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OCT 09 2000

STA 4 (5)

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 625141

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) Nuclear Safety & Licensing		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: Nuclear Safety & Licensing		6. Design Authority/Design Agent/Cog. Engr.: W. H. Grams		7. Purchase Order No.: N/A	
8. Originator Remarks: This document is being released into the supporting document system for retrievability purposes				9. Equip./Component No.: N/A	
11. Receiver Remarks: For release				10. System/Bldg./Facility: N/A	
11A. Design Baseline Document? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date:	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
	RPP-6954	N/A	0	Hazard Evaluation for a Salt Well Centrifugal Pump Design Using Service Water for Lubrication and Cooling	N/A	2	1	1

16. KEY		
Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
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# Hazard Evaluation for a Salt Well Centrifugal Pump Design Using Service Water for Lubrication and Cooling

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management

**CH2MHILL**  
*Hanford Group, Inc.*

Richland, Washington

Contractor for the U.S. Department of Energy  
Office of River Protection under Contract DE-AC06-99RL14047

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# **Hazard Evaluation for a Salt Well Centrifugal Pump Design Using Service Water for Lubrication and Cooling**

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Date Published  
October 2000

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# HAZARD EVALUATION FOR A SALT WELL CENTRIFUGAL PUMP DESIGN USING SERVICE WATER FOR LUBRICATION AND COOLING

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U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 625141                      UC:  
Org Code: 7B300                      Charge Code: 113187  
B&R Code:                              Total Pages: 56

**Key Words:** Hazards, Hazard Analysis, Salt Well Pumping, Pump, Single-Shell Tanks, Authorization Basis, Tank Waste Remediation System, River Protection Project

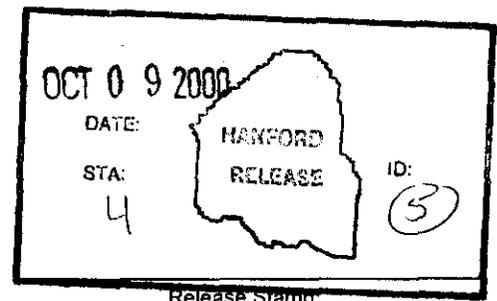
**Abstract:** This report documents the results of a preliminary hazard analysis (PHA) covering the new salt well pump design. The PHA identified ten hazardous conditions mapped to four analyzed accidents: flammable gas deflagrations, fire in contaminated area, tank failure due to excessive loads, and waste transfer leaks. This document also presents the results of the control decision/allocation process. A backflow preventer and associated limiting condition were assigned.

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**TABLE OF CONTENTS**

1.0 INTRODUCTION .....1  
    1.1 PURPOSE .....1  
    1.2 BACKGROUND.....1  
2.0 DESCRIPTION OF NEW CENTRIFUGAL PUMP.....3  
3.0 HAZARD IDENTIFICATION AND EVALUATION .....7  
    3.1 METHODOLOGY .....7  
    3.2 MAJOR ASSUMPTIONS.....9  
    3.3 EVALUATION.....9  
4.0 CONTROL ALLOCATION .....27  
    4.1 METHODOLOGY .....27  
    4.2 ALLOCATED CONTROLS .....27  
5.0 CONCLUSIONS.....29  
6.0 REFERENCES .....37

**APPENDICES**

A PRELIMINARY HAZARDS ANALYSIS TEAM BIOGRAPHICAL  
INFORMATION .....39  
B CONTROL ALLOCATION TEAM BIOGRAPHICAL INFORMATION .....43  
C PRELIMINARY HAZARDS ANALYSIS AND CONTROL  
ALLOCATION PEER REVIEW .....49

**TABLES**

Table 3.1. Salt Well Pumping New Pump Design Hazardous Conditions as Initially Identified .....13

Table 3.2. Salt Well Pumping New Pump Design Hazardous Conditions as Amended During Control Allocation.....18

Table 3.3. Salt Well Pumping New Pump Design Hazardous Conditions Sorted According to Consequence .....23

Table 3.4. New Salt Well Pump Design Hazardous Conditions Mapped to Analyzed Representative Accident.....25

Table 4.1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions.....31

**FIGURES**

Figures 1. P&ID for New Salt Well Pump .....5

**TERMS**

AB	Authorization Basis
AC	Administrative Control
AIChE	American Institute of Chemical Engineers
AWF	aging waste facility
CAM	Continuous Air Monitor
Cat	category
Con	consequence
DCRT	Double-Contained Receiver Tank
DST	double-shell tank
Env	environmental
Freq	Frequency
FSAR	Final Safety Analysis Report
gal	gallon(s)
GRE	gas release event
Grp	group
HEPA	high efficiency particulate air [filter]
hr	hour
ID	identification
KPa	kilopascals
LCO	Limiting Condition for Operation
MAR	Material at Risk
Mit	mitigative
NC	No Controls
PA	Pennsylvania
P & ID	Piping and Instrumentation Diagram
PHA	Preliminary Hazards Analysis
Prev	preventive
psig	pounds per square inch gage
Rep Acc	representative accident
RPP	River Protection Project
SS	stainless steel
SSC	structures, systems, and components
SST	single-shell tank
SWP	salt well pumping
TSR	Technical Safety Requirement

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## 1.0 INTRODUCTION

### 1.1 PURPOSE

The River Protection Project (RPP) Authorization Basis (AB) Technical Safety Requirements (TSR) [CHG 2000a] contains controls that address salt well pumping and waste transfers. Currently, the design of salt well pumping (SWP) equipment uses a process lubricated centrifugal pump. The purpose of this document is to record the hazardous conditions identified during the Preliminary Hazards Analysis (PHA) of the new SWP design and to evaluate the relationship to the hazardous conditions currently included in the AB as documented in the hazard analysis database (CHG 2000b). Also provided in this document is a description of the process and the results of the subsequent control decision/allocation meetings.

This document is not intended to authorize the activity. It documents the results of the hazard identification process and subsequent control decision process as defined in the AB. The hazard identification/evaluation process is used to determine the adequacy of controls and whether the proposed activity is within the AB. This hazard evaluation does not constitute an accident analysis.

### 1.2 BACKGROUND

The SWP process uses an integral motor/centrifugal pump and separate jet pump (foot valve). The motive power for the pumping process is provided by a centrifugal pump/induction motor unit that is located on top of the salt well screen assembly in an single-shell waste tank pump pit. The pump and motor assembly, as currently procured for SWP, is rated for, or otherwise qualifies for, service in Ignition Control Set 2 environments. The current design uses a series G, Chempump manufactured by the Chempump Division of Crane Pumps and Systems, Inc., Warrington, PA. This pump design is process fluid lubricated and cooled; i.e., the salt well liquid is circulated through the pump/motor to provide both lubrication and cooling. Recent SWP operations have been hampered by problems with this design. During SWP operations, the jet pump, foot valve, or other equipment may be clogged with salt crystals or other debris. One method of restarting pump flow is to place the SWP system into recirculation mode and then flush with a clean caustic solution. A recent attempt to restart flow using a caustic flush resulted in hydrogen gas being generated from the caustic reacting with internal aluminum components of the rotor. It was determined that waste salt crystallization in the pump caused a hydraulic imbalance allowing the rotor to exert significant force on the axial thrust surfaces. A hole wore through the stainless steel rotor canister end cap allowing the caustic solution to come in contact with the aluminum which generated aluminum hydroxide and hydrogen gas. This was detected when pump pressure increased without the pump running. To remedy this situation the motor was locked out and the gas was allowed to bleed back to the tank. The new SWP centrifugal pump design addresses these problems.

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## 2.0 DESCRIPTION OF NEW CENTRIFUGAL PUMP

The replacement pump system utilizes a canned rotor pump which is specifically designed to pump waste slurry. A piping and instrumentation diagram is shown in Figure 1 indicating equipment that changed from the previous design.

The new pumping system utilizes heated filtered water as bearing lubrication and motor cooling. The existing SWP dilution system is used to provide a source of heated, filtered water to the new design pump. Upgrades to the dilution system include adding a new design pump with a similar metering pump capable of developing higher pressures, and installation of a raw water filtering system upstream of the dilution tank to provide clean water to the new salt well pump. Additional instrumentation to support operation of the new salt well pump includes a remote bearing monitor, a pump power monitor, and stator winding resistance temperature detectors. A backflow preventer is installed to prevent backflow of tank waste into the pump flush water supply (service water system).

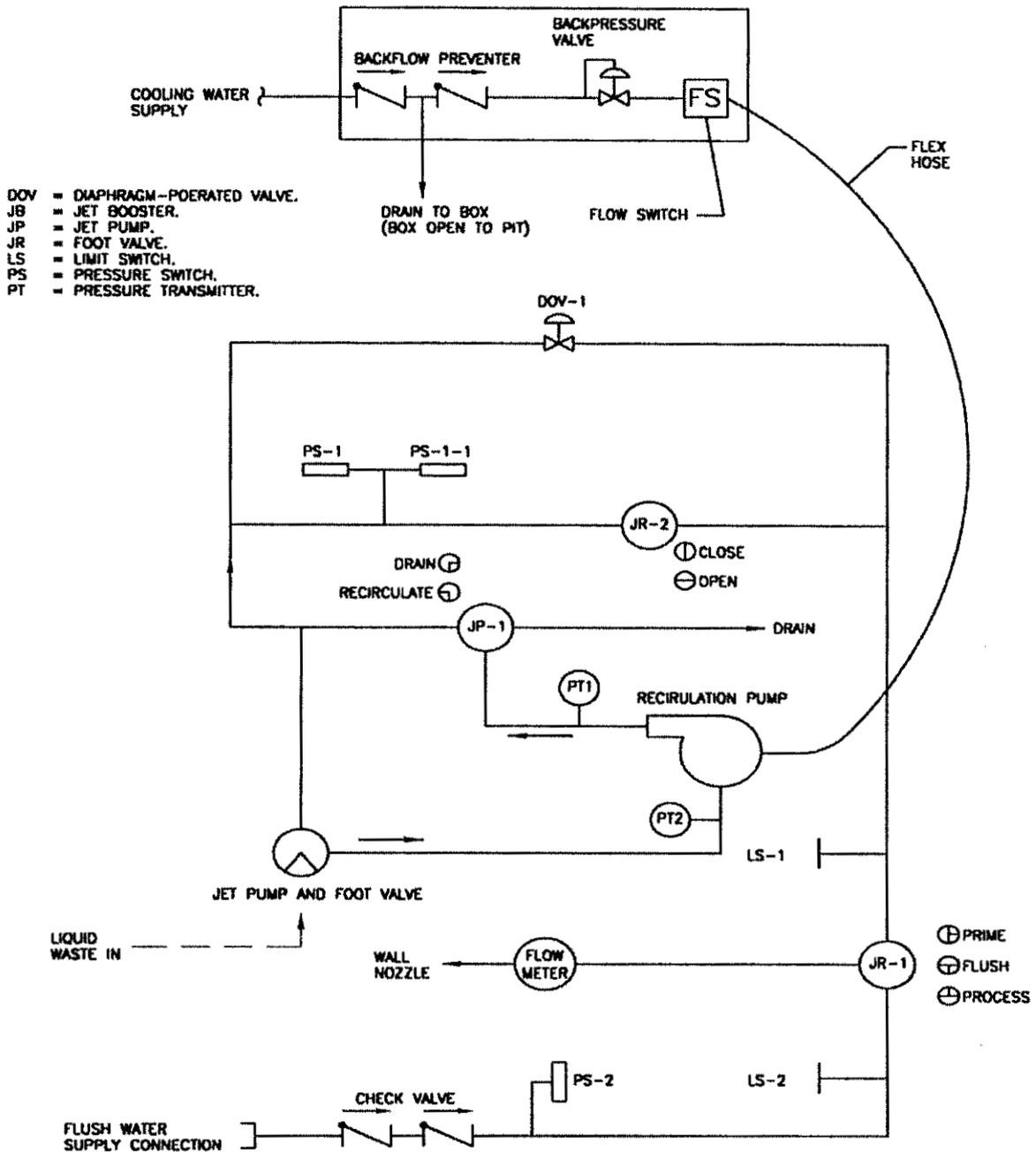
The following are the design attributes that were specifically evaluated in the hazard identification process:

The pump rotor has aluminum components and is fully encapsulated in stainless steel (SS);

- The pump includes thrust washers which prevent shaft bearings from contacting the rotor can in the event of a thrust imbalance;
- The pump is cooled and lubricated with heated and filtered service water;
- The cooling fluid exits into the waste stream through the pump motor front bearing;
- The cooling water metering pump is capable of delivering 318 liters/hour (84 gal/hr ) with normal injection rates of 1.14 to 2.27 liters/hour (0.3 to 0.6 gal/hr);
- The cooling water supply from the filter skid to the backflow preventer is SS, heat traced hard piping;
- The cooling line from the exit of the backflow preventer/back pressure valve assemble to the pump is flexible hose; and
- A relief valve is installed downstream of the new metering pump set to relieve at 1206 kPa (175 psig).

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Figure 1. Piping and Instrument Diagram for New Salt Well Pump.



SALT WELL PUMP PIPING AND INSTRUMENT DIAGRAM

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### 3.0 HAZARD IDENTIFICATION AND EVALUATION

The hazards identification and evaluation of the new process water cooled and lubricated pump design for SWP used the Preliminary Hazards Analysis (PHA) method. The PHA consisted of a systematic brainstorming process which included the following:

- Postulating hazards associated with the new pump design;
- Estimating the frequencies and consequences of the hazardous conditions; and
- Identifying the possible mitigative and preventive measures for each postulated hazardous condition.

The American Institute of Chemical Engineers in their publication "Guidelines for Hazard Evaluation Procedures," (AIChE 1992) recognizes the PHA process as a creditable method of hazard evaluation. A multi-disciplinary team records the results of this brainstorming process using a tabular format. The depth of the PHA is directly related to the experience and knowledge of the participants. A short resume of each team member is included in Appendix A to document the experience and knowledge of the PHA team.

#### 3.1 METHODOLOGY

The PHA team met to develop the raw data. The information was recorded systematically in tabular format. The following sections describe the PHA table structure and details for recording information. The PHA was structured to ensure a systematic and thorough evaluation of the potential hazards. The PHA captured the following information:

- **Item ID:** The item identification (ID); used to record a unique identifier for the hazardous condition.
- **Location/Activity:** Specific point in the system or process where the deviation from the desired condition of a process variable is evaluated.
- **Hazardous Condition:** The hardware failures, operational faults, or conditions that could result in undesired consequences during waste transfer activities.
- **Candidate Causes:** The causes leading to the Hazardous Condition. Identifying causes is important when determining potential existing engineering and administrative features for significant hazardous conditions as well as potential consequences. In many cases, multiple hardware or operational faults are required to produce a hazardous condition. This column identifies the sequence of hardware and operational faults required to produce the postulated hazardous condition.
- **Material at Risk:** The material which could be released in an associated accident.
- **Immediate Consequence:** The potential consequences that could result from the postulated hazardous condition.

- **Engineered Safety Features:** Existing engineered features (hardware items) identified by the PHA team that have the potential to mitigate or prevent the hazardous condition of concern. The engineered features are candidates for designation as Safety-Significant items for hazardous conditions that pose a significant threat to the health of facility workers and onsite personnel or Safety-Class for hazards that pose a significant threat to offsite individuals. These items should not be construed as being the “official” controls that would eventually be credited in the AB.
- **Administrative Safety Features:** Technical Safety Requirements and other existing controls identified by the PHA team that have the potential to mitigate or prevent the hazardous condition of concern. These items should not be construed as being the “official” administrative features that would eventually be credited in the AB.
- **Consequence Category No Controls (Con Cat NC):** The consequence ranking is a “first cut,” qualitative estimate of the safety severity of the consequences assuming no controls are present. The following system is used:
  - S0 Negligible safety concerns for the facility worker.
  - S1 Potential industrial injury, low radiological dose consequences or chemical exposure to the facility worker.
  - S2 Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility.
  - S3 Potential significant radiological dose consequences or chemical exposure to the offsite population.
- **Frequency Category No Controls (Freq Cat NC):** The frequency category is a “first cut,” qualitative estimate of the likelihood of the hazardous condition assuming no controls are present. The following system is used:
  - F3 Events that are expected to occur one or more times during the lifetime of the facility, categorized as “anticipated” events. The frequency range associated with this category is less than 1E-02/yr.
  - F2 Events that could occur during the lifetime of the facility, but with low probability. Such events are categorized as “unlikely” and fall in the range of 1E-04/yr to 1E-02/yr.
  - F1 Events not expected to occur during the lifetime of the facility, categorized as “extremely unlikely.” The frequency range associated with this category is 1E-06/yr to 1E-04/yr.
  - F0 Events categorized as “beyond extremely unlikely,” with a frequency less than 1E-06/yr. Events in this category (such as a meteor strike) are so unlikely they generally do not require special controls.
- **Environmental Category (Env Cat):** The environmental consequence ranking is a “first cut,” qualitative estimate of the environmental severity of the hazardous condition assuming no controls are present. The following system is used:
  - E0 No significant environmental effect outside the facility confinement systems.
  - E1 Limited environmental discharge of hazardous material outside the facility.

- E2 Large environmental discharge of hazardous material within the plant site boundary.
- E3 Significant environmental discharges of hazardous material outside the plant site boundary.

- **Remarks:** Miscellaneous observations or clarifying comments for a given item.

### 3.2 MAJOR ASSUMPTIONS

The following assumptions were used during the hazard identification process:

- A rotor canister breach as well as a backflow of waste or flush solution is required to allow caustic solution to come in contact with aluminum components of the pump.
- The pump design is appropriate for use with tank waste.
- The aluminum/caustic reaction will develop sufficient pressure to cause hydrogen to escape in the recirculation (closed loop) mode.
- Cooling water (filtered service water) is limited to flows from 1.14 to 3.03 liters per minute (0.3 to 0.8 gpm) by the metering pump
- The cooling water metering pump is capable of a maximum delivery of 318 liters/hour (84 gal/hr).
- The operating pressures, approximately 345 kPa (50 psi) in the volute of the new salt well pump, are sufficient to allow backflow of waste through the cooling water supply line.
- SSTs suitable for salt well pumping are not likely to experience large gas release events.
- The throttle bushing (front near impeller) will restrict flow in the reverse direction.

### 3.3 EVALUATION

Ten hazardous conditions associated with the new SWP pump design were identified by the PHA team. These hazardous conditions are presented in Table 3-1. The table includes the following information: Item ID, Location/Activity, Hazardous Condition, Candidate Cause, Material at Risk, Immediate Consequence, Engineered Safety Features, Administrative Safety Features, Consequence Category No Control, Frequency Category No Control, and remarks. The qualitatively assigned consequence (severity) of the 10 hazardous conditions assigned by the PHA team resulted in the following totals for each consequence category:

- 0 S0, Negligible safety concerns for the facility worker;
- 1 S1, Potential industrial injury, low radiological dose consequences or chemical exposure to the facility worker;
- 6 S2, Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility; and
- 3 S3, Potential significant radiological dose consequences or chemical exposure to the offsite population.

Following the initial PHA deliberations, a control decision/allocation team was impaneled. The control decision/allocation team roster and short resumes are presented in Appendix B. The initial step during the control decision meeting is to review the results of the PHA. This review identified three hazardous conditions where the frequency of occurrence was revised. The changes (see Table 3-1) that resulted from this review are:

- **ID# NEWSWP-01:** The frequency changed from F3 to F2 based on the need for multiple failures to initiate the hazardous condition.
- **ID# NEWSWP-02:** The frequency changed from F1 to F0 based on additional details of the design which revealed that the re-circulation loop could not be pressurized, eliminating the cause of a piping failure and subsequent release of flammable gas.
- **ID# NEWSWP-10:** The frequency changed from F2 to F0 based upon the team consensus that the failure of the backflow preventer, such that waste could leak to the surface, was not credible.

Table 3.2 lists hazardous conditions identified during the PHA as revised by the control allocation team. This listing is further sorted according to consequences in Table 3-3.

Table 3-4 provides a mapping of the hazardous conditions identified for the new SWP design to the analyzed representative accidents as described in the Tank Waste Remediation System Final Safety Analysis Report (FSAR) [CHG 2000c]. The information presented in this table includes the BIN, Item ID, Material at Risk, Hazardous Condition, Cause, Initial Frequency No Controls, Initial Safety Consequence No Controls, Cause Group, and Representative Accident. The information not previously defined is:

- **BIN:** A code that describes the release attributes for high Safety Consequences (S2 or S3) and Worker (S1) with anticipated frequency (F3) hazardous conditions.
- **Cause Group (Cause Grp):** – An alpha/numeric code used to permit sorting of data by the cause of the hazardous conditions.
- **Representative Accident (Rep Acc):** Representative Accident – An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high Safety Consequence (S2 or S3) are assigned to representative accidents.

Included with the hazardous conditions identified for the new salt well pump design are the hazardous conditions identified as being represented by the analyzed accident. The breakdown for Table 3-4 shows:

2 hazardous conditions are related to Flammable Gas Deflagrations – SST (Rep Acc 05)

1 hazardous condition is related to Fire in Contaminated Area (Rep Acc 07)

1 hazardous condition is related to Tank Failure Due to Excessive Loads (Rep Acc 12)

1 hazardous condition is related to Waste Transfer Leak Into Structure (Rep Acc 33A)

4 hazardous conditions are related to Waste Transfer Leak Due To Misrout (Rep Acc 33D)

There was one hazardous condition related to worker safety (minor exposure or environmental release) that is not mapped to a representative accident.

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Table 3-1. Salt Well Pumping New Pump Design Hazardous Conditions As Initially Identified. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-01	SWP/New Pump	Release of toxic or radioactive aerosols to atmosphere from SST pump pit due to flammable gas deflagration in pit	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in re-circulation mode to produce hydrogen which escapes to the pit with ignition source [Caustic Flush Activity]	SST Waste contamination in pump pit	Fire in pump pit burns paint and releases radioactive contaminants to atmosphere	Back-flow preventer in cooling water supply line Flow switch interlock for cooling water supply system Cooling water supply supplied at higher pressure than pump operation High motor temperature trip interlock Throttle bushing limits backflow into rotor area Pump design has thrust washers that prevent rotor contact with pump bearings Pump has bearing wear monitor and alarm	Procedures for pump operation (water supply on, motor temperature OK, backflow preventer verified, caustic only added when pump running, and continuous pump monitoring during caustic flush) AC 5.10 Ignition Source Control Requirements AC 5.11 Flammable Gas Monitoring	S2/E2	F3	A rotor canister breach is required to allow OH to come into contact with Al metal.  It is assumed that the pump design is appropriate for use with tank waste.  Al-OH reaction assumed to pressurize the line sufficiently to cause hydrogen escape.  Pump is not process cooled or lubricated (design feature).

Table 3-1. Salt Well Pumping New Pump Design Hazardous Conditions As Initially Identified. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-02	SWP/New Pump	Release of toxic or radioactive aerosols to atmosphere from SST tank headspace due to flammable gas deflagration in tank head space	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in re-circulation mode to produce hydrogen which escapes to the tank headspace with ignition source [Caustic Flush Activity]	SST Waste	Fire/deflagration in SST with high energy release of toxic or radioactive material	Back-flow preventer in cooling water supply line Flow switch interlock for cooling water supply system Cooling water supply supplied at higher pressure than pump operation High motor temperature trip interlock Throttle bushing limits backflow into rotor area Pump design has thrust washers that prevent rotor contact with pump bearings Pump has bearing wear monitor and alarm	Procedures for pump operation (water supply on, motor temperature OK, backflow preventer verified, caustic only added when pump running, and continuous pump monitoring during caustic flush) AC 5.10 Ignition Source Control Requirements AC 5.11 Flammable Gas Monitoring	S3/E3	F1	A rotor canister breach is required to allow OH to come into contact with Al metal. It is assumed that the pump design is appropriate for use with tank waste. Al-OH reaction assumed to pressurize the line sufficiently to cause hydrogen escape. Pump is not process cooled or lubricated (design feature).
NEW SWP-03	SWP/New Pump	Release of radioactive/hazardous material to soil surface from SST due to overflow	Coolant leaks into tank until tank overflows	SST Waste	SST Waste (dilute form) released to soil surface	Metering pump design	AC 5.12 Material balance AC 5.22 Service water intrusion monitoring	S2/E2	F1	Flow is intended to be limited to 0.3 to 0.8 gpm by metering pump. Metering pump is capable of a maximum of 84 gallons/hour.

Table 3-1. Salt Well Pumping New Pump Design Hazardous Conditions As Initially Identified. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-04	SWP/New Pump	Release of waste to atmosphere from SST due to flammable gas fire/deflagration in tank	Coolant leak into tank induces a flammable gas release event	SST Waste	Fire/deflagration in salt well causes overpressure of HEPA filter releasing material on HEPA with continued release of contaminants released thereafter from active ventilation			S3/E2	F0	SSTs are not assumed to experience GRE events
NEW SWP-05	SWP/New Pump	Release of waste to atmosphere from SST due to excessive weight causing dome collapse	Coolant line rupture causes flood on top of tank resulting in dome collapse due to excessive load	SST Waste			AC Service water intrusion monitoring	S3/E3	F0	None
NEW SWP-06	SWP/New Pump	Release of waste to soil surface from SWP cooling line due to mistransfer of waste into salt well line	Misttransfer into SWP causes tank waste to backflow through the coolant line, backflow preventer failed	SST Waste	SST Waste leak to soil surface (without back flow preventer waste ends up in service water tank)	Back-flow preventer in cooling water supply line Pit drain Throttle bushing limits backflow into rotor area JR-1 interlock Metering pump has internal check valves that can prevent backflow through pump	AC 5.12 Waste Transfer Controls	S2/E2	F3	None

Table 3-1. Salt Well Pumping New Pump Design Hazardous Conditions As Initially Identified. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-07	SWP/New Pump	Release of waste to soil surface from SWP cooling line due to backflow of waste through coolant line	Salt Well Pumping without cooling line backflow preventer and open line outside the cover block extension	SST Waste	Pool of SST waste on soil surface	Throttle bushing restricts flow Back flow preventer Flow switch on cooling water supply shuts pump off if flow low Power monitor interlock for high and low load Pump motor high temperature shutoff	Operating procedure for salt well pump Operator training	S2/E2	F3	This hazardous condition evaluates a design without a backflow preventer The operating pressures across the pump are high enough to cause flow out of the cooling line. Flow rates are assumed to be the driving pressure which is the differential pressure across the salt well pump (50 psig). Throttle bushing will restrict flow rate. The cooling supply line is SS with heat tracing and supports. The cooling supply line is hard piped from positive displacement pump to backflow preventer. Hose will be used from the cover block extension to the back end of the pump.

Table 3-1. Salt Well Pumping New Pump Design Hazardous Conditions As Initially Identified. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-08	SWP/New Pump	Release of waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a coolant leak which overflows pit	SST Waste Contamination in Pit	Dilute SST Waste on soil surface (pit drain plugged)	Leak detection system Cooling line heat tracing and insulation Cooling water flow switch	LCO and AC for leak detection	S1/E1	F3	None
NEW SWP-09	SWP/New Pump	Release of SST waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a waste leak which overflows pit	SST Waste	SST Waste on soil surface (pit drain plugged)	Leak detection system Cooling line heat tracing and insulation Cooling water flow switch	LCO and AC for leak detection	S2/E1	F3	None
NEW SWP-10	SWP/New Pump	Release of SST waste to soil surface from cooling water system due to failed backflow preventer (caused by high cooling water temperature)	Failures in cooling water heating system create high temperature water that damages backflow preventer AND backflow conditions exist	SST Waste	Backflow of SST waste into cooling water supply (no flow or dump into pit)	Design of the backflow preventer Leak detection system	LCO and AC for leak detection	S2/E1	F2	This is an accident sequence that creates a preexisting condition of a failed backflow preventer.  This event captures concerns for backflow preventer failure causes.

Table 3-2. Salt Well Pumping New Pump Design Hazardous Conditions As Amended During Control Allocation. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-01	SWP/New Pump	Release of toxic or radioactive aerosols to atmosphere from SST pump pit due to flammable gas deflagration in pit	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in re-circulation mode to produce hydrogen which escapes to the pit with ignition source [Caustic Flush Activity]	SST Waste contamination in pump pit	Fire in pump pit burns paint and releases radioactive contaminants to atmosphere	Back-flow preventer in cooling water supply line Flow switch interlock for cooling water supply system Cooling water supply supplied at higher pressure than pump operation High motor temperature trip interlock Throttle bushing limits backflow into rotor area Pump design has thrust washers that prevent rotor contact with pump bearings Pump has bearing wear monitor and alarm	Procedures for pump operation (water supply on, motor temperature OK, backflow preventer verified, caustic only added when pump running, and continuous pump monitoring during caustic flush) AC 5.10 Ignition Source Control Requirements AC 5.11 Flammable Gas Monitoring	S2/E2	F2	A rotor canister breach is required to allow OH to come into contact with Al metal.  It is assumed that the pump design is appropriate for use with tank waste.  Al-OH reaction assumed to pressurize the line sufficiently to cause hydrogen escape.  Pump is not process cooled or lubricated (design feature).

Table 3-2. Salt Well Pumping New Pump Design Hazardous Conditions As Amended During Control Allocation. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-02	SWP/New Pump	Release of toxic or radioactive aerosols to atmosphere from SST tank headspace due to flammable gas deflagration in tank head space	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in re-circulation mode to produce hydrogen which escapes to the tank headspace with ignition source [Caustic Flush Activity]	SST Waste	Fire/deflagration in SST with high energy release of toxic or radioactive material	Back-flow preventer in cooling water supply line Flow switch interlock for cooling water supply system Cooling water supply supplied at higher pressure than pump operation High motor temperature trip interlock Throttle bushing limits backflow into rotor area Pump design has thrust washers that prevent rotor contact with pump bearings Pump has bearing wear monitor and alarm	Procedures for pump operation (water supply on, motor temperature OK, backflow preventer verified, caustic only added when pump running, and continuous pump monitoring during caustic flush) AC 5.10 Ignition Source Control Requirements AC 5.11 Flammable Gas Monitoring	S3/E3	F0	A rotor canister breach is required to allow OH to come into contact with Al metal. It is assumed that the pump design is appropriate for use with tank waste. Al-OH reaction assumed to pressurize the line sufficiently to cause hydrogen escape. Pump is not process cooled or lubricated (design feature).
NEW SWP-03	SWP/New Pump	Release of radioactive/hazardous material to soil surface from SST due to overflow	Coolant leaks into tank until tank overflows	SST Waste	SST Waste (dilute form) released to soil surface	Metering pump design Pump has bearing wear monitor and alarm	AC 5.12 Material balance AC 5.22 Service water intrusion monitoring	S2/E2	F1	Flow is intended to be limited to 0.3 to 0.8 gpm by metering pump. Metering pump is capable of a maximum of 84 gallons/hour.

Table 3-2. Salt Well Pumping New Pump Design Hazardous Conditions As Amended During Control Allocation. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-04	SWP/New Pump	Release of waste to atmosphere from SST due to flammable gas fire/deflagration in tank	Coolant leak into tank induces a flammable gas release event	SST Waste	Fire/deflagration in salt well causes overpressure of HEPA filter releasing material on HEPA with continued release of contaminants released thereafter from active ventilation			S3/E2	F0	SSTs are not assumed to experience GRE events
NEW SWP-05	SWP/New Pump	Release of waste to atmosphere from SST due to excessive weight causing dome collapse	Coolant line rupture causes flood on top of tank resulting in dome collapse due to excessive load	SST Waste			AC Service water intrusion monitoring	S3/E3	F0	None
NEW SWP-06	SWP/New Pump	Release of waste to soil surface from SWP cooling line due to mistransfer of waste into salt well line	Mistransfer into SWP causes tank waste to backflow through the coolant line, backflow preventer failed	SST Waste	SST Waste leak to soil surface (without back flow preventer waste ends up in service water tank)	Back-flow preventer in cooling water supply line Pit drain Throttle bushing limits backflow into rotor area JR-1 interlock Metering pump has internal check valves that can prevent backflow through pump	AC 5.12 Waste Transfer Controls	S2/E2	F3	None

Table 3-2. Salt Well Pumping New Pump Design Hazardous Conditions As Amended During Control Allocation. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-07	SWP/New Pump	Release of waste to soil surface from SWP cooling line due to backflow of waste through coolant line	Salt Well Pumping without cooling line backflow preventer and open line outside the cover block extension	SST Waste	Pool of SST waste on soil surface	Throttle bushing restricts flow Back flow preventer Flow switch on cooling water supply shuts pump off if flow low Power monitor interlock for high and low load Pump motor high temperature shutoff	Operating procedure for salt well pump Operator training	S2/E2	F3	This hazardous condition evaluates a design without a backflow preventer The operating pressures across the pump are high enough to cause flow out of the cooling line. Flow rates are assumed to be the driving pressure which is the differential pressure across the salt well pump (50 psig). Throttle bushing will restrict flow rate. The cooling supply line is SS with heat tracing and supports. The cooling supply line is hard piped from positive displacement pump to backflow preventer. Hose will be used from the cover block extension to the back end of the pump.

Table 3-2. Salt Well Pumping New Pump Design Hazardous Conditions As Amended During Control Allocation. (5 pages)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
NEW SWP-08	SWP/New Pump	Release of waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit dram) causing a coolant leak which overflows pit	SST Waste Contamination in Pit	Dilute SST Waste on soil surface (pit drain plugged)	Leak detection system Cooling line heat tracing and insulation Cooling water flow switch	LCO and AC for leak detection	S1/E1	F3	None
NEW SWP-09	SWP/New Pump	Release of SST waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit dram) causing a waste leak which overflows pit	SST Waste	SST Waste on soil surface (pit drain plugged)	Leak detection system Cooling line heat tracing and insulation Cooling water flow switch	LCO and AC for leak detection	S2/E1	F3	None
NEW SWP-10	SWP/New Pump	Release of SST waste to soil surface from cooling water system due to failed backflow preventer (caused by high cooling water temperature)	Failures in cooling water heating system create high temperature water that damages backflow preventer AND backflow conditions exist	SST Waste	Backflow of SST waste into cooling water supply (no flow or dump into pit)	Design of the backflow preventer Leak detection system	LCO and AC for leak detection	S2/E1	F0	This is an accident sequence that creates a preexisting condition of a failed backflow preventer.  This event captures concerns for backflow preventer failure causes.

**Table 3-3. Salt Well Pumping New Pump Design Hazardous Conditions  
Sorted According To Consequence.**

Item ID	Hazardous Condition	Cause	Freq Cat	Env Cons
<b>Hazardous Conditions with Potentially Significant Facility worker Consequences (S1)</b>				
NEW SWP-08	Release of waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a coolant leak which overflows pit	F3	E1
<b>Hazardous Conditions with Potentially Significant On-site Worker Consequences (S2)</b>				
NEW SWP-01	Release of toxic or radioactive aerosols to atmosphere from SST pump pit due to flammable gas deflagration in pit	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in recirculation mode to produce hydrogen which escapes to the pit with ignition source [Caustic Flush Activity]	F2	E2
NEW SWP-03	Release of radioactive/hazardous material to soil surface from SST due to overflow	Coolant leaks into tank until tank overflows	F1	E2
NEW SWP-06	Release of waste to soil surface from SWP cooling line due to mistransfer of waste into salt well line	Mistransfer into SWP causes tank waste to backflow through the coolant line, backflow preventer failed	F3	E2
NEW SWP-07	Release of waste to soil surface from SWP cooling line due to backflow of waste through coolant line	Salt Well Pumping without cooling line backflow preventer and open line outside the cover block extension	F3	E2
NEW SWP-09	Release of SST waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a waste leak which overflows pit	F3	E2
NEW SWP-10	Release of SST waste to soil surface from cooling water system due to failed backflow preventer (caused by high cooling water temperature)	Failures in cooling water heating system create high temperature water that damages backflow preventer AND backflow conditions exist	F0	E2
<b>Hazardous Conditions with Potentially Significant Offsite Individual Consequences (S3)</b>				
NEW SWP-02	Release of toxic or radioactive aerosols to atmosphere from SST tank headspace due to flammable gas deflagration in tank head space	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in recirculation mode to produce hydrogen which escapes to the tank headspace with ignition source [Caustic Flush Activity]	F0	E3
NEW SWP-04	Release of waste to atmosphere from SST due to flammable gas fire/deflagration in tank	Coolant leak into tank induces a flammable gas release event	F0	E3
NEW SWP-05	Release of waste to atmosphere from SST due to excessive weight causing dome collapse	Coolant line rupture causes flood on top of tank resulting in dome collapse due to excessive load	F0	E3

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Table 3-4. New Salt Well Pump Design Hazardous Conditions Mapped to Analyzed Representative Accidents. (2 pages)

BIN	Item ID	Material at Risk	Hazardous Condition	Cause	Freq Cat	Cons Cat	Cause Grp	Rep Acc
<b>Analyzed Accident: Flammable Gas Deflagrations - SST (Rep Acc 05)</b>								
A-1-a	XS-01-FLOW03	SST and DCRT tank contents	Release of liquids, solids and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	05
<b>New Salt well Pump Design Represented Hazardous Conditions (Rep Acc 05)</b>								
A-1-a	NEWSWP-02	SST Waste	Release of toxic or radioactive aerosols to atmosphere from SST tank headspace due to flammable gas deflagration in tank head space	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in recirculation mode to produce hydrogen which escapes to the tank headspace with ignition source [Caustic Flush Activity]	F0	S3	B08	05X
A-1-a	NEWSWP-04	SST Waste	Release of waste to atmosphere from SST due to flammable gas fire/deflagration in tank	Coolant leak into tank induces a flammable gas release event	F0	S3	B08	05X
<b>Analyzed Accident: Fire in Contaminated Area (Rep Acc 07)</b>								
A-1-a	CRN-05	Pits and risers inventory	Release of radioactive and/or toxic materials from pits and risers due to fuel tank fire in crane or support vehicle (see In-Tank Equipment Installation for tank fires)	Human error in positioning crane load	F3	S2	B26	07
<b>New Salt well Pump Design Represented Hazardous Conditions (Rep Acc 07)</b>								
A-1-a	NEWSWP-01	SST Waste contamination in pump pit	Release of toxic or radioactive aerosols to atmosphere from SST pump pit due to flammable gas deflagration in pit	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in recirculation mode to produce hydrogen which escapes to the pit with ignition source [Caustic Flush Activity]	F2	S2	B08	07X
<b>Analyzed Accident: Tank Failure Due to Excessive Loads (Rep Acc 12)</b>								
B-1-a	CRN-03	Tank inventory	Release of radioactive and/or toxic materials from tank due to dome collapse	Human error results in excessive weight on dome	F3	S3	C10	12A
B-1-a	CRN-04	Tank inventory	Release of radioactive and/or toxic materials from tank due to dome collapse	Crane or rigging failures drop load resulting in large impact to dome	F3	S3	C10	12B
B-1-a	CRN-11	Tank inventory	Radioactive or toxic material release from tank due to boom failure and tank/equipment damage and dome collapse	Human error: improper load assembly, rigging, crane overloaded	F3	S3	C10	12C

Table 3-4. New Salt Well Pump Design Hazardous Conditions Mapped to Analyzed Representative Accidents. (2 pages)

BIN	Item ID	Material at Risk	Hazardous Condition	Cause	Freq Cat	Cons Cat	Cause Grp	Rep Acc
<b>New Salt well Pump Design Represented Hazardous Conditions (Rep Acc 12)</b>								
B-1-a	NEWSWP-05	SST Waste	Release of waste to atmosphere from SST due to excessive weight causing dome collapse	Coolant line rupture causes flood on top of tank resulting in dome collapse due to excessive load	F0	S3	D10	12X
<b>Analyzed Accident: Waste Transfer Leak into Structure (Rep Acc 33A)</b>								
N/A	STOCHAS-01	Liquid radioactive waste being transferred	Release of radioactive aerosols to the atmosphere or direct radiation exposure from waste transfer structures due to waste leaks into waste transfer structures (includes leaks in OGT leaks)	Corrosion, erosion, gasket or packing failure, jumper leaks, water hammer, high temperature waste, in-pipe flammable gas deflagration, or seismic events	F3	S2	N/A	33A
<b>New Salt well Pump Design Represented Hazardous Conditions (Rep Acc 33A)</b>								
C-2-b	NEWSWP-09	SST Waste	Release of SST waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a waste leak which overflows pit	F3	S2	D24	33A X
<b>Analyzed Accident: Waste Transfer Leak due to Misroute (Rep Acc 33D)</b>								
N/A	STOCHAS-04	Liquid radioactive waste being transferred	Release of radioactive aerosols or direct radiation exposure from waste leaked on soil surface or into atmosphere due to waste leaks caused by misroute	Tank overflows (caused by misroutes, material balance errors, service water or fire water intrusion), backflow into clean systems, misroutes into pits, leaks into 204-AR, or pressurization of isolated portions of transfer systems	F3	S2	N/A	33D
<b>New Salt well Pump Design Represented Hazardous Conditions (Rep Acc 33D)</b>								
C-2-b	NEWSWP-03	SST Waste	Release of radioactive/hazardous material to soil surface from SST due to overflow	Coolant leaks into tank until tank overflows	F1	S2	D06	33D X
C-2-b	NEWSWP-06	SST Waste	Release of waste to soil surface from SWP cooling line due to mistransfer of waste into salt well line	Mistransfer into SWP causes tank waste to backflow through the coolant line, backflow preventer failed	F3	S2	D06	33D X
C-2-b	NEWSWP-07	SST Waste	Release of waste to soil surface from SWP cooling line due to backflow of waste through coolant line	Salt Well Pumping without cooling line backflow preventer and open line outside the supplemental cover	F3	S2	D06	33D X
C-2-b	NEWSWP-10	SST Waste	Release of SST waste to soil surface from cooling water system due to failed backflow preventer (caused by high cooling water temperature)	Failures in cooling water heating system create high temperature water that damages backflow preventer AND backflow conditions exist	F0	S2	D02	33D X

## **4.0 CONTROL ALLOCATION**

### **4.1 METHODOLOGY**

The control decision/allocation team first considered the results of the PHA. Prior to the meeting, the hazardous conditions identified during the PHA meeting were evaluated and then mapped to existing analyzed accidents. From this mapping, a suite of proposed controls was identified. This information was then reviewed for accuracy, with changes incorporated as necessary. The team then reviewed the proposed AB controls. Consensus was reached to determine if controls were adequate to prevent or mitigate the identified potential hazardous conditions or might introduce new hazards.

If existing controls were determined to adequately address the hazardous condition, the applicable controls were selected. If existing controls are not sufficient or inadequate for any reason, the control decision/allocation team proposed new or modified controls.

### **4.2 ALLOCATED CONTROLS**

The results of the control decision/allocation meeting is presented in Table 4-1. The hazardous conditions identified for the new salt well pump are listed in ascending order of the representative accidents. In all but one case, existing controls for the representative accidents were found adequate to prevent or mitigate the hazardous condition. For one hazardous condition related to backflow of waste through the pump motor cooling line, ID # NEWSWP-07, a backflow preventer was determined to be required as a preventive SSC with a related LCO to ensure operability.

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## 5.0 CONCLUSIONS

There were 10 hazardous conditions identified specific to the new salt well pump design. Of these, one was a low consequence hazardous condition related to worker exposure to ionizing radiation and minor contamination events (spills or leaks). This is adequately addressed by the Tank Farms Radiation Protection Program.

Of the remainder, the hazardous conditions are related to four representative accidents. There were two hazardous conditions related to Flammable Gas Deflagrations in an SST, one hazardous condition is related to the Fire in Contaminated Area accident, one hazardous condition is related to the Tank Failure Due to Excessive Loads accident, one hazardous condition is related to the Waste Transfer Leak Into Structure accident, and four hazardous conditions are related to the Waste Transfer Leak Due To Misroute accident. In all cases it was determined that the consequences of these hazardous conditions were bounded by the representative accident.

The controls allocated, for all but one hazardous condition, were existing controls currently allocated to the related representative accident. For the remaining hazardous condition, ID # NEWSWP-07, the control decision/allocation team determined that a backflow preventer was required to prevent a backflow of waste into the pump motor cooling line. The addition of this backflow preventer and a related LCO will require an amendment to the Authorization Basis.

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Table 4-1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions. (4 pages)

Item ID	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks	Cons Cat NC	Rep Acc
NEW SWP-02	SST Waste	Release of toxic or radioactive aerosols to atmosphere from SST tank headspace due to flammable gas deflagration in tank head space	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in recirculation mode to produce hydrogen which escapes to the tank headspace with ignition source [Caustic Flush Activity]	None required	None required	None required	None required	No controls required based on low accident frequency.	A rotor canister breach is required to allow OH to come into contact with Al metal.  It is assumed that the pump design is appropriate for use with tank waste.  Al-OH reaction assumed to pressurize the line sufficiently to cause hydrogen escape.  Pump is not process cooled or lubricated and cooling water will protect rotor from caustic (design feature).  The frequency of this event was determined to be F0 by the control decision board based on the limited amount of gas generated and inability to pressurize recirculation loop during caustic flush.	S3	05X
NEW SWP-04	SST Waste	Release of waste to atmosphere from SST due to flammable gas fire/deflagration in tank	Coolant leak into tank induces a flammable gas release event	None required	None required	None required	None required	No controls required based on low accident frequency.	SSTs are not assumed to experience GRE events.	S3	05X

Table 4-1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions. (4 pages)

Item ID	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks	Cons Cat NC	Rep Acc
NEW SWP-01	SST Waste contamination in pump pit	Release of toxic or radioactive aerosols to atmosphere from SST pump pit due to flammable gas deflagration in pit	Aluminum internal components in damaged pump rotor (SS can around rotor damaged) react with caustic solution during caustic flushing in recirculation mode to produce hydrogen which escapes to the pit with ignition source [Caustic Flush Activity]	None required	AC: Ign Cntris (Flam Gas) AC: Flam Gas Mon Cntris AC: Process Instrument/ Measure/ Test Equip	None required	AC: Emergency Prep (Fire)	Controls based on accident analysis (Fire in Contaminated Area and Waste Transfer Leak due to Misroute).	A rotor canister breach is required to allow OH to come into contact with Al metal.  It is assumed that the pump design is appropriate for use with tank waste.  Al-OH reaction assumed to pressurize the line sufficiently to cause hydrogen escape.  Pump is not process cooled or lubricated (design feature).  The control decision board determined the frequency of the event to be F2 based on need to have a failed pump plus no cooling water plus inability to pressurize line during recirculation.	S2	07X
NEW SWP-05	SST Waste	Release of waste to atmosphere from SST due to excessive weight causing dome collapse	Coolant line rupture causes flood on top of tank resulting in dome collapse due to excessive load	None required	None required	None required	None required	No controls required based on low accident frequency.	None	S3	12X

Table 4-1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions. (4 pages)

Item ID	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks	Cons Cat NC	Rep Acc
NEW SWP-09	SST Waste	Release of SST waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a waste leak which overflows pit	None required	None required	SS: Trans Leak Detect Sys SS: Master Pump Shutdown Sys	LCO: Trans Leak Detect Sys AC: Safety Management Programs AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip AC: Emergency Prep	Controls based on accident analysis (Waste Transfer Leak)	None	S2	33AX
NEW SWP-03	SST Waste	Release of radioactive/hazardous material to soil surface from SST due to overflow	Coolant leaks into tank until tank overflows	None required	None required	None required	AC: Tank Service Water Intrusion Mon Program AC: Process Instrument/Measure/Test Equip AC: Emergency Prep	Controls based on accident analysis (Waste Transfer Leak)	Flow is intended to be limited to 0.3 to 0.8 gpm by metering pump.  Metering pump is capable of a maximum of 84 gallons/hour.	S2	33DX

Table 4-1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions. (4 pages)

Item ID	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks	Cons Cat NC	Rep Acc
NEW SWP-06	SST Waste	Release of waste to soil surface from SWP cooling line due to mistransfer of waste into salt well line	Mistransfer into SWP causes tank waste to backflow through the coolant line, backflow preventer failed	None required	AC: Trans Pump Admin Lock Cntrls	SS: Master Pump Shutdown Sys	AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip AC: Trans Sys Cover Removal Cntrls AC: Safety Management Programs AC: Emergency Prep	Controls based on accident analysis (Waste Transfer Leak)	None	S2	33DX

Table 4-1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions. (4 pages)

Item ID	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks	Cons Cat NC	Rep Acc
NEW SWP-07	SST Waste	Release of waste to soil surface from SWP cooling line due to backflow of waste through coolant line	Salt Well Pumping without cooling line backflow preventer and open line outside the cover block extension	SS: Backflow Preventer	LCO: Backflow Prev Sys	None required	AC: Trans Cntrls AC: Process Instrument/M easure/Test Equip AC: Safety Management Programs AC: Emergency Prep	Controls based on accident analysis (Waste Transfer Leak)	This hazardous condition evaluates a design without a backflow preventer.  The operating pressures across the pump are high enough to cause flow out of the cooling line.  Flow rates are assumed to be proportional to the driving pressure which is the differential pressure across the salt well pump (50 psig).  Throttle bushing will restrict flow rate.  The cooling supply line is SS with heat tracing and supports.  The cooling supply line is hard piped from positive displacement pump to backflow preventer.  Hose will be used from cover block extension to the back end of the pump.	S2	33DX

**Table 4-1. Control Allocation for the New Salt Well Pump Design Hazardous Conditions. (4 pages)**

Item ID	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks	Cons Cat NC	Rep Acc
NEW SWP-10	SST Waste	Release of SST waste to soil surface from cooling water system due to failed backflow preventer (caused by high cooling water temperature)	Failures in cooling water heating system create high temperature water that damages backflow preventer AND backflow conditions exist	None required	None required	None required	None required	No controls required based on low accident frequency.	This is an accident sequence that creates a preexisting condition of a failed backflow preventer.  This event captures concerns for backflow preventer failure causes.  The control decision board determined that the failure frequency of the backflow prevention device was F0 based on failure mode of backflow preventer where a backflow of waste to the supply line occurs (not a credible failure mode).	S2	33DX
<b>Control Allocation For S1-F3 Hazardous Conditions</b>											
NEW SWP-08	SST Waste Contamination in Pit	Release of waste to soil surface from pump pit caused by freezing and rupture of backflow preventer or coolant line	Freezing temperature ruptures backflow preventer or coolant line in pit (with plugged pit drain) causing a coolant leak which overflows pit	None	None	None	AC: Safety Management Programs	Controls based on safety management program	None	S1	

## 6.0 REFERENCES

CHG 2000a, *Tank Waste Remediation System Technical Safety Requirements*, HNF-SD-WM-TSR-006, Rev. 1-L, CH2M HILL Hanford Group, Inc., Richland, Washington.

CHG 2000b, *Hazard Analysis Database Report*, HNF-SD-WM-TI-764, Rev. 2-F, CH2M HILL Hanford Group, Inc., Richland, Washington

CHG 2000c, *Tank Waste Remediation System Final Safety Analysis Report*, HNF-SD-WM-SAR-067, Rev. 1-M, CH2M HILL Hanford Group, Inc., Richland Washington.

AIChE, 1992, *Guidelines for Hazard Evaluation Procedures*, American Institute of Chemical Engineers, New York, New York.

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**APPENDIX A**

**PRELIMINARY HAZARDS ANALYSIS  
TEAM BIOGRAPHICAL INFORMATION**

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**APPENDIX A**

**PRELIMINARY HAZARDS ANALYSIS  
TEAM BIOGRAPHICAL INFORMATION**

James R. Bellomy III – Cognizant Engineer, Maintenance and Reliability Engineering. Mr. Bellomy has 20 years of engineering experience in design, construction, start-up and testing at both commercial and government owned reactor and non-reactor nuclear facilities. He has over 16 years experience at the Hanford Site supporting numerous Hanford construction projects and facility upgrades at N-Reactor and the 200 Area tank farms. He has experience in all aspects of systems design, fabrication, construction, and testing and has been involved in several hazard evaluations and safety assessments. Mr. Bellomy has been an Unreviewed Safety Question (USQ) Evaluator for the past 6 years and has provided support to several tank waste retrieval projects including tank 241-C-106 waste retrieval, tank 241-AZ-101 mixer pump testing, long length equipment removal, and salt well pumping.

William H. Grams – B.S. Mining Engineering, M.S. Mechanical Engineering. Mr. Grams has more than 20 years of experience in the nuclear industry, all of it with the disposal of high and low-level radioactive waste. He has over 15 years of experience at the Hanford Site including authorization basis (AB) assessments of new activities, accident analysis and release calculations, USQ screening and determinations, hazard assessments, and AB revisions. Other nuclear related experience includes low-level waste certification, waste management assessments and audits, preparation of characterization requirements for low-level waste, preparation of design requirements for waste tank retrieval systems, and identification of regulatory requirements.

Clifford E. Hampton – A.A. in Science. Mr. Hampton has more than 23 years of experience in the nuclear industry, most is in the Navy Nuclear field. He has over 20 years experience in the maintenance, testing, and operation of nuclear equipment. He was assigned as the Assistant Naval Reactor Representative (DOE oversight) for overhaul of nuclear submarines. He has 3 years of experience at Hanford working in the maintenance and shift operations areas. He is a certified Shift Manager, a Building Emergency Director and a USQ screener.

Grant W. Ryan, P.E. — B.S. Physics, B.S. Nuclear Engineering, PE Mechanical Engineering. Ten years experience in nuclear facility safety analysis and general engineering support. Author of numerous documents at Hanford to support safe nuclear facility operations. These have included operating and alarm response procedures, safety analysis reports Tank Waste Remediation System Basis for Interim Operations (BIO), and the Final Safety Analysis Report (FSAR), calculation notes, topical reports, and engineering studies.

Milton V. Shultz Jr. – Fluor Federal Services Inc., Safety Analysis and Risk Assessment. B.S. Nuclear Engineering Technology. Scribe for salt well pump Process Hazard Analysis (PHA). More than 26 years experience in a broad range of engineering and technical assignments at the Hanford Site. Experience includes leading PHAs and HAZOPs for a variety of River Protection Project facilities, including several for the FSAR and BIO efforts, contributor to the hazards analysis work for the FSAR. Has performed independent nuclear safety evaluations of reactor plant design and operation at Hanford N Reactor.

Ryan D. Smith – B.S. Mechanical Engineering. Six years of experience at the Hanford Site with the last three years specific to Nuclear Safety and Licensing (NS&L) support. NS&L Engineer for the Interim Stabilization, Characterization, and Vadose Zone programs. Extensive knowledge in flammable gas related issues related to pumping waste to and from tank farm facilities. Key team member in establishing the AB for Interim Stabilization and reconciliation of the Los Alamos National Laboratory Safety Assessment with the BIO. Assisted in the transition of the BIO to the FSAR as well as ongoing AB maintenance and clarification support.

Michael A. White – B.S. in Mechanical Engineering. Mr. White has over 8 years of experience in the nuclear industry, all with the storage, treatment, handling, and transfer of radioactive liquid waste at the Hanford Site. His responsibilities have been focused in support of facility operations, including facility modification/upgrades, testing, and startup. Mr. White assisted in the development of the 242-A Evaporator/Liquid Effluent Retention Facility Safety Analysis Report, Safety Equipment List, and Part B Permit application, and has experience as a core USQ Evaluator.

William F. Zuroff – B.S. Degree, University of Idaho, Mr. Zuroff has more than 30 years of experience in the nuclear industry including nuclear operations, instrument maintenance, and plant engineering. He has over 15 years experience at the Hanford Site including equipment design, testing, operations, and USQ evaluations. Other nuclear related experience includes preparation of design requirements, and procurement specifications for nuclear monitoring systems.

**APPENDIX B**

**CONTROL ALLOCATION TEAM  
BIOGRAPHICAL INFORMATION**

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**APPENDIX B**

**CONTROL ALLOCATION TEAM  
BIOGRAPHICAL INFORMATION**

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Gregory L. Jones – Mr. Jones has over 23 years of experience in activities related to the safety of nuclear facilities. He has experience in nuclear plant licensing/safety evaluations (Probabilistic Risk Assessment (PRA) and deterministic), nuclear fuels reprocessing facility safety assessment, and plant/facility design and operational review. Areas of specialization in safety and licensing include: Safety Analysis Report (SAR) and Technical Specification/Operational Safety Requirements preparation for both nuclear power plants and fuels reprocessing facilities; USQ screenings and determinations; release and transport of radioactivity during normal, abnormal and accident conditions; evaluation of containment/confinement system capabilities for nonreactor risk assessment; dose consequence evaluations; natural forces design and accident evaluations; accident analysis, fault tree modeling, uncertainty/sensitivity analysis using CAFTA; and application of human reliability analysis. Other areas of specialization include project planning, program management engineering, peer review of PRA and deterministic analysis; and applied above specialties to over 20 Boiler Water Reactor and Pressurized Water Reactor FSAR updates.

Lawrence J. Kripps – B.S. and M.S. Nuclear Engineering. Over twenty-six years experience managing and performing safety analyses and environmental assessments of U.S. Department of Energy and commercial nuclear and non-nuclear facilities. Provided technical direction and support in the development of the hazard and accident analyses and controls for the and FSAR and the associated Technical Safety Requirements.

David J. Saueressig – B.S. in Mechanical Engineering. Mr. Saueressig has more than 13 years of experience in the nuclear industry, all of it with the storage, handling, and transfer of radioactive liquid waste. He has 13 years of experience at the Hanford Site including assignments in Process Engineering and Shift Operations Management. He is a certified Shift Manager within RPP, is a Building Emergency Director, and USQ screener. He has spent six years on shift as a supervisor/manager supporting operations, including salt well pumping.

Ryan D. Smith – B.S. Mechanical Engineering. Six years of experience at the Hanford Site with the last three years specific to Nuclear Safety and Licensing (NS&L) support. NS&L Engineer for the Interim Stabilization, Characterization, and Vadose Zone programs. Extensive knowledge in flammable gas related issues related to pumping waste to and from tank farm facilities. Key team member in establishing the Authorization Basis (AB) for Interim Stabilization and reconciliation of the Los Alamos National Laboratory Safety Assessment with the BIO. Assisted in the transition of the BIO to the FSAR as well as ongoing AB maintenance and clarification support.

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**CONTROL DECISION MEETING ATTENDANCE SHEET**

<b>Control Decision Meeting Attendance</b>			
<b>Name</b>	<b>Knowledge Area(s) Represented (see below)</b>	<b>Organization</b>	<b>Telephone Number</b>
William H. Grams	1, 2, 3, 8, 15, 16, 17	NSFL	373-7308
<del>Gregory Smith</del>	1, 2, 3, 9, 15, 16, 17	NSFL	373-3255
LAWRENCE J. KRIPPS	15, 16	NSFL	376-1061
William F. Zuroff	3, 10, 15	NSFL	373-1003
Bellomy, James R	3, 4, 5, 14, 20	MERE	372-1473
Saueressig, David J	4, 5	1/S OPS	373-0183
Smith, Ryan D	1	NSFL	372-1883
Mike White	3, 4, 11, 14, 15, 20	ESE	3-5453

**Knowledge Areas:**

- |                       |                          |   |
|-----------------------|--------------------------|---|
| 1 Licensing Engineer  | 8 Safety Analyst         | 15 Safety Structures, Systems, & Components |
| 2 Hazard Analysis     | 9 Accident Analysis      | 16 Technical Safety Requirements            |
| 3 Engineering         | 10 Design Authority      | 17 Nuclear Safety & Licensing               |
| 4 Operations          | 11 Design Agent          | 18 Safety & Emergency Preparedness          |
| 5 Project Management  | 12 Radiological Control  | 19 Regulatory Compliance Support            |
| 6 Quality Assurance   | 13 Environmental Support | 20 Maintenance & Reliability Engineering    |
| 7 Process Engineering | 14 Equipment Engineering | 21 Other - Specify                          |

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**APPENDIX C**

**PRELIMINARY HAZARDS ANALYSIS AND  
CONTROL ALLOCATION PEER REVIEW**

APPENDIX C

PRELIMINARY HAZARDS ANALYSIS AND CONTROL ALLOCATION PEER REVIEW

Practice 134 290 1112  
 Publication Date 22Nov99  
 Attachment 02 - Sheet 1 of 1

FLUOR DANIEL NORTHWEST

TECHNICAL PEER REVIEWS

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: *RPP-6954, DRAFT 2*  
 Title: *HAZARD EVALUATION FOR A SALT WELL CENTRIFUGAL PUMP DESIGN USING SERVICE WATER FOR LUBRICATION AND COOLING*  
 Author: *WILLIAM H. GRAMS*  
 Date: *DRAFT 2 SENT BY EMAIL ON 10/4/00*  
 Scope of Review: *MAIN BODY OF REPORT RELATED TO PRELIMINARY HAZARDS ANALYSIS BUT NOT RELATED TO CONTROL ALLOCATION*

Yes	No*	NA	
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	** Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Problem completely defined.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Accident scenarios developed in a clear and logical manner.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Necessary assumptions explicitly stated and supported.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Computer codes and data files documented.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Data used in calculations explicitly stated in document.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Data checked for consistency with original source information as applicable.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Mathematical derivations checked including dimensional consistency of results.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Models appropriate and used within range of validity, or use outside range of established validity justified.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Software input correct and consistent with document reviewed.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Software output consistent with input and with results reported in document reviewed.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Limits/criteria/guidelines applied to analysis results are appropriate and referenced.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Limits/criteria/guidelines checked against references.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Safety margins consistent with good engineering practices.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Conclusions consistent with analytical results and applicable limits.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Results and conclusions address all points required in the problem statement.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Format consistent with applicable guides or other standards.
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	** Review calculations, comments, and/or notes are attached.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Document approved (for example, the reviewer affirms the technical accuracy of the document).

*THOMAS B. POWERS Thomas B. Powers*  
 Reviewer (printed name and signature)

*10/4/2000*  
 Date

\* All "no" responses must be explained below or on an additional sheet.

\*\* Any calculations, comments, or notes generated as part of this review should be signed, dated, and attached to this checklist. The material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.