stabilization of wastes will have been accomplished in a SST before intrusion prevention activities are finalized.

2. Actions taken to intrusion prevent/interim isolate SSTs will also be implemented for SSTs that are partially interim isolated.

3. Jet pumps in the salt wells can be removed from stabilized waste, i.e., it is not frozen in place. (Original isolation left salt well pumps in place.)

5.3 STRATEGIES

Past and future intrusion actions are investigated, evaluated, and reported in the subsections below. Minimal monitoring requirements needed to ensure waste remains safely stored and SSTs remain intrusion prevented are also reported.

5.3.1 Interim Isolation Activities

In the past, the term "interim isolation" was used to describe actions performed in SSTs and tank farms to prevent the intrusion of liquids into the stored wastes. The terms "partially interim isolation," "interim isolation," and "intrusion prevention" are defined below.

- Partially interim isolation was performed on all SSTs when they were removed from service. Partially interim isolation included sealing all existing SST accesses not required for the ongoing salt well pumping or other methods of stabilization. (Note: The SST risers isolated were limited to risers existing above grade or within 3 feet of the surface.)

- By definition, a typical SST was considered interim isolated when all existing accesses not required for long-term surveillance were sealed in a way that provided for at least one barrier (weather cover, plug, cap, or a mechanical seal) to an inadvertent liquid addition. Previous methods of SST isolation allowed for future reentry, further in-tank stabilization or retrieval projects. (Note: The SST risers to be isolated were limited to risers existing above grade or within 3 feet of the surface. In June 1993, the designated term "interim isolated" was replaced with a new term, intrusion prevention.

- The Tank Farm Surveillance And Waste Status Summary Report for January 1994 (WHC 1994) states: "Intrusion prevention is the administrative designation reflecting the completion of the physical effort required to minimize the addition of liquids into an inactive storage tank, process vault, sump, catch tank, or diversion box. Under no circumstances are electrical or instrumentation devices disconnected or disabled during the intrusion prevention process (with the exception of the electrical pump), in accordance with WHC-SD-WM-SAR-006, Rev. 2, Single Shell Tank Isolation Safety Analysis Report, March 1986" (WHC 1986c).

5.3.1.1 Past Programmatic Interim Isolation Activities. During the design and construction period (approximately 1977 through the mid 1980s) for the past partially interim or interim isolation (intrusion prevention) modes, Project B-139, "Tank Farm Water Line Modification" was initiated in direct support of ongoing SST farm isolation activities. Project B-139 was designed to control tank farm water usage and eliminate the uncontrolled release of water to SSTs and surrounding soils. Modifications to each of the 12 SST farms included piping route changes and abandonment of existing services followed by installation of hose stations, water meters, backflow preventers, and hose reels.

Currently, 51 partially interim isolated SSTs will require intrusion prevention activities as designed for each tank to be completed (see Tables D-5 and D-6 in WHC-EP-0182-70, WHC 1994). (Note: The design information required to complete intrusion prevention for each of the 51 partially interim isolated SSTs exist on the original design/isolation drawing for each SST, e.g., Piping Waste Tank Isolation 241-BY-109, Drawing H-2-73253 (WHC 1986b) [see Note 5 on drawing].)

5.3.1.2 Potential SST Liquid Intrusion Sources Investigated. Potential SST liquid intrusion sources considered in past SST isolation studies include the following:

- Rain water
- Snow melt water
- Uncontrolled service water usage on or near a typical SST farm
- Condensate in underground concrete structures, i.e., pump pits, diversion boxes, etc.
- Active process lines connected to existing SST farm transfer piping network

5.3.1.3 Potential SST Liquid Intrusion Routes Evaluated. Potential SST liquid intrusion routes considered in past SST isolation studies include the following:

- Spaces between cover blocks on various concrete pits, i.e., pump pits, diversion boxes, heel pits, sluice pits, etc.
- Small access openings through metal pit covers and concrete cover blocks
- Equipment penetrations/openings into SSTs, i.e., air-cooled reflex condensers
- Overflow lines between SST tanks
- Subsurface blank tank risers
- Incoming process lines from diversion boxes
- Floor drains within various service and process concrete pits

- Wall and floor cracks within various concrete structures, i.e., pump, sluice, heel, and diversion boxes

- Cracks within SST concrete dome.

5.3.1.4 Past SST Interim Isolation Design Details. Past SST isolation activities involved the sealing of readily accessible facilities and equipment by installation of weather covers, pipe caps and plugs, flange blanks, floor drain plugs and remote mechanical seals. These sealing systems and mechanical devices provide the single barrier required to interim isolate SSTs from potential liquid intrusions. Various SST isolation systems for sealing SST access are listed below:

- Weather covers (silicone rubber/polyurethane) were used to protect metal and concrete structures (i.e., valve and pump pits, diversion boxes, etc.) from rainwater and snow melt intrusions. The weather cover was designed to protect the small openings existing between the cover block and the concrete diversion box or other small openings in metal utility pits etc., from weather-related moisture (see Figure 5-1). Note: No effort was made to seal the side walls or the floor of a given concrete structure. See Drawing H-2-71844, sheets 1 and 2, Rev. 0, Waste Tanks - Typical Isolation Details-Pit Weather Covers (WHC 1976b).

- Tank risers, from which equipment has been removed, were sealed with a new blind flange and gasket. See the following drawings:

  - H-2-71841, Rev. 0, Waste Isolation - Typical Isolation Details Flanged Risers (WHC 1976a)

  - H-2-73450, sheet 1, Rev. 9; sheet 2, Rev. 3; sheet 3, Rev. 1; and sheet 4, Rev. 0; Piping Isolation Details Pipe and Riser Closures (WHC 1993b)

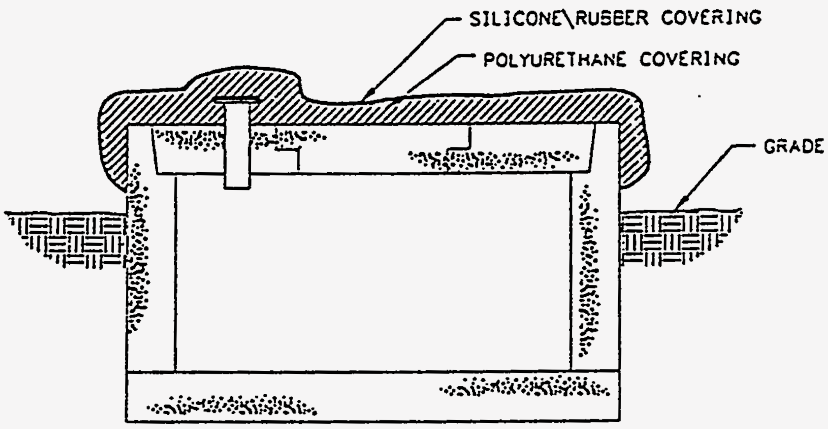
  - H-2-73451, Rev. 5, Piping Isolation Details Riser Closures (WHC 1986a)

- Out-of-service tank risers that were above and less than 3 feet below grade were regasketed.

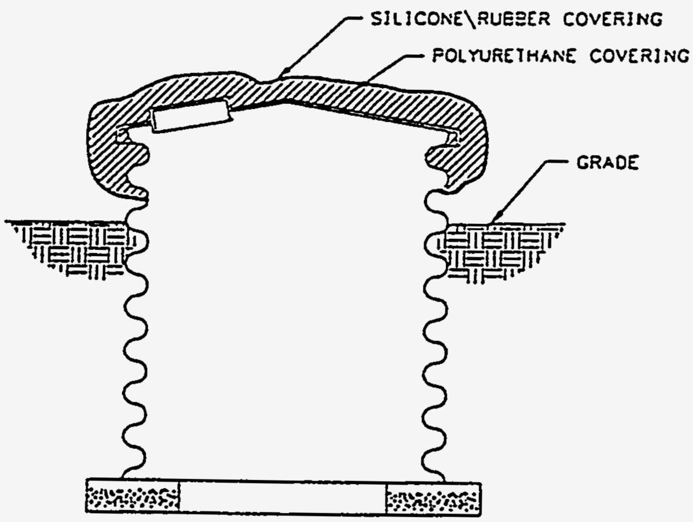
- All tank risers that could not be regasketed, were "cocooned" with a weather cover of polyurethane/silicone rubber (see Figure 5-2).

- Open pipe ends were sealed with welded pipe caps or threaded pipe caps that were back welded. Blanking plates were welded to continuous pipe to form an internal seal (see Figure 5-3, and Drawing H-2-71842, Rev. 1, Waste Tanks - Typical Isolation Details Pipe Ends and Seals) (WHC 1985a).

Figure 5-1. Typical Weather Cover for Metal and Concrete Structures.



TYPICAL CONCRETE PIT OR STRUCTURE



TYPICAL CORRUGATED METAL PIT

- Floor drain plugs were used to seal and isolate floor drains and openings within various metal and concrete structures. Seals consist of a rubber plug backed up by a low shrink grout. (See Figure 5-4. and Drawing H-2-71843, Rev. 1, Waste Tanks - Typical Isolation Details Floor Drain - Seals (WHC 1977).

- Remote connector nozzles within existing metal or concrete structures were sealed by one of two types of remote mechanical seals. One type (Drawing H-2-73453, Rev. 3, Waste Tank Typical Remote Seals For Connector Nozzles, WHC 1985b) was used to isolate non-pressure services (see Figure 5-5). Another type (i.e., Drawing H-2-32420, Rev. 9, Assembly Horizontal and Vertical 2 Connector) was used to isolate pressure services (WHC 1993a) (see Figure 5-5).

5.3.1.5 Past SST Interim Isolation (Intrusion Prevention) Failures. Information provided in the January 1994 *Tank Farm Surveillance and Waste Status Summary Report* (WHC 1994) indicates that the liquid-level measuring instruments in several interim isolated SSTs have detected small increases in levels. Based on these post interim stabilization changes in surface levels, it may be assumed that liquid accesses have not been completely sealed in some SSTs. (Note: The discovery of yet unaccounted for and unsealed SST openings will require the development of innovative remote observation and sampling methods to determine the location and origin of the liquid sources.)

The original isolation design details for each SST access is based on information provided by existing as-built design drawings and reviews conducted by SST farm personnel. Possibly, undocumented entries or facility/equipment failures are providing liquid access to these SSTs. Individual field investigations are anticipated to be needed to identify the source of the liquid in-leakage for each SST.

The SSTs listed below are known to have liquid in-leakage/intrusion after having had isolation activities completed. (Note: Summaries of "past history" and "resolution status" for the suspect liquid intrusion SSTs are routinely published in the *Tank Farm Surveillance and Waste Status Summary Report*" (WHC 1994).

241-B-202	241-TX-113
241-BX-101	241-TX-115
241-BX-103	241-TY-102
241-TX-111	

Single-shell tanks undergoing liquid intrusion will require periodic pumping of accumulated liquids until the source of the intruding liquid has been identified and stopped. As the location and source of the intruding liquids are determined for each SST, it may be necessary to revisit intrusion prevention activities for other SSTs to ensure potential liquid pathways are truly blocked/prevented. Intrusion prevention activities cannot be closed until the in-leakage into the seven SSTs listed above have been prevented.

Figure 5-2. Typical Single-Shell Tank Riser Weather Cover.

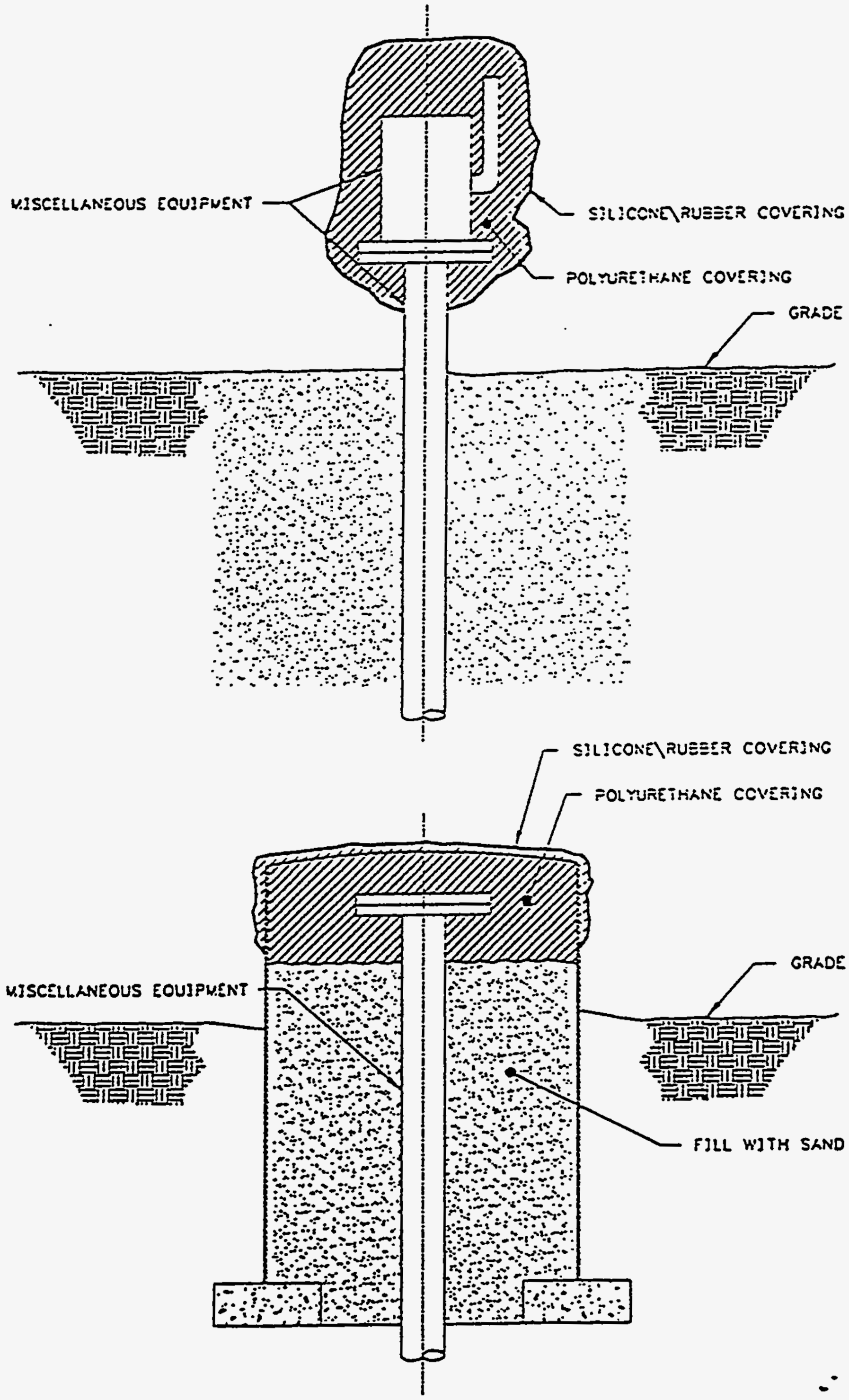


Figure 5-3. Typical Single-Shell Tank Isolation Details for Open Pipe Ends.

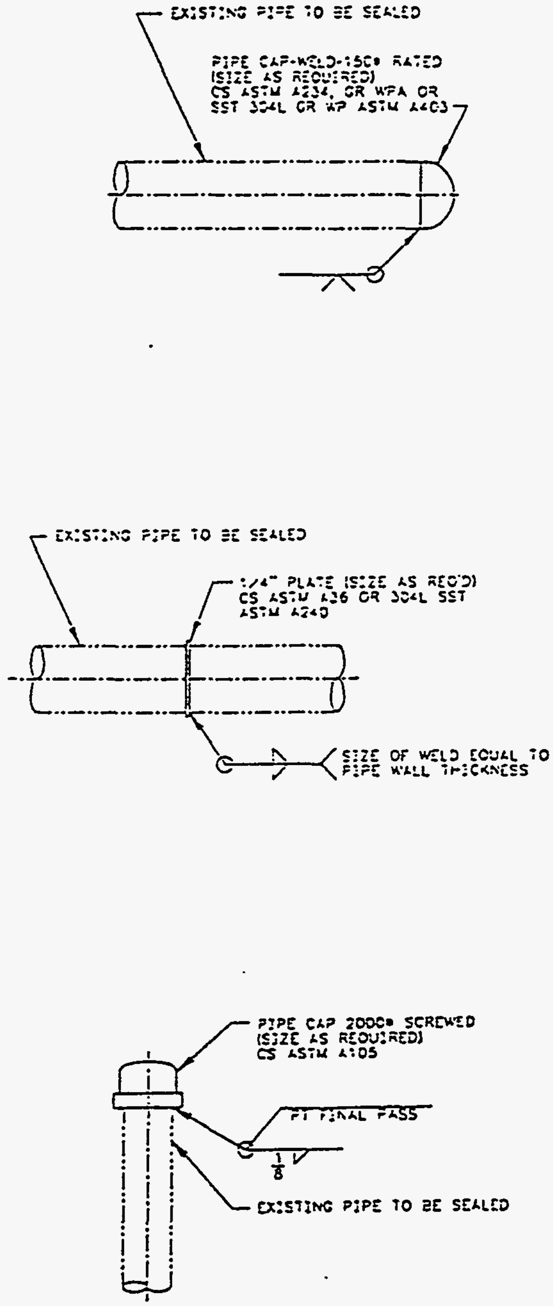


Figure 5-4. Typical Plugs for Floor Drains and Openings.

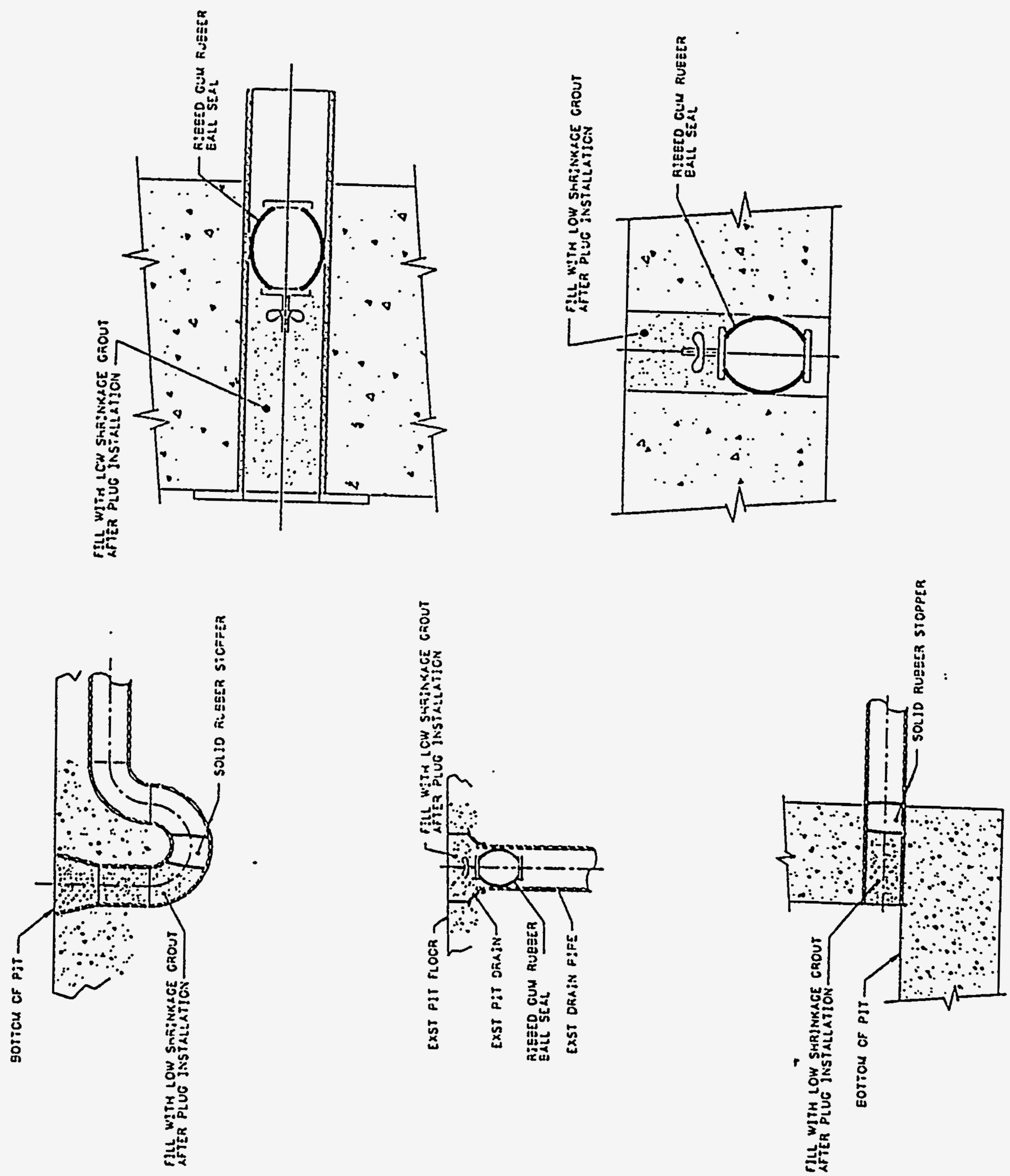
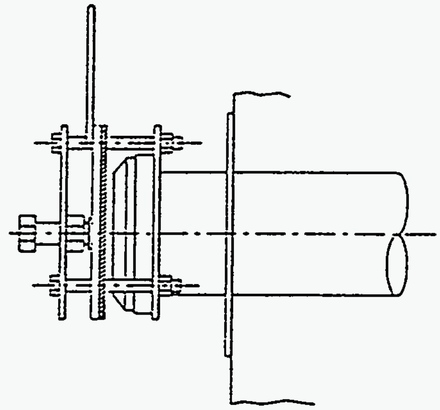
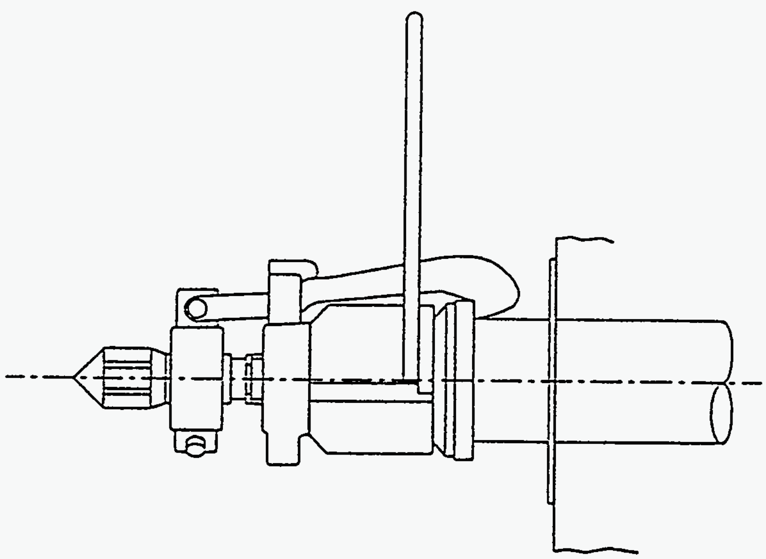


Figure 5-5. Remote Mechanical Seals.



REMOTE SEAL FOR CONNECTOR NOZZLE
(ISOLATED NON PRESSURE SERVICE)



HORIZONTAL OR VERTICAL BLANK CONNECTOR
(ISOLATED PRESSURE SERVICE)

5.3.1.6 Potential Failure Modes for Interim Isolation Weather Covers, Seals, and Gaskets. The sealing systems and isolation devices designed and installed in 106 existing interim isolated SSTs appear to be working well but are nearing the end of their design life. Exceptions are the seven SSTs undergoing liquid intrusion from unknown sources (see Section 5.3.1.5). Potential failure modes for the various components used to isolate the SSTs are as follows.

- **Weather Covers**

  Weather covers need inspecting annually to monitor deterioration from weathering, largely ultraviolet radiation. As the weather covers approach their design life of 20 years, replacement requirements to support extended schedules for intrusion prevention activities will need to be determined.

- **Floor Drain and Opening Seals**

  Rubber plugs backed up with sealing grout were used to form a sealing barrier in floor drains and openings. Potential radiation degradation of the rubber plugs could cause plug failure. Inspection of these rubber plugs for signs of failure is impractical given their location within weather-covered isolated structures.

- **Gaskets**

  Gaskets used in flanged connections located above ground deteriorate slowly through weathering (sun, heat, and oxidation). Most aboveground gasket installations can easily be inspected and replaced as required. Gaskets installed on existing SST risers may also fail prematurely due to high radiation exposure.

- **Remote Mechanical Seal Gaskets**

  The most common cause for failure of gaskets is their slow deterioration from exposure to radiation. Inspection of gaskets in the remote mechanical seals is complicated in many cases by the need to first remove weather covers to gain entry. Destruction and replacement of the weather covers may make gasket inspections too costly to implement until weather covers also need replacement.

5.3.1.7 Maintenance Concerns for Damaged Weather Covers. When existing weather covers on interim isolated facilities require replacement because of facility reentry or damage from inadvertent abuse or accidents, considerable amounts of contaminated silicone rubber/polyurethane waste are generated during decommissioning of the covers. To minimize this waste, alternative reusable covers are being considered that are made from durable metals and plastics. Bryce Reynolds (WHC) proposes to use form fitted, removable hypalon or aluminum weather covers as replacement for silicone rubber/polyurethane once its integrity has been lost. These proposed new weather coverings appear to be a cost effective method for permitting multiple reentry into pits and boxes for maintenance and operations without the destruction of the covers and the generation of large amounts of waste. Life expectancies for aluminum and hypalon covers are also considerably beyond that anticipated for the silicone rubber/polyurethane foam covers. Operational concerns associated with the replacement of silicone rubber/polyurethane weather covers are as follows.

- The silicone rubber/polyurethane spraying process involves handling of hazardous materials.
- The spraying of polyurethane can generate a large static electrical charge.
- The spraying process is labor intensive and requires a dedicated staff.
- Toxic fumes may be present during and after the application of polyurethane.
- Continuous training of maintenance personnel is required.
- Continued usage of silicone rubber/polyurethane for replacement of weather covers will add significantly to the volume of future solid waste that must be processed.

5.3.2 Intrusion Prevention Activities

In June 1993, the designation term interim isolated was replaced by intrusion prevention. The Tank Farm Surveillance and Waste Status Summary Report for January 1994 (WHC 1994) states: "Intrusion prevention is the administrative designation reflecting the completion of the physical effort required to minimize the addition of liquids into an inactive storage tank, process vault, sump, catch tank, or diversion box. Under no circumstances are electrical or instrumentation devices disconnected or disabled during the intrusion prevention process (with the exception of the electrical pump), in accordance with WHC-SD-WM-SAR-006, Rev. 2, "Single-Shell Tank Isolation Safety Analysis Report," March 1986 (WHC 1986c).

In this section, past efforts to interim isolate (intrusion prevent) SSTs are examined with the intent to identify areas where further actions might be taken to increase the level of liquid intrusion prevention.

The criteria used for past design activities to interim isolate (intrusion prevention) utilized a one-barrier concept to isolate out-of-service SST tank farm facilities. Intrusion prevention as defined above suggests single barriers used to isolate facilities may not be adequate to serve future intrusion prevention activities. Future such activities should include using a combination of barrier designs to ensure all existing accesses (pathways) are sealed to potential liquid intrusion into isolated SST farm facilities.

Selected drawings (for seven SSTs) were collected that illustrate the previous efforts to interim isolate or intrusion prevent SSTs. The drawings which summarized intrusion prevention efforts for the tanks of interest were reviewed along with their related engineering change notices. From these drawings, a list of the prominent penetration routes into each of the tanks studied was developed (see Appendix A). Each penetration route was examined for current intrusion prevention measures and was evaluated for further measures that could increase the level of intrusion prevention (see Appendix B). For those penetration routes in which access to the penetration was obviously not feasible due to radiological and/or financial constraints, further investigations were terminated (such as tank nozzles 23 feet below grade e.g.).

Each activity intended to increase the level of intrusion prevention was then evaluated and ranked based on the relative improvement it provided (see Appendix C). For example, the benefit of installing a nozzle seal to isolate a SST line that connected to an operational diversion box was ranked higher in benefit than installing a similar nozzle seal onto a line that connected to a thoroughly isolated flush pit.

5.3.2.1 List of Additional Recommended Intrusion Prevention Actions. Based on study findings as developed and discussed for seven selected tanks in Appendices B and C, the following additional intrusion prevention actions are recommended for implementation where possible in all transfer/diversion boxes and SSTs.

- Transfer/diversion boxes located on active cross-site transfer system may require intrusion prevention actions as described below.
  - If a leak detection device exists, verify it works.
  - If missing, add leak detection device to box.
  - Seal all transfer/diversion box nozzles connected to existing pipe lines routed to and from isolated SST Tank Farm. (Note: Ongoing SST interim stabilization efforts, e.g., salt well pumping may require interim usage of specific existing piping between SST tank arm and the transfer/diversion box prior to completing all intrusion prevention activities.)
- Diversion boxes located on or near existing out-of-service SST tank farms may require additional intrusion prevention actions as follows.
  - If a leak detection device exists and is accessible, verify that it works.

  - Add a leak detection device to diversion boxes not currently weather covered. This action would detect potential liquid intrusions within an isolated diversion box.

  - Seal all nozzles and floor drains located within all diversion boxes not currently weather covered. This action would eliminate potential liquid intrusion pathways via deteriorating piping systems connected to unsealed floor drains and wall nozzles.

  - Provide an observation opening for inspection and maintenance of leak detection devices for all diversion boxes not currently weather covered.

  - If existing isolated SST farm diversion boxes weather covers are to be replaced in the future, one may complete the above intrusion prevention actions prior to reinstalling a new weather cover. (Note: The proposed sealing of all existing floor drains and wall nozzles not currently sealed would minimize potential pathways for liquid intrusion into isolated diversion boxes.)

- SSTs have various accesses (see Section 5.3.1.3) located on or near existing out-of-service SSTs which may require additional intrusion prevention actions describe below.

  - If a leak detection device exists and is accessible, verify that it works.

  - Add a leak detection device to underground structures (pump pits, sluice pits, etc.) not currently weather covered. This action would detect potential liquid intrusions within an isolated structure.

  - Seal all nozzles and floor drains located within underground structures (pump pits, sluice pits, etc.) not currently weather covered. This action would eliminate potential liquid intrusion pathways via deteriorating piping systems connected to unsealed floor drains and nozzles.

  - Provide an observation opening for inspection and maintenance of leak detection devices for all underground structures (pump pits, sluice pits, etc.) not currently weather covered.

  - If existing isolated underground structures (pump pits, sluice pits, etc.) weather covers are to be replaced in the future, one may complete the above intrusion prevention actions prior to reinstalling a new weather cover. (Note: The proposed sealing of all existing floor drains and nozzles not currently sealed would minimize potential pathways for liquid intrusions into isolated structures.)

5.3.2.2 Cost/Benefit Evaluations. The efforts previously conducted and depicted within the drawing reviewed were found to quite thorough, though minimalistic. The suggested improvements listed within this report must therefore be weighed accordingly. The decision whether to perform specific activities listed herein must be based on numerous factors including available money, degree of risk to the worker and/or the environment, and the degree of improved intrusion prevention resulting from the change.

Appendix A is a list of the previously implemented interim isolation/intrusion prevention activities for seven tanks shortly to be salt well pumped and intrusion prevented. It is based on available drawings. Those items marked with an asterisk (*) in the drawings are identified as future interim isolation activities to be performed once salt well pumping activities have been completed. For the purpose of this study, salt well pumping activities are considered complete for the tank and the asterisked isolation activities completed. Additional intrusion prevention activities are identified and evaluated to determine those that can be safety and cost effectively implemented. These are in addition to the minimalistic interim isolation activities originally accomplished or remaining to be accomplished as asterisked items on drawings for tanks that have yet to be salt well pumped.

Appendix B is an in-depth assessment of the additional intrusion activities that could be accomplished to ensure there is no liquid intrusion into SSTs. Seven SSTs are selected for in-depth analysis representing all SSTs: BX-107, -109, -110, -111, -112; and BY-102 and BY-109. They are also scheduled to be salt well pumped in Fiscal Year 1994 and 1995 and will need to be intrusion prevented reasonably soon thereafter. From these in-depth studies and the cost/benefit assessment, the generic recommended intrusion prevention activities were developed along with the practicality of the activity with respect to the tank farm.

Appendix C is a first cut evaluation of the cost and benefit of performing the intrusion prevention activities identified within this study. Where possible, costs are listed in total dollars needed to perform the activity. Relative benefit has been given a value between 1 and 5, based on the comparative effectiveness and practicality of the identified activity. When viewed together, the cost and benefit are evaluated, and a cost/benefit weighed value is designated for each activity. Those activities having low impact on cost, safety, etc. while improving the level of intrusion prevention are recommended. Those activities having high cost, safety, etc., impacts are not recommended. Categories, which fall between extremes and are too close to call with the available information, must be evaluated by the customer in light of resources and programmatic goals before proceeding with implementation.

5.3.3 Intrusion Prevention Storage Mode Monitoring Requirements

The monitoring of SSTs requires a minimum of the following:

- In-tank temperatures monitored by a temperature probe mounted on an existing tank riser. As a minimum, the temperature probe (thermocouple tree) needs to have one thermocouple located within the tank vapor space and one located in the salt cake/sludge. A SST with a large volume of waste may require a thermocouple tree design that locates several temperature sensors within the existing salt cake/sludge waste to ensure safe storage of wastes. The in-tank temperature sensors should be connected to the Tank Monitor and Control System to permit automatic temperature reading to be collected, maintained, and recorded.

- Flow indicator control (FIC)-type gauges (manual or automated) to measure waste surface levels. Depth is determined by lowering an electrically charged calibrated metal tape until contact with the level is indicated by current flow through the SST wall. The FIC gauge enclosure is mounted on a SST riser located above grade. (Note: The automated FICA gauge is connected to a Computer Automated Surveillance System for monitoring).

- Manual tapes to measure surface level changes in waste within a SST (backup system). These tapes are mounted on existing above grade SST risers and are manually lowered until they contact the waste, i.e., make electrical contact.

- Liquid Observation Well (LOW) System to measure interstitial liquid levels. The LOW consists of a 3 inch inside diameter fiberglass dry well that extends above grade and down through an SST riser and the tank waste to within 1.5 feet of the tank bottom. Three different types of probes are lowered into the fiberglass wells on a calibrated cabling system: gamma, neutron, and acoustic probes. The cabling system and associated electronics are mounted on a mobile van that can be driven from drywell to drywell. (Note: the Hanford LOW System is designed as an intermittent monitoring system for intrusion prevention. It can gauge a change in interstitial liquid level [possible liquid intrusion] to an accuracy of approximately 0.1 foot).

- Observation port for taking in-tank photographs (aboveground, 12-inch diameter SST risers). In-tank photographs can aid in resolving in-tank measurement anomalies and help determine whether salt cake/sludge and liquid level changes are caused by liquid intrusion.

- Characterization and sampling port for taking samples of liquid and solid waste. Dedicated tank risers through which sampling equipment can be operated to grab liquid samples or core solid wastes.

6.0 NO ACTION STRATEGY (CONTINUED INTERIM STORAGE OF SSTs)

The SST waste stabilization program is intended to reduce the liquid fraction of wastes to the greatest extent technically and economic extent possible. Its purpose is to minimize the risk of exposure to the environment should a tank failure occur. The liquid intrusion prevention program is intended to isolate the interim stabilized waste and prevent its destabilization through in-leakage of liquids into the tank. The ultimate purpose is to minimize to the extent practicable the risk from releases of hazardous liquids into the environment. No action, i.e., continuing the present status of partially isolated SSTs and their stored unstabilized wastes would result in a noncompliance condition. To remain compliant, waste management plans for SSTs and their waste; intrusion prevented tank; monitored waste storage until the wastes can be retrieved and processed into a suitable safe geological form and disposed. Decontamination and decommissioning of SSTs and their respective sites to an acceptable safe level of hazard will follow as part of the *Resource Conservation and Recovery Act* (RCRA) cleanup program. Continuing the present status of no action for interim storage of SST wastes with unstabilized waste as well as partially isolated tanks, would violate current Tri-Party Agreement milestones with the Washington State Department of Ecology. A failure to achieve the agreed milestone completion date will cause the facility to be categorized as non compliant.

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7.0 REFERENCES

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APPENDIX A

IMPLEMENTED AND PLANNED INTERIM ISOLATION/INTRUSION PREVENTION ACTIVITIES FOR SEVEN SELECTED SINGLE-SHELL TANKS

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The status of current SST piping and associated equipment is listed in detail in this Appendix for seven selected SSTs that were only partially interim isolated to allow future salt well pumping (waste stabilization). This information was used to determine the following: (1) the extent to which interim isolation/intrusion prevention had been accomplished for each SST, (2) the plans to finish interim isolation activities (shadowed areas on drawings), and (3) additional intrusion prevention actions that could cost effectively and safely be implemented to further ensure isolation of SSTS from inadvertent liquid intrusions during the interim storage of wastes.

A.1 CURRENT STATUS OF TANK BX-107 ISOLATION ACTIVITIES DRAWING H-2-73318 (WHC 1988a)

Interim isolation/intrusion prevention activities completed and planned for completion after salt well pumping Tank 241-BX-107 are described in the following subsections.

A.1.1 Completed Interim Isolation Activities for 241-BX-107 Tank Penetrations

- From 244-BX receiver vault

1 1/4-in. SN-215-M25	2 in. connector nozzle seal installed per H-2-73453 (WHC 1985c)
1 1/4-in. SN-216(217)-M25	2 in. connector nozzle seal installed per H-2-73453

- From diversion box 241-BX-153 Weather covered

  V-345 (Left as is)
  V-346 (Left as is)
  V-347 (Left as is)
  V-348 (Left as is)

• 4-in. nozzle BX-N-5 grade	Left as is - overflow nozzle approx 23 feet below
• 4-in. riser BX-R-1	Left as is to accommodate salt well pumping efforts
• 12-in. riser BX-R-2	Air filter installed - Air filter enables tank to "breathe" and filter out contaminants
• 12-in. riser BX-R-3	Blind flange installed per Detail I, H-2-73450 (WHC 1993b)

• 4-in. riser BX-R-4	Left as is - temperature probe needed to monitor tank temperature
• 4-in. riser BX-R-5	Thermometer removed and blind flange installed per Detail I, H-2-73450
• 12-in. riser BX-R-6	Observation port installed
• 12-in. riser BX-R-7	Dip tubes removed and blind flange installed per Detail I, H-2-73450
• 4-in. riser BX-R-8	Left as is - FIC needed to detect possible intrusion into the tank and for verifying any tank leakage
• 42-in. riser BX-R-9	Left as is - manhole below grade at dome's surface
• 42-in. riser BX-R-10	Left as is - manhole below grade at dome's surface
• 4-in. riser BX-R-11	Left as is to accommodate salt well pumping efforts
• 4-in. riser BX-R-13	Left as is to accommodate salt well pumping efforts
• Weight factor enclosure	Left as is to accommodate salt well pumping efforts
• 2-in. transfer line U-2	Left as is to accommodate salt well pumping efforts

A.1.2 Planned 241-BX-107 Interim Isolation Activities Upon Completion of Salt Well Pumping Activities

• 4-in. riser BX-R-1	Caisson cut 12-in. below grade and backfilled with loadbearing fill
• 4-in. riser BX-R-11	Caisson cut 12-in. below grade and backfilled with loadbearing fill
• 12-in. riser BX-R-13	Salt well pump pit isolated and covered with a weather cover

•	Weight factor enclosure	Instrument enclosure removed, all pipes cut 2-in. above concrete and capped

A.1.3 Further Suggested Intrusion Prevention Actions

•	From diversion box 241-BX-153	
	V-345	Install 3-in. connector nozzle & seal horizontal assembly 2 per H-2-73453
	V-346 V-347 V-348	
•	Diversion box detector	When the entire farm is ready for intrusion prevention, install a leak detection device

A.2 CURRENT STATUS OF TANK 241-BX-109 ISOLATION ACTIVITIES - DRAWING H-2-73319 (WHC 1988c)

Interim isolation activities completed and planned for completion after salt well pumping Tank 241-BX-109 are described in the following subsections.

A.2.1 Completed Interim Isolation Activities for 241-BX-109 Tank Penetrations

•	From diversion box 241-BX-153 weather covered	
	V-345	Left as is - connect to 3-in. nozzle BX-N-4
•	3-in. nozzle BX-N-1	Left as is - spare nozzle approx 23 feet below grade
•	3-in. nozzle BX-N-2	Left as is - spare nozzle approx 23 feet below grade
•	3-in. nozzle BX-N-3	Left as is - spare nozzle approx 23 feet below grade
•	3-in. nozzle BX-N-5	Left as is - overflow nozzle approx 23 feet below grade
•	3-in. nozzle BX-N-6	Left as is - inlet nozzle approx 23 feet below grade

• 4-in. nozzle BX-R-1	Spool piece removed, blind flange installed per Detail I, H-2-73450
• 12-in. riser BX-R-2	Left as is
• 12-in. riser BX-R-3	Left as is - temperature probe needed to monitor tank temperature
• 4-in. riser BX-R-4	Air filter installed per H-2-73450 - air filter enables tank to "breathe" and filter out contaminants
• 4-in. riser BX-R-5	Left as is - temperature probe needed to monitor tank temperature
• 12-in. riser BX-R-6	Spool piece removed, blind flange installed per Detail I, H-2-73450
• 12-in. riser BX-R-7	Observation port installed per H-2-93726 (WHC 1985a)
• 4-in. riser BX-R-8	Left as is - FIC needed to detect possible intrusion into tank and for verifying any tank leakage
• 42-in. riser BX-R-9	Left as is - manhole below grade at dome's surface
• 12-in. riser BX-R-13	Left as is to accommodate saltwell pumps efforts
• Weight factor enclosure	Left as is to accommodate salt well pumping efforts
• 2-in. transfer line U-1	Weight factor order
• Condenser hatchway	Covered with a weather cover per H-2-73634, Sheet 7 (WHC 1984b)
• 1 1/2-in. RW-M-35	Abandoned per H-2-70826 (WHC 1981)
• Electrical pull box	Remains active
• 18-in.- dia vent duct	Reference H-2-36780 (WHC 1973)
• Pit drain	Left as is

• 1 1/2-in. M-35 transfer line	1 1/2-in. cap per H-2-70889 (WHC 1983)
• 1 1/2-in. M-35	1 1/2-in. cap per H-2-70889
• Phosphoric controller leak detector station	Electrical equipment removed, cut flush, plugged and grouted per Detail 7 on H-2-73451 (WHC 1986a)

A.2.2 Planned 241-BX-109 Interim Isolation Activities to be Completed after Salt Well Pumping

• 12-in. riser BX-R-13	Salt well pump pit isolated and covered with a weather cover
• Weight factor enclosure	Instrument enclosure removed, all pipes cut 2-in. above concrete and capped
• 2-in. transfer line U-1	Cut and capped

A.2.3 Further Suggested Intrusion Prevention Actions

• Diversion box 241-BX-153	
V-345	Install 3-in. connector nozzle seal horizontal assembly 2 per H-2-73453
• Diversion box detector	When the entire farm is ready for intrusion prevention, install a leak detection device
• 12-in. riser BX-R-2	Install blind flange per Detail I, H-2-73450
• 12-in. riser BX-R-3	Remove temperature probe, install blind flange per Detail 1, H-2-73450
• Condenser hatchway	Install a leak detection device
• Pit drain	Plug drain per H-2-71893 (WHC 1978)
• Pump pit	Install a leak detection device

A.3 CURRENT STATUS OF TANK 241-BX-110 ISOLATION ACTIVITIES - DRAWING H-2-73312 (WHC 1988d)

Interim isolation activities completed and planned for completion after salt well pumping Tank 241-BX-110 are described in the following subsections.

A.3.1 Completed Interim Isolation Activities for 241-BX-110 Tank Penetrations

- From 244-BX Receiver Vault

1 1/4-in. SN-216-M25	2-in. connector nozzle seal installed per H-2-73453

- From diversion box 241-BX-153 weather covered

V-342	3-in. connector nozzle seal installed per H-2-73453
V-343	3-in. connector nozzle seal installed per H-2-73453
V-344	3-in. connector nozzle seal installed per H-2-73453

• 4-in. nozzle BX-N-1	Left as is - spare nozzle approx 23 feet below grade
• 4-in. nozzle BX-N-5	Left as is - overflow nozzle approx 23 feet below grade
• 4-in. riser BX-R-1	Left as is - temperature probe needed to monitor tank temperature
• 12-in. riser BX-R-2	Left as is - liquid level reel required to detect possible intrusion into the tank and for verifying tank leakage
• 12-in. riser BX-R-3	Observation port installed per H-2-93726
• 4-in. riser BX-R-4	Air filter installed per H-2-73450 - air filter needed to allow tank to "breathe" and filter out contaminants
• 4-in. riser BX-R-5	Regasketed

• 12-in. riser BX-R-6	Blind flange installed per Detail 1, H-2-73450
• 12-in. riser BX-R-7	Left as is - pump remains within weather covered pump pit
• 4-in. riser BX-R-8	Left as is - within weather covered pump pit
• 12-in. riser BX-R-13	left as is to accommodate saltwell pumping efforts
• 42-in. riser BX-R-14	Left as is - manhole below grade at dome's surface
• 42-in. riser BX-R-15	Left as is - manhole below grade at dome's surface
• Flush pit	3-in. drain plugged per H-2-71893, valves removed and lines blanked, caisson cut 12-in. below grade and filled with loadbearing fill
• Pump pit	3-in. drain left as is, weather cover installed per H-2-73631
• Weight factor enclosure	Left as is to accommodate salt well pumping efforts
• 2-in. transfer line U-1 (R-13)	Left as is to accommodate salt well pumping efforts
• 3-in. nozzle U-1 (pump pit)	Left as is - within weather covered pump pit
• 3-in. nozzle U-2 (pump pit)	Left as is - within weather covered pump pit
• 3-in. nozzle U-3 (pump pit)	Nozzle seal installed per H-2-73453
• 3-in. nozzle U-4 (pump pit)	Left as is - within weather covered pump pit
• 2-in. nozzle U-5 (pump pit)	Left as is - within weather covered pump pit

A.3.2 Planned 241-BX-110 Interim Isolation Activities to be Completed after Salt Well Pumping

• 12-in. riser BX-R-13	Salt well pump pit isolated and covered with a weather cover

•	Weight factor enclosure	Instrument enclosure removed, all pipes cut 2-in. above concrete and capped
•	2-in. transfer line U-1 (R13)	Cut and capped

A.3.3 Further Suggested Intrusion Prevention Actions

•	Diversion box 241-BX-153	
	Diversion box detector	Install a leak detection device after tank farm intrusion prevented
•	12-in. riser BX-R-7	Remove pump and install blind flange per H-2-73450
•	4-in. riser BX-R-8	Install blind flange per H-2-73450
•	Pump pit	Plug 3-in. drain per H-2-71893, install a leak detection device
•	3-in. nozzle U-1 (pump pit)	Install nozzle seal assembly per H-2-73453
•	3-in. nozzle U-2 (pump pit)	Install nozzle seal assembly per H-2-73453
•	3-in. nozzle U-4 (pump pit)	Install nozzle seal assembly per H-2-73453
•	2-in. nozzle U-5 (pump pit)	Install nozzle seal assembly per H-2-73453

A.4 CURRENT STATUS OF TANK 241-BX-111 ISOLATION ACTIVITIES - DRAWING H-2-73313

Interim isolation activities completed and planned for completion after salt well pumping Tank 241-BX-11 are described in the following subsection.

A.4.1 Completed Interim Isolation Activities for 241-BX-111 Tank Penetrations

•	From 244-BX receiver vault	
	1 1/4-in. SN-215-M25	2-in. connector nozzle seal installed per H-2-73453

• 3-in. nozzle BX-N-1	Left as is - spare nozzle approx 23 feet below grade
• 3-in. nozzle BX-N-2	Left as is - spare nozzle approx 23 feet below grade
• 3-in. nozzle BX-N-3	Left as is - spare nozzle approx 23 feet below grade
• 3-in. nozzle BX-N-4	Left as is - spare nozzle approx 23 feet below grade
• 3-in. nozzle BX-N-5	Left as is - overflow nozzle approx 23 feet below grade
• 3-in. nozzle BX-N-6	Left as is - overflow nozzle approx 23 feet below grade
• 4-in. riser BX-R-1	Left as is - Thermocouple probe needed to monitor tank temperature
• 4-in. riser BX-R-2	Left as is - liquid level reel required to detect possible intrusion into tank and for verifying any tank leakage
• 12-in. riser BX-R-3	Observation port installed per H-2-93726
• 4-in. riser BX-R-4	Air filter installed per H-2-73450 - air filter enables tank to "breathe" and filter out contaminants
• 4-in. riser BX-R-5	Liquid Observation Well installed as part of project B-436
• 12-in. riser BX-R-6	Blind flange installed per Detail 1 as per H-2-93726
• 12-in. riser BX-R-7	Left as is - pump remains within weather covered pump pit
• 4-in. riser BX-R-8	Left as is - within weather covered pump pit
• 12-in. riser BX-R-13	Left as is to accommodate saltwell pumping efforts

•	42-in. riser BX-R-14	Left as is - manhole below grade at dome's surface
•	42-in. riser BX-R-15	Left as is - manhole below grade at dome's surface
•	Flush pit	3-in. drain plugged per H-2-71843 (WHC 1977), valves removed and lines blanked, caisson cut 12-in. below grade and filled with load-bearing fill
•	Pump pit	Drains left as is, weather cover installed per H-2-73631
•	Weight factor	Left as is to accommodate salt well pumping efforts
•	2-in. transfer line U-1 (R13)	Left as is to accommodate salt well pumping efforts
•	3-in. nozzle U-1 (pump pit)	Left as is - within weather covered pump pit
•	3-in. nozzle U-2 (pump pit)	Left as is - within weather covered pump pit
•	3-in. nozzle U-3 (pump pit)	Left as is - within weather covered pump pit
•	3-in. nozzle U-4 (pump pit)	Nozzle seal installed per H-2-73453
•	2-in. nozzle U-5 (pump pit)	Left as is - within weather covered pump pit

A.4.2 Planned 241-BX-111 Interim Isolation Activities to be Completed after Salt Well Pumping

•	12-in. riser BX-R-13	Salt well pump pit isolated and covered with a weather cover
•	Weight factor enclosure	Instrument enclosure removed, all pipes cut 2-in. above concrete capped
•	2-in. transfer line U-1 (R13)	Cut and capped

A.4.3 Further Suggested Intrusion Prevention Actions

- 12-in. riser BX-R-7 — Remove pump and install blind flange per H-2-73450
- 4-in. riser BX-R-8 — Install blind flange per H-2-73450
- Pump pit — Plug 3-in. drain per H-2-71843, plug 4-in. drain similarly, install a leak detection device
- 3-in. nozzle U-1 (pump pit) — Install nozzle seal assembly per H-2-73453
- 3-in. nozzle U-2 (pump pit) — Install nozzle seal assembly per H-2-73453
- 3-in. nozzle U-3 (pump pit) — Install nozzle seal assembly per H-2-73453
- 2-in. nozzle U-5 (pump pit) — Install nozzle seal assembly per H-2-73453

A.5 CURRENT STATUS OF TANK 241-BX-112 ISOLATION ACTIVITIES - DRAWING H-2-73320 (WHC 1988f)

Interim isolation activities completed and planned for completion after salt well pumping Tank 241-BX-112 are described in the following subsections.

A.5.1 Completed Interim Isolation Activities for 241-BX-112 Tank Penetration

- From diversion box 241-BX-153 weather covered
- V-350 nozzle BX-N-4 — Left as is
- 3-in. nozzle BX-N-1 — Left as is - spare inlet nozzle approx 23 feet below grade
- 3-in. nozzle BX-N-2 — Left as is - spare inlet nozzle approx 23 feet below grade
- 3-in. nozzle BX-N-3 — Left as is - spare inlet nozzle approx 23 feet below grade
- 3-in. nozzle BX-N-5 — Left as is - overflow nozzle approx 23 feet below grade

•	3-in. nozzle BX-N-6	Left as is - inlet nozzle approx 23 feet below grade
•	4-in. riser BX-R-1	Left as is - thermocouple probe needed to monitor tank temperature
•	12-in. riser BX-R-2	Left as is
•	12-in. riser BX-R-3	Left as is
•	4-in. riser BX-R-4	Air filter installed per H-2-73450 - air filter enables tank to "breathe" and filter out contaminants
•	4-in. riser BX-R-5	Left as is - pit drain within weather covered pump pit
•	12-in. riser BX-R-6	Left as is - pump within weather covered pump pit
•	12-in. riser BX-R-7	Observation port installed per H-2-93726
•	4-in. riser BX-R-8	Left as is - FIC needed to detect possible intrusion into the tank and for verifying any tank leakage
•	12-in. riser BX-R-13	Left as is to accommodate salt well pumping efforts
•	2-in. transfer line U-1 (R-13)	Left as is to accommodate salt well pumping efforts
•	Flush pit	Drain plugged per H-2-71843, caisson cut 12-in. below grade and filled with load-bearing fill
•	1 1/2-in. ST M2 (flush pit)	Left as is
•	1 1/2-in. RW M19 (flush pit)	Isolated per project B-139
•	Pump pit	Weather cover installed per H-2-73631 (WHC 1984c)
•	3-in. nozzle A (pump pit)	Left as is - pump pit covered with weather cover
•	3-in. nozzle B (pump pit)	Left as is - pump pit covered with weather cover

•	3-in. nozzle C (pump pit)	Left as is - pump pot covered with weather cover
•	2-in. nozzle D (pump pit)	Left as is - pump pit covered with weather cover
•	2-in. nozzle E (pump pit)	Left as is - pump pit covered with weather cover
•	Condenser hatchway	Weather cover installed per H-2-73634, Sheet 7
•	Weight factor enclosure	Left as is to accommodate salt well pumping efforts
•	2-in. transfer line U-2	Left as is to accommodate salt well pumping efforts
•	Heat trace controller	Electrical equipment removed, conduit cut and capped 1 foot below grade per Detail A or E, H-2-71842 (WHC 1985b)
•	Heat trace control system	Electrical equipment removed, conduit cut flush with concrete plug and grouted per Detail 7 on H-2-73451
•	Steam trap	Left as is

A.5.2 Planned 241-BX-112 Interim Isolation Activities to be Completed after Salt Well Pumping

•	12-in. riser BX-R-13	Salt well pump pit isolated and covered with a weather cover
•	2-in. transfer line U-1 (R13)	Cut and capped
•	Weight factor enclosure	Instrument enclosure removed, all pipes cut 2-in. above concrete and capped
•	2-in. transfer line U-2	Cut and capped

A.5.3 Further Suggested Intrusion Prevention Actions

- Diversion box 241-BX-153

V-350	Install 3-in. connector nozzle seal horizontal assembly 2 per H-2-73453
Diversion box detector	When the tank farm is ready for intrusion prevention, install a leak detection device

• 12-in. riser BX-R-2	Install blind flange per Detail I, H-2-73450
• 12-in. riser BX-R-3	Install blind flange per Detail I, H-2-73450
• 4-in. riser BX-R-5	Plug drain per H-2-71843
• 12-in. riser BX-R-6	Remove pump and install blind flange per H-2-73450
• 1 1/2-in. ST M2 (flush pit)	Cut and cap
• 3-in. nozzle A (pump pit)	Install nozzle seal assembly 5 per H-2-73453
• 3-in. nozzle B (pump pit)	Install nozzle seal assembly 5 per H-2-73453
• 3-in. nozzle C (pump pit)	Install nozzle seal assembly 5 per H-2-73453
• 2-in. nozzle D (pump pit)	Install nozzle seal assembly 5 per H-2-73453
• 2-in. nozzle E (pump pit)	Install nozzle seal assembly 5 per H-2-73453
• Flush pit	Install a leak detection device
• Pump pit	Install a leak detection device
• Condenser hatchway	Install a leak detection device

A.6 CURRENT STATUS OF TANK 241-BY-102 ISOLATION ACTIVITIES - DRAWING H-2-73244 (WHC 1988g)

Interim isolation activities completed and planned for completion after salt well pumping Tank 242-BY-102 are described in the following subsections.

A.6.1 Completed Interim Isolation Activities for 241-BY-102 Tank Penetrations

- 4-in. riser BY-R-1 — Liquid Observation Well installed as part of project B-436, see H-2-93715 (WHC 1984a)
- 4-in. riser BY-R-2 — Left as is - covered with concrete
- 4-in. riser BY-R-3 — Left as is to accommodate salt well pumping efforts
- 4-in. riser BY-R-4 — Left as is - sludge level tape needed to detect possible intrusion into the tank and for verifying any tank leakage
- 12-in. riser BY-R-5 — Left as is - liquid level reel needed to detect possible intrusion into the tank and for verifying any tank leakage
- 12-in. riser BY-R-6 — Left as is - covered with concrete
- 12-in. riser BY-R-7 — Left as is to accommodate salt well pumping efforts
- 12-in. riser BY-R-8 — Left as is - covered with concrete
- 42-in. riser BY-R-9 — Left as is - Adapter plate
- 12-in. riser BY-R-9A — Left as is
- 42-in. riser BY-R-10 — Left as is - Adapter plate
- 12-in. riser BY-R-10A — Observation port installed per H-2-93726
- 42-in. riser BY-R-11 — Left as is
- 42-in. riser BY-R-12 — Left as is - Adapter plate
- 12-in. riser BY-R-12A — Left as is
- 42-in. riser BY-R-13 — Left as is
- 4-in. riser BY-R-14 — Air filter installed pre H-2-73450 - air filter enables tank to "breathe" and filter out contaminants

•	3-in. nozzle BY-N-1	Left as is - inlet nozzle plugged
•	3-in. nozzle BY-N-2	Left as is - spare nozzle plugged
•	3-in. nozzle BY-N-3	Left as is - spare nozzle approx 23 feet below grade
•	3-in. nozzle BY-N-4	Left as is - spare nozzle approx 23 feet below grade
•	3-in. nozzle BY-N-5	Left as is - spare nozzle approx 23 feet below grade
•	3-in. nozzle BY-N-6	Left as is - outlet nozzle plugged
•	Pump pit BY-R-02A	2-in. floor drain left as is, weather cover installed per H-2-73634, Sheet 8
•	4-in. nozzle U-1 (pump pit)	Left as is - sealed in Diversion Box BY-R-152
•	2-in. nozzle U-2 (pump pit)	Left as is - used for salt well pumping
•	2-in. nozzle U-3 (pump pit)	Left as is - blanked
•	4-in. nozzle U-4 (pump pit)	Left as is
•	4-in. nozzle U-5 (pump pit)	Plugged with rubber ball seal and filled with non shrinkage grout per Detail 6, H-2-73450
•	4-in. nozzle U-6 (pump pit)	Plugged with rubber ball seal and filled with non shrinkage grout per Detail 6, H-2-73450
•	4-in. nozzle U-7 (pump pit)	Plugged with rubber ball seal and filled with nonshrinkage grout per Detail 6, H-2-73450
•	3-in. nozzle U-8 (pump pit)	Left as is
•	Flush pit	Drain plugged, existing lines cut and blanked, backfilled with load-bearing fill
•	Sluice pit BYR-02C	2-in. floor drain left as is, weather cover installed per H-2-73634, Sheet 8
•	4-in. nozzle U-1 (sluice pit)	Left as is - sealed in diversion box BYR-152

• 4-in. nozzle U-2 (sluice pit)	Left as is - sealed in diversion box BYR-152
• 4-in. nozzle U-3 (sluice pit)	Left as is - blanked
• 2-in. nozzle U-4 (sluice pit)	Horizontal nozzle seal assembly installed per H-2-73453-3
• 2-in. nozzle U-5 (sluice pit)	Horizontal nozzle seal assembly installed per H-2-73453-3
• 4-in. nozzle U-6 (sluice pit)	Plugged per Detail 6, H-2-73450
• Sluice pit BYR-02D	2-in. floor drain left as is, weather cover installed per H-2-73634, Sheet 8
• 4-in. nozzle U-2 (sluice pit)	Left as is - sealed in diversion box BYR-152
• 4-in. nozzle U-3 (sluice pit)	Left as is - blanked
• 3-in. nozzle U-4 (sluice pit)	Left as is - blanked in flush pit
• 4-in. nozzle U-5 (sluice pit)	Left as is
• 2-in. nozzle U-6 (sluice pit)	Plugged per Detail 6, H-2-73450
• 2-in. nozzle U-7 (sluice pit)	Left as is - blanked in Tank 302, see H-2-73243 (WHC 1988B)
• 3-in. nozzle U-8 (sluice pit)	Plugged per Detail 6, H-2-73450
• 4-in. nozzle U-9 (sluice pit)	Plugged per Detail 6, H-2-73450
• Instrument pit	Weather cover installed per H-2-73634, Sheet 8
• Riser pit (South)	2-in. Floor drain left as is, weather cover installed per H-2-73634, Sheet 8
• Riser pit (North)	3-in. Floor drain left as is, weather cover installed per H-2-73634, Sheet 8
• I & E Enclosure Base	Equipment removed, filled with concrete to seal all lines

A.6.2 Planned 241-BY-102 Interim Isolation Activities to be Completed after Salt Well Pumping

- 4-in. riser BY-R-3 — Drain isolated at completion of salt well pumping effort
- 12-in. riser BY-R-7 — Salt well pump pit isolated and covered with a weather cover

A.6.3 Further Suggested Intrusion Prevention Actions

- 12-in. riser BY-R-9A — Flange per Detail I, H-2-73450
- 42-in. riser BY-R-11 — Install blind flange per H-2-73450
- 12-in. riser BY-R-12A — Flange per Detail I, H-2-73450
- 42-in. riser BY-R-13 — Install blind flange per H-2-73450
- Pump pit BYR-02A — Plug drain per H-2-71843, install a leak detection device
- 4-in. nozzle U-1 (pump pit) — Install nozzle seal assembly per H-2-73453
- 2-in. nozzle U-2 (pump pit) — Install nozzle seal assembly per H-2-73453
- 4-in. nozzle U-4 (pump pit) — Install nozzle seal assembly per H-2-73453
- 3-in. nozzle U-8 (pump pit) — Install nozzle seal assembly per H-2-73453
- Sluice pit BYR-02C — Plug drain per H-2-71843, install a leak detection device
- 4-in. nozzle U-1 (sluice pit) — Install nozzle seal assembly per H-2-73453
- 4-in. nozzle U-2 (sluice pit) — Install nozzle seal assembly per H-2-73453
- Sluice pit BYR-02D — Plug drain per H-2-71843, install a leak detection device
- 4-in. nozzle U-2 (sluice pit) — Install nozzle seal assembly per H-2-73453
- 3-in. nozzle U-4 (sluice pit) — Install nozzle seal assembly per H-2-73453

- 4-in. nozzle U-5 (sluice pit) Install nozzle seal assembly per H-2-73453
- 2-in. nozzle U-7 (sluice pit) Install nozzle seal assembly per H-2-73453
- Instrument pit — Install a leak detection device
- Riser pit (South) — Plug drain per H-2-71843, install a leak detection device
- Riser pit (North) — Plug drain per H-2-71843, install a leak detection device

A.7 CURRENT STATUS OF TANK 241-BY-109 ISOLATION ACTIVITIES - DRAWING H-2-73253 (WHC 1986b)

Interim isolation activities completed and planned for completion after salt well pumping Tank 241-BY-109 are described in the following subsections.

A.7.1 Completed Interim Isolation Activities for 241-BY-109 Tank Penetrations

- 4-in. riser BY-R-1 — Left as is - riser is 3 feet + below grade
- 4-in. riser BY-R-2 — Left as is - pit drain within weather covered pump pit
- 4-in. riser BY-R-3 — Left as is - riser is 3 feet + below grade
- 4-in. riser By-R-4 — Left as is - FIC needed to detect possible intrusion into the tank and for verifying any tank leakage
- 4-in. riser BY-R-5 — Left as is - covered with concrete
- 12-in. riser BY-R-6 — Left as is to accommodate salt well pumping efforts
- 12-in. riser BY-R-7 — Left as is - covered with concrete
- 12-in. riser BY-R-8 — Left as is - covered with concrete
- 42-in. riser BY-R-9 — Left as is - adapter plate
- 12-in. riser BY-R-9A — Flanged per Detail I, H-2-73450

- 42-in. riser BY-R-10 — Left as is - adapter plate
- 12-in. riser BY-R-10A — Air filter installed pre H-2-90718 (WHC 1993a) - air filter enables tank to "breathe" and filter out contaminants
- 12-in. riser BY-R-10B — Observation port installed per H-2-93726
- 42-in. riser BY-R-11 — Riser cut to 6-in. below top of instrumentation pit, isolated per Detail 7, H-2-73450
- 42-in. riser BY-R-12 — Left as is - adapter plate
- 4-in. riser BY-R-12A — Equipment removed and blind flange installed per Detail 1, H-2-73450
- 12-in. riser BY-R-12B — Liquid Observation Well installed as part of project B-436, see H-2-93715
- 12-in. riser BY-R-12C — Equipment removed and flange installed per Detail I, H-2-73450, conduit capped 1 foot below grade
- 42-in. riser BY-R-13 — Left as is - pump within weather covered pump pit
- 3-in. nozzle BY-N-1 — Left as is - valve pit drain approx 22 feet below grade
- 3-in. nozzle BY-N-2 — Left as is - spare nozzle capped
- 3-in. nozzle BY-N-3 — Left as is - spare nozzle capped
- 3-in. nozzle BY-N-4 — Left as is - inlet nozzle approx 22 feet below grade
- 3-in. nozzle BY-N-5 — Left as is - inlet nozzle approx 22 feet below grade
- Pump Pit BY-09A — Pit drain left as is, weather cover installed per H-2-73634, Sheet 8
- 4-in. nozzle U-1 (pump pit) — Left as is
- 4-in. nozzle U-2 (pump pit) — Left as is - capped

- 4-in. nozzle U-3 (pump pit) Left as is
- 3-in. nozzle U-4 (pump pit) Left as is
- 2-in. nozzle U-5 (pump pit) Left as is
- 4-in. nozzle U-6 (pump pit) Left as is
- 2-in. nozzle U-7 (pump pit) Left as is
- 2-in. nozzle U-8 (pump pit) Left as is
- Weight factor enclosure — Left as is to accommodate salt well pumping efforts
- Instrument pit — Equipment removed from enclosure and filled with concrete to seal all lines, covered with ASTM-A36 cover plate, weather cover installed per H-2-73634, Sheet 8
- Condenser hatchway — Air intake stack removed and blind flanged, weather cover installed per H-2-73634, Sheet 8
- Valve pit — Weather cover installed per H-2-73634, Sheet 8

A.7.2 Planned 241-BY-109 Interim Isolation Activities to be completed after Salt Well Pumping

- 12-in. riser BY-R-6 — Salt well pump pit isolated and covered with a weather cover
- Weight factor enclosure — Instrument enclosure removed, all pipes cut 2-in. above concrete and capped

A.7.3 Further Suggested Intrusion Prevention Actions

- 4-in. riser BY-R-2 — Plug drain per H-2-71843
- 42-in. riser BY-R-13 — Remove pump and install blind flange per H-2-73450
- Pump Pit BY-09A — Plug drain per H-2-71843, install a leak detection device

- 4-in. nozzle U-1 (pump pit) Install nozzle seal assembly per H-2-73453
- 4-in. nozzle U-3 (pump pit) Install nozzle seal assembly per H-2-73453
- 3-in. nozzle U-4 (pump pit) Install nozzle seal assembly per H-2-73453
- 2-in. nozzle U-5 (pump pit) Install nozzle seal assembly per H-2-73453
- 4-in. nozzle U-6 (pump pit) Install nozzle seal assembly per H-2-73453
- 2-in. nozzle U-7 (pump pit) Install nozzle seal assembly per H-2-73453
- 2-in. nozzle U-8 (pump pit) Install nozzle seal assembly per H-2-73453
- Instrument pit Install a leak detection device
- Condenser hatchway Install a leak detection device
- Valve pit Install a leak detection device

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APPENDIX B

INTRUSION PREVENTION STRATEGIES/ACTIONS CONSIDERED

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B.1 LIST OF POSSIBLE INTRUSION PREVENTION ACTIONS

In addition to accomplished and planned interim isolation activities, further intrusions prevention strategies and/or activities are considered in this appendix for possible inclusion in activities recommended to be accomplished after interim waste stabilization (salt well pumping). Tank waste stabilization maintenance activities including supernate pumping of intrusion liquids may offer additional cost effective opportunities for further intrusion prevention activities. Possible intrusion prevention actions are considered and listed individually for each of the seven tanks and their associated diversion boxes. Viable intrusion prevention concepts and strategies are evaluated against safety and cost/benefit criteria to determine those meriting a recommendation to implement. The evaluation process is reported in Appendix C.

B.1.1 Tank Farm Diversion Boxes

- **241-BX-153 Diversion Box**

  According to available drawings, lines V-345, 346, 347, 348 and 350 have not been sealed. The lines lead from the diversion box to the SSTs 241-BX-107, 109, 110, 111 and 112, respectively. The sealing of these nozzles in the diversion box needs to be accomplished to prevent liquid draining from the diversion box to an individual tank or vicinity of the BX Tank Farm.

  When the BX Tank Farm complex is ready for intrusion prevention, i.e., the diversion box is no linger necessary for normal operations, the possibility of installing a leak detection device in the box should be evaluated. This would permit the early detection and removal of any accumulated liquids in the box and prevent drain back to the SSTs should the nozzle seals leak or the drain plugs fail. Other possibilities include weather proofing the box by grouting or filling with concrete or bentonite which makes decontamination and decommissioning more difficult and costly.

- **241-BY-152 Diversion Box**

  The lines to 241-BY-102 and 109 appear to have been capped. The possibility of installing a leak detection device or weather proofing the box should be explored as suggested above for diversion box 241-BX-153.

- **241-BX-107 Single-Shell Tank**

  Consideration was given to the possibility that the structure of the tank itself may be compromised due to extreme age. Tanks are being used considerably beyond their design life. To counteract the possibility of surface water (due to rain, snow, or inadvertent liquid discharges) penetrating the dome's surface or the walls of the tank, protection is being considered for continued long-term storage of waste. An impermeable membrane could be placed over the immediate tank site. This protective cover or roof should have a gradient sufficient to collect surface liquids to a common area and divert them elsewhere (via trench, gravity feed piping, or pump). For tanks that are known to be leakers or have had liquid intrusion, or where interim storage for SSTs will be extended into decades, this type of preventive action may be needed.

The interim isolation drawings 241-BX-107 do not show additional piping, risers and drains that need capping and/or plugging. Previous interim isolation actions appear thorough.

- **241-BX-109 Single-Shelled Tank**

As discussed for tank BX-107, a weather cover maybe needed for long term storage of waste in certain SSTs. A cover prevents surface liquids from penetrating the tank dome and walls if there are structural cracks in the concrete or steel liner.

Two risers on Tank BX-109 are not isolated. It is unclear from this review why riser 109-BX-R-2 was not isolated during previous interim isolation activities. The riser should be blind flanged as are other risers on the tank. Riser 109-BX-R-3 was not isolated probably because it contains a temperature probe. Since there is another temperature probe in use for this tank (109-BX-R-5) and since there is no apparent need for redundancy on other tanks reviewed, it is recommended that the temperature probe be removed from this riser if waste is stored for a long time (> 10 years) and that it be blind flanged as are other risers on the tank to ensure that no leakage occurs because of metal corrosion or gasket failure.

Two other possible areas of intrusion are the salt well pump pit and the condenser hatchway. Although both are weather covered surface, liquids could intrude into these locations from natural and manmade sources. The accumulation of significant amounts of liquid in these areas could lead to drain back liquid intrusion into the tank. For this reason, it is suggested that maintainable leak detectors be installed in these two areas. This will assist intrusion prevention efforts by providing early detection of potential intrusion sources and by identifying the pathway. It is also suggested that the drain within the pump pit be plugged to prevent intrusion into the tank in the event that the weather cover over the pump pit is compromised.

- **241-BX-110 Single-Shelled Tank**

  A weather cover is suggested for long term protection. (See the discussion under BX-107).

  The pump pit for Tank BX-110, as for all pump pits for the reviewed tanks, is covered with a weather cover for protection. Within this pit, several items were left "as is," presumably because the weather cover protected the pit from surface liquids until intrusion prevention activities could be concluded. The unprotected items include two risers (BX-R-7 and BX-R-8), the pump pit drain, and 4 nozzles (U-1, U-2, U-4, and U-5). One of the risers (BX-R-7) houses the pump.

  As discussed for BX-109, ground-related liquids could intrude into the pit despite the protective weather cover. These items should be isolated to provide additional protection in case liquid does enter the pump pit. These isolation activities include plugging the pit drain, installing blind flanges on the two risers, and installing nozzle seals on the appropriate nozzles. In order to truly isolate BX-R-7, the pump would need to be removed from the riser. The benefit of this action should be weighed against the cost involved in removing the pump (both in terms of resources and the risk to personnel and the environment). A maintainable leak detector should also be considered for installation in the pump pit.

- **241-BX-111 Single-Shelled Tank**

  A weather cover is suggested for 241-BX-111. (See the discussion under BX-107).

  The configuration for this tank closely resembles those for Tank BX-110. Again, a pump pit is covered with a weather cover for protection. Within the pit, two risers (BX-R-7 and BX-R-8), two drains, and 4 nozzles (U-1, U-2, U-3, and U-5) were left "as is." One of the risers (BX-R-7) houses the pump itself. The need to isolate these items are the same as those for Tank BX-110.

- **241-BX-112 Single-Shell Tank**

  A weather cover is suggested for 241-BX-112 (See the discussion under BX-107).

  Two risers on tank BX-112 have been left "as is." It is unclear from this review why tanks 112-BX-R-2 or 112-BX-R-3 were not isolated; these risers should be blind flanged similarly to the other risers on the tank.

The pump pit for tank BX-112 is covered with a weather cover for protection. Within the pit, several items were left "as is," presumably because the weather cover was deemed adequate to protect the pit from liquid intrusions until final intrusion prevention were conducted. The items include two risers (BX-R-5 and BX-R-6) and 5 nozzles (A-E). One of the risers (BX-R-6) holds the pump.

As discussed for BX-109, ground-related liquids could intrude into the pit despite the protective weather cover. It is suggested that these items be isolated to provide additional protection in case liquid does enter the pump pit. These isolation activities include plugging the pit drain (BX-R-5), installing nozzle seal assemblies onto the five nozzles, removing the pump from BX-R-6 to install a blind flange, and installing a maintainable leak detector in the pump pit.

Two areas similar to the pump pit are the flush pit and the condenser hatchway. These areas should have maintainable leak detectors installed. The 1-1/2 inch line ST M2 from the flush pit should be cut and capped.

- **241-BY-102 Single-Shell Tank**

Note: The drawings reviewed for Tank BY-102 were difficult to read. Where necessary, conservative assumptions were made, e.g., that a riser was not isolated where the drawing was not legible. It is recommended that the status of identified penetrations be field verified.

A weather cover is suggested for 241-BY-102. (See the discussion under BX-107).

Four risers on Tank BX-112 appear to have been left "as is." It is unclear why these risers (BY-R-9A, BY-R-11, BY-R-12A and BY-R-13) were not isolated. The risers should be blind flanged as are the other risers on the tank.

Numerous pits exist on tank BY-102. As discussed previously for tank BX-109, it is desirable to perform proactive activities for the intrusion prevention of items within these pits in case the weather covers or pits fail to prevent liquids from entering. The individual pits and their recommended isolation activities are identified below.

Pump pit BYR-02A contains a drain and 4 nozzles (U-1, U-2, U-4, and U-8) that were left "as is." The drain should be plugged and the nozzles sealed, and maintainable leak detector should be installed within the pit to detect unanticipated liquid in-leakage.

Sluice pit BYR-02C contains a drain and 2 nozzles (U-1 and U-2) that were left "as is." The drain should be plugged and the nozzles sealed. A maintainable leak detector should be installed within the pit to detect unanticipated liquid in-leakage.

Sluice pit BYR-02D contains a drain and 4 nozzles (U-2, U-4, U-5, and U-7) that were left "as is." The drain should be plugged and the nozzles sealed. A maintainable leak detector should be installed within the pit to detect unanticipated liquid in-leakage.

The south riser pit contains a drain that was left "as is." This drain should be plugged. A maintainable leak detector should be installed within the pit to detect unanticipated liquid in-leakage.

The north riser pit contains a drain that was left "as is." This drain should be plugged. A maintainable leak detector should be installed within the pit to detect unanticipated liquid in-leakage.

The instrument pit should have a maintainable leak detector installed to detect unanticipated liquid in-leakage.

- **241-BY-109 Single-Shell Tank**

A weather cover is suggested for 241-BY-109. (See the discussion under BX-107).

The pump pit for 241-BY-109 has had its weather cover removed to permit salt well pumping of the tank. Within the pit, several items were left "as is," presumably because the weather cover protected the pit from liquid intrusion. Items include two risers (BY-R-2 and BY-R-13), the pump pit drain, and 7 nozzles (U-1, 3, 4, 5, 6, 7 and 8). Riser BY-R-13 holds the salt well pump.

As discussed for BX-109, ground-related liquids may intrude into the pit despite a protective weather cover. These items should be isolated to ensure any liquid entering the pump pit does not enter the tank. The isolation activities include plugging a pit drain (riser BY-R-2) and possibly removing the pump in riser BY-R-13. The benefit must be weighed against the cost involved in removing the pump both in terms of resources and the risk to personnel and the environment. A maintainable leak detector should be installed in the pump pit. A new removable weather cover is suggested as a replacement for existing weather covers that must be removed for operational or maintenance purposes. Current weather covers must be destroyed to remove and generate large amounts of potential contaminated waste.

Three additional areas of concern include the instrument pit, the condenser hatchway, and the valve pit. Although all three are weather covered, liquid could intrude into these locations from unknown ground sources. The accumulation of significant amounts of liquid in these areas have potential for draining into the tank. For this reason, maintainable leak detectors should be installed in these areas. This will assist intrusion prevention efforts by providing early warning of potential intrusion sources, as well as identifying the pathway.

B.2 MONITORING STATUS FOR SEVEN SELECTED SINGLE-SHELLED TANKS

The status of the current intrusion prevention monitoring equipment and the instruments needed to upgrade monitoring are listed below for each of the seven selected SST's. Note: Two source documents used to determine the status of existing intrusion prevention monitoring equipment located on risers for the seven selected SST's were WHC-SD-RE-TI-053, *Riser Configuration Document for Single-Shell Waste Tanks*, Rev. 8 (Alstad 1992) and *Tank Farm Surveillance and Waste Status Summary Report for January 1994*, (WHC 1994). These seven selected SSTs are scheduled to be salt well pumped in Fiscal Year 1994 and early FY 95.

B.2.1 241-BX-107 Intrusion Prevention Monitoring Equipment Status and Need

- The tank breather filter (H-2-90718) located on existing riser R-2 (12-inch diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- The existing temperature probe located on riser R-4 (4-inch diameter) is out-of-service. A new thermocouple tree for monitoring existing tank vapor space and sludge/salt cake temperatures is needed. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an abovegrade, 4-inch-diameter tank riser.

- The automatic FIC gauge on riser R-8 (4-inch diameter) is out-of-service (failed December 30, 1992). A new like-in-kind gauge is needed to measure potential surface level changes during interim storage of wastes. The new gauge needs to be automated and connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data.

- A liquid observation well (LOW) has not been installed in this tank. Note: In the single-shell tank stabilization record, WHC-SD-RE-TI-178, Rev 4, tank BX-107 is estimated to contain 29,330 gal of drainable liquid. Future monitoring for possible liquid level changes requires the installation of a LOW presumably on an existing abovegrade, 4-inch-minimum-diameter tank riser.

- This tank has an observation port (H-2-93726) located on an existing abovegrade 12-inch-diameter tank riser (R-6). Future intrusion prevention monitoring on in-tank conditions may require use of this riser for in-tank photography.

B.2.2 241-BX-109 Intrusion Prevention Monitoring Status Includes the Following Items

- The tank breather filter (H-2-90718) located on existing riser R-4 (4-inch diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- The existing temperature probe located on riser R-5 (4-inch diameter) is out-of-service. A new thermocouple tree for monitoring existing tank vapor space and sludge/salt cake temperatures is needed. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an abovegrade, (4-inch diameter) tank riser.

- The automated FIC gauge on riser R-8 (4-inch diameter) is currently connected to the Computer Automated Surveillance System. A new like-in-kind gauge is needed to measure potential surface level changes during interim storage of wastes. The new gauge needs to be automated and connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data.

- A liquid observation well (LOW) has not been installed in this tank. Note: In the *Single-Shell Tank Stabilization Record*, Rev. 2, (Boyles 1992) tank BX-109 contains an estimated 7,655 gal of drainable liquid. Future monitoring for possible liquid level changes requires the installation of a LOW presumably on an existing abovegrade, 4-inch-minimum-diameter tank riser.

- This tank has an observation port (H-2-93726) (WHC 1985), located on an existing abovegrade 12-inch-diameter tank riser (R-7). Future intrusion prevention monitoring on in-tank conditions may require use of this riser for in-tank photography.

B.2.3 241-BX-110 Intrusion Prevention Monitoring Status Includes the Following Items

- The tank breather filter (H-2-69148) (WHC 1977), located on existing riser R-4 (4-inch diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- The existing temperature probe located on riser R-1 (4-inch diameter) is out-of-service. A new thermocouple tree for monitoring existing tank vapor space and sludge/salt cake temperatures is needed. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an abovegrade, (4-inch diameter) tank riser.

- The automatic FIC gauge on riser R-2 (4-inch diameter) is currently connected to the Computer Automated Surveillance System. A new like-in-kind gauge is needed to measure potential surface level changes during interim storage of wastes. The new gauge needs to be automated and connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data.

- A liquid observation well (LOW) has not been installed in this tank. Note: In the single-shell tank stabilization record, WHC-SD-RE-TI-178, Rev. 4, Tank BX-110 is estimated to contain 20,700 gal of drainable liquid. Future monitoring for possible liquid level changes requires the installation of a LOW presumably on an existing abovegrade, 4-inch-minimum-diameter tank riser.

- This tank has an observation port (H-2-93726) located on an existing abovegrade 12-inch-diameter tank riser (R-3). Future intrusion prevention monitoring on in-tank conditions may require use of this riser for in-tank photography.

B.2.4 241-BX-111 Intrusion Prevention Monitoring Status Includes the Following Items

- The tank breather filter (H-2-69148) located on existing riser R-4 (4-inch diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- The existing temperature probe located on riser R-1 (4-inch diameter). A new thermocouple tree for monitoring existing tank vapor space and sludge/saltcake temperature is needed. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an above grade, (4-inch diameter) tank riser.

- An existing manual tape on riser R-2 (12-inch diameter) is used to monitor in-tank surface level changes. In the future, intrusion prevention Monitoring will require a new automatic FIC gauge to measure potential surface level changes during interim storage of waste. The new gauge needs to be connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data. A new FIC gauge will require as a minimum an above grade 4-inch diameter tank riser.

- Tank riser R-5 (4-inch diameter) has a Liquid Observation Well (LOW) in service per drawing H-2-93715 (WHC 1984).

- This tank has an Observation Port (H-2-93726) located on an existing above grade 12-inch-diameter tank riser (R-3). Future intrusion prevention monitoring on in-tank conditions may require use of this riser for in-tank photography.

B.2.5 241-BX-112 Intrusion Prevention Status Includes the Following Items:

- The tank breather filter (H-2-90718) (WHC 1993), located on existing riser R-4 (4-inch diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- The existing temperature probe located on riser R-1 (4-inch diameter). A new thermocouple tree for monitoring existing tank vapor space and sludge/salt cake temperatures is needed when this existing temperature probe fails to function. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an abovegrade, (4-inch diameter) tank riser.

- The automated FIC gauge on riser R-8 (4-inch diameter) is currently connected to the Computer Automated Surveillance System. A new like-in-kind gauge is needed to measure potential surface level changes during interim storage of wastes. The new gauge needs to be automated and connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data.

- A liquid observation well (LOW) has not been installed in this tank. Note: In the single-shell tank stabilization record, WHC-SD-RE-TI-178, Rev. 4, tank BX-107 is estimated to contain 8,100 gal of drainable liquid. Future monitoring for possible liquid level changes requires the installation of a LOW presumably on an existing abovegrade, 4-inch-minimum-diameter tank riser.

- This tank has an observation port (H-2-93726) located on an existing abovegrade 12-inch-diameter tank riser (R-7). Future intrusion prevention monitoring on in-tank conditions may require use of this riser for in-tank photography.

B.2.6 241-BY-102 Intrusion Prevention Status Includes the Following Items

- The tank breather filter (H-2-69748) (WHC 1981), located on existing riser R-14 (4-inch diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- A new thermocouple tree for monitoring existing tank vapor space and sludge/salt cake temperatures is needed. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an abovegrade, (4-inch diameter) tank riser.

- An existing manual tape on riser R-5 (4-inch diameter) is used to monitor in-tank waste surface level changes. In the future, intrusion prevention monitoring will require a new automatic FIC gauge to measure potential surface level changes during interim storage of waste. The new gauge needs to be connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data. The new automatic FIC gauge will require as a minimum an abovegrade (4-inch-diameter) tank riser.

- Tank riser R-1 (4-inch diameter) has a liquid observation well (LOW) in service per drawing H-2-93715.

- This tank has an observation port (H-2-93726) located on an existing abovegrade 12-inch-diameter tank riser (R-10A). Future intrusion prevention monitoring on in-tank conditions may require use of this riser for in-tank photography.

B.2.7 241-BY-109 Intrusion Prevention Monitoring Status Includes the Following Items

- The tank breather filter (H-2-90718) located on existing riser R-10A (12-inch-diameter) has a field monitor differential pressure loop to ensure its proper maintenance and change out.

- A new thermocouple tree for monitoring existing tank vapor space and sludge/salt cake temperatures is needed. The new thermocouple tree needs to be connected to the Tank Monitor and Control System. Thermocouple tree assemblies need as a minimum an abovegrade, (4-inch diameter) tank riser.

- The automated FIC gauge on riser R-4 (4-inch diameter) is currently connected to the Computer Automated Surveillance System. A new like-in-kind gauge is needed to measure potential surface level changes during interim storage of wastes. The new gauge needs to be automated and connected to the Tank Monitor and Control System to permit routine collection and storage of waste surface level data.

- Tank riser R-12B (12-inch diameter) has a liquid observation well (LOW) in service per drawing H-2-93715.

- This tank has an observation port (H-2-93726) located on an existing abovegrade 12-inch-diameter tank riser (R-10B).

REFERENCES

Alstad, Allen, 1992, *Riser Configuration Document for Single-Shell Waste Tanks*, Rev. 8, WHC-SD-RE-TI-053, Westinghouse Hanford Company, Richland, Washington.

Boyles, Victor, 1992, *Single-Shell Tank Stabilization Record*, Rev. 2, WHC-SD-RE-TI-178, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Tank Farm Surveillance and Waste Status Summary Report for January 1994*, WHC-EP-0182, Westinghouse Hanford Company, Richland, Washington.

DRAWING REFERENCES

WHC, 1977, *Civil Plot Plan and Finish Grading*, February 1977, Drawing H-2-69148, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1981, *Air Filter for Waste Tank Atmospheric Breathing*, September 1981, Drawing H-2-69748, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

WHC, 1984, *Piping Liquid Observation Well Assembly and Detail*, December 1984, Drawing H-2-93715, Westinghouse Hanford Company, Richland, Washington.

WHC, 1985 *Piping Observation Port Riser Locations*, November 1985, Drawing H-2-93726, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Piping Air Filter Installation Atmospheric Breathing*, November, 1993, Drawing H-2-90718, Rev. 7, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX C

EVALUATION OF INTRUSION PREVENTION STRATEGIES

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Several activities are suggested in Appendix C as possible means to improve current levels of intrusion prevention for the seven SSTs being considered in detail in this study. An attempt is made to evaluate these activities on the basis of criteria mentioned in Section 5.1 (i.e., "worker safety concerns," "costs," "maintainability," and "degree of improved intrusion prevention provided to the tank"). The results of this evaluation are presented the following subsections.

C.1 ESTIMATED COST FOR IMPLEMENTING PROPOSED INTRUSION PREVENTION ACTIVITIES

The activities proposed in Appendix B as possible means to improve present levels of intrusion prevention for the seven SSTs are summarily costed in Table C-1 on a tank-by-tank basis. Table C-1 consists of two columns: the left column lists the intrusion prevention activities; the right column contains the corresponding estimated dollar sum for the proposed activities. This estimate includes sales taxes, overheads, and expected profit allowances. A 30 percent contingency (not factored into this estimate) may also be considered to compensate for any unexpected or unforseen costs encountered during the implementation of these activities. Cost details are provided in Appendix D.

C.2 EVALUATION OF PROPOSED INTRUSION PREVENTION ACTIVITIES

Proposed intrusion prevention activities are evaluated against selected criteria using engineering judgment and experience and cost analyses (see Appendix D). The selection criteria chosen include worker safety, cost, maintainability and the deemed intrusion prevention benefit. A weight factor is given each criterion that is independent of the intrusion prevention activity being considered and is a function of its perceived importance. It remains constant. The score given an intrusion prevention activity is a function of the performance of that activity as perceived by the evaluation team and thus varies. Impact, or the weighted score, for a given activity is determined by multiplying the weight factor for a criterion (importance with respect to the other criterion) times the score factor (how well the activity is judged to perform). The lower the weighted score or impact, the more desirable the proposed action.

In Section 5.1, a description is given of how the weight factors and activity scores were determined by the team. To obtain the level of importance or impact assigned to the criterion or activity score factor, see Tables 5-1 and 5-2.

Table C-1. Estimated Costs to Conduct Proposed Intrusion Prevention Activities

Intrusion Prevention Activity	Cost[1]/Comments
Diversion Box 241-BX-153	$37,000
Install nozzle seal on V-345	
Install nozzle seal on V-346	
Install nozzle seal on V-347	
Install nozzle seal on V-348	
Install nozzle seal on V-350	
Install a leak detection device in diversion box	
Tank 241-BX-107	Not Costed
Dome intrusion membrane	Deleted - too costly
Tank 241-BX-109	$50,000
Dome intrusion membrane	Deleted - too costly
Install blind flange on 12-inch riser BX-R-2	
Remove temperature probe and install blind flange on 12-inch riser BX-R-3	
Install a leak detection device in condenser hatchway	
Plug pump pit drain	
Install a leak detection device in pump pit	
Tank 241-BX-110	$110,000
Dome intrusion membrane	Deleted - too costly
Remove pump from 12-inch riser BX-R-7 and install blind flange	
Install blind flange on 4-inch riser BX-R-8	
Plug 3-inch pump pit drain	
Install a leak detection device in pump pit	
Install nozzle seal on pump pit nozzle U-1	
Install nozzle seal on pump pit nozzle U-2	
Install nozzle seal on pump pit nozzle U-4	
Install nozzle seal on pump pit nozzle U-5	

Table C-1. Estimated Costs to Conduct Proposed Intrusion Prevention Activities

Intrusion Prevention Activity	Cost[1]/Comments
Tank 241-BX-111	$126,000
Dome intrusion membrane	Deleted - too costly
Remove pump from 12-inch riser BX-R-7 and install blind flange	
Install blind flange on 4-inch riser BX-R-8	
Plug 3-inch pump pit drain	
Plug 4-inch pump pit drain	
Install a leak detection device in pump pit	
Install nozzle seal on pump pit nozzle U-1	
Install nozzle seal on pump pit nozzle U-2	
Install nozzle seal on pump pit nozzle U-3	
Install nozzle seal on pump pit nozzle U-5	
Tank 241-BX-112	$145,000
Dome intrusion membrane	Deleted - too costly
Install blind flange on 12-inch riser BX-R-2	
Install blind flange on 12-inch riser BX-R-3	
Plug 4-inch riser BX-R-5	
Remove pump from 12-inch riser BX-R-6 and install blind flange	
Cut and cap flush pit line 1-1/2-inch ST M2	
Install nozzle seal on pump pit nozzle A	
Install nozzle seal on pump pit nozzle B	
Install nozzle seal on pump pit nozzle C	
Install nozzle seal on pump pit nozzle D	
Install nozzle seal on pump pit nozzle E	
Install a leak detection device in flush pit	
Install a leak detection device in pump pit	
Install a leak detection device in condenser hatchway	

Table C-1. Estimated Costs to Conduct Proposed Intrusion Prevention Activities

Intrusion Prevention Activity	Cost[1]/Comments
Tank 241-BY-102	$189,000
Dome intrusion membrane	Deleted - too costly
Install flange on 12-inch riser BY-R-9A	
Install blind flange on 42-inch riser BY-R-11	
Install flange on 12-inch riser BY-R-12A	
Install blind flange on 42-inch riser BY-R-13	
Plug pump pit drain	
Install a leak detection device in pump pit	
Install nozzle seal on pump pit nozzle U-1	
Install nozzle seal on pump pit nozzle U-2	
Install nozzle seal on pump pit nozzle U-4	
Install nozzle seal on pump pit nozzle U-8	
Plug sluice pit BYR-02C drain	
Install a leak detection device in sluice pit BYR-02C	
Install nozzle seal on sluice pit nozzle U-1	
Install nozzle seal on sluice pit nozzle U-2	
Plug sluice pit BYR-02D drain	
Install a leak detection device in sluice pit BYR-02D	
Install nozzle seal on sluice pit nozzle U-2	
Install nozzle seal on sluice pit nozzle U-4	
Install nozzle seal on sluice pit nozzle U-5	
Install nozzle seal on sluice pit nozzle U-7	
Install a leak detection device in instrument pit	
Plug south riser pit drain	
Install a leak detection device in south riser pit	
Plug north riser pit drain	
Install a leak detection device in north riser pit	

Table C-1. Estimated Costs to Conduct Proposed Intrusion Prevention Activities

Intrusion Prevention Activity	Cost[1]/Comments
Tank 241-BY-109	$200,000
Dome intrusion membrane	Deleted - too costly
Plug 4 inch riser BY-R-2	
Remove pump from 42 inch riser BY-R-13 and install blind flange	
Plug drain within Pump Pit BY-09A	
Install a leak detection device in pump pit BY-09A	
Install nozzle seal on pump pit nozzle U-1	
Install nozzle seal on pump pit nozzle U-3	
Install nozzle seal on pump pit nozzle U-4	
Install nozzle seal on pump pit nozzle U-5	
Install nozzle seal on pump pit nozzle U-6	
Install nozzle seal on pump pit nozzle U-7	
Install nozzle seal on pump pit nozzle U-8	
Install a leak detection device in instrument pit	
Install a leak detection device in condenser hatchway	
Install a leak detection device in valve pit	

[1] Total cost details are available in Appendix D.

The total score in Table C-2, i.e., the sum of individual weighted scores for a particular activity, is indicative of the desirability of implementing the intrusion prevention activity. The higher the total score, the greater the impact associated with an activity, and the less desirable it is to implement. Total scores below 20 were deemed desirable for implementing intrusion prevention in SSTs. Scores between 20 and 40 were deemed increasingly marginal. Scores above 40 were generally considered undesirable for implementing intrusion prevention in SSTs. Special circumstances may alter the assessment for a given tank. Some activities like salt well pump removal will eventually have to be accomplished either to permit waste recovery or the decommissioning of SSTs.

C.3 Discussion of Preferred Intrusion Prevention Technologies

Several intrusion prevention technologies were identified in Section 5.3.2 as having the potential to improve current levels of intrusion prevention for the seven SSTs being considered in this study. These technologies are in addition to those already designed for implementation following the completion of salt well pumping. A weighted scoring procedure was developed to rate these technologies on the basis of the following selected criteria:

- Worker safety
- Implementation costs
- Maintainability
- Degree of improved intrusion prevention provided to the tanks
  The results of this evaluation are presented in Table C-2.

The total weighted score received by a technology in Table C-2 was used to designate it to one of the following categories:

- Technologies highly recommended for implementation
- Technologies deserving further consideration before a decision to implement them can be made
- Technologies that should not be implemented at the present time.

Table C-2. Engineering Evaluation of Potential Prevention Activities.

Intrusion Prevention Activity	Worker Safety weight factor = 5		Costs weight factor = 3		Maintainability weight factor = 3		Degree of IP weight factor = 4		Total Score	Notes
	Score Factor (0-5)	Wgtd. Score (0-25)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-20)		
Diversion Box 241-BX-153										
Install nozzle seal on V-3453	1	5	1	3	0	0	2	8	16	Weather cover in place, numerous sources of penetrations into diversion box.
Install nozzle seal on V-346	1	5	1	3	0	0	2	8	16	Weather cover in place, numerous sources of penetrations into diversion box.
Install nozzle seal on V-347	1	5	1	3	0	0	2	8	16	Weather cover in place, numerous sources of penetrations into diversion box.
Install nozzle seal on V-348	1	5	1	3	0	0	2	8	16	Weather cover in place, numerous sources of penetrations into diversion box.
Install nozzle seal on V-350	1	5	1	3	0	0	2	8	16	Weather cover in place, numerous sources of penetrations into diversion box.
Tank 241-BX-107										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Tank 241-BX-109										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Install a plug and concrete seal in condenser airway	2	10	2	6	0	0	2	8	24	Condenser hatchway has a weather cover and steel plate that restricts access to airway.
Remove pump from pump pit riser and blind flange the riser	4	20	5	15	0	0	3	12	47	Riser within weather covered pump pit.
Tank 241-BX-110										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Remove pump from 12-in. riser BX-R-7 and install blind flange	4	20	5	15	0	0	3	12	47	Riser within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-4	1	5	1	3	0	0	3	12	20	Vertical nozzle connected to BX-110 pit 10A. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-5	1	5	1	3	0	0	4	16	24	Connection to isolated flush pit. Within weather-covered pump pit.

Table C-2. Engineering Evaluation of Potential Prevention Activities.

Intrusion Prevention Activity	Worker Safety weight factor = 5		Costs weight factor = 3		Maintainability weight factor = 3		Degree of IP weight factor = 4		Total Score	Notes
	Score Factor (0-5)	Wgtd. Score (0-25)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-20)		
Tank 241-BX-111										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Remove pump from 12 inch riser BX-R-7 and install blind flange	4	20	5	15	0	0	3	12	47	Riser within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-3	1	5	1	3	0	0	3	12	20	Vertical nozzle connected to BX-110 pit 10A. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-5	1	5	1	3	0-	0	4	16	24	Connection to isolated flush pit. Within weather covered pump pit.
Tank 241-BX-112										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Remove pump from 12-in. riser BX-R-6 and install blind flange	4	20	5	15	0	0	3	12	47	Riser within weather covered pump pit.
Cut and cap flush pit line 1-1/2-in. ST M2	1	5	1	3	0	0	4	16	24	1-1/2-in. RW M19 isolated per project B-139.
Install nozzle seal on pump pit nozzle B	1	5	1	3	0	0	3	12	20	BWCTL from BY-109. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle C	1	5	1	3	0	0	3	12	20	BWCTL to BX-111. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle E	1	5	1	3	0	0	4	16	24	Connection to isolated flush pit. Within weather-covered pump pit.
Install plug and concrete seal in condenser airway	2	10	2	6	0	0	2	8	24	Weather cover and steel plate covers the condenser hatchway, restricting access to airway.

Table C-2. Engineering Evaluation of Potential Prevention Activities.

Intrusion Prevention Activity	Worker Safety weight factor = 5		Costs weight factor = 3		Maintainability weight factor = 3		Degree of IP weight factor = 4		Total Score	Notes
	Score Factor (0-5)	Wgtd. Score (0-25)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-20)		
Tank 241-BY-102 (Field Verification required for all accesses)										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Install nozzle seal on pump pit nozzle U-1	1	5	1	3	0	0	4	16	24	Sealed in diversion box BYR-152. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-2	1	5	1	3	0	0	3	12	20	Used for salt well pumping. (No clear indication of isolation at completion of salt well pumping efforts found.) Within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-8	1	5	1	3	0	0	3	12	20	Within weather covered pump pit.
Install nozzle seal on nozzle U-1 of sluice pit BYR-02C	1	5	1	3	0	0	4	16	24	Sealed in Diversion Box BYR-152. Within weather covered sluice pit.
Install nozzle seal on nozzle U-2 of sluice pit BYR-02C	1	5	1	3	0	0	4	16	24	Sealed in Diversion Box BYR-152. Within weather covered sluice pit.
Install nozzle seal on nozzle U-2 of sluice pit BYR-02D	1	5	1	3	0	0	4	16	24	Sealed in Diversion Box BYR-152. Within weather covered sluice pit.
Install nozzle seal on nozzle U-4 of sluice pit BYR-02D	1	5	1	3	0	0	4	16	24	Blanked in flush pit. Within weather covered sluice pit.
Install nozzle seal on nozzle U-5 of sluice pit BYR-02D	1	5	1	3	0	0	4	16	24	Drain from isolated flush pit. Within weather covered sluice pit.
Install nozzle seal on nozzle U-7 of sluice pit BYR-02D	1	5	1	3	0	0	4	16	24	Blanked in tank #302 (See H-2-73243) (WHC 1988a). Within weather covered sluice pit.
Plug South Riser Pit drain	1	5	1	3	0	0	2	8	16	Provides a direct route for any unsuspected in-leakage to reach the tank contents.
Plug North Riser Pit drain	1	5	1	3	0	0	2	8	16	Provides a direct route for any unsuspected in-leakage to reach the tank contents.

Table C-2. Engineering Evaluation of Potential Prevention Activities.

Intrusion Prevention Activity	Worker Safety weight factor = 5		Costs weight factor = 3		Maintainability weight factor = 3		Degree of IP weight factor = 4		Total Score	Notes
	Score Factor (0-5)	Wgtd. Score (0-25)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-15)	Score Factor (0-5)	Wgtd. Score (0-20)		
Tank 241-BY-109										
Dome intrusion membrane	3	15	4	12	4	12	4	16	55	Provides protection to entire tank area from surface water.
Remove pump from 42-in. riser BY-R-13 and install blind flange	4	20	5	15	0	0	3	12	47	Riser within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-1	1	5	1	3	0	0	3	12	20	Process line. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-3	1	5	1	3	0	0	3	12	20	Line #7435. Within weather covered pump pit.
Install nozzle seal on pump pit nozzle U-4	1	5	1	3	0	0	3	12	20	Line #7406. Within weather-covered pump pit.
Install nozzle seal on pump pit nozzle U-5	1	5	1	3	0	0	3	12	20	Line #SN-205. Within weather-covered pump pit.
Install nozzle seal on pump pit nozzle U-6	1	5	1	3	0	0	3	12	20	Process line. Within weather covered pump pit.
Install a plug and concrete seal within condenser airway	1	5	1	3	0	0	3	12	24	Weather cover and steel plate covers the condenser hatchway, restricting access to airway.

A classification of a given technology into one of these categories is high subjective to the conditions and constraints of the data and objectives of the study. For example:

- For a given technology, the weighted scores assigned to individual criteria, as well as the total weighted score depend on the relative importance (weight factor) attached to each criterion. Should a different level of importance (than that assigned by the study contributors) be attached to a criterion, or should the importance of a criterion relative to other criteria change with time, the total weighted scores received by the technologies will change. This may result in a technology being placed in a different category than it was originally.

- The identification of accesses requiring intrusion-prevention measures is based on information provided by the isolation design drawings (and corresponding ECNs) for the seven SSTs being considered in this study. Accurate identification of such accesses (and consideration of suitable technologies/activities required to seal them) is dependent on the accuracy and clarity of the isolation drawings. This is especially true for tank BY-102 whose isolation drawing (H-2-73244) (WHC 1988b) is of extremely poor quality. Conservative assumptions (non isolated) were made with regard to those accesses whose isolation details weren't clearly legible or identifiable on the drawing. For such accesses, field verifications need to conducted to determine their true isolation status.

C.3.1 Technologies Highly Recommended for Implementation

The following technologies are highly recommended for intrusion prevention based on the low total weighted impact scores (less than 20) they received. The implementation of these technologies pose minimal safety concerns, require relatively small procurement and installation costs, need little or no maintenance, and are expected to significantly decrease the amount of liquid intrusion into tanks.

C.3.1.1 Installation of Seals on Diversion Box 241-BX-153 Nozzles

Total Weighted Score = 16

Diversion box 241-BX-153 nozzles that are connected to lines V-345, V-346, V-347, V-348, and V350 (transfer lines connected to one or more of the seven SSTs being considered in this study) may be sealed with 3-in. horizontally-assembled connector nozzle seals. Access to the nozzles must be gained by removing the three layers of weather cover over the diversion box. Although the atmosphere within the diversion box may be contaminated with radioactive and chemical waste, the nozzle seals can be installed remotely, thereby significantly reducing workers' exposure to radiation and chemicals. The potential for industrial accident occurring either during weather cover removal/ replacement and installation of seals is minimal. Thus a very low score (score factor of 1) was awarded to this activity in the "worker safety" category. A low score (score factor of 1) was also awarded to this activity in the "costs" category because nozzle seal fabrication and installation costs are estimated to be relatively inexpensive (see Table C-1), and no design, utility, and burial costs would be incurred to develop, test, operate and dispose off the seals.

The cost, however, is significant to replace the weather cover. The structural integrity and performance of similar nozzles used in other diversion boxes on site have proven to be very reliable, thus assuring the need for little or no maintenance. The maintenance frequency and the maintenance costs were assumed to be zero, and the lowest possible score of 0 was awarded to this activity in the "maintainability" category. Since the seals are to placed on nozzles connected to transfer lines (which provide the most direct route for the diversion box's liquid waste to reach the SSTs), the additional "degree of improved intrusion prevention attained" was assumed to be quite high, and a low score (score factor of 2) was awarded to the sealing of diversion box nozzle seals for this criterion. The precise "degree of improved intrusion prevention attained" by the tanks upon installing the diversion box nozzles will depend to a large extent upon whether the diversion box is located at the upper or lower end of the transfer line relative to the tank of interest. The presence of nozzle seals in those cases where the diversion box is located on the upper end of transfer lines, could significantly reduce (if not eliminate) any intrusion of the diversion box's liquid wastes into the tanks. In cases where the diversion box is located on the lower end of the transfer line, the presence of the seal is likely to protect the diversion box from intrusion against the tanks' liquid wastes and/or any liquid that leaked into the transfer line from the surrounding soil.

C.3.1.2 Installation of Test Plugs in Riser Pit Drains

Total Weighted Score = 16

The south and north riser pit drains of tank 241-BY-102 may be plugged with test plugs. The riser pits are located above grade, and the plugs can be inserted into the drains remotely. Thus worker exposure to radiation and chemical wastes during the installation of test plugs is minimal, and a very low score (score factor 1) was awarded to this activity in the "worker safety" category. Procurement and installation costs for test plugs are relatively small (see Table C-1). Since test plugs are available "off-the-shelf," no expenses for the design and testing of these plugs are expected. There are also no operation costs associated with the plugs. Thus a very low score (score factor of 1) was awarded to this activity in the "costs" category. No maintenance is expected to be required for the plugs, and thus the lowest possible score (0) was awarded to this activity in the "maintainability" category. Since the riser pit drain provides a direct route for any unsuspected in-leakage to reach the tank contents, plugging this drain will significantly reduce the intrusion of liquids into the tanks. A score factor of 2 was thus awarded to this activity in the "degree of improved intrusion prevention attained" category.

C.3.2 Technologies Deserving Further Consideration

Technologies in this category fall between the two extremes of technologies that are highly recommended for implementation and those that are rejected for implementation at the present time. In Table C-2, such technologies received a total weighted score between 20 and 40. The closer a technology's score is to 20, the more deserving it is of being considered a candidate for implementation. Technologies with scores close to 40 are unlikely to be considered as suitable candidates for implementation. The following technologies belong to this category.

C.3.2.1 Installation of Seals on Pump Pit Discharge Nozzles

Total Weighted Score = 20

A review of the isolation design drawings for Tanks BX-110, -111, and -112, and BY-102 and -109 indicates that certain nozzles within the pump pits are to be "left as is" following the termination of salt well pumping. These nozzles are connected to one of the following lines:

1. Transfer line running between the pump pits of two SSTs (e.g., nozzle U-4 in the tank 241-BX-110 pump pit which is connected to the tank 241-BX-111 pump pit, and nozzle U-3 in the tank 241-BX-111 pump pit which is connected to the tank 241-BX-110 pump pit).

2. BWCTL running to or from another SST (e.g., nozzle C in the tank 241-BX-112 pump pit which is connected to a BWCTL running to tank 241-BX-111).

3. An active process line (e.g., nozzle U-3 in the tank 241-BY-109 pump pit which is connected to line 7435).

Access to the nozzles is gained by removing the pump pit's weather cover. Although the atmosphere within the pump pit may be contaminated with the tank's radioactive and chemical waste, the nozzle seals can be installed remotely, thereby significantly reducing workers' exposure to radiation and chemicals. The potential for industrial accident occurring during weather cover removal/replacement and installation of seals is minimal. Thus a very low score (score factor of 1) was awarded to this activity in the "worker safety" category. Fabrication and installation costs for the nozzle seals are relatively small (see Table C-1). Since the nozzle seals proposed for use are available "off-the-shelf," no expenses for the design and testing of these seals are expected. There are also no operation costs associated with nozzle seals. Hence a very low score (score factor of 1) was awarded to this activity in the "costs" category. The nozzles are located in weather-covered pump pits; hence maintenance of nozzle seals are not expected.

Thus maintenance frequency and maintenance costs were assumed to be zero, and the lowest possible score (0) was awarded to this activity in the "maintainability" category. The level of intrusion prevention provided by pump pit nozzle seals to a tank is not as significant as that provided by a weather cover (which serves as the primary deterrent against liquid intrusion into tanks through their pump pits). However nozzle seals probably act as the only barriers against any liquid being carried by a transfer line (that was accidentally left not isolated prior to, during, and following the stabilization of the concerned SSTs) from entering the tanks. Thus a moderate score (score factor of 3) was awarded to this activity in the "degree of improved intrusion prevention attained" category. The extra amount of intrusion prevention attained by the tanks coupled with minimal worker safety concerns, installation costs, and maintenance requirements, make this technology worthy of further consideration as a candidate for implementation.

C.3.2.2 Installation of Seals on Pump Pit and Sluice Pit Nozzles Connected to Isolated Flush Pits/Diversion Boxes

Total Weighted Score = 24

It is suggested that nozzle seals be installed on pump pit and sluice pit nozzles of tanks BX-110, -111, and -112 and BY-102 that were connected to one of the following:

- an isolated flush pit (e.g. pump pit nozzle U-5 in Tank 241-BX-110)
- a transfer line originating from a diversion box, i.e., already sealed at the diversion box end (e.g., sluice pit nozzles U-1 and U-2 in tank 241-BY-102 which are connected to transfer lines already sealed in diversion box BYR-152).

The extra amount of intrusion prevention provided to the tanks by sealing these nozzles is minimal since they are already connected to isolated pits/sealed lines. Additionally, the nozzles are located within weather covered pump pits or sluice pits. However the presence of a nozzle seal would prevent small amounts of liquids from entering the tank should the line between the diversion box or the isolated flush pit and the pump pit/sluice pit corrode. Owing to the very small amount of improved intrusion prevention provided to the tanks by these seals, a high score (score factor of 4) was awarded to this activity in the "degree of improved intrusion prevention attained" category. Worker safety concerns, costs, and maintainability requirements for such seals are minimal, and comparable to nozzle seals installed at the end of incoming process lines (see Section C.3.2.1). The additional amount of intrusion prevention attained by the tanks coupled with minimal worker safety concerns, installation costs and maintenance needs, make this technology worthy of further consideration as a candidate for implementation.

C.3.2.3 Installation of a Plug and Concrete Seal in Condenser Airway

Total Weighted Score = 24

A plug and concrete seal combination may be used to seal the condenser airways of tanks BX-109, BX-112, and BY-109 to prevent liquid from entering the tank through the condenser hatchways. A weather cover and a steel plate which cover the condenser hatchway will need to be removed/replaced prior to/following the sealing of the airway. The condenser airway is highly contaminated with the tank's radioactive and chemical wastes; however the plug and concrete seal can be remotely installed in the airway thereby significantly reducing the potential of worker exposure to radiation and hazardous chemicals. Thus a moderately low score (score factor of 2) was awarded to this activity in the "worker safety" category. No operation, design and burial costs are expected. Fabrication and installation costs although quite low, are not nearly as inexpensive as those for installing nozzle seals or plugging pit drains. Thus a moderately low score (score factor of 2) was awarded to this activity in the "costs" category. Access to the condenser airway will be blocked with a steel plate and a weather cover following the installation of the seal, thus restricting access to maintenance. Maintenance frequency and costs were therefore assumed to be zero, and the lowest possible score (0) was awarded to this activity in the "maintainability" category. The installation of a plug and concrete seal in the condenser airway provides a near foolproof barrier against liquid intrusion through one of the largest possible intrusion routes (the inner diameter of the condenser airway is 24 inches). Thus a low score was awarded to this technology in the "degree of improved intrusion prevention attained" category.

C.3.3 Technologies Note Recommended For Implementation at the Present Time

The technologies in this category are those whose implementation although feasible, are not recommended at this time. These technologies received a total weighted score of greater than 40 in Table C-2. The implementation of these technologies were determined to pose major worker safety concerns, require large procurement and installation costs, and contribute only minimally towards the overall intrusion prevention of the SSTs.

C.3.3.1 Remove Pump From Pump Pit Riser and Blind Flange Riser

Total Weighted Score = 47

Pumps used to remove liquid waste from tanks may be removed following the stabilization of those tanks, followed by the blind flanging of risers that contain the pumps. The removal of a pump is often a difficult and expensive process, given the high probability of the pump being firmly lodged in the solid wastes of the tank. Water may have to be added to the tank's sludge to loosen the pump for retrieval. The addition of water to a stabilized tank is not be desirable since it may jeopardize the tank's stabilization status. In the event that a pump is lodged in a tank's salt cake, the pump will need to be lanced out.

Once it is retrieved from the solid waste, the highly contaminated pump must be safely packaged, transported, and buried at a suitable site. Also, the pump pit riser's existing flange must be modified to accommodate the blind flange proposed for installation. The handling of equipment required to dislodge and retrieve the pump from the tank's waste, and the transportation and burial of the highly contaminated pump is expected to significantly raise the potential for industrial accidents and worker exposure to radiation and hazardous chemicals. Thus this technology was awarded the second highest possible score (score factor of 4) in the "worker safety" category. The special and excess equipment, manpower (labor), and transportation required to first dislodge, and then transport and bury the contaminated pump adds substantially to the cost of implementing this technology. Although the cost of procuring and installing the blind flange is minimal, the cost of modifying the existing riser flange to accommodate the blind flange is substantial compared to the cost of implementing some of the previously discussed activities (see Table C-1). Thus the highest possible score (score factor of 5) was awarded to this technology in the "costs" category. Since the blind flanged riser will be located in a weather-covered pump pit, it is not expected to require or be accessed for maintenance. Thus maintenance frequency and costs were assumed to be zero, and the technology was awarded the lowest possible score (0) in the "maintainability" category. The weather cover over the pump pit serves as the primary barrier against any liquid likely to enter the tank through the pump pit; thus blind flanging the pump pit riser is expected to provide a very limited amount of intrusion prevention to the tank. This technology was therefore awarded a moderately high score (score factor of 3) in the "degree of improved intrusion prevention attained" category.

C.3.3.2 Install a Tank Dome Weather Cover

Total Weighted Score = 55

The installation of a tank dome cover was considered as an option to reduce the intrusion of water from rain and snow through cracks in tank domes and walls. Four types of dome weather covers were considered, but none were determined suitable for installation. An asphalt weather cover would likely induce a significant load on the tank dome thereby endangering the structural integrity of the tank itself. Hence it was rejected as a suitable dome cover. A membranous weather cover was found unsuitable largely because it is durability was determined to be suspect (subject to frequent wear and tear, requiring a high level of maintenance, and occasional replacement). The membranous cover once installed, would also constrain future access to the tanks. An enclosed tent-like structure was rejected because of the high cost required to install, operate, and maintain its ventilation system. A suspended structure with a roof but no walls was rejected because of its inability to prevent drifting snow/rain from reaching the surface soil over the dome. The effectiveness of any dome weather cover in preventing rain or melted snow from reaching the dome surface is limited given that the dome cover only blocks precipitation that falls directly over soil covering the dome. Once rain and snow water penetrates the soil, the dome cover cannot prevent the lateral migration of water towards cracks in tanks domes and walls. The tank dome weather cover if installed, must be supplemented with a drainage system to remove water from the vicinity of the tank farm.

REFERENCES

WHC, 1988a, *Piping Waste Tank Isolation 241 B4 Form-Plot Plan*, July 1988, Drawing H-2-73243, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Piping Waste Tank Isolation 241-BY-102*, July 1988, Drawing H-2-73244, Rev. 5, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX D

COST ESTIMATES

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KAISER ENGINEERS HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. ER 4916
FILE NO. Z170SAA1

** IEST - INTERACTIVE ESTIMATING **
INTRUSION PREVENTION OF 7 SELECTED SSTs
STUDY ESTIMATE
DOE_R01 - PROJECT COST SUMMARY

DATE 03/30/94 14:07:54
BY KDE

COST CODE	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING	860,000	30	260,000	1,120,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	3,020,000	30	910,000	3,930,000
	(ADJUSTED TO MEET DOE 5100.4)	20,000		30,000	50,000
	TOTAL ESTIMATED CONSTRUCTION COST (TEC)	3,900,000	30	1,200,000	5,100,000

CHECK

TYPE OF ESTIMATE	STUDY ESTIMATE MARCH 30, 1994	REMARKS: ESTIMATE PROVIDES COST FOR ENGINEERING AND CONSTRUCTION.
ARCHITECT ENGINEER	[signature]	
OPERATING CONTRACTOR		

(ROUNDED/ADJUSTED TO THE NEAREST " 10,000 / 100,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

KAISER ENGINEERS HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. ER 4916
FILE NO. Z170SAA1

** IEST - INTERACTIVE ESTIMATING **
INTRUSION PREVENTION OF 7 SELECTED SSTs
STUDY ESTIMATE
DOE_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

DATE 03/30/94 14:07:56
BY KDE

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
110000	DEFINITIVE DESIGN	576432	0	576432	2.52	14526	590958	30	177287	768246
120000	ENGINEERING/INSPECTION	247042	0	247042	8.06	19912	266954	30	80086	347040
SUBTOTAL 1	ENGINEERING	823474	0	823474	4.18	34438	857912	30	257373	1115286
200000	PROCUREMENT	55640	0	55640	8.20	4562	60202	30	18061	78263
SUBTOTAL 2	PROCUREMENT	55640	0	55640	8.20	4562	60202	30	18061	78263
310100	DIVERSION BOX 241-BX-153	26009	0	26009	8.20	2133	28142	30	8443	36584
310300	TANK 241-BX-109	35531	0	35531	8.20	2913	38444	30	11534	49977
310400	TANK 241-BX-110	77966	0	77966	8.20	6393	84359	30	25308	109667
310500	TANK 241-BX-111	89894	0	89894	8.20	7371	97265	30	29179	126445
310600	TANK 241-BX-112	103070	0	103070	8.20	8451	111521	30	33456	144978
310700	TANK 241-BY-102	134408	0	134408	8.20	11021	145429	30	43630	189058
310800	TANK 241-BY-109	139248	0	139248	8.20	11419	150667	30	45200	195865
310900	BURNOUT	2083151	0	2083151	8.20	170818	2253969	30	676191	2930160
SUBTOTAL 31	FA CONST-ONSITE E/C	2689277	0	2689277	8.20	220519	2909796	30	872941	3782734
330000	BURIAL FEES	50000	0	50000	8.20	4100	54100	30	16230	70330
SUBTOTAL 33	BURIAL FEES	50000	0	50000	8.20	4100	54100	30	16230	70330
SUBTOTAL 3	CONSTRUCTION	2739277	0	2739277	8.20	224619	2963896	30	889171	3853064
PROJECT TOTAL		3,618,391	0	3,618,391	7.29	263,619	3,882,010	30	1,164,605	5,046,613

1. DOCUMENTS AND DRAWINGS
****
DOCUMENTS: NONE

DRAWINGS: SKETCHES

2. MATERIAL PRICES
****
UNIT COSTS REPRESENT CURRENT PRICES FOR SPECIFIED MATERIAL.

3. LABOR RATES
****
CURRENT KEH BASE CRAFT RATES, AS ISSUED BY KEH FINANCE (EFFECTIVE 10-01-93), INCLUDE FRINGE BENEFITS, LABOR INSURANCE, TAXES AND TRAVEL WHERE APPLICABLE, PER HANFORD SITE STABILIZATION AGREEMENT, APPENDIX A (EFFECTIVE 09-06-93). HOURLY RATES FOR NON-BARGAINING UNIT LABOR ARE BASED UPON KEH ESTIMATING OUTYEAR FACTOR/BILLING SCHEDULE, REVISION 0, DATED MARCH 10, 1994. LIQUIDATION RATES, AS ISSUED BY KEH FINANCE (EFFECTIVE 03-01-94).

4. GENERAL REQUIREMENTS/TECHNICAL SERVICES/OVERHEADS
****
A.) ONSITE CONSTRUCTION FORCES GENERAL REQUIREMENTS, TECHNICAL SERVICES AND CRAFT OVERHEAD COSTS ARE INCLUDED AS A COMPOSITE PERCENTAGE BASED ON THE KEH ESTIMATING FACTOR/BILLING SCHEDULE, REVISION 14, DATED OCTOBER 01, 1992. THE TOTAL COMPOSITE PERCENTAGE APPLIED TO ONSITE CONSTRUCTION FORCES LABOR, FOR THIS PROJECT, IS 94% FOR SHOP WORK AND 136% FOR FIELD WORK, WHICH IS REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL.

5. ESCALATION
****
ESCALATION PERCENTAGES WERE CALCULATED BY THE HANFORD MATERIAL & LABOR ESCALATION STUDY, DATED FEBRUARY 1993.

6. ROUNDING
****
U.S. DEPARTMENT OF ENERGY - DOE ORDER 5100.4 PAGE I-32 SUBPARAGRAPH (M), REQUIRES ROUNDING OF ALL GENERAL PLANT PROJECTS (GPP'S) AND LINE ITEM (LI) COST ESTIMATES. REFERENCE: DOE 5100.4, FIGURE I-11, DATED 10-31-84.

7. REMARKS
****
A.) ESTIMATE ASSUMES CONTAMINATION LEVEL OF 100 MR PER DIRECTION OF PROJECT MANAGER. AN ALLOWANCE WAS USED FOR BURNOUT AND BULLPEN SUPPORT BASED ON THIS ASSUMPTION. BURNOUT WAS CALCULATED FOR ACTIVITIES THAT EXPOSED WORKERS TO THE INTERIOR OF THE TANK, SUCH AS WORK ON FLANGES, PUMPS AND DRAINS.
B.) NO SCHEDULE WAS PROVIDED FOR THIS ESTIMATE. ESCALATION IS BASED ON PROJECTED SCHEDULE FROM PROJECT MANAGER.
C.) ESTIMATE ASSUMES WORK ON THE SELECTED TANKS TO BE PERFORMED ON MASK.
D.) ESTIMATE ASSUMES GREENHOUSES TO BE CONSTRUCTED PRIOR TO THE PERFORMANCE OF THE WORK.
E.) AN ALLOWANCE WAS MADE IN THE ESTIMATE FOR BURIAL COSTS. BURIAL BOXES WERE ASSUMED TO DISPOSE OF THE PUMPS REMOVED FROM THE TANKS AS WELL AS MISCELLANEOUS CONTAMINATED MATERIAL PRODUCED BY THIS EFFORT.
F.) ALLOWANCES WERE USED FOR THE REMOVAL OF THE PUMPS AS THERE WAS NO DRAWINGS OR DETAIL OF THE CONFIGURATION OF THESE PUMPS.
G.) ALLOWANCES WERE USED FOR THE PLACEMENT OF THE MOISTURE SENSORS. THESE SENSORS ARE ASSUMED TO BE OFF THE SHELF ITEMS AND THE COST OF PURCHASING THEM BASED ON THIS ASSUMPTION.

KAISER ENGINEERS HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. ER 4916
FILE NO. Z170SAA1

** IEST - INTERACTIVE ESTIMATING **
INTRUSION PREVENTION OF 7 SELECTED SSTs
STUDY ESTIMATE
DOE_R03 - ESTIMATE BASIS SHEET

PAGE 4 OF 8
DATE 03/30/94 13:44:23
BY KDE

H.) ESTIMATE DOES NOT CONTAIN ANY EXTRA COSTS FOR WORK INSIDE THE BX AND BY TANK FARMS. ESTIMATE IS BASED ON NORMAL OPERATING PRACTICES INSIDE THE TANK FARMS.

I.) ENGINEERING AND E & I ARE BASED ON PERCENTAGES OF CONSTRUCTION DERIVED FROM HISTORICAL DATA:

ENGINEERING	- 21% OF DIRECT CONSTRUCTION
E&I	- 9% OF DIRECT CONSTRUCTION

J.) ESTIMATE ASSUMES MINIMAL INTERFERENCE WHEN REMOVING THE FOUR PUMPS FOR THE TANKS. ESTIMATE DOES NOT CONTAIN COSTS FOR REMOVING PUMPS IF THEY ARE ENTOMBED IN THE WELL CASING.

K.) WORK BEING PERFORMED IS ASSUMED TO BE FUNDED BY EXPENSE FUNDS. APPROPRIATE MARKUPS ARE APPLIED FOR EXPENSE FUNDED WORK.

KAISER ENGINEERS HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. ER 4916
FILE NO. 2170SAA1

** IEST - INTERACTIVE ESTIMATING **
INTRUSION PREVENTION OF 7 SELECTED SSTs
STUDY ESTIMATE
DOE_R04 - COST CODE ACCOUNT SUMMARY

PAGE 5 OF 8
DATE 03/30/94 14:07:57
BY KDE

COST CODE/WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING									
110000	DEFINITIVE DESIGN	576432	0	576432	2.52	14526	590958	30	177287	768246
120000	ENGINEERING/INSPECTION	247042	0	247042	8.06	19912	266954	30	80086	347040
TOTAL 000	ENGINEERING	823474	0	823474	4.18	34438	857912	30	257373	1115286
700	SPECIAL EQUIP/PROCESS SYSTEMS									
200000	PROCUREMENT	55640	0	55640	8.20	4562	60202	30	18061	78263
310100	DIVERSION BOX 241-BX-153	26009	0	26009	8.20	2133	28142	30	8443	36584
310300	TANK 241-BX-109	35531	0	35531	8.20	2913	38444	30	11534	49977
310400	TANK 241-BX-110	77966	0	77966	8.20	6393	84359	30	25308	109667
310500	TANK 241-BX-111	89894	0	89894	8.20	7371	97265	30	29179	126445
310600	TANK 241-BX-112	103070	0	103070	8.20	8451	111521	30	33456	144978
310700	TANK 241-BY-102	134408	0	134408	8.20	11021	145429	30	43630	189058
310800	TANK 241-BY-109	139248	0	139248	8.20	11419	150667	30	45200	195865
310900	BURNOUT	2083151	0	2083151	8.20	170818	2253969	30	676191	2930160
330000	BURIAL FEES	50000	0	50000	8.20	4100	54100	30	16230	70330
TOTAL 700	SPECIAL EQUIP/PROCESS SYSTEM	2794917	0	2794917	8.20	229181	3024098	30	907232	3931327
PROJECT TOTAL		3,618,391	0	3,618,391	7.29	263,619	3,082,010	30	1,164,605	5,046,613

KAISER ENGINEERS HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. ER 4916
FILE NO. Z170SAA1

** IEST - INTERACTIVE ESTIMATING **
INTRUSION PREVENTION OF 7 SELECTED SSTs
STUDY ESTIMATE
DOE_R05 - ESTIMATE SUMMARY BY CSI DIVISION

DATE 03/30/94 14:07:59
BY KDE

CSI	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
ENGINEERING										
00	TECHNICAL SERVICES	823474	0	823474	4.18	34438	857912	30	257373	1115286
	TOTAL ENGINEERING	823,474	0	823,474	4.18	34,438	857,912	30	257,373	1,115,286
CONSTRUCTION										
01	GENERAL REQUIRMENTS	2383526	0	2383526	8.20	195450	2578976	30	773693	3352666
15	MECHANICAL	411391	0	411391	8.20	33731	445122	30	133539	578661
	TOTAL CONSTRUCTION	2,794,917	0	2,794,917	8.20	229,181	3,024,098	30	907,232	3,931,327
	PROJECT TOTAL	3,618,391	0	3,618,391	7.29	263,619	3,882,010	30	1,164,605	5,046,613

REFERENCE: ESTIMATE BASIS SHEET — PAGE 3,4 OF 8
COST CODE ACCOUNT SUMMARY — PAGE 5 OF 8

THE U.S. DEPARTMENT OF ENERGY - RICHLAND ORDER 5700.3 "COST ESTIMATING, ANALYSIS AND STANDARDIZATION" DATED 3-27-85, PROVIDES GUIDELINES FOR ESTIMATE CONTINGENCIES. THE GUIDELINE FOR A STUDY ESTIMATE SHOULD HAVE AN OVERALL RANGE OF 20 TO 30%.

CONTINGENCY IS EVALUATED AT THE THIRD COST CODE LEVEL AND SUMMARIZED AT THE PRIMARY AND SECONDARY COST CODE LEVEL OF THE DETAILED COST ESTIMATE.

ENGINEERING — A 30% CONTINGENCY WAS APPLIED TO ALL ENGINEERING BECAUSE OF LACK OF DETAIL AND THE UNCERTAINTY OF THE ENGINEERING BEING BASED ON A PERCENTAGE OF CONSTRUCTION WHICH ALSO HAS A 30% CONTINGENCY.

AVERAGE ENGINEERING CONTINGENCY 30%

CONSTRUCTION — A 30% CONTINGENCY WAS APPLIED TO CONSTRUCTION AS A RESULT OF LACK OF DETAIL, UNCERTAINTIES ASSOCIATED WITH PULLING THE PUMPS, ASSUMED RADIOLOGICAL LEVELS, UNKNOWN BURIAL QUANTITIES AND THE INFLUENCE OF PERFORMING WORK WITHIN A TANK FARM.

AVERAGE CONSTRUCTION CONTINGENCY 30%

AVERAGE PROJECT CONTINGENCY 30%

KAISER ENGINEERS HANFORD
WESTINGHOUSE HANFORD COMPANY
JOB NO. ER 4916
FILE NO. 2170SAA1

** IEST - INTERACTIVE ESTIMATING **
INTRUSION PREVENTION OF 7 SELECTED SSTs
STUDY ESTIMATE
DOE_R07 - ONSITE INDIRECT COSTS BY WBS

DATE 03/30/94 14:08:00
BY KDE

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONTRACT %	ADMINISTRATION TOTAL	BID PACK PREP.	OTHER INDIRECTS	TOTAL INDIRECTS
110000	DEFINITIVE DESIGN	576432	0.00	0	0	0	0
120000	ENGINEERING/INSPECTION	247042	0.00	0	0	0	0
200000	PROCUREMENT	55640	0.00	0	0	0	0
310100	DIVERSION BOX 241-BX-153	26009	0.00	0	0	0	0
310300	TANK 241-BX-109	35531	0.00	0	0	0	0
310400	TANK 241-BX-110	77966	0.00	0	0	0	0
310500	TANK 241-BX-111	89894	0.00	0	0	0	0
310600	TANK 241-BX-112	103070	0.00	0	0	0	0
310700	TANK 241-BY-102	134408	0.00	0	0	0	0
310800	TANK 241-BY-109	139248	0.00	0	0	0	0
310900	BURNOUT	2083151	0.00	0	0	0	0
330000	BURIAL FEES	50000	0.00	0	0	0	0
PROJECT TOTAL		3,618,391		0	0	0	0