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U.S. Department of Energy (DOE), Richland Operations Office (RL) Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) Integrated Control Decision Team (ICDT) Meetings, January 22-31, 1997

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Revision 0

U. S. Department of Energy
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Final Safety Analysis Report (FSAR)

Integrated Control Decision Team (ICDT) Meetings

January 22-31, 1997

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U. S. Department of Energy
Richland Operations Office
Tank Waste Remediation System
Final Safety Analysis Report

Integrated Control Decision Team Meetings

January 22-31, 1997

Executive Summary

On November 15, 1996, the Project Hanford Management Contractor (Contractor) submitted the draft Final Safety Analysis Report (FSAR) for U.S. Department of Energy (DOE), Richland Operations Office (RL) review and guidance in preparation of the approval submittal. A review of the document was performed by a team of subject matter experts and on January 15, 1997, RL provided direction to the Contractor for enhancing the FSAR and, ultimately, the Tank Waste Remediation System (TWRS) Authorization Basis.

The FSAR was found to be based on a thorough identification of the hazards associated with the operation of TWRS. However, the analysis of postulated accidents provides severe bounding consequences which are of limited usefulness in understanding the actual TWRS risk and the effectiveness of planned safety controls. Therefore, RL considered it necessary to develop a more realistic evaluation of risk and risk reduction that will then be included in the FSAR.

To this end, RL directed the establishment of a joint RL-Contractor Integrated Control Decision Team (ICDT) to discuss the accident analysis and determine supplemental controls and future commitments for selected accidents. The Contractor was to prepare a process for conducting working sessions which would include qualitative evaluation of specific postulated accidents and selection of additional physical or administrative controls for consideration in the FSAR to further reduce risk.

The ICDT selected six postulated accidents from the draft FSAR to review. The selected accidents had analyzed consequences above the DOE directed risk evaluation guidelines defined in "Interim Radiological Dose Acceptance Criteria for the Hanford Tank Farms Safety Analysis," J. Kinzer, RL letter to A.L. Trego, WHC, 96-MSD-069, dated April 8, 1996.

The selected accidents were:

1. Organic Solvent Fire
2. Organic Salt-Nitrate Reaction
3. Spray Leak
4. Flammable Gas Deflagration
5. Steam Intrusion
6. Seismic Event

Five of the above postulated accidents exceed radiological risk evaluation guidelines. Although the postulated steam intrusion accident does not exceed the radiological risk evaluation guidelines, it was considered in the ICDT evaluation because its calculated consequences exceed toxilogical risk evaluation guidelines.

The goal of the ICDT was to examine selected accident scenarios qualitatively and identify supplemental controls that either individually or in combination with other controls would reduce accident scenario risks. The results of the meetings were to be: 1) the identification of FSAR control modifications that need to be made; 2) the identification of selected accident reanalyses that need to be conducted before the FSAR is resubmitted for approval; and 3) the identification of future FSAR commitments.
As a result of the ICDT meetings, supplemental direction is being provided to the Contractor for preparation of the TWRS FSAR.

This report describes the process the ICDT used to evaluate accidents. The interactive process utilized can serve as a tool for FSAR updates to develop an array of controls agreed to by DOE and the Contractor.

This report also contains the meeting minutes, control options considered, and conclusions reached. The control options defined in this report, which were not selected for integration into the FSAR at this time, should be re-examined during the next FSAR update.

U. S. Department of Energy
Richland Operations Office
Tank Waste Remediation System
Final Safety Analysis Report

Integrated Control Decision Team Meetings

January 22-31, 1997

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U. S. Department of Energy
Richland Operations Office
Tank Waste Remediation System
Final Safety Analysis Report

Integrated Control Decision Team Meetings

January 22-31, 1997

I. INTRODUCTION

U.S. Department of Energy (DOE), Richland Operations Office (RL) letter 97-MSD-163 dated January 15, 1997, directed the Project Hanford Management Contractor (Contractor), Fluor Daniel Hanford, Inc., to form a joint RL-Contractor Integrated Control Decision Team (ICDT) to evaluate the Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) accident scenarios that were identified to be above the risk evaluation guidelines (radiological and/or toxicological) defined by the April 8, 1996, letter from J. Kinzer, RL-TWRS (96-MSD-069) to Dr. A. L. Trego, Westinghouse Hanford Company.

The ICDT evaluated six postulated accidents from the draft FSAR which had analyzed consequences above the DOE directed risk evaluation guidelines after controls were applied. The accidents were:

1. Organic Solvent Fire;
2. Organic Salt-Nitrate Fire;
3. Spray Leak;
4. Flammable Gas;
5. Steam Intrusion; and
6. Seismic Event.

Five of the postulated accidents exceed radiological risk guidelines. Although the postulated steam intrusion accident does not exceed the radiological risk guidelines, it was considered in the ICDT evaluation because its calculated consequences exceed toxicological risk evaluation guidelines. Figure 1 delineates the mitigated and unmitigated risk evaluations performed for the FSAR.

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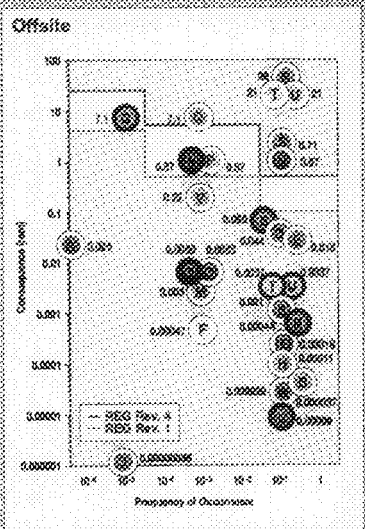
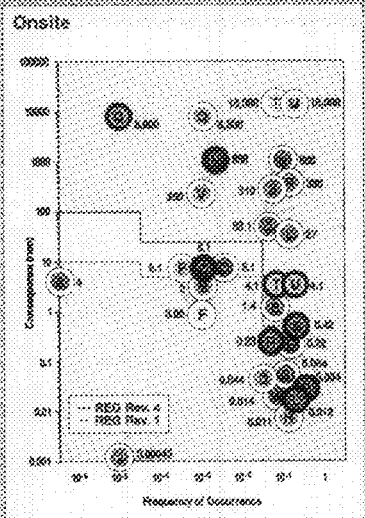
Mitigated and Unmitigated Risk Evaluations





Nuclear Criticality
HEPA Filter Failure
Fire in Contaminated Area
Evaporator Dump
Steam Intrusion
Leak from Railcar/Tank Trailer
Subsurface Leak Remaining Subsurface
Excavation/Drilling in Ditch/Crib/Pond
Caustic Spray Leak (do not commission)
Sodium Fire - Initiator High Wind
Incompatible Waste Toxic Vapors (do not commission)
Mixing of Incompatible Material
Tank Failure Excessive Loads
Flammable Gas Deflagration (1) Slowly Rate 2) Not Release Area)
Organic Solvent Fire
In-Tank Fire/Fire Deflagration
Organic Nitrate Fire
Surface Leak Resulting in Pool
Subsurface Leak Pool
Severe Overground Structure/Transfer Lines
Excavation Accident (Spray Release)
Tank Bump
Above Ground Structure Failure
Waste Transport Vehicle Accident (addressed by other)
Mitigated
Unmitigated

All five of the accidents which exceed Radiological Risk Evaluation Guidelines are shown on this figure: Organic Solvent (O), Organic Salt-Nitrate (Q), Flammable Gas (N), Spray Leak (U), and Seismic Event (comprised of several accident scenarios including all of the above). The Steam intrusion accident exceeds toxicological Risk Evaluation Guidelines and does not appear on this figure.

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The six accident scenarios evaluated during the ICDT meetings are included as appendices to this report. Each appendix includes:

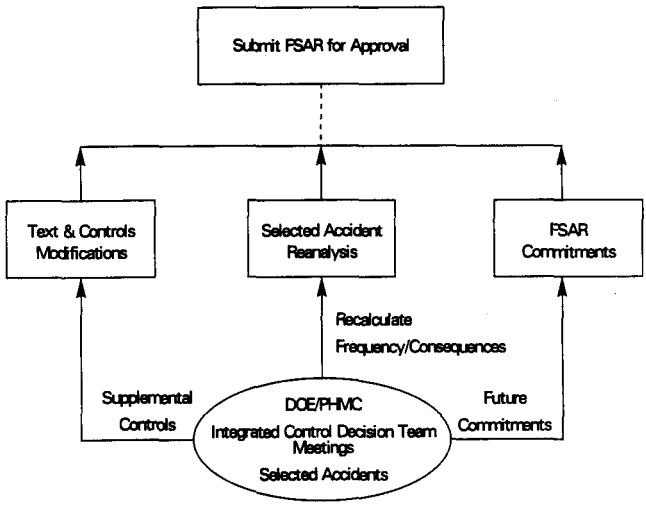
- The meeting minutes;
- The accident presentation;
- The table identifying the complete suite of controls resulting from the brainstorming session with the controls selected marked; and
- The data evaluation sheets.

It is RL's expectation that the FSAR, when submitted for approval, will clearly describe the process that will be used for safely managing TWRS. It was the goal of the ICDT to examine selected accident scenarios qualitatively and identify supplemental controls that either individually or in combination with other controls would reduce accident scenario risks.

The output from the ICDT meetings was to consist of: 1) the identification of FSAR control modifications that need to be made; 2) the identification of selected accident reanalyses that needed to be conducted before the FSAR was submitted for approval; and 3) the identification of future FSAR commitments. Figure 2 delineates the purpose of the ICDT meetings.

Figure 2

Purpose of the ICDT Meetings



II. THE ICDT PROCESS

The ICDT Process section consists of four parts: 1) Orientation Session; 2) Planning Session; 3) ICDT Meeting Structure; and 4) Evaluation of Results.

1. Orientation Session

During the morning of January 22, 1997, an Orientation Session was held for ICDT participants. The Orientation Session included:

a. An introduction of ICDT participants.

Participants consisted of RL and Contractor personnel from various organizations with various expertise (e.g., TWRS, ES&H). DOE-Headquarters (DOE-HQ) personnel and Defense Nuclear Facilities Safety Board (DNFSB) staff were invited to observe the meetings.

b. A presentation of hazard analysis/accident analysis information.

Hazards analysis and accident analysis information used by the Contractor during preparation of the FSAR was presented to inform ICDT participants of the information available.

c. A presentation of the control decision process/criteria.

The process used by the Contractor in selecting controls to mitigate postulated accidents and hazardous conditions as part of preparing the draft FSAR was reviewed and proposed as a starting point for developing the ICDT decision process.

d. A presentation of the current status of TWRS calculated risk.

The Contractor identified where the TWRS risk guidelines would be met by FSAR controls and where additional analysis or controls might be of value in understanding and reducing risk.

e. A presentation on the safety analysis evaluation/path forward.

The Contractor outlined the work planned prior to submitting the FSAR for approval.

f. The identification of the overall objectives for each ICDT meeting. The objectives were to:

1) Review the Contractor control decisions for accidents presented; and

2) Identify the recommendations for managing risk (i.e., additional controls for inclusion in the FSAR, controls for future implementation, and analytical activities to improve the understanding of risk).

g. The identification of the ground rules for the ICDT meetings. The ground rules were:

1) Focus the meeting on reasonableness of the suite of controls;

2) Make control decisions in the context of the existing control; and

3) Limit discussion to areas which relate to waste storage and transfer.

h. The identification of the deliverables that would result from the ICDT meetings. The deliverables would be:

1) Final Report containing the meeting minutes, a definition of the decision process used, the control options considered and the conclusions reached; and

2) Letter of Direction from RL to the Contractor providing the path forward to finalizing the TWRS FSAR .

2. Planning Session

During the afternoon of January 22, 1997, the ICDT conducted a planning session to clarify the control evaluation process. The following products were the result of the Planning session:

a. Control evaluation process

The control evaluation process is depicted in Figures 3 and 4. The process was interactively carried out by the participants with the goal of identifying specific controls for further analysis in the FSAR. The following steps were included in the process:

1) Select an accident. Each of the accidents was selected by the participants for evaluation on a separate date to allow a very focused discussion.

2) Brainstorm the controls. Following a discussion of the postulated accident and currently proposed controls, a brainstorming session was held to identify additional controls to be considered. The potential controls were listed on a white board during the meeting.

Figure 3

Control Evaluation Process

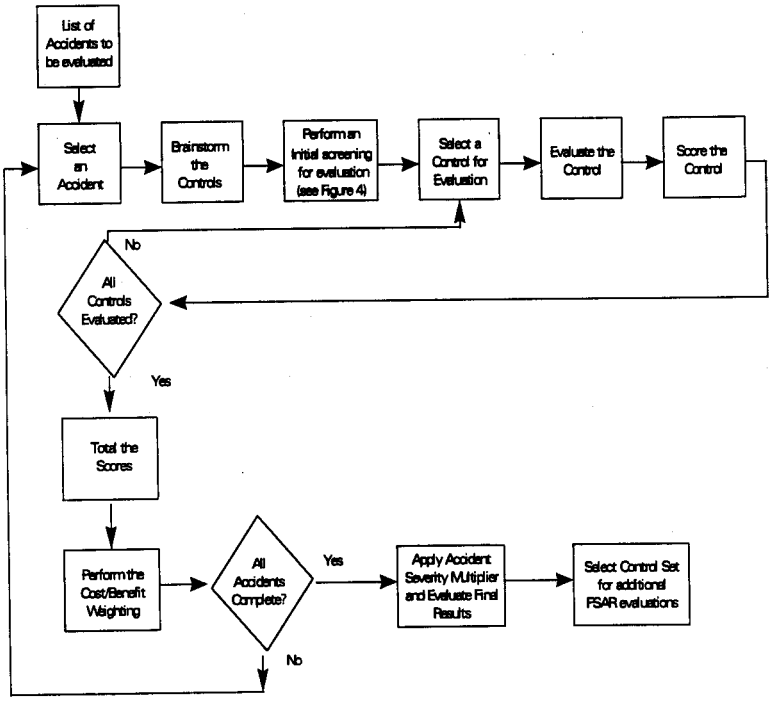
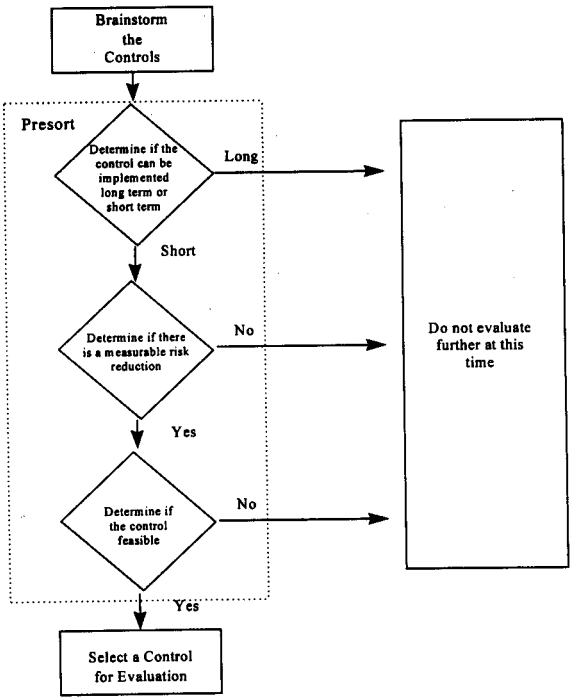


Figure 4

Details of the Control Initial Prescreening Process



3) Perform an initial screening. In order to achieve a reasonable set of controls for further evaluation, an initial screening was held to identify whether: a) the control would be implemented in a time period short enough to gain reasonable safety benefits (normally three years); b) there was a measurable risk reduction; and c) implementing the control was feasible. Figure 5 is an example tabulation of the brainstorming list. In the figure, a specific control is identified as to whether the control is short or long term and whether the control was selected for evaluation based on potential benefit and feasibility.

4) Select a control for evaluation. From the listing of controls that passed the initial screening, each control was taken in sequence for further evaluation.

5) Evaluate the control. Each control was evaluated in a discussion format during the meetings and summarized on the form depicted in Figure 6. The definitions for each criteria are described in Section II.2.b. The level of evaluation was arrived at by group consensus and recorded along with key qualifying comments for clarification.

6) Score the control. For each level rating (i.e., high, moderate, or low) numerical scores were determined based on the process described in Section II.2.c. The numerical rating process was intended to provide a relative evaluation of controls as an aid in decision making.

7) Total the scores. When all controls for a particular accident were evaluated and scored, a subtotal score was determined for the parameters of feasibility, optimization, and preference.

8) Perform the cost/benefit weighting. The subtotal scores for each potential additional control were multiplied by a weighting factor based on the cost/benefit score. The determination of weighting factors is depicted in Section II.2.f. The scoring determinations for each accident was summarized as depicted in Figure 7, and graphically as depicted in Figure 8.

9) Apply accident severity multiplier and evaluate final results. When controls for all the accidents were fully scored, a severity multiplier was applied. The multiplier was used to normalize scores for controls, across all the accidents, to ensure that the value of a control from one accident could be compared to controls for other accidents.

Figure 5

Organic Salt-Nitrate Accident - Initial Controls

Term	Evaluated	Control
S	√	Accelerate filter change out
S	√	Prohibit flame cutting
S	√	Markers at tank riser
S	√	Catenary lightning systems
S	√	Area radiation monitoring/personnel
S	√	Waste tank cooling system
L		In-tank chemical treatment
S	√	Tank sprinklers
L		Waste mixing
S	√	Prohibit/remove all ignition filaments
	√	Revamp ventilation (S) to prevent tank pressurization and/or mitigate (L) release
L		Additional saltwell pumping
L	√	Tank Misting - Add moisture/monitoring - Fog generator
L		Add surface fire retardant
S		Waste surface moisture monitoring
S	√	Temperature/evacuation alarm
S		Smoke detector alarm
S		Sniffers (vapors)
L		Baffles to isolate waste
L		Debris collector
L		Selected retrieval
L		New storage design
S	√	Ventilation coolers - Ventilation coolers (chilled air) - Recirculate coolant gas
S		Coil insertion (cooling waste)
S		Tarp/cover and gravel mix
L		Rupture disk/separator

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Ventilation Cooler

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M *Impact on Operations* (TWRS)	Moderate	2	New equipment to operate/SSC
H Impact on Worker	Low	23	Simple training, minimum dose impact
H Technical Feasibility	Moderate	7	Transfer properties, localized heat
L *Mission Impacts*	Low	3	
H Timeliness of Control Implementation	Moderate	7	Actively ventillating passive systems
H Installation Risk	Moderate	7	Potential waste drying
Feasibility Subtotal		49	
2. Optimization of Controls			
H Reliability	High	30	Availability, heating is slow
M Human Factors Practicality	High	10	
H Applicability to Multiple Accidents	High	30	Tank bump but not flammable gas
H Compatibility of Controls	Low	3	Effects other monitoring & controls, possible ice containment of gas
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention
M Engineered over Administrative	High	10	*Engineering control*
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	
Cost/Benefit Subtotal		40	

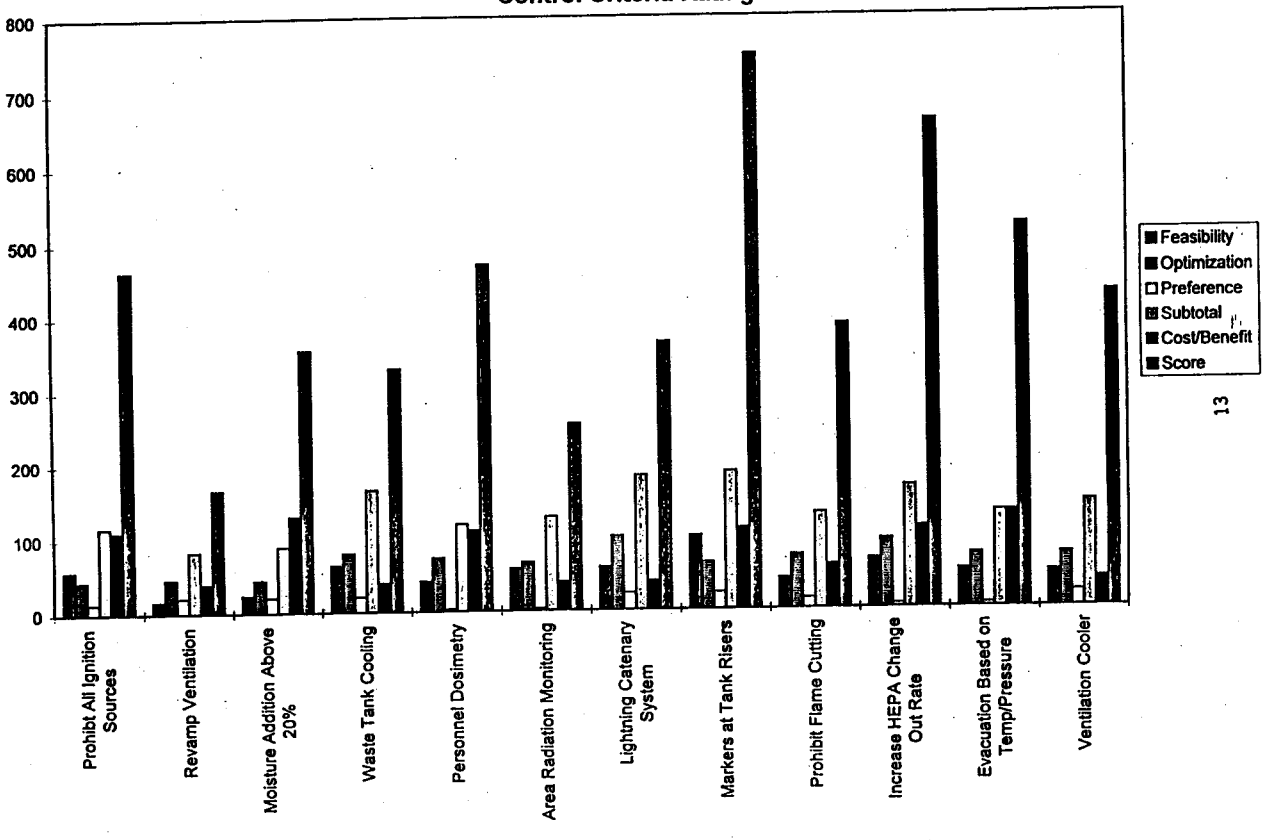
Figure 6

Figure 7

Organic Salt Nitrate
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Tank Sprinklers	48	26	12	0	130	4	**0**
Prohibt All Ignition Sources	58	44	14	116	110	4	**464**
Revamp Ventilation	16	46	21	83	40	2	**166**
Moisture Addition Above 20%	24	44	21	89	130	4	**356**
Waste Tank Cooling	64	80	21	165	40	2	**330**
Personnel Dosimetry	42	73	3	118	110	4	**472**
Area Radiation Monitoring	58	66	3	127	40	2	**254**
Lightning Catenary System	59	100	23	182	40	2	**364**
Markers at Tank Risers	100	64	23	187	110	4	**748**
Prohibit Flame Cutting	42	73	14	129	60	3	**387**
Increase HEPA Change Out Rate	67	93	5	165	110	4	**660**
Evacuation Based on Temp/Press	52	73	5	130	130	4	**520**
Ventilation Cooler	49	73	21	143	40	3	**429**

Figure 8
Organic Salt-Nitrate Control Criteria Rating



10) Select control set for additional FSAR evaluations. With the aid of the scoring process, several controls were selected for additional evaluation in the FSAR. The controls are believed to be achievable in a reasonable time and would provide measurable improvements in risk reduction.

b. Control selection initial prescreening criteria (Figure 4)

1) Long/Short Term

Each control was examined to determine the length of time necessary to implement the control. Controls were then divided into two categories: 1) those that would take less than 3 years to implement (Short Term), and 2) those that would take more than 3 years to implement (Long Term). The Short Term controls were retained for further evaluation.

2) Benefit/Consequence

The second screening considered the magnitude of the impact on the accident. Controls with little or no discernable impact on the accident frequency and/or consequences were eliminated.

3) Feasibility

Controls remaining from the second screening (Benefit/Consequence) were examined to determine the technical feasibility. Controls based on standard industry practice were included on the list to provide a robust list of technically feasible options. Untested technology, new concepts, and/or impractical ideas were not carried forward for further evaluation at this time.

c. Control evaluation scoring

Control evaluation scores were established to provide a relative quantification for comparison among the additional controls. Figure 9 is a compilation of the judgement of RL participants. The ratings were used to generate numerical scores to be translated to the evaluation form for each control. The score for each criteria is listed under the columns titled High, Moderate and Low.

Initial subtotal scores were developed for each control by adding the scores for feasibility, optimization and preference based on the following equation:

(Feasibility + Optimization + Preference) = Subtotal

Figure 9

Criteria Evaluation Scoring

Criteria	High	Moderate	Low
1. Feasibility of Implementation			
Impact on Operations (TWRS)	1	2	6
Impact on Worker (ALARA and Training)	2	7	23
Technical Feasibility (Demonstrated/Off-Shelf)	23	7	2
Mission Impacts (Site)	0	1	2
Timeliness of Control Implementation	23	7	2
Installation Risk (New Hazard)	2	7	23
2. Optimization of Controls			
Reliability	30	10	3
Human Factors Practicality (Surveillance of Control)	10	3	1
Applicability to Multiple Accidents (Robustness)	30 (Yes)	10	3 (No)
Compatibility of Controls	30 Compliments	10 Neutral	3 Conflicts
3. Preference of Control Suite			
Prevention over Mitigation	10	3	1
Engineered over Administrative	10	3	1
Passive over Active	10	3	1
4. Cost/Benefit			
Qualitative Benefit of Controls	100	30	10
Capital Costs plus Operating, Life Cycle Costs	10	30	100

d. Control evaluation score weighting and multipliers

Weighting factors were determined for cost/benefit. Accident multipliers were established to allow the comparison of controls from different postulated accidents.

1) Cost/Benefit Weighting

Weighting factors were developed utilizing the cost/benefit scores as an aid in differentiating among controls. The following tabulation depicts weighting factors from 1-6 with 6 being the highest multiplier for the greatest cost/benefit score.

Cost/Benefit Range Determination

Score	Weighting Factor
20	1
40	2
60	3
110	4
130	5
200	6

Total raw scores for each control are determined based on the following equation:

(Feasibility + Optimization + Preference) x (Cost/Benefit Weighting) = Score

2) Derivation of Accident "Multipliers"

The ability to compare controls across accidents for purposes of determining investment strategies was necessary. To allow this, an accident severity multiplier was developed. Figure 10 identifies the basis for multipliers of 1-3 with the higher number being applied to the most serious potential accident consequences.

By utilizing this multiplier, the final rating is derived from the following equation:

(Feasibility + Optimization + Preference) x (Cost/Benefit Weighting) x (Accident Multiplier) = Final Rating

Figure 10

Derivation of Accident "Multipliers"

Multiplier	Accident with Controls	Radiological [a]	Toxicological [a]
2	Organic Solvent	6	40
3	Organic Nitrate	8,800	1,000
3	Flammable Gas	23,400 (Flammable Gas Detonation)	500[b]
1	Spray Leak	4	OK
2	Steam Intrusion	OK	93
3	Seismic Event	23,400 (Flammable Gas Detonation) 15,000 (Spray Leak)	500[b]

Notes:
a. Onsite receptor
b. Based on Beyond Evaluation Basis accident calculations for onsite toxicological consequences using 50% meteorology

e. *Control criteria definitions*

The control criteria definitions were developed by the RL participants of the ICDT meetings. Four categories were identified for the control criteria:

1) Feasibility of implementation
2) Optimization of controls
3) Preference of control suite
4) Cost/benefit

The categories and the criteria (with definitions) are provided below.

1) *Feasibility of Implementation*

Impact on Operations (TWRS)

Controls that affect the TWRS Program mission, that would curtail critical activities, such as, saltwell pumping and/or waste consolidation, and would have an impact on operations. Controls with a high impact on operations would:

- Curtail operations that affect the TWRS mission.
- Curtail future cleanup operations (e.g., high-level or low-level waste treatment).
- Prevent TWRS from meeting waste volume projection goals.
- Prevent TWRS from achieving external commitments.

Impact on Worker

Controls that affect "As Low As Reasonably Achievable (ALARA)" projections or current operational practices (e.g., training, staffing levels, Conduct of Operations practices) and would have an impact on workers. Controls with a high impact on workers would:

- Require additional manpower than that already required.
- Increase exposure or impose additional hazards to the worker.
- Require workers to have significantly more training to be qualified to perform activities.

Technical Feasibility

Controls that are readily available and proven in the industry to be reliable. Controls that have a high technical feasibility would:

- Be an off-the-shelf piece of hardware.
- Have a high known reliability factor based on industry experience.

Mission Impacts

Controls that prevent the accomplishment of any of the Hanford Strategic Goals would have an impact on the Hanford Site and/or TWRS mission. Controls that would have a high impact on the mission would prevent Hanford Site program elements, other than TWRS, from performing their mission (e.g., K-Basin Sludge Storage).

Timeliness of Control Implementation

A control was considered of high value for consideration, if its risk reduction benefits could be fully realized within the next fiscal year. A low rating was given for up to three years. Greater than three years to full implementation would result in the control not having passed initial prescreening.

Installation Risk

By installing some controls, new hazards may be created. Controls that would receive a high negative rating in this category would cause an increase in the risk of any hazard through its installation.

2) Optimization of Controls

Reliability

Controls which are considered reliable, and would receive high ratings, are controls that:

- Perform the task selected for with minimal false alarms.
- Capable of operating within a defined environment for an extended period of time.
- Require little or no maintenance.

- Require limited administrative controls.
- Provide accurate data in a timely manner.
- Have tested/proven technology.

Controls which would receive low ratings would:

- Generally be complex.
- Have a significant potential for false indications.
- Require substantial administrative controls.

Human Factors Practicality

Controls that take human factors into consideration are controls that are easily operated and maintained by qualified personnel. Controls that receive a high rating are:

- Of minimal psychological impact.
- Located in areas with minimal hazards to maintenance and operations personnel.
- Positioned to ensure that information is easily retrieved by maintenance and operations personnel.
- Cause minimal impact to personnel workload.

Controls that would receive low ratings are:

- Controls that present a hazard to maintenance and operations personnel.
- Controls that are difficult for maintenance and operations personnel to use.
- Controls that are not accessible to maintenance and operations personnel

Applicability to Multiple Accidents

Controls that are applicable to multiple accidents have greater benefit than controls applicable to only a single accident. To achieve a high rating, the controls should:

- Achieve beneficial effects directly to the prevention or mitigation of more than one accident.
- Not degrade the effectiveness of existing or planned controls.

Controls would be rated low if:

- Degraded planned or existing controls.
- Increased the probability or consequences of accidents.

Compatibility of Controls

Controls are deemed compatible and given a high rating if they:

- Do not damage the effectiveness of other controls.
- Do not create new hazards.
- Do not increase the consequences or probability of known accidents.
- Enhance existing controls.

3) Preference of Control Suite

Certain characteristics of the controls can be compared to establish preference. It is generally more desirable to prevent an accident than to minimize the impact after the accident occurs. Engineered control features have been found to be more reliable than administrative because they normally do not require a decision and action on the part of operating personnel. Passive controls are generally more likely to function properly than active controls because no physical movement or operation is required for them to function. Each potential control was scored based on these characteristics.

Prevention over Mitigation

- Prevention is preferred because greater safety exists if the event does not happen.
- Mitigation is rated lower because limiting the effect of an event is less of a consideration to safety than preventing the event.
- A combination of prevention and mitigation would receive a medium rating.

Engineered over Administrative

- Engineered solutions rely on a feature that performs a designated function that is not dependent on human interaction and is rated high.
- Administrative features are assumed to rely on human interaction which is generally less reliable than engineered features and is rated low.
- Combination of engineered and administrative solutions are rated medium.

Passive Over Active

- Passive features generally perform the safety function without added energy or activation. Passive features are highly reliable and are rated high.
- Active features perform the safety function with the addition of energy or activation. Active features are less reliable and are rated low.

4) Cost/Benefit

To determine a score for cost/benefit, the judgement of Contractor and DOE representatives was relied upon because actual cost estimates and risk analyses were not available.

Qualitative Benefit of Controls

Qualitative, and if available, quantitative decrease of dose and/or frequency were determined relative to the risk evaluation guidelines. Generally, the judgement of the personnel present was the basis for determining the benefits.

- Rating per level of risk improvement

Low rating	Risk improvement <5%
Medium rating	Risk improvement 5% to 25%
High rating	Risk improvement ≥ 25%

In performing the cost/benefit analysis both toxicological and radiological risk, and on-site and off-site consequences were considered.

Capital Costs plus Operating, Life Cycle Costs (LCC)

- For the purposes of the evaluation, the judgement of personnel present was used as the basis for cost expectations.

- LCC were considered in the evaluation. The costs include initial capital cost, design, construction, installation, operations, maintenance, decontamination and decommissioning, and disposal. Controls having a low LLC would receive a high rating.

- Control options that had low secondary costs (i.e., secondary waste generation) received high ratings.

- With the implementation of a control, certain costs could be avoided. The costs include:

  - If an accident is prevented, the cost of recovery is avoided. Avoided costs include environmental damage, site cleanup, facility repair, and potential injury to people. High ratings were given when the potential cost avoidance was judged to be high.

- The elimination of administrative controls by implementing a new control. High ratings were given when the potential cost avoidance was judged to be high.

- Control LCC were defined as follows:

Low LCC	< $5M
Medium LCC	$5M - $20M
High LCC	> $20M

3. ICDT Meeting Structure

Meetings were scheduled for each day during the period January 22-31, 1997. The day prior to each meeting, a package was given to each of the participants identifying the specific accident to be covered the next day. The package consisted of the accident analysis writeup from the FSAR and a hard copy of the accident presentation.

The agenda for each day was structured as follows:

a. Review previous day's results;

b. Present accident analysis and previously identified controls;

c. Discuss (brainstorm) potential controls;

d. Apply control prescreening criteria ;

e. Evaluate selected controls; and

f. Summarize the day's results.

III. CONCLUSIONS

Final qualitative evaluation of the full set of potential additional controls supported by the scoring process was discussed on January 31, 1997. Resulting planned modifications in the content of the FSAR and other actions are described in the following sections.

1. Control Modifications

The ICDT process identified promising controls for further evaluation. Because the process was qualitative, final decisions on the control suite will be based on analytical processes of FSAR preparation and review.

Figure 11 depicts the numerical results from the evaluation of potential additional controls. From the evaluation and discussion among RL-TWRS management, several controls were selected for analysis in the FSAR. For each of the following accident scenarios, it was determined appropriate to evaluate the effectiveness of the listed controls and incorporate the results in the FSAR, prior to submittal to RL for approval.

Accident Scenario	Control
Organic Salt-Nitrate Reaction	Tank farm evacuation based on temperature and pressure alarms
Spray Leaks	Leak detectors in valve pits
Steam Intrusion	Blanking of steam jet lines used in the transfer of waste
Seismic Event	Addition of seismic monitors within the 200 area

To address the organic solvent fire and flammable gas deflagration accident scenarios, a study will be included in the Fiscal Year (FY) 1998 Multi-Year Work Plan (MYWP) to determine the feasibility of establishing an inert atmosphere within the head space of each waste tank. If the control is determined to be feasible, it will be incorporated into the next update of the FSAR.

Two of the proposed controls, blanking of steam jet lines and seismic monitors, present a considerable benefit towards reducing risk in TWRS operations. Blanking of steam jet lines, for example, will eliminate the steam intrusion accident scenario completely. As a result, the Contractor should evaluate what impacts would result from blanking the steam jet lines during FY 1998 and to complete installation of seismic monitor controls in the 200 area within the next three years.

2. Selected Accident Reanalysis

During discussions, it was determined that some reanalysis is necessary to achieve a minimum technically credible result. Several specific components of the analysis were determined to be essential for the FSAR to be approved. This is based on the recognition that as additional waste characterization and safety issues resolution data becomes available, further analytical enhancements will be accomplished and included in future updates of the FSAR. The following enhancements were identified for the approvable FSAR:

a. Account for realistic plume rise and plume depletion models in the analyzed scenarios;

b. Refine the modeling of valve pit size for the spray leak scenario analysis; and

c. Modify the steam intrusion event to account for actual steam introduction rates expected.

3. Future FSAR Commitments

No specific items were identified as a result of this process. However, several generally recognized facts should be clearly stated in the FSAR that have future implications including:

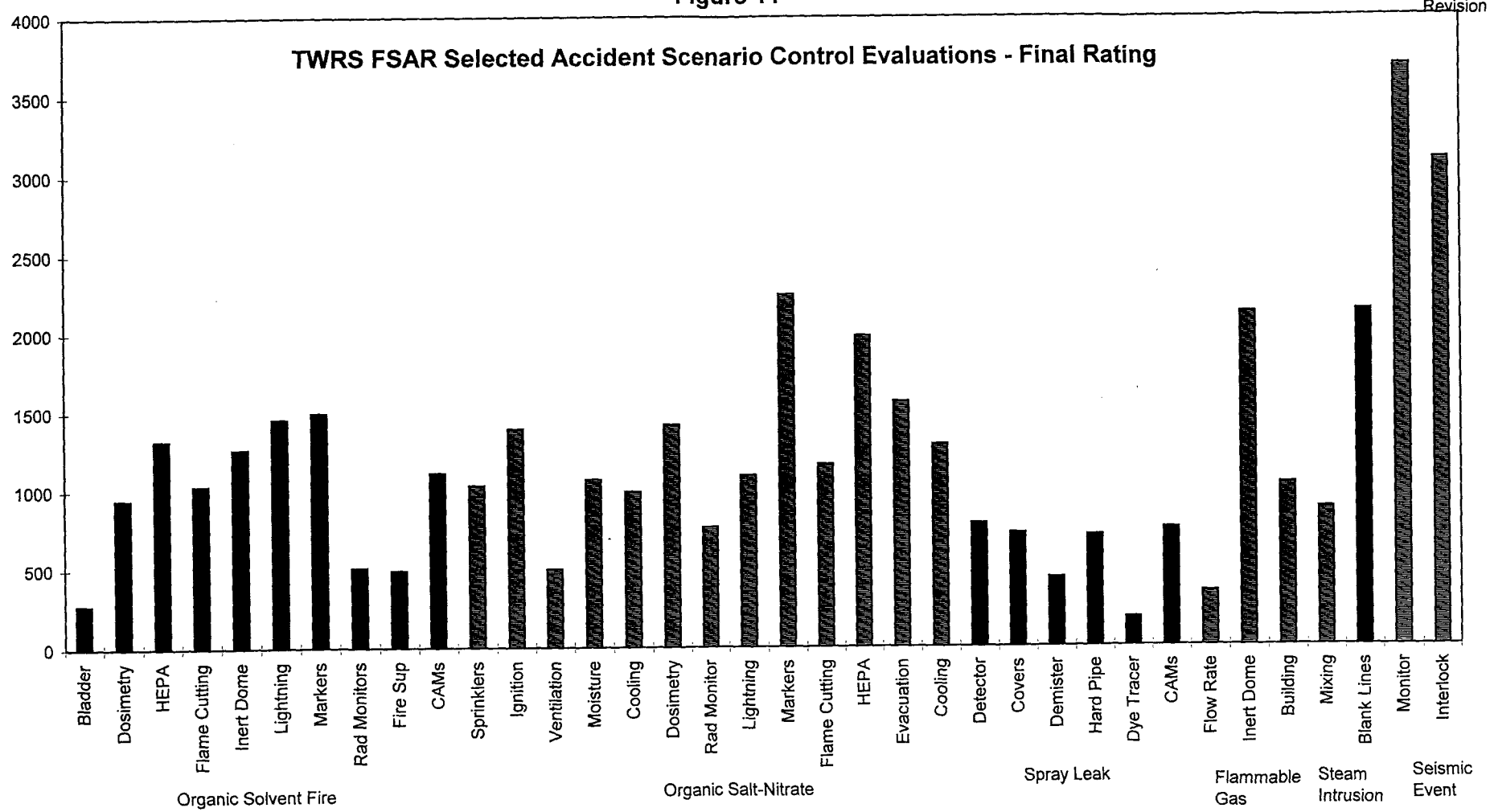
a. In several cases, the accident analysis covers topics that are unresolved safety issues, that of necessity, must be based on conservative assumptions at this time. As the Safety Issues Resolution Program achieves a more clear understanding, new knowledge will be reflected in FSAR annual updates.

b. The source term is extremely conservative and will be updated based on waste characterization.

c. This FSAR represents a phased upgrade of the TWRS Authorization Basis and reflects on an evolving understanding of the real risk in the TWRS operation. It is the judgement of experts preparing and reviewing the FSAR, that the currently calculated risk as implied by the accident analysis is greater than the real risk.

d. The real risk of TWRS is managed and minimized by engineered and administrative controls selected from a combination of analysis and expert judgement. As the process to upgrade the TWRS Authorization Basis continues, and risks can be more realistically analyzed based on credible data, less conservative judgement will be defendable.

Figure 11


TWRS FSAR Selected Accident Scenario Control Evaluations - Final Rating
4000
3500
3000
2500
2000
1500
1000
500
0
Bladder
Dosimetry
HEPA
Flame Cutting
Inert Dome
Lightning
Markers
Rad Monitors
Fire Sup
CAMs
Sprinklers
Ignition
Ventilation
Moisture
Cooling
Dosimetry
Rad Monitor
Lightning
Markers
Flame Cutting
HEPA
Evacuation
Cooling
Detector
Covers
Demister
Hard Pipe
Dye Tracer
CAMs
Flow Rate
Inert Dome
Building
Mixing
Blank Lines
Monitor
Interlock
Organic Solvent Fire
Organic Salt-Nitrate
Spray Leak
Flammable Gas
Steam Intrusion
Seismic Event

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TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 22, 1997

These minutes and the attachments document the material covered and processes discussed at the Orientation and Planning Sessions to be used during the series of FSAR Integrated Control Decision Team meetings. The series of meetings will provide DOE-RL the information and forum to provide "directed" input into the FSAR at this time, instead of waiting until the Safety Evaluation Report (SER) stage to impose additional controls or future commitments.

Observers to these sessions, either in the room or linked via a teleconference were DOE-HQ (EM-4, EM-38, and FDH S-3) personnel and DNFSB staff. The attendance sheet is attached.

The Orientation Session agenda is attached, as well as the formal presentations presented by Jon Young (Hazard and Accident Analysis) and Larry Kripps (Contractor's FSAR Control Selection Process). Following the break, a brief discussion was held on the FSAR Results to date and ongoing work.

The next major discussion focused on which "selected" accidents the team was scheduled to review. The team reviewed the logic used to generate the initial list of accidents. The logic was developed using a recommendation from Ed Lipke's work associated with SEN-35-91 and the BIO results.

Following group discussion, DOE held an executive session, and for this series of meetings, decided that the accidents to be reviewed at this time were the six accidents reported in the FSAR as still being above risk evaluation guidelines (radiological and toxicological) with controls applied. The accidents that meet this criteria are Organic Solvent, Organic Salt-Nitrate, Seismic, Flammable Gas, Steam Intrusion, and Spray Leaks.

The daily agenda and meeting objectives were reviewed. The meeting objectives, as modified, are attached.

The remaining morning discussion focused on control selection criteria (or values). The criteria the Contractor used was reviewed followed by a brainstorming session for the criteria appropriate for this review. DOE then met to prioritize/weight the criteria and flowchart the process for application.

The Organic Solvent review material was handed out. The session ended at 3:00 p.m.

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TWRS FSAR Integrated Control Decision Meetings
Attendance List

January 22, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Dennis Irby	RL-TWRS
Fran DeLozier	TWRS, LMHC
Keith Hampton	TWRS, FDH
Rick Tedeschi	TWRS, LMHC
Surya Maruvada	ES&H, FDH
Ko Chen	RL-TWRS
Jon Young	TWRS, MSI
Don Foss	TWRS, GSSC
Ben Harp	RL-TWRS
Diane Clark	RL-TWRS
Mark Jackson	RL-ESH
Carol Sohn	RL-TWRS
Maureen Hunemuller	RL-TWRS
Michael L. Cowen	WSRC
Vince Saladin	RL-TWRS
Michael Mikolanis	DOE-HQ, S-3
Sandy Trine	RL-DNFSB Liaison
Paul Gubanc	DNFSB Hanford Representative
Via Teleconference	
Tim Veneziano	FDH S-3 (on detail to DOE-HQ)
Chandra Majumdar	DOE-HQ, EM-4
Tom Wright	DOE-HQ, EM-38
Ralph Arcaro	DNFSB

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TWRS FSAR Control Decision Review Meetings

January 22-31, 1997

January 22, 1997 Agenda

Orientation	7:00-9:30 a.m.
Introductions	
Hazard Analysis/Accident Analysis	Young
Control Decision Process/Criteria	Kripps
Current Status of TWRS Risk	Dunford
Safety Analysis Evaluation/Path Forward	Dunford
Break	9:30-10:00 a.m.
Planning	10:00-12:00 p.m.
Daily Agenda	
Objectives	
Results	
Ground Rules	
Open Discussion	

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TWRS FSAR Integrated Control Decision Meetings

Issue

The FSAR has several accidents with scenarios above evaluation guidelines. DOE needs to evaluate selected accidents to ensure that an appropriate set of controls are committed to as part of the FSAR.

1. Are there existing or near term controls that could be applied to further reduce selected accident consequences/frequency?

2. Are there future hardware installations, investigations, or analyses that should be "committed" to that can practically/reasonably reduce accident consequences/frequency?

Solution

Establish a RL-Contractor team to evaluate controls using a modified "control decision process" similar to that used during FSAR development. The output from the joint DOE/PHMC Integrated Control Decisions Meetings are expected to be supplemental controls, inputs into selected accident reanalysis, and future FSAR commitments.

Scope

Use the control decision process on selected accidents, and the related items that the Contractor recommended for consideration in FSAR Section 3.3.2.3.5, "Planned Design and Operational Safety Improvements," to identify supplemental controls, inputs to selected accident reanalysis, and future FSAR commitments.

Schedule

Weekday	Date	Time	Topic
Wednesday	1/22/97	7:00-12:00 p.m.	Orientation/planning
Thursday	1/23/97	7:00-12:00 p.m.	Organic Solvent
Friday	1/24/97	7:00-12:00 p.m.	Organic Nitrate
Monday	1/27/97	7:00-12:00 p.m.	Spray Leaks
Tuesday*	1/28/97	10:00-12:00 p.m.	Spray Leaks
Wednesday	1/29/97	7:00-12:00 p.m.	Flammable Gas
Thursday	1/30/97	7:00-12:00 p.m.	Steam Intrusion/Seismic
Friday	1/31/97	7:00-12:00 p.m.	Seismic/Flammable Gas

Tuesday's meeting will be held at 2704HV, Room G229. All other meetings will be held in the Federal Building, Room 249. There will be a break from 9:30-10:00 a.m. each day.

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Tank Waste Remediation System
Final Safety Analysis Report
Hazard and Accident Analysis Process

January 1997

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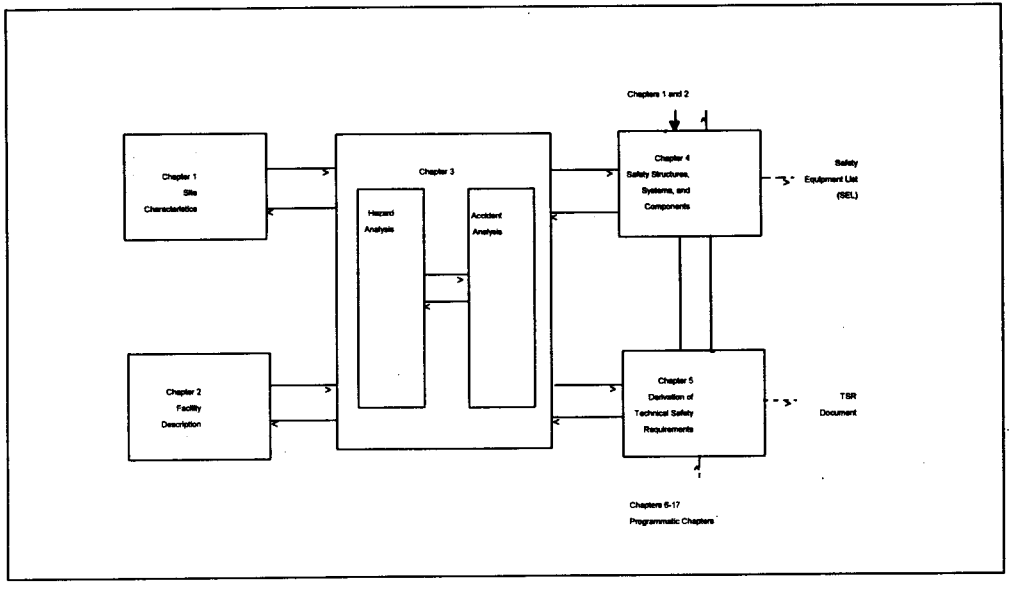
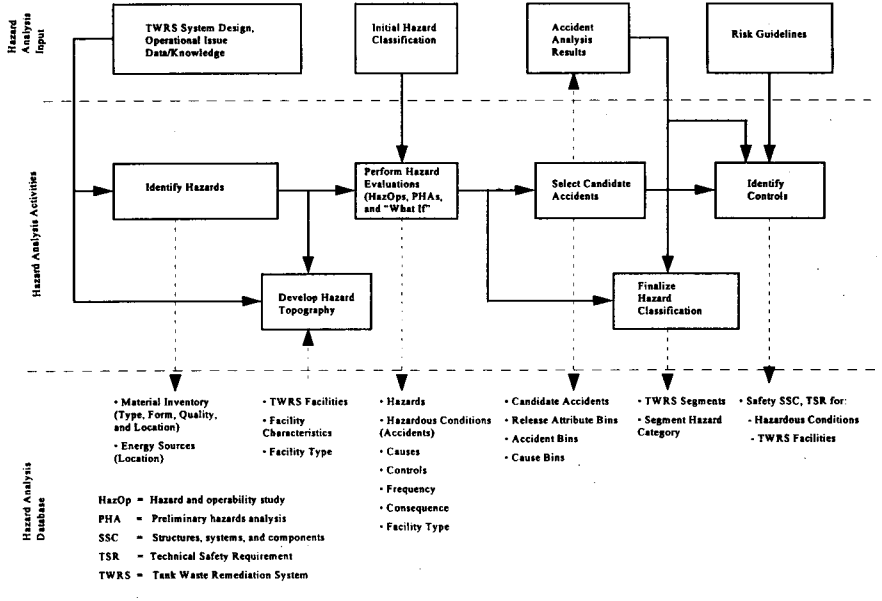
TWRS FSAR Chapter 1-5 Integration



Hazard Analysis Process



Candidate Accident Selection

All hazardous conditions identified as having the potential for significant offsite (S3) or onsite (S2) consequences.

- Release attribute assignments
- Binning
  - release attribute
  - cause
- Selection criteria application to each release bin
  - bounding consequence
  - highest risk (frequency and consequence)
  - unique
- Representative set of accidents for hazardous conditions identified

Accident Reconciliation

Results in identification of accidents for quantitative analysis.

- Determines set of representative accidents analyzed based on consideration of:
  - accident phenomena
  - bounding consequences
  - representative cases
- All hazardous conditions (S3 and S2) rebinned by set of representative accidents

Risk Guidelines

Event frequency category	Event frequency (yr^{-1})	Effective dose equivalent mSv	
		Onsite	Offsite
Radiological risk guidelines			
Anticipated	$>10^{-2}$ to 10^{0}	5.0 E-03 (0.5)	1.0 E-03 (0.1)
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	50.0 E-02 (5)	5.0 E-03 (0.5)
Extremely Unlikely	$>10^{-6}$ to $\leq 10^{-4}$	100.0 E-01 (10)	40.0 E-02 (4)
Event frequency category	Event frequency (yr^{-1})	Primary concentration guidelines	
		Onsite	Offsite
Toxic chemical risk guidelines			
Anticipated	$>10^{-2}$ to 10^{0}	$\leq$ ERPG-1	$\leq$ PEL-TWA
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	$\leq$ ERPG-2	$\leq$ ERPG-1
Extremely Unlikely	$>10^{-6}$ to $\leq 10^{-4}$	$\leq$ ERPG-3	$\leq$ ERPG-2

ERPG = Emergency Response Planning Guideline
PEL = permissible exposure limit
TWA = time-weighted average

Accident Analysis: Provides a quantitative assessment of accident consequences with and without controls.

- Developed details of accident scenario to address topography
- Unmitigated (without controls) consequences based on deterministic, bounding approach
- Assessed frequency of accident to support control decision process
- Assessed mitigated (with controls) consequences if one or more controls were accident mitigators
- Identified key assumptions/sensitivities to address level of conservatism in results to support control decisions

Tank Waste Remediation System
Final Safety Analysis Report
Control Decision Process and Criteria

January 1997

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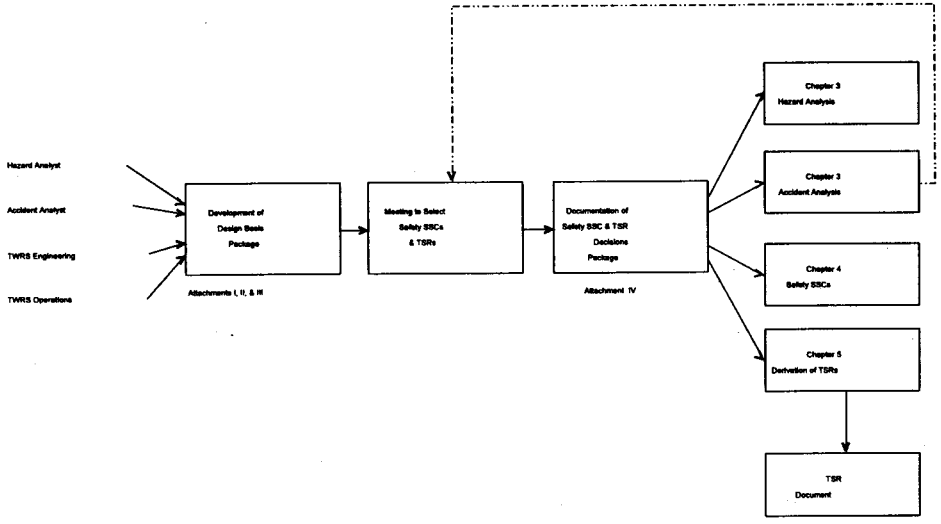
Revision 0

Control Decision Process

Mechanics

TWRS FSAR Process for Selecting SSCs and TSRs



Attachment I - Hazard/Accident Analysis Results

Hazard/Accident Title:
Hazard/Accident Scenario Summary:
Major Assumptions:

Attachment I - Hazard/Accident Analysis Results (cont'd)

HAZARD/ACCIDENT RISK (WITHOUT CONTROLS):

Frequency:

Consequences:

Receptor/Hazard	Calculated Dose/Exposure	Risk Guidelines		
		Anticipated	Unlikely	Extremely Unlikely
Off-Site/ Radiological		0.5 rem	5 rem	25 rem
On-Site/ Radiological		5 rem	25 rem	100 rem
Off-Site/ Toxicological		1	1	1
On-Site/ Toxicological		1	1	1

Attachment II - Hazard/Accident Topography

HAZARD/ACCIDENT TITLE:

APPLICABLE TWRS FACILITIES AND OPERATIONS:

HAZARDOUS CONDITIONS REPRESENTED BY ACCIDENT:

BIN	ID	Material at Risk	Hazardous Condition	Cause	Like Cat	Safety Cons Cat	Cause Grp	Rep Acc

Attachment III - Existing and Possible Alternative Controls

PART A

HAZARD/ACCIDENT TITLE:

Control Option	Control Function (Type)*	Effect of the Control on Risk					Controls Optimization
		Off-Site Rad	On-Site Rad	Off-Site Toxic	On-Site Toxic	Facility Worker Safety	
I. Existing							
II. Possible Alternate Controls							

* E is engineered
A is administrative
P is preventive
M is mitigative

Attachment III - Existing and Possible Alternative Controls

PART B (OPTIONAL)

HAZARD/ACCIDENT TITLE:

Control Option	Capital Cost	Operating Cost	Facility Worker ALARA Impacts	Environmental Compliance Impacts	Mission Impacts

Attachment IV - Selected Safety SSCs and TSRs

HAZARD/ACCIDENT TITLE:

TWRS FACILITY AND/OR OPERATION:

SAFETY STRUCTURES, SYSTEMS OR COMPONENTS (SSCs):

SSC	Classification		SAFETY FUNCTION	Comments
	SC*	SS*		

* SC is safety class
SS is safety significant

TECHNICAL SPECIFICATION REQUIREMENTs (TSRs):

TSR	SAFETY FUNCTION	COMMENTS

Control Decision Process

Technical

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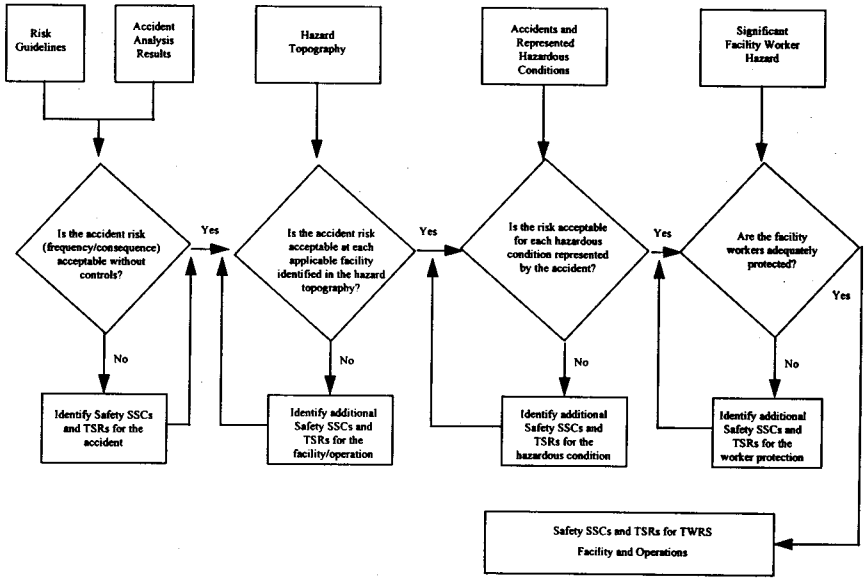
Process to Identify Controls



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Control Decision Criteria

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Control Decision Criteria - Bases (DOE)

DOE Order 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)

DOE Order 5480.22, *Technical Safety Requirements*, Change 2 (1992)

DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*

Control Decision Criteria - Bases (PHMC)

WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*

Section 6, "Technical Safety Requirements," Rev. 1, Change 1 (i.e., Appendix B, "Guidance for the Selection of Technical Safety Requirements")

Section 7, "Risk," Rev. 4

Section 9, "Safety Systems, Structures, and Components," Rev. 2, (i.e., Table 1, "Safety Systems, Structures, and Component Criteria")

Control Decision Criteria - Additional Criteria

- Controls are primarily limited to existing SSCs. Exceptions were made if the control could be rapidly implemented and no reasonable alternative existed.

- Control preferences are as follows:

  - Controls that prevent the accident versus those that mitigate its consequences

  - Passive engineered versus active engineered controls

  - Engineered controls versus administrative controls

Control Decision Criteria - Additional Criteria

- Controls providing significant defense-in-depth are classified as safety SSCs or are elevated to a TSR control

- TSRs are <u>not</u> developed for postulated accidents resulting in only toxicological or environmental consequences

- SSCs are <u>not</u> classified safety class or safety significant solely for preventing or mitigating postulated accidents resulting in environmental consequences

Control Decision Criteria - Additional Criteria

- Control reliability, availability, and maintainability
- Control effects on facility workers (i.e., increased radiation doses or toxicological exposures - as low as reasonably achievable issues)
- Control optimization and integration
- Control cost/benefit
- Control human factors impact
- Control impact on TWRS mission

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Tank Waste Remediation System
Final Safety Analysis Report
Control Decision Process Mechanics

January 1997

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Revision 0

Daily Agenda

- Review previous day's results
- Presentation of accident/controls
- Discussion
- Summary of day's results

Objectives of Meeting

- Review control decisions for accidents presented
- Identify recommendations for managing risk
  - Additional controls for inclusion in FSAR
  - Controls for future implementation
  - Analytical activities to improve the understanding of risk
- Deliverables
  - Minutes of process (Dunford)
  - Letter with recommendations for future funding (DOE)
  - Path forward on FSAR

Form of Results

- Item (control/analytical activity)
- Recommended action
- Rationale/comment

Meeting Ground Rules

- Discussion focused on reasonableness of suite of controls
- Control decisions will be made in the context of the existing control
- Limit discussion to those items which relate to waste storage and transfer

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TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 23, 1997

Organic Solvent Fire Accident Scenario Controls Evaluation

The attendance sheet for this meeting is attached. DOE Headquarters (EM-4 and EM-38) personnel were involved by telephone. A revised schedule of the ICDT meeting was handed out adding the Steam Intrusion and Seismic Event accident scenarios to the list of accidents to be reviewed and removing Pool Leaks.

Larry Kripps presented the Organic Solvent material, presenting background, assumptions, existing controls, and future considerations. There were extensive discussion as the team probed avenues and ideas to better understand potential control schemes. The team then brainstormed potential controls.

Following the break, DOE personnel developed screening criteria and performed an initial screening on the potential controls. Then the team reformed and ran the remaining potential controls through the criteria. The completed evaluation sheets are attached along with the complete list of potential controls considered.

The Organic Solvent session ended at 3:00 p.m.

The Organic Salt-Nitrate review material was handed out. The Organic Salt-Nitrate Accident Control Decision meeting will be held at the Federal Office Building, Room 249, from 7 a.m. through noon on Friday, January 24, 1997.

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TWRS FSAR Integrated Control Decision Meetings Attendees

January 23, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Dennis Irby	RL-TWRS
Keith Hampton	TWRS, FDH
Rick Tedeschi	TWRS, LMHC
Surya Maruvada	ES&H, FDH
Ko Chen	RL-TWRS
Jon Young	TWRS, MSI
Don Foss	TWRS, GSSC
Bill Cowley	TWRS, DESH
Ben Harp	RL-TWRS
Ryan Dodd	200 East Operations, LMHC
Carol Sohn	RL-TWRS
Tom Geer	TWRS, DESH
Michael L. Cowen	WSRC
Vince Saladin	RL-TWRS
Michael Mikolanis	DOE-HQ, S-3
Bob Cash	TWRS, DESH
Paul Gubanc	DNFSB Hanford Representative
Via Teleconference	
Chandra Majumdar	DOE-HQ, EM-4
Tom Wright	DOE-HQ, EM-38

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Tank Waste Remediation System Final Safety Analysis Report Organic Salt Solvent Accident

January 1997

DOE/RL-97-26
Revision 0

Accident Description

Ignition of the separable-phase organic solvents present in the Hanford waste tanks.

Possible Accident Scenarios

- Pool Fires (area greater than 1 m^3)
- Puddle Fires (area less than 1 m^3)
- Wick-Stabilized Fires (solvent permeated sludge or salt cake)

Accident Description

Potential Accident Initiators

- Lightning and vehicle fuel fires for organic solvent pool/puddle fires

- Lightning, vehicle fuel fires, and hot metal resulting from use of a cutting torch (not sparks or slag from welding) for wick-stabilized fires

Accident Description

Topography

- 241-C-103
  Known organic solvent layer floating on the waste surface
- 241-BX-104; 241-BY-107, 108; 241-C-101,102; 241-TY-103
  Based on tank vapor space sampling
- Estimate of 10 single-shell tanks and 6 double-shell tanks
- DCRTs, catch tanks, MISFs

Accident Analysis Results (Without Controls)

Eighteen different cases were evaluated to address the different organic solvent fire types (pool, puddle, and wick-stabilized,) tank type (SST, DST, DCRT,) and type of ventilation (active or passive) that could result in:

- Maximum tank pressure
- Maximum tank vacuum
- Maximum radiological release
- Maximum toxicological impact

Accident Analysis Results (Without Controls)

Initiator Probability

- Lightning (per tank) 3.0 E-5
- Vehicle fire (per tank) 4.3 E-5
- Flame cutting (per tank) 1.0 E-3

Accident Analysis Results (Without Controls)

Calculated Accident Consequences

- The maximum cases for pressure and vacuum do not result in a loss of containment due to structural damage to the tanks.
- The maximum cases for radiological and toxicological consequences do not exceed off-site risk evaluation guidelines
- The maximum cases for radiological consequences (6.1 rem, 5.6 rem) exceed the on-site risk evaluation guidelines (5 rem)
- The maximum cases for toxicological consequences exceed the on-site guidelines (ERPG-2)

Selected Controls

Safety SSCs

- Physical barriers around above ground waste tank structures
- SST, DST, and AWF tank structures

Selected Controls

TSRs

- AC: Ignition Controls
  - Intrusive Controls (TSR 5.10.2a)
    - Stop INTRUSIVE activities in tanks with a potential organic solvent hazard when lightning is identified within a 30 mile radius of the tank farm.
    - Secure equipment in lowest position (e.g., lay down equipment elevated above the tanks and lower crane boom) if lightning is identified within 30 miles of the tank farm.
    - If flame cutting is performed where debris could fall onto the WASTE surface in a tank with a potential organic solvent or organic salt-nitrate hazard, a barrier or device is required to prevent hot metal from falling on the WASTE surface.

Selected Controls

- Vehicle Controls (TSR 5.10.2b)
  - Vehicle access within the tank farm boundary shall be limited to vehicles whose fuel systems are protected from damage to the integrity of the fuel systems caused by potential collisions with tank structures (e.g., mechanical protection such as a skid plate on the fuel tank or reservoir tanks physically located higher than risers).
  - Establish controls to limit vehicle speeds within the tank farms.

- AC: Emergency Preparedness (TSR 5.14.2c)
  - Emergency response plans for a fire shall include response procedures based on the type, location, and size of the fire to protect the offsite public, onsite worker, and facility worker (e.g., firefighting coverage and response, limitations on TWRS activities, site evacuation).

Selected Controls

- AC: Transfer Controls
  - Waste Compatibility Controls (TSR 5.12.2c)
    - Evaluate the planned final state of both the pumped and receiving tanks prior to WASTE transfer through a transfer system.

- AC: HEPA Filter Controls (TSR 5.18.2a)
  - VERIFY periodically that the HEPA filter and prefilter housing radiation level is ≤ 200 mrem/hr on contact. Replace the HEPA filters and prefilters prior to filter housing radiation levels exceeding 200 mrem/hr.

Selected Controls

Defense in Depth

- Vehicle positioning spotters
- Existing and planned lightning protection (grounded air terminals, grounded tank risers, and bonded instrumentation in risers)
- HASP direction for workers to leave tank farm if lightning strikes within 5 miles
- HEPA filter replacement typically performed at 100 rem/hr

Accident Analysis Results (With Controls)

The selected controls reduce the probability of an organic solvent fire by preventing or reducing the likelihood of the initiators. The estimated frequency of an organic solvent fire, however, remains unlikely and the calculated consequences are not changed.

Key Parameters and Assumptions/Sensitivity Analyses

Key Parameters and Assumptions

- flame spread rate
- over pressure
- solvent pool area
- fire extinguishment at 13% oxygen
- tank parameters (headspace air volume, vent path flow capacity, carryover of aerosols with vented gases)

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk:

- Inclusion of more rigorous treatment of agglomeration and deposition in the atmospheric modeling of accident consequences.
- Inclusion of momentum or buoyant (thermal) plume rise and initial source size effects in the atmospheric dispersion modeling of accident consequences
- Evaluation and incorporation, where possible, of emergency response actions in the accident consequence analysis
- Development and application of revised high-level waste radiological and toxicological source terms for the accident analysis
- Installation of additional lightning protection systems (e.g., additional grounded air terminals, catenary network) for waste tanks

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd'):

- Complete the tank vapor space sampling program for all tanks.
- Remove or reduce the organic solvent inventory in tanks (especially tank 241-C-103)
- Installation and operation of a radiation monitoring system for the tank farm areas

Further Defense Considered/Suggested/Ongoing

Further Actions That Are Ongoing to Reduce the Calculated or Real Risk:

- Finish planned lightning protection improvements (grounding and bonding)
- Vapor sampling to determine number of solvent tanks
- Refine conservative assumptions used in the safety assessment
  - Include aerosol depletion for radiological consequences
  - Include dilution of contaminants (jet mixing) at tank vent for toxicological consequences

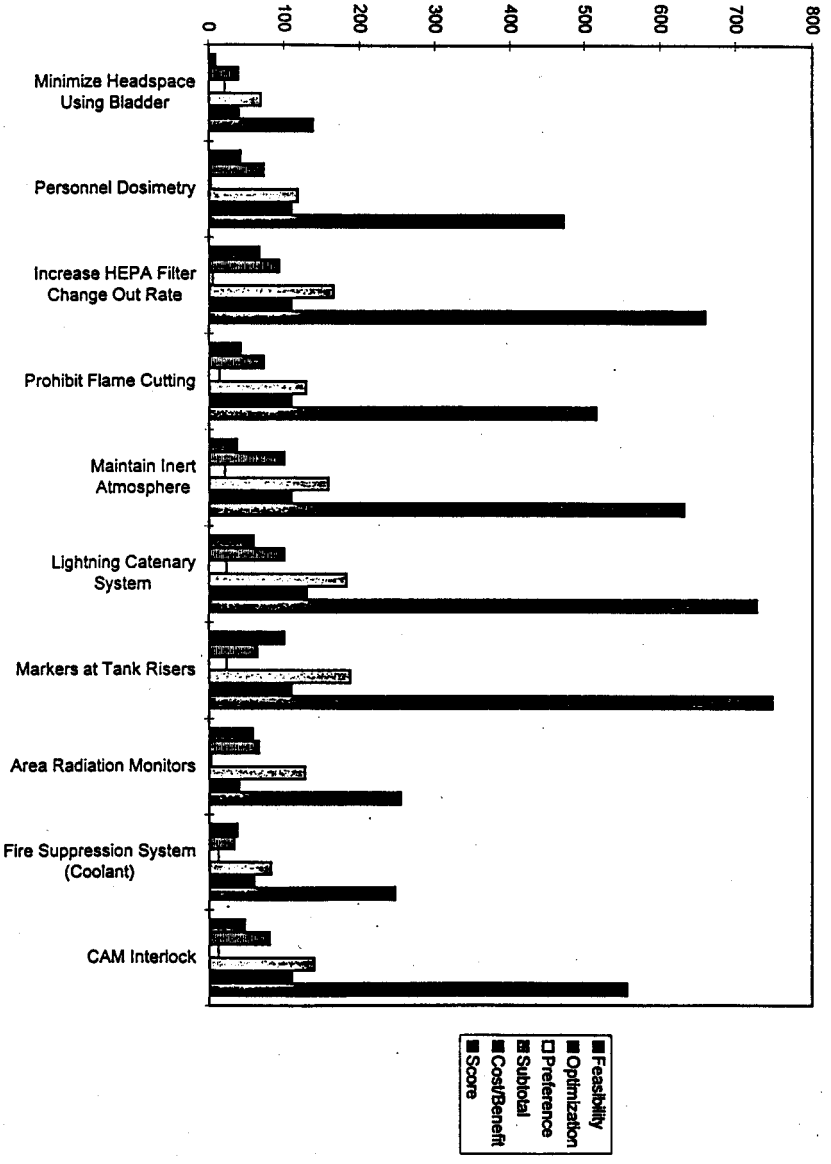
Organic Solvent Fire Accident - Initial Controls

Term	Evaluated	Control
S	√	Accelerate HEPA filter change out
L		Prevent HEPA blowout
L		HEPA filter protection
L		Provide confinement of blowout
L		Install in-tank equipment to accelerate evaporation
L		In-tank chemical treatment
L	√	Inerting (vapor or solid)
S	√	Ventilation fan interlock shutdown with CAM
S	√	Fire coolant system
S	√	Alarming personnel dosimeters
L		Alternate fuel source vehicles
S	√	Prohibit flame cutting
S		Limit fuel volumes in vehicles
S	√	Markers at tank risers
S	√	Lightning catenary system
L		Early retrieval
S	√	Area radiation monitoring

Analysis Additional Calculations:

a. Respirable Fraction Refinement using ICRP 30 Lung Model/ICRP 60 Methodology

b. Flame Spread Rate


Organic Solvent Fire Control Criteria Rating
0
100
200
300
400
500
600
700
800
Minimize Headspace Using Bladder
Personnel Dosimetry
Increase HEPA Filter Change Out Rate
Prohibit Flame Cutting
Maintain Inert Atmosphere
Lightning Catenary System
Markers at Tank Risers
Area Radiation Monitors
Fire Suppression System (Coolant)
CAM Interlock
Feasibility
Optimization
Preference
Subtotal
Cost/Benefit
Score

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Organic Solvent Fire
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Minimize Headspace Using Bladder	9	39	21	69	40	2	**138**
Personnel Dosimetry	42	73	3	118	110	4	**472**
Increase HEPA Filter Change Out Rate	67	93	5	165	110	4	**660**
Prohibit Flame Cutting	42	73	14	129	110	4	**516**
Maintain Inert Atmosphere	37	100	21	158	110	4	**632**
Lightning Catenary System	59	100	23	182	130	4	**728**
Markers at Tank Risers	100	64	23	187	110	4	**748**
Area Radiation Monitors	58	66	3	127	40	2	**254**
Fire Suppression System (Coolant)	37	33	12	82	60	3	**246**
CAM Interlock	47	80	12	139	110	4	**556**

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Minimize Headspace Using Bladder

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	No transfers, no HEPA passive breathing, GRE from radiolytic decay
H Impact on Worker	High	2	Training (inert gas)
H Technical Feasibility	Low	2	High Risk, no large riser to insert, interferences with future activity
L Mission Impacts	High	0	Retrieval, K-Basin Sludge
H Timeliness of Control Implementation	Low	2	Long design, time insertion in risers to be resolved
H Installation Risk	High	2	ALARA
Feasibility Subtotal		9	
2. Optimization of Controls			
H Reliability	Low	3	Not off the shelf item, unproven
M Human Factors Practicality	Moderate	3	Retrieval following use or damage
H Applicability to Multiple Accidents	High	30	Reduces volume of oxygen in tank
H Compatibility of Controls	Low	3	Smaller volume to dilute evolved gas
Optimization Subtotal		39	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Moderate	30	25% reduction in dose (tox)
H Capital Costs plus Operating, Life Cycle Costs (LCC)	High	10	Equipment purchases, installation, and testing
Cost/Benefit Subtotal		40	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Personnel Dosimetry

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Variability of radiation background, false alarms
H Impact on Worker	Moderate	7	Additional training and maintenance
H Technical Feasibility	Moderate	7	Existing technology but new application
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Low	2	Available technology/Alarm setpoint determination
H Installation Risk	Low	23	Worn by workers
Feasibility Subtotal		42	
2. Optimization of Controls			
H Reliability	Moderate	10	Potential for false alarms
M Human Factors Practicality	Moderate	3	Psychological impact of alarm
H Applicability to Multiple Accidents	High	30	Decreases in exposure time for spray leaks and other release events
H Compatibility of Controls	High	30	Worn by personnel
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Low	1	Administrative
M Passive over Active	Low	1	
Preference Subtotal		3	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	No change to analysis
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Administration of program (# workers - office)
Cost/Benefit Subtotal		110	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Increase HEPA Change Out Rate

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	
H Impact on Worker	Moderate	7	Increased worker dose
H Technical Feasibility	High	23	Demonstrated
L Mission Impacts	Moderate	1	Waste minimization impacted
H Timeliness of Control Implementation	High	23	Easy to implement
H Installation Risk	Moderate	7	ALARA
Feasibility Subtotal		67	
2. Optimization of Controls			
H Reliability	High	30	Only change frequency is impacted
M Human Factors Practicality	Moderate	3	
H Applicability to Multiple Accidents	High	30	Organic nitrate, HEPA filter fire
H Compatibility of Controls	High	30	Existing control
Optimization Subtotal		93	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Low	1	Administrative
M Passive over Active	Moderate	3	
Preference Subtotal		5	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	10% onsite, rad and tox - stronger preference for LT
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		110	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Prohibit Flame Cutting

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Current projects would need to find alternate cutting method
H Impact on Worker	Moderate	7	Apply new techniques/training
H Technical Feasibility	Low	2	Alternate technique applied to current work
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Alternatives must be developed/implemented
H Installation Risk	Low	23	
Feasibility Subtotal		42	
2. Optimization of Controls			
H Reliability	Moderate	10	Dependent on distance constraints/testing required
M Human Factors Practicality	Moderate	3	Impact on tank farm work/may increase errors initially
H Applicability to Multiple Accidents	High	30	Flammable gas, organic salt
H Compatibility of Controls	High	30	No obvious conflicts
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	Low	1	Administrative
M Passive over Active	Moderate	3	
Preference Subtotal		14	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Small, lightning is primary contributor
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	100	Cost of alternate methods is not well established
Cost/Benefit Subtotal		110	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Maintain Inert Atmosphere
(Inert Gas Circulation)

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	New equipment installation and surveillance, new hazard, confined space
H Impact on Worker	High	2	Air quality, respiratory protection, training
H Technical Feasibility	Moderate	7	Must maintain and monitor atmosphere
L Mission Impacts	Low	2	May be OK from K Basins perspective
H Timeliness of Control Implementation	High	23	Gas circulation continuous inerting
H Installation Risk	High	2	Flammable Gas - confined space asphyxiation
Feasibility Subtotal		37	
2. Optimization of Controls			
H Reliability	High	30	Inerting atmosphere well established practice
M Human Factors Practicality	High	10	
H Applicability to Multiple Accidents	High	30	Flammable gas, organic salt nitrate
H Compatibility of Controls	High	30	
Optimization Subtotal		100	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	May reduce the extent of existing ignition controls
H Capital Costs plus Operating, Life Cycle Costs (LCC)	High	10	$10-100M
Cost/Benefit Subtotal		110	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Lightning Catenary System

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Cranes, pull pumps, winds, existing work practices may change
H Impact on Worker	Low	23	Design will limit impact
H Technical Feasibility	High	23	Demonstrated in other environments
L Mission Impacts	Low	2	Retrieval
H Timeliness of Control Implementation	Low	2	Long time to design, construct
H Installation Risk	Moderate	7	Wind impact on structural requirements
Feasibility Subtotal		59	
2. Optimization of Controls			
H Reliability	High	30	Based upon how well system is constructed
M Human Factors Practicality	High	10	Designed to limit impact
H Applicability to Multiple Accidents	High	30	Minimizes natural ignition source
H Compatibility of Controls	High	30	Minimizes natural ignition source
Optimization Subtotal		100	
3. Preference of Control Suite			
M Prevention over Mitigation	Moderate	3	Prevention
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	High	10	
Preference Subtotal		23	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Addresses highest probability ignition source with controls applied
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	$200-400K (12SST farms) (3 farm) $10-15M
Cost/Benefit Subtotal		130	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Markers at Tank Risers

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	Large number per tank farm, wind, maintainance requirements
H Impact on Worker	Low	23	Minimal impact, exposure, and training
H Technical Feasibility	High	23	Off the shelf item
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Easily implemented
H Installation Risk	Low	23	Mechanical fasteners create no new events
Feasibility Subtotal		100	
2. Optimization of Controls			
H Reliability	Low	3	Wind, weather, night visibility
M Human Factors Practicality	Low	1	Less effective than spotters, confusing if many present
H Applicability to Multiple Accidents	High	30	Minimize vehicular impact
H Compatibility of Controls	High	30	No new hazards introduced
Optimization Subtotal		64	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	Moderate	3	Engineered and administrative control
M Passive over Active	High	10	
Preference Subtotal		23	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Very little change to accident frequency
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Administrative reports
Cost/Benefit Subtotal		110	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Area Radiation Monitors

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Additional system to operate/maintain
H Impact on Worker	Low	23	ALARA benefit
H Technical Feasibility	Low	2	Background variation, some accidents of short duration
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Utilities required to support system
H Installation Risk	Low	23	Existing hardware and typical application
Feasibility Subtotal		58	
2. Optimization of Controls			
H Reliability	Low	3	Placement with source is important/variation with operating condition
M Human Factors Practicality	Moderate	3	Potential false alarms, could be high maintenance
H Applicability to Multiple Accidents	High	30	Spray leaks and pools
H Compatibility of Controls	High	30	No new hazard created
Optimization Subtotal		66	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation only
M Engineered over Administrative	Low	1	Administrative control
M Passive over Active	Low	1	
Preference Subtotal		3	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Short duration
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Maintenance, installation, capital, life cycle costs
Cost/Benefit Subtotal		40	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
Fire Supression System (Coolant)

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Costs, ventilation, maintenance
H Impact on Worker	Moderate	7	Asphyxiation, inadvertant activations
H Technical Feasibility	High	23	Established technology in other application
L Mission Impacts	Low	2	None
H Timeliness of Control Implementation	Low	2	Long time to build equipment
H Installation Risk	High	2	Limited access, exposure concerns
Feasibility Subtotal		37	
2. Optimization of Controls			
H Reliability	Moderate	10	Activates when desirable and not desirable (inadvertant discharge)
M Human Factors Practicality	Moderate	3	Changing, maintenance
H Applicability to Multiple Accidents	Moderate	10	Response time too slow for some events (flammable gas)
H Compatibility of Controls	Moderate	10	Potential impact to HEPA filter effectiveness
Optimization Subtotal		33	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		12	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Moderate	30	Inadvertent actuation
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	
Cost/Benefit Subtotal		60	

Control Criteria Rating

Accident:
Organic Solvent Fire

Control:
CAM Interlock

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Maintenance, installation, calibration, routines
H Impact on Worker	Low	23	Control used in other applications
H Technical Feasibility	Moderate	7	Response time for rapid events
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Some design and installation required
H Installation Risk	Moderate	7	
Feasibility Subtotal		47	
2. Optimization of Controls			
H Reliability	Moderate	10	Potential failures/false alarms
M Human Factors Practicality	High	10	In use in other areas
H Applicability to Multiple Accidents	High	30	Unfiltered release accidents (HEPA fire, pressure blowout, and others)
H Compatibility of Controls	High	30	Standard application
Optimization Subtotal		80	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered
M Passive over Active	Low	1	
Preference Subtotal		12	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Response time limits effectiveness for rapid events
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		110	

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TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 24, 1997

Organic Salt-Nitrate Reaction Accident Scenario Controls Evaluation

The attendance sheet for this meeting is attached. DOE Headquarters (EM-4, EM-38, FDH S-3) and DNFSB staff were involved by telephone.

Larry Kripps presented the Organic Salt-Nitrate material, presenting background, assumptions, existing controls, and future considerations. There was extensive discussion to understand the differences between the Organic Solvent and the Organic Salt-Nitrate accident scenarios and the potential controls schemes. The team then brainstormed potential controls.

Following the break, the team performed an initial screening on the potential controls. Then the team applied the remaining potential controls to the criteria. The completed evaluation sheets are attached along with the list of potential controls considered.

Michael Cowen prepared some scoring options on how the evaluation criteria could be used. Following group discussion, DOE took the action to finalize a scoring/weighting method for the controls options. Michael Cowen needed to return to Savannah River and Jon Young filled the role of facilitator for the remaining meetings.

The Spray Leak review material was handed out. The Spray Leak Accident Control Decision meeting will be held at the Federal Office Building, Room 249, from 7 a.m. through noon on Monday, January 27, 1997, and from 10:00 a.m. to noon on Tuesday, January 28, 1997, at the TWRS Office Building (2704HV).

The Organic Salt-Nitrate session ended at 2:30 p.m.

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TWRS FSAR Integrated Control Decision Meetings Attendees

January 24, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Dennis Irby	RL-TWRS
Joe Meacham	DESH
Rick Tedeschi	TWRS, LMHC
Surya Maruvada	ES&H, FDH
Jon Young	TWRS, (MSI)
Don Foss	TWRS, GSSC
Ben Harp	RL-TWRS
Carol Sohn	RL-TWRS
Allen Webb	FDNW
Bob Cash	TWRS, DESH
Ryan Dodd	TWRS, LMHC
Stan Branch	RL-WSD
Michael L. Cowen	WSRC
Vince Saladin	RL-TWRS
Michael Mikolanis	DOE-HQ, S-3
Via Teleconference	
Tim Veneziano	FDH S-3 (on detail to DOE-HQ)
Chandra Majumdar	DOE-HQ, EM-4
Tom Wright	DOE-HQ, EM-38
Ralph Arcaro	DNFSB

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Tank Waste Remediation System Final Safety Analysis Report Organic Salt-Nitrate Reaction Accident

January 1997

DOE/RL-97-26
Revision 0

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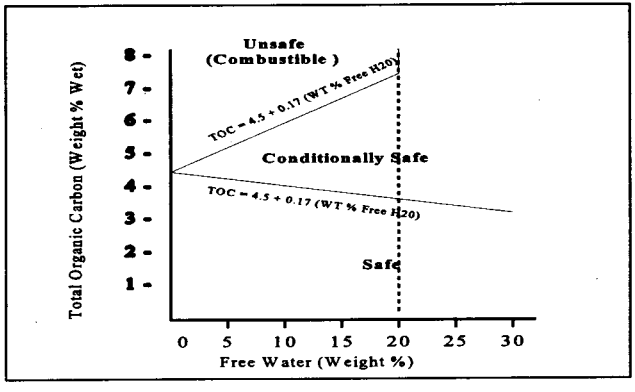
Accident Description

Ignition of sodium salts of complexants (organic complexants) present in the Hanford waste tanks.



Accident Description

Potential Accident Initiators

- Chemical runaway
- Point source ignitors (>3.3 Joules)
  - Lightning
  - Hot debris from flame cutting or welding
  - Hot filaments from equipment
  - Vehicle fuel fire
  - Rotary mode core drilling

Accident Description

Topography

- **DSTs, AWF tanks**
  Pose no hazard because of supernatant above the waste solids level

- **63 SSTs**
  SAFE

- **SSTs: 241-AX-102, 241-C-201, 241-C-202, 241-U-105**
  CONDITIONALLY SAFE

- **No UNSAFE tanks**

- **82 SSTs, DCRTs, catch tanks, MISF, waste transfer lines**
  Unassigned because of lack of information and analysis (unsampled)

DOE/RL-97-26
Revision 0

Accident Analysis Results (Without Controls)

Consequences were evaluated for an organic salt-nitrate reaction involving 25 m^3 of combustible waste. This is the worst case with a 95% confidence from the analysis of variance performed.

Frequency estimated as unlikely.

Accident Analysis Results (Without Controls)

Radiological and Toxicological Consequences for 25 m^3 (883 ft^3) Organic Salt-Nitrate Reaction With and Without Controls

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
Organic salt-nitrate reaction	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Organic salt-nitrate reaction without controls	8.8 E+0.1 (8.8 E+03)	5.0 E-02 (5.0)	7.3 E-02 (7.3)	5.0 E-03 (0.5)	1.4 E+05	1	160	1	Unlikely
Organic salt-nitrate reaction with controls	8.8 E+01 (8.8 E+03)	1.0 E-01 (10)	7.3 E-02 (7.3)	4.0 E-02 (4.0)	1.0 E+03	1	120	1	Extremely Unlikely

Selected Controls

Safety SSCs

- Physical barriers around above ground waste tank structures
- SSTs, DSTs, and AWF tank structures

TSRs

SL:	SST waste temperature
LCS/LCO:	SST waste temperature controls
SL:	DST and AWF tank waste temperature
LCS/LCO:	DST and AWF tank waste temperature controls

Selected Controls

- AC: Ignition Controls
  - Intrusive Controls (TSR 5.10.2a)
    - Stop intrusive activities in tanks with a potential organic salt-nitrate hazard when lightning is identified within a 30 mile radius of the tank farm.
    - Secure equipment in lowest position (e.g., lay down equipment elevated above the tanks and lower crane boom) if lightning is identified within 30 miles of the tank farm.
    - If flame cutting is performed where debris could fall onto the waste surface in a tank with a potential organic solvent or organic salt-nitrate hazard, a barrier or device is required to prevent hot metal from falling on the waste surface.

Selected Controls

- Intrusive Controls (cont'd)

  - If welding is performed where debris could fall onto the waste surface in a tank with a potential organic salt-nitrate hazard, a barrier or device is required to prevent hot slag from falling on the waste surface.

  - When installing equipment (e.g., cameras, videos, lights, etc.) with hot filaments in a tank with a potential organic salt-nitrate hazard, a method shall be used to prevent these hot sources from falling and contacting the waste.

- Vehicle Controls (TSR 5.10.2b)

  - Vehicle access within the tank farm boundary shall be limited to vehicles whose fuel systems are protected from damage to the integrity of the fuel systems caused by potential collisions with tank structures (e.g., mechanical protection such as a skid plate on the fuel tank or reservoir tanks physically located higher than risers).

Selected Controls

- Vehicle Controls (cont'd)
  - Establish controls to limit vehicle speeds within the tank farms.

- AC: Transfer Controls
  - Waste Compatibility Controls (TSR 5.12.2c)
    - Evaluate the planned final state of both the pumped and receiving tanks prior to waste transfer through a transfer system.

- AC: Emergency Preparedness (TSR 5.14.2c)
  - Emergency response plans for a fire shall include response procedures based on the type, location, and size of the fire to protect the offsite public, onsite worker, and facility worker (e.g., firefighting coverage and response, limitations on TWRS activities, site evacuation).

Selected Controls

- AC: Moisture Controls (TSR 5.15)
  - Interim Stabilization
  - Emergency Pumping
  - Moisture Monitoring
  - Ventilation System Changes
- AC: HEPA Filter Controls (TSR 5.18.2a)
  - Verify periodically that the HEPA filter and prefilter housing radiation level is $\leq$ 200 mrem/hr on contact. Replace the HEPA filters and prefilters prior to filter housing radiation levels exceeding 200 mrem/hr.

Selected Controls

Defense in Depth

- Vehicle positioning spotters
- Existing and planned lightning protection (grounded air terminals, grounded tank risers, and bonded instrumentation in risers)
- HASP direction for workers to leave tank farm if lightning strikes within 5 miles
- HEPA filter replacement typically performed at 100 rem/hr

Accident Analysis Results (With Controls)

The selected controls reduce the probability of an organic salt-nitrate reaction by preventing or reducing the likelihood of the initiators. The estimated frequency with controls is extremely unlikely. Radiological consequences are the same and toxicological consequences are reduced because the risk guidelines (ERPG) change with frequency.

Key Parameters and Assumptions/Sensitivity Analyses

Sensitivity Analyses

- Oxidizer is plentiful
- Ignitor strength
- Salt cake specific heat
- Spreading rate of reaction
- Vacuum condition effects discounted
- Actual fuel content is unknown
- Aging effects not included
- Fuel is in solution
- Reactive waste is contiguous

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk:

From Draft FSAR (Table 3.3.2.3.5-1)

- **Inclusion of more rigorous treatment of agglomeration and deposition in the atmospheric modeling of accident consequences**
- **Inclusion of momentum or buoyant (thermal) plume rise and initial source size effects in the atmospheric dispersion modeling of accident consequences**
- **Evaluation and incorporation, where possible, of emergency response actions in the accident consequence analysis**
- **Development and application of revised high-level waste radiological and toxicological source terms for the accident analysis**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Perform additional waste characterization on SSTs to determine their organic salt-nitrate reaction potential and to differentiate between complexants versus other organics, rather than total organic carbon**
- **Investigate saltwell pumping or washing with sodium hydroxide solution to identify their efficiency in removing soluble organic species that could cause propagating reactions**
- **Installation and operation of tank spray system for SSTs with a high potential for organic salt-nitrate reaction**
- **Evaluate the potential for chemical runaway reactions especially in actively ventilated SSTs**
- **Installation of additional lightning protection systems (e.g., additional grounded air terminals, catenary network) for waste tanks**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Accelerate tank waste retrieval where retrieval can eliminate high risk situations**
- **Installation and operation of a radiation monitoring system for the tank farm areas**

From Control Decision Record (CDR)

- **Add bulk water to tanks to ensure waste moisture exceeds 20 %**
- **Ignition prevention by adding fire barrier/retardant (e.g., "kitty litter) to surface of waste to prevent ignitor from coming into contact with waste**
- **Provide assured pressure relieving capacity to prevent tank dome failure**
- **Provide waste moisture monitoring instruments**

Further Defense Considered/Suggested/Ongoing

Further Actions That Are Ongoing to Reduce the Calculated or Real Risk:

- **Show Through Modeling and Monitoring that the Waste Cannot Combust**
  - **TMACS**
  - **Neutron and EMI probes developed for in situ moisture measurements**
  - **Moisture retention experiments on waste samples and modeling are examining waste dryout**

- **Demonstrate that Ignition Sources are Adequately Controlled**
  - **Finish planned lightning protection improvements (grounding and bonding)**
  - **Quantify ignition source requirements**
  - **Current safety analyses show controls do not bring accident within risk guidelines**

Further Defense Considered/Suggested/Ongoing

Further Actions That Are Ongoing to Reduce the Calculated or Real Risk (cont'd):

- **Demonstrate Through Experiments, Modeling, and Sampling that the Waste Cannot Combust (Aging and Solubility)**
  - **Simulant Experiments**
    - **Relative aging rates**
    - **Trace metal effect on solubility**
  - **Corroborate Solubility and Aging on Tank Waste**
    - **Analytical methods development**
    - **Speciate tank waste samples (liquids and solids)**
  - **Quantify the Effect of Aging and Solubility**
    - **Use sample data and history to estimate current conditions for all tanks**
    - **Model future tank behavior during interim storage**
    - **Include effects of aging and solubility**

Organic Salt-Nitrate Accident - Initial Controls

Term	Evaluated	Control
S	√	Accelerate filter changeout
S	√	Prohibit flame cutting
S	√	Markers at tank riser
S	√	Catenary lightning systems
S	√	Area radiation monitoring/personnel
S	√	Waste tank cooling system
L		In-tank chemical treatment
S	√	Tank sprinklers
L		Waste mixing
S	√	Prohibit/remove all ignition filaments
	√	Revamp ventilation (s) to prevent tank pressurization and/or mitigate (L) release
L		Additional saltwell pumping
L	√	Tank Misting - Add moisture/monitoring - Fog Generator
L		Add surface fire retardant
S		Waste surface moisture monitoring
S	√	Temperature/Evacuation Alarm
S		Smoke Detector Alarm
S		Sniffers (vapors)
L		Baffles to isolate waste
L		Debris collector
L		Selected retrieval
L		New storage design
S	√	Ventilation coolers - Ventilation coolers (chilled air) - Recirculate coolant gas
S		Coil insertion (cooling waste)
S		Tarp/cover & gravel mix
L		Rupture disk/separator

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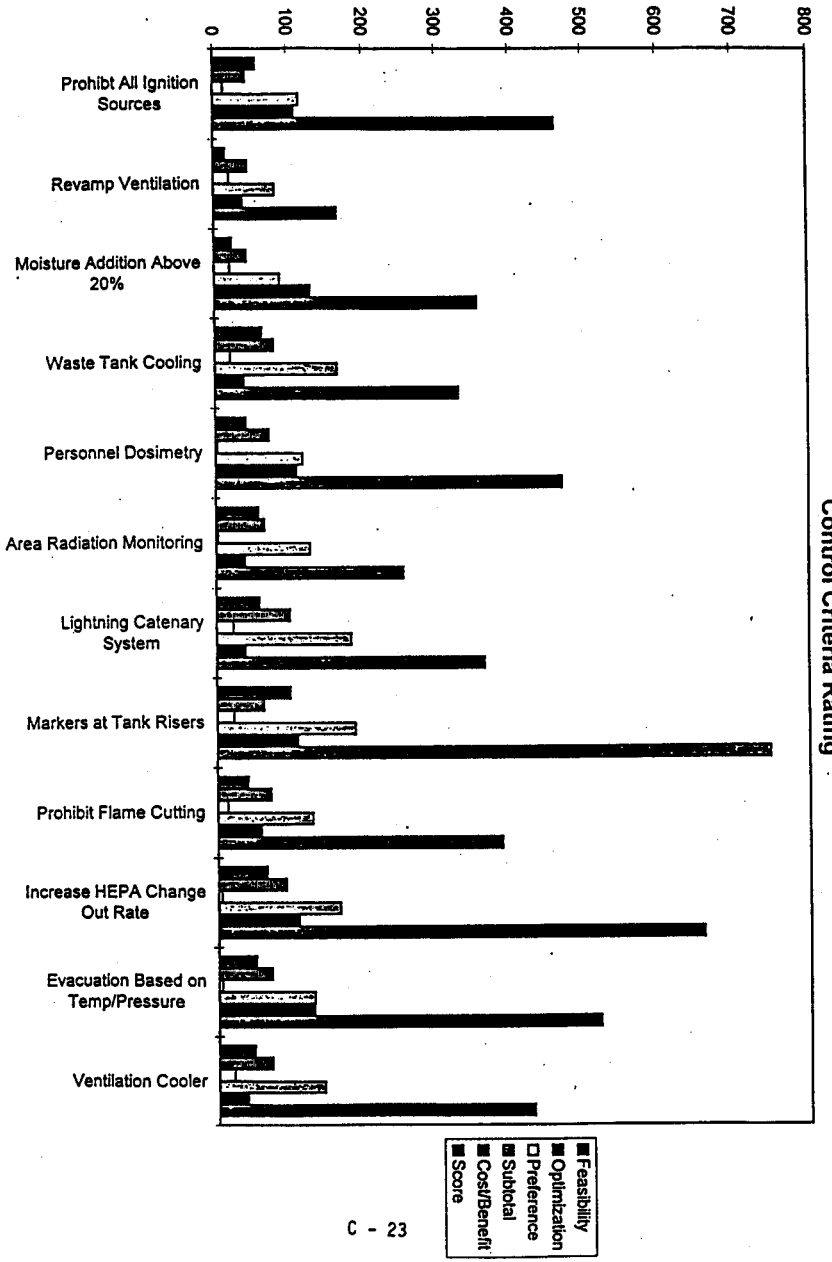
Organic Salt-Nitrate
Control Criteria Rating
0
100
200
300
400
500
600
700
800
Prohibt All Ignition Sources
Revamp Ventilation
Moisture Addition Above 20%
Waste Tank Cooling
Personnel Dosimetry
Area Radiation Monitoring
Lightning Catenary System
Markers at Tank Risers
Prohibit Flame Cutting
Increase HEPA Change Out Rate
Evacuation Based on Temp/Pressure
Ventilation Cooler
Feasibility
Optimization
Preference
Subtotal
Cost/Benefit
Score

Organic Salt Nitrate
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Tank Sprinklers	48	26	12	0	130	4	0
Prohibt All Ignition Sources	58	44	14	116	110	4	464
Revamp Ventilation	16	46	21	83	40	2	166
Moisture Addition Above 20%	24	44	21	89	130	4	356
Waste Tank Cooling	64	80	21	165	40	2	330
Personnel Dosimetry	42	73	3	118	110	4	472
Area Radiation Monitoring	58	66	3	127	40	2	254
Lightning Catenary System	59	100	23	182	40	2	364
Markers at Tank Risers	100	64	23	187	110	4	748
Prohibit Flame Cutting	42	73	14	129	60	3	387
Increase HEPA Change Out Rate	67	93	5	165	110	4	660
Evacuation Based on Temp/Press	52	73	5	130	130	4	520
Ventilation Cooler	49	73	21	143	40	3	429

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Tank Sprinklers

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Complex system
H Impact on Worker	Moderate	7	Installation in-tank work
H Technical Feasibility	High	23	Simple concept
L Mission Impacts	Low	2	High potential positive
H Timeliness of Control Implementation	Moderate	7	Could do within 3 years
H Installation Risk	Moderate	7	
Feasibility Subtotal		48	
2. Optimization of Controls			
H Reliability	Moderate	10	Detection/initiation limited maintain/design for winter conditions
M Human Factors Practicality	Moderate	3	Surveillance and maintenance
H Applicability to Multiple Accidents	Low	3	
H Compatibility of Controls	Moderate	10	Possible impact on HEPA filters
Optimization Subtotal		26	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		12	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Significantly reduces dose by about a factor of 10
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Conditionally safe tanks - 4 tanks - 10M (10 tanks)
Cost/Benefit Subtotal		130	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Prohibit All Ignition Sources

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Loss of visibility/loss of camera viewing
H Impact on Worker	Moderate	7	Familiar practices discontinued
H Technical Feasibility	Low	2	Alternatives not available or must be found.
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Quickly accomplished
H Installation Risk	Low	23	
Feasibility Subtotal		58	
2. Optimization of Controls			
H Reliability	Moderate	10	New work methods are identified
M Human Factors Practicality	Low	1	Some work will use alternative methods (training, ALARA)
H Applicability to Multiple Accidents	High	30	Flammable gas, organic solvent
H Compatibility of Controls	Low	3	May impact instrumentation
Optimization Subtotal		44	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention
M Engineered over Administrative	Low	1	Adminstrative control
M Passive over Active	Moderate	3	
Preference Subtotal		14	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Current controls provide significant benefit
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Some work will be done another way.
Cost/Benefit Subtotal		110	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Revamp Ventilation

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	*Difficult to install, required modification controls*
H Impact on Worker	High	2	Exposure during installation
H Technical Feasibility	Moderate	7	May impact structural integrity of dome
L Mission Impacts	Low	2	Waste generation
H Timeliness of Control Implementation	Low	2	Takes time to implement
H Installation Risk	High	2	Exposure
Feasibility Subtotal		16	
2. Optimization of Controls			
H Reliability	High	30	Existing hardware can be used
M Human Factors Practicality	High	10	Maintenance and inspection required
H Applicability to Multiple Accidents	Low	3	Flammable gas applicability is uncertain
H Compatibility of Controls	Low	3	Structural integrity issue
Optimization Subtotal		46	
3. Preference of Control Suite			
M *Prevention over Mitigation*	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	High	10	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	200 rem reduction out of 8,000 rem
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Larger riser or other relief, large cost avoidance
Cost/Benefit Subtotal		40	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Moisture Addition Above 20%

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	More systems to operate/ periodic operation
H Impact on Worker	High	2	Surveillance required/maintenance required
H Technical Feasibility	Moderate	7	System maintenance
L Mission Impacts	High	0	Release of materials to environment
H Timeliness of Control Implementation	Moderate	7	
H Installation Risk	Moderate	7	Some in tank work required
Feasibility Subtotal		24	
2. Optimization of Controls			
H Reliability	High	30	Established process
M Human Factors Practicality	Low	1	More sys. to operate, caustic may impact work execution
H Applicability to Multiple Accidents	Low	3	
H Compatibility of Controls	Moderate	10	Could impact monitoring, filters, tanks
Optimization Subtotal		44	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Greatly reduces opportunity for accident
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Assume 10-50 tanks, Avoid pot. sig. cleanup, deterior tanks
Cost/Benefit Subtotal		130	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Waste Tank Cooling
(Bulk Runaway)

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Additional systems to operate
H Impact on Worker	Low	23	Minimal training or ALARA impacts
H Technical Feasibility	High	23	Established technology
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Some emergency design and installation required.
H Installation Risk	Moderate	7	Installed in tank
Feasibility Subtotal		64	
2. Optimization of Controls			
H Reliability	High	30	Slow heating if system fails or degrades
M Human Factors Practicality	High	10	Simple to add and operate
H Applicability to Multiple Accidents	High	30	Help tank bumps, not flam gas
H Compatibility of Controls	Moderate	10	Neutral
Optimization Subtotal		80	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Mitigate runaway
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	
Cost/Benefit Subtotal		40	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Personnel Dosimetry

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Potential false alarms due to background
H Impact on Worker	Moderate	7	Additional training and maintenance
H Technical Feasibility	Moderate	7	Existing technology but new application
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Low	2	Available technology/alarm set point determination
H Installation Risk	Low	23	Worn by workers
Feasibility Subtotal		42	
2. Optimization of Controls			
H Reliability	Moderate	10	Potential for false alarms
M Human Factors Practicality	Moderate	3	Psychological impact of alarm.
H Applicability to Multiple Accidents	High	30	Detects external dose
H Compatibility of Controls	High	30	Worn by personnel
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Low	1	Administrative
M Passive over Active	Low	1	
Preference Subtotal		3	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	No change to accident analysis
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Administration of program (# workers - office)
Cost/Benefit Subtotal		110	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Area Radiation Monitoring

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Additional system to operate/maintain
H Impact on Worker	Low	23	ALARA benefit
H Technical Feasibility	Low	2	Background variation, some accidents of short duration
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Installed utilities required
H Installation Risk	Low	23	Existing hardware and typical application
Feasibility Subtotal		58	
2. Optimization of Controls			
H Reliability	Low	3	Placement w/source important/variation of set point w/operating condition
M Human Factors Practicality	Moderate	3	Potential false alarms, could be high maintenance
H Applicability to Multiple Accidents	High	30	Numerous applications
H Compatibility of Controls	High	30	No new hazard created
Optimization Subtotal		66	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation only
M Engineered over Administrative	Low	1	Administrative control
M Passive over Active	Low	1	
Preference Subtotal		3	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Short duration
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Maintenance, installation, capital, life cycle costs
Cost/Benefit Subtotal		40	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Lightning Catenary System

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Cranes, pull pumps, winds, exist work practices may be different
H Impact on Worker	Low	23	Design will limit impact
H Technical Feasibility	High	23	Demonstrated
L Mission Impacts	Low	2	Retrieval
H Timeliness of Control Implementation	Low	2	Long time to design, construct
H Installation Risk	Moderate	7	Wind impact on structural requirements
Feasibility Subtotal		59	
2. Optimization of Controls			
H Reliability	High	30	Based upon how well system is constructed
M Human Factors Practicality	High	10	Designed to limit impact
H Applicability to Multiple Accidents	High	30	Different tanks/limits impact of ignition source
H Compatibility of Controls	High	30	Eliminate natural ignition source
Optimization Subtotal		100	
3. Preference of Control Suite			
M Prevention over Mitigation	Moderate	3	Prevention
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	High	10	
Preference Subtotal		23	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Smaller benefit than solvent
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	$200-400K (12 SST farms) (3 farm) $10-15M
Cost/Benefit Subtotal		40	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Markers at Tank Risers

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	Large number per tank farm, wind, maintenance requirement
H Impact on Worker	Low	23	Minimal impact, exposures, and training
H Technical Feasibility	High	23	Off the shelf item
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Easily implemented
H Installation Risk	Low	23	Mechanical fasteners create no new events
Feasibility Subtotal		100	
2. Optimization of Controls			
H Reliability	Low	3	Wind, weather, night visibility
M Human Factors Practicality	Low	1	Less effective than spotters, confusing if many present
H Applicability to Multiple Accidents	High	30	Minimize vehicular impact
H Compatibility of Controls	High	30	No new hazards introduced
Optimization Subtotal		64	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	Moderate	3	Engineered and administrative control
M Passive over Active	High	10	
Preference Subtotal		23	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Very little change to accident frequency
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Administrative reports
Cost/Benefit Subtotal		110	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Prohibit Flame Cutting

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Current projects would need to find alternate cutting methods
H Impact on Worker	Moderate	7	Apply new techniques/training
H Technical Feasibility	Low	2	Alternative availability applied to current work
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Must demonstrate alternative technique
H Installation Risk	Low	23	
Feasibility Subtotal		42	
2. Optimization of Controls			
H Reliability	Moderate	10	Proof testing required/distance constraints
M Human Factors Practicality	Moderate	3	New approach may intially increase errors
H Applicability to Multiple Accidents	High	30	Flammable gas, organic solvent
H Compatibility of Controls	High	30	No obvious conflicts
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	Low	1	Administrative
M Passive over Active	Moderate	3	
Preference Subtotal		14	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Moderate	30	New techniques must be demonstrated.
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Cost of alternative methods is not well established
Cost/Benefit Subtotal		60	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Increase HEPA Change Out Rate

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	
H Impact on Worker	Moderate	7	Increased worker dose
H Technical Feasibility	High	23	Demonstrated
L Mission Impacts	Moderate	1	Waste Minimization impacted
H Timeliness of Control Implementation	High	23	Easy
H Installation Risk	Moderate	7	ALARA
Feasibility Subtotal		67	
2. Optimization of Controls			
H Reliability	High	30	Only change out frequency is impacted
M Human Factors Practicality	Moderate	3	
H Applicability to Multiple Accidents	High	30	Organic solvent, HEPA filter fire
H Compatibility of Controls	High	30	Existing control
Optimization Subtotal		93	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Low	1	Administrative
M Passive over Active	Moderate	3	
Preference Subtotal		5	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	0.1% onsite (rad and tox) - stronger preference for LT
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		110	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Evac Based on Temperature/Pressure Alarm

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	Operations activities not limited
H Impact on Worker	Moderate	7	Alarm set point to be determined
H Technical Feasibility	High	23	Established technology
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Installation and design are required
H Installation Risk	Moderate	7	
Feasibility Subtotal		52	
2. Optimization of Controls			
H Reliability	High	30	Established technology
M Human Factors Practicality	Moderate	3	Established technology/no additional training
H Applicability to Multiple Accidents	High	30	Removes receptor from radiation field (tank bump, pressurization event)
H Compatibility of Controls	Moderate	10	
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Moderate	3	
M Passive over Active	Low	1	
Preference Subtotal		5	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	25% dose reduction based on evacuation
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	
Cost/Benefit Subtotal		130	

Accident:
Organic Salt-Nitrate

Control Criteria Rating

Control:
Ventilation Cooler

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	New equipment to operate/SSC
H Impact on Worker	Low	23	Simple training, minimum dose impact
H Technical Feasibility	Moderate	7	Transfer properties, localized heat
L Mission Impacts	Low	3	
H Timeliness of Control Implementation	Moderate	7	Actively ventillating passive systems
H Installation Risk	Moderate	7	Potential waste drying
Feasibility Subtotal		49	
2. Optimization of Controls			
H Reliability	High	30	Availability, heating is slow
M Human Factors Practicality	High	10	
H Applicability to Multiple Accidents	High	30	Tank bump but not flammable gas
H Compatibility of Controls	Low	3	Effects other monitoring & controls, possible ice containment of gas
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention
M Engineered over Administrative	High	10	Engineering control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	
Cost/Benefit Subtotal		40	

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TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 27-28, 1997

Spray Leak Accident Scenario Controls Evaluation

The attendance sheet for this meeting is attached. DOE Headquarters (EM-4, EM-38 and S-3) personnel were involved by telephone.

Larry Kripps presented the Spray Leak material, presenting background, assumptions, existing controls, and future considerations. There was extensive discussion on the Spray Leak accident scenario topography. The team then brainstormed potential controls and performed an initial screening on the potential controls for the Spray Leak accident scenario. The team completed this shortly before lunch and adjourned until January 28, 1997, at 10:00 a.m.

The team reformed the next day at Building 2704HV and evaluated the potential controls. The completed evaluation sheets and the list of potential controls considered are attached.

The meetings scheduled for January 30, 199, were replanned to accommodate a schedule conflict. The meetings were moved to Building 2704HV and scheduled for 7:00-9:00 a.m. (Steam Intrusion) and 11 a.m. - 1 p.m. (Seismic Event).

The Flammable Gas Accident Control Decision meeting will be held at the Federal Office Building, Room 249, from 7 a.m. through noon on Monday, January 27, 1997.

The Spray Leak session ended at noon on both days.

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TWRS FSAR Integrated Control Decision Meetings Attendees

January 27-28, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Rick Tedeschi	TWRS, LMHC
Surya Maruvada	ES&H, FDH
Jon Young	TWRS, (MSI)
Ben Harp	RL-TWRS
Brett Hall	Safety Analysis, FDNW
Bob Nelson	FSAR Tier II Review Team, Jason Associates
Mark Jackson	RL-QSH
Carol Sohn	RL-TWRS
Ryan Dodd	TWRS, LMHC
Vince Saladin	RL-TWRS
Via Teleconference	
Michael Mikolanis	DOE-HQ, S-3
Chandra Majumdar	DOE-HQ, EM-4
Tom Wright	DOE-HQ, EM-38

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Tank Waste Remediation System Final Safety Analysis Report Spray Leak Accident

January 1997

DOE/RL-97-26
Revision 0

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Accident Description

Pressurized leak from a small hole or crack in waste transfer piping, improperly installed transfer jumpers, or defective or degraded seals or gaskets. Causes include aging, corrosion, erosion, water hammer, overpressure, freezing, mechanical fatigue, thermal stress, and human error (misalignment of jumpers or improper valve lineups).

Accident Description

Topography

- Inside process pits along transfer routes
- Inside other process pits not along normal transfer routes where waste could be inadvertently misrouted
- Inside diversion boxes
- Inside vault pits (e.g., 244-AR Vault, CR Vault)
- Inside cleanout boxes (COBs) along slurry transfer lines
- From encasement risers on pipe-encased transfer lines
- Inside flush pits or service buildings
- From abovegrade components of flush water systems
- From temporary overground transfer lines
- Inside the 204-AR Waste Unloading Facility
- From buried or bermed sections of transfer lines if uncovered and damaged in an excavation accident during a transfer
- Inside ventilated waste storage tanks (DSTs, DCRTs, and some SSTs)

Accident Analysis Results (Without Controls)

The analyzed accident is a spray leak in a valve pit during an aging waste transfer. The pit cover blocks are postulated to be off at the time of the spray leak and the spray is directed to the atmosphere through the top of the open valve pit. The spray release is assumed to continue undetected for 24 hours.

The postulated accident frequency is estimated as anticipated based on the frequency of the initiating event.

Accident Analysis Result (Without Controls)

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray leak from Waste Transfer System	150 (15,000)	5 E-03 (0.5)	0.21 (21)	1 E-03 (0.1)	46	1 (ERPG-1)	0.24	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline
PEL = permissible exposure limit
SOF = sum of fractions
TWA = time-weighted average

Selected Controls

Safety SSCs

- Transfer system covers
- Above grade portions of process pits, diversion boxes, vault pits, and COBs
- Pressure switch interlock/alarm systems (water service lines)
- Ventilation stack CAM interlock systems
- OGT encasement and connections
- OGT concrete shielding system
- 204-AR Waste Unloading Facility structure
- Backflow prevention devices

TSRs

- LCO: Transfer system covers
- LCO: Service water pressure detection systems
- LCO: Ventilation stack CAM interlock systems

Selected Controls

TSRs (cont'd)

- AC: Transfer Controls
  - Transfer System Configuration Management (TSR 5.12.2a)
    - Establish and maintain controlled status of the waste transfer systems as-built and jumper configuration
    - Perform waste transfer system operations by approved procedures
    - Wherever practical, isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves (including 3-way valves) in series, and valves that are normally closed on the other side of service water pressure detection systems to ensure system functionality.

Selected Controls

TSRs (cont'd)

- Independently verify the planned waste transfer route is proper for the intended transfer; piping is in place per configuration status controls; correct and operable pumps are specified; and valves are properly aligned prior to transfer

- Prior to waste transfer through over-ground waste transfer piping, verify either vehicle restrictions (i.e., vehicle access limitations to the tank farm) or concrete shielding systems surrounding the over-ground transfer line portion of the transfer route are in place.

- Encasement Seal Loop Control (TSR 5.13.2a)

  - During waste transfer through a waste transfer system, all encasement seal loop drain line isolation valves associated with physically connected piping shall be in either the "drain" or "operate" position.

Selected Controls

TSRs (cont'd)

- Transfer Pump Administrative Lock Controls (TSR 5.20)
- Transfer System Cover Removal Controls (TSR 5.22)
- Excavation Controls (TSR 5.17)
  - Excavation permit
  - Permanent above ground labeling of waste transfer lines outside tank farm boundaries
  - No transfer through uncovered lines without compensatory controls
  - Transfers prohibited in vicinity of ongoing excavations
  - Emergency response for terminating waste transfer

Selected Controls

Safety SSC and TSR Control Mapping to Spray Leak Accident

- Spray leak inside process pits, diversion boxes, vault pits, and COBs
  - Transfer system covers (Safety SSC and TSR)
  - Transfer controls (TSR)
  - Transfer pump administrative lock controls (TSR)
- Spray leaks from encasement risers
  - Encasement seal loop control (TSR)
- Spray leaks from service water system components coincident with backflow of waste
  - Pressure switch interlock/alarm systems (Safety SSC and TSR)
  - Backflow prevention devices (Safety SSC)

Selected Controls

Safety SSC and TSR Control Mapping to Spray Leak Accidents (cont'd)

- Spray leak from OGT lines
  - OGT encasement and connectors (Safety SSC)
  - OGT concrete shielding systems (Safety SSC and TSR)
  - Encasement seal loop control (TSR)
- Spray leaks inside the 204-AR Waste Unloading Facility
  - Ventilation stack CAM interlock system (Safety SSC and TSR)
  - 204-AR Waste Unloading Facility structure (Safety SSC)
- Spray leaks inside actively ventilated tanks
  - Ventilation stack CAM interlock systems (Safety SSC and TSR)

Selected Controls

Safety SSC and TSR Control Mapping to Spray Leak Accidents (cont'd)

- Spray leaks from buried or bermed transfer line, uncovered and damaged during excavation
  - Excavation controls (TSR)

Defense in Depth Controls

- Spray Leaks General
  - Mass balance calculations during waste transfer (TSR 5.12.2b)
  - Monitor for increasing level in all tanks physically connected to the waste transfer route during waste transfers (TSR 5.12.2b)
  - Newly installed jumpers shall be leak tested prior to use (TSR 5.12.2a)
  - Emergency Preparedness-response procedures (TSR 5.14.2d)
  - Transfer leak detection systems (Safety SSC, TSR 3.1.3)
  - Encasement leak detection systems

Selected Controls

Defense in Depth Controls (cont'd)

- Spray Leaks from service water system backflow
  - Isolation valves
  - Check valves
  - Quick disconnect (for saltwell systems)
  - Valve position limit switches
- Spray from OGT
  - Heat trace
  - Insulation
  - Primary pipe

Selected Controls

Defense in Depth Controls (cont'd)

- Spray leaks inside the 204-AR Waste Unloading Facility
  - Ventilation system HEPA filters
  - Ventilation system deentrainer and heater
  - Mechanical equipment room and unloading area CAMs
  - High DP alarms across HEPA filters
  - Low DP alarms across HEPA filter and interlock to exhaust fan
  - Doors closed except when railcar or trailer entering/exiting
- Spray leaks inside actively ventilated tanks
  - Ventilation system HEPA filters
  - Ventilation system deentrainer and heater
  - High DP alarms across HEPA filter
  - Low DP alarms across HEPA filter and interlock to exhaust fan

Accident Analysis Results (With Controls)

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray leak from Waste Transfer System	0.041 (4.1)	5 E-03 (0.5)	3.7 E-05 (3.7 E-03)	1 E-03 (0.1)	0.081	1 (ERPG-1)	4.2 E-04	1 (PEL-TWA)	Anticipated

ERPG = Emergency Response Planning Guideline
PEL = permissible exposure limit
SOF = sum of fractions
TWA = time-weighted average

Key Parameters and Assumptions/Sensitivity Analyses

Key Parameters and Assumptions - Accident Analysis Without Controls

- slit length
- slit width
- waste pressure
- accident duration
- solids content
- waste inventory

Key Parameters and Assumptions - Accident Analysis With Controls

- aerosol concentration of air expelled from the pit
- temperature and humidity change
- leak flowrate
- spray leak location

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk:

From Draft FSAR (Table 3.3.2.3.5-1)

- **Inclusion of more rigorous treatment of agglomeration and deposition in the atmospheric modeling of accident consequences**
- **Inclusion of momentum or buoyant (thermal) plume rise and initial source size effects in the atmospheric dispersion modeling of accident consequences**
- **Evaluation and incorporation, where possible, of emergency response actions in the accident consequence analysis**
- **Development and application of revised high-level waste radiological and toxicological source terms for the accident analysis**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Improve the accident analysis modeling of spray leaks**
- **Installation of HEPA filter systems on process pits, diversion boxes, vault pits, and cleanout boxes**
- **Installation and operation of radiation monitors in process pits, diversion boxes, vault pits, and cleanout boxes to detect waste leaks**
- **Development and implementation of additional in-service surveillance and maintenance programs for DSTs (including AWF tanks), SSTs, DCRTs, catch tanks, and waste transfer lines**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Installation and operation of a radiation monitoring system for the tank farm areas**

From Control Decision Record (CDR)

- **Walk down of waste transfer routes once per shift**
- **Limit switches on transfer system covers**
- **Flowmeter on waste transfer systems**

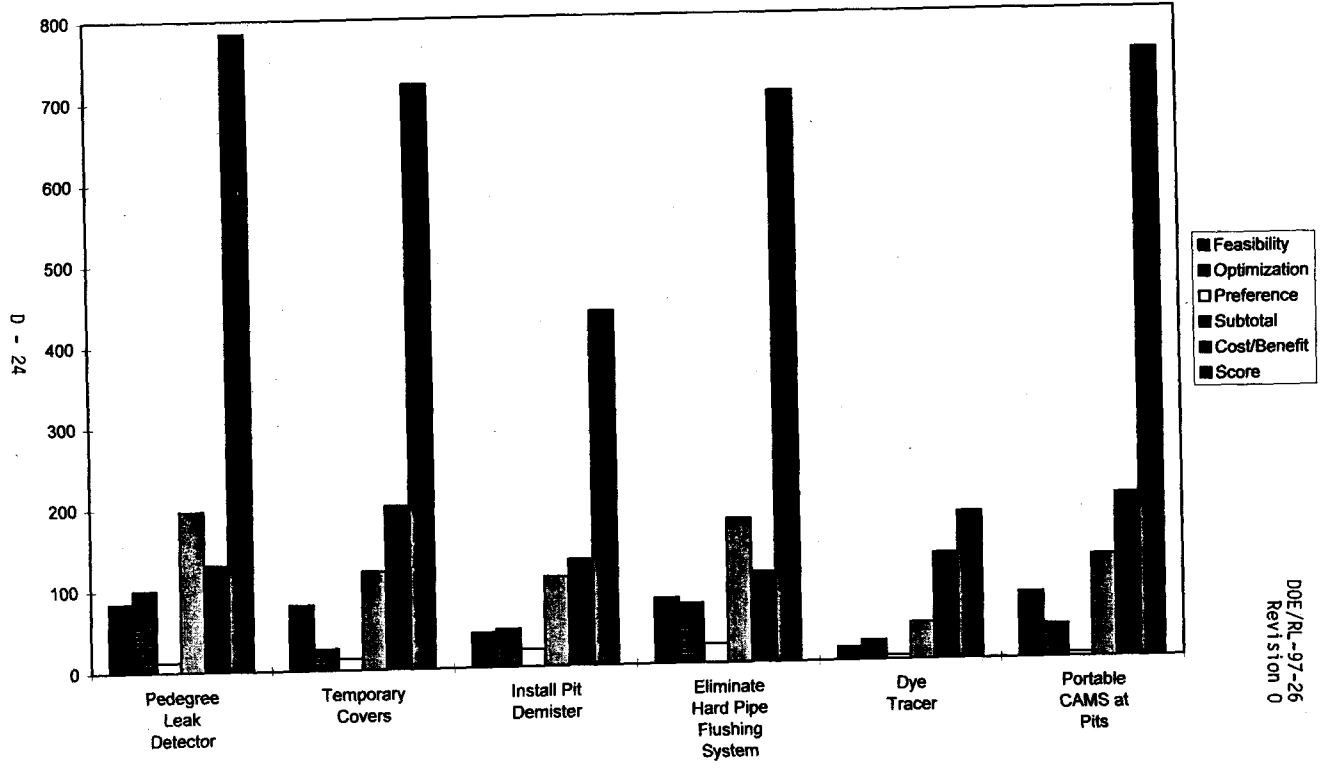
Spray Leak Accident - Initial Controls

Term	Evaluated	Control
L		New valves and test ports
S		New/better transfer cover seals
S	√	Pedigree leak detector
S		Prohibit aging waste transfer
S		Install HEPAs on pits (passive)
S	√	Install radiation monitors in pits (CAM)
L		Develop/implement additional hardware surveillance and monitoring
S	(1)	Install area radiation monitor
S		Additional route walk-down during transfer
L		Limit switches (w/alarms and interlocks) on covers
L		Install new/improved transfer line flowmeters
S		Sonic/Motion detectors in pits
S		Controlling other energy sources
	√	Pit/OGT covers/Bldg/tarp (perm (L) and temp (S)
S	(1)	Alarming personnel dosimeters
S		Limit solids content of transfer
L		Flow/pressure regulators (limiting)
		Remote (video) surveillance of covers (S)/pits (L)
L		New multiple-valve jumpers which would limit pit entries
S		New leak detection detector (fog)
S		Only use small # of dedicated lines
S	√	Install pit demister
L		New pit ventilation system

Term	Evaluated	Control
L		New piping
L		Accelerate interim stabilization
S		Better identify blocks (paint, flags, etc.)
L		Replace jumpers with welded pipe
S		Encase pit piping/valves
S	√	Eliminate all hard-pipe flushing sysems
S		Upgrade configuration control system (drawings, etc.)
S		Disconnect/isolate 204-AR
S		Perform shorter distance transfers
S		Berm OGT piping (soil e.g.)
L		Remove personell/trailers, etc. from tank farms
S	√	Tracer and detection system for within waste
L		Install pipe identification above buried piping (below ground for detection during excavation)
L		Halt pipeline transfers - pursue truck/trialer transport
s		Limit high pressure/flow transfers

(1) Evaluated for Organic Solvent Fire and Organic Salt-Nitrate accidents.

Spray Leak Control Criteria Rating



Spray Leak
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Pedegree Leak Detector	84	100	12	196	130	4	**784**
Temporary Covers	80	26	14	120	200	6	**720**
Install Pit Demister	42	46	21	109	130	4	**436**
Eliminate Hard Pipe Flushing System	80	73	23	176	110	4	**704**
Dye Tracer	16	24	5	45	130	4	**180**
Portable CAMS at Pits	80	40	5	125	200	6	**750**

Accident:
Spray Leak

Control Criteria Rating

Control:
Pedegree Leak Detector

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	Known equipment, additional surveillance and monitoring
H Impact on Worker	Low	23	Known characteristics of equipment
H Technical Feasibility	Moderate	7	Variable pit configuration
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Detector is installed
H Installation Risk	Low	23	Detector currently exists
Feasibility Subtotal		84	
2. Optimization of Controls			
H Reliability	High	30	Established
M Human Factors Practicality	High	10	Worker familiarity
H Applicability to Multiple Accidents	High	30	Pool leaks, subsurface leaks
H Compatibility of Controls	High	30	In use
Optimization Subtotal		100	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		12	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Moderate	30	25% reduction in consequences
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Already installed for other accidents
Cost/Benefit Subtotal		130	

Accident:
Spray Leak

Control Criteria Rating

Control:
Temporary Covers

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	
H Impact on Worker	Moderate	7	Additional ground cover
H Technical Feasibility	High	23	Essentially a filter/barrier to release
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Easily installed
H Installation Risk	Low	23	Minimal installation or operating risk
Feasibility Subtotal		80	
2. Optimization of Controls			
H Reliability	Moderate	10	Not air tight
M Human Factors Practicality	Moderate	3	May impede access
H Applicability to Multiple Accidents	Moderate	10	Provides release barrier for several events
H Compatibility of Controls	Low	3	Could lead to increase in flammable gas concentrations
Optimization Subtotal		26	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Moderate	3	
M Passive over Active	High	10	
Preference Subtotal		14	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Factor of 10 reduction in projected dose
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		200	

Accident:
Spray Leak

Control Criteria Rating

Control:
Install Pit Demister

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Would require handling of structures to install
H Impact on Worker	High	2	
H Technical Feasibility	High	23	DF will be increased by demister
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Design and Installation
H Installation Risk	Moderate	7	Exposure
Feasibility Subtotal		42	
2. Optimization of Controls			
H Reliability	High	30	Simple design
M Human Factors Practicality	Moderate	3	Contamination Trap
H Applicability to Multiple Accidents	Moderate	10	Pool leak splatter
H Compatibility of Controls	Low	3	May interfere with instrumentation, visual inspection
Optimization Subtotal		46	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered
M Passive over Active	High	10	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Factor of 10 increase in decontamination factor
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	High cost reduced by avoided cost
Cost/Benefit Subtotal		130	

Accident:
Spray Leak

Control Criteria Rating

Control:
Eliminate Hard Pipe Flushing System

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Confined space, must be done everytime
H Impact on Worker	Low	23	ALARA, training, confined space entries
H Technical Feasibility	High	23	Easy to do
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Quickly accomplished
H Installation Risk	Moderate	7	Welding in confined space
Feasibility Subtotal		80	
2. Optimization of Controls			
H Reliability	High	30	High once implemented
M Human Factors Practicality	Moderate	3	Remove and replace /hydro test required
H Applicability to Multiple Accidents	Moderate	10	Pool leak
H Compatibility of Controls	High	30	System eliminated
Optimization Subtotal		73	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention
M Engineered over Administrative	Moderate	3	Engineered with admin
M Passive over Active	High	10	
Preference Subtotal		23	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	Small part of spray potentials
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		110	

Accident:
Spray Leak

Control Criteria Rating

Control:
Dye Tracer

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	New system to operate (dye injection system)
H Impact on Worker	High	2	Toxic potential
H Technical Feasibility	Low	2	Does not help detection at night
L Mission Impacts	Moderate	1	New material to deal with
H Timeliness of Control Implementation	Moderate	7	Significant engineering required
H Installation Risk	High	2	Personnel exposure - rad and tox
Feasibility Subtotal		16	
2. Optimization of Controls			
H Reliability	Low	3	Lack of knowledge for proposed application
M Human Factors Practicality	Low	1	Human interaction, visibility of leak or spray during daylight only
H Applicability to Multiple Accidents	Moderate	10	Pools
H Compatibility of Controls	Moderate	10	Potential issues
Optimization Subtotal		24	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Moderate	3	
M Passive over Active	Low	1	
Preference Subtotal		5	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	50% reduction in dose
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Moderate	30	Injection system, installation at multiple locations
Cost/Benefit Subtotal		130	

Accident:
Spray Leak

Control Criteria Rating

Control:
Portable CAMS at Pits

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Maintenance, moving (less feasible for transfer lines, etc.)
H Impact on Worker	Moderate	7	ALARA, additional activity to install
H Technical Feasibility	High	23	Well known and proven
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Existing hardware
H Installation Risk	Low	23	Similar equipment currently in use
Feasibility Subtotal		80	
2. Optimization of Controls			
H Reliability	Moderate	10	Potential CAM failure/false alarms
M Human Factors Practicality	High	10	Existing practice
H Applicability to Multiple Accidents	Moderate	10	Pool leaks
H Compatibility of Controls	Moderate	10	Flammable gas controls concern
Optimization Subtotal		40	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Moderate	3	
M Passive over Active	Low	1	
Preference Subtotal		5	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	~50% reduction/topography
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		200	

TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 29, 1997

Flammable Gas Accident Scenario Controls Evaluation

The attendance sheet for this meeting is attached. DOE Headquarters (EM-4, EM-38, S-3 and FDH S-3) personnel and DNFSB staff were involved by telephone.

Larry Kripps presented the Flammable Gas material, presenting background, assumptions, existing controls, and future considerations. The team then brainstormed potential controls.

DOE performed the initial screening on the potential controls. Then the team applied the the evaluation criteria to the remaining potential controls. The completed evaluation sheets are attached along with the list of potential controls considered.

The Steam Intrusion and Seismic Event Accidents Control Decision packages were handed out and the meetings will be held at the TWRS Office Building, room G230, from 7-9 a.m. (Steam Intrusion) and 11 a.m. - 1 p.m. (Seismic Event) on Wednesday, January 29,1997.

The Flammable Gas session ended at 4:00 p.m.

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TWRS FSAR Integrated Control Decision Meetings Attendees

January 29, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Ko Chen	RL-TWRS
Rick Van Vleet	TWRS, FDNW
Jerry Johnson	DESH
Paul Hernandez	RL-TWRS
Mike Grigsby	TWRS
Rick Tedeschi	TWRS, LMHC
Surya Maruvada	ES&H, FDH
Jon Young	TWRS, MSI
Ben Harp	RL-TWRS
Carol Sohn	RL-TWRS
Via Teleconference	
Tom Wright	DOE-HQ, EM-38
Chandra Majumdar	DOE-HQ, EM-4
Ralph Arcaro	DNFSB
Tim Veneziano	FDH S-3 (on detail to DOE-HQ)
Mike Mikolanis	DOE-HQ, S-3

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Tank Waste Remediation System Final Safety Analysis Report Flammable Gas Accident

January 1997

DOE/RL-97-26
Revision 0

Accident Description

Deflagration of flammable gas (e.g., hydrogen, ammonia, methane) generated in waste by radiolysis, organic degradations, and corrosion.

Distinguishing accident scenario characteristics/causes:

- Steady state generation vs. gas release event (GRE)
- Headspace vs. subsurface
- GRE initiators - natural, seismic event, subsurface deflagration, and waste intrusive or waste disturbing activity
- Local vs. global release

Accident Description

Ignition Sources

Very small energy source required; only 0.017 mJ to 0.1 J.

- Installed equipment in the tank or ventilation system
- Activities being conducted in the tank
- Human error
- Natural phenomena (i.e., earthquake, lightning)

Accident Description

Topography

- DSTs, AWF tanks, SSTs, DCRTs, catch tanks, IMUSTs, 244-AR Vault, waste transfer system, (i.e., waste transfer line and waste transfer-associated structures)

- DST and AWF tank annulus

- Tank 241-SY-101 mixer pump removal

Accident Analysis Results (Without Controls)

Cracking of the tank dome.

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Double-Shell Tank Deflagration in the Headspace	1.9 E-01 (1.9 E+01)	5.0 E-03 (5.0 E-01)	1.6 E-04 (1.6 E-02)	1.0 E-03 (1.0 E-01)	1,100	1	0.94	1	Anticipated
Aging Waste Facility Tank Deflagration in the Headspace	4.4 E-02 (4.4 E+00)	5.0 E-03 (5.0 E-01)	4.0 E-05 (4.0 E-03)	1.0 E-03 (1.0 E-01)	820	1	0.70	1	Anticipated
Deflagration during Mixer Pump Removal from a Double-Shell Tank	7.2 E-01 (7.2 E+01)	5.0 E-02 (5.0 E+00)	6.2 E-04 (6.2 E-02)	5.0 E-03 (5.0 E-01)	1,500	1	1.3	1	Unlikely

SOF = sum of fractions

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Single-Shell Tank Deflagration in the Headspace	6.5 E+00 (6.5 E+02)	5.0 E-03 (5.0 E-01)	5.7 E-03 (5.7 E-01)	1.0 E-03 (1.0 E-01)	1,800	1	2.3	1	Anticipated
Double-Contained Receiver Tank Burn	4.4 E+00 (4.4 E+02)	5.0 E-03 (5.0 E-01)	3.8 E-03 (3.8 E-01)	1.0 E-03 (1.0 E-01)	1,000	1	1.1	1	Anticipated

SOF = sum of fractions

Accident Analysis Results (Without Controls) (cont'd)

Collapse of the dome into the tank

- **Results in an additional 3.8 L of respirable waste released compared to 2.63 L (SSTs) and 2.76 L (DSTs) respirable waste release for the tank dome cracking scenario**

Tank dome loss (i.e., blowout)

- **For a detonation, estimated consequences exceed those for a deflagration by a factor of 36**

Selected Controls

Safety SSCs

- DST/AWF primary tank ventilation systems
- SST ventilation systems
- DCRT ventilation systems
- 244-AR TK-002 ventilation system
- Primary tank leak detection systems
- SY-101 mixer pump
- SY-101 hydrogen monitor
- SY-101 level monitoring system
- SY-101 pressure monitoring system
- SY-101 ventilation flowmeter
- SY-101 ammonia detection systems
- SY-101 temperature monitoring systems
- DST structure
- AWF tank structure
- SST structure

Selected Controls

TSRs

LCO: DST and AWF tank ventilation systems (TSR 3.2.1)

LCO: SST ventilation systems - active (TSR 3.2.2)

LCO: SST ventilation systems - passive (TSR 3.2.3)

LCO: DCRT ventilation systems (TSR 3.2.4)

LCO: 244-AR TK-002 ventilation system (TSR 3.2.5)

LCO: Primary tank leak detection systems (TSR 3.2.6)

Selected Controls

TSRs (cont'd)

AC: Flammability controls (TSR 5.9)

- Tank 241-SY-101 Flammability Controls
  - Establish controls for the operation of flammable gas mitigation equipment (e.g., mixer pump operation) in Tank 241-SY-101. These controls shall include the Level I requirements of Chapter 6 of the mixer pump safety assessment (LA-UR-92-3196)
  - Establish controls for the removal of the mixer pump from Tank 241-SY-101 to minimize the risk of a flammable gas deflagration

- Flammable Gas Control Restriction
  - Saltwell pumping is prohibited in the listed tanks

Selected Controls

TSRs (cont'd)

- Flammable Gas Data Collection
  - Collect flammable gas generation data using permanent gas monitors to evaluate the adequacy of flammability-based controls

AC: Ignition Controls (TSR 5.10)

Intrusive Controls

- Stop waste-intrusive activities in tanks with a potential flammable gas hazard when lightning is identified within a 30 mile radius of the tank farm

Flammable Gas Ignition Controls

- Ignition Source Control Set #1
- Ignition Source Control Set #2

Selected Controls

TSRs (cont'd)

AC: Flammable Gas Monitoring Controls (TSR 5.11)

- Manned work activity controls
- Unmanned operations controls
- DCRT ventilation requirements

AC: Transfer Control

Waste Compatibility Controls (TSR 5.12.2c)

- Evaluate the planned final state of both the pumped and receiving tanks prior to waste transfer through a transfer system

AC: Emergency Preparedness (TSR 5.14)

Selected Controls

TSRs (cont'd)

AC: HEPA Filter Controls (TSR 5.18.2a)
Verify periodically that the HEPA filter and prefilter housing radiation level is $\leq$ 200 mrem/hr on contact. Replace the HEPA filters and prefilters prior to filter housing radiation levels exceeding 200 mrem/hr

AC: Process Instrumentation and Measuring and Test Equipment (TSR 5.19)

Defense In Depth Controls

Monitor for increasing level in catch tanks physically connected to the waste transfer route during waste transfer

Selected Controls

Comparison of Safety SSC/TSR Controls from JCO/BIO/FSAR

- **BIO and FSAR include Tank 241-SY-101 Level I controls from LA-UR-92-3196**

- **FSAR includes an additional Flammable Gas Control (TSR 5.9) key element on "Flammable Gas Data Collection"**

Accident Analysis Results (With Controls)

Cracking of the tank dome

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Double-Shell Tank Deflagration in the Headspace	1.9 E-01 (1.9 E+01)	5.0 E-02 (5.0 E+00)	1.6 E-04 (1.6 E-02)	5.0 E-03 (5.0 E-01)	130	1	0.94	1	Unlikely
Aging Waste Facility Tank Deflagration in the Headspace	4.4 E-02 (4.4 E+00)	5.0 E-02 (5.0 E+00)	4.0 E-05 (4.0 E-03)	5.0 E-03 (5.0 E-01)	93	1	0.70	1	Unlikely
Deflagration during Mixer Pump Removal from a Double-Shell Tank	7.2 E-01 (7.2 E+01)	1.0 E-01 (1.0 E+01)	6.2 E-04 (6.2 E-02)	4.0 E-02 (4.0 E+00)	35	1	1.3	1	Extremely Unlikely

SOF = sum of fractions

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Single-Shell Tank Deflagration in the Headspace	6.5 E+00 (6.5 E+02)	5.0 E-02 (5.0 E+00)	5.7 E-03 (5.7 E-01)	5.0 E-03 (5.0 E-01)	430	1	1.5	1	Unlikely
Double-Contained Receiver Tank Burn	4.4 E+00 (4.4 E+02)	1.0 E-01 (1.0 E+01)	3.8 E-03 (3.8 E-01)	4.0 E-02 (4.0 E-00)	22	1	0.13	1	Extremely Unlikely

SOF = sum of fractions

Accident Analysis Results (With Controls) (cont'd)

Collapse of the dome into the tank

- Results in an additional 3.8 L of respirable waste released compared to 2.63 L (SSTs) and 2.76 L (DSTs) respirable waste release for the tank dome cracking scenario

Tank dome loss (i.e., blowout)

- For a detonation, consequences exceed those for a deflagration by a factor of 36

Key Parameters and Assumptions/Sensitivity Analyses

- Gas composition
- Gas release volumes
- Retained gas volumes
- Calculated pressures
- Released material

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk:

From Draft FSAR (Table 3.3.2.3.5-1)

- **Inclusion of more rigorous treatment of agglomeration and deposition in the atmospheric modeling of accident consequences**
- **Inclusion of momentum or buoyant (thermal) plume rise and initial source size effects in the atmospheric dispersion modeling of accident consequences**
- **Evaluation and incorporation, where possible, of emergency response actions in the accident consequence analysis**
- **Development and application of revised high-level waste radiological and toxicological source terms for the accident analysis**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Design modifications to allow the direct measurement of the flow rate through each actively ventilated DST (including AWF tank) and SST**

- **Design modifications to provide an inlet flow path to each DCRT and to allow the direct measurement of the flow rate through each DCRT**

- **Design modifications to add monitoring systems (e.g., flammable gas) or improve existing monitoring systems (e.g., waste level) to DSTs (including AWF tanks) and SSTs that either (a) exhibit gas release, level change, or other parameters that would be valuable in better defining the hazards or (b) where intrusive work is planned**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Verification that DST (including AWF tank), SST, and DCRT ventilation systems, instrumentation, and equipment used for intrusive activities meet industry standards (e.g. National Fire Protection Association, National Electrical Code) for flammable gas environments. Implementation of design modifications for ventilation systems, instrumentation, and equipment that do not meet industry standards or justification that the design is equivalent to industry standards**

- **Installation and operation of mixer pumps in DSTs (including AWF tanks) with the potential for large gas release events**

- **Continue or accelerate research on tank waste flammable gas deflagration/detonation hazards. Prioritize work based on uncertainties and importance to the accident risk assessment**

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk (cont'd):

- **Installation of additional lighting protection systems (e.g., additional grounded air terminals, catenary network) for waste tanks**
- **Accelerate tank waste retrieval where retrieval can eliminate high risk situations**
- **Installation and operation of a radiation monitoring system for the tank farms area**

Further Actions Considered/Suggested/Ongoing

Further Actions that are Ongoing to Reduce the Calculated or Real Risk

- Gas generation
  - Tests on selected SST waste samples
  - Determine effects of key organic compounds
- Gas retention
  - Determine in-situ gas volumes and compositions for selected SSTs
  - Conduct limited laboratory tests on waste samples to improve knowledge of retention mechanisms
  - Refine modeling efforts to relate gas volume to changes in atmosphere pressure and waste level
  - Effects of saltwell pumping on retained gas inventory
  - Establish predictive capability for "new" or "altered" tank conditions for gas retention
  - Complete void fraction measurements of AN-105 and AN-107

Further Actions Considered/Suggested/Ongoing

Further Actions that are Ongoing to Reduce the Calculated or Real Risk (cont'd)

- **Gas release**
  - **Establish magnitude of passive ventilation**
  - **Establish predictive capability for "new" or "altered" tank conditions for gas release**
  - **Continue to analyze release data from SHMS**
  - **Improve understanding of "plumes"**
  - **Complete flammability tests of CIT/LANL (turbulent conditions, detonation, and plumes)**

- **Activities for Obtaining Tank Data**
  - **Installation of additional gas monitors**
  - **Complete connections of equipment to TMACS**
  - **Complete installation of pressure monitors in SSTs**
  - **Complete installation of flow meters in DSTs**

Further Actions Considered/Suggested/Ongoing

Further Actions that are Ongoing to Reduce the Calculated or Real Risk (cont'd)

- **Major Equipment Actions**
  - **Complete ventilation upgrades**
    - **Inlet filters/controllers in AN Farm**
    - **Sparkless fan in AW Farm and AN Farm**
    - **Flow controllers in SY Farm**
  - **Complete procurement of exhausters in SSTs to support saltwell pumping**
  - **Complete miscellaneous items for SY-101 pump**

Review of Potential Means for Mitigating or Preventing Flammable Gas Event

Step in Flammable Gas Combustion	Potential Prevention Measure	Notes
Generation of flammable gas in tank waste	1. Fully oxidize the flammable gas generating materials. 2. Control tank temperatures to low levels to minimize gas generation.	1. *Will eventually be done for vitrification.* 2. *Controls on tank waste temperatures are in place.*
Retention of flammable gas in tank liquid and wetted waste	1. Mixer pump to reduce flammable gas retention inventory. 2. Saturating the tank waste liquid with an inert gas. 3. Drying out tank waste. 4. Making the waste very soggy or liquid to allow generated gas to escape.	1. *Being done for tank SY-101. Very effective for reducing flammable gas levels sufficiently to avoid roll overs but not sufficient to avoid a seismically induced release.* 2. *Not well analyzed yet but would probably increase rollovers though with minimal flammable gas.* 3. *Saltwell pumping has drained supernate from 114 of 149 SSTs, but some wetting of waste is needed to control temperatures and prevent chemical reactions.* 4. *Very wet conditions allow the gas to escape but increases volume and creates a leak potential.*
Release of flammable gas to dome area	1. Reducing total gas inventory by mixer pump. 2. During intrusive work, collect gas through a ventilation exhaust at the point a tool enters the waste pool/pile.	1. *Mixer pumps have been able to keep gas levels low enough to avoid non-seismically induced releases. It is not feasible to actively avoid earthquakes. Capturing the gas as it leaves the waste but before it mixes in the dome area would interfere with heat transfer and create a permanent bubble in the capture device.* 2. *Such an exhaust collection duct would be heavy but could safety collect any gas released from a salt dome or other interior bubble.*

Step in Flammable Gas Combustion	Potential Prevention Measure	Notes
Oxygen available in dome area for combustion	1. Displace the oxygen by using a nitrogen filled balloon in the dome region. 2. Eliminate oxygen by ventilating with nitrogen.	1. *Expensive to design and build so that would not interfere with dome operations, and NO_3 oxidizer is still produced and released with flammable gas.* 2. *Expensive to ventilate with nitrogen.*
Retention of sufficient flammable gas and oxygen for a long enough period to be ignited	Rapid ventilation	*Being done in several tanks with forced ventilation for steady state conditions. Large gas releases (GREs) could be accompanied by severe rattling that could generate a spark.*
Ignition of the flammable gas and oxygen to initiate propagating combustion	1. Control ignition sources. 2. Stop intrusive work whenever the measures dome area gas exceeds limits. 3. For retrieval, require tools that are internally explosion proof or internally inerted.	1. *Controls are currently in place. Note that known ignition sources would create a downward moving flame which is slower than an upward moving flame.*
Over pressure sufficient to get a major airborne release	1. Improve structural integrity 2. Provide controlled blowoff port path (rupture disk leading to pebble and sand bed) 3. Nitrogen balloon to absorb shock and allow inert gas venting for pressure control	1. *Limited to analysis or minor changes with existing tanks. Unknowns for material conditions limit benefits from analysis.* 2. *Unclear feasibility.* 3. *Expensive.*

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Flammable Gas Spark Sources

- Mechanical Spark
- Electronic Spark
- Electrostatic Spark
- Hot (thermal) Surfaces
- Natural Phenomena
- Friction

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Flammable Gas Accident - Initial Controls

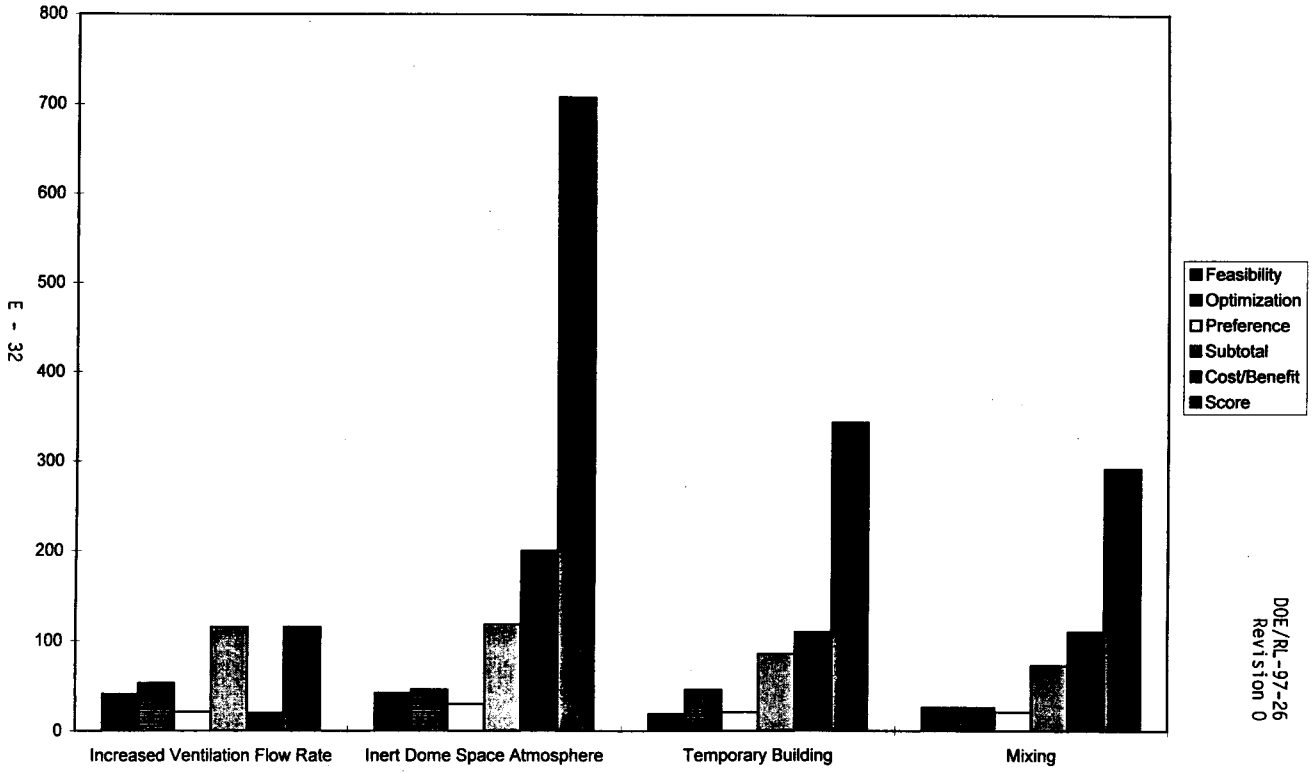
Term	Evaluated	Control
		Viscosity Lowering
S		- dilution
S		- sonic and ultrasonic/mixing
L	√	- Inert gas sparging/mixing
S		- removal of supernate in DSTs
L		Waste segregation into additional tanks
		Dry out SST Waste
L		- accelerate saltwell pumping
S		- add/increase ventilation
S	√	Increase ventilation flow rate (DST)
S		Install Non-H_2 chemical monitoring systems (e.g, NH_3, organic)
L		Install H_2/Flam Gas recombiners
S		Install ignitor in tank
S		Install additional exhaust system to actively ventilated tanks
S		Install additional inlet HEPA filters on passively ventilated tanks
S	√ (1)	Inert tanks
S		Purge with a blanket layer
L		Install an inert balloon/bladder
S		Seal tanks to reduce O_2 inlet
L		Add other inert solids
L		Upgrade potential spark source instrumentation/hardware to decrease failure
L		Remove all spark source instrumentation/hardware from tanks
L		Move onsite receptor
		Install Confinement to Limit Airborne Dispersal

Term	Evaluated	Control
L		- permanent building
S		- tarps
S	√	- temporary building/structure/tent
L		Install systems to capture radioactive releases
L		Spark resistant fans (upgrade)
S		Install new ventilation flow meters (DST &SST) (to beyond Facility Group 1 tanks)
S		Modify flow piping and install flow meters (DCRT)
S		Install permanent/continuous monitoring systems - flammable gas - pressure - level
S		Upgrade other instrument systems to highest NEPA standard
L		Install mixer pumps in DSTs
L		Install additional lightning protection
S		Upgrade grounding systems to balance impedance
L		Accelerate retrieval
S	(2)	Install area radiation monitoring
		Treat Waste to Reduce Gas Generation and/or Remove Organics
S		- caustic addition
L		- sonic
L		- microwave
L		- mechanical
L		- Cs removal
S		- dilution
L		- other chemicals
L		Accelerate pretreatment

Term	Evaluated	Control
		Transfer SST Contents to Ventilated DSTs (waste segregation)
S		- liquids
L		- sludge
L		Sand filters
L		Install rupture disc and capture system
L		Upgrade HEPA filter design
S		Accelerate emergency response (offsite) (take cover)
S		Monitor/sampling waste transferred into DCRTs
S		Seal release points other than stack
S		Install flame-front dissipator/cooler
S		Install additional stack height
L		Modify tank to direct pressure front or release to the side, i.e., into secondary tank or soil
S		Limit intrusive activities and/or simultaneous tank activities
S		Limit intrusive activity timing duration

(1) Evaluated for Organic Solvent Fire accident.
(2) Evaluated for Organic Solvent Fire and Organic Salt-Nitrate accidents.

Flammable Gas Control Criteria Rating



Flammable Gas
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Increased Ventilation Flow Rate	41	53	21	115	20	1	**115**
Inert Dome Space Atmosphere	42	46	30	118	200	6	**708**
Temporary Building	19	46	21	86	110	4	**344**
Mixing	26	26	21	73	110	4	**292**

Accident:
Flammable Gas

Control Criteria Rating

Control:
Increased Ventilation Flow Rate

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Increased maintenance, access
H Impact on Worker	Moderate	7	More filters to change
H Technical Feasibility	High	23	Current technology with minor modifications
L Mission Impacts	Moderate	1	Increased waste generation, worker exposure
H Timeliness of Control Implementation	Low	2	Design and installation
H Installation Risk	Moderate	7	Crane work
Feasibility Subtotal		41	
2. Optimization of Controls			
H Reliability	Moderate	10	Maintenance Requirements
M Human Factors Practicality	High	10	Similar system currently in use
H Applicability to Multiple Accidents	High	30	Provides cooling, bump
H Compatibility of Controls	Low	3	Dry out related to Organic Nitrate, Spark Source
Optimization Subtotal		53	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	Low	10	
H Capital Costs plus Operating, Life Cycle Costs (LCC)	High	10	
Cost/Benefit Subtotal		20	

Accident:
Flammable Gas

Control Criteria Rating

Control:
Inert Dome Space (Cover Gas)

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Additional hazard, confined space, new equipment
H Impact on Worker	High	2	Training, breathing air quality concerns
H Technical Feasibility	Moderate	7	Not done for this application
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Initial inerting with periodic makeup
H Installation Risk	Moderate	7	New hazard
Feasibility Subtotal		42	
2. Optimization of Controls			
H Reliability	Moderate	10	Potential leaks, impact of work activities
M Human Factors Practicality	Moderate	3	Potential air quality hazard to worker
H Applicability to Multiple Accidents	High	30	Solvent and nitrate (wick fires), flammable gas
H Compatibility of Controls	Low	3	Low for actively ventilated tanks
Optimization Subtotal		46	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Prevention and mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	High	10	
Preference Subtotal		30	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Potential order of magnitude
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	Constant supply needed, avoided cost
Cost/Benefit Subtotal		200	

Accident:
Flammable Gas

Control Criteria Rating

Control:
Temporary Building

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Limited access, overhead restrictions
H Impact on Worker	Moderate	7	Physical constraints to work environment
H Technical Feasibility	Low	2	Unproven in this application
L Mission Impacts	High	0	Waste generation, infrastructure
H Timeliness of Control Implementation	Low	2	Building may require HVAC, lighting, and other services
H Installation Risk	Moderate	7	
Feasibility Subtotal		19	
2. Optimization of Controls			
H Reliability	Moderate	10	Material degradation, fire hazard
M Human Factors Practicality	Moderate	3	Change to existing work environment
H Applicability to Multiple Accidents	High	30	Minimizes release
H Compatibility of Controls	Low	3	May impact visual inspections
Optimization Subtotal		46	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	High	10	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Minimizes releases
H Capital Costs plus Operating, Life Cycle Costs (LCC)	High	10	
Cost/Benefit Subtotal		110	

Accident:
Flammable Gas

Control Criteria Rating

Control:
Mixing Waste by Sparging

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	High	1	Significant added staff
H Impact on Worker	High	2	Training and certifications
H Technical Feasibility	Moderate	7	Monitoring required
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	Moderate	7	Design and installation required
H Installation Risk	Moderate	7	
Feasibility Subtotal		26	
2. Optimization of Controls			
H Reliability	Moderate	10	High maintenance anticipated
M Human Factors Practicality	Moderate	3	Depletion of oxygen by sparge gas
H Applicability to Multiple Accidents	Low	3	Dominantly flammable gas control
H Compatibility of Controls	Moderate	10	Neutral
Optimization Subtotal		26	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Reduces frequency of event
M Engineered over Administrative	High	10	Engineering control
M Passive over Active	Low	1	
Preference Subtotal		21	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	
H Capital Costs plus Operating, Life Cycle Costs (LCC)	High	10	
Cost/Benefit Subtotal		110	

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TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 30, 1997

Steam Intrusion and Seismic Event Accident Scenario Controls Evaluation

Today's meeting Attendee List is attached. The day was off to a slow start when bad roads delayed the site two hours. The Steam Intrusion accident scenario controls evaluation started at 11:15 a.m. and was immediately followed by the Seismic Event accident scenario controls evaluation.

Larry Kripps presented the Steam Intrusion material; presenting background, assumptions, existing controls, and future considerations. Also discussed was a recently completed preliminary re-evaluation of the Steam Intrusion accident scenario. By adding a realistic tank head displacement rate, the accident consequences are below guidelines. Since the new analysis is not complete, the team brainstormed potential controls using the original analysis.

The team did initial screening on the potential controls. The completed evaluation sheets are attached along with the list of potential controls considered. Then the team ran the remaining potential controls through the evaluation criteria.

The Seismic material was presented and discussed. Potential controls were brainstormed and screened by the team. The completed evaluation sheets along with complete set of considered controls are attached.

The Conclusion/Evaluation meeting will be held by DOE at the Federal Office Building, room 249, from 7 a.m. - Noon, on January 30, 1997.

The Steam Intrusion session ended at about 1:00 p.m, the Seismic Event session ended at 2:30 p.m. The Action Item List is attached.

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TWRS FSAR Integrated Control Decision Meetings Attendees

January 30, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Surya Maruvada	ES&H, FDH
Jon Young	TWRS, (MSI)
Ben Harp	RL-TWRS
Carol Sohn	RL-TWRS
Via Teleconference	
None	

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Tank Waste Remediation System Final Safety Analysis Report Steam Intrusion Accident

January 1997

DOE/RL-97-26
Revision 0

Accident Description

A liquid waste transfer to a DST is initiated from the 242-A Evaporator or Plutonium Finishing Plant using a steam jet as the motive force to move the liquid. After the waste has been transferred, the steam jet is not shut off and pure steam is routed to the headspace of the receiving tank.

Accident Analysis Results (Without Controls)

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxicological				
	Onsite		Offsite		Onsite		Offsite		
	Calculated Dose	Risk Guideline	Calculated Dose	Risk Guideline	Calculated SOF	Risk Guideline	Calculated SOF	Risk Guideline	
Steam intrusion from interfacing systems		5 E-03 (0.5)		1 E-03 (0.1)		1 (ERPG-1)		1 (PEL-TWA)	
Original	2.2 E-03 (0.22)		1.9 E-06 1.9 E-04		93		1.1 E-03		Anticipated
New	5.2 E-04 (0.052)		6.3 E-07 (6.3 E-05)		.91		8.0 E-04		

Selected Controls

Safety SSCs

None

TSRs

AC: HEPA Filter Controls (TSR 5.18.2a)

- Verify periodically that the HEPA filter and prefilter housing radiation level is $\leq$ 200 mrem/hr contact. Replace the HEPA filters and prefilters prior to filter housing radiation levels exceeding 200 mrem/hr.

Selected Controls

Defense In Depth

- Tank pressure alarms
- Transfer line temperature interlock in place for transfer from Plutonium Finishing Plant
- Operating ventilation system during steam jet transfers
- HEPA filter differential pressure alarm
- HEPA filter replacement typically performed at 100 mrem/hr

Accident Analysis Results (With Controls)

The frequency and consequences are the same with the selected controls, but the defense in depth controls provide significant protection against this accident.

Key Parameters and Assumptions/Sensitivity Analyses

Key Parameters and Assumptions

- Assumes no steam condensation in the DST

Sensitivity Analyses

- Steam flow
- Steam pressure
- Steam temperature
- Headspace volume (full, half-full, empty tank)
- Vent path size

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk:

From Draft FSAR (Table 3.3.2.3.5-1)

- **Accelerate elimination of requirements for steam jets and the blanking or removal of steam lines.**

Steam Intrusion Accident - Initial Controls

Term	Evaluated	Control
S	√	Eliminate steam jets/blank lines
S		Pressure alarms in tanks
S		Alarm waste generator when steam transfer w/o waste
L		Multi-purpose filter (for tanks)
S		Transfer at lower steam pressure
L		Add shut off valve in transfer line
S		Add steam regulator at generator
S		Transfer line temperature alarm (at TWRS)

Notes

- Item 7 has insufficient design date.
- All other short term items provide very little effect.

Steam Intrusion Control Criteria Rating

Steam Intrusion
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Eliminate Steam Jets/Blank Lines	82	66	30	178	200	6	**1068**

Accident:
Steam Intrusion

Control Criteria Rating

Control:
Eliminate Steam Jets/Blank Lines

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	Alternatives already exist. Affects PFP Evaporator
H Impact on Worker	Low	23	Remove steam hazard, eliminate accident
H Technical Feasibility	High	23	Alternatives exist, lines easily blanked
L Mission Impacts	High	0	Generator impact, interface
H Timeliness of Control Implementation	High	23	
H Installation Risk	Moderate	7	at evaporator
Feasibility Subtotal		82	
2. Optimization of Controls			
H Reliability	High	30	Other systems proven
M Human Factors Practicality	Moderate	3	Requires change to current practice
H Applicability to Multiple Accidents	Low	3	Only steam intrusion is affected
H Compatibility of Controls	High	30	Eliminates source of accident
Optimization Subtotal		66	
3. Preference of Control Suite			
M Prevention over Mitigation	High	10	Totally eliminates accident
M Engineered over Administrative	High	10	Change transfer mechanism
M Passive over Active	High	10	Permanent elimination of steam intrusion accident
Preference Subtotal		30	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Analysis being redone, control eliminates accident
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	No other control needed ($100K estimated cost)
Cost/Benefit Subtotal		200	

TWRS FSAR Integrated Control Decision Meetings
Meeting Minutes

January 30, 1997

Steam Intrusion and Seismic Event Accident Scenario Controls Evaluation

The attendance sheet for this meeting is attached. The meeting delayed by a Site-wide 2-hour work delay due to inclement weather. The Steam Intrusion accident scenario controls evaluation commenced at 11:15 a.m. and was immediately followed by the Seismic Event accident scenario controls evaluation.

Larry Kripps presented the Steam Intrusion material; presenting background, assumptions, existing controls, and future considerations. Also discussed was a recently completed preliminary re-evaluation of the Steam Intrusion accident scenario. By adding a realistic tank head displacement rate, the accident consequences are below guidelines. Since the new analysis is not complete, the team brain stormed potential controls using the original analysis.

The team performed an initial screening on the potential controls. The completed evaluation sheets are attached along with the list of potential controls considered. Then the team applied the evaluation criteria to the remaining potential controls.

The Seismic material was presented and discussed. Potential controls were brain stormed and screened by the team. The completed evaluation sheets along with complete set of considered controls are attached.

The Conclusion/Evaluation meeting will be held by DOE at the Federal Office Building, room 249, from 7 a.m. - Noon, on January 30, 1997.

The Steam Intrusion session ended at about 1:00 p.m, and the Seismic Event session ended at 2:30 p.m.

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TWRS FSAR Integrated Control Decision Meetings Attendees

January 30, 1997

Name	Organization
Gary Dunford	TWRS, DESH
Steve Wiegman	RL-TWRS
Joe Bevelacqua	RL-TWRS
Larry Kripps	TWRS, Scientech
Surya Maruvada	ES&H, FDH
Jon Young	TWRS, (MSI)
Ben Harp	RL-TWRS
Carol Sohn	RL-TWRS
Via Teleconference	
None	

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Tank Waste Remediation System
Final Safety Analysis Report
Seismic Accident

January 1997

DOE/RL-97-26
Revision 0

Accident Description

Seismic events (i.e., earthquakes) are a potential common cause initiator of multiple accidents.

For existing Hazard Category 2 facilities with Performance Category 3 equipment such as the waste storage tanks, a peak horizontal ground acceleration of 0.19g and a return frequency of 10^{-3}/year is the evaluation basis accident.

Accident Description

Tank failures or collapse of major structures are not expected for the evaluation basis seismic event.

Three seismically initiated accidents dominate:

- Spray leak
- Pipe break causing surface pool
- Seismically induced GREs and deflagrations of flammable gas

Accident Analysis Results (Without Controls)

Accident	Consequences								Frequency
	Radiological, Sv (rem)				Toxilogical				
	Onsite		Offsite		Onsite		Offsite		
	Calculated dose	Risk guideline	Calculated dose	Risk guideline	Calculated SOF	Risk guideline	Calculated SOF	Risk guideline	
Spray leak during transfer	1.5 E+02 (1.5 E+04)	5.0 E-02 (5.0 E+00)	2.1 E-01 (2.1 E+01)	5.0 E-03 (5.0 E-01)	5.8	1 (SERPG-2)	3.7 E-02	1 (SERPG-1)	Unlikely
Pool leak during transfer	3.3 E+00 (3.3 E+02)	5.0 E-02 (5.0 E+00)	3.6 E-01 (3.6 E+01)	5.0 E-03 (5.0 E-01)	2.1	1 (SERPG-2)	4.6 E-03	1 (SERPG-1)	Unlikely
SST deflagration with dome collapse	16 E+00 (16 E+02)	5.0 E-02 (5.0 E+00)	1.4 E-02 (1.4 E+00)	5.0 E-03 (5.0 E-01)	830	1 (SERPG-2)	2.2	1 (SERPG-1)	Unlikely
DST deflagration with dome collapse	4.5 E-01 (4.5 E+01)	5.0 E-02 (5.0 E+00)	3.9 E-04 (3.9 E-02)	5.0 E-03 (5.0 E-01)	140	1 (SERPG-2)	1.1	1 (SERPG-1)	Unlikely
Summation assuming one of each accident element	1.7 E+02 (1.7 E+04)	5.0 E-02 (5.0 E+00)	5.8 E-01 (5.8 E+01)	5.0 E-03 (5.0 E-01)	978	1 (SERPG-2)	3.3	1 (SERPG-1)	Unlikely

DST = double-shell tank
ERPG = Emergency Response Planning Guideline
SOF = sum of fractions
SST = single-shell tank

Selected Controls

Safety SSCs

- SST structure
- DST structure
- AWF tank structure

TSRs

AC: Emergency Preparedness (TSR 5.14)

- Emergency response plans/procedures

Accident Analysis Results (With Controls)

The consequences assuming controls are conservatively assumed the same as the accident without controls since the ability of emergency response actions to mitigate consequences of seismically-induced spray leaks, pool leaks, and flammable gas deflagrations are uncertain and unquantifiable.

Key Parameters and Assumptions/Sensitivity Analyses

Seismic Acceleration Magnitudes

Peak Horizontal Ground Acceleration	Likelihood of Occurrence Per Year	Description
0.19g	1.0 E-03	Design criteria for existing PC-3 equipment.
0.24g	5.0 E-04	Design criteria for new PC-3 equipment for the 200 East Area.
0.26g	5.0 E-04	Design criteria for new PC-3 equipment for the 200 West Area.
0.43g	1.5 E-04	High confidence, low probability of gross leakage of waste storage tank.
0.6g	5.0 E-05	Median acceleration of gross leakage of SSTs.
0.8g	2.0 E-05	Median acceleration for gross leakage of DSTs.

Further Actions Considered/Suggested/Ongoing

Further Actions Considered or Suggested to Reduce the Calculated or Real Risk:

From Draft FSAR (Table 3.3.2.3.5-1)

- **Design modification to add a seismic monitor in the 200 Area.**
- **Design modification to add seismic interlocks for the automatic shut down of waste transfer pumps upon sensing a seismic event.**
- **Perform a comprehensive seismic vulnerability study of TWRS SSCs.**

Seismic Event Accident - Initial Controls

Term	Evaluated	Control
S	√	Seismic shutdown switches on transfer systems
S	√	Add seismic monitor to 200 areas used to initiate emergency response
L		Seismic isolation/damping for tank farms
S		Emergency Response credit (was evaluated in connection to seismic monitor)
L		Tank structure upgrade
L		Early retrieval
S		Controls applied to other accidents (e.g. tank inerting, tarps...)
S		Seismic vulnerability study/walkdown (not evaluate a control, but to be considered as part of Authorization Basis upgrade)

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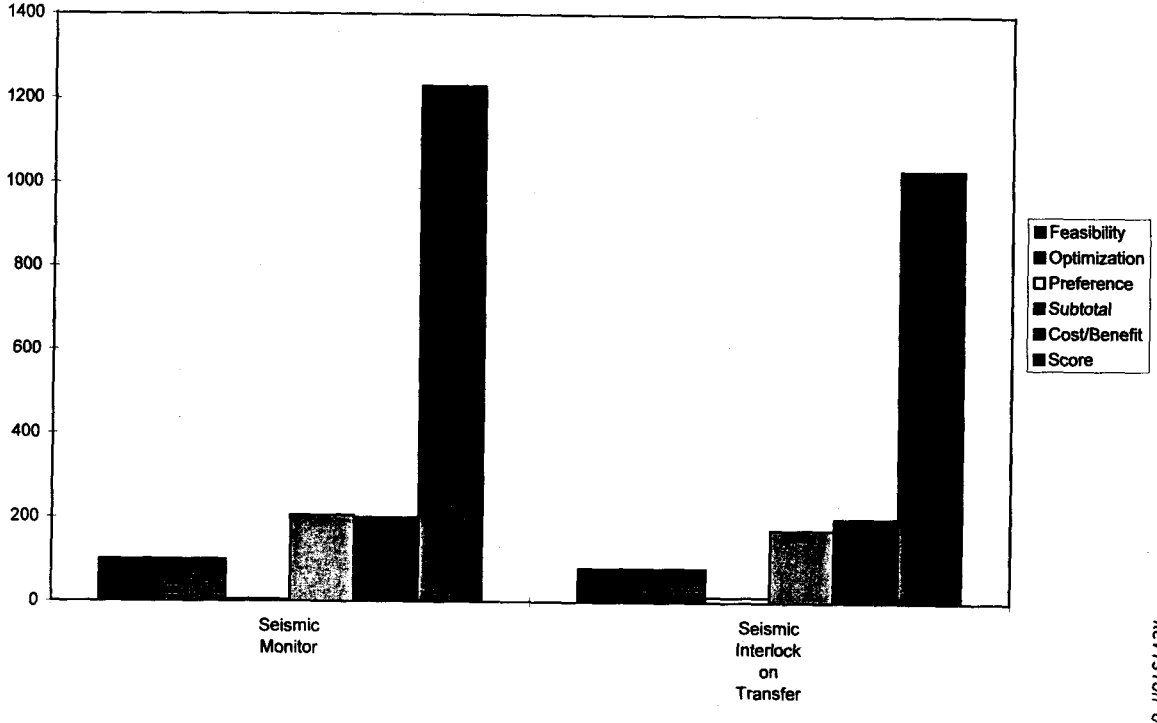
Seismic Event Control Criteria Rating



Seismic Event
Controls Criteria Rating

Control	Feasibility	Optimization	Preference	Subtotal	Cost/Benefit	Weighting Factor	Score
Seismic Monitor	100	100	5	205	200	6	**1230**
Seismic Interlock on Transfer Pumps	80	80	12	172	200	6	**1032**

Accident:
Seismic Event

Control Criteria Rating

Control:
Seismic Monitor

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Low	6	No operational impact
H Impact on Worker	Low	23	No ALARA, training, staffing or procedure changes
H Technical Feasibility	High	23	Demonstrated technology
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Readily implemented
H Installation Risk	Low	23	Installation outside tanks
Feasibility Subtotal		100	
2. Optimization of Controls			
H Reliability	High	30	Demonstrated relability/Human action required
M Human Factors Practicality	High	10	Minimal impact on operations
H Applicability to Multiple Accidents	High	30	Spray and pool leaks
H Compatibility of Controls	High	30	
Optimization Subtotal		100	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	Moderate	3	Engineered control/Human action required
M Passive over Active	Low	1	
Preference Subtotal		5	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	Supports emergency response on sprays - 1 order mag.
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	$250K (estimate)
Cost/Benefit Subtotal		200	

Accident:
Seismic Event

Control Criteria Rating

Control:
Seismic Interlock on Transfer Pumps

Criteria	Level	Score	Comments
1. Feasibility of Implementation			
M Impact on Operations (TWRS)	Moderate	2	Potential calibration difficulties/inadvertant actuation
H Impact on Worker	Moderate	7	
H Technical Feasibility	High	23	Established technology
L Mission Impacts	Low	2	
H Timeliness of Control Implementation	High	23	Readily implemented
H Installation Risk	Low	23	No new hazards created by interlock installation
Feasibility Subtotal		80	
2. Optimization of Controls			
H Reliability	Moderate	10	Calibration and external nonseismic induced pump trips
M Human Factors Practicality	High	10	Established mode to stop pumping
H Applicability to Multiple Accidents	High	30	Spray and pool leaks
H Compatibility of Controls	High	30	Interlock creates no new hazard
Optimization Subtotal		80	
3. Preference of Control Suite			
M Prevention over Mitigation	Low	1	Mitigation
M Engineered over Administrative	High	10	Engineered control
M Passive over Active	Low	1	
Preference Subtotal		12	
4. Cost/Benefit			
H Qualitative Benefit of Controls	High	100	3 orders of magnitude dose reduction (estimate)
H Capital Costs plus Operating, Life Cycle Costs (LCC)	Low	100	
Cost/Benefit Subtotal		200	

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